Level 2
Whole Site Design

Prepared for:	John and Jane Doe
Site:	Doe Family Ranch
	7405 Mission Road
	Paso Robles, CA 93446
Site Visit Date(s):	July 23rd, 2019

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Context and Design Maps

7th Generation Design was invited by the Doe family to visit and conduct an assessment of their 12.57 acre ranch located in Paso Robles, CA. The Doe Family Ranch (DFR) currently has approximately 5,860 sq-ft of structures (roof area; including a main house, shop, and shed) and 14,700 sq-ft of gravel access roads. The predominant land features include:

- Approximately 5 acres of the toe of a southeast facing ridge with annual grasses and forbs and a handful of trees (proposed future home site),
- Two interconnecting valleys at the lowest point on the property linking at total of 136 acres of upstream watershed,
- Approximately 2.5 acres of steep northeast facing hillside, atop which the shop is located.

The property currently serves as a base for the Doe family and their woodworking business, John Doe Design. Their business includes not only the creation of custom furniture but also the milling of raw lumber and 8-12 workshops per year in furniture design and construction, with up to 8 attendees at each workshop. Workshop attendees currently find their own accommodations off-site.

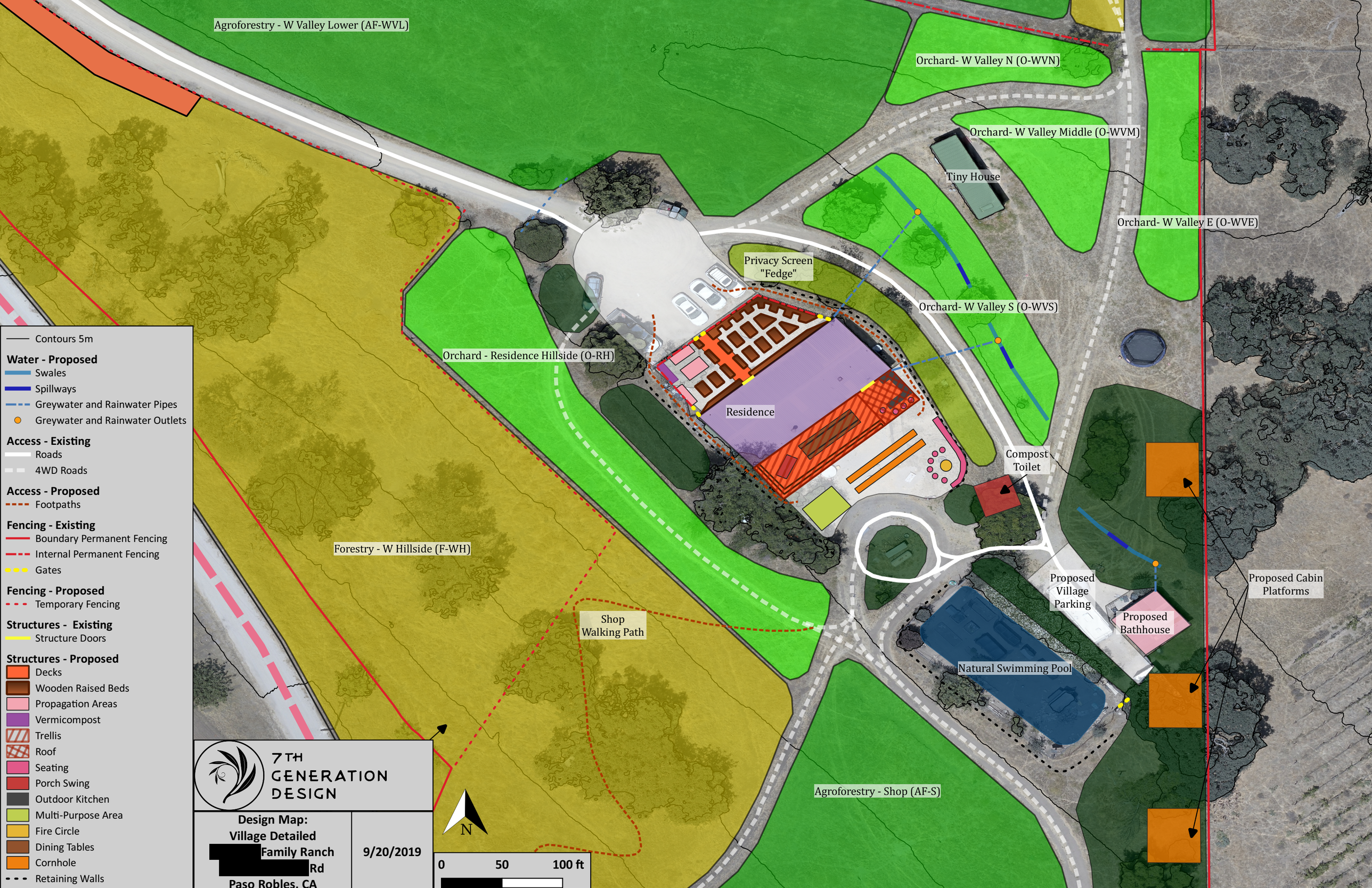
The Doe family has communicated their desire to create a living and working homestead that supports their family, community, and business in thriving. Key aspects of this vision include developing a sanctuary for residents, guests, and workshop attendees that is nourishing to the mind, body, and spirit and segregated from the business activities on the property; increasing the functionality of the woodshop and milling area, and making it more inconspicuous to the neighbors; providing overnight accommodations for workshop attendees; growing a natural capital resource base to support themselves and others; and providing learning opportunities for themselves and their children in how to steward the landscape in a healthy way. They aim to find a balance in the design and development of the project so that it is a beautiful learning experience that brings the family closer together, rather than a burden.

This report is largely organized according to the Keyline Scale of Permanence, presented in order from things we are least able to change down to those things that we as humans have greater agency with.

Climate > Geography > Water> Access > Structures > Forestry > Boundaries > Economy > Energy Systems > People & Relationships

Each chapter begins with a contextual overview of the topic at hand, after which relevant sub-topics are written up and diagrammed in detail appropriate to the current and near-future phases of the project. Each sub-topic includes a description of the existing conditions that need to be understood and worked with along with the design elements recommended to help bring the larger vision to life.


Forestry - E Valley (F-EV)
Trailer Pad
Agroforestry - N Ridge (AF-NR)
Agroforestry - E Valley (AF-EV)
Forestry - N Ridge (F-NR)
Agroforestry - W Valley Upper (AF-WVU)
Agroforestry - W Valley Lower (AF-WVL)
Forestry - W Hillside (F-WH)
Tiny House
Residence
Bathhouse
Pool
Forestry - Shop Entrance (F-SE)
Shop
Agroforestry - Shop (AF-S)
Milling Pit
Shop Parking
Native Privacy Screen
Property Lines
Contours 5m
Water - Existing
Water Tanks
Culverts
Water - Proposed
Zuni Bowl
Weirs
Swales
Infiltration Basins
Spillways
Greywater and Rainwater Pipes
Greywater and Rainwater Outlets
Pool
Access - Existing
Roads
4WD Roads
Access - Proposed
Road Additions/Modifications
Footpaths
Driveway Modifications
Grading
Fencing - Existing
Boundary Permanent Fencing
Internal Permanent Fencing
Gates
Fencing - Proposed
Temporary Fencing
Structures - Existing
Existing Residences
Existing Outbuildings
Portable Structures - Existing
Structure Doors
Structures - Proposed
Cabin Platforms
Compost Toilets
Retaining Walls
Forestry
Erosion Control Plantings
Privacy Screens
Shade Plantings
Orchard Blocks
Agroforestry Blocks
Forestry Blocks
7TH GENERATION DESIGN
Design Map:
[redacted] Family Ranch
[redacted] Rd
Paso Robles, CA
9/20/2019
0
50
100 ft
N


Agroforestry - W Valley Lower (AF-WVL)
Orchard- W Valley N (O-WVN)
Orchard- W Valley Middle (O-WVM)
Tiny House
Orchard- W Valley E (O-WVE)
Privacy Screen "Fedge"
Orchard- W Valley S (O-WVS)
Orchard - Residence Hillside (O-RH)
Residence
Compost Toilet
Forestry - W Hillside (F-WH)
Shop Walking Path
Proposed Village Parking
Proposed Bathhouse
Proposed Cabin Platforms
Natural Swimming Pool
Agroforestry - Shop (AF-S)
Contours 5m
Water - Proposed
Swales
Spillways
Greywater and Rainwater Pipes
Greywater and Rainwater Outlets
Access - Existing
Roads
4WD Roads
Access - Proposed
Footpaths
Fencing - Existing
Boundary Permanent Fencing
Internal Permanent Fencing
Gates
Fencing - Proposed
Temporary Fencing
Structures - Existing
Structure Doors
Structures - Proposed
Decks
Wooden Raised Beds
Propagation Areas
Vermicompost
Trellis
Roof
Seating
Porch Swing
Outdoor Kitchen
Multi-Purpose Area
Fire Circle
Dining Tables
Cornhole
Retaining Walls
7TH GENERATION DESIGN
Design Map:
Village Detailed
[redacted] Family Ranch
[redacted] Rd
Paso Robles, CA
9/20/2019
N
0
50
100 ft

1 - Site Work Up

General Site Information

Client(s): John and Jane Doe - Doe Family Ranch

Address: 7405 Mission Road, Paso Robles, CA 93446

Parcel Number: 027-14-41 (parcel #14 on aggregate map)

Area: 12.57 acres

Latitude: 35°18'41.01"N

Longitude: 120°10'43.22"W

Altitude: 889'

Proximity to Ocean: ~ 24 miles as the crow flies

Figure 1-1
Satellite image of Doe Family Ranch

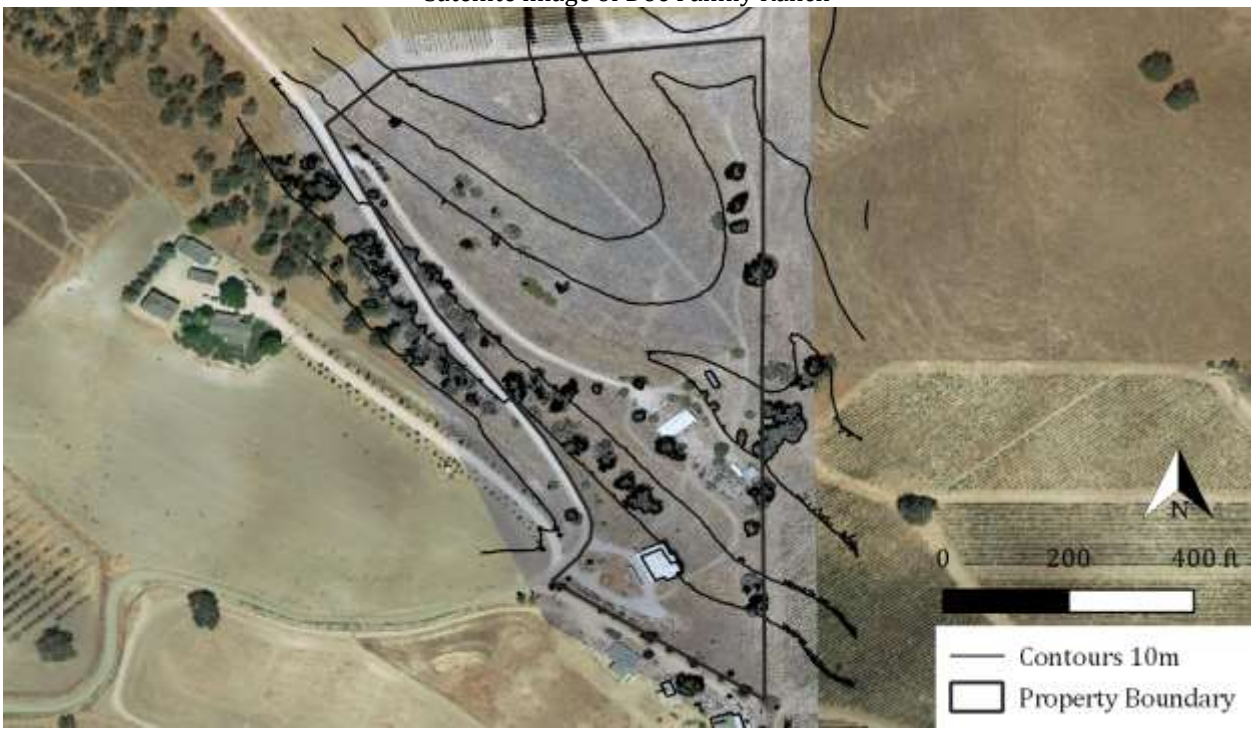
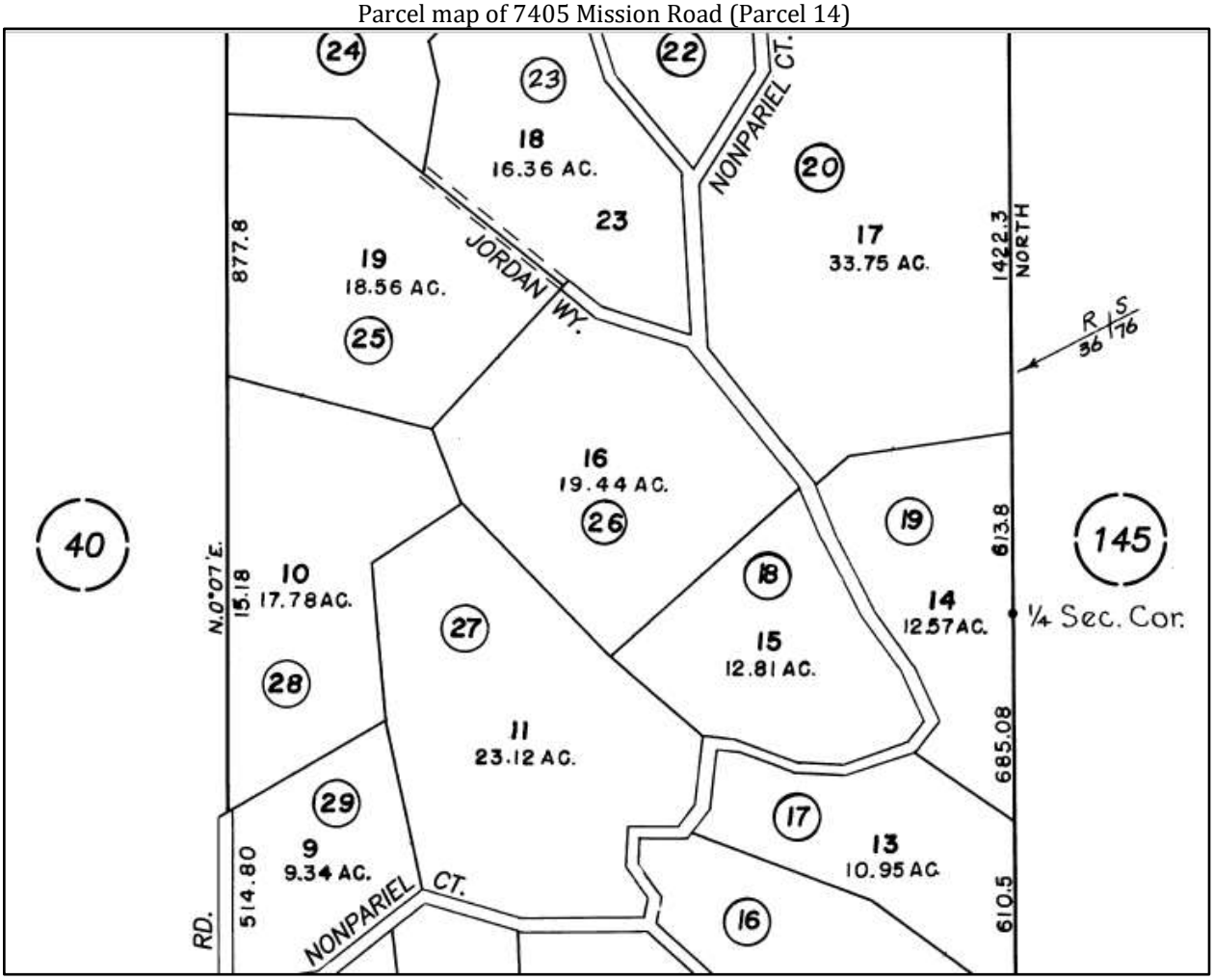


Figure 1-2
Parcel map of 7405 Mission Road (Parcel 14)



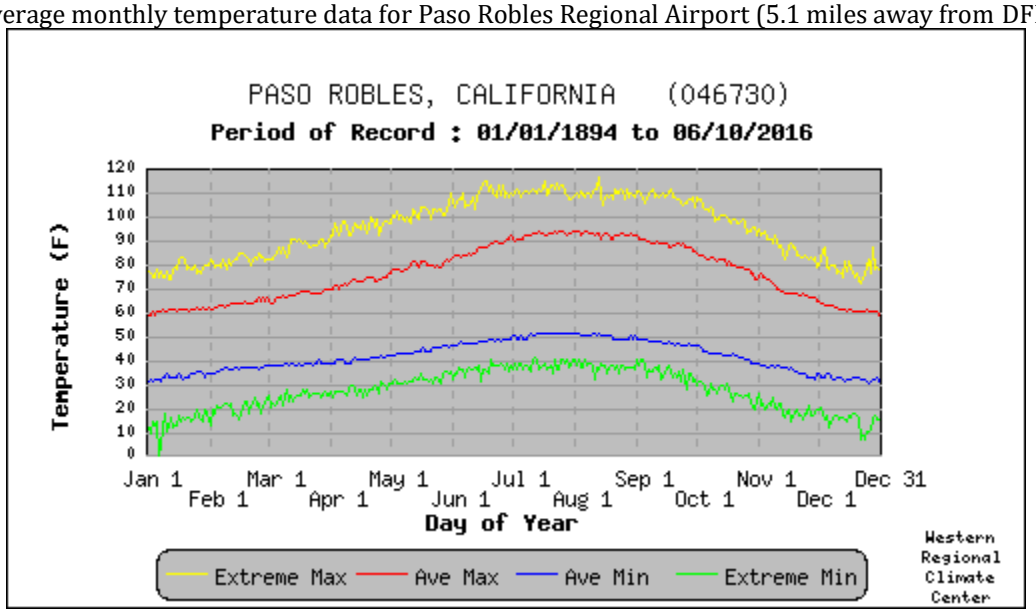
Climate

Temperature Data

The closest weather station to DFR with real-time weather data is KCAPASOR85, located at Vista Serrano Vineyard 2.5 miles away.

The closest weather station with historical data is at the Paso Robles Regional Airport, 5.1 miles away from DFR [Link 1, Link 2]. Annual temperature data for typical meteorological year at the Paso Robles Regional Airport is shown in Figure 1-3. The coldest months of the year are December through February; the hottest months are July through August. The average daily low temperature is 34°F (record low is 0°F, 1913); the average daily high temperature is 90°F (record high is 115°F).

Figure 1-3
Average monthly temperature data for Paso Robles Regional Airport (5.1 miles away from DFR)



The range between the high and low temperatures in Paso Robles is large, especially compared to San Luis Obispo and even more-so the coastal towns in the county. This is due to the 2,000 foot tall Santa Lucia mountain range that separates Paso Robles from the coast. The range serves as a tremendous climactic barrier-it blocks all significant influence of the maritime air, allowing Paso and other nearby towns to achieve the highest daytime highs and the lowest nighttime lows in the region.

Chilling Hours

Deciduous fruit trees, which lose their leaves in the fall and are dormant throughout the winter, need to accumulate a minimum number of hours below 45°F during their dormancy in order to set fruit the following year. Knowing the approximate amount of chilling hours an area experiences throughout the cold season enables better selection of fruit trees that are likely to do well in that area.

In what is called the *Below 45 Model*, chilling hours are the total number of hours below 45°F accumulated each year while the tree is dormant. Paso Robles Regional Airport (5.1 miles away from DFR) sees an average of **1,534 hours** below 45°F. A full chart of hourly temperature distribution for a typical meteorological year at Paso Robles Regional Airport is provided in Appendix A.

While the Paso Robles Regional Airport is located in a similar area geographically and topographically as DFR, the chill hours at DFR may nonetheless vary. Chilling hours can vary significantly even across the same piece of land; low spots, frost pockets, slopes and wind tunnels or wind buffered areas will all experience different chill hours. The best way to know for a specific site, especially before undertaking any capital-intensive agroforestry project, is to install temperature data loggers on-site and record hourly data during a winter season. However, on cold days and nights valuable information can be gained simply by walking up and down slopes with

some bare skin exposed so that you can sense where a thermocline - a thin but distinct layer in the atmosphere in which temperature changes more rapidly with depth than it does in the layers above or below - might persist. Often, the difference in 10 feet of vertical elevation will make the difference between a citrus tree thriving or dying. Knowing these invisible lines in the landscape will inform better decisions about which types of plants will do best where.

When it comes to fruit tree selection, making selections for staple tree crops with a chilling hours buffer is suggested. For this site, trees that require 1,200 chilling hours or less are recommended. While it can be fun to push the boundaries for select plantings, for your staple tree crops staying within this range will create the greatest chance for successful harvests year after year.

Precipitation Data

Annual Precipitation Total

The average and mean amounts of annual rainfall recorded at Paso Robles Regional Airport (5.1 miles away from DFR) from 1894-2016 are 15.21 inches and 14.77 inches, respectively [Link 1, Link 2]. The record high annual total during that period was 29.19 inches in 1941; the record low total was 2.78 inches in 2013.

Annual Distribution of Precipitation

There are an average of 42 rainy days (>.1 inch) per year. Typically 80 - 90% of total annual rainfall falls between December and March, making this a brittle climate (see "Climate Brittleness", below). The longest period at Paso Robles Regional Airport without precipitation on record was 202 days (2/28/1997 - 9/18/1997). Periods without effective rainfall (moderate intensity rainfall that falls in sufficient amount that it can actually infiltrate and is not immediately lost to evaporation) can be much longer, on the the order of 240-270 days.

Rainfall Intensity and Recurrence Interval

Paso Robles Regional Airport has experienced 4-5"+ of rainfall in a 24 hour period numerous times during the recorded period from 1894-2016.

Table 1-1 lists rainfall intensity and the recurrence interval for the Paso Robles area. This information is helpful in determining capacity for installed earthworks, drains, basins and other structures or design elements that will need to be able to move, absorb or withstand these expected volumes and intensities if they are to last across generations.

Earthworks design is typically informed by the 1,000-year recurrence interval event - a rainfall event of certain intensity that has a 0.1% probability of occurring on any given year. This information is used to size spillways, drains, catchment basins and overflows to ensure that the system can endure such an event without damage.

In this case, the table below shows the median 1,000-year recurrence interval event to be 5.95 inches of rain in a 12-hour period and 7.96 inches of rain in a 24-hour period.

Table 1-1
Rainfall intensity and recurrence interval at Doe Family Ranch

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.110 (0.095-0.129)	0.140 (0.120-0.165)	0.181 (0.155-0.213)	0.216 (0.183-0.257)	0.265 (0.215-0.329)	0.304 (0.241-0.388)	0.346 (0.265-0.455)	0.390 (0.289-0.531)	0.451 (0.318-0.647)	0.501 (0.339-0.749)
10-min	0.158 (0.136-0.185)	0.201 (0.172-0.236)	0.259 (0.222-0.306)	0.309 (0.262-0.368)	0.380 (0.308-0.472)	0.436 (0.345-0.556)	0.495 (0.380-0.652)	0.558 (0.414-0.760)	0.647 (0.456-0.927)	0.718 (0.486-1.07)
15-min	0.191 (0.164-0.224)	0.243 (0.208-0.285)	0.314 (0.269-0.370)	0.374 (0.317-0.446)	0.459 (0.373-0.571)	0.527 (0.417-0.673)	0.599 (0.460-0.788)	0.675 (0.501-0.920)	0.783 (0.552-1.12)	0.868 (0.587-1.30)
30-min	0.260 (0.224-0.305)	0.330 (0.284-0.388)	0.427 (0.366-0.504)	0.509 (0.431-0.606)	0.625 (0.508-0.777)	0.718 (0.568-0.916)	0.815 (0.626-1.07)	0.919 (0.682-1.25)	1.07 (0.751-1.53)	1.18 (0.799-1.77)
60-min	0.367 (0.316-0.431)	0.467 (0.401-0.549)	0.603 (0.516-0.712)	0.719 (0.609-0.857)	0.883 (0.717-1.10)	1.01 (0.802-1.29)	1.15 (0.885-1.52)	1.30 (0.963-1.77)	1.51 (1.06-2.16)	1.67 (1.13-2.50)
2-hr	0.562 (0.483-0.659)	0.710 (0.610-0.835)	0.914 (0.783-1.08)	1.09 (0.921-1.30)	1.33 (1.08-1.66)	1.53 (1.21-1.95)	1.73 (1.33-2.28)	1.95 (1.45-2.66)	2.26 (1.59-3.24)	2.51 (1.70-3.75)
3-hr	0.706 (0.608-0.829)	0.893 (0.767-1.05)	1.15 (0.982-1.35)	1.36 (1.16-1.63)	1.67 (1.36-2.08)	1.92 (1.52-2.44)	2.17 (1.67-2.86)	2.45 (1.82-3.33)	2.83 (2.00-4.06)	3.14 (2.12-4.69)
6-hr	1.01 (0.866-1.18)	1.28 (1.10-1.50)	1.65 (1.41-1.94)	1.96 (1.66-2.33)	2.39 (1.95-2.98)	2.74 (2.17-3.50)	3.11 (2.39-4.09)	3.50 (2.59-4.76)	4.04 (2.85-5.79)	4.48 (3.03-6.69)
12-hr	1.31 (1.13-1.53)	1.68 (1.45-1.98)	2.19 (1.88-2.59)	2.62 (2.22-3.12)	3.21 (2.61-3.99)	3.68 (2.91-4.69)	4.16 (3.20-5.48)	4.68 (3.47-6.37)	5.39 (3.80-7.72)	5.95 (4.02-8.89)
24-hr	1.70 (1.54-1.91)	2.22 (2.01-2.50)	2.92 (2.64-3.31)	3.50 (3.14-4.00)	4.31 (3.73-5.08)	4.94 (4.19-5.95)	5.60 (4.62-6.91)	6.28 (5.04-7.97)	7.22 (5.56-9.56)	7.96 (5.92-10.9)
2-day	2.07 (1.88-2.33)	2.73 (2.47-3.08)	3.62 (3.27-4.10)	4.37 (3.91-4.98)	5.41 (4.68-6.38)	6.24 (5.29-7.52)	7.10 (5.87-8.77)	8.01 (6.44-10.2)	9.28 (7.15-12.3)	10.3 (7.65-14.1)
3-day	2.29 (2.07-2.58)	3.04 (2.75-3.43)	4.09 (3.69-4.62)	4.97 (4.45-5.67)	6.22 (5.38-7.34)	7.23 (6.12-8.71)	8.29 (6.85-10.2)	9.43 (7.57-12.0)	11.0 (8.50-14.6)	12.3 (9.17-16.9)
4-day	2.47 (2.24-2.78)	3.30 (2.99-3.72)	4.45 (4.02-5.04)	5.44 (4.87-6.20)	6.85 (5.93-8.08)	7.99 (6.77-9.63)	9.21 (7.61-11.4)	10.5 (8.44-13.4)	12.4 (9.53-16.4)	13.9 (10.3-19.1)
7-day	2.91 (2.63-3.28)	3.88 (3.51-4.37)	5.23 (4.72-5.92)	6.39 (5.72-7.29)	8.05 (6.97-9.50)	9.40 (7.96-11.3)	10.8 (8.95-13.4)	12.4 (9.94-15.7)	14.6 (11.2-19.3)	16.4 (12.2-22.4)
10-day	3.25 (2.95-3.66)	4.34 (3.93-4.89)	5.85 (5.28-6.62)	7.15 (6.40-8.15)	9.01 (7.80-10.6)	10.5 (8.91-12.7)	12.1 (10.0-15.0)	13.9 (11.1-17.6)	16.3 (12.6-21.6)	18.4 (13.7-25.2)
20-day	3.94 (3.57-4.44)	5.27 (4.77-5.95)	7.14 (6.44-8.07)	8.73 (7.82-9.96)	11.0 (9.55-13.0)	12.9 (10.9-15.6)	14.9 (12.3-18.4)	17.0 (13.7-21.7)	20.1 (15.5-26.6)	22.6 (16.8-31.0)
30-day	4.62 (4.19-5.21)	6.20 (5.61-6.99)	8.40 (7.58-9.50)	10.3 (9.22-11.7)	13.0 (11.3-15.4)	15.3 (12.9-18.4)	17.6 (14.5-21.7)	20.1 (16.2-25.6)	23.7 (18.3-31.4)	26.7 (19.8-36.6)
45-day	5.44 (4.93-6.13)	7.32 (6.62-8.25)	9.93 (8.96-11.2)	12.2 (10.9-13.9)	15.4 (13.3-18.2)	18.0 (15.2-21.7)	20.8 (17.2-25.6)	23.7 (19.0-30.1)	27.9 (21.5-36.9)	31.3 (23.2-42.9)
60-day	6.35 (5.75-7.15)	8.55 (7.74-9.64)	11.6 (10.5-13.1)	14.2 (12.7-16.2)	17.9 (15.5-21.1)	20.8 (17.7-25.1)	24.0 (19.8-29.6)	27.3 (21.9-34.6)	31.9 (24.6-42.3)	35.6 (26.5-48.9)

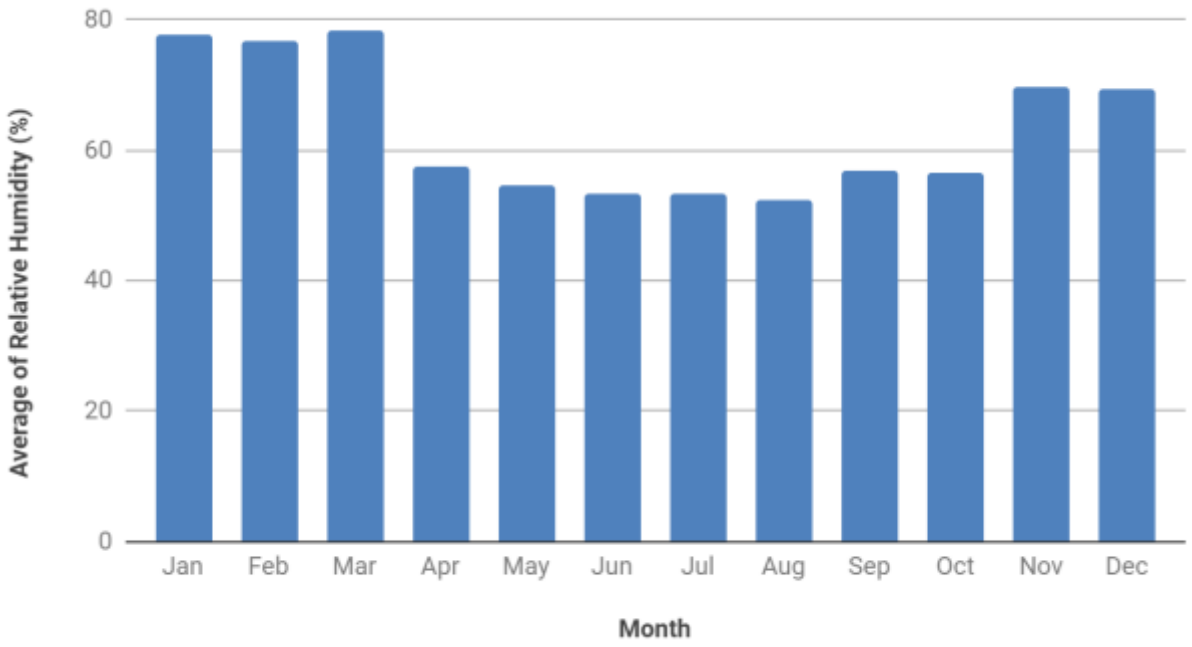
**PDS: precipitation data server; PF: precipitation frequency*

Humidity

Humidity is highest during the winter rainy season from November through March, with monthly averages ranging from 70-80%. Monthly average humidity levels during the spring and summer months ranges between 50-60%.

The average monthly relative humidity over the course of a typical meteorological year at Paso Robles Regional Airport (5.1 miles away) is shown in Figure 1-4; the hourly distribution of relative humidity in 5% ranges is provided in Appendix A, Figure A-3.

Figure 1-4
Relative humidity for a typical meteorological year at Paso Robles Regional Airport (5.1 miles away from DFR)



Fog

Offshore wind events during the fall and winter bring moist inland air towards the coast, where it gets trapped by the Santa Lucia mountain range. This moist air condenses over the cold inland land areas, causing fog in the Paso Robles area. This pattern is the inverse of the coastal pattern, where fog typically develops during onshore wind events in the spring and summer.

Climate Brittleness

Brittleness gauges climate vulnerability to desertification. The brittleness scale is subjective and has no formula for calculation, but can be thought of as a continuum, ranging from a 1 - very humid with moisture distributed throughout the year (tropical rainforest) to a 10 - very arid with long dry periods (desert). Brittleness classifications are used to inform management decisions for a given property or bioregion.

Where any given climate falls on the brittleness scale is determined not so much by total rainfall, but rather by the distribution of precipitation and humidity throughout the year. This pattern determines the degree of brittleness. Very brittle environments typically have a long period of non-growth (often due to long periods without precipitation and low humidity) and can be very arid. Brittle environments also tend to accumulate more dead plant material as biological breakdown of carbon-based plant tissues by insects, microbes and fungi all but cease during the long dry season. This can have a negative effect on the health and resilience of the vegetation due to increased risk of catastrophic fire (due to built up fuel levels) and decreased light penetration to young growing tips (blocked by dead, standing vegetation).

The climate at DFR is quite brittle. Long summer dry seasons and fairly short winter wet seasons predominate. There is minimal marine influence on the property (ocean 24 miles distant as the crow flies, and blocked by the Santa Lucia mountain range). Design and development of the property should utilize every possible chance to infiltrate water and retain it as long as possible on site. Dramatically increasing the number of trees on property will have the greatest effect in moderating climate extremes and creating soil that can retain more moisture for longer. Use of ruminant grazing animals should be carefully planned and attentively managed to ensure they are benefiting the larger processes of soil creation and establishment of perennial cover across the property.

Solar Data

Solar aspect describes the way that the sun moves across the sky at a location during the various seasons. Having an understanding of the sun's seasonal path is critical for properly siting various elements in the property design, designing housing and other structures for passive heating/cooling, and situating solar panels.

Table 1-2 presents the solar aspect information for each season at DFR. Detailed solar aspect charts and info are available through suncalc.org, sunearthtools.com.

Table 1-2
Solar aspect information for Doe Family Ranch

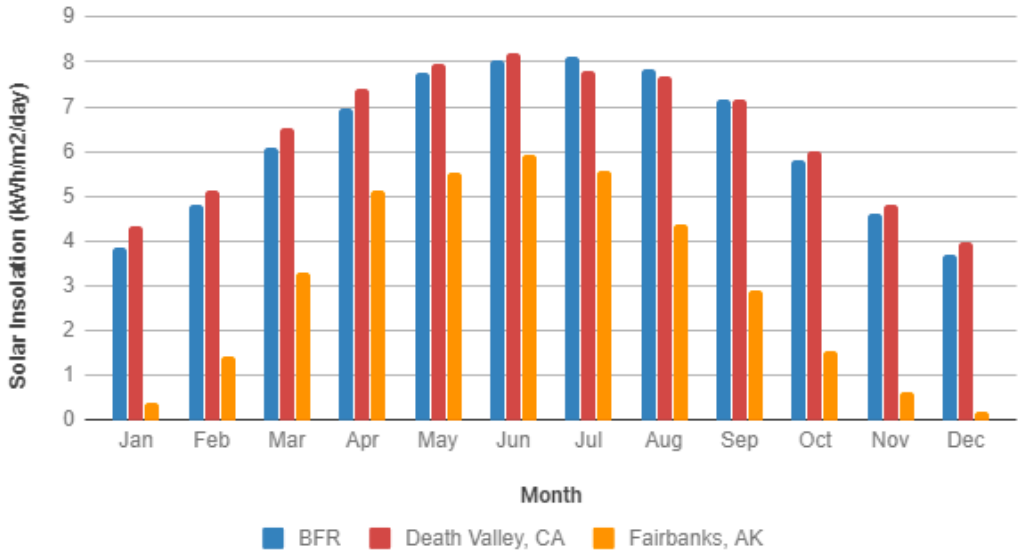
Season Change	Sun Angle*	Shadow Length**	Sunrise Location***	Sunset Location***
Winter Solstice	30.88°	1.67	118.52°	241.33°
Spring Equinox	54.27°	.72	89.46°	270.60°
Summer Solstice	79.73°	.22	59.93°	300°
Fall Equinox	54.10°	.72	89.44°	270.17°

** Sun angles measured when highest in sky (peak solar activity) a.k.a. azimuth.*
*** Shadow length expressed as multiple of object height, taken at peak solar activity*
**** Exact locations of sunrise/sunset on the horizon from SET's Sunrise-Sunset Calendar - visit mooncalc.org to get similar data for lunar cycles.*

The longest day length is 14h35m29s on the Summer Solstice, and the shortest day length is 9h45m1s on the Winter Solstice.

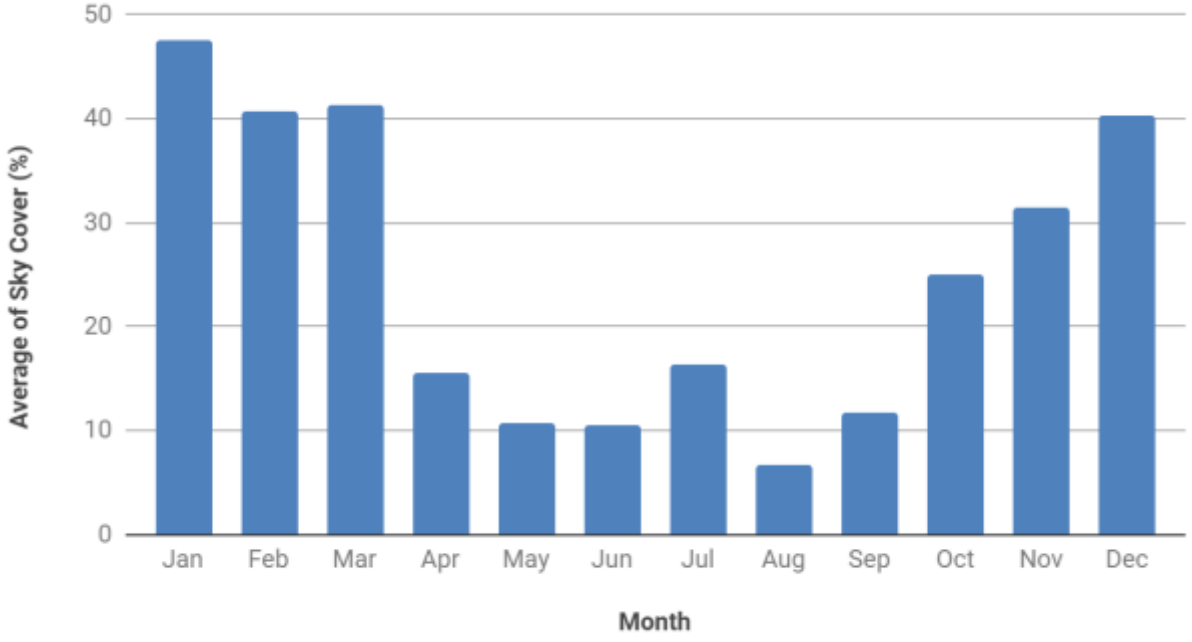
There are an average of 286 days of sun per year in Paso Robles. The average annual solar insolation (used to measure energy production of solar PV systems, in kWh/m2/day) is 6.2 kWh/m^2/day, compared to that of Death Valley, CA at 6.4 kWh/m2/day, and Fairbanks, AK at 3.1 kWh/m2/day- considered to be among the sunniest and least sunny places in the US, respectively. The monthly average solar insolation at DFR is presented in Figure 1-5, and also compared with Death Valley, CA and Fairbanks, AK. It is clear from the data that DFR is ideally suited for solar PV electricity generation.

Figure 1-5
Monthly average of solar insolation (kWh/m2/day) measured at a station 1.5 miles away from DFR



The monthly average percent of sky cover is shown in Figure 1-6. A chart of the hourly distribution of cloud cover for a typical meteorological year at Paso Robles Regional Airport (5.1 miles away) is provided in Appendix A, Figure A-2.

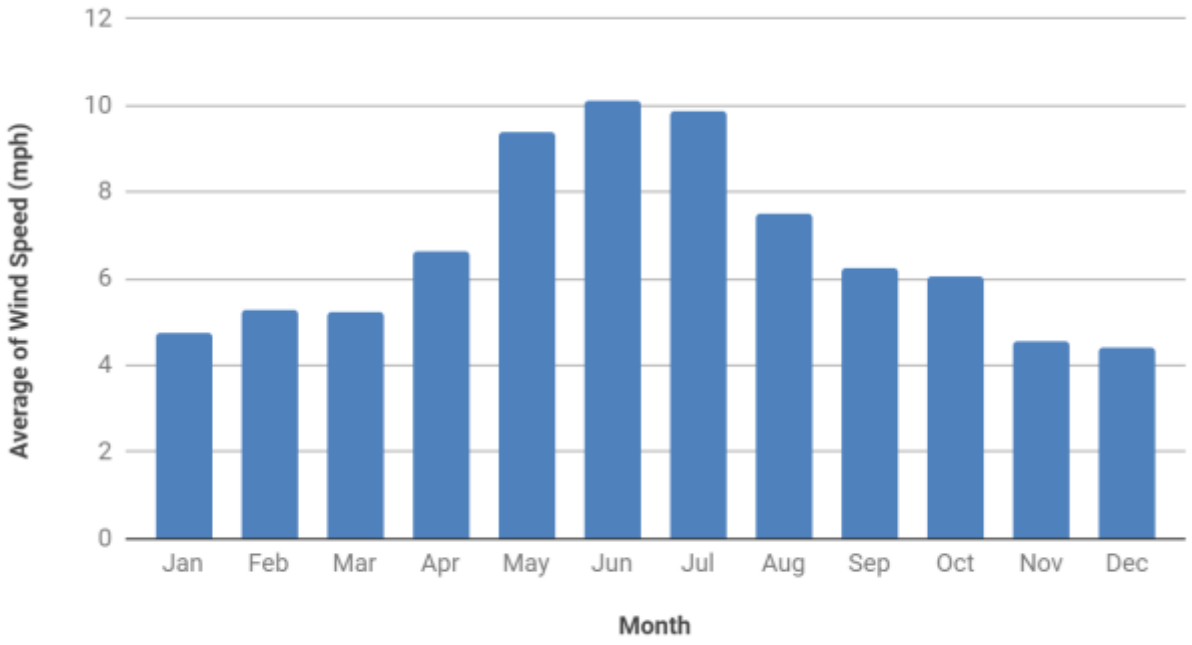
Figure 1-6
Monthly average of cloud cover at DFR, plotted over a typical meteorological year at Paso Robles Regional Airport (5.1 miles away)



Wind Data

The monthly average wind speed over the course of a typical meteorological year at Paso Robles Regional Airport is shown in Figure 1-7. Average wind speeds are highest during the late spring and summer months, the highest being 10.1 mph during the month of June. The lowest monthly average wind speed of 4.4 mph occurs during December.

Figure 1-7
Monthly average wind speed and wind direction, plotted over a typical meteorological year at Paso Robles Regional Airport (5.1 miles away)



The prevailing wind blows onshore from Northwest to Southeast, over the Santa Lucia range. These prevailing winds are most present during the spring and summer months. Fall days see frequent warmer offshore wind events from Northeast to Southwest. Winter sees a mix of onshore and offshore winds during clear days and winds from South to North during the passage of storms.

The hourly distributions for wind direction and wind speed for a typical meteorological year at Paso Robles Regional Airport are available in Appendix A, Figures A-4 and A-5, respectively.

Climate Zones

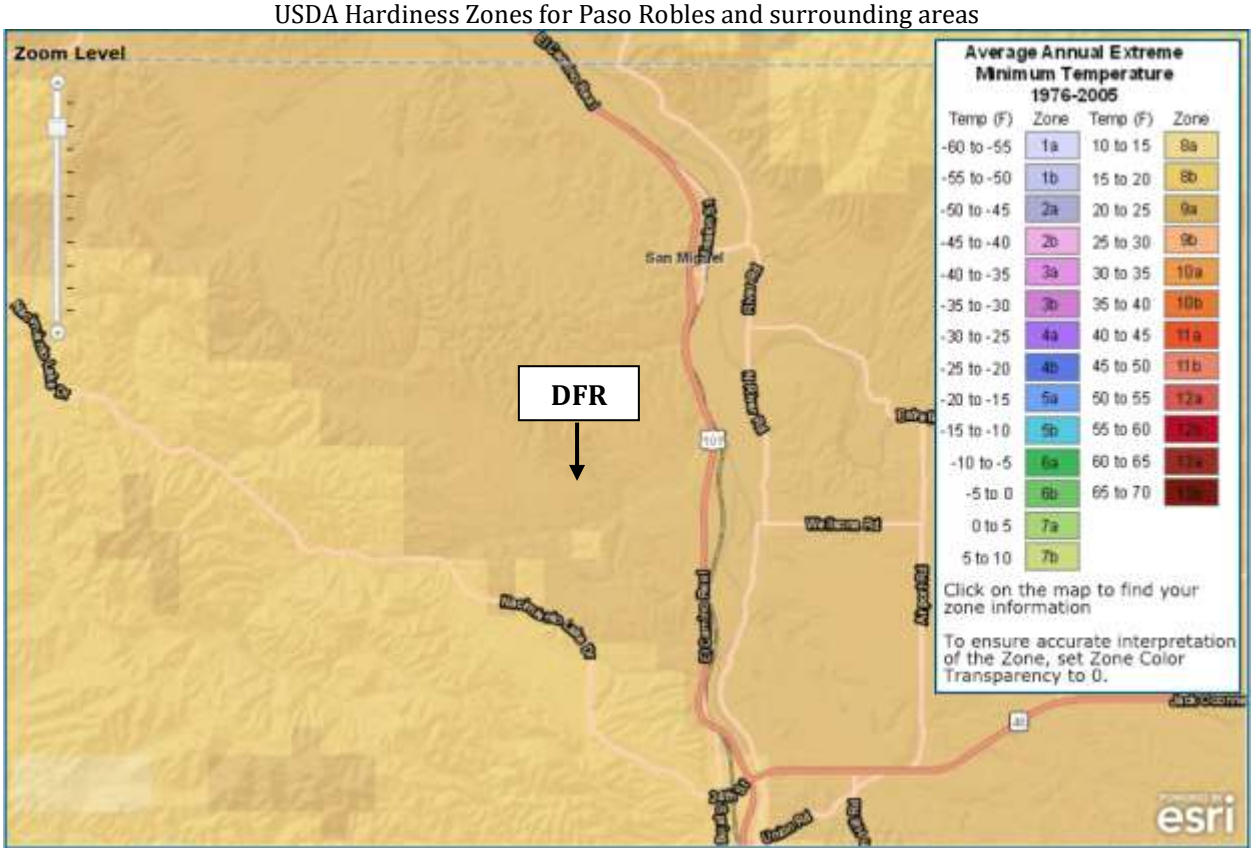
USDA Hardiness Zone

USDA Hardiness Zones gives an approximation of the lowest temperatures a site will experience in a given year. It is a helpful, if somewhat limited tool in determining what will survive (but not necessarily *thrive*) in an area. Hardiness zones can be determined for a given zip code at http://planthardiness.ars.usda.gov/PHZMWeb/. Microclimates and site specific characteristics will vary.

The USDA Hardiness Zone for 7405 Mission Road, Paso Robles 93446 is **8b/9a**. This zone is characterized by cold-season low temperatures that do not generally fall lower than 20-25ºF, and extremes that rarely fall below 15ºF. Frost tender perennial plants are likely to suffer damage and/or not thrive in this climate. Potted frost-tender plants should be moved indoors or somehow protected.

Figure 1-8 below presents a map of USDA hardiness zones for the general area.

Figure 1-8
USDA Hardiness Zones for Paso Robles and surrounding areas



Sunset Climate Zone(s)

Sunset climate zones take into account length of growing season, timing and amount of rainfall, winter lows, summer highs, wind and humidity. They provide a more detailed climate description than the USDA model, helpful in selecting which plants will not only survive but thrive with local climate variability. List of maps and climate zone descriptions.

The Sunset Climate Zone(s) for Doe Family Ranch is Zone 7. This climate zone encompasses several thousand square miles west of the Sierra Nevada and Cascade ranges, and in the mountains that separate the Southern California coast from interior deserts. Because of the influence of latitude, this climate lies mostly at low elevations in Oregon's Rogue Valley, middle elevations around California's Central Valley, and at middle to higher elevations farther south. Gray pines define the heart of Zone 7 around the Central Valley, but more adaptable incense cedars replace them farther north and south.

Hot summers and mild but pronounced winters give Zone 7 sharply defined seasons without severe winter cold or enervating humidity. The climate pleases plants that require a marked seasonal pattern to do well—flower bulbs, peonies, lilacs, and flowering cherries, for example. Deciduous fruit trees do well also; the region is noted for its pears, apples, peaches, and cherries.

Gardeners in a few spots around the San Francisco Bay will be surprised to find their gardens mapped in Zone 7. These areas are too high and cold in winter to be included in milder Zones 15 and 16. In the mildest parts of Zone 7—in the extreme southern Salinas Valley, for example— one could get away with growing borderline plants such as citrus, oleanders, and almonds if a spot with good air drainage is chosen to take the edge off winter chill. At weather-recording stations in Zone 7, typical winter lows range from 35 to 26°F (2 to –3°C),with record lows averaging from 18 to -0° F (–8 to –18°C).

Figure 1-9
Sunset Climate Zones for California's Central Coast

Koppen Geiger Climate Classification

The Koppen Geiger Climate Classification System is a widely used climate classification system, useful in tracking large scale climate changes over time. Helpful visualizations are available as .kmz files in Google Earth. Knowing your KGCC rating can be especially helpful in quickly finding climate analogues around the world as a starting place for researching biological systems, management practices and species that will have a high likelihood of success at your location. The Kopper Geiger Climate Classification System map, viewable by county, is available at http://koeppen-geiger.vu-wien.ac.at/.

The Koppen Geiger Climate Classification for San Luis Obispo County is **Csb/BSk.**

- **Csb:** The **C** stands for warm temperate, the lower case **s** for precipitation mode of 'summer dry' and the lower case **b** for a temperature rating of 'warm summer'. This is generally considered a Mediterranean climate.
- **BSk:** The B stands for Arid, the s stands for Steppe, and the k stands for 'cold arid'. This is generally considered a semi-arid, dry-steppe type environment.

Growing Season

The growing season for climate-adapted native plants typically occurs during and immediately following the rainy season (December through March) and tapers by the end of spring (Early June), entering some sort of stasis come the hot, dry months of summer. For non-native, food producing, or other plant varietals the growing season is quite long with an average of 286 sunny days in a typical meteorological year at Paso Robles Regional Airport.

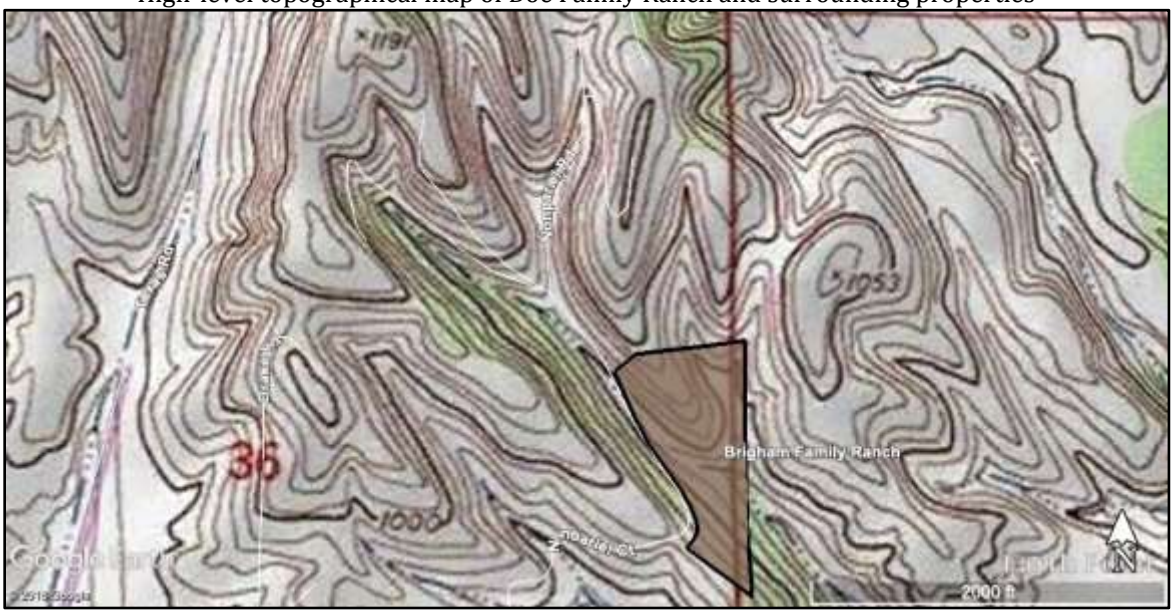
Topography

Topography describes the variation in elevation across a landscape. Topographic maps use contour lines to show the shape of the earth's surface in addition to the geographic features included on typical maps, including roads, railroads, rivers, streams, lakes, buildings, built-up areas, boundaries, place or feature names, mountains, elevations, survey control points, vegetation types, and much more.

A contour line joins points of equal height. Contours make it possible to show the height and shape of mountains, depths of the ocean bottom, and steepness of slopes. Basically, contours are imaginary lines that join points of equal elevation on the surface of the land above or below a reference surface, usually mean sea level.

Figure 1-10 presents the high level topographical map for DFR and the surrounding properties of Mission Court.

Figure 1-10
High-level topographical map of Doe Family Ranch and surrounding properties



The DFR property spans the intersections of two primary valleys. The proposed future home site sits atop the toe of a primary ridge with west and east-facing aspects. Grades are as steep as 35-40%, and the proposed access road to the future home site current traverses a grade of ~22% at its steepest. From the highest point atop the primary ridge where the future home site is proposed there is a 2% drop to the current siting of the water tank that supplies the main residence on property. The grade measurements taken at DFR are shown in Figure 1-11.

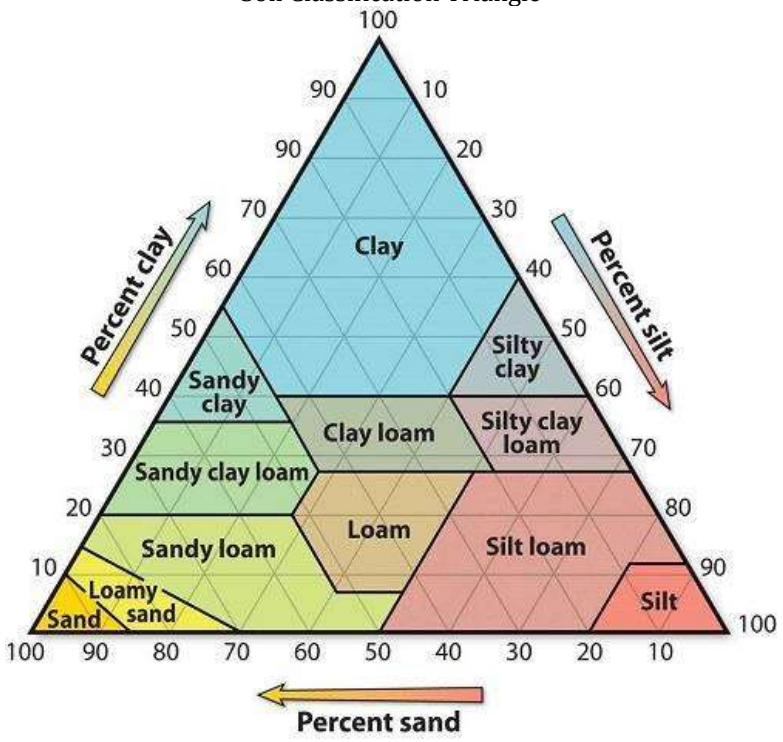
Figure 1-11
Slope Aspects at DFR

Soil Data

Fertile soil is the foundation for a healthy landscape. Soil data provides information for the landowner of what actions will be required to facilitate healthy development of the landscape. This information can be used to determine the best methods to organically build soil to optimal levels.

The soil texture classification triangle is shown in Figure 1-12, depicting the different proportions that occur between the three main particles that comprise soil: sand, silt, and clay. The percentages of each of these result in soil classifications such as "loam", "sandy loam", etc.

Figure 1-12
Soil Classification Triangle



Soil Condition Summary

All of the predominant soil types present on-property and up-watershed are predominantly of shale and/or sandstone origin. Soil pH is notably alkaline in these soil strata, with Natural Resources Conservation Service (NRCS) data suggesting an average pH of 8.2.

All NRCS soil layer data indicates that all soil types on the property and up-watershed are either fragile or moderately fragile, with high run-off potentials and low soil-moisture holding capacity, meaning they are quite susceptible to erosion. There was some evidence of the down-valley sediment migration from the up-valley vineyards and properties. Potential for high inbound sediment loads in the event of heavy rain events falling on pre-saturated soils should be taken into account and designed for to mitigate future issues with sediment deposition.

The fragility and general high-erodibility of the soil types present, along with low water holding capacities indicate that plant and tree roots will be among the most effective ways to infiltrate and

store water. Care will need to be taken during wet periods with grazing animals to time their presence to allow the land to dry somewhat (and to dry significantly on the steeper slopes), so as to avoid physical damage on steeper slopes (>20%).

Soil organic matter content is quite low in its present state. Establishment of perennial plants and tree cover throughout the property is recommended to increase soil organic matter, particularly with drought hardy pioneer tree species that can be managed by coppicing, pollarding and/or chop-and-drop to rapidly increase soil carbon levels and consequent moisture holding capacity. Highly targeted and well-managed animal grazing at certain times of the year will also help to increase soil fertility and process perennial biomass into milk, meat and manure.

The Natural Resources Conservation Service (NRCS) map for DFR is provided in Figure 1-13. Detailed descriptions of the soil classifications shown on the map follow.

Figure 1-13
NRCS Web Soil Survey Data for Doe Family Ranch and surrounding areas

On-Property

- **181—Nacimiento-Los Osos complex, 50 to 75 percent slopes**
  - 50-75% slopes, very high run-off, low infiltration rate.
  - Soil pH is generally quite alkaline, averaging ~8.2 for DFR's native soil complex.
    - ***Map Unit Composition***
    - *Nacimiento and similar soils:* 35 percent
    - *Los osos and similar soils:* 20 percent

        - *Minor components:* 30 percent
    - **Nacimiento:** Composed of residuum weathered from calcareous shale, typically 20-40" to paralithic bedrock, moderate capacity for infiltration (0.2 - 0.57" /hr) in most limiting layer, run-off is very high, not considered prime agricultural soil, has low ability to store water in the soil profile (~ 5").
        - Hydrologic Soil Group: C
            - **Group C** soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
        - Landscape Capability Classification: **7e**
            - **Class 7** soils have very severe limitations that make them unsuited to cultivation and that restrict their use mainly to grazing, forestland, or wildlife.
            - **Subclass e** is made up of soils for which the susceptibility to erosion is the dominant problem or hazard affecting their use. Erosion susceptibility and past erosion damage are the major soil factors that affect soils in this subclass.
    - **Osos:** Composed of residuum weathered from shale and/or sandstone, typically 20-40" to paralithic bedrock, low-moderately high capacity for infiltration (0.06 - 0.2" /hr) in most limiting layer, run-off is very high, not considered prime agricultural soil, has low ability to store water in the soil profile (~ 3.9").
        - Hydrologic Soil Group: D
            - **Group D** soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This Hydrologic Soil Group has the highest runoff potential. They have *very low infiltration rates when thoroughly wetted* and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and *shallow soils over nearly impervious material*.
        - Landscape Capability Classification: **7e**
            - **Class 7** soils have very severe limitations that make them unsuited to cultivation and that restrict their use mainly to grazing, forestland, or wildlife.
            - **Subclass e** is made up of soils for which the susceptibility to erosion is the dominant problem or hazard affecting their use. Erosion susceptibility and past erosion damage are the major soil factors that affect soils in this subclass.

Infiltration Tests

Infiltration tests were performed at several locations on property. The number of seconds were measured for 1 gallon of water to infiltrate into a 80.5 sq in area of soil, and that infiltration rate was extrapolated over the larger area this test site represented. The data gathered from these tests in summarized in Table 1-3, and is available in full detail in the DFR Water Catchment Calculator Google Spreadsheet.

Table 1-3
Infiltration test results for various locations at DFR

Infiltration Test Location	Time Elapsed (sec)	Infiltration Rate (gal/sq.ft./min) Standing Water	Infiltration Rate (in/min) Standing Water	Infiltration Per Acre Per Min (gal/acre/min) Standing Water	Infiltration Per Acre Per Hour (gal/acre/hr) Standing Water
East Valley Bottom	195	0.55	0.88	23,976	1,438,560
West Valley Bottom	12000	0.01	0.01	390	23,400
Ridge Toe Slope	270	0.40	0.64	17,316	1,038,960
West Facing Slope	90	1.19	1.91	51,947	3,116,820

Land History

The Salinan people inhabited the area in which Paso Robles is located for thousands of years prior to the arrival of the Spanish. The area where Paso Robles is used to known to the Salinan as The Springs due to the large number of natural hot springs in the area. The Salinan tribal council is still active in Northern San Luis Obispo county and the Morro Bay area. The Salinan are an officially recognized tribe by the state of California and are petitioning for federal recognition. Their traditional language of Hokan is the oldest known spoken language in California. Archaeological evidence indicates that the Salinan have inhabited this region for over 10,000 years. For more information, visit the Salinan Tribal Council website.

The Salinan were quickly and brutally incorporated into the mission system following the arrival of the Spanish. General History of Mission System from the Native American Heritage Commission of California.

In August of 1857 the Paso de Robles Land Grant of 25,933 acres was purchased by brothers Daniel and James Blackburn and Lazarus Godchaux from Petronilo Rios. Daniel became the owner of the land west of the Salinas River that eventually became the town of Paso Robles. At the time of purchase there was no town, only a small wooden log shack built around the spring that was located on the northeast corner of what ultimately become 10th and Spring Streets. The spring went dry in 1906 but later became active again in 2003 following an earthquake.

The first post office was established in 1867, and the first train reached the town in 1886, which opened up the original land grant to additional prospective buyers. Paso Robles became a health resort, and many people came to enjoy the hot mineral springs and mud baths.

Paso Robles once had the highest concentration of almond orchards in the world, and some of these orchards still exist, though many have been replaced by vineyards.

2 - Water

The water used on most properties for household and landscape is typically piped in from a municipal water company or pumped from a drilled well. While, for many landowners, the day-to-day consistency of these sources provide a convincing case for water security, others are quickly realizing the hard way that these water sources are not as secure as once thought. Landowners on a municipal water supply are subject to the pricing and whims of the utility, which is subject to the whims of the environment, electrical grid, and water supply. Well owners are also subject to the whims of the electrical grid (or solar/wind systems) – but additionally, in many areas owners are coming to find their flow rate dropping or even disappearing altogether as underground aquifers are depleted.

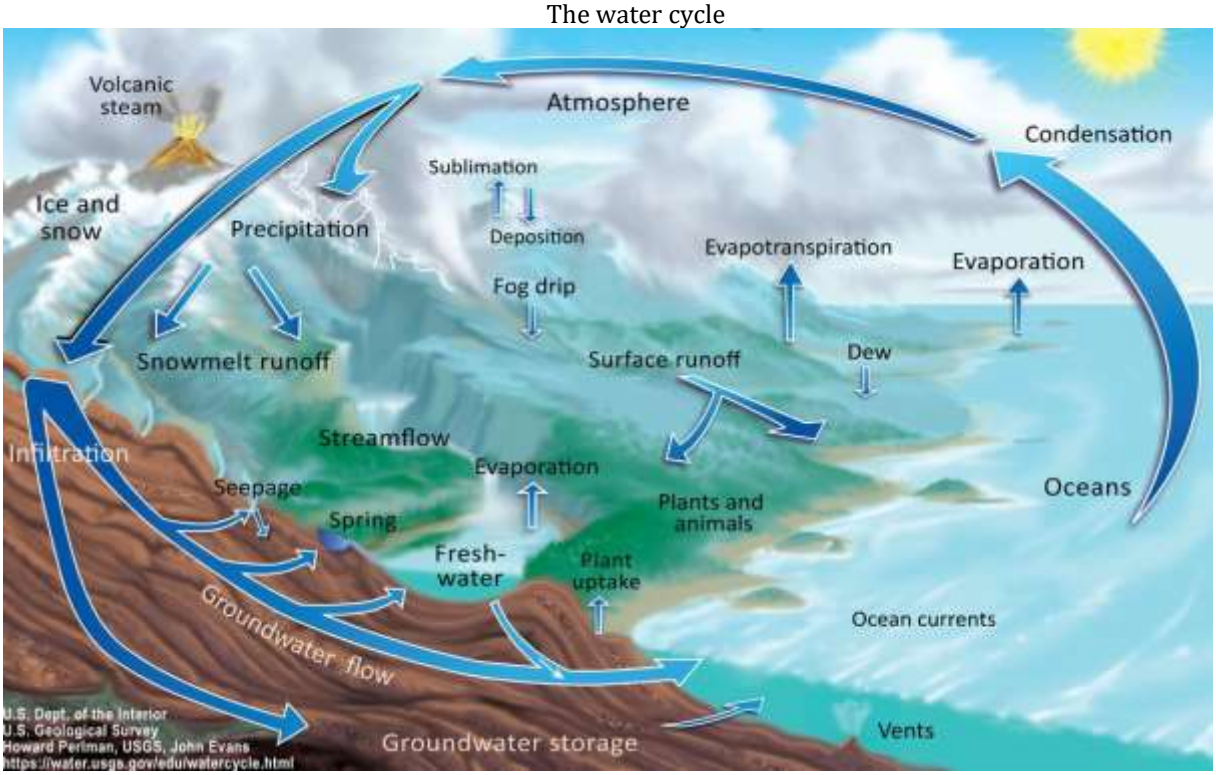
Additionally, conventional property development in the past century was geared towards moving rainwater away from structures and off-property as quickly as possible in an effort to prevent damage. While this seemed to work at first, unfortunately in the long-term this has resulted in major erosion issues (exacerbated by the clearcutting of land and overgrazing with cattle), landscape dehydration, and aquifer depletion.

These issues speak to the critical need for landowners to work with water and embrace its presence on-site rather than fight it by designing for and implementing rainwater harvesting strategies - to work towards regenerating the hydrological cycle on the landscape.

The Four R's of Regenerative Hydrology

The actions of regenerative hydrology can be expressed in terms of sound fiscal budget management. The 4 R's of a water budget - receive, recharge, retain, and release - are equivalent to income, deposit, savings, and expense. Landowners should ensure that the water balance of local watersheds is in the blue and not in the red, that liquid assets continually produce a high-quality return on investment, and re-invest returns back into local watersheds to continue building principal.

Figure 2-1
The water cycle



Receive = Income

Watersheds only receive water as snowfall, rainfall, dew condensation and fog precipitation. Annual precipitation is the only true source of ***income*** to re-supply a property's water budget allowance. Everything else (drafting fossil aquifers, importing from other areas) is drawing down on principal.

Regenerative hydrology advocates the adaptive management of watershed lands to optimize rehydration by promoting land use patterns that enhance the receptive capacity of a watershed in times of excess and the retentive capacity in times of drought.

Recharge = Deposit

Recharge processes are critical for the landscape to annually refresh itself via the deposit slip called infiltration. The capacity to make water deposits depends on the watershed's recharge potential. Precipitation received by the watershed must percolate and be absorbed, or else there is no replenishment of the water savings account.

Recharge potential and functions are impaired by the hardening and paving over of natural recharge areas, the disconnection of rivers from their floodplains, the deforestation of native vegetation, and the draining of wetlands.

To increase recharge, a landowner can:

- Limit impervious surfaces and the wholesale conversion of native vegetation.

- Implement stormwater pacification techniques designed to slow, spread, and sink water into earthen storage.
- Protect open space in known groundwater recharge areas. If site conditions are not conducive to recharge, then the landowner is wise to ensure proper bio-filtration of all surface waters prior to their discharge and deposit into rivers, wetlands, lakes, estuaries, and oceans.
- Most Importantly - Landowners can plant trees and establish perennial vegetation wherever bare soil exists. Trees are far and away the best producers of future rainfall, in addition to being the best protectors of soil *from* the impacts of rainfall as well as the most effective means by which to infiltrate precipitation into the soil and increase soil moisture to the benefit of all lifeforms. Trees and perennial vegetation are *critical* to increasing the recharge capacity of the landscape.

Retention = Savings

The retention of recharged precipitation is like a savings account asset that yields interest. The storage of water is often the most challenging aspect of water supply management. Regenerative hydrology strategies should appropriately slow water down, increasing the residence time of water storage in our watersheds. This will optimize the amount of water available for local expense by living processes.

A landowner is wise to avoid overdrafting of their local watersheds. To be in the blue, a healthy albeit challenging goal is to never extract out of storage (groundwater) in amounts greater than what is annually received and recharged. While this can go on for a while, eventually a penalty must be paid. In situations where this is currently occurring, landowners can take steps to mend the broken hydrological cycle to ensure that as much water as possible is being returned and put to highest use in the landscape before it leaves.

Release = Expenditure

Ideally, expenditure of water assets will go to further increase the reception, recharge and retention capacities (the first 3 R's) of the watershed.

Water is released naturally to the ocean, land and atmosphere in a process known as the water cycle. Through seasonal snow and ice melts, groundwater springs and seeps, water is returned to creeks and rivers. Solar evaporation and the evapo-transpiration of plants help to form new clouds and feed the cycle anew. The infinite nature of this cycle is to continually flow and be in flux as the expense of one stage produces income for the next.

Common modern development practices (creating impervious surfaces, channelizing stormwater, etc.) tend to increase the rate and volume of storm water's return to the ocean via excessive runoff and heightened flood discharges. This directly reduces the landscape's ability to retain water and diminishes the amount of water available for later release during the dry season when it is most needed.

Water Patterning Strategies for Regenerative Hydrology

Slow, Spread, Sink, Grow

1. **Slow The Water Down -** By slowing the movement of water over a landscape, its erosive potential is reduced and infiltration is allowed to occur. Common methods for achieving this are increasing vegetative cover (grasses, trees, plants), installing earthworks (swales, catchment basins, net-and-pan, boomerangs, keyline plowing etc.) and limiting/reducing the use of hardscape and consequent concentrated run-off flows, and when possible using permeable surfaces.
2. **Spread The Water Out -** Part of slowing water down is to spread it over as much surface area as possible, and reduce any peaks in concentration. The more surface area the water can touch the greater the opportunity for it to sink in and be put to work in the landscape. Common methods for spreading water include those mentioned above as well as geological and biological flow spreaders (plants and/or rocks arranged to pacify and spread overland flows).
3. **Sink The Water Into Soil -** If Steps 1 and 2 have been designed well, this part will take care of itself. For this, an emphasis is placed on permeable surfaces where hardscape is necessary and encouraging vegetation where it is not (plant and tree roots are the best infiltration mechanisms we have).
4. **Grow Biomass -** Slowing water down, spreading it out, and encouraging infiltration into living soil creates the greatest amount of living edge possible for water to interact with. It is here that the landscape and its stewards reap the greatest rewards, as evaporation is reduced, solar energy conversion to biomass is maximized and life expression is steered towards abundance.

Rainwater harvesting falls into two major categories—passive water harvesting and active water harvesting. Very simply, passive water harvesting works by shaping the earth to slow the velocity of runoff, infiltrate it into the soil, and direct it to where it can be beneficially used by vegetation. Active water harvesting, in contrast, uses rain barrels, cisterns, and other types of containers to store rainwater for later distribution. The stored water can be used outdoors to irrigate vegetation or indoors for non-potable (toilet flushing, laundry washing) and potable (with appropriate filtration) uses. Both passive and active water harvesting systems can "extend" the rainfall season and maximize the use of water that falls on property. Passive systems are more cost effective than active systems per gallon harvested, but yield fewer options for water use.

Most landowners opt for a combination of active and passive water harvesting. Below is a summary of the rainwater calculations for the DFR property, existing passive and active water harvesting systems in place, as well as recommendations of strategies to increase water harvesting capacity.

Context

Rainwater Harvesting Potential

A watershed, also known as a drainage basin or catchment, is an area bounded by hills, ridges, and valleys where any rainfall and runoff leads to a single outlet. Watersheds can be as small as a footprint, the roof of a house, a small urban residential property, a broad-acre farm, or large enough

to encompass all of the land that drains water into rivers that drain into the ocean (such as the portion of the San Luis Obispo watershed draining into San Luis Obispo Creek, ultimately draining into Avila Bay). It all depends on the outflow point; all of the land that drains water to the outflow point is the watershed for that outflow location.

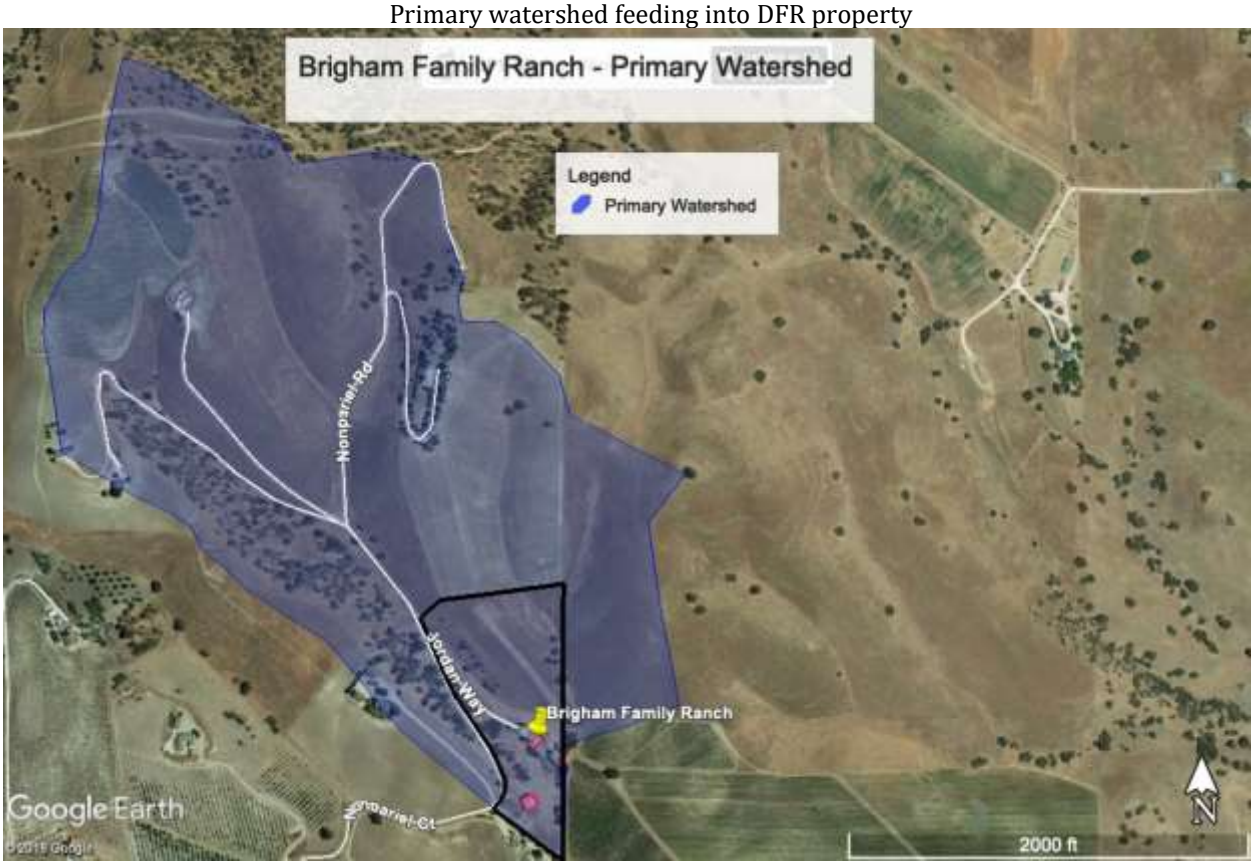
Doe Family Ranch is located at the intersection of two primary valleys. The property has 12.57 acres of catchment area comprised of structures, hardscape, and softscape - summarized in Table 2-1. An additional ~123 acres of up-canyon catchment is located above the DFR property.

Table 2-1
Summary of catchment areas within DFR boundaries

Catchment Name	Area (sq. ft.)	Surface Type
Structures - House Roof	1,780	Roofs
Structures - Shop Roof	3,700	Roofs
Structures - Shed Roof	380	Roofs
Access - Main Driveway	10,100	Drives and Walks
Access - Shop Driveway	4,600	Drives and Walks
Access - Seasonal Shop	7,900	Drives and Walks
Access - Seasonal Shed	2,700	Drives and Walks
Access - Seasonal East Valley	6,000	Drives and Walks
Access - Seasonal North Hilltop	9,100	Drives and Walks
East Valley East Aspect	103,000	Ag - Bare Packed Soil/Rough
East Valley West Aspect	28,000	Ag - Bare Packed Soil/Rough
West Valley East Aspect	146,000	Ag - Bare Packed Soil/Rough
West Valley West Aspect	155,000	Ag - Bare Packed Soil/Rough
West Valley Bottom	55,000	Ag - Bare Packed Soil/Smooth
East Valley Bottom	14,000	Ag - Bare Packed Soil/Smooth

During an mean rain year of 14.77 inches, the total volume of rainfall that lands within DFR property lines is 5.04 million gallons; the total volume that lands on structure roofs is 53,960 gallons. Based on runoff estimates for the terrain, an estimated 1.3 - 2.7 million gallons of this water is lost to runoff during an average rain year. Detailed calculations are available on the Catchment and Runoff Calculation spreadsheet.

Figure 2-2
Primary watershed feeding into DFR property



In a mean rainfall year of 14.77 inches, over 49.3 million gallons of rain falls on the 123 acres up-canyon from DFR. Based on runoff estimates for the terrain, an estimated 9.8 - 24.7 million gallons of this water is lost to runoff during an average rain year, which ultimately passes through DFR. This watershed ultimately feeds into the Salinas Valley watershed and the Salinas River via the San Marcos Creek watershed. Macro scale views of this watershed can be viewed at the San Luis Obispo County Interactive Data Viewer.

Figure 2-3
DFR location within the San Marcos Creek Watershed

Aquifer

Information about the aquifer underneath Doe Family Ranch can be gathered from the following websites:

- Principal Aquifer Map of U.S.
- California Groundwater Basin Boundary Assessment Tool
- California Water Management Planning Tool

Figure 2-4
DFR's location within larger Salinas Valley Groundwater Basin

The Salinas Valley Groundwater Basin is currently classified as Critically Overdrafted. Groundwater overdraft occurs when groundwater use exceeds the amount of recharge into an aquifer, which leads to a decline in groundwater level.

Wells

The DFR has a dedicated well, located near the existing house. The well is at a depth of 318 feet, with a recorded flow rate of 10gpm in 2015. During the course of a 4 hour test, the flow rate only dropped by 0.9 gpm. The well is configured with a storage tank of estimated 2,500 gallon capacity located near the shop on the ridge in the southern corner of the property.

Municipal Water

The property is not currently tied to any municipal water systems.

Passive Rainwater Harvesting

Passive water harvesting works by shaping the earth to slow the velocity of runoff, infiltrate it into the soil, and direct it to where it can be beneficially used by vegetation. Passive water harvesting features include swales and berms, dry stream beds, infiltration basins, retention ponds, pumice wicks, French drains, and more. They are typically less expensive, simpler to build, lower maintenance, and longer lasting than active water harvesting systems.

Existing Conditions

While over 5 million gallons of water falls within property boundaries during an average rain year, most of it exits the property via runoff or evaporates before being able to be utilized by living systems due to the predominance of fast-growing, short-lived annual grasses and the lack of tree cover. The infiltration rate of the soil is fairly high, but once saturation is reached, which occurs fairly quickly due to the thin nature of the soil and thus low total water holding capacity, no additional water can infiltrate. Additionally, organic matter content is very low, further reducing the soil's capacity to retain water for productive use later into the growing season. Wind exposure and bare soil without cover or shade currently create high evaporation conditions.

Recommendations

In order to improve water infiltration and retention on-site, the following elements and steps are recommended:

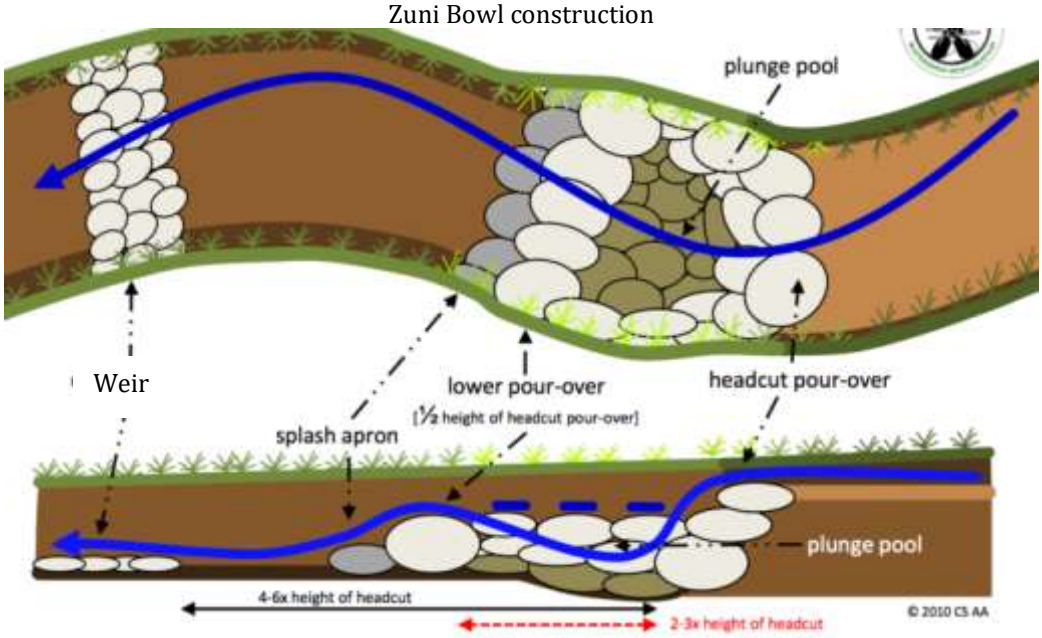
- Installation of an armored plunge pool (Zuni Bowl) and three stone weirs at the outlet of the culvert under Mission Road in the northwestern corner of the property to prevent future headcutting and erosion issues.
- Installation of an infiltration basin in the east valley drainage to slow the flow of surface runoff and allow it an opportunity to sink into the soil
- Installation of swales on the slope between the Main Residence/Garage and valley bottom to capture Garage access road runoff and collect rainwater and greywater from the two structures.
- Planting drought-tolerant, leguminous pioneer trees along both the West and East Valley bottoms and a mix of drought-tolerant shrubs and trees on the ridges and hillsides to shade soil and increase organic matter in the soil, thus improving water retention capacity and reducing evaporation losses.

Zuni Bowl and Weirs at NW Culvert Outlet

At the exit of the culvert crossing under Mission Road, there is evidence of significant downcutting, which if not remedied will eventually become a headcut, undercutting the road and necessitating repair. Additionally, there is evidence of road sediment and soil erosion for over 100 feet downslope of the drainage.

An armored plunge pool, known in the regenerative hydrology world as a Zuni Bowl, should be installed at the exit of the culvert crossing under Mission Road in the northwestern corner of the property to pacify the water's exit from the culvert and allow it to be discharged over a broader area of the landscape than it is currently. The flow dispersal area should be planted with perennial vegetation to protect the soils and further improve infiltration. A Zuni Bowl is illustrated in Figure 2-5.

Figure 2-5
Zuni Bowl construction



Downstream of the Zuni Bowl, three weirs (only one is shown in the image above) are recommended across the valley drainage. A weir is an assembly of rocks placed across a drainage perpendicular to incoming flow, as shown in Figure 2-6 and illustrated in this excellent video. These serve to slow the flow of water and allow the sediment to settle upstream of the weir. As sediment builts, a variety of plants will grow into the areas, further flowing the flow of water, and ultimately becoming vegetated terraces. The recommended locations for the weirs are shown in Figure 2-7.

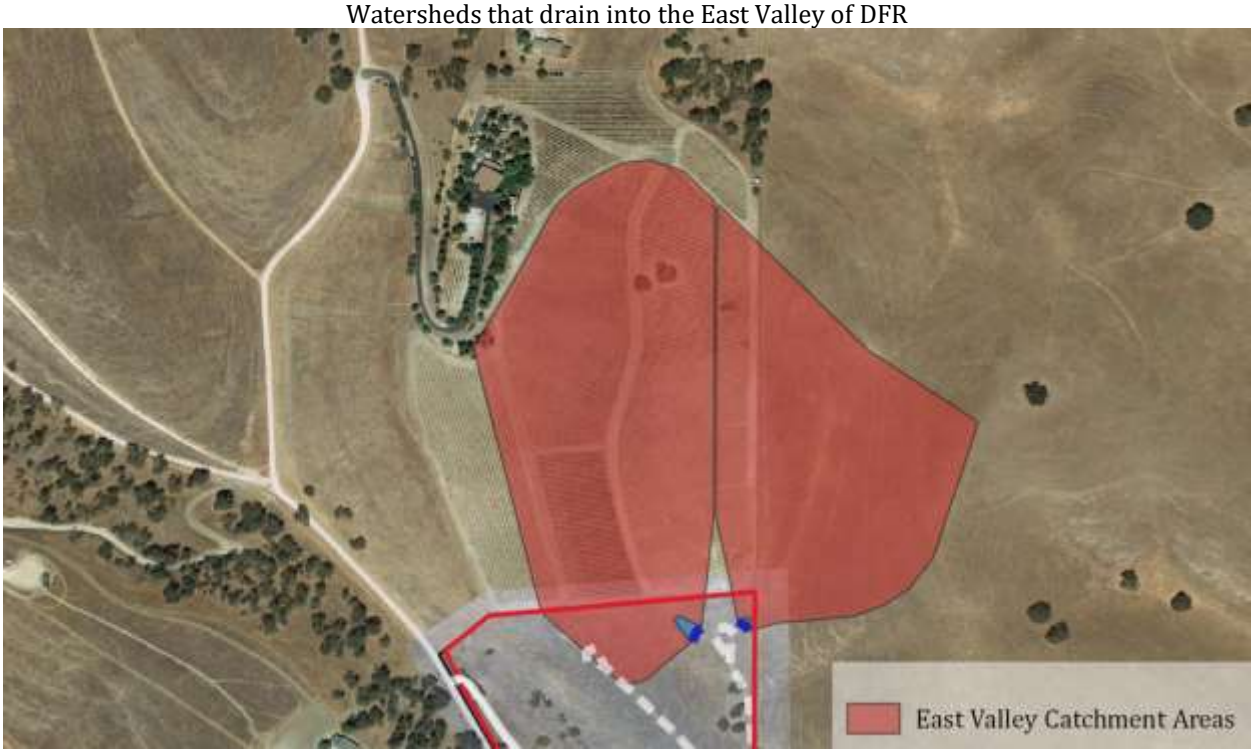
Figure 2-6
A rock weir in a drainage

Figure 2-7
Recommended Zuni Bowl and Weir locations at DFR

Infiltration Basins in East Valley

Two different catchment areas drain into the East Valley, currently merging at the location of the existing East Valley turnaround/brush pile as shown in Figure 2-8 below. Both catchment areas roughly total 500,000 square feet, and create an estimated combined 2 million gallons of surface runoff during a typical rain year, which flows into the east valley from the north and ultimately exits the property.

Figure 2-8
Watersheds that drain into the East Valley of DFR



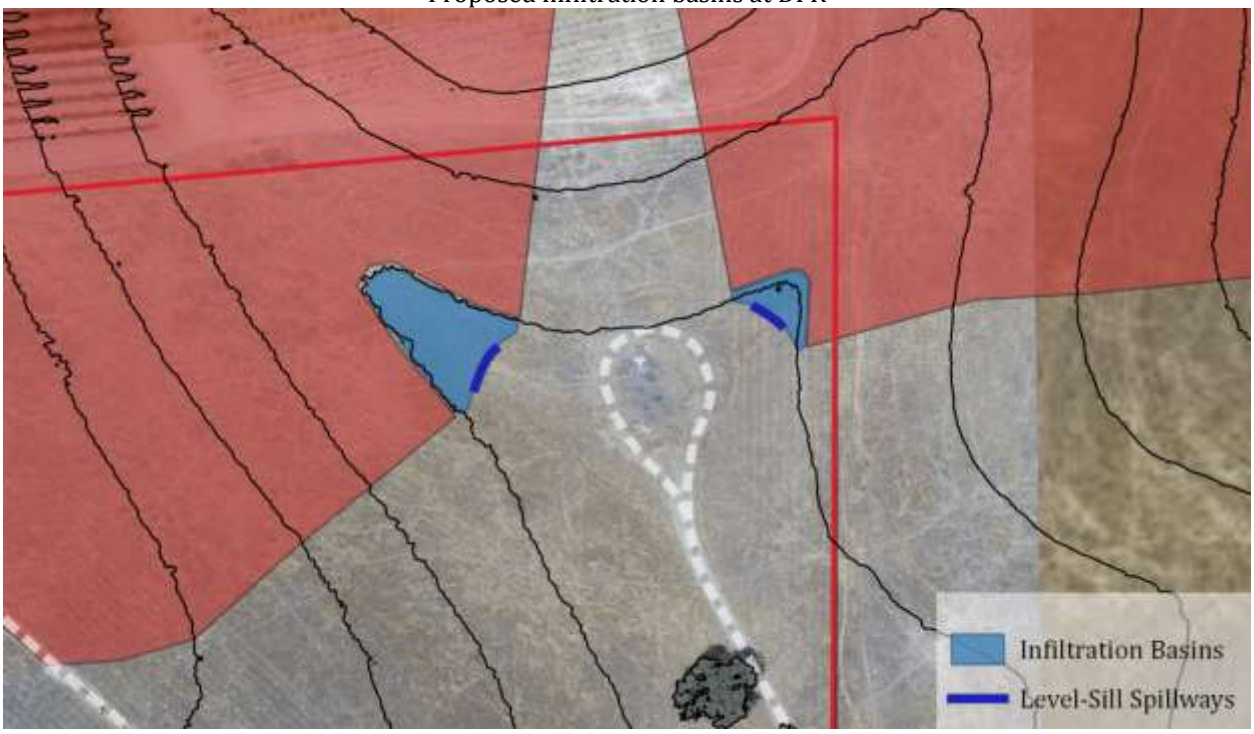
Infiltration basins, also known as pocket ponds, can be used on property to capture some of this runoff and infiltrate it into the soil. They are constructed by excavating out an area of soil in a drainage and piling the material on the downslope edge of the infiltration basin to create a dam. A level-sill spillway, several feet wide and approximately 10-12" below the level of the dam wall, is constructed to properly direct any overflow. This spillway should be not be located on the dam wall, and should be reinforced to prevent erosion. An infiltration basin is shown in Figure 2-9.

Figure 2-9
Infiltration basin

Infiltration basins provide valuable seasonal habitat to many forms of wildlife, in addition to allowing for the growth and persistence of different vegetation communities. The persistence of water in these locations for slightly longer after the rainy season will also allow for biomass production on the edges of the basins that can be harvested as a fertility source and used elsewhere on property (compost feedstocks, cut forage for animals, firewood, craft materials etc). Species that appreciate or can tolerate higher levels of soil saturation (such as elderberry) will do well planted just downslope of these basins and the soil water lense they create.

The proposed locations of the infiltration basins are illustrated in Figure 2-10

Figure 2-10
Proposed infiltration basins at DFR



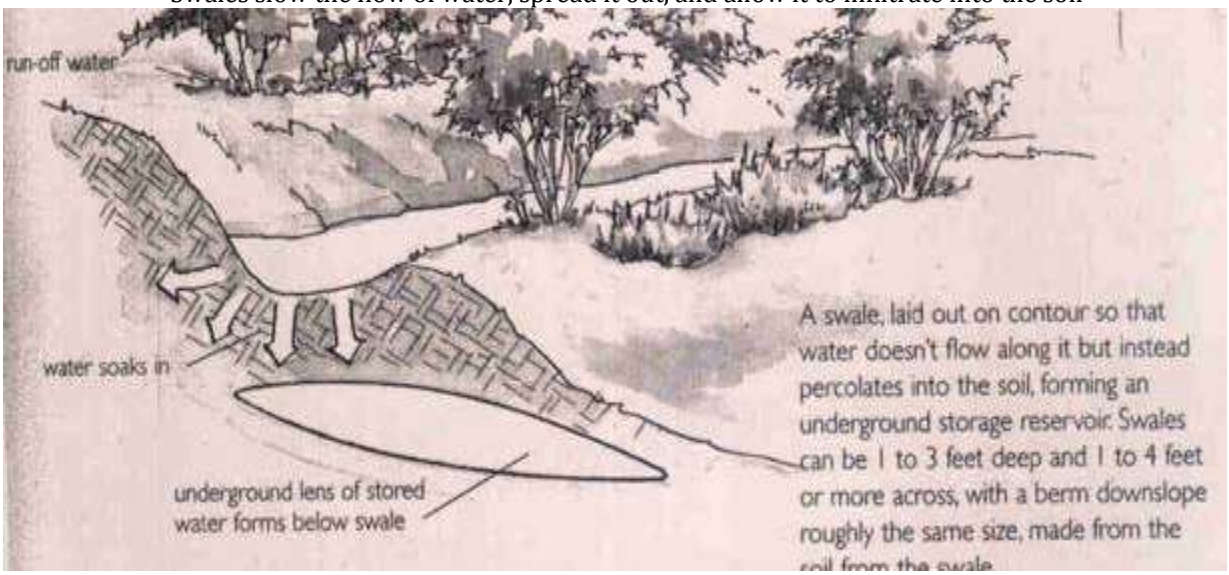
Swales

The rain gutters on the Main Residence currently drain into flexible pipes that run underneath the Garage access road to the east and empty onto the hillside above the Tiny Home. There are no rain gutters on the Garage; rain drips down off the roofline and has created erosion channels along the drip line.

Swales are recommended on the hillside in between the Main Residence/Garage and valley bottom to provide a place for both roof runoff and the runoff from the Garage access road to collect and infiltrate into the soil. Swales are shallow trenches dug along the land's contour, with a berm on the downhill side. These slow any surface runoff from the area uphill, spread it out along the length of the swale, and contain it long enough to allow for infiltration. The infiltrated water creates a "lens" of saturated subsoil just downslope of the swale, as illustrated in Figure 2-11, which provides water to plant roots long into the dry season. Swales are typically 1-3 feet deep and 1-4 feet or

more across (actual capacity will depend on inbound catchments and infiltration rates of the subsoil), with the berm downslope roughly the same size and made from soil from the swale.

Figure 2-11
Swales slow the flow of water, spread it out, and allow it to infiltrate into the soil

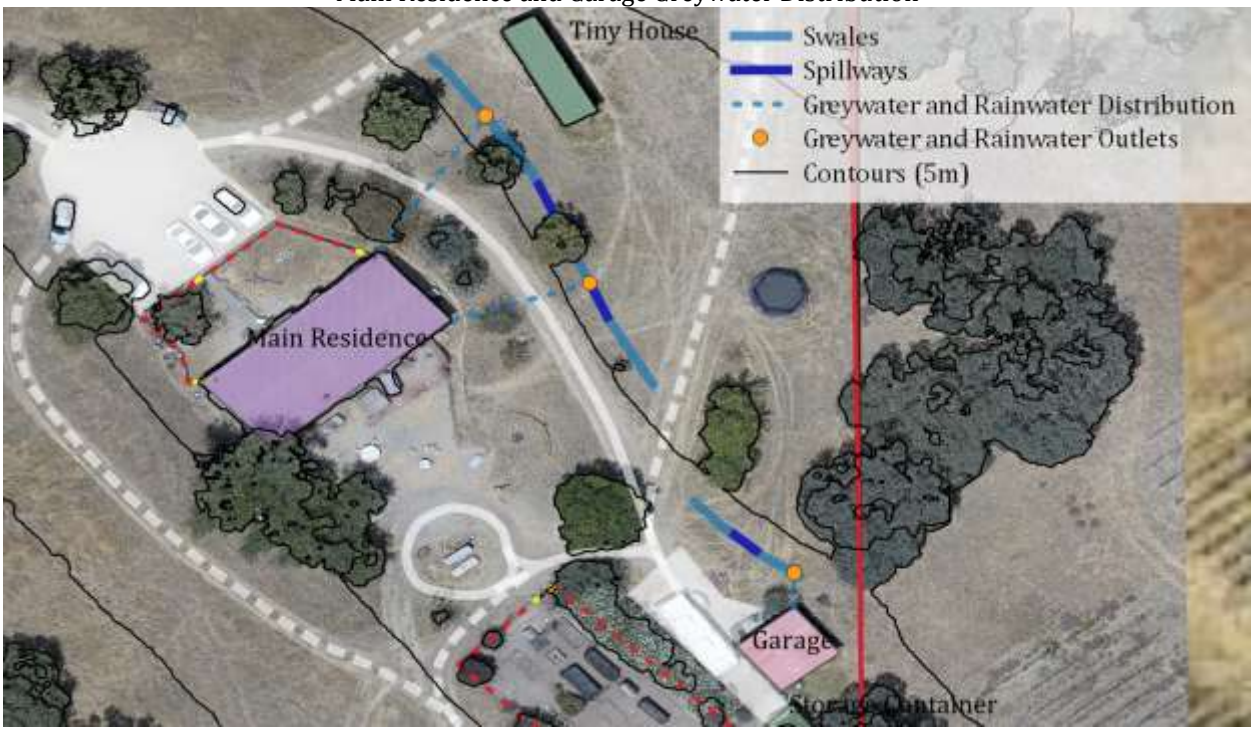


Critical in the design of swale systems are planned overflow points called level sill spillways. A level sill spillway is a broad, perfectly level part of the swale set below the height of the swale berm, as shown in Figure 2-12. The height of the level sill spillway from the bottom of the swale will determine the swale's holding capacity. A swale will have a measurable holding capacity as well as a generally known infiltration rate. There will be rain events during a swale's functional lifespan that exceed its capacity to infiltrate standing water as fast as new water is entering. When these events occur the swale will overflow. When installing a swale it must have a level sill spillway set below the maximum height swale berm. This distance is called the freeboard. It is generally wise to keep freeboard at 12" or greater. Level sill spillways are sized to have the water discharge as slowly as possible, ideally flowing gently downhill until it is picked up by yet another linked swale.

Figure 2-12
Level sill spillways provide for the planned overflow of water without eroding the berm

Figure 2-13 illustrates the recommended swale installations at DFR. The berm should be planted with species that will provide, among other functions, a privacy screen between the Main Residence and current Tiny Home location. Further information about this is provided in Chapter 5 - Forestry.

Figure 2-13
Main Residence and Garage Greywater Distribution



Forestry

Planting drought-tolerant, leguminous pioneer trees along both the West and East Valley bottoms and a mix of drought-tolerant shrubs and trees on the ridges and hillsides will shade soil reducing evaporation losses and increase organic matter in the soil via leaf fall, and is the best long-term strategy for improving infiltration during rain events. Further information about this recommendation is provided in the Chapter 5 – Forestry.

Active Rainwater Harvesting

Active rainwater harvesting uses rain barrels, cisterns, and other types of containers to store rainwater for later distribution. The stored water can be used outdoors to irrigate vegetation or indoors for non-potable (toilet flushing, laundry washing) and potable (with extensive filtration and disinfection) uses. Active water harvesting systems can "extend" the rainfall season and maximize the use of collected water, but are also significantly more expensive than passive systems.

Existing Conditions

The only water storage on-site is fed from the well - no rainwater storage systems exist.

Recommendations

In order to improve water harvesting on-site, further investigation on the following elements and steps is recommended:

- Configure the shop roof raingutter system with a first flush diverter and dedicated storage tank, and integrate with the existing domestic water distribution system.

Shop Rainwater Collection

The 3,700 sq-ft Shop roof collects 34,000 gallons of precipitation during an average rain year. Currently, this water is captured in raingutters, with the downspouts piped to an outlet on the hillside.

The Shop is ideally sited for rainwater catchment because of its elevation above the main house and village, which provides good gravity-fed pressure. The 7GD team has considered recommending that the downspouts configured with the Shop raingutter system be patterned into a rainwater storage tank, with the overflow directed toward the surrounding landscape and backup filling during dry spells provided by the well pump. In this scenario, the storage tank would then be integrated with the existing water tank distribution system serving the main house via a three-way valve and backflow preventer. This would effectively increase the storage system size, and provide a redundant means of storing water during the rainy season should the well-pump ever fail.

The costs for a system like this will be large, but the increased water security may make it worthwhile to the Doe family. As an alternative, the raingutters for the Shop roof should be patterned into the proposed natural swimming pool, described in Chapter 4 – Structures.

Greywater

Greywater is relatively clean water that has been used in bathroom sinks, showers, tubs, and washing machines. The average person in the United States produces between 20 and 45 gallons of greywater per day[1], which, for a typical 4-person home, equates to between 29,200 and 65,700 gallons annually. It is a valuable resource, often wasted down sewer drains or filling up septic tanks, that can be utilized to provide a consistent source of moisture to landscaped areas.

The key things to remember for the safe use of greywater are:

- Don't store greywater. When greywater is stored, the nutrients in it start to break down, creating bad odors.
- Minimize contact with greywater. Greywater could potentially contain a pathogen if an infected person's feces got into the water, so a system should be designed for the water to soak into the ground and not be available for people or animals to drink.
- Infiltrate greywater into the ground quickly, don't allow it to pool up or run off.
- Keep the system as simple as possible, avoiding pumps and filters that need upkeep. Simple systems last longer, require less maintenance, require less energy and cost less money.
- Install a 3-way valve for easy switching between the greywater system and the sewer/septic.

[1] https://www.thegreywaterguide.com/how-much-greywater.html/

Existing Conditions

The greywater produced at the Main Residence is currently piped into the septic system. The greywater produced at the Shop is piped to an outlet on the hillside below the Shop.

Recommendations

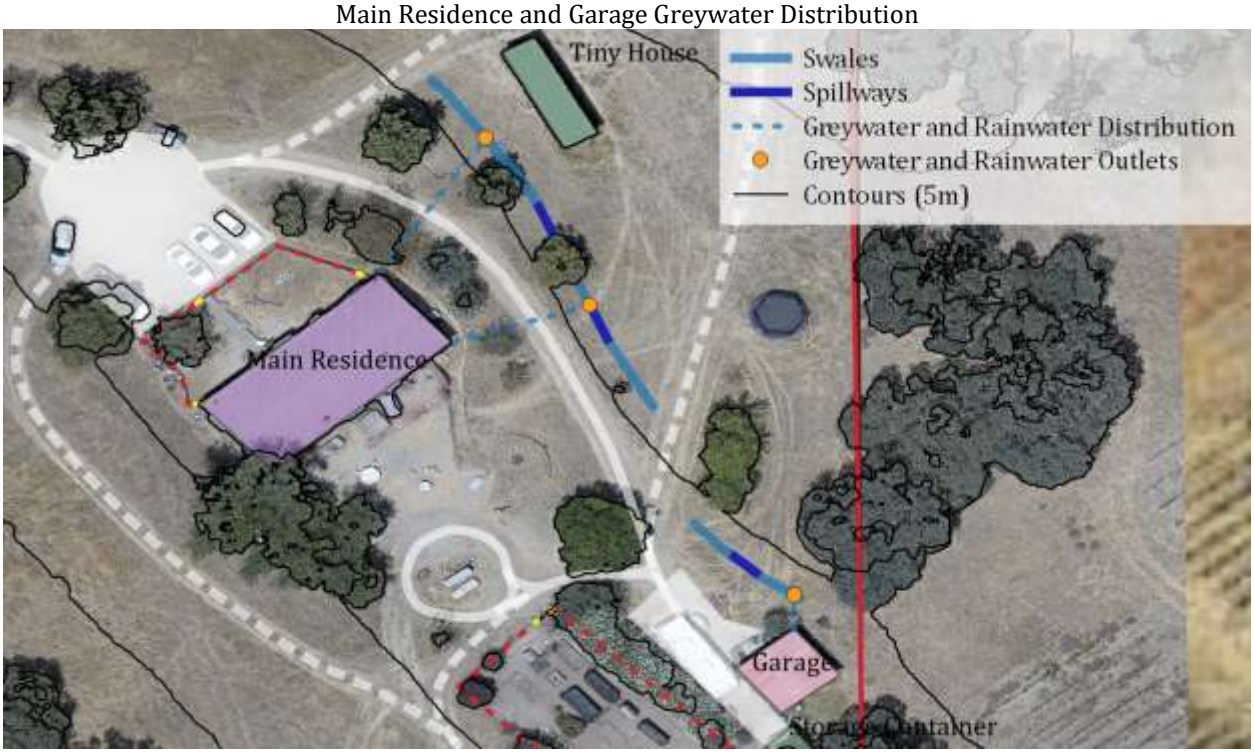
In order to improve greywater harvesting on-site, the following is recommended:

- Diverting the main residence greywater from the septic system to the two swales on the east side of the house.

Main Residence Greywater Collection

The greywater produced at the Main Residence should be diverted from the septic system and piped to the two swales on the east side of the house, detailed in the Passive Rainwater Harvesting section above and illustrated in Figure 2-14 below. The greywater discharge can be integrated with the rain gutter downspout discharge pipes so no new trenches are required. It is critical that a healthy layer of mulch be kept in the swales, especially at the greywater discharge outlet, as the mulch absorbs the greywater and provides plenty of surface area for beneficial microbes to continue breakdown of residual nutrients in the water.

Figure 2-14
Main Residence and Garage Greywater Distribution



3 - Access

Access patterning is a critical design component for creating low-maintenance, low-input properties. It can often be a limiting factor when selecting appropriate management strategies. Additionally, access routes present huge opportunities for passive water harvesting on-property. While access routes, especially roads, are costly to create or modify, a well-designed and placed access route can result in lower long-term maintenance costs, and efficient movement of people, animals, and materials around a property – while a poorly designed access route can lead to huge erosion issues, extensive maintenance costs (until the route ultimately becomes infeasible to maintain and access is lost), the sacrifice of water harvesting opportunities, and large amounts of unnecessary energy expenditure over the lifespan of the access route (in fuel and human/animal calories burned).

Site topography and its' resultant influence on the movement of water through and within the site is the primary influencer of access route placement. How water interacts with any access route, be it a hard top road or a deer trail, will determine the route's long term stability and required level of maintenance. The following list summarizes the rules of thumb for good access design:

- Harmonize with the patterns of water already present in the landscape when planning, installing or remodeling access routes. This will always lead to better performance and lower maintenance costs. Good access at minimum maintains watershed function, and ideally improves it.
- Cross valleys, whenever possible, along dam/pond walls or following contour; traverse a landscape on contour as much as possible; and ascend and descend the landscape along ridge lines (these areas have the least potential to accumulate water in destructive volumes).
- Drain water from access routes as often as possible, and always at first chance and last chance locations (areas immediately before and after stretches where drainage is not feasible. Erosive runoff water should be diverted from the access roads as shallow, non-erosive flow using rolling dips, crowning, cut-off drains, and water bars into passive water harvesting systems such as swales, infiltration basins, biological flow spreaders and multi-level perennial vegetation.
- Maintain access routes regularly - A stitch in time saves nine.

For reporting purposes, access routes have been divided into two categories: roads and human/animal access paths.

Roads

Roads refer to any access routes that are designed and built to accommodate vehicle use. Roads typically have a specially prepared surface designed to sustain vehicle traffic during four-seasons-in urban and suburban areas with heavy vehicle traffic this surface is usually asphalt or concrete laid on a compacted base course, but most ranch and farm roads still utilize dirt and gravel road surfaces.

Existing Conditions

Mission Road delineates the Western property line at DFR. It is composed of gravel road base and runs at ~6.5% grade down to the intersection with the DFR driveway (Jordan Way), which is also composed of gravel road base and runs at ~2.7% grade to the main house. The driveway continues to the lower garage. A loop composed of gravel road base runs in front of the shop, connecting to Mission road at two locations allowing for bidirectional access to the shop and larger shop area. All other access routes on the DFR property are currently dirt roads and require a 4-wheel drive vehicle to access. The two vehicle paths leading directly up the East-facing slope from the main house to the shop reach ~35% grade at their steepest. The path heading from the garage across the West Valley Bottom and leading up to the future proposed home site has a maximum grade of ~22%. At the base of the toe slope upon which the proposed future home site is located, an access track branches to the east, with a maximum grade of 15%, and runs along the East Valley Bottom once permitted by the property fence line.

Figure 3-1

Existing access routes for Doe Family Ranch – Driveway, Future Homesite, East Valley

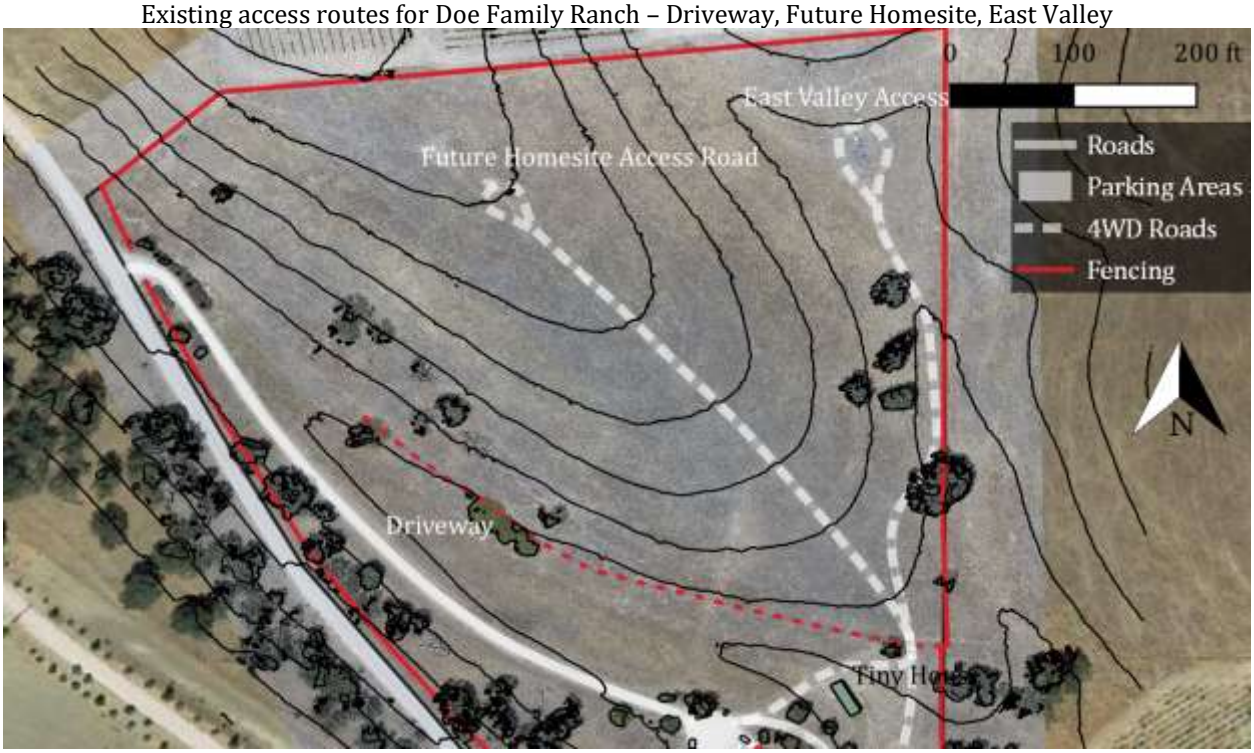


Figure 3-2
Existing access routes for Doe Family Ranch – Residence, Garage, Shop

Recommendations

The following is recommended to improve road access on the property:

- Construction of a "milling pit" near the Shop by excavating soil to create a sunken, level area in between the west and east Shop access road. Access can then be created for the milling pit from both the north and south sides.
- Improve drainage at Mission Road/Driveway Intersection, including:
    - Re-grading of the section of Mission Road just uphill of the turn onto the DFR Driveway to keep water on the west side of the road until it reaches the culvert at the northwest corner of the property. This may entail raising the roadway level slightly in order to ensure water transits through the culvert and not across Mission Road.
    - Installation of a rolling dip at the intersection of Mission Road and the DFR Driveway to redirect water flow from Mission Road onto the property. A rolling dip is a long, shallow depression in a road with a very slight elevation drop that crosses the road at a diagonal towards a desired lead-out point where water can be safely discharged from the road surface. This rolling dip should direct any water flow down Mission Road into the culvert entrance, rather than down the driveway.
- Raise grade of driveway where it dips down to the level of the valley bottom to ensure runoff through the valley does not pool in the driveway.
- Limit use of existing 4WD access routes from the Main Residence to the Shop.

- Improve East Valley access road to allow for truck and trailer access.
- Reconfigure area around Garage to provide additional parking, and add signage/lighting to direct overnight guests to area.
- Create a level trailer pad and parking area in the East Valley for the Tiny Home or other future trailers.

Milling Pit Construction and Updated Access Near Shop

The lumber mill is currently located near the Shop. It is the first thing people see as they are approaching the property. The lumber mill is very close to the neighbors, and the noise from the milling operation is of concern to the well being of long-term neighbor relations.

Figure 3-3
The mill, as seen when approaching the property

The construction of a "Milling Pit" is recommended in the same area where the mill is currently located, as shown in Figure 3-4. By excavating out the area so it is level with the downhill edge of the mill area (on the backside of the Metal Shop), the mill will drop several feet below the level of the access road to the southwest. In addition to effectively removing the mill from the neighbor's and approaching vehicles' views, this earthen buffer will greatly reduce noise. A retaining wall on the west and southwest sides of the pit can be used to increase the size of the milling pit area, and also extended as high as necessary to create further sound reduction. The excavated material can be used to further elevate the access road forming the western border of the milling pit, further reducing sound infiltration into the neighboring properties. Access to the milling pit area will be via the southeast side, from the Shop parking area. Several photos of the existing milling area proposed for excavation are provided below.

Figure 3-4
Proposed milling pit excavated area, access, and compost toilet near shop

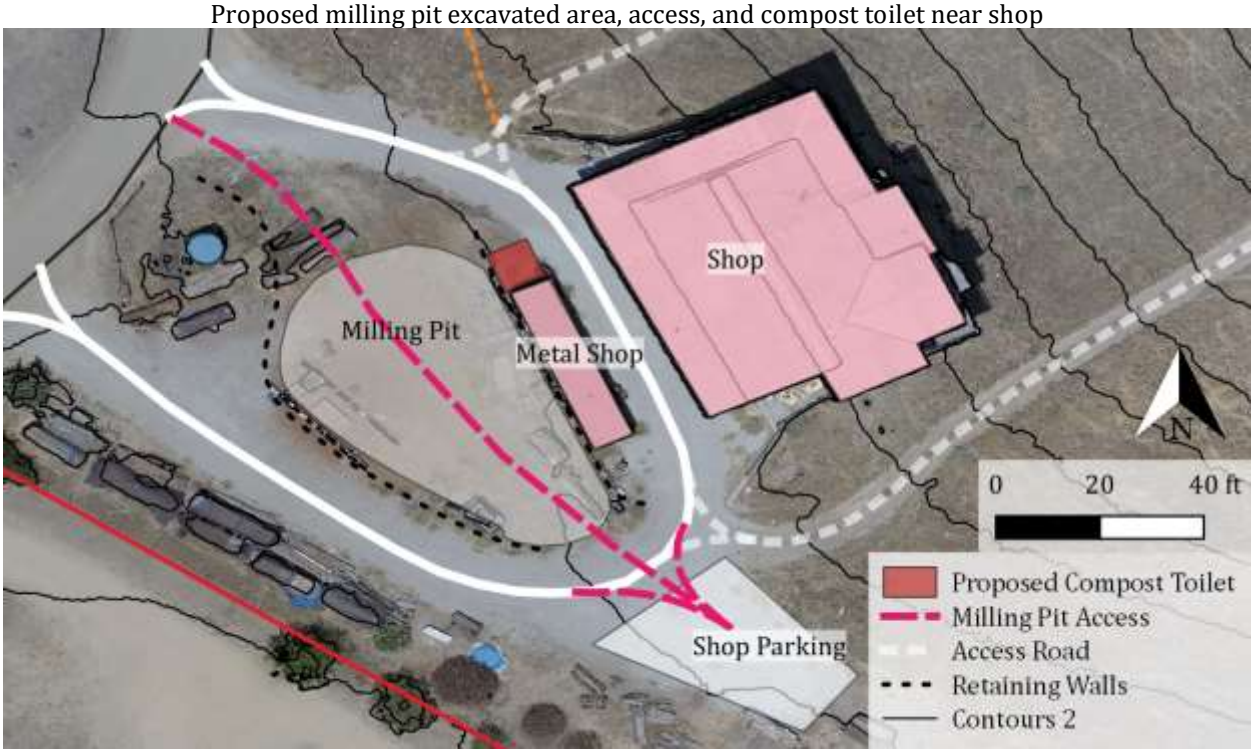


Figure 3-5
The milling pit area, as seen from the Shop parking area

Improving Drainage at Mission Road/Driveway Intersection

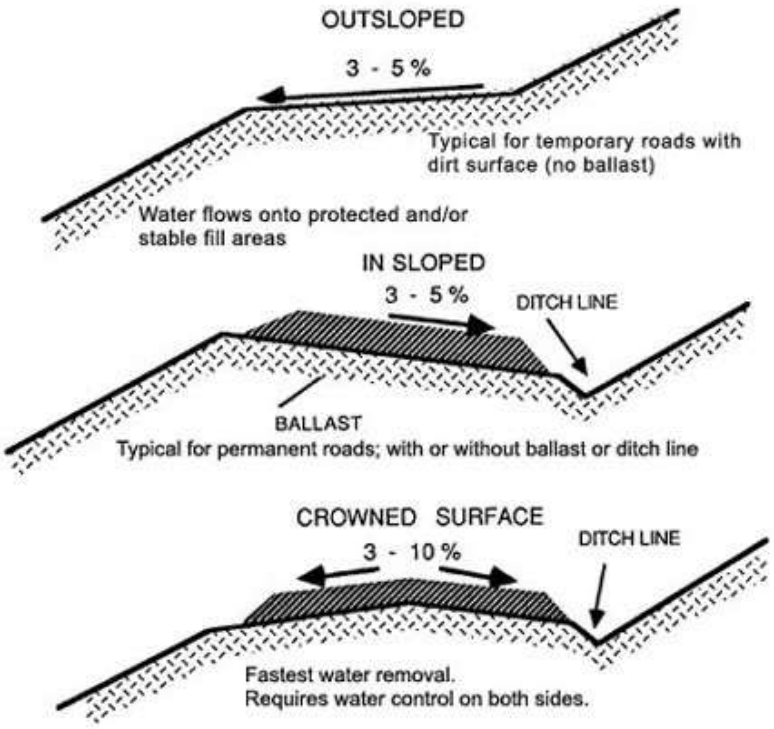
The portion of Mission Road between the Shop and the driveway entrance is crowned, and some of the sheet flow down the road during a rain event was noted to be traveling down the east side of the road, collecting and ultimately flowing into the south side of the driveway. Past erosion issues

are apparent here; rocks have been installed to remedy it, however the erosion continues, as shown in Figure 3-6.

Figure 3-6
Erosion on south side of driveway entrance

The section of Mission Road just uphill of the turn onto the DFR Driveway should be regraded to an inslope in order to keep water on the west side of the road until it reaches the culvert at the northwest corner of the property. This may entail raising the roadway level slightly in order to ensure water transits through the culvert and not across Mission Road. Insloped, outsloped, and crowned roads are illustrated in Figure 3-7 below.

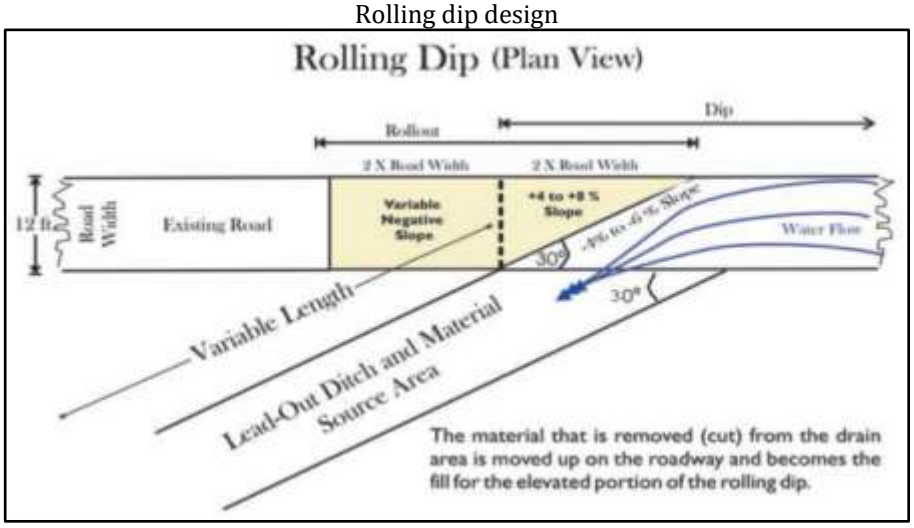
Figure 3-7
Road drainage design



The regrading of the road from the shop to the driveway is the best long term solution to reduce both road erosion and issues at the driveway for DFR. If for some reason the regrading of the road is not possible, the installation of a pickup point in the form of a rolling dip is recommended to direct any runoff at the transition from Mission Road to the DFR Driveway into the culvert on the west side of the road. A rolling dip is a long, shallow depression in a road with a very slight elevation drop that crosses the road at a diagonal towards a desired lead-out point where water can be safely discharged from the road surface. The long shallow nature of the dip ensures that the road maintains comfortable high speed vehicle passability, while the slight grade from one side to the other ensures that the water exits the roadway without puddling , pooling, or deposition, but moves slowly enough to prevent any erosion. The most thorough literature on the construction of rolling dips is the text "A Good Road Lies Easy on the Land" by Bill Zeedyk[2]. A plan view of a rolling dip is shown in Figure 3-8.

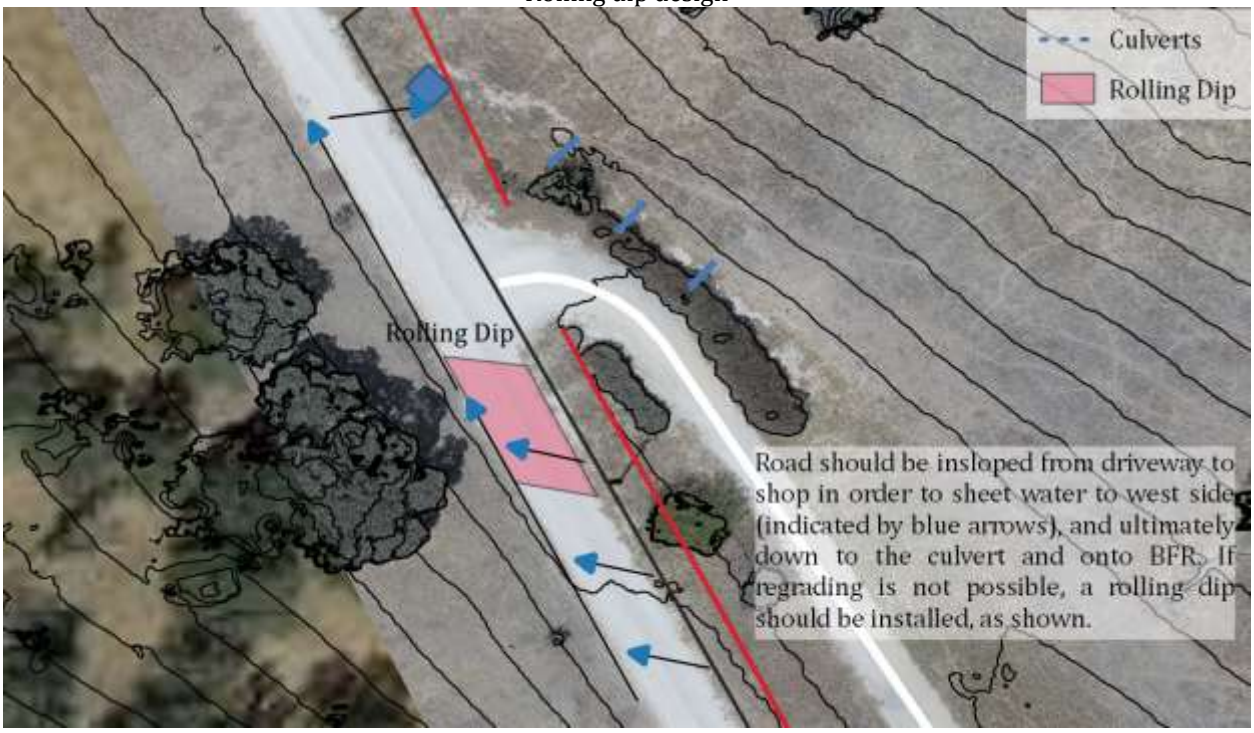
[2] https://quiviracoalition.org/good-road/

Figure 3-8
Rolling dip design



The road improvements are illustrated in Figure 3-9.

Figure 3-9
Rolling dip design



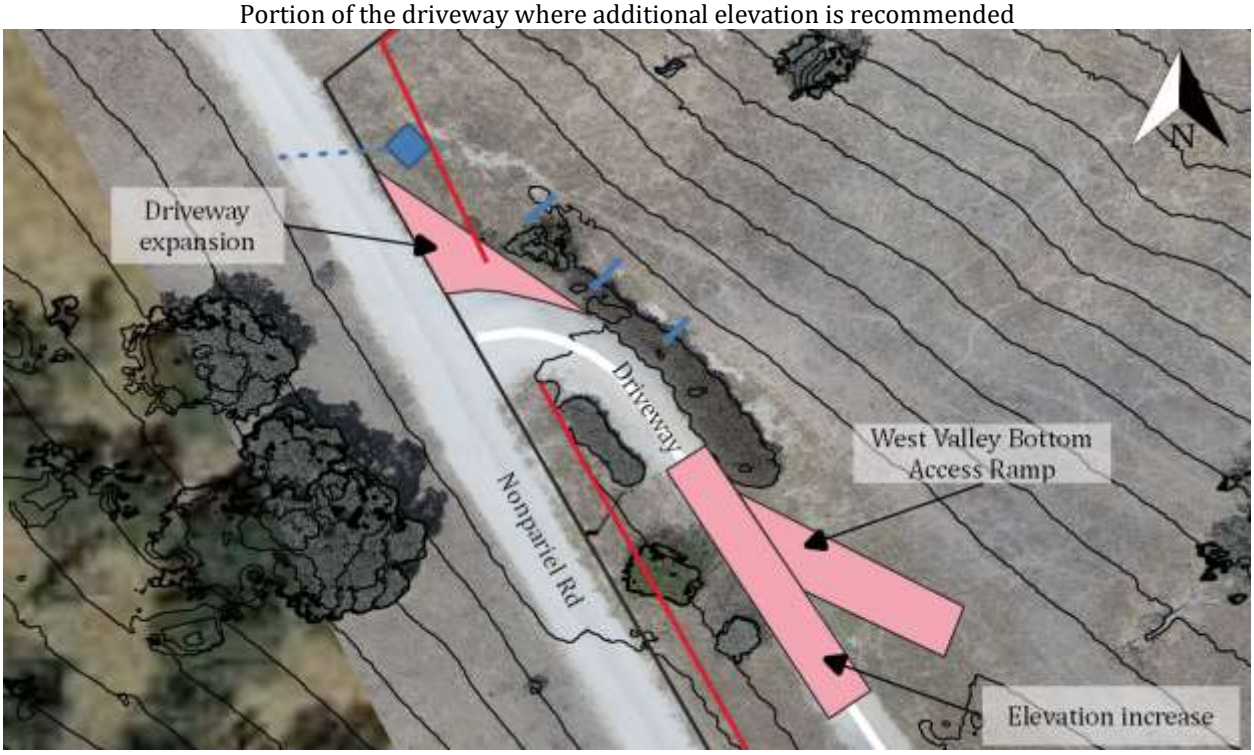
Operations and Maintenance – Culvert Inlet

During one of the site visits, it was noted that the inlet to the culvert that crosses Mission Road just north of the driveway entrance was above the lead-out ditch grade, resulting in pooling water below the inlet. However, during a site visit several months later, the culvert inlet was noted to be at grade with the lead-out ditch. The culvert inlet should be monitored in coming rain seasons to ensure that water is properly transiting through the culvert.

Driveway Improvements

Trucks with trailers and other large equipment destined for the lower portion of the property must drive past the driveway entrance heading north on Mission Rd, and then back down a very narrow driveway entrance which quickly angles sharply. Fill dirt from the milling pit excavation should be added to the north side of the existing driveway entrance to widen the entrance from Mission and facilitate easier access for vehicles backing into the property via the driveway, as shown in Figure 3-10. Also highlighted in the image is a portion of the driveway that is nearly at grade with the valley bottom. In a major rain event, water flowing down the valley bottom may actually move onto the driveway, which could ultimately lead to road issues. It is recommended that the road level be raised slightly in this area in order to ensure that any runoff in the valley does not flow onto the driveway. A ramp leading from this area down into the valley bottom can be created using additional fill dirt.

Figure 3-10
Portion of the driveway where additional elevation is recommended



Updated Access/Parking at the Garage

There is a Garage building southeast of the Main Residence that is currently used for storage. It is currently accessed from the driveway by a road that begins in the Main Residence parking area and continues on the northeast side of the residence to the garage and surrounding parking area. The level parking area in front of and to the west of the garage is currently occupied by an RV and a 20' shipping container used for storage.

In conjunction with recommendations for the installation of tent cabin platforms and a compost toilet facility in the surrounding area, and the conversion of the Garage into a bathhouse for workshop attendees (all further detailed in Chapter 5 – Structures), it is recommended that the RV

and storage container be relocated to the storage area near the Shop in order to free up the area around the Garage for workshop attendee/guest parking. The Garage, parking area (with RV and Shipping Container), proposed compost toilet, and two of the three proposed cabin platform locations are illustrated in Figure 3-11.

Figure 3-11
East Valley Access Road Modifications

The transition from the driveway upon pulling up to the home into the more public backyard spaces and the parking area around the garage should be made very clear and welcoming. The road leading from the driveway to the future proposed parking area near the existing garage/backyard area should be clearly marked with welcoming signage and roadside lighting directing guests.

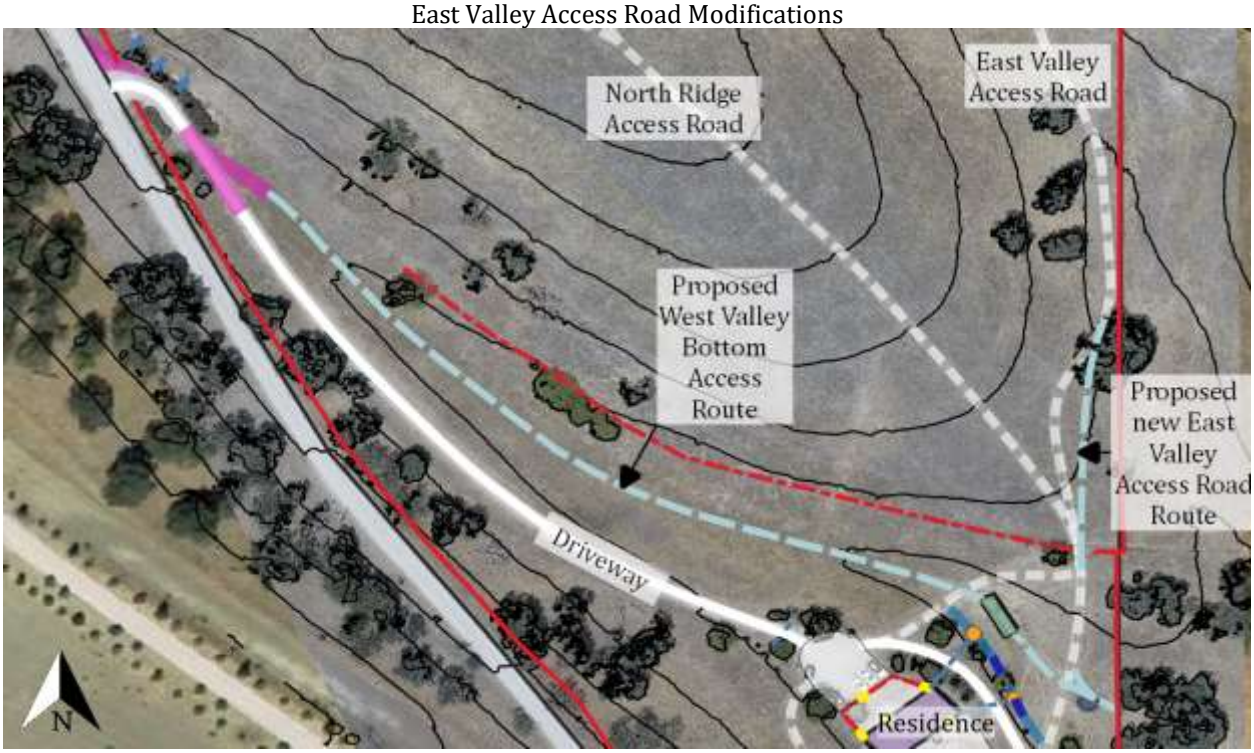
Valley Access Road Modifications

Any trucks with trailers destined for the Main Residence area or East Valley will require access through the West Valley bottom. It is suggested that, when implementing the agroforestry and orchard systems detailed in Chapter 5, a vehicle access track be kept clear in the valley bottom from the proposed West Valley bottom access ramp (detailed in Driveway Improvements above) to the south fence. This will enable a vehicle to back down the valley all the way to the fence when soil conditions permit, and then turn onto the East Valley access road.

Additionally, the access road leading from the West Valley into the East Valley has a manageable grade for truck and trailer passage with the exception of the portion just north of the break in the internal fence, where it has a grade of 15%. There is a route lower on the ridge that the road could take through that section, shown in Figure 3-12, where the grade would only be 8.5%, improving passage and making it feasible to tow trailers and other equipment into the East Valley.

The access road is illustrated in Figure 3-12 below.

Figure 3-12
East Valley Access Road Modifications

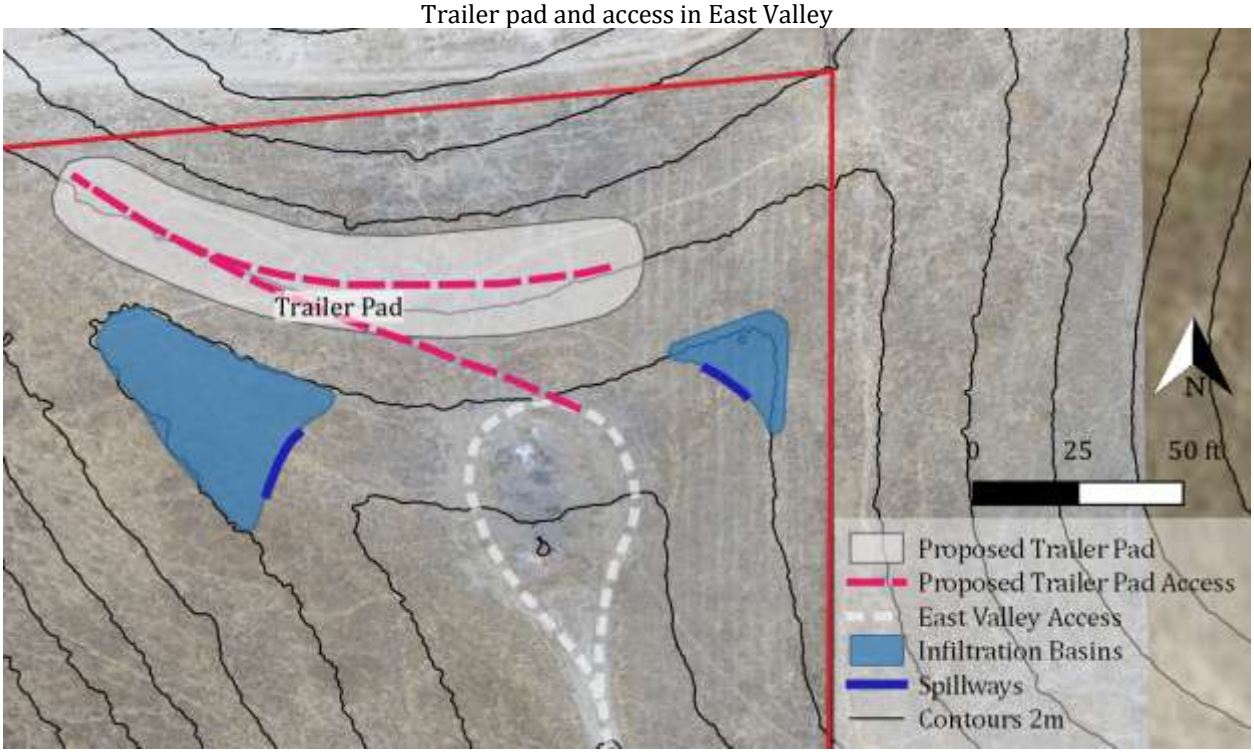


Trailer Pad in East Valley

The toe of a ridge lies between two drainages from the neighboring property at the far north end of the East Valley. This area is private and has a decent view down the valley and onto the neighboring properties. The area just below the toe, where the two drainages meet, is currently being used for a burn pile. There is a seasonal access road with a turn-around that leads to the area through the East Valley.

A pad could be graded onto the toe of the ridge for a trailer, and the access from the turnaround could be extended onto the trailer pad, as shown in Figure 3-13. The tiny house in the West Valley bottom could potentially be moved there to provide more privacy for both families, or it could be used as a camping spot for any guests.

Figure 3-13
Trailer pad and access in East Valley



Limit Use of Existing 4WD Roads to Shop

Due to the fragility of the soil and the steepness of the grade, consistent use of the two existing 4WD tracks from the house to the shop (shown in Figure 3-14) will ultimately lead to downcutting, which dramatically increases the erosion risk (and erosion mitigation cost) of this east-facing slope. The two 4WD tracks leading up to the shop from the main house should be used as sparingly as possible. Use should be minimal or non-existent when soils are wet or during precipitation events.

Figure 3-14
Shop 4WD access roads

Human/Animal Walking Paths

The paths described in this section are only built or recommended for human and animal walking access. They may be large enough to accommodate a wheelbarrow or handcart, though in many cases may only be suitable for foot traffic due to steepness.

Existing Conditions

There are few existing dedicated foot paths on property. Most of the transit between structures happens on the vehicle access roads. There is a footpath leading from the Main Residence parking area to the backyard around each side of the house, however neither is clearly marked or particularly welcoming at this time.

Evidence of animal access paths on the hillsides is evident (dogs, rogue cow, deer?).

Recommendations

The following new walking paths, or modifications to existing walking paths, are recommended:

- Improvement of pathways that lead from Main Residence parking area to backyard area
- Installation of a switchback footpath from the Main Residence backyard/Future Village to the Shop.

Improve Pathways from Main Residence Parking Area to Backyard

The paths from the Main Residence parking area around the east and west sides of the house into the backyard should be widened, leveled, and be visibly marked with welcoming signage and

pathway lighting to help transition guests from the parking area to the backyard area. The pathways are shown in Figure 3-15 below.

Figure 3-15
Proposed footpaths between Main Residence parking area and backyard

For the pathway on the west side of the house, the section of fence/gate forming the west boundary of the front yard simply needs to be straightened to connect with the corner of the house, as shown in Figure 3-15 above and further illustrated in Figure 3-16 below, and the pathway area cleaned up and leveled.

Figure 3-16
Footpath along west side of Main Residence

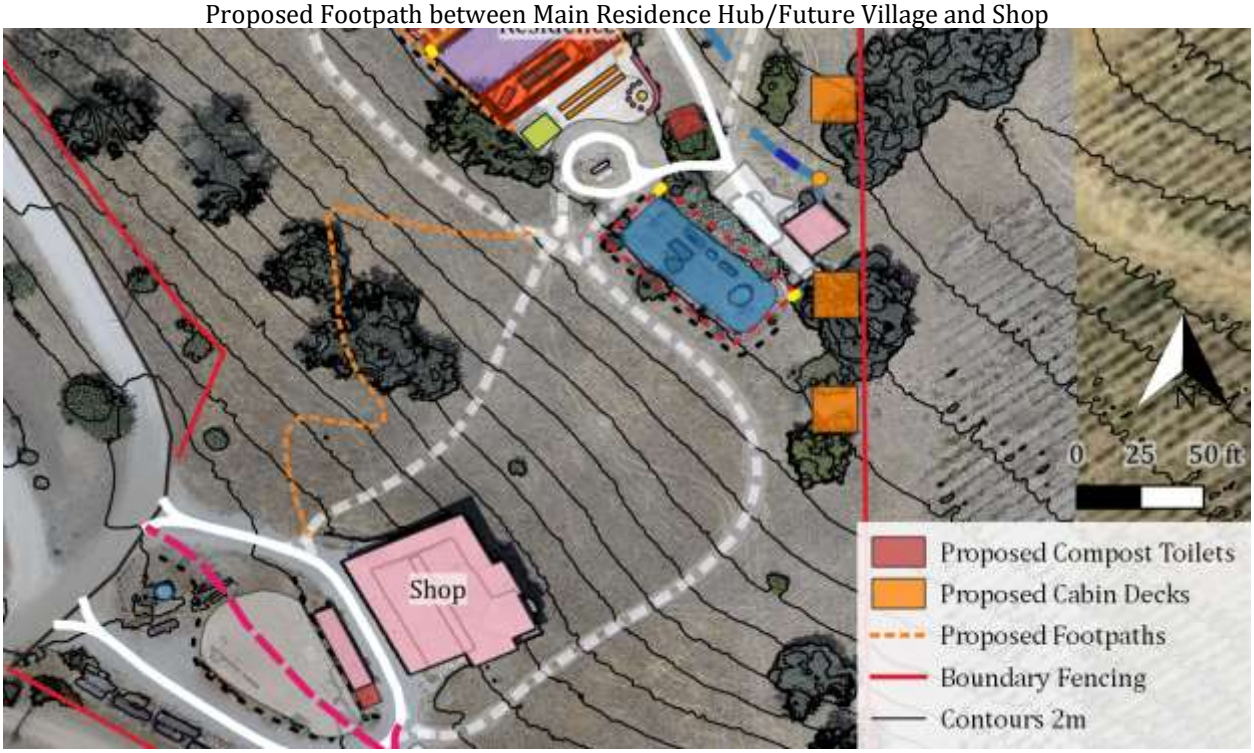
For the pathway on the east side of the house, it is suggested that the retaining walls on that side of the home (between the residence and the garage access road, shown below in Figure 3-17 be reconstructed to raise the grade of the path to the same level as the front and backyards. It is suggested that this retaining wall be extended to the backyard area to level the backyard area and expand the usable space, as shown in Figure 3-15 above. The backyard is discussed further in Chapter 5 – Structures.

Figure 3-17
Footpath along east side of Main Residence

Footpath from the Village/House to the Shop

A switchback footpath can be constructed leading from the Main Residence backyard area to the Shop to create a walkable "commute" and take pressure off of the fragile vehicle tracks on this hillside. A switchback path follows a zig-zag pattern up a hillside, which keeps the trail at a consistent gradient to minimize erosion and also provide for less steep of access.

Figure 3-18
Proposed Footpath between Main Residence Hub/Future Village and Shop



For more information about constructing a switchback path, see this excellent Forest Service video.

4 - Structures

In a good design, homes, sheds, animal shelters, greenhouses, and other buildings are placed in relation to on-site water patterning and desired/necessary frequency of access. This interconnected, efficient approach to element placement saves large amounts of energy over the lifetime of the site. Siting a home for a view (for example, at the highest point on the property) is often costly from an energy efficiency standpoint, as inefficiencies increase due to the reliance on mechanical sources to bring pressurized water to the site, comfort levels decrease due to higher wind speeds and greater temperature swings, and the cost of placing and maintaining a road up a slope is greatly increased.

Designing with a consideration for the entire site provides foresight that enables expansion to happen intentionally and consciously. When site patterns are examined, such as topography, natural water features, access, and environmental and human sectors, the ideal positions for the various design elements quickly reveal themselves. Even if a home or other structures were already present in less than ideal locations when the land was purchased, any future structures can be placed with these principles in mind.

Context

The existing structures at DFR are shown in Figure 4-1. A summary of any applicable county/city building codes and restrictions, as well as an analysis of environmental and human sectors at the main residential sites on the property, is provided below.

Figure 4-1
Existing structures at Doe Family Ranch

Restrictions - Building Codes / Permits / Legal Barriers

Building Code Restrictions and Permits

SLO County has especially stringent regulations on building. These codes should be thoroughly researched and taken into account when planning for the placement of additional structures on-property. The codes are available at the SLO County Planning and Building website.

Building permits information, forms, and submissions can be accessed at the SLO County Planning & Building website.

Septic Codes

Septic systems/hookups are required at this site.

Zoning ordinances

Doe Family Ranch is zoned for agriculture. The applicable zoning code for residential use on agriculturally-zoned land is 22.30.480, for which further information can be found in the SLO County Land Use Ordinance document. The property is permitted one primary dwelling and an accessory dwelling of up to 1,200 square feet, located a maximum of 250 feet from the primary dwelling. There is the opportunity for farm housing depending upon how the land is utilized.

Utility easements

The following utility easements exist at DFR:

- Electricity

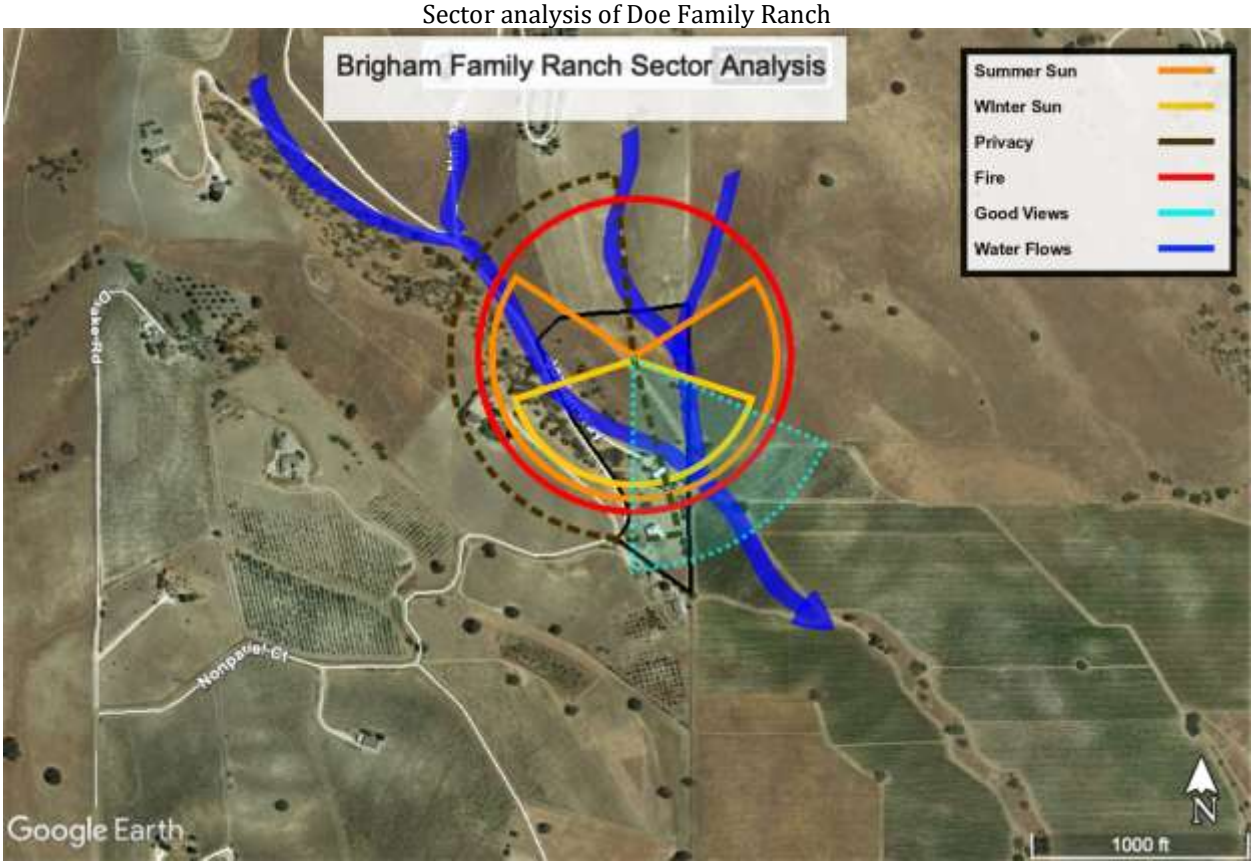
Home-Owners Associations

The property is not associated with any home-owners associations.

Sector Analysis

A sector analysis examines the natural environmental factors that affect a site. The sector analysis and a brief written summary of the sectors affecting Doe Family Ranch is provided below.

Figure 4-2
Sector analysis of Doe Family Ranch



- Solar Aspect & Access
    - Sun's relationship to structure siting, orientation, construction, materials
    - Main house is oriented Northeast by Southwest lengthwise, good opportunities for roof top solar PV and/or solar thermal.
- Physical Access
    - Mission Road approaches the property from the West.
- Visual Privacy / Exposure
    - Neighbors with direct lines of sight onto the property to the North, Northwest, West and South.
- Wind
    - See Wind Data section.
- Fire
    - Fire could approach the property from all directions. However, due to the barren condition of the neighboring properties and the surrounding vineyards, risk of catastrophic fire is quite low. Fast moving grass fires are the most likely fire vector, though do not pose a great danger to existing structures.
    - As additional vegetation is established on the property, careful attention should be paid to spacing, composition and species selection to ensure that fire danger is not increased. More information on this topic is available in Living With Fire - Part 2:

Regenerative Firescaping - Protecting Your Home With Good Design on the 7th Generation Design website.

- Security
    - Access to the property via Mission Road and Jordan Way (driveway to main house). The property is fenced, though the fence is fallen and has large gaps in numerous locations, permitting access by large animals (cow) and people. The driveway not gated at its intersection with Mission Road.
    - The entire property is visible upon from the point where Mission Road meets with the shop driveway loop. Visibility is also nearly complete from neighboring properties and dwellings to the North, Northwest, and West.

Homes

Homes for the purposes of this report are permanent structures intended to provide shelter and comfort for humans.

Existing Conditions

There is a single-story Residence (1,500 interior/1,780 roof sq-ft) on the west side of the West Valley Bottom. The rear of the home has a small deck and gravel entertainment area. The home is ideally positioned on the property to take advantage of favorable microclimate - its location at a higher elevation than the valley bottom makes the area warmer during the wintertime than it would be if located at the valley bottom, and it sees lower intensity hot and cold winds than it would if located at the top of a ridge.

Recommendations

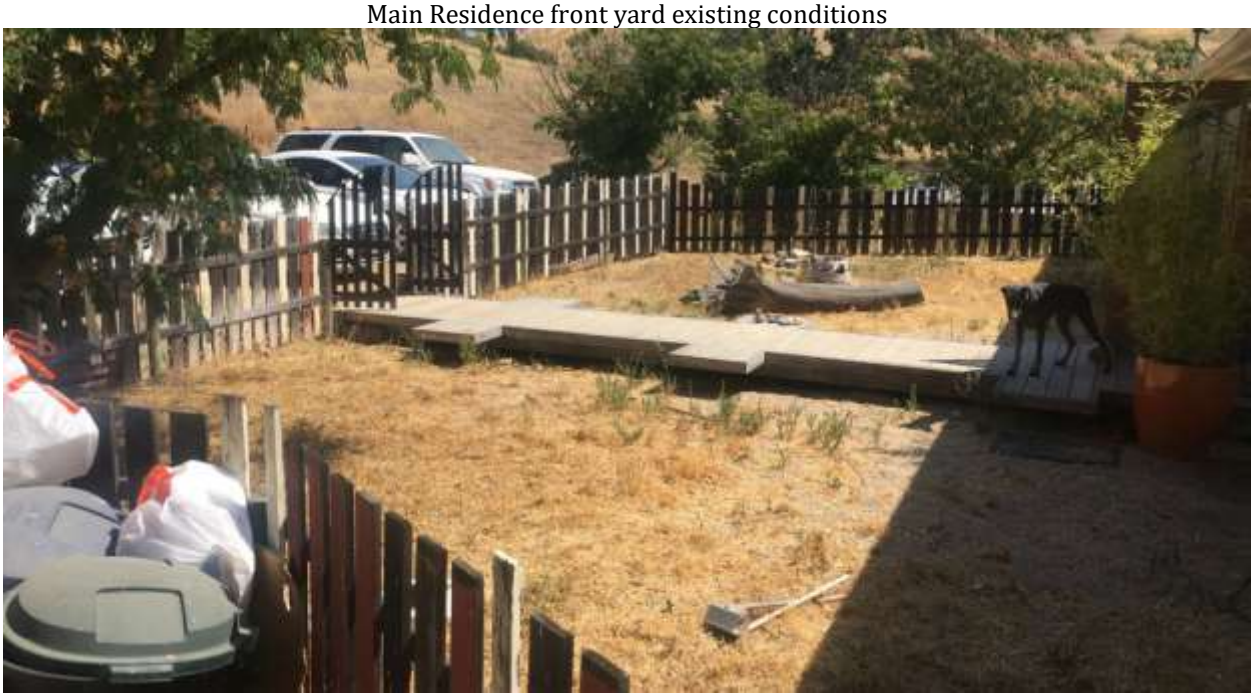
The following is recommended to improve the structural development on the property:

- Improve Main Residence front yard to provide a more welcoming arrival for residents and guests
- Improving Main Residence back yard area to serve as an improved hub for workshop after-hours activity and dining. Recommended elements include a partially trellis-covered, partially roof-covered deck along length of the house, outdoor kitchen, long dining table, perimeter seating, fire pit, and dedicated cornhole/ping pong/darts area.
- Construct a natural swimming pool at the site of the current poultry yard.
- Choose a site for the future home that takes into account the desire for a great view and the natural energetic costs associated with building at various points along a ridge toe.

Improve the Main Residence Front Yard

The Main Residence front yard is the area between the Main Residence and the parking area. It is currently bordered by a wooden fence, with a gated entranced that provides access from the parking area to a raised wooden pathway that leads to the front door, as well as two gates on the east and west sides of the property that lead from the parking area to the footpaths on each side of the residence (discussed in Chapter 3 – Access). There is a tree in the northeast corner, and a potted plant on each side of the front door, but the remainder of the yard is filled with dead grass and gravel, as shown in Figure 4-3.

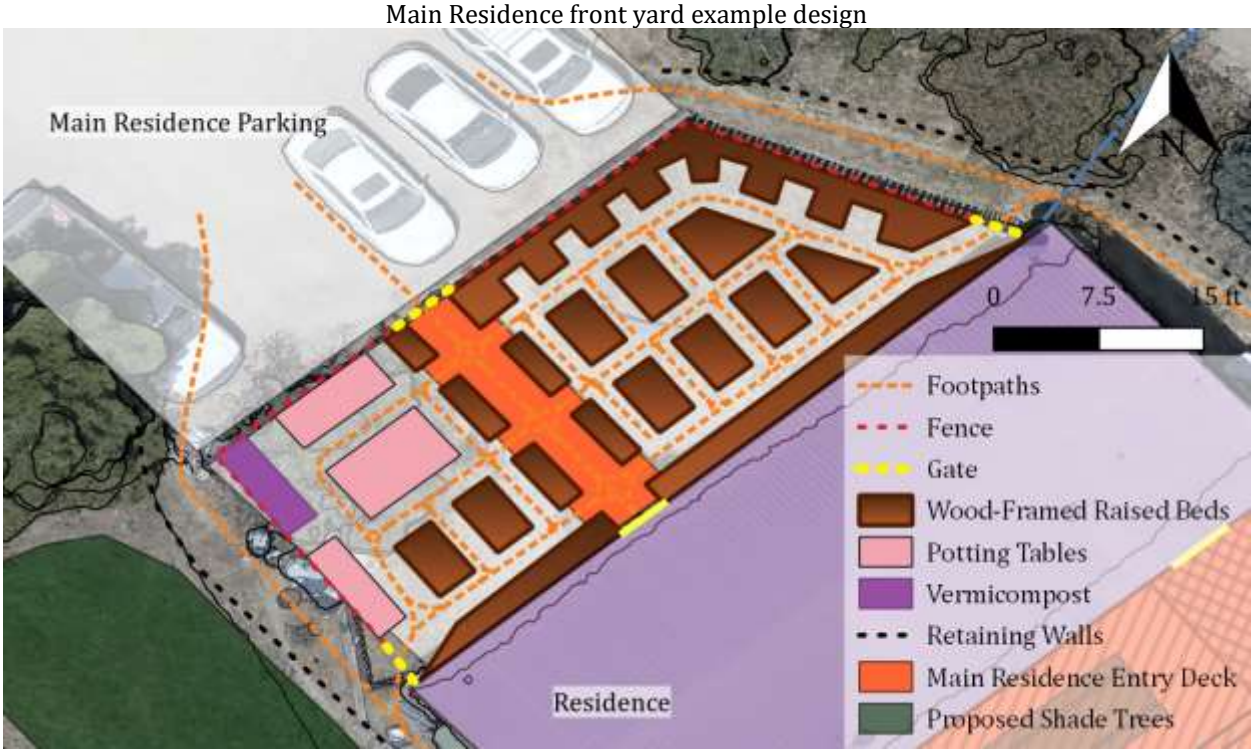
Figure 4-3
Main Residence front yard existing conditions



The front yard could be improved to provide greater function and beauty for the Doe family, as well as more welcoming energy for the residents, guests, and workshop attendees. The installation of raised beds along the perimeter, pathway, and interstitial areas will provide a significant area for growing food that will be much more easily and enjoyably tended than the current garden beds located in the poultry pen (gardens that are walked by daily are much easier to tend!). Deciduous fruit trees could be planted in the beds to provide fruits and nuts, and also protection from the sun during hot summer and fall months for perennial shrubs or annual veggies in the understory. Paths should be thickly mulched in order to reduce weeds and shade the soil. If a lawn area is desired, an area within the yard can be planted with drought tolerant grass.

An example of a garden bed/path layout that utilizes the existing wooden walkway and maximizes growing space for annual vegetable production in the yard is shown in Figure 4-4 below. The design features raised wooden beds along the walkway, "keyhole" garden beds along the fence (which maximize the garden bed/path area ratio), raised bed "islands" throughout the yard, propagation tables and a pass-through vermicompost system (discussed in the "Food Gardens" section of Chapter 5) to process with food scraps underneath the deciduous Albizia tree in the west corner to provide relief from the sun for seedlings during the summertime and full sun during the winter. An arbor built over the entrance gates can be planted with vines to provide a beautiful entrance to the garden space, and shrubs can be planted densely around the outside of the fence to provide a visual screen of the parking area from the garden. If intensive planting and management strategies are used, this area can provide a surplus of food for family, guests, and workshop attendees.

Figure 4-3
Main Residence front yard example design



For any wood-framed raised beds that are decided upon, "wicking beds" are suggested, which are discussed further in the Food Gardens section of Chapter 5 – Living Systems. These beds function particularly well in hot, arid climates.

There are of course many variations that can be explored in the front yard design, depending on the Doe family's goals. If less vegetable production is desired, the wood-framed beds creating the "islands" can be replaced with mulched mounds planted with dwarf fruit trees, or native flowering plants, etc.

Improve Main Residence Backyard - ("The Village" Heart)

The Main Residence backyard is centrally located and currently serves as the center for outdoor gathering and activity on the property, or the "Village Heart", for both residents as well as workshop attendees. Current elements include a wood-fired grill, fire pit, round table and chairs, hot tub, and lawn games including darts, ping pong, and corn hole. There is limited shade except on the southwest side under the oak trees planted on the slope. The existing backyard conditions are shown in Figures 4-4 and 4-5

Figure 4-4
Main Residence backyard looking north

Figure 4-5
Main Residence backyard looking northwest

The Village Heart could be improved to provide greater function and beauty for the Doe family for both personal use as well as the hosting of guests.

Functionally, the backyard area of the Main Residence (the "Village Heart") needs to perform a multitude of roles. It will act as the starting and ending point for most days spent on the property, for both residents and workshop attendees, and so needs to be a comfortable place for family and friends to gather but also be able to handle feeding and entertaining larger groups (15-20 people). The area needs to provide respite from the summer and fall heat but also warmth during the cooler winter and spring days.

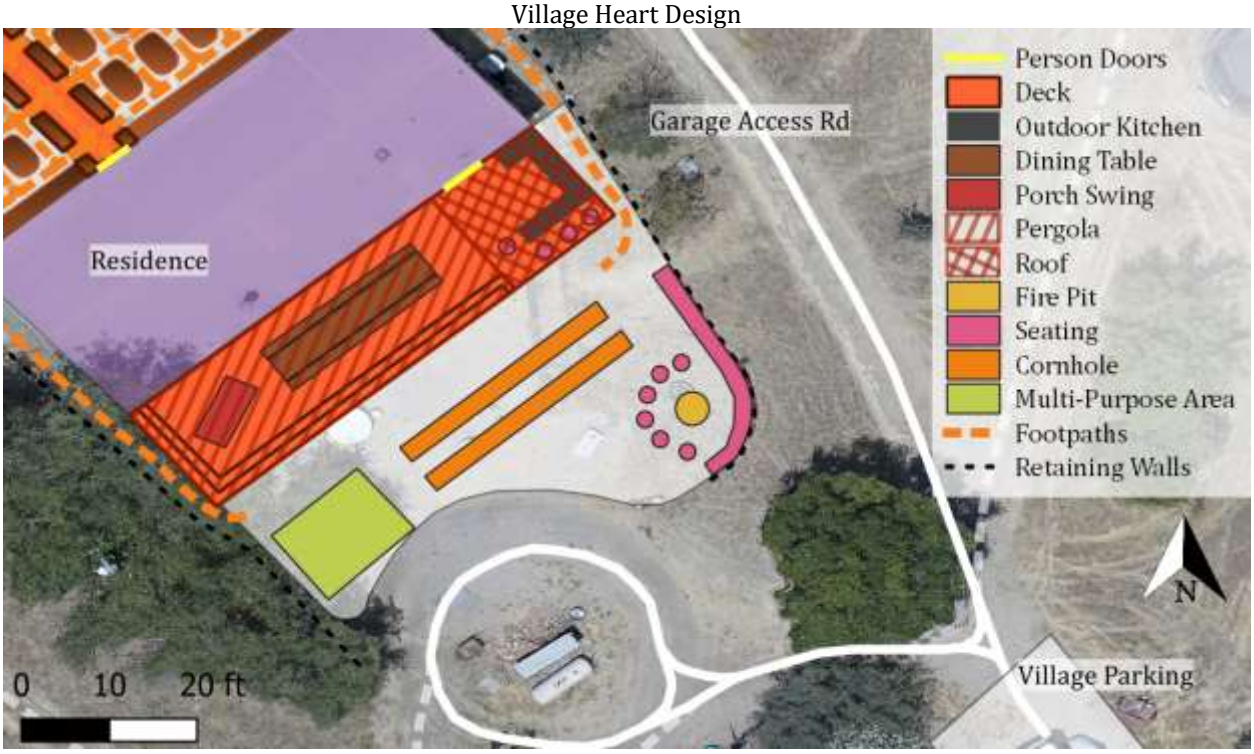
A list of the needs/functions that the space needs to fill, and the proposed elements to provide for those functions, is provided in Table 4-6.

Table 4-6
"Village Heart" Functions and Proposed Elements List

Needs/Function	Proposed Element
Flat graveled area for family and small groups to eat, sit, and hang out that is shaded during the hot summer and sunny during cool winter.	Trellis- covered deck along the entire length of the south side of the Main Residence, planted with a deciduous vine at the base of each column to grow over the trellis and provide summer shade and winter sun
Place to sit in circle and converse, play music, enjoy beverages	Circular seating area, with small tables and/or cupholders on chairs
Place to sit/stand around a fire	Fire pit located in center of circular seating area
Open area for multiple people to prepare food (prep table, cooktop, grill, bake), wash hands, clean dishes, etc. Shaded, close to residence kitchen, overflow refrigeration, overhead storage, nearby firewood storage, seating at bar	Outdoor kitchen located close to Main Residence backdoor, underneath all-weather covering. Prep table, Cooktop, Argentine-style grill, rocket oven, large single-basin farm sink, overhead hanging system for pots, pans, and food prep tools, undercounter storage for food prep equipment, tableware, and firewood. Seating along perimeter.
Entertainment area(s)	Ping pong table, cornhole alley, darts
Additional seating area further away from house	Outdoor table and chairs
Night-time illumination	LED wedding lights, LED pathway lighting from all cabins, compost toilet, bathhouse to Village Hub
Place to cool off, get wet, play	Natural swimming pool

The design of the Village Heart area is provided in Figure 4-6.

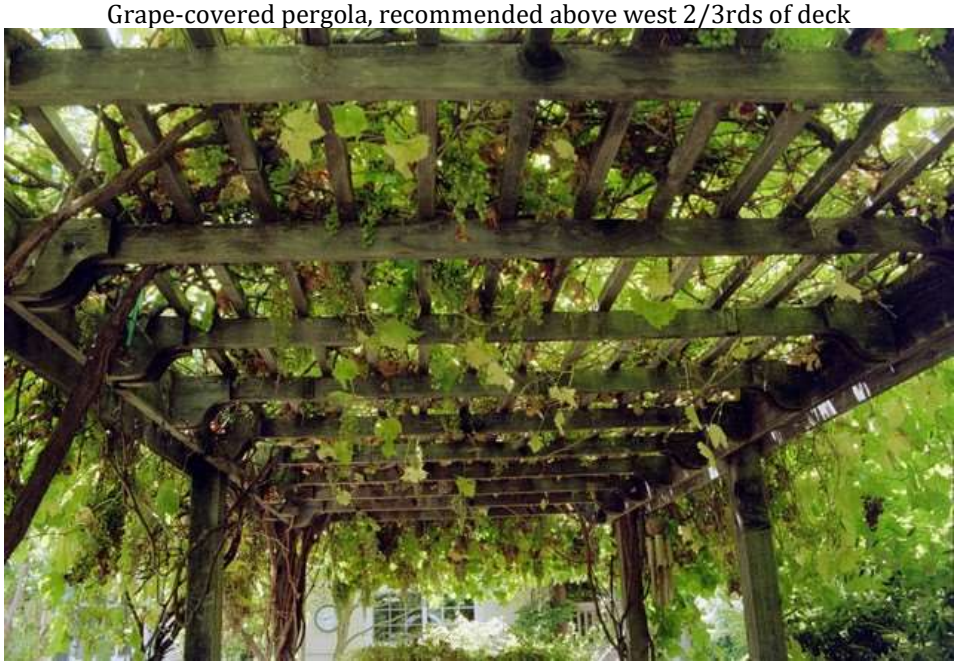
Figure 4-6
Village Heart Design



Deck and Trellis

It is recommended that the existing deck area be replaced or expanded for a deck built along the entire south-facing length of the Main Residence. The additional deck area will allow for an outdoor kitchen located near the back door on the east end of the deck (described in greater detail below), a long dining table in the middle of the deck, and a swinging seat on the west end. An impermeable covering is recommended for the east end of the deck, providing shade and rain protection for the backdoor egress and outdoor kitchen, transitioning to a trellis covering for the west 2/3rds of the deck, with deciduous grapes growing up the columns and over the trellis to provide shade during the summer and fall and sunlight during the winter and spring, as shown in Figure 4-7.

Figure 4-7
Grape-covered pergola, recommended above west 2/3rds of deck



Full-length steps are recommended on the west and most of the south side of the deck (not on the far east end, behind the outdoor kitchen seating, where a railing is suggested). This will provide plenty of access onto the deck from south side where most of the guests will be coming from, and also provide a place for people to sit and converse that looks out towards the gaming/gathering area and valley.

Outdoor Kitchen

Kitchens are a place that people invariably gravitate towards – gathering around food is a social activity that has likely taken place since the beginning of human existence, and everyone wants to know what's cooking when they're hungry.

Currently, the cooking for all of the functions near the Village Heart take place at the kitchen within the Main Residence, with the exception of any grilling, which occurs outdoors with the Santa Maria-style grill. An outdoor kitchen will help to relocate much of the food prep, cooking activities, and social gathering for guests from the indoor kitchen in the Main Residence to the outdoor area. The kitchen location and floorplan should be designed to accommodate the desire for people to gather nearby, the space required for multiple cooks, and the likely need to frequently transit between the Main Residence kitchen/pantry/refrigerators and the outdoor kitchen.

The proposed outdoor kitchen location is on the east end of the extended deck. This is located just outside the Main Residence backdoor and is ideally located for the likely frequent trips into the residence. By having the Outdoor Kitchen near the indoor kitchen, both facilities can share resources and complement one another's functional spaces to create an efficient and dynamic place for cleaning, preparing, cooking, and preserving food.

The proposed C-shape of the Outdoor Kitchen will allow for multiple people to be in the space helping to prep/cook food without it becoming dysfunctionally crowded. The cooks will have a great view of the Village Heart and down the valley. An impermeable roof covering for the whole area (including the egress from the backdoor) is recommended to keep the backdoor egress and outdoor kitchen area shaded, dry, and protected. The runoff from this roofing should be directed into the existing raingutter drain leading to the swales recommended in Figure 2-13.

Additionally, a counter should be built on the south side of the outdoor kitchen where people can sit, talk, and watch. People will put themselves in positions to see what is going on in the kitchen and engage with it, whether this archetypal human interaction is planned for or not. By having a counter with a good view of the kitchen heart, but not necessarily in it, people can feel invited to stop, pull up a seat, chat, and move on at their leisure while not disrupting the workings of the kitchen crew by being in the way. An example of an outdoor kitchen of a similar shaped to the one proposed is shown in Figure 4-8 below.

Figure 4-8
C-shaped outdoor kitchen with seating

Elements of the outdoor kitchen will ultimately best be decided by the Doe family, but some proposed elements include a prep surface, a large farm-style stainless steel sink, a hanging system from the covered roof for cooking equipment, and a cooktop. A grill and a pizza oven can also be incorporated. If a part of the Doe family's vision is to use wood to fuel the outdoor kitchen cooking processes, there are several options that will fulfill the needed functions as outlined in Table 4-2. If wood-fired cooking equipment is used, a storage space in the outdoor kitchen for fuel should be designed for, as fuel addition will be a frequent task during cooking.

Table 4-2
Wood-Fired Outdoor Kitchen Functions and Elements

Needs/Function	Potential Design Elements	Description
Oven	Rocket Stove Barrel Oven - a (stick-fueled rocket stove linked to 55 gallon barrel oven) (book and video documentary)	Large, quick to heat oven, entirely wood fired, excellent for baking, performs similarly to a standard gas oven.
Oven	Double Chamber Cob Oven (video of Double Chamber oven warming up)	4x cleaner burn than a traditional cob oven, heats up rapidly, maintains heat for up to 8 hours for multi-dish cooking.
Cooktop	Walker Stove Riserless Core Rocket Cook Top (video walk through)	Flat griddle cook top for flameless cooking, stick fueled, very efficient and clean burn.
Grill	Santa Maria Style Grill	Large roasting surface (whole animal cookery), adjustable height of grill surface to flames/coals, great for community feasts.

Seating Area and Fire Pit

Along the south end of the retaining wall proposed to level the east side of the house and Village Heart, a wooden bench with a backrest is proposed. This bench will follow the line of the retaining wall, eventually wrapping back towards the Village Heart on the south end. At the center of this curve, the fire pit is recommended, with additional seating on the opposing side from the bench. This bench will create a boundary on the perimeter of the Village Heart and a feeling of enclosure, while also providing plenty of seating for guests to face into the space and converse, watch the games, or enjoy the fire. An example of a wrap-around bench with a backrest is shown in Figure 4-9. The final shape and design of the bench can be determined as the backyard development occurs.

Figure 4-9
Example of a wooden wrap-around bench with backrest

Multi-Purpose Area

The existing concrete platform and the area south of the deck is left open in the design to serve a variety of uses. The concrete platform could be used as a stage for any live music, and the area south of the deck left open for dancing and gathering. A folding table and chairs can be set up on the concrete platform for additional dining seating, or to relocate dining to that area if quietness next to the house is desired. Or, a folding ping pong table can be set up on the concrete platform, and there is room for multiple corn hole game setups in the space south of the deck to create a gaming area.

Natural Swimming Pool

The Doe family has conveyed a desire for a swimming pool on property. There has been conversation about this swimming pool being located on the crest of the southeast-facing ridge near the future homesite. It is recommended that this pool be instead located in the site of the existing poultry yard, as shown in Figure 4-10 below.

Figure 4-10
Proposed location of the natural swimming pool at DFR

The main benefits of locating the pool on the ridge are the proximity to the future residence, as well as the access to additional gravity-fed water in the event of an emergency. However, on the ridge it will be most exposed to the heat, winds, and energy sectors. Additionally, if property guests and workshop attendees would like to use the pool, they will be required to transit the property and pass the future Doe residence. Placing the pool at the location of the existing poultry yard will better centrally locate it – it will be passed by everyone walking to and from the Shop, and is quickly accessed by everyone in the current Main Residence as well as the future guest cabins. It is within sight of the Village Heart, making for easy monitoring from the activity hub, and it will be less windy, resulting in more comfortable swimming throughout the day.

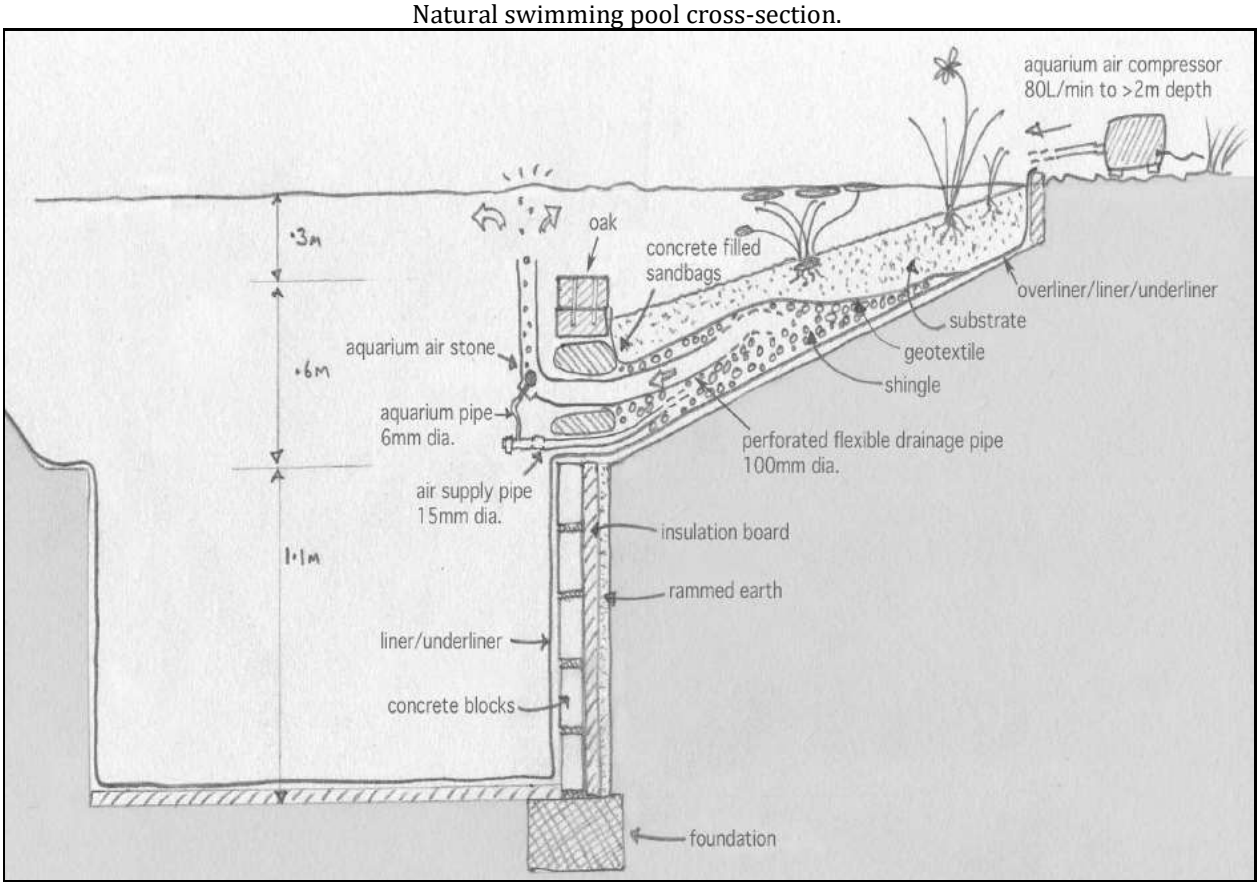
The poultry yard is fairly flat – a retaining wall can be built along the west side to better level the area, and also create a natural area for people to sit, place towels, etc. The poultry can be placed in a mobile chicken coop, and moved along the valley bottoms to better take advantage of on-site food sources and spread fertilizer. The pool can be designed to accept roof runoff from the Shop up the hill, and any overflow can be designed to drain into the swales accepting the roof runoff and greywater from the Main Residence and Garage.

As for the design of the pool itself, natural swimming pools are gaining in popularity as awareness continues to grow about the negative health consequences of swimming in chlorinated or otherwise sterilized water. Natural swimming pools mimic the water filtration and purification processes found in nature while also providing a dedicated swim zone. Natural pools can come in many different shapes and forms while still adhering to a consistent set of design principles that ensure high water quality, safety, fun and beauty.

Figure 4-11
David Pagan Butler's natural swimming pool in the UK.

Natural swimming pools utilize riparian planted zones to filter and purify the water and decrease available nutrient levels to maintain clarity. However, simply depending on natural temperature fluctuations and air movement to circulate the water column adequately to create a reliable safe and clean swimming environment would be insufficient in most cases. The design detailed in Figure 4-12, developed by David Pagan Butler, utilizes air lift pumps, essentially air stones set inside vertically arranged pipes, to lift water while simultaneously aerating it (good for plants and desired aquatic creatures) and pulling it through the established root net of the riparian plantings. Air lift pumps have no moving parts (only bubbles!) and are so gentle that frogs and fish can pass through unharmed, unlike typical submersible pumps.

Figure 4-12
Natural swimming pool cross-section.



By using air to lift the water column ever so slightly (6") a subtle but consistent vacuum is created that actively pulls water through the riparian root zone before aerating it and lifting it to the upper water strata of the pool. There are no submersible pumps, no noisy and expensive pump houses, and no large electric bill. A typical natural pool can be cycled using a single 60 watt air compressor, which can be run off a set of solar panels and a small battery bank. Additionally, air lift pumps can be used to lift water through a natural, gravity-fed water filtration system to keep the pool clean of debris.

Natural swimming pools built in this style are much more affordable, in both construction and lifetime maintenance costs, when compared to mainstream, hard bottom swimming pools. They are also healthy to swim in and require absolutely no chemicals.

Two important things to keep in mind when constructing a natural pool are 1) surface flows are not good to introduce directly into the pond (i.e. having surface run-off channeled into the pond is a bad idea due to high nutrient levels) and 2) this type of soft bottom pool can only be constructed in areas where the water table does not rise above the height of the bottom of the pool (because the pool bottom is pond liner held down by the weight of the pool water, should ground water "push up" from underneath the pond liner will rise and the shape and function of the pool will be degraded.

Natural Swimming Pool Resources

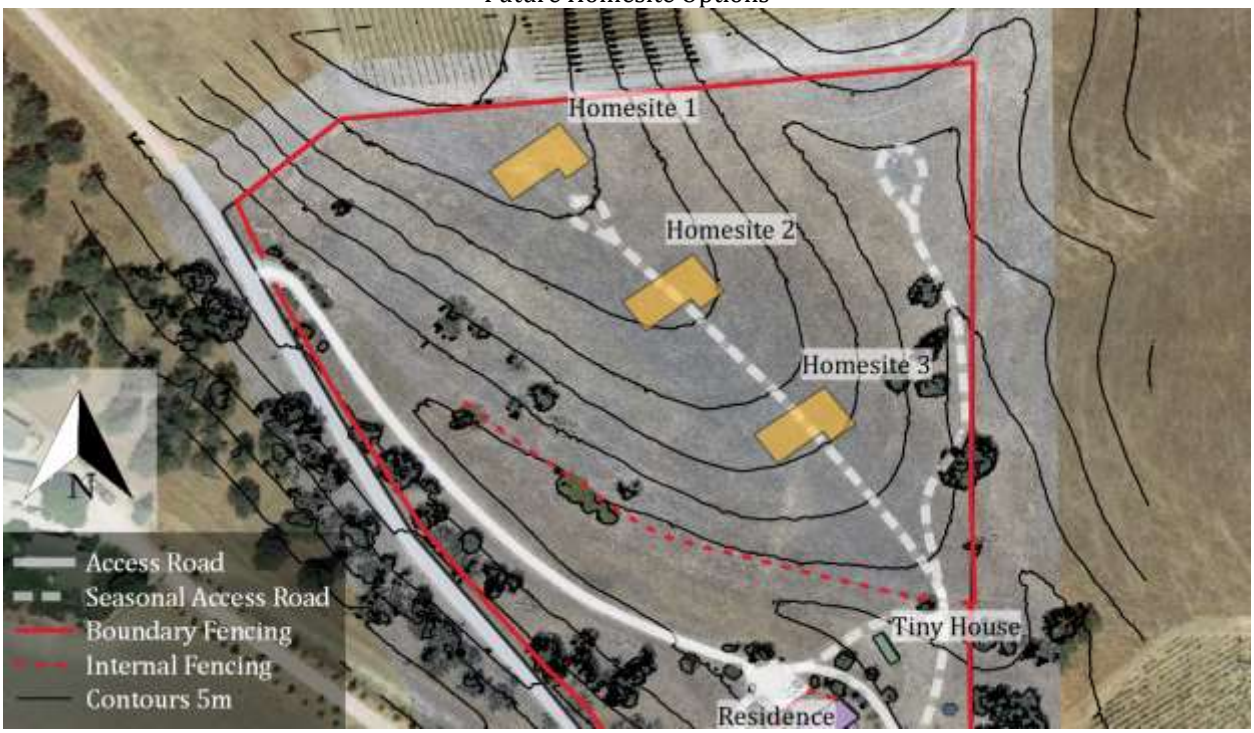
David Pagan Butler of the U.K. has been largely responsible for popularizing natural pools during the past decade. His websites, manual and YouTube channel are excellent resources for inspiration as well as the nuts and bolts of actually building a natural swimming pool.

- David's YouTube Channel
- David's Website: OrganicPools.co.uk
- David's DIY Natural Pool Manual

Future Homesite Selection on Southeast-Facing Ridge

The Doe family has conveyed a 5-year plan to build a new residence on the crest of the southeast-facing ridge on the north end of the property. Three potential homesites on the ridge are illustrated in Figure 4-13. All three homesites are located on an exposed, tree-less south-facing slope, which means full summer sun (extreme heat) and full winter winds (strong and cold). Fast-growing deciduous shade trees (which will block summer sun but allow winter sun to pass through) should be planted around the selected site as soon as possible, and fast-growing windbreak trees (evergreen, to diffuse winter winds) should be planted on contour downslope of the home on the south-east facing ridge. Even if the exact size, design, and orientation of the home is not yet known, planting in the general area and giving these trees a head start will result in much more comfort when the home is built. Any trees that end up interfering with the house location can be removed at that time.

Figure 4-13
Future Homesite Options



The pros and cons of each homesite have been evaluated, with a summary provided in further detail in Table 4-3 below. Homesite 2 is a good middle-of-the-road selection, not just spatially but in terms of the pros and cons, and is the one preferred by the 7th Generation Design team.

Table 4-3
DFR Future Homesite Comparison

Consideration	Homesite 1	Homesite 2	Homesite 3
View	Largest and longest viewscape, with not only the Paso Robles area visible to the south but also the Santa Lucia ridgeline to the west	Good view of the valley. Santa Lucia ridge to the west slightly less visible than from Homesite 1	Good (but slightly reduced) view of valley. Sight of Santa Lucia ridge to the west is lost.
Grade Level/Sill	Broadest sill, which will result in the easiest (and thus least expensive) construction of a large level pad for the house, parking area, and outdoor zones.	Less of a broad sill than Homesite 1, though still substantial and larger than Homesite 3. This will reduce the size of the extended level area around the house.	Smallest sill – less room for parking/extended area adjacent to house, although the garage/parking area can be located further up the ridge.
Driveway Length	Longest driveway needed, meaning most cost.	Approximately 200 feet lower on the hillside than Homesite 1.	Approximately 380 feet lower on the hillside than Homesite 1. Lowest cost, though parking may be needed above the house, requiring the longer driveway.
Privacy	Neighbors to the West have full visibility (easily remedied with privacy screen plantings). No visibility from current Main Residence hub in the valley bottom (meaning also less sound infiltration from after-hours workshop activities).	It is slightly less exposed to the neighbors, but has some visibility from the current Main Residence hub in the valley bottom.	Least exposure to the neighbors. Full visibility of current Main Residence hub in valley bottom. (also, most sound infiltration)
Security	Full view of Shop, Mission Rd. No view of current resident hub in valley bottom (though a short (50 yard) walk further down the ridge provides this).	Full view of Shop and Mission Rd, and also has a bit of a view of the current main residence hub – meaning easy monitoring of after-hours activity	Good view of Shop and Mission Rd. Good view of Main Residence hub.
Winds	Most exposed to cool west summer winds, which is beneficial during warm summer days, but also most exposed to hot autumn east winds and cold winter winds funneled upcanyon.	A little lower on the ridge means slightly less benefit of cool west summer winds during warm summer days, but also slightly less intensity of cold winter winds funneled upcanyon. Hot autumn east winds will likely be no different here than at either of the other homesite options.	Lowest site on the ridge means less benefit of cool west summer winds during warm summer days (though still very present), but also slightly the least intensity of cold winter winds funneled upcanyon. Hot autumn east winds will likely be no different here than at either of the other homesite options.
Sun	Full sun exposure, and the most solar radiation on surrounding area during peak summer (meaning most heat). Least solar radiation during winter time,	Slightly less sun exposure (sun will hit homesite a later in the morning and disappear a little earlier in the evening.), Significant solar radiation during summer,	The least sun exposure (though still much more than the existing homesite in the valley bottom). Significant summer solar radiation, just like other sites, though also the most

Consideration	Homesite 1	Homesite 2	Homesite 3
	meaning less warmth..	though more solar radiation during winter than Homesite 1(more warmth).	solar radiation during winter time, resulting in the most warmth.
Water	Above the elevation of the current water tank, meaning no water supply without additional pumping equipment from further down the ridge, or installation of a new water tank at the top of the southeast-facing ridge with the future homesite. If a new water tank is installed, it is possible that the existing well pump can be utilized to fill this tank, depending on size – a new water supply line going up the ridge will be required regardless. An additional pump will be also be required to supply pressurized water from the new water tank to this homesite, for both domestic uses as well as irrigation for nearby plantings, as there will little to no gravity-fed water pressure available since both the tank and home will be located at nearly equal elevation. This also means no flowing water at the house in the event of pump failure.	Gravity pressure would be attained at the home if a water tank is installed higher up on the ridge (~10 psi estimated). A pump would still be needed to achieve typical residential water pressure, but having even low-pressure water flow would reduce the needed size of the pump, and is enough flow to serve as a backup in the event that the pump failed. The gravity pressure will likely also be sufficient for plantings requiring irrigation around the house. This homesite is at the same elevation as the existing water tank next to the Shop, which may mean, depending upon distribution system pressure drops, that the existing water tank can be utilized at the homesite with an additional pump/pressure tank installed in the home or in a nearby shed.	Gravity pressure would be attained at the home if a water tank is installed higher up on the ridge (~20 psi estimated). A pump would still be needed to achieve typical residential water pressure for sinks/showers, but only a small pump would be required, minimizing cost, and the gravity feed would be great as a backup in the event that the pump failed. The gravity pressure will be sufficient for plantings requiring irrigation around the house, and perhaps some other homesite functions. This homesite is at a lower elevation than the existing water tank next to the Shop, with an estimated 5-10 psi available at the site (depending upon pipe losses). If the existing water tank is used, this could potentially also serve irrigation plantings with need for the auxiliary pump,

Shops/Sheds/Outbuildings

Shops, sheds, and other outbuildings are permanent structures designed to provide indoor working space, storage or another function besides overnight accommodation.

Existing Conditions

There is a shop on the west side of the property (3,700 sq-ft roof area). There is a detached garage/shed at the bottom of the property (380 sq-ft roof area).

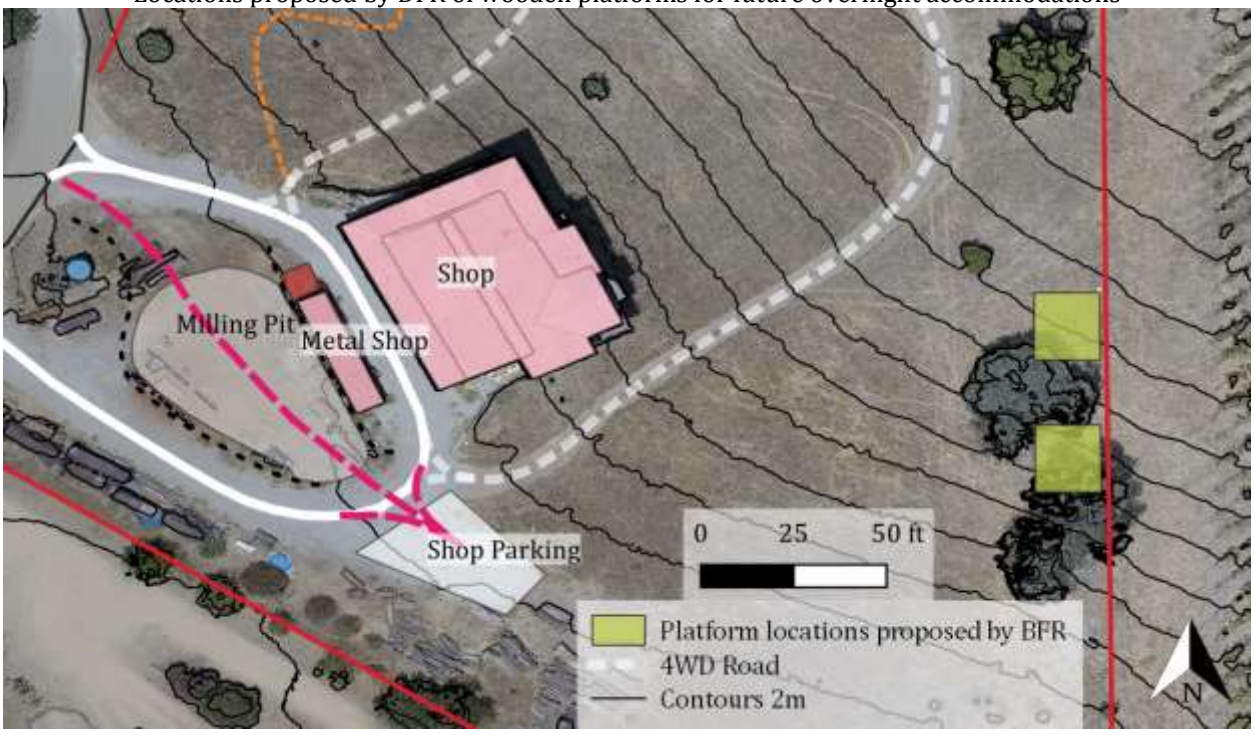
Recommendations

- Creating a "Village" for workshop attendees downslope of the main house along the East Property Boundary Fence, including three wooden decks for tent cabins or other temporary shelters, conversion of Garage into Lounge/Bathhouse, and two-chamber compost toilet.
- Constructing a two-chamber compost toilet facility next to the Metal Shop to serve Shop area workers/workshop attendees.

Guest "Village"

The Doe family has expressed interest in providing overnight accommodations for workshop attendees, who currently have to find off-site accommodation. Discussed accommodations thus far include 2-3 tent cabins assembled on top of wooden platforms. The location of the wooden platforms suggested by the Doe family are shown in Figure 4-14 below.

Figure 4-14
Locations proposed by DFR of wooden platforms for future overnight accommodations



It is recommended that the wooden platforms for future accommodations be instead located closer to the existing Garage and "Village Heart" (Main Residence backyard), as shown in Figure 4-15.

These locations are still on the north side of large shade trees, like the locations proposed by DFR, but are on less of a slope, and are closer to the "Village Heart" – resulting in easier access, a more connected feel to the community, and less risk of tripping and falling down a hill on the way to bed after some workshop after-hours festivities.

Figure 4-15
Locations proposed by 7GD of wooden platforms for future overnight accommodations, along with other elements of Village including Parking Area, Lounge/Bathhouse and Compost Toilet

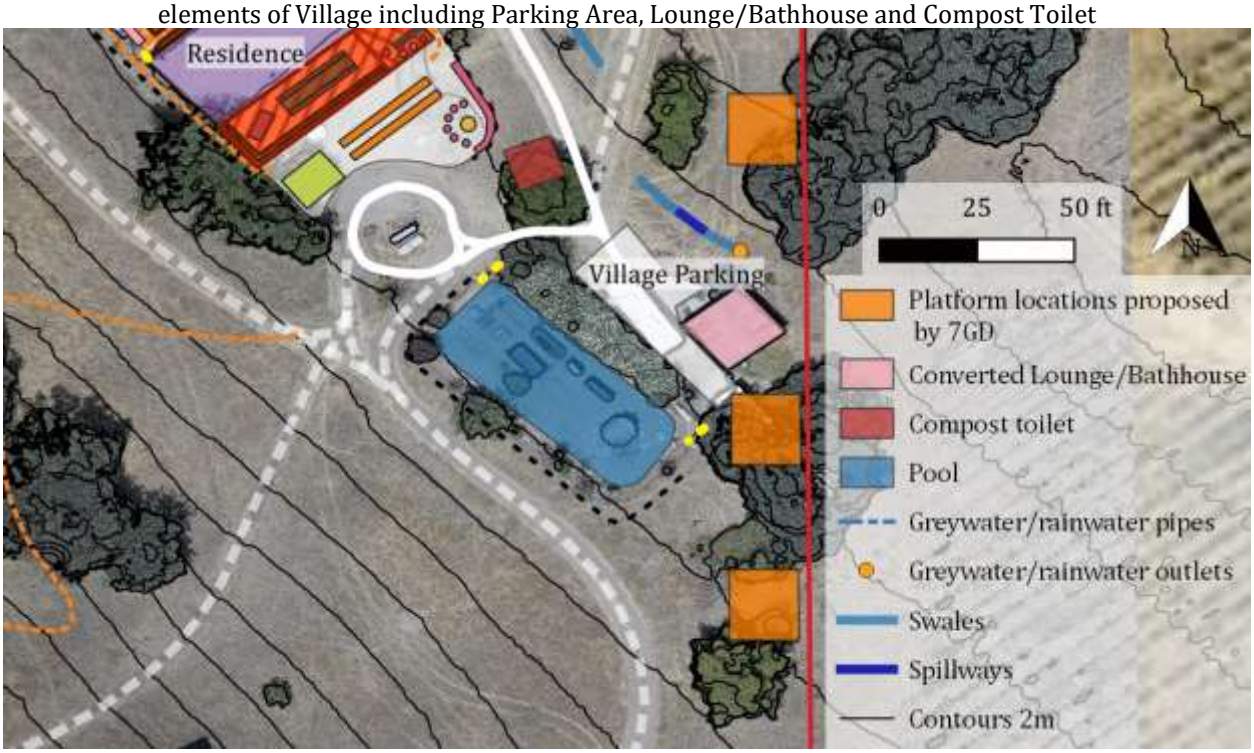


Figure 4-16
Site of the proposed platform downhill from the existing Garage

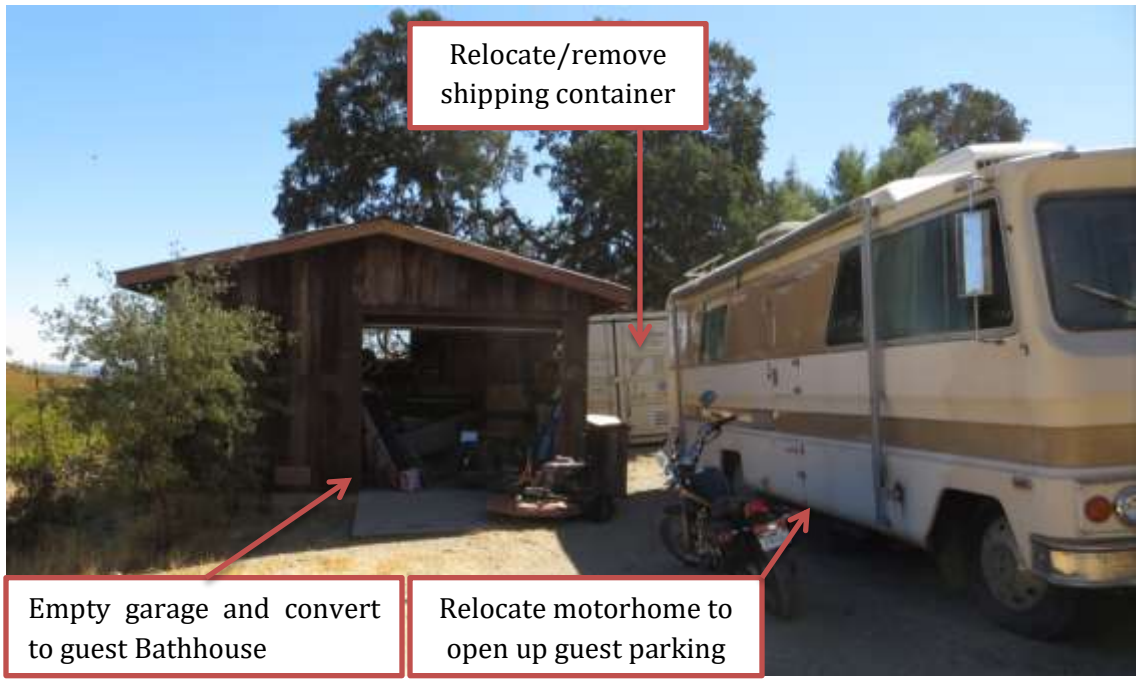
The shipping container currently located near the Garage interferes with the location of one of the proposed platforms. This could be relocated near the Shop or elsewhere on property, or the items in it consolidated in a different location and the shipping container eliminated from the property altogether.

Also shown on the map are a Village parking area, the Garage converted into a Bathhouse, and a compost toilet. These are the other elements that will help to fulfill the needs of workshop attendees and overnight guests, and they are described more fully below.

Parking is currently an issue down by the Village area, and overnight guests will bring more vehicles. The area in front of and on the southwest side of the Garage (shown in Figure 4-15 above) is relatively large, flat, and covered with road base, making it an ideal parking area for the overnight guests. The area is currently occupied by a motorhome awaiting rehabilitation. Since it is likely that future work on the motorhome will take place near the Shop, it is recommended that the motorhome be relocated up near the Shop area, or elsewhere on property in the meantime, freeing up this valuable parking area located near the Village.

Also appreciated by overnight guests is a place to cleanse and recharge. It appears that the Garage is currently underutilized, storing a handful of stuff that looks to be rarely used. If the items in the Garage could be consolidated and relocated elsewhere, the Garage could be converted into a bathhouse for workshop and property guests, with multiple showers and sinks to facilitate cleaning up after a day in the Shop or in the pool. This is centrally located near all of the proposed overnight accommodation areas, the pool, and the Village Heart, making it easily accessed.

Figure 4-17
Existing Garage with parking area currently occupied by motorhome, and shipping container used for storage in the rear

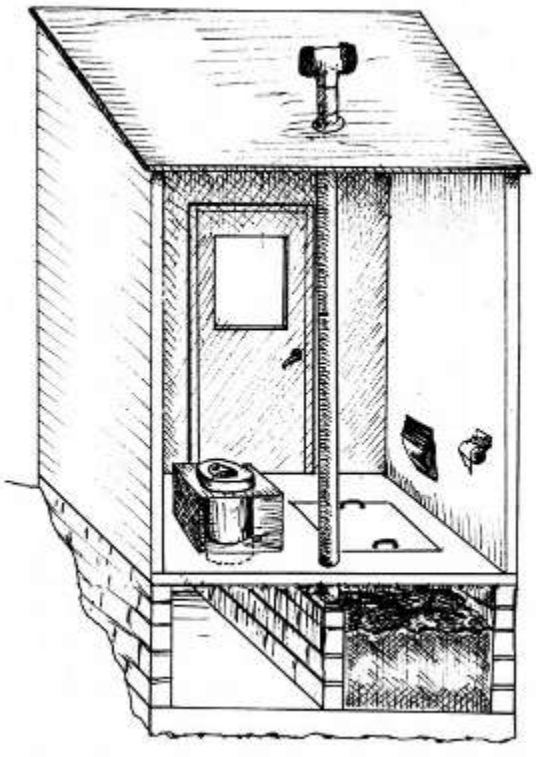


There are no other toilet facilities on-site besides the Main Residence, the Tiny House, and the Shop. To minimize visits from overnight guests in the Main Residence, a double-chamber compost toilet is recommended on the northwest side of the pistachio tree just downhill of the Village Heart. This is centrally located between the proposed overnight accommodations, the pool, and the Village Heart. The dual chamber design is recommended so that one chamber can be actively used while another can be actively curing, ideally for one year. Situating the compost toilet on the slope from the Village Heart area to the Garage access road will allow for easy access to the main door with minimal or no steps, and easy accessibility on the downhill side to the chambers and removal of cured humanure compost once mature.

A design for a double-chamber compost toilet on a slope is shown in Figure 4-18 below.

Figure 4-18

Double chamber compost toilet built on a slope. The person entrance is located on the uphill side (in the case of DFR, just outside of and slightly downhill from the Village Heart proposed firepit area), and the contents are removed from the chambers from the downhill side (in this case, the Garage access road).



Compost Toilet Near Shop

A compost toilet, of a similar two-chamber design to the one recommended for the Village, should also be built near the Shop to reduce the load on the Shop toilet and septic system, and convert the waste into nutrients for the property. The proposed location is on the north side of the Metal Shop, with the entrance on the uphill side and the content removal access from the Shop road on the downhill side, as shown in Figures 4-19 and 4-20.

Figure 4-19
Proposed location of compost toilet adjacent to the Metal Shop

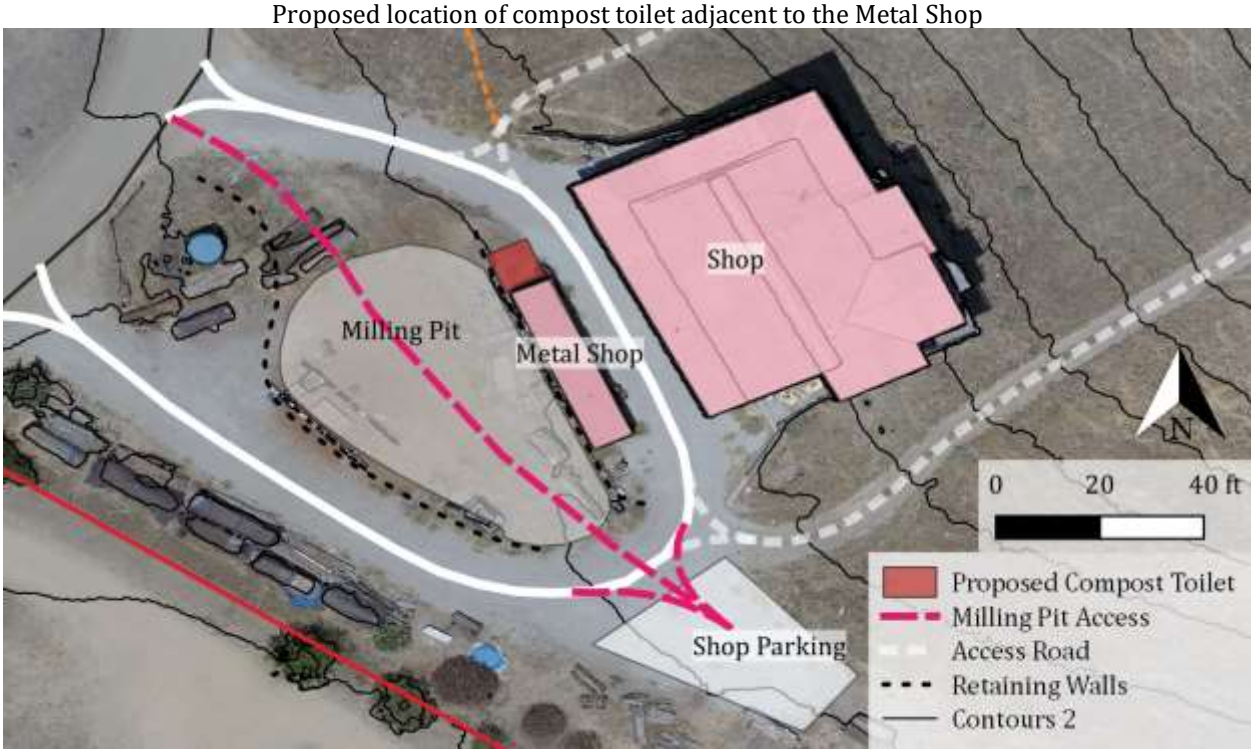


Figure 4-20
Proposed double chamber compost toilet location next to Metal Shop. The person entrance is located on the uphill side (from the milling pit area), and the content removal access on the downhill side (from the Shop access road).

Portable Structures

Portable structures are designed to be somewhat easily relocated. They can be used temporarily or semi-permanently in a location.

Existing Conditions

There is currently a tiny house located at the low point of the West Valley Bottom, shown in Figure 4-21

Figure 4-21
Tiny house

Recommendations

No additional portable structures are recommended at this time.

Animal Enclosures

Animal enclosures are designed to provide shelter for animals, and may potentially also provide storage for feed. They can be either permanent, portable or temporary.

Existing Conditions

There is an enclosed chicken yard with a coop to the southeast of the main house. The poultry are permitted open access within the yard, and have completely denuded the area, leaving dead fruit trees and barren soil.

Recommendations

- Utilize mobile coop(s) to pasture poultry in future orchard and agroforestry systems

Mobile Chicken Coops

If the proposed natural swimming pool is constructed in the place of the existing poultry yard, the poultry yard can be built in a different location and/or mobile coops can be used. Mobile chicken coops, popularly called chicken tracors, can be moved every few days to allow the chickens

seasonal access to fresh pasture in the valley bottoms and other areas outside of the fenced garden zone. Chickens like to eat the tender tips of grass and weeds, and they especially relish bugs, slugs, and snails – which helps make a dent in the pest population on a property. As the tractor is moved around, they leave their nitrogen- and phosphorus-rich manure behind them. There are many plans for chicken tractor construction available - an example of one is shown in Figure 4-22.

Figure 4-22
Chicken tractor example

5 - Food and Forestry

For most of human history, the landscape was covered with forests, and the food was found in these forests. Only with the advent of agriculture 11,000 years ago did farms begin replacing forests as a means to grow massive quantities of human food that could be stored. The number of farms exponentially increased, and the idea that food had to come from the linear, annually-tilled rows of a farm became prevalent. Only in relatively recent history in the U.S. has the hugely negative environmental impact of this industrial, tillage-based agriculture begun to be felt - in the form of topsoil loss, wildlife extinction, pollution, drought and other forms of ecosystem decline.

The awareness that forests are critical to regenerating the health of planet and creating a sustainable future is growing - as is the knowledge of how to design and plant forests that produce even greater yields of food on a per-acre basis than industrial farms, as well as fodder, fuel, and timber. In addition to these methods of integrating agriculture with forestry - known as agroforestry - sustainable methods of growing the annual vegetables that have become staples in the modern diet have been revived and refined.

This chapter presents the various vegetative elements that are presented with this design. This includes but is not limited to tree planting suggestions for climax, midstory and understory trees, as well as shrubs, bushes, herbs, groundcovers, vines, and garden planning. There exist abundant possibilities for what can be grown on any piece of land. The process of whittling down the mountain of possibilities to readily implementable, maintainable and in some cases marketable vegetative elements will require intimate examination of the landowners' values, desires and goals for their life on this property. The Minimum Holistic Goal created at the outset of this consultancy will serve as a valuable lens through which to evaluate the congruence of any and all elements within the landowners' shared vision. Understandably, the 7GD team will have injected some personal biases into interpreting the landowners' shared vision, and by no means are the elements detailed here the "best" or only way to proceed. Each element is a suggestion, a jumping off point, for future iterations, followed by many enjoyable years of tending and adjusting this landscape at it matures.

Context

Doe Family Ranch is located in an area that was formerly characterized by a plant community referred to as the Central Oak Woodland[3], also sometimes known as the Foothill Woodland. Plants in this community include:

- Overstory trees such as Valley Oak (Quercus lobata), Blue Oak (Quercus douglasii), Coast Live Oak (Quercus agrifolia), Interior Live Oak (Quercus wislizenii), California Sycamore, California Black Walnut, and Gray Pine (Pinus sabiniana),
- Shrubs such as Manzanita (Arctostaphylos spp.), Coffeeberry and Redberry (Rhamnus spp.), Currant and Gooseberry (Ribes spp.), and Toyon or California Holly (Heteromeles arbutifolia), and

[3] https://www.laspilitas.com/nature-of-california/communities/central-oak-woodland

- Groundcovers such as annual goldfields (Lasthenia spp.), Poppies (Eschscholzia spp.), Lupines (Lupinus spp.) and other forbs.

Some surrounding areas within Paso Robles have retained some aspects of this woodland, but annual invasive grasses having replaced almost all of the native forbs and wildflowers that used to fill the understory. At the DFR property in particular, there is almost no sign of this plant community still remaining with the exception of a few Valley Oaks that appear to be in their final years of life (several have fallen in recent years). This is likely due to some combination of clearing, burning, overgrazing, and the introduction of invasive grasses, and the few remaining Valley Oaks are likely dying due to a combination of the loss of their companion plants, the introduction of invasive weeds, as well as the lowered level of the water table (Valley Oaks require a water source within 70 feet - which likely existed before the surrounding hills were clearcut and planted with a sea of grapes).

The challenges come with getting plants established in the extreme summer heat, which is exacerbated by the denuded ground. However, once the right trees and shrubs become established they will thrive. Recently introduced non-native plants to the property that appear to be thriving include Oleander, Pistachio, Carob, and Mimosa. Nearby orchards have walnuts, pomegranates, almonds, and of course the surrounding hills indicate that grapes also do very well.

Erosion Control

Existing Conditions

The most pressing erosion issue is the weakening of the west edge of Mission Rd. above the DFR Driveway. The road edge continues to degrade, primarily due to burrowing squirrels creating tunnels at the downhill road edge and the dogs digging into the squirrel burrows. These excavations are exacerbated during the winter when they become wet, due to the passing of vehicles and some erosive sheetflow. They become fragile to the point where even a human foot step can collapse the edge.

Additional downcutting at the culvert exit where it crosses Mission Road and empties onto DFR property is also evident. A 2' deep erosion runnel has formed all the way up to the culvert edge, which is even with the edge of Mission Road.

The driveway also has a steep cut edge on the uphill side that is persistently degrading, due in part to rampant squirrel burrowing and the lack of any existing perennial vegetation upslope to aid in soil retention.

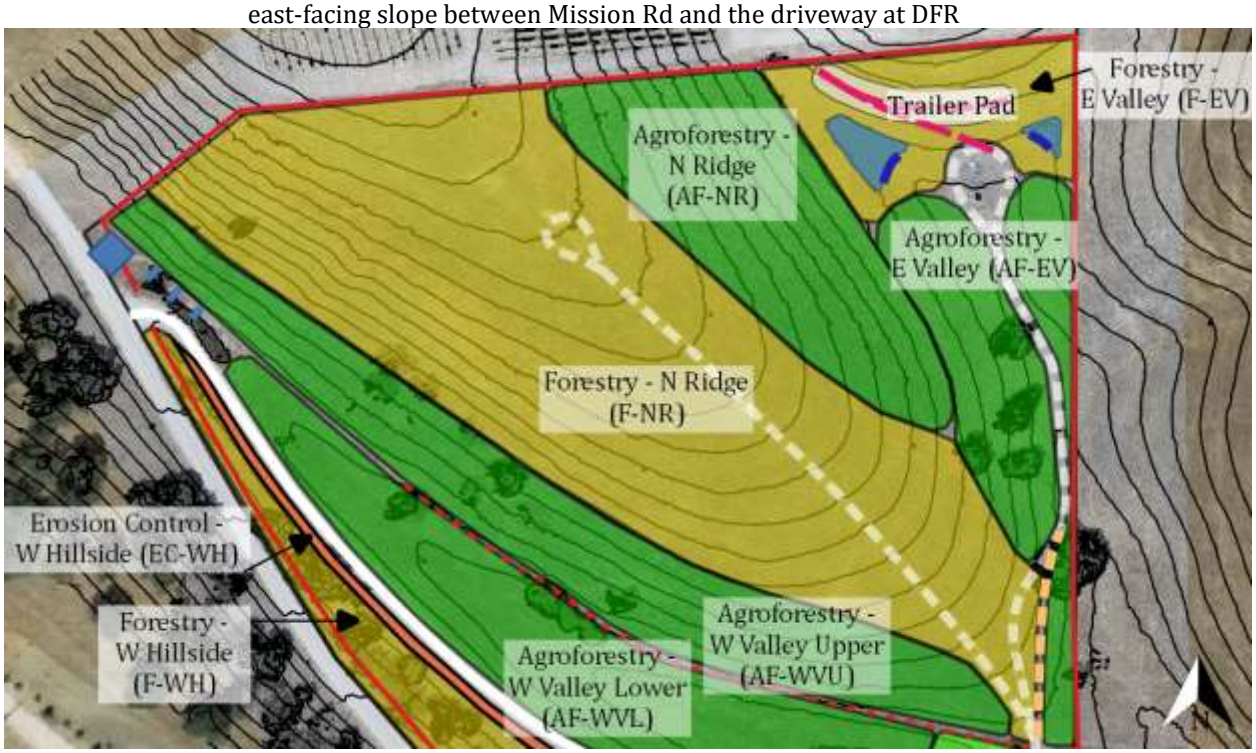
Recommendations

Plantings for erosion control are recommended in the following areas:

- Rehabilitation of existing oaks and planting of understory companion plants on the west hillside (labeled Forestry – W Hillside in image below). In particular, dense road edge plantings of perennials with fibrous roots capable of stabilizing the road edge (Coyote Brush, *Baccharis pilularis* is particularly good for this).

- Live-staking of willows on and around the proposed weirs and zuni bowl at the culvert exit onto DFR.
- Biological retaining wall of vetiver grass contour plantings along the steep cut edge on the west side of the DFR Driveway, labeled in the image below as Erosion Control – W Hillside).

Figure 5-1
Recommended vetiver planting area, labeled "Erosion Control – W Hillside" (EC-WH) on bottom of steep, east-facing slope between Mission Rd and the driveway at DFR



Rehabilitate Existing Oaks Below Mission Road

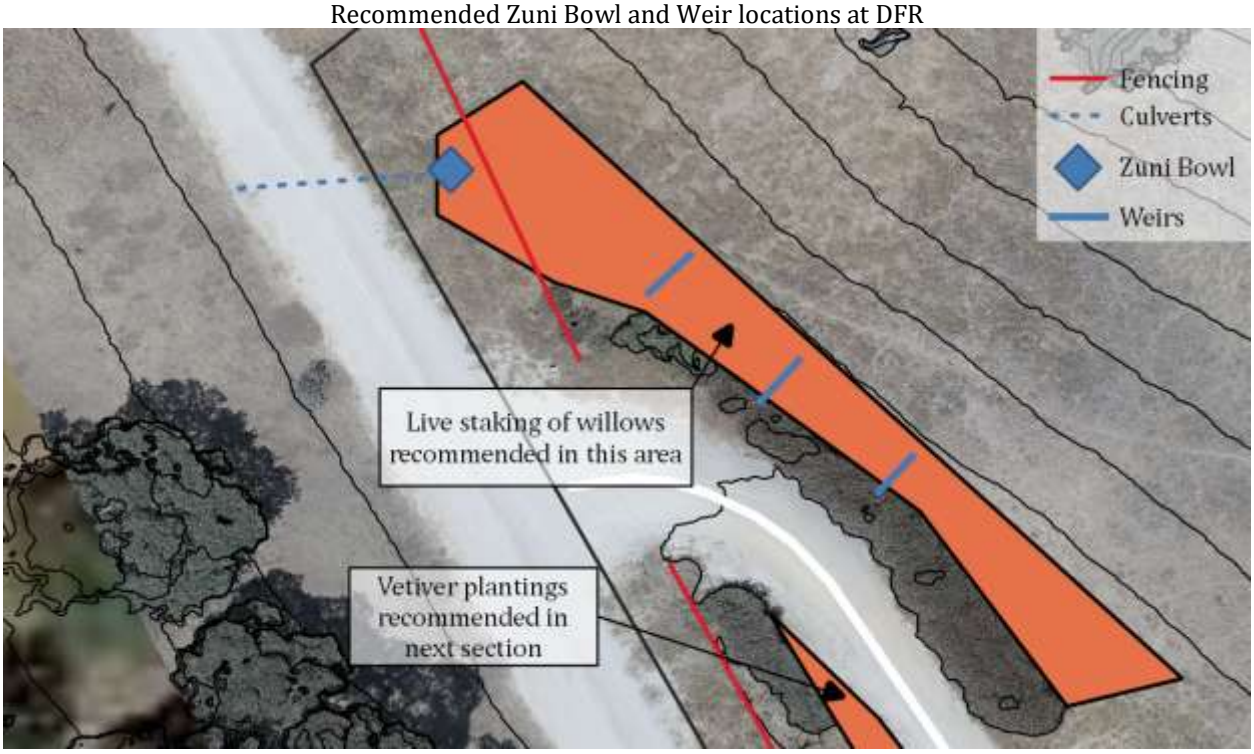
The rehabilitation of the oaks and re-establishment of the native plant community on the hillside below Mission Road (labeled F-WH) as recommended in greater detail in the Forestry section later in this chapter will help to bind the hillside together and greatly reduce erosion issues.

Live-Staking Willows At Culvert Exit and Weirs

An armored plunge pool, known in the regenerative hydrology world as a Zuni Bowl, is recommended at the exit of the culvert crossing under Mission Road in the northwestern corner of the property to pacify the water's exit from the culvert and allow it to be discharged over a broader area of the landscape than it is currently. Downstream of the Zuni Bowl, three weirs are recommended across the valley drainage. These erosion control systems are further discussed in Chapter 2 – Water.

Willows should be live staked around the culvert exit and around the proposed weirs. Stem cuttings taken from willow trees during their dormant season (before the buds break in the spring) and are inserted directly into the soil. These cuttings, referred to as "live stakes," will eventually grow into new trees and are an effective way to establish a root network in the valley and help prevent further soil loss.

Figure 5-2
Recommended Zuni Bowl and Weir locations at DFR



Biological Retaining Walls with Vetiver Grass

Vetiver grass should be planted in strips on contour every 18-20" of vertical fall on the section of east-facing cut edge on the uphill side of the DFR Driveway (EC-WH). This will protect the fragile slope just above the cut edge from wind and rain erosion, and promote revegetation of the area.

Vetiver grass is a sterile, non-running clumping perennial grass known for its incredibly deep root system. It has many qualities that make it an excellent candidate for erosion prevention and repair on steep, dry hillsides. Vetiver grass is native to India, though is now employed throughout the world as a biological remediator. Vetiver grass clumps can grow up to 2 feet in diameter and up to 6' tall within their first growing season in Central California, depending on water supply. Vetiver grass responds well to cutting once several or more feet in height, and produces tremendous amounts of biomass that is both an excellent soil builder and a nutrition source for livestock. It can be cut with a simple rice knife[4].

Vetiver grass is unique in its fantastic ability to handle sheet flow and sediment build up. Because the clump is so dense, it creates a backstop behind which sediment can build up. Instead of this

[4] Rice Knife: https://www.amazon.com/GrowTech-KNK-HTS1200-Grass-Sickle/dp/B007KKCHG8/ref=asc_df_B007KKCHG8/?tag=hyprod-20&linkCode=df0&hvadid=193150648923&hvpos=1o5&hvnetw=g&hvrand=15480528364792255815&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9032143&hvtargid=pla-362798857127&psc=1

killing the plant, vetiver is capable of rooting into this new soil build up even when buried through nodes on mature stems. In this way, over time vetiver 'self-terraces' creating level contour paths of sediment. Ultimately this installation will build soil between the vetiver lines, enabling deep rooted CA native species to take root and thrive and ultimately take over for the vetiver grass in securing the hillside.

Once established for a full growing season, the plants are effectively drought and frost hardy due to their deep root system (which can grow up to 9-15' deep depending on the soil type). Vetiver tolerates a wide range of soil types, from dense clay to steep volcanic hillsides to sandy, alkaline and acidic soils, as well as high levels of salt.

For erosion control on moderately-steep slopes, vetiver grass slips are typically planted on contour in a narrow trench (3-6" wide), approximately one every 4-6 inches. When planted at this spacing and provided with establishment irrigation, the vetiver slips will grow into a solid wall of culms that acts as a 'biological retaining wall' - a self-repairing structure that gets stronger and more effective as it gets older instead of vice versa. Once the planting trench is dug, it is underlain with burlap (mainstream methods suggest using aviary wire to hold back ground vermin until plants are establish, but this is non-biodegradable and good success has been observed using burlap for the same purpose) and then filled with compost or rotted steer manure (1 cubic foot of rotted manure fills ~ 6' of trench). The high nitrogen compost or manure helps the young slips to grow rapidly and set their roots.

In drier climates with cold wet winters, some establishment irrigation is recommended during the first dry season to help the slips interweave and set deep roots. Each line of vetiver should have its own designated ¼" drip line with emitters spaced every 6". These can be effectively run up to 50' lengths, provided they are tapped into a supply line at both ends. Each line can have its own ¼" valves to make seasonal shut off very simple, should there be other seasonal uses for the same irrigation line.

Figure 5-3
Left: Vetiver grass contour strips cut to 18" high after first growing season. *Right:* 6' tall vetiver grass anchoring natural stone pathway on a 65% grade slope of very fragile and formerly eroding fill soil.

Visit the 7th Generation Design Portfolio Page to see detailed before and after photos of a vetiver grass installation during the summer of 2017. Additional detailed information on the proposed

guilds and planting blocks are included in Appendix A – Plant Guild Details and Appendix B – Planting Areas

Shade Plantings

Species within shade plantings are typically fast-growing, umbrella-shaped trees specifically selected to provide shade for human occupants, animals, or structures underneath or nearby. This provides relief from sun exposure, more even lighting for gatherings/workshop/events, and respite from hot weather. Deciduous trees (trees that lose their leaves in the fall and enter dormancy for the winter) are often desirable in shade plantings in a coastal California climate as, in addition to tempering the light and heat during warmer months when they are leafed out, they also allow light and radiant warmth from the sun into a space during the colder winter months.

Existing Conditions

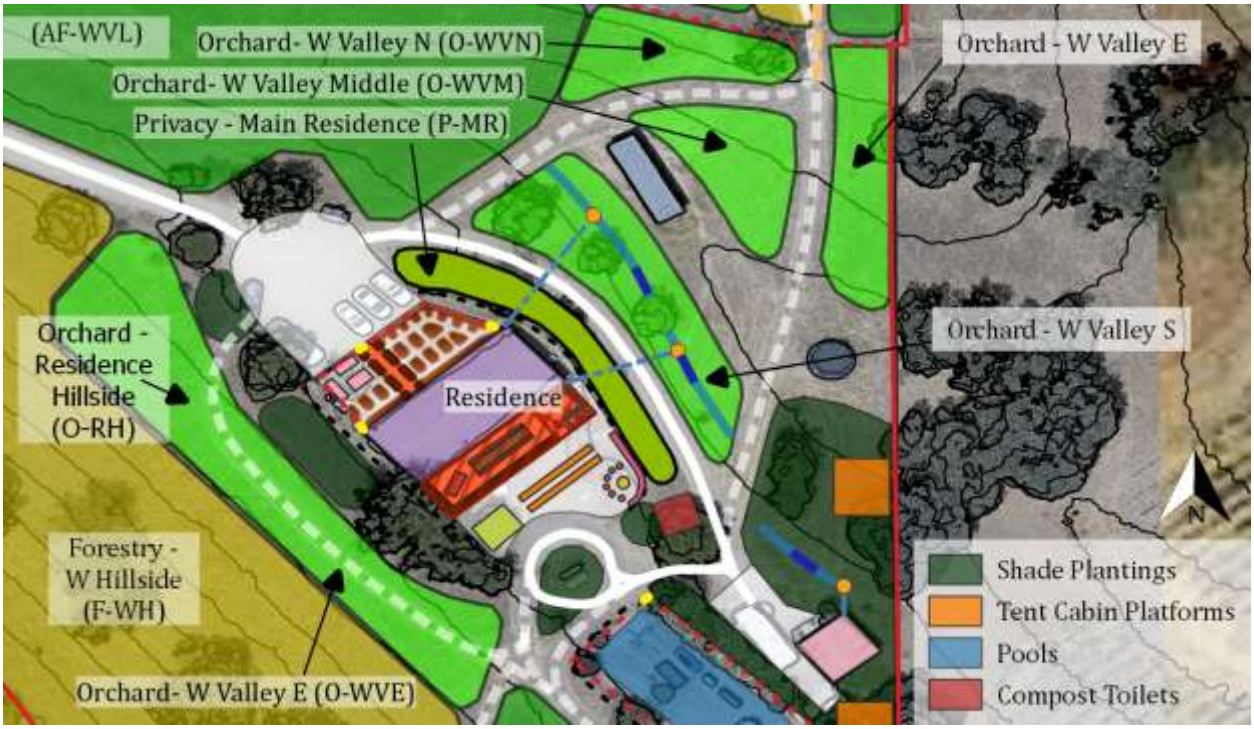
There are currently no significant, intentional shade tree plantings at DFR. There are several trees scattered throughout the property that do provide good shade, including valley oaks, black walnuts, and chinese pistachios.

Recommendations

Shade plantings are recommended in the following areas:

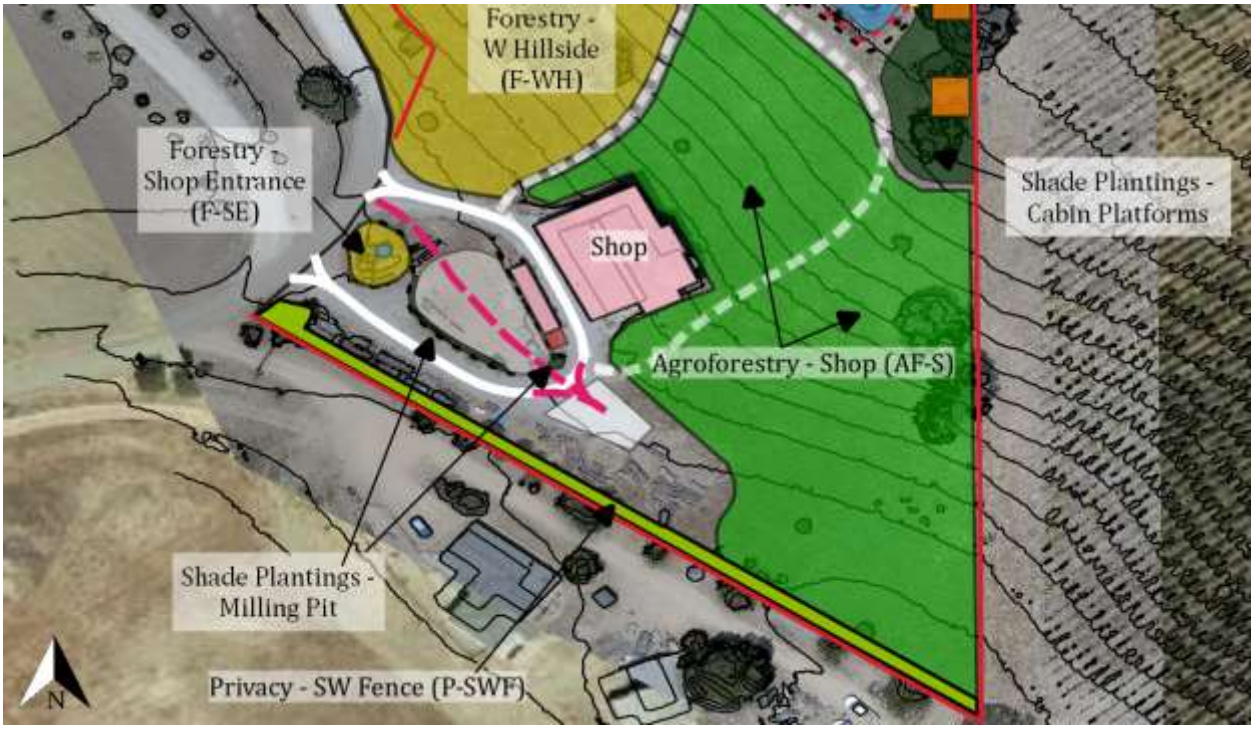
- **Village Areas** - Shade plantings are recommended on the southwest sides of the guest cabin platforms proposed along the west fence, as shown in Figure 5-4 (all three of the tent cabin platform locations already one or more large valley oaks located to the southwest) and on the south-west side of the compost toilet next to the village (adjacent to the existing Chinese pistachio tree). Deciduous trees are recommended in order to allow sunlight through during the colder winter months.

Figure 5-4
Proposed area for shade plantings in Village area



- **West Side of Milling Pit** – A line of shade trees is recommended at the base of the retaining wall forming the west boundary of the milling pit, as illustrated in Figure 5-5. These will eventually provide shade to the milling pit area during the heat of the summer afternoons. Deciduous trees will allow sunlight and warmth in during the winter months.

Figure 5-5
Proposed shade plantings at "Milling Pit"



A list of excellent shade trees appropriate for this climate is provided in Table 5-1. They all serve numerous other functions in the landscape and have their own unique look and feel. There are many ways to go about bringing shade to the proposed tent zone, so instead of projecting a single style or placement, several options have been presented.

Table 5-1
Recommended Shade Tree Species

Shade Tree Description	Image
Tipuana Tipu a.k.a. Rosewood Tree Fast-growing, heat-loving, nitrogen-fixing, semi-deciduous (short periods from late-winter to late-spring, often the coldest time of year in CA) tree that produces yellow flowers in spring and summer. Umbrella-like canopy casting a pleasant dappled shade spreading up to 40' wide and 40' tall. Common shade tree grown on streets and in parking lots in the Central Coast.	
Thornless Chilean Mesquite Drought-hardy, fast-growing, semi-deciduous (loses most but not all leaves in the winter), nitrogen fixing tree that produces small greenish-yellow flowers from spring to summer. They typically grow to 30-40' wide and 30-40' tall with uniquely twisted trunks. Thorns up to 3" long are variably present.	
Mimosa The "Silk Tree" is a deciduous, fast-growing, 20-25' wide and 20-25' tall, umbrella-shaped tree that is very drought tolerant once established, despite its tropical roots and vibe. Beautiful flowers that have an amazing fragrance that will perfume the surrounding air, this tree will literally hum with the vibration of bees and other insects throughout the flowering window.	

Shade Tree Description	Image
Valley Oak A native, deciduous tree that, while slow-growing, is very emblematic of place: a true legacy tree. Might be best planted with some friendly, faster-growing nurse trees that can provide shade until this tree ultimately takes their place for the long term. Productive mast tree, beautiful lobed leaves, high quality shade.	
Chinese Elm Fast-growing, heat-loving, semi-deciduous tree up to 50' wide and 50' tall with beautiful, mottled bark. Casts amazing, even shade with its dark green foliage. A great climbing tree and also excellent for hanging hammocks.	
Modesto Ash Fast-growing, small, deciduous shade tree to 30' x 30'. Best planted in association with other trees to maximize shade coverage. Produces stunning fall color in leaves, great summer shade.	

Privacy Screens

Privacy screens are plantings of trees/shrubs that serve to block either an unwanted view from a location or the unwanted viewing of a location. The same characteristics that define a good windbreak species (fast-growing, dense growth habit) also define a good privacy screen species.

Existing Conditions

There are currently no significant privacy screen plantings at DFR.

Recommendations

Privacy screen plantings are recommended in the following locations:

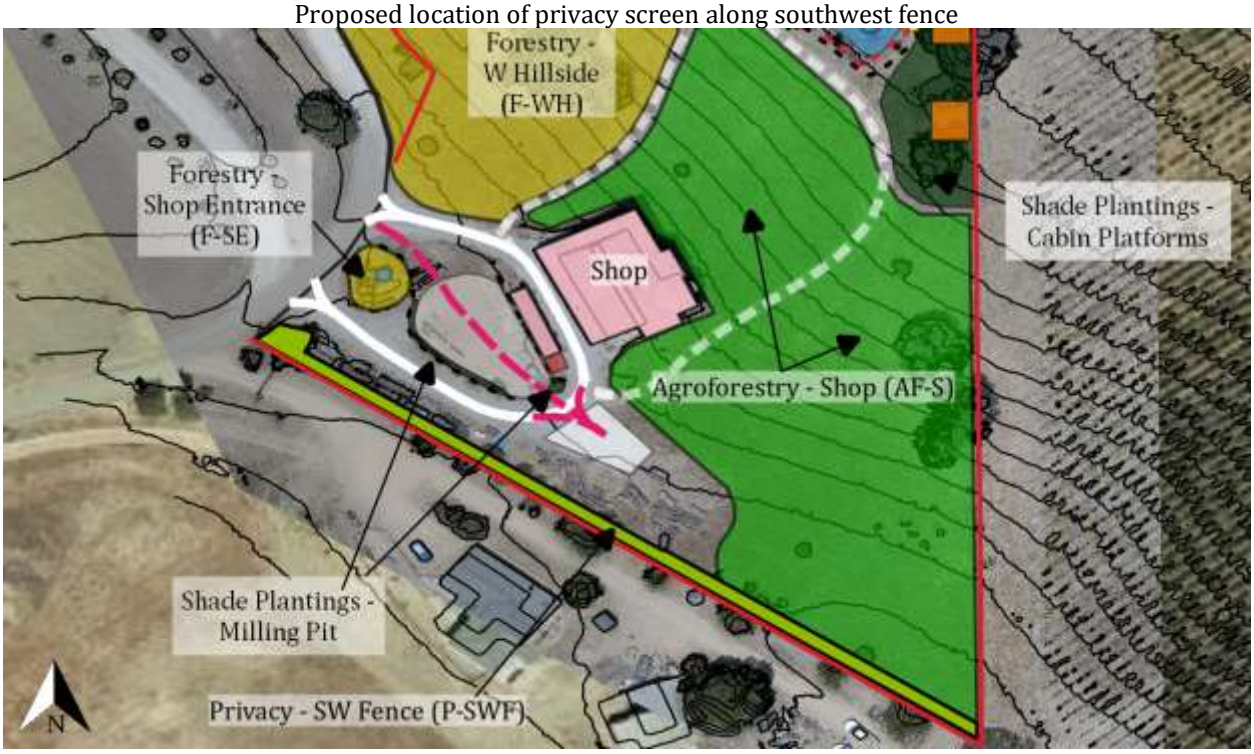
- Entire length of the southwest fence between the shop and neighboring property.
- Slope on east side of main residence, between walking path and garage access road

The native plant community re-establishment on the steep hillside between Mission Rd and the main driveway to the house (recommendation detailed in the "Forests" section earlier in the chapter) will also provide an excellent view screen for the Village and Main Residence from vehicles driving along Mission Rd.-

Southwest Fence

The neighboring property to the southwest currently has a full view of the shop, milling area, and materials staging yard. The installation of the "milling pit" recommended in the Structures chapter will remove much of the milling activities from view and greatly dampen the milling noise currently experienced by the neighbors to the southwest of the shop. Further screening of the shop activities can be provided by a wildlife and/or food hedge ("fedge") planted along the entire length of the southwest fence (400'). The proposed location of the privacy screen along the southwest fence is illustrated in Figure 5-6 below with the label "Privacy – Southwest Fence".

Figure 5-6
Proposed location of privacy screen along southwest fence



Two different approaches to the hedge have been considered: a native wildlife hedge that will thrive with zero water or fertility inputs once established with one year of regular watering, or a hedge that will provide plants for human consumption but will require more attention and care.

Considering how uncommonly the area along the southwest fence is frequented, the pumping requirement to obtain pressurized water near the Shop, and the large and more highly-frequented space available closer to the Village and Main Residence for food-producing plants (see Main Residence Fedge recommendation below, and Orchard recommendations later in this chapter), a native evergreen wildlife hedge is the most strongly recommended in this location, which includes a native cherry tree with delicious edible cherries for human consumption (though with not as much flesh as the commonly cultivated varieties).

Native species that have been selected for their drought-tolerance, beauty, habitat and food desirability for wildlife, year-round leaves, and dense growth pattern are provided in Table 5-2 below.

Table 5-2
Recommended plants for wildlife hedge along southwest fence at DFR

Common Name	Scientific Name	Plant Size	Notes	Photo
White Bark Mountain Lilac	*Ceanothus L.T. Blue*	Height: 10' Width: 5''	Blue flowers, good fragrance	
Holly-leafed Cherry	*Prunus ilicifolia*	Height:: 14' Width: 14'	White flowers in spring, large red cherries in fall (edible but mostly skin and seed, loved by birds)	
Toyon (or Christmas Berry)	*Heteromeles arbutifolia*	Height: 6' Width: 5'	White flowers in summer, red berries in winter	
Coffeeberry	*Rhamnus californica*	Height: 8' Width: 8'	Dark green foliage, black berries	

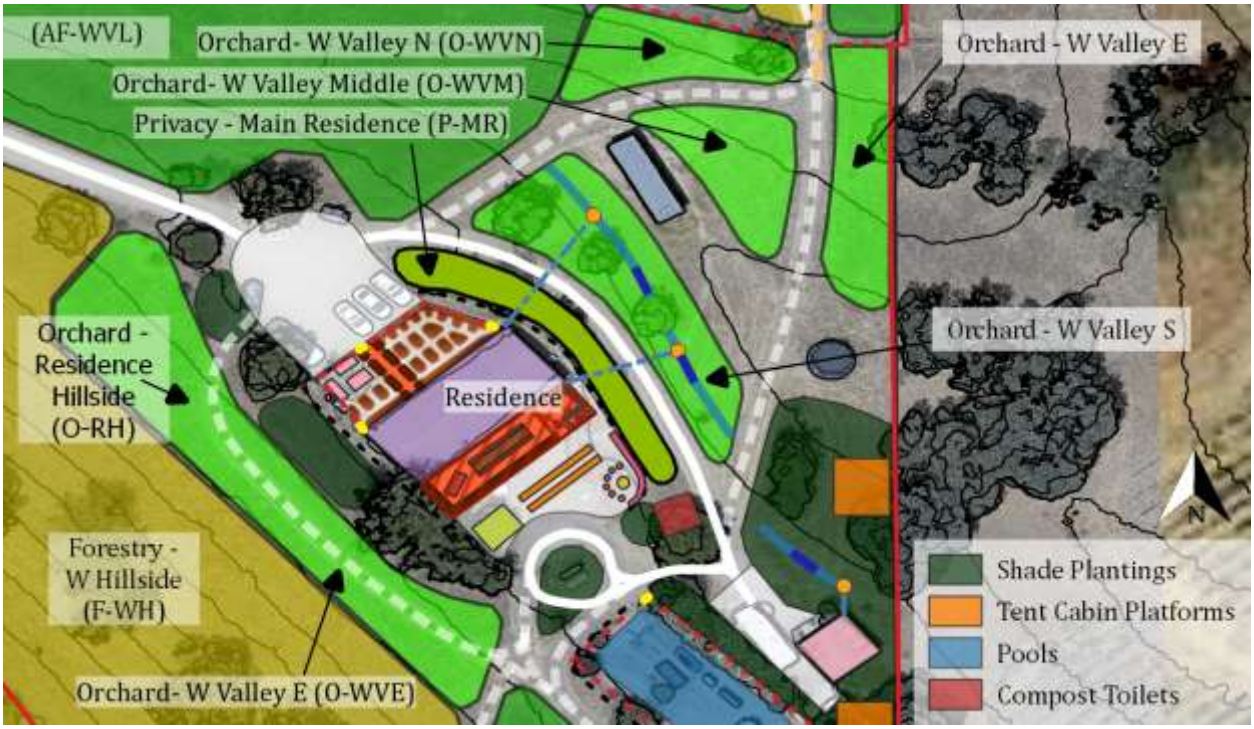
The recommended species should be alternately planted in a line approximately 5 feet from the existing fence. They should be spaced rather densely, with centers places approximately 1-2' less than half the width of the neighboring plants. For example, when placing a Ceanothus L.T. Blue (mature width 5') next to a Coffeeberry (mature width 8'), they should be planted approximately 5' apart from each other to ensure dense coverage. Silver bush lupine should be sporadically added on either side of the hedge, with plantings staggered between the shrubs, to provide nitrogen fixation into the soil.

Plants with edible fruits and nuts can still be incorporated near the Shop if additional plantings are desired after the orchard and other areas near the Village and Main Residence are established. These can be planted in a line in front of the native wildlife hedge, or on the relatively flat area to the southwest of the Shop. Additional detailed information on the proposed plantings including counts can be found in Appendix A – Plant Guild Details and Appendix B – Planting Areas

Main Residence East Side

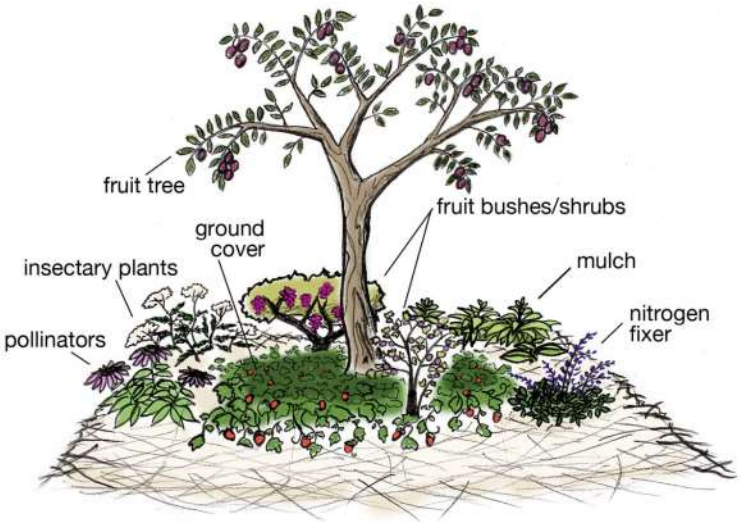
The steep hillside between the Main Residence and the Garage access road has a few young oaks, which provide some level of privacy from the Tiny House and the valley bottom, but otherwise is populated with annual grasses. A new retaining wall is suggested on the upper portion of the slope to provide a better walking path around the house equal with the level of the back yard area. In between the retaining wall and the Garage access road, a food hedge ("fedge") is recommended for planting along the entire length of the slope from the main parking area to the proposed compost toilet, in order to provide a privacy screen for the Main Residence and the backyard area from activities in the valley bottom, provide food for residents and guests, and also bind the hillside to reduce the potential of future erosion. The proposed fedge area is approximately 125' long, with an approximate width of 15', and is illustrated in Figure 5-7 with the label "Privacy – Main Residence).

Figure 5-7
Area in between Main Residence and Garage access road for Fedge



In a fedge, groundcovers, shrubs, trees, and vines, selected with a focus on providing human food, are integrated together in a dense planting scheme. Support species that provide soil fertility (nitrogen-fixing and mulch-producers) and groundcover for weed abatement are also included. An example of how these different plants can be integrated together in one space is illustrated in Figure 5-8.

Figure 5-8
Fruit Tree Guild



The recommended trees, listed in detail in Table 5-3, average approximately 15' in height x 15' in width, and should be planted next to each other in narrower part of strip closer to parking lot and staggered as the area widens closer to proposed compost toilet. Tree species include varieties of Fig, Pineapple Guava, Persimmon, Pomegranate, Asian Pear, Almond, Apple, Cherry, and Elderberry.

Table 5-3
Trees for fedge at DFR

Name	Qty	Description
Brown Turkey Fig	1	Large fig with brown skin, pink flesh and sweet, rich flavor. Used fresh. Widely adapted to coast or inland climates. Small tree, prune to any shape. Cold hardy to zone 7. 100 hrs. Self-fruitful.
Pineapple Guava	1	Versatile, and easy to grow with an upright branching form, edible flowers, and tropical fruit! Fleshy white flower petals have showy red accents, contrasting nicely with the gray-green foliage. Tasty guava-like fruit ripens in late fall. Easily trained as espalier, a hedge, or a small specimen tree for landscape or container. Evergreen
Fuyu Persimmon	1	Fuyu' (or 'Fuyugaki')–oblate, faintly 4-sided, 2 in (5 cm) long; 2 3/4 in (7 cm) wide; skin deep-orange; flesh light-orange; firm when ripe; non-astringent even when unripe; with few seeds or none.
Pomegranate	1	A shrub, growing from to 2-6 m tall. It suits areas with a long hot dry summer and cool winter. It can grow in soils with a wide range of pH. It suits hardiness zone 8-11.
Shinsheiki Asian Pear	1	Juicy, sweet, refreshing, crisp like an apple. Easy to grow. Keeps well. Bright yellow skin. Vigorous, heavy bearing (usually by 2nd year).
All-in-one Almond	1	No. 1 almond for home orchards. Heavy crops of soft shell nuts with sweet, flavorful kernels. Hot summer required to ripen. 15 ft. tree, very winter and frost hardy.
Pink Lady	1	Hot climate apple from Western Australia. Very crisp, sweet tart, distinct flavor, good keeper. Skin reddish pink over green when ripe. White flesh resists browning. Harvest begins late October in Central CA, about three weeks after Fuji. Self-fruitful. 300-400 hours. USDA Zones 6-9.
Blue Elderberry	1	Mexican elderberry or Tapiro,(Sambucus mexicana) is a deciduous shrub to tree with butter yellow flowers in Apr.-Aug. followed by purple berries in September-October. . This elderberry is native to canyons, valleys west of Sierra Nevada from Oregon to Baja and east to West Texas. It likes full sun to part shade, garden water. It will take extreme drought after it gets its roots down. Its bluish-black berries are excellent in jelly, fair in pie. It is an excellent wildlife plant.

Understory species, listed in detail in Table 5-4, should be interplanted amidst the recommended trees, both in the understory and on the margins on the west and east side of the trees. Edibles include Golden Currant and Dwarf Yaupon (caffeinated leaves used for tea); Nitrogen fixers include False Indigo Bush, Goumi (also edible), and Silver Bush Lupine (native); brambles include thornless Blackberry (edible); vines include Perlette Grape (edible); herb layer includes Comfrey (medicinal, mulch producer), Yarrow (native, insectary), and Creeping Thyme (groundcover).

Table 5-4
Understory species for fedge at DFR

Name	Qty	Description
Yaupon (Stoke's Dwarf)	3	This dwarf evergreen shrub with tight branches that create a tidy spreading mound is excellent for low hedges, borders, or around foundations. The twiggy branches covered with fine-textured, glossy, dark green foliage take well to shearing. A tough plant that tolerates a range of soil conditions and can withstand drought or flooding.
Golden Currant	3	Golden currant is deciduous shrub that produces edible fruits. California thrashers, with their curved beaks, Robins, Phainopeplas, and Solitaires, love the berries.

Name	Qty	Description
		Bumblebees and hummingbirds love the flowers. Also, monarchs love the flowers in early spring. The fruit varies from to 3/8 inch, yellow to pale red, about 1/3 seed and tastes like a store bought Thompson seedless with a dash of vanilla, some cream of tartar, and maybe a little apple juice.
False Indigo Bush	3	Native N-fixer, Its spreading tendency and fibrous root system make it useful for bank stabilization. Easily grown in average, medium to wet, well-drained soils in full sun to light shade. Tolerant of occasional flooding. Also tolerates poor, sandy, somewhat dry soils. With most of its foliage in the upper third of the tall, bushy plant, Amorpha fruticosa can form thickets in dense plantings. The genus name is from the Greek for formless or deformed, because the single-petaled flower is unlike most blossoms in the pea family. Other Common Names in use: Desert False Indigo and Indigo Bush.
Silver Bush Lupine	4	A nitrogen-fixing shrub. It grows up to 2-6 m tall. It suits areas with a long hot dry summer and cool winter. It can grow in soils with a wide range of pH. It suits hardiness zone 8-11.
Goumi	3	This close relative of the autumnberry produces huge amounts of healthy fruits in large clusters. The dark red berries are easy to harvest as they grow all along the branches. Each plant is quite different with ripening going from summer to fall. The leaves and flowers of this species are larger and more ornamental than autumnberry but otherwise very similar in appearance, and the flavor of the fruit is as good or better, with the same antioxidant properties. Worth growing just for making juice, jelly, and drying. This strain produces a more varied ripening time, fruit size and different colored fruits too. Nitrogen fixing. Durable in a variety of soils except wet. Full sun is ideal.
Blackberry - Triple Crown Thornless	3	This cultivar can produce 30 pounds of large, very sweet, shiny blackberries per plant, making it, with Chester, by far the most productive. Fruit has superb flavor both eaten fresh and used to make jelly, toppings or juice. Vigorous canes, up to 2" in diameter and 15' long, thrive in areas of the country too cold for other blackberries and produce huge crops in July and early August. Grow it like a vining blackberry, at 8' spacing, or for those with less space, cut new canes the first summer at 6' tall and snip the laterals back to 2' long in winter. With this method, use a 3' spacing and a top wire to tie the upright canes.
Perlette Grape	3	Perlette is a large grape with white, thin skin. The flesh is firm, crisp, and juicy. The Perlette Grapes are very similar to Thompson Seedless, but with a wider climate range. An excellent fruit for table use as well as raisins. Cane pruning. Ripens Mid-July. Grows in zones: 5 - 10
Comfrey	8	This coarse, spreading, perennial herb grows up to 4 feet tall and likes moist, somewhat shady locations. It has a long history as a medicinal herb but no culinary uses. Other species in this genus are more suited to ornamental plantings outside of the herb garden. Excellent plant for soil building guilds and shading root zones of establishing trees. Prolific biomass that can be used as chop and drop mulch, cut forage for all manner of livestock. Bees love the bell shaped flower clusters. Long history of medicinal use for mending broken/damaged bones, healing wounds.
Yarrow	8	Shade and low water tolerant. Tolerates pH down to 4, low growing, pollinator and predatory insect attractor, self propagates via rhizomes. Western Yarrow is a small perennial that spreads by rhizomes. It varies by locale from 1-4'. The cream-colored (off-white?) flowers are in 3- 4"clusters. It's native to the western U.S. and is drought tolerant, swamp tolerant., somewhat alkali tolerant.
Woodland Strawberry	24	Wood Strawberry is a perennial, with white flowers, edible red fruits, and spreads by horizontal above ground stems (stolons). Fragaria californica, (F. vesca), Woodland Strawberry makes a good ground cover for dry to damp shady areas or sunny areas with moderate water.

Additional detailed information on the proposed plantings including counts can be found in Appendix A – Plant Guild Details and Appendix B – Planting Areas

Food Gardens

Existing Conditions

There are currently several raised beds within the existing chicken yard at DFR. These beds have a cage around them to keep the chickens and ducks out of them.

Recommendations

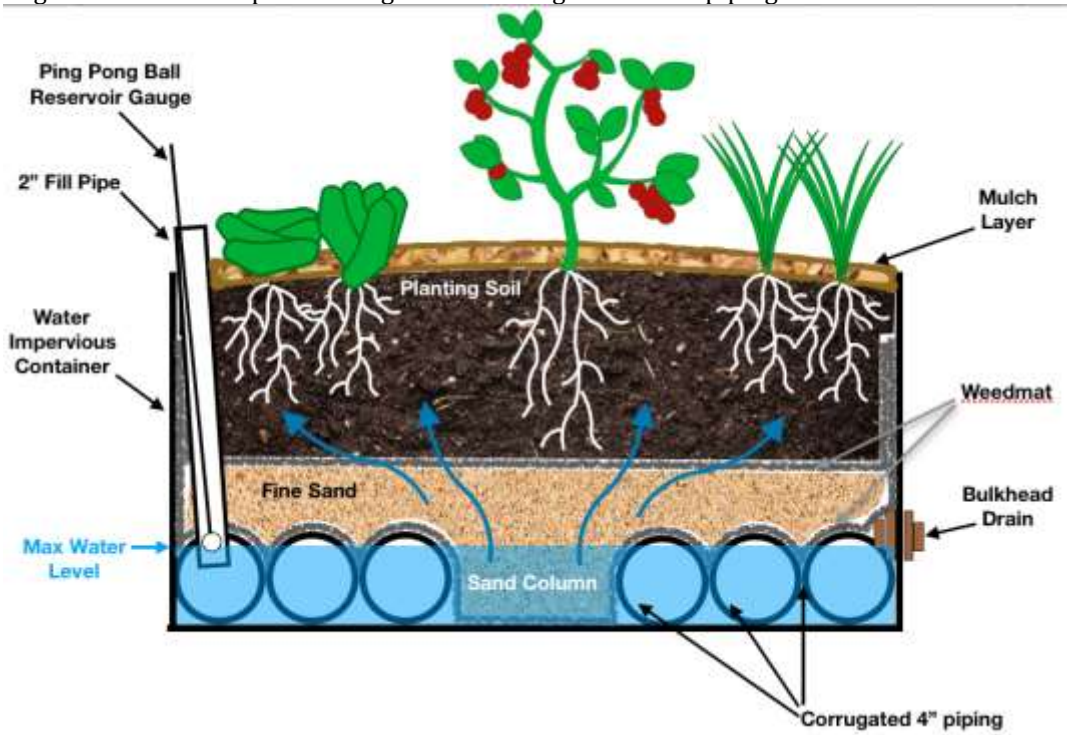
The following food garden elements are recommended:

- Wicking beds for any intensive vegetable-growing areas

Wicking Beds

Wicking beds are fully contained, self-watering planting beds that use capillary action to maintain consistent soil moisture. Wicking beds typically have a reservoir of water stored sub-surface that is passively drawn on by plants as they need it. Figure 5-9 below illustrates one method of wicking bed construction.

Figure 5-9
Wicking bed construction profile using flexible corrugated vented piping to create the water reservoir.



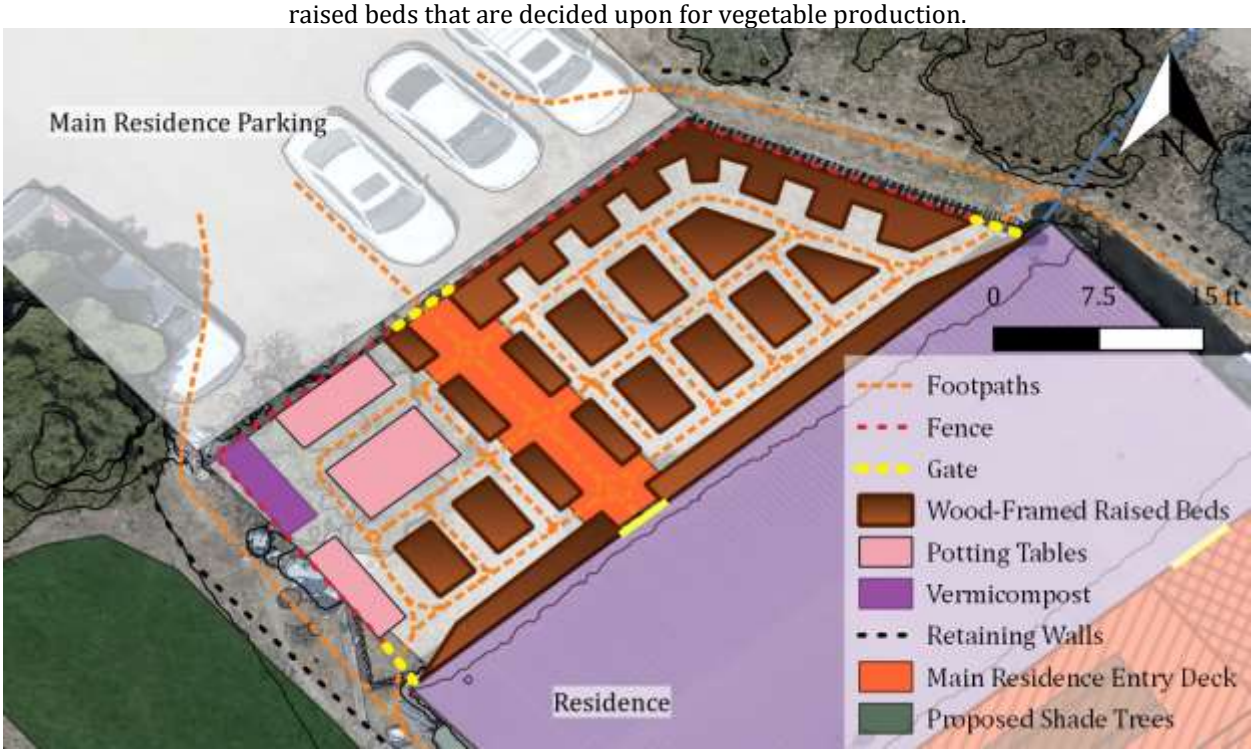
Wicking beds are appropriate in very dry climates, where they can save enormous amounts of water by limiting evaporation loss occurring during surface irrigation and by eliminating water dissipation into surrounding dry soils. Wicking beds are very appropriate for low-maintenance home gardens, as the sub-surface water reservoir allows beds to go weeks, even months between

fill ups. Similar design principles can also be applied to larger production based systems, but the cost can be prohibitive. Depending on conditions (arid to semi-arid), it may be absolutely necessary.

Wicking beds can be designed to fit almost any garden bed shape, size, or style. They are commonly built in pre-made containers – like galvanized livestock watering troughs, polyethylene or rubber feed troughs – as well as in custom built wooden raised beds (the bottoms are lined with pond liner). Wicking beds can even look like standard in-ground garden beds by excavating the bed footprint and laying pond liner down to create the water retention basin. Any option where pond liner is used to retain the water needs to take into account the presence of ground vermin, as they are likely to chew through pond liner. Bottoms of raised beds should be lined with gopher wire and have layers of old carpet or rug lain atop it to prevent the pond liner from tearing on the gopher wire. All it takes is one hole and the wicking function of the bed will be ruined. For these reasons it is recommended to build wicking beds in galvanized or rubber livestock troughs, or if building a wooden raised-bed, to have a rot-resistant wooden bottom (black locust, cedar, redwood) on the bed capable of excluding rodents and ground vermin.

In the example front-yard layout described in Chapter 4-Structures and provided again below, for any wooden-raised beds that are built (and any other additional raised beds that are built on property for the purpose of growing annual veggies – for example, on the proposed rear deck, or elsewhere in the backyard/Village Heart zone), wicking beds are recommended.

Figure 5-10
Main Residence front yard example design. A wicking bed design is recommended for any wood-framed raised beds that are decided upon for vegetable production.



For a step-by-step construction guide, see the Wicking Bed Construction And Performance[5] post on the 7th Generation Design blog. This design is the same as the one pictured above in Figure 5-9.

Supporting Elements

The recommended supporting elements for the food garden are illustrated in Figure 5-9 (above) and described in the following paragraphs.

Nursery/Potting Tables

Tables for seed starting and potting are recommended in the northwest corner and along the west side of the front yard to create an effective workspace for starting and potting seedlings, gathering produce and vegetative matter, and performing other home garden related tasks. This location has been selected for the dappled shade the nearby existing tree provides, which will make the propagation of starts during the heat of summer feasible.

Composting/Fertility Systems

Given the planned presence of animals at DFR, there exists plenty of feedstock to produce high quality compost for the garden, orchards and other plantings. There are many ways to make compost, some requiring much more work than others, and all producing different types of outputs. Three methods (among many that exist) are outlined below that may be a good fit for the DFR garden.

- **Home-scale Flow-Through Vermicomposting**: There are many different methods of vermicomposting (composting with worms). Many of them involve multiple tiers of black plastic grates, some are just old bathtubs. One method the 7GD team members have experience maintaining and operating is a Flow-Through Vermicomposter (FTV). An FTV, once set up, never requires the operator to bait the worms to a different corner, and then excavate the material while trying to minimize worm loss. With an FTV system, the operator instead only feeds the worm bed from the top, keeps the media moist, and collects worm casting as they fall out from the bottom.

  This type of system, depending on size, can take 2-6 months to begin producing worm castings, but once it does the output is continuous as long as inputs are consistent and the worm population is stable. A table 4' long and 2-3' wide is recommended for this system. Should additional capacity in this regard be desired at a future date, it is straightforward to add an additional table.

  This system is recommended for placement in the northwest corner of the front yard garden in the dappled shade of the existing tree and the future shade of the proposed tree to the southwest of the front yard, which will help to keep the worms shaded and moist during the summer months as well as provide a structure for the grapes to grow on.

[5] Wicking Bed Construction And Performance: https://www.7thgenerationdesign.com/wicking-bed-construction-and-performance/

- **Johnson-Su BioReactor**: This is a rather new composting method, but is worth mentioning because of it's "do nothing" nature. Do nothing is a bit of a misnomer, however- once set up, this system can be let go for a year, the final product being the highest quality most fungi-rich worm castings the 7th Generation Design team has seen.

  Linked here is a video[6] with David Johnson discussing this system as well as a link to the BioReactor page on his website.

  Essentially a 4' diameter, 6' tall wire mesh cage lined with shadecloth or weedmat is set upon a pallet. Seven 6.5' tall 4" diameter PVC pipes are inserted before the cage is filled to created future aeration points. The cage is then filled with a mix of materials, the more diverse the better, following general Carbon:Nitrogen composting recommendations. If using animal manures that have been dried they need to be pre-hydrated. Once full, an automated sprinkler is placed on top of the pile, set to run 1-2 minutes per day to keep the entire pile hydrated. 24-48 hours after initial filling the pipes are removed, leaving air columns penetrating to the bottom of the cylinder, thus ensuring that no point in the entire system is more than 1' from air (key to excellent thermophilic compost). The pile will go through the thermophilic stage remarkably fast (12-14 days) at which point it will cool and the fungal population will begin to surge.

  The Johnson-Su BioReactor is worthy of note due to the extremely high quality of output and low time demands once set up. The final worm castings are of the same consistency as a clay slip, which means they can be blended into an aerobic compost tea, expanded, and applied as a fungal-rich nutrient spray over the entire DFR property.

- **Standard Thermophilic Composting**: While more labor intensive than either of the prior two options, this a tried and true method for producing compost - if you're willing to work for it! The vetiver plantings around the perimeter of the Market Garden can be a primary carbon source for creating piles once allowed to dry in the sun. It can also serve as a nitrogen source if used while green. Piles should be constructed in layers of carbonaceous material and nitrogenous material and wetted as they are constructed. Minimal size is approximately 1 cubic yard (3' tall x 3' wide x 3' deep) to allow the mass to get up to thermophilic temperatures. Tarping piles in between turnings can help abate moisture loss. If actively managed and kept well hydrated a pile can produce finished compost in 21-28 days depending on the feedstocks.

Irrigation System

Since the recommended wicking beds require such infrequent water, and will likely require different amounts of water to refill depending upon location and sun exposure, manual refilling is recommended. However, an automated irrigation system may still be desired for the seed starting areas in order to ensure regular watering. This can likely be provided by one or two battery-operated valves located near the closest spigot.

[6] Johnson Su BioReactor: https://www.youtube.com/watch?v=MuW42tFC4Ss

Soil Stewardship

The true job of the home gardener is to grow healthy living soil. When the soil is healthy, the seeds sown in it will grow into healthy plants of the highest nutritional value. The following principles can be employed to create conditions for rapid soil formation and steadily increasing soil health.

- **Soil is alive and needs to be fed.** Soil microbiota that create a well structured and nutrient rich soil need to be fed in order to thrive. The primary way Nature does this is through trading root exudates (carbohydrate secretions from living roots) for bio-available nutrients in the soil profile.
    - **Key Takeaway:** Keep living roots in the soil as much as possible. Avoid long fallow periods between bed rotations if possible. Use cover crops if not actively cropping a bed. Make and use aerobic compost teas and nutrient amendments.
- **Soil needs to breathe.** Oxygen is critical for healthy root zones, as anaerobic soils are prone to disease. Through cover cropping, feeding the soil life, and addition of organic matter the soil structure will become more porous, enabling better air penetration to root zones and more effective infiltration and utilization of irrigation water.
    - **Key Takeaway:** Once beds are formed avoid soil compaction at all costs (especially with native heavy clay soils). Try to avoid stepping on the beds as much as possible to keep aeration channels open.
- **Soil needs to be protected.** Bare soil is dying soil. The UV light from the sun, evaporative and erosive effect of the wind and erosive impact of precipitation (whether rain or overhead irrigation) can remove valuable top soil and kill soil life quickly.
    - **Key Takeaway:** Keep the soil covered as much as possible, either with a living crop or with a tarp (if stale seed bedding).
- **Soil needs to communicate.** Plants are capable of communicating over great distances with one another through their root zones and mutualist soil mycelium. Another valuable reason for choosing a no-till garden is the promotion and expansion of intact mycelial webs that can run amongst a given bed and in between beds. Communication between plants helps with controlling pest outbreaks and nutrient delivery across mycelial networks.
    - **Key Takeaway:** Think of the entire garden as a living, sensate organism that needs to be able to communicate with all parts of itself. Use pathways as sponges to soak up overspray/rain and as information superhighways to allow for mycelial networks that span the entire garden.

Orchard

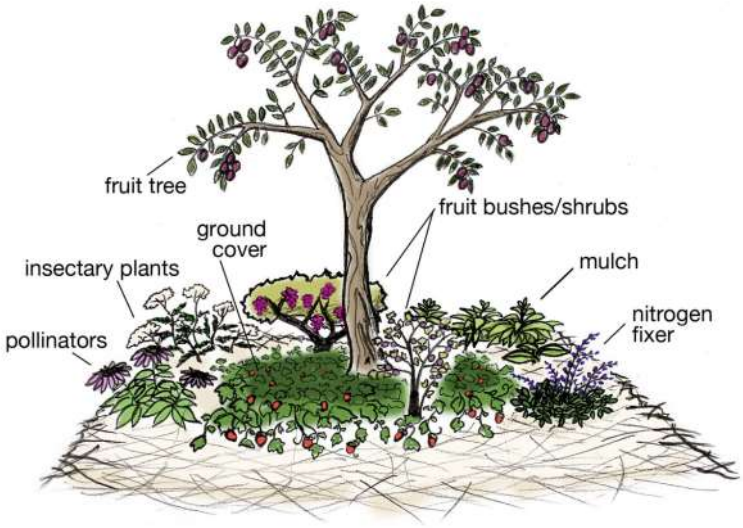
An orchard is an intentional planting of fruit- or nut-producing trees or shrubs that is maintained for food production. While many commercial orchards are planted for a single variety of fruit in a linear grid-shape with no understory for ease of mechanical harvesting, this typically leaves the trees vulnerable to pests and disease (thus requiring expensive and potentially harmful chemical inputs), leaves the soil exposed (increasing water needs and fertilization needs), reduces the water harvesting and retention capacity of the area (increasing water needs), and minimizes the diversity of yields.

A resilient orchard is one with species diversity (akin to a real forest), where trees are planted on contour with a dense underplanting of support species. This underplanting of complementary support species, known as a "guild", provides several functions:

- Living mulch shades the soil, protecting soil life and reducing evaporation,
- Shade for young tree trunks (protection from sun scald),
- Nutrients, in the form of decomposing biomass and varied root exudates capable of supporting a more diverse array of soil microbiota,
- Fertilizer, via nitrogen-fixing and dynamic accumulating plants,
- Insectary (pollinators and pest predators),
- Diverse mycorrhizal web that provides minerals, additional micronutrients and information exchange with surrounding trees and plants (fungi).

The layers of a guild are illustrated in Figure 5-11.

Figure 5-11
Fruit Tree Guild



There are two physically distinct plant profiles that will perform all of the above functions. First, herbaceous/shrubby plants that grow vertically up to several feet and can be readily chopped and dropped at the foot of the tree, and second, a creeping, low-growing, low-to-no water groundcover that will not compete with feeder roots from the tree (i.e. not a super aggressive or nutrient-hungry plant). At a bare minimum this function list will require at least two species of plants, and certainly more can be used.

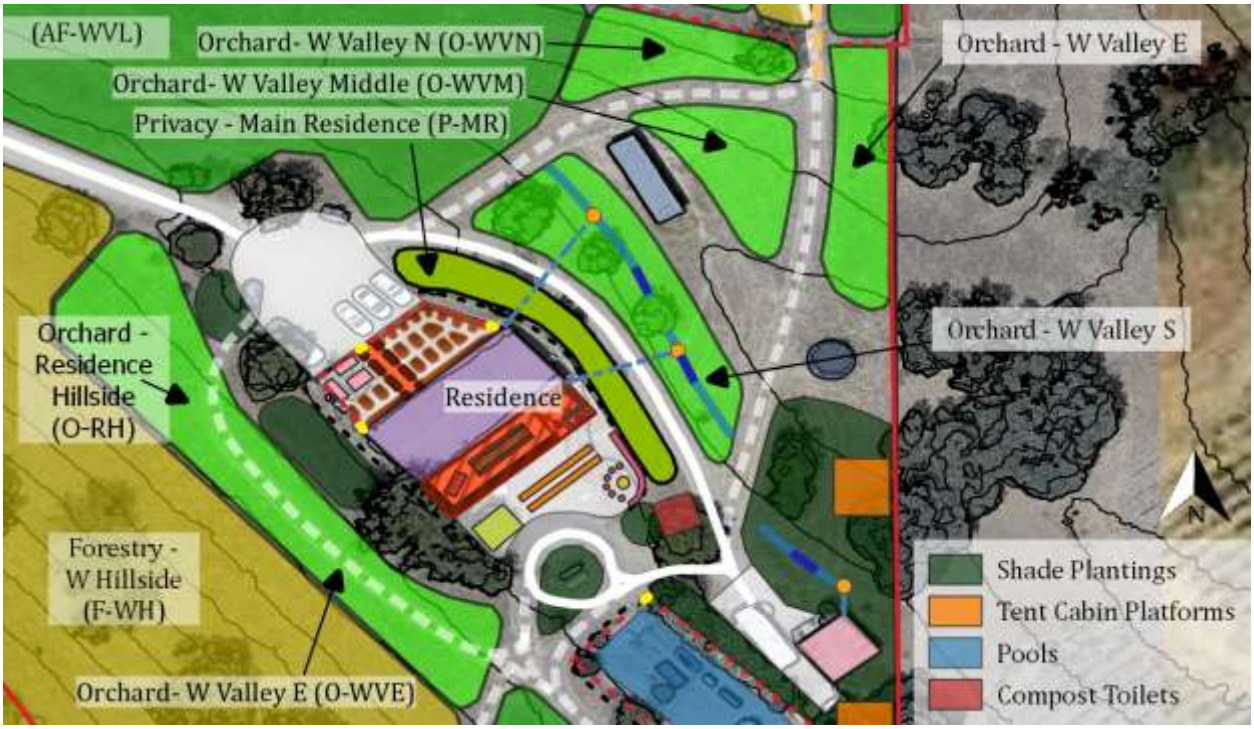
Existing Conditions

There are currently no orchards at DFR.

Recommendations

Recommended orchard blocks at DFR are illustrated below.

Figure 5-12
Orchard blocks at DFR



Layout and Guilds

The orchard blocks have been sized based on water reticulation, access patterning, slope and solar access. These criteria will also be used to determine which species will be applied to which blocks.

Guilds have been formed with the idea of producing fruit and nuts for harvest, as well as providing for the other needs of the orchard, including soil fertility, pollination, mulch, and more. Each guild is named for its' primary crop. Each guild can be broken down to a singular Guild Unit - the repeating unit and species assemblage that has been used to calculate costs and plant counts for applying the guild across the blocks at DFR. Additional detailed information on the proposed guilds and planting blocks are included in Appendix A – Plant Guild Details and Appendix B – Planting Areas. The proposed guilds and plantings of orchard trees and support species for all designated orchard planting blocks at DFR are summarized below.

Table 5-5
Proposed fruit tree guilds guilds for DFR orchard blocks

Planting Zone	Recommended Plantings
O-WVS (60%) **O-WVM (50%)** **O-RH (30%)**	**Orchard – Apple Guild:** (1) Apple as guild centerpiece, planted on 25' centers. Recommend full-sized rootstock for added drought hardiness in a hot climate like Paso Robles. Semi-dwarfing rootstock is ok, though may require more supplemental irrigation. Apple variety may be substituted with any from the list of apple cultivars included in this report. (1) Silver Bush Lupine for nitrogen fixation and pollinator attraction. (2) Comfrey cuttings planted in the hole with the apple, to be chopped and dropped for surface mulch and fertilizer while also shading the trunk prior to development of a fully canopy. Yarrow, salad burnet, lemon balm and tansy can be all sown from seed amidst the mulch in autumn, or planted as starts at other times of the year with supplemental irrigation during initial establishment. (3) California woodland strawberry- a shade-, drought- and neglect-loving groundcover that produces tiny alpine strawberries (more for wildlife than for humans, though very beautiful), and it does an excellent job of spreading via runners wherever there is bare soil. Additional helpful companion plants include chives, salvias, agastaches, daffodils, irises, naked ladies, and bulbing onions.
O-WVN (100%) **O-WVM (50%)**	**Orchard - *Prunus* Guild:** (1) *Prunus* species (peach, plum, cherry, apricot) – Santa Rosa plum recommended in this specific guild, other species or varieties may also be suitable. Plant on 20' centers. (2) Comfrey cuttings in the planting hole with the tree for chop and drop fertility and surface mulch, as well as trunk sun protection while canopy forms. (1) Lemon balm to attract pollinators, parasitoid wasps. (4) Woolly yarrow plants planted 2' from trunk to create drought resistant ground cover (this could be substituted with woodland strawberry, creeping thyme, Greek oregano, green carpet rupturewort). Full size yarrow can be sown from seed around tree, for chop and drop, insectary and groundcover purposes. Bulbs like daffodil, iris and naked lady can be planted in arcs several feet off the trunk.
O-WVE (100%)	**Orchard Mulberry Guild:** (1) Black mulberry centerpiece, planted on 18-20 foot centers. Black mulberry may be substituted with Pakistani mulberry as well. (2) Comfrey cuttings in the hole with the tree. (1) 16”x16" tray of Baby Sun Rose planted in clumps around the developing root zone for drought-tolerant ground cover that bees will enjoy. (2) Yarrow plants planted within 3' of tree, to the sunny south side, for trunk shading, insectary, chop and drop mulch and fertility. (1) Lemon balm planted on east side for insectary, herb harvest, chop and drop. (1) False indigo bush as main nitrogen fixer, planted within 3’ of tree and chopped and dropped several times per annum as needed to feed the developing mulberry.
O-WVS (40%) **GS-VB (100%)**	**Moringa Livestock Fodder Guild:** This guild is recommended for the swale berm that runs through the Orchard – West Valley Swale block (approximately 40% of the block area), as well as the swale receiving greywater from the Village Bathhouse (GS-VB). (1) Moringa planted every 3' for coppiced animal fodder source. (1) *Leucaena* and (1) dwarf koa planted downhill of moringa, off set 18" and ~2' downhill from moringa center. (3) Comfrey planted interstitially amongst the other plants. All plants can be cut repeatedly for animal fodder, and will respond well planted atop the swale berm where the greywater outlet pipes terminate. Guild provides food for humans, rabbits, chickens, ducks, goats, sheep, cows and pigs. The plantings on the swale in O-WVS are recommended at a 60% planting density due to it being within the footprint of the West Valley South Orchard block.

The proposed guild planting lines should utilize contour to the advantage of the orchard tender. Not only will planting on contour improve solar access for the trees, it will improve water reticulation capacity within the orchard while allowing for denser plantings than would otherwise be possible. The understory should also be thickly mulched to help with weed abatement, water retention, and soil building.

Additional detailed information on the proposed plantings including counts can be found in Appendix A – Plant Guild Details and Appendix B – Planting Areas

Local Nurseries That Carry Fruit Trees

- Farm Supply – Paso Robles, cooperative, fair-priced, can order fruit trees not in stock, no frills.
- Bay Laurel Garden Center - Atascadero, CA - large selection of bare root trees tested for Central Coast growing.
- Honey Badger Nursery - San Luis Obispo and Santa Cruz - Dryland/Mediterranean agroforestry species and chestnut trees with air-pruned non-circling healthy tap roots.

Bioregional Nurseries That Carry Fruit Trees

- La Sumida Nursery - Santa Barbara CA, has many of the fruit trees recommended in this report.
- California Tropical Fruit Trees - North San Diego County , Vista, CA - wide range of tropical fruits trees, including many types of citrus. Recommend visiting nursery to pick out trees, they do offer delivery, though rates vary. 10 tree order minimum for delivery.

Agroforestry

Agroforestry is an intensive land management system that optimizes the benefits from the biological interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock. The main types of agroforestry practices today in the North America include alley cropping, silvopasture, riparian buffers, windbreaks, and forest farming.

The benefits created by agroforestry practices are both economic and environmental. Agroforestry can increase farm profitability in several ways:

- the total output per unit area of tree/ crop/livestock combinations is greater than any single component alone,
- crops and livestock protected from the damaging effects of wind are more productive, and
- new products add to the financial diversity and flexibility of the farming enterprise.

There are four key characteristics of an agroforestry system that distinguish it from other farming or forestry practices. They are:

- **Intentional:** Combinations of trees, crops and/or animals are intentionally designed and managed as a whole unit, rather than as individual elements which may occur in close proximity but are controlled separately.

- **Intensive:** Agroforestry practices are intensively managed to maintain their productive and protective functions, and often involve annual operations such as cultivation, fertilization and irrigation.
- **Interactive:** Agroforestry management seeks to actively manipulate the biological and physical interactions between the tree, crop and animal components. The goal is to enhance the production of more than o-ne harvestable component at a time, while also providing conservation benefits such as non-point source water pollution control or wildlife habitat.
- **Integrated:** The tree, crop and/or animal components are structurally and functionally combined into a single, integrated management unit. Integration may be horizontal or vertical, and above- or below-ground. Such integration utilizes more of the productive capacity of the land and helps to balance economic production with resource conservation.

Existing Conditions

There are no existing agroforestry elements at Doe Family Ranch.

Recommendations

The following agroforestry elements are recommended at Doe Family Ranch:

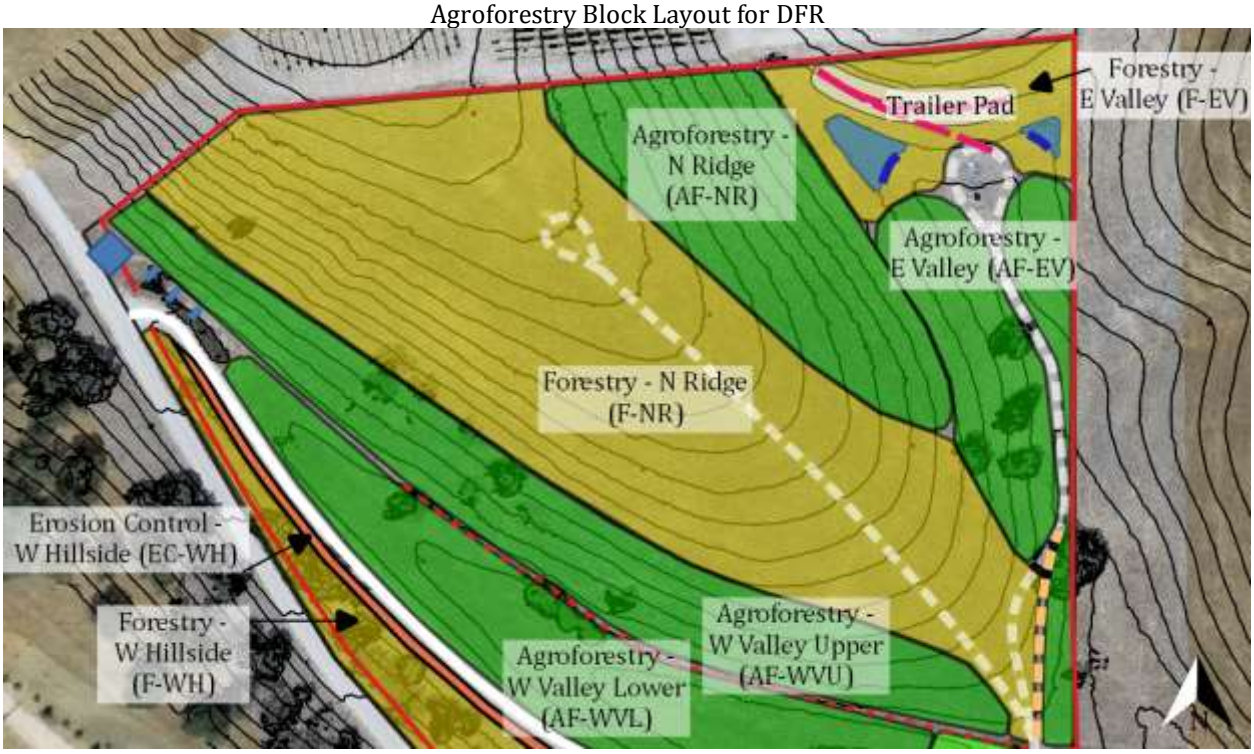
- **Silvopasture in the W and E Valley Bottoms** - A silvopasture system with that will integrate black walnut trees for timber and support plants with livestock production is recommended for the West and East Valley Bottoms.
- **Chestnut Overstory Agroforestry plantings** – Located on the predominantly east x northeast facing slopes found south of the shop and in the East Valley.

Silvopasture in the East and West Valley Bottoms

Silvopasture is a form of agroforestry that combines trees with forage and livestock production. The trees in a silvopasture system are typically managed for high-value tree crops or timber and, at the same time, provide shade, shelter and forage for livestock. The partial shade throughout a silvopasture helps to reduce stress on the animals from wind and sun, and in DFR's case, will help provide both tree forage and extend ground forage availability later into the dry season by decreasing soil surface temperatures and thus evaporation.

The areas recommended for silvopasture are labeled in the below illustration as "Agroforestry – W Valley Lower (AF-WVL), Agroforestry – W Valley Upper (AF-WVU), and Agroforestry – E Valley (AF-EV), Agroforestry – East Valley Chestnuts (AF-EVC) and Agroforestry – Shop Chestnuts (AF-SC). It should be noted that in the Agroforestry – W Valley Lower Block, a vehicle access route should be kept clear along the valley bottom as outlined in the Access chapter.

Figure 5-13
Agroforestry Block Layout for DFR



Layout and Guilds

The silvopasture blocks have been sized based on water reticulation, access patterning, slope and solar access. These criteria will also be used to determine which agroforestry guilds will be applied to which silvopasture blocks.

Guilds have been formed with the idea of producing black walnut trees for timber, as well as creating a year-round food source on-property for desired livestock species – cattle, and pigs and other grazers based on the Doe family's wishes. Each guild is named for either its' principal climax canopy tree or for its' primary purpose for being in the landscape. Each guild can be broken down to a singular Guild Unit - the repeating unit and species assemblage that has been used to calculate costs and plant counts for applying the guild across the landscape at DFR. Additional detailed information on the proposed guilds and planting blocks are included in Appendix A – Plant Guild Details and Appendix B – Planting Areas. The proposed guilds and plantings of trees and support species for all designated agroforestry planting zones at DFR are summarized below.

Table 5-6
Proposed agroforestry guilds for DFR zones

Guild Name	Description, Spacing, Seasonal Yields and Management
Black Walnut Guild Recommended Planting Areas:	(1) California black walnut tree as guild centerpiece. (1) Black locust tree planted approximately 4' away to southwest to serve as nurse tree for walnut tree. The locust tree can be coppiced seasonally at the end of the summer to provide nitrogen, and will then re-sprout vigorously to provide shade to root zone for young walnut trees. Eventually the walnut trees will shade out the locust trees, at which points they will

Guild Name	Description, Spacing, Seasonal Yields and Management
AF-WVL (50%)	no longer be needed. Once walnut trees are established and cast a decent shade canopy (~3-5 years), under-plantings of other high-value plants can be made, such as elderberry, California woodland strawberry, raspberry, black raspberry, currants and gooseberries. Additional companion plants include yarrow, holly hock, bee balm, miner's lettuce, *Calendula*, iris, daffodil, and *Crocus*. Once walnut trees are of decent size - 5-10 years - vines like *Clematis* and *Wisteria* can be planted in the understory to run through the trees.
Black Walnut Interplanting Recommended Planting Areas: **AF-WVL (50%)**	The following trees are juglone-tolerant and will do well planted adjacent to walnuts: sycamore, elderberry, persimmon, white mulberry, catalpa, Callery pear, black locust, hawthorne, thornless honey locust. Recommend planting one of these species 1:1 with walnut plantings to create a more diverse tree stand and eventual intact shade canopy over the West Valley bottom. Smaller-sized fruit trees from the *Prunus* genus (plums, peaches, cherries, apricots) are also juglone-tolerant and can be interplanted amongst the walnut trees to create additional fruit yields, either for human or livestock consumption.
Carob & Mesquite Guild Recommended Planting Areas: **AF-WVU (100%)**	Carob and mesquite trees alternate in a dense planting ideal for higher elevation sites that get minimal water. Both trees yield high-quality and carbohydrate-rich pods - mesquite early in summer and both in the early-to-mid autumn when conditions are most dry. Both trees fix nitrogen and have extremely deep root systems (mesquite roots have been found 175' deep at pit mines). Understory can be grazed during pod-fall when other forages are not present in abundance, or pods can be collected and stored or processed for feed supplement.
Chestnut Agroforestry Guild Recommended Planting Areas: **AF – NR (100%)** **AF-S (100%)**	(1) Chestnut, planted on 80' centers. Chinese x American crosses are recommended. Chestnuts can be planted as 1 year whips with the Groasis Waterboxx to help them establish, or from seed, in which case the Waterboxx would likely need to be in place for 2 years. (1) Black locust planted 6-8' off-center to the southwest, to be coppiced in the late autumn / early winter each year beginning in year 3, will block the most intense sun aspect experienced by the chestnut tree and serve as nurse plant, nitrogen-fixer, mulch and shade producer to aid chestnut tree establishment. Will eventually be shaded out by chestnut trees. (1) Southern California grape planted by seed downhill 10' from each chestnut, allowed to sprawl on the ground, provides wildlife food and groundcover. (8) Perennial sweet pea sown in autumn in octagonal formation around the chestnut tree for living mulch, nitrogen-fixation, groundcover, and soil temperature moderation around the developing root zone. Perennial sweet pea can be chopped and dropped if and when it grows and spreads large enough to climb into the chestnut. Eventually it will be shaded out by the chestnut after 5-8 years.
Dryland Fodder Guild Recommended Planting Areas: **AF-EV (100%)**	Alternating randomized patterns of honey mesquite, Fuyu or American persimmon, white mulberry, carob, and thornless honey locust planted at 80% mature canopy diameter of one another to one day create closed canopy effect and maximize ground shade. Black locust and *Leucaena* can be interplanted throughout and coppiced or grazed annually to help build soil. These trees will ultimately be shaded out by mature overstory or can be manually removed prior to that time. This guild grouping will provide both late-dry season and late-winter forages for pigs should they end up being a part of the vision for the property. Fuyu persimmon, white mulberry and carob also make excellent food for humans as well.

Additional detailed information on the proposed plantings including counts can be found in Appendix A – Plant Guild Details and Appendix B – Planting Areas

Tree Establishment

Establishing trees is challenging in brittle climates with long dry seasons. Healthy trees and well adapted trees that will have a long and productive life need to be established well (i.e. have a properly structured root system) or they will languish and never grow to their potential. Setting up irrigation for dense agroforestry plantings across broad acreage gets expensive quickly. However, applying some new technologies that harmonize with natural seed germination and tap root development processes while also doing everything possible to increase soil organic matter levels and moisture persistence will create an environment that spurs trees to grow to their full potential - neither coddled by climate and soil type inappropriate irrigation methods and schedules, nor starved for necessary moisture and nutrition required to establish well.

One of those new technologies is the Groasis Waterboxx, shown in Figure 5-14. The Waterboxx is essentially a water battery that is pre-charged with several gallons of water. The water is contained inside a covered container that sits around the tree seedling or tree seed. A wick from the internal reservoir leaches out some 50mL per day of water - not enough to make the tree lazy, just enough to create a water column of moisture directly beneath the soil upon which the Waterboxx sits. There is not enough water in this column for the tree to thrive, but there is enough to continually stimulate the taproot to continue growing deeper into the soil (a very desirable trait in drought-prone climates). The water reservoir also serves as a thermal mass that condenses warmer, moisture laden air on the Waterboxx's surface, which refills the reservoir. These devices are meant to filled once and left for a year or longer, and they will continue to self-fill and maintain the water column training the young tree to develop a strong, deep root system.

Figure 5-14
Groasis Waterboxx

An animated walkthrough of how the Groasis Waterboxx works is available here.

Though the members of the 7GD team have not yet had the opportunity to personally test the Groasis Waterboxxes, after research and conversations with distributors, there are several benefits of utilizing them in an agroforestry system over conventional irrigation:

- If one fails or gets punctured by a wayward cow, it affects only one tree, whereas if an irrigation supply line gets chewed by rodents, stepped on by a cow, or an emitter pops out at a single tree, the entire system's performance is degraded if not completely shut down.

Integrating animals into pasture with irrigation tubing is guaranteed to be a costly and time-intensive endeavor.

- Capitalizing on the far lower cost of seeds vs seedlings, the ability to plant two seeds in each Waterboxx increases the establishment success rate of each planting to 99%, versus 85% for planting just a single tree. This equates to more trees established in a shorter amount of time when looking at a 3+ year time horizon.
- They allow time for observation and adjustment. As an example, 200 Waterboxxes in rotation every year would allow for an annual review of how things went the year prior - and allow time and space for the incorporation of new knowledge and understanding of the landscape, new species that have popped up on the radar, and changes in future land use ideas and desires etc.

Though the Waterboxxes are pricey, a quantity can be purchased that fits the landowner's budget, used to start a block of trees, and then reused the following year for an entirely new block. This can continue year after year until the property is populated with the desired number of trees. As an example, if 2,000 trees are planned for establishment over a 10 year period, only 200 boxes are required. In this example, based on current Waterboxx pricing, the per tree establishment cost (irrigation, protection) at the end of that 10 year period comes to approximately $3.10 - approximately 75% less than the estimated per tree establishment cost if using conventional poly irrigation line and drip emitters.

Integrating Livestock into the Silvopasture System

The Doe family has expressed a desire to pasture livestock their property. Current livestock on property consist solely of poultry, but there is interest in cattle, pigs, and other ungulates (hooved animals). All are excellent candidates for a silvopasture system. However, without proper management, any animal integrated into an agricultural system can and likely will destroy it. Proper management will be essential to the long-term success of the system.

Livestock should not be introduced while newly planted trees are without protection. Protecting young trees can come in many forms, and there are many makes and models of tree guards available that vary based on what they are protecting the tree from (protection from a cow versus a rabbit entails drastically different designs), how long they are meant to protect it, how much they cost and how much time they take to install. Below are links to several different styles of tree guards with varying applications.

- **BEST OPTION:** If using the Groasis Waterboxx, Groasis also manufactures its own tree guard called the Growsafe Telescoprotexx. This guard is unique in that it can be telescoped as the tree grows (new 18" sections can continue to be added on). It does not require stakes (saving cost and time) and can grow with the tree until the tree no longer needs protection. Additionally, these guards let in 100% of red and blue light (necessary for plant growth) and filters the rest of the light spectrum out, thus reducing light intensity and reducing evapotranspirative stress on the young tree by decreasing its temperature. Unlike many other tree guards that use ventilation to reduce temperature (which increases wind stress

and evapotranspirative loss) the Telescoprotexx protects trees from wind, further increasing their success rates in harsh environments.

- BioBark - Biodegradable Tree Shelters.
- Tri-Cone Tree Guards - Not bio-degradable, despite the site name.

Creative electric fencing layouts can also be used to reduce the likelihood of young trees being damaged by livestock, however, electric fences do fail and animals do (will) escape, and are capable of doing immense damage to young trees in a very short period of time. The costs and risks of various management styles and tree establishment protocols will need to be weighed based on a variety of factors like cost of tree stock, rate of growth, palatability to various grazers, livestock demeanor, forage availability, frequency of monitoring by residents, etc.

Careful selection of the specific livestock breeds is also critical. Some breeds are able to utilize a wider range of forage and conditions, whereas others are not as willing to be as flexible. Often, farmers can have success "training" animals to be better browsers on a range of forage, if they are not accustomed to seeking it out.

Some pig breeds have much less of a rooting habit and more of of a foraging habit, making them better suited for a silvopasture system. Pig breeds that have been noted to integrate well into a silvopasture system include:

- Berkshire
- Tamworth
- Red Wattle
- Large Black
- Old Spot (Gloucestershire)

All of the above pigs species will root in the soil, but less so if they are allowed access to the paddock when ample fruit/nuts/pods have already fallen. Nose rings are recommended for pigs - one across the columella (the fleshy part between the nostrils) and another into the tip of the snout. Inserting he nose ring is best done immediately after weaning or as soon as you receive feeder pigs from the farm. The nose rings cause them discomfort when they try to root, and quickly teach them to graze instead.

Grazing Strategy and Cell Design

Proper pasture rotation through the use of small, electro-fenced paddocks provides recovery periods for the grazed forage, minimizes soil compaction, and protects trees in a silvopasture system. Grazing recovery periods can only be achieved when well-designed livestock water supplies and cross fences are used.

Water Access

Portable, lightweight water troughs are recommended to allow for simple paddock shifts when changing grazing cells. Placement of troughs within each grazing cell will be determined by terrain, proximity to water supply lines and forage density. When water is located close to the forage resource, the herd's "social structure" is modified such that animals tend to water more frequently

as individuals. This tends to keep the herd dispersed throughout the paddock and results in a greater portion of time spent grazing. Water requirements vary for the kind, size, age, and breed of livestock. The rule-of-thumb used by some livestock managers is one gallon of water per day per 100 pounds of body weight per animal. Water use also varies considerably depending upon the animal's health, air temperature, water temperature, stage of lactation, and other environmental factors.

Fencing

Paddock fencing, wherever possible, should be installed 3-5 feet from tree seedlings in order to minimize browsing damage from livestock while the system establishes. Polywire or polytape energized with a solar system and supported by fiberglass or rebar step-in posts is recommended for the mobile fencing used to create paddocks. This enhances the manager's ability to provide optimum, forage recovery periods. A 5-wire system is sufficient for both pigs and sheep: one wire 4" off the ground, one wire 8" off the ground, one wire 16" off the ground, one wire 30" off the ground, and one wire 42" off the ground.

Shelter

In the long term, the tree canopy will provide shelter for the animals in this system. In the early stages of the system however, shelter that can be rotated with the animals will be needed.

For animals such as pigs and sheep, mobile shelters can be easily built, such as the one detailed here and shown in Figure 5-15. The best material to use for the shading in DFR's climate will be hi-density shadecloth, ideally 80%, that will help to reduce light intensity but will allow for better air circulation unlike a tarp or canvas covering.

Figure 5-15
Mobile pig shelter

Livestock Grazing Practice

The rotational grazing aspect of silvopasture is often the biggest hurdle for adopting the practice, especially by grazers who have been practicing continuous grazing (leaving animals in one large paddock) for some time. Regardless, it is the universal opinion of silvopasture advocates that

animals should not be placed in tree-based systems if they will not be managed through rotational grazing.

Forests

While there are a large number of precise and varying definitions for a forest, incorporating factors such as tree density, tree height, land use, legal standing, and ecological function, for the purposes of this report, a forest is a large area dominated by trees. They provide a crucial and irreplaceable role in Earth's ecology: they are the second largest storehouse of carbon and producer of oxygen on the planet, provide habitat for a myriad of plants, animals, and fungi, and provide food, fuel, shelter, and water (through their immense influence on climate and the water cycle) for humans.

Existing Conditions

There are a few remaining Valley Oaks on property that appear to be precariously close to death, or may be past the point of no return. Several have fallen in recent years. This is likely due to a combination of reasons:

- Lack of companion plants from the oak plant communities,
- Invasive weeds competing for water and nutrients,
- Lack of oak leaf-litter that provides beneficial microorganisms that protect the tree, and
- Lowered water table

Recommendations

The following forestry elements are recommended, and illustrated in the following images:

- Reestablish the native central oak woodland plant community on the steep slope between Mission Rd and the driveway, and on the west- and south-facing aspects of the north ridge. In the areas where there are existing oaks, appropriate steps should be taken to rehabilitate them and bring in their companion plants. On the barren hillsides, reforesting the property to this state will require reestablishing a shrub and groundcover layer to nurse the slower-growing new oaks.

Figure 5-16
Areas on the north end of DFR recommended for re-establishment of the native central oak woodland plant include "Forestry – N Ridge" (F-NR), "Forestry – E Valley" (F-EV) and "Forestry – W Hillside" (F-WH)

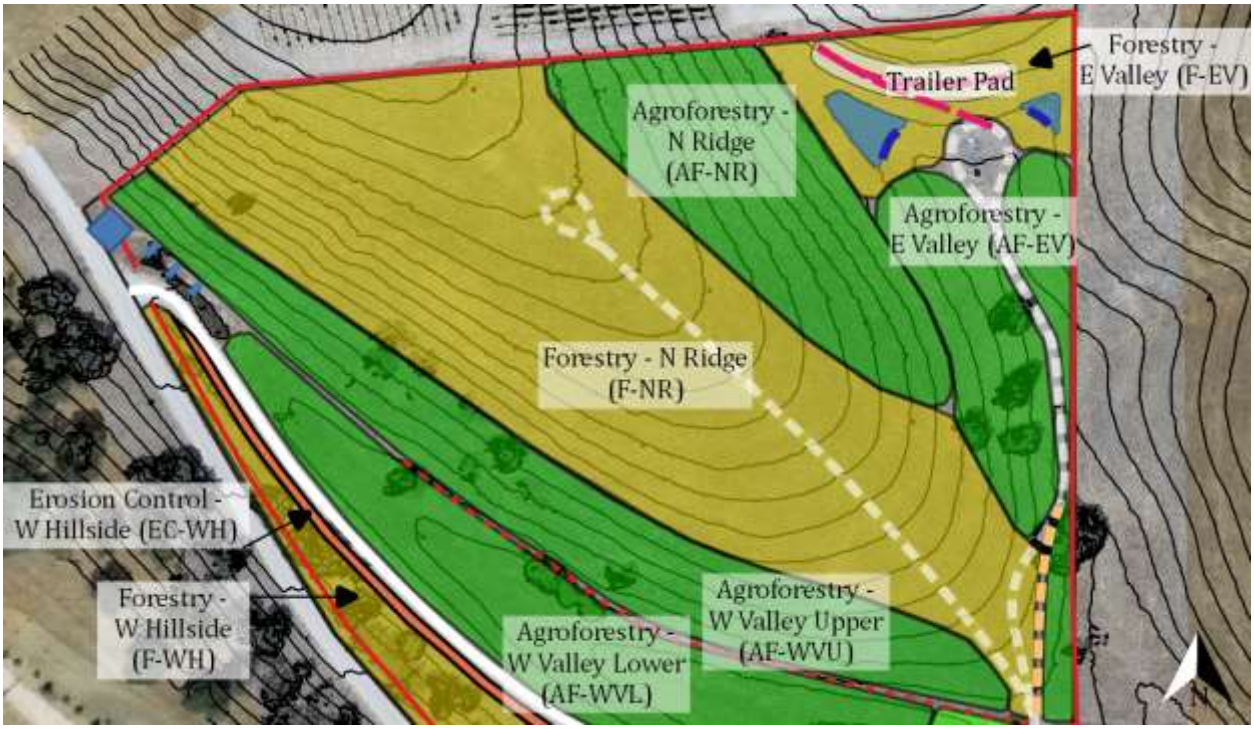
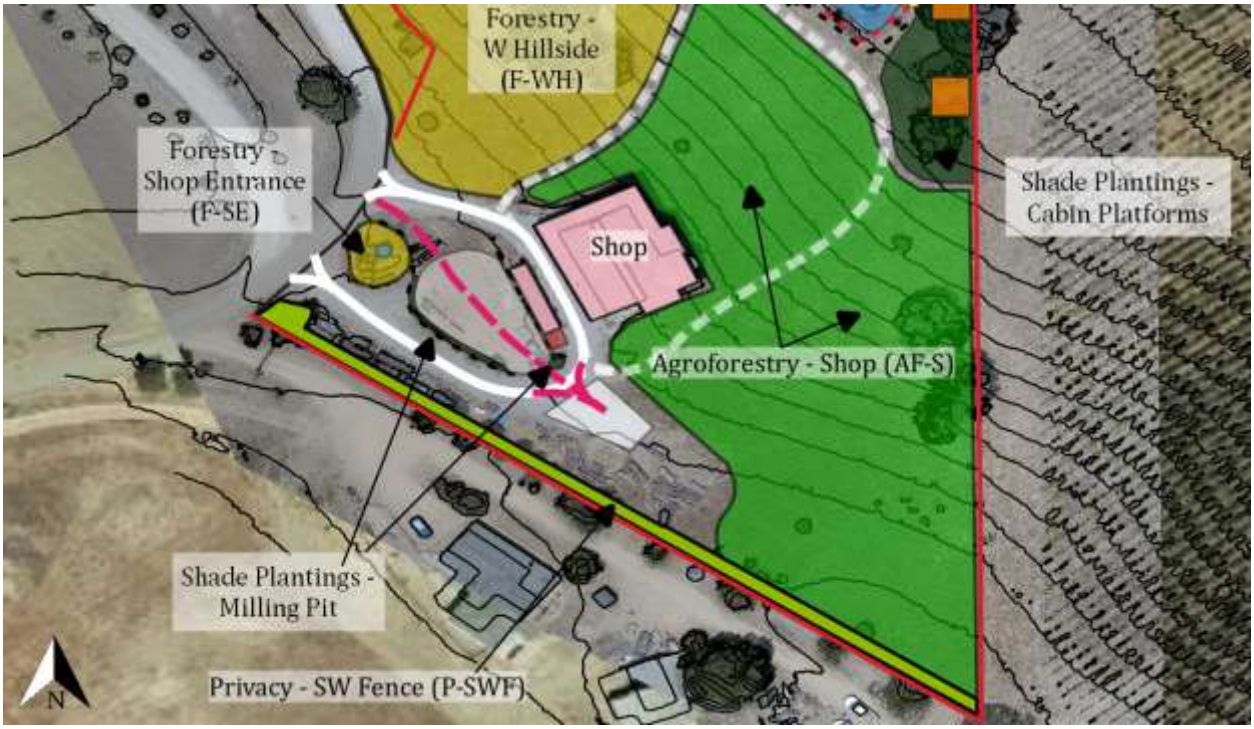


Figure 5-17
Areas on the south end of DFR recommended for re-establishment of the native central oak woodland plant community include "Forestry – W Hillside" (F-WH), and "Forestry – Shop Entrance" (F-SE)



Foresting these areas on the property will greatly mitigate fire risk (if managed properly), help to moderate the microclimate on property, reduce erosion issues and stabilize the soil, drastically reduce the invasion of foreign annuals (weeds), and rehabilitate the soil conditions. Examples of a central oak woodland community in the Paso Robles area and a not-very-intact chestnut forest (missing companion plants, so actually considered an orchard) are shown in Figure 5-18 below.

Figure 5-18
Left: central oak woodland plant community, *Right:* Skyline Chestnuts Orchard, missing companion plants, in Palo Alto, CA

Re-establish Native Central Oak Woodland Plant Community

Reestablishment of the native central oak woodland plant community on the steep slope between Mission Rd and the driveway, and on the west- and south-facing aspects of the north ridge is recommended. This should begin with the existing oaks, where appropriate steps should be taken to rehabilitate them and bring in their companion plants. On the barren hillsides, reforesting the property to this state will require reestablishing a shrub and groundcover layer to nurse the slower-growing new oaks.

Rehabilitate Existing Oaks

Rehabilitating the existing oaks requires clearing out the invasive weeds in the understory and replacing them with the companion plants in their native community and a healthy layer of mulch – recreating the forest floor that used to exist. Undertaking the reestablishment of the native plant community in this area should occur in the winter, spring, or summer[7] to ensure the highest success rate for new plantings.

Start by gently hand pulling the non-native weeds (identify the native plants and keep them!) present within the drip line of the tree, trying to disturb the native soil as little as possible, and then immediately mulching the area in their place (mulch around the native plants that were left unpulled). Following the weeding with a thick layer of mulch (4-6 inches) is critical, as the soil will be disturbed from hand pulling, no matter how delicately it is done, and this will create a perfect seedbed for weed seeds as well as attract gophers.

[7] https://www.laspilitas.com/advanced/advwhentoplant.htm

The mulched area should then be planted with plants native to the Valley Oak community, some of which are summarized in Table 5-7.

Table 5-7
Suggested plants for re-establishment of companion plants under existing oaks at DFR

Common Name	Scientific Name	Plant Diameter (for spacing)	Notes
Toyon	*Heteromeles arbutifolia*	7-10'	Within or at dripline
Buckbrush Lilac	*Ceanothus cuneatus*	7-10'	At dripline on south side
Mountain Lilac Joyce Coulter	*Ceanothus Joyce Coulter*	6-8'	Within dripline
Mountain Lilac Yankee Point	*Ceanothus Yankee Point*	10-14'	Within dripline
Hollyleaf Redberry	*Rhamnus ilicifolia*	3-6'	Within or at dripline
Coffeeberry	*Rhamnus californica*	7-10'	Within or at dripline
Harmony Manzanita	*Arctostaphylos Wayside*	3-6'	Within dripline
Golden Currant	*Ribes aureum*	3'	Within dripline
Yerba buena	*Satureja douglasii*	3-6'	Within dripline
Hummingbird Sage	*Salvia spathacea**	3-6'	Within or at dripline

This process, of removing the invasive weeds, mulching, and planting will likely be done one tree at a time, and even one area under one tree at a time, as time permits. Do not apply soil amendments or fertilizer, and, if applying any water during the dry season, only apply sparingly on new plantings if they need help becoming established. Planting in the fall just prior to the rainy season should eliminate the need for this. Otherwise, oaks, and the plant community that grows with them, do not want summer water.

Leaving the oak leaf litter in place, once the invasive weeds have been removed, is critical to rehabilitating oaks (or maintaining the health of new ones). Healthy oak leaf litter (without weeds) supports microorganisms that provide protection to oaks from disease, critical nutrients, and water.

How to Plant California Native Plants

Las Pilitas Nursery in Santa Margarita, CA offers the following in-depth guide for planting native plants. The most efficient approach is to pick an area to plant, mulch, and water all at once. Depending on the size of the area, multiple low-flow sprinklers or microspray emitters may be needed. Once that area is planted and watered, move to an adjacent area, moving across the landscape.

- Dig a hole of a size into which the plant will fit, not larger than.
- Carefully remove the plastic bag or plastic pot from around the plant and recycle bag/pot.

- Disturb the root ball as little as possible, but gently run a finger along edge so roots are not coiling.
- Carefully place the plant into the hole, slightly higher (1-2 mm) than the surrounding soil. Do not add amendments, do not add fertilizer. Backfill the hole with the soil.
- The first watering: water lavishly unless planting is immediately followed by an extensive rain. Las Pilitas recommends watering an area for 8-12 hours with a sprinkler if planting in the spring/summer/fall. Water the plant, and the ground around the plant in a circle one foot past the drip line. Dig into this area after watering, to ensure that the moisture made it to at least 18 inches deep.
- Subsequent waterings: DO NOT USE DRIP IRRIGATION. Use microspray emitters or low volume sprinklers instead, so that the plant will be irrigated in a pattern more similar to rainfall. Do not water against the crown (the main stem of the plant at the soil surface) of the plant. Water should fall in the area of the drip line of the plant and beyond. Again, check that the water made it down at least 18 inches; 24 inches + would be better. Let the top inch or so dry out between waterings. Check at least a few times until an understanding is developed for the water and soil conditions
- The first year, check the soil, down about an inch or two, once a week; if it is dry, water it to 18 inches deep; if it is moist, provide no additional water. The second and succeeding year-water, if needed, during the months of November through April, abstaining from watering in the summer. In really dry years, add extra water once a week either between plants or a overhead sprinkler like a summer shower. This may need to occur throughout the year if the rainfall is below normal.
- Place evergreen oak leaf mulch, shredded redwood bark, or shredded cedar bark 2-4 inches deep on top of the soil around the plant in a four-foot-diameter circle.
- If unable to get plants in the ground immediately, poke a few holes in the bottom of the bag, place in morning sun or part shade, water once or twice a week if needed.

Re-establish Central Oak Woodland

In the exposed areas, the native pioneer plants should be established to cover the soil and provide nurse habitat for the oaks, which will be planted in their midst. Here, due to the full sun exposure, some different species from those recommended in the rehabilitation of the existing oaks should be used- species that can handle the full and intense sun until the overstory trees fill in. The species suggested for the exposed areas are provided in Table 5-8. Again, planting in the winter, spring, or summer is recommended. Due to the large area recommended for re-establishment, phasing the planting using "resource islands" is recommended. In this, a circular area that can be covered by a single sprinkler, approximately 40 ft, should be planted. This size is manageable enough that if deer, rabbits, or squirrels become an issue during plant establishment, a fence can be placed around the area at the edge of the sprinkler radius. Water the area for a year to establish the plants, and then move the sprinkler (and fence, if used) to a new area for establishment. Within a few years, there will be islands everywhere, and the interstitial areas can be filled in.

Table 5-8
Proposed central oak woodland guild for re-establishment of forestry zones at DFR

Guild Name	Description, Spacing, Seasonal Yields and Management
Central Oak Woodland Recommended Planting Areas: **AF-WVL (50%)**	Central oak woodland native plant community for establishment of "resource islands" in areas marked for forest re-establishment. (3) Big berry manzanita and (2) buckbrush lilac are the largest at 8' mature diameter; (5) coyote brush with a 6' mature diameter; and (3) California sagebrush, (4) California buckwheat, (3) black sage, and (10) silver bush lupine with a 4-5' mature diameter. Select a location about 100' from an existing valley oak tree in the forestry blocks, and mark off a 40' diameter at that point that can be covered by a single rotary sprinkler placed in the middle. Plant the guild in a randomized and evenly spaced pattern within that circle (leave a little extra space around the manzanita and lilac, 1-2'), all the way out to the outer radius. Provide periodic deep watering during the first year. If deer, rabbits, or squirrels become an issue, place a fence around the outer radius. After the first year, the plants will have established, and the sprinkler (and fence, if needed) can be removed and used in the next location. In time, the animals enjoying their new habitat will inadvertently help plant new oak trees within the guild when they forget about some of their acorn stashes, which will be supported on many levels by the surrounding, already-established vegetation.

According to Bert Wilson, now-deceased creator of Las Pilitas Nursery in Santa Margarita, CA and author of their in-depth online database, if this native understory is planted and allowed to establish, the oak trees will eventually show up on their own, through the arrival of Jays that will come to take advantage of the berries and other food in the native habitat that's been planted. However, oaks can also be intentionally planted in the mix to speed things up.

6 - Boundaries

Fences serve several important functions, including confining and protecting animals and crop areas, providing visual barriers, and supporting trellised growing systems. There are three broad categories of fencing: permanent, semi-permanent, and temporary. Within these categories are dozens of different fencing options. The choice of fencing for any given area should be made based on what purpose it serves:

Permanent Fencing

Permanent fences are typically used for boundary and subdivision fences on land that's owned by the user—and whose usage is not likely to change. They are usually constructed of strong wood, steel or fiberglass posts that support high-tensile solid wires, woven wire, rope or wide tape—of which one or more strands are electrified. They are more reliable and durable than other options but more expensive to install. A professional installer is often needed.

Existing Conditions

Doe Family Ranch is mostly enclosed by barbed-wire supported by metal t-posts. There are some areas, like the border between the southwest corner of the property and the neighbors, that are fenced with wire livestock fencing. The areas that are not enclosed include the driveway entrance and Shop access road entrance.

There is also an internal livestock fence that runs along the base of the north ridge. It does not fully enclose any section of the property. The permanent fencing is highlighted in Figure 6-1 below.

Recommendations

There are several areas where the barbed-wire perimeter fence has been compromised, and cattle are able to access the property. An example of this is shown in Figure 6-1 below. In particular, the fencing along the east property border should be repaired, in order to keep cattle from the neighboring property from coming into DFR.

Figure 6-1
Barbed wire fencing in need of repair

Temporary Fencing

Temporary fencing is typically used in applications that require daily or weekly movement. They should be quick to install and remove and eliminate the need for large end and corner posts, and the fence strands (whether single, multiple or a mesh/netting) must be only hand-tensioned. They must also be electrified properly.

Existing Conditions

No temporary fencing is currently in use.

Recommendations

Temporary fencing is suggested for use in the following areas:

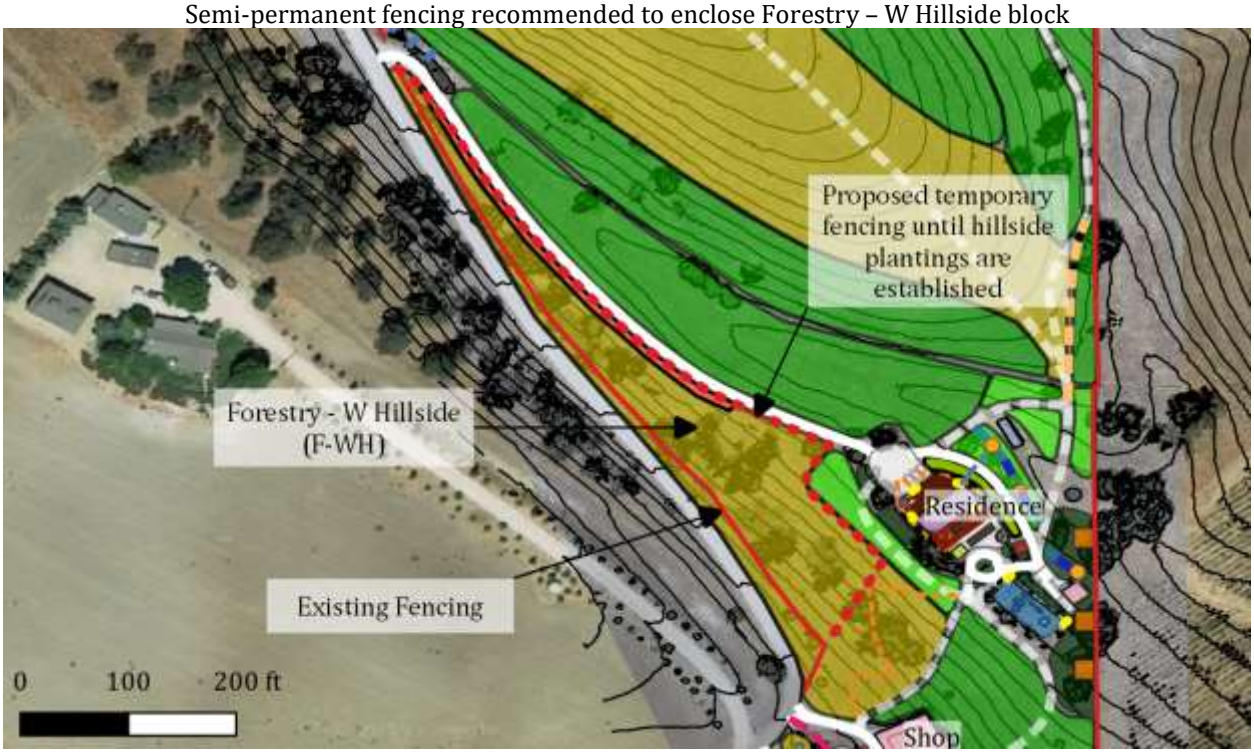
- On the east and south perimeter of the forestry block recommended for the steep hillside in between Mission Rd and the Driveway.
- Various locations - temporary fencing is recommended for the grazing of chickens, pigs, cattle, and other livestock in the orchard and agroforestry blocks.

Fencing Around Forestry – W Hillside Block

Temporary fencing is recommended along the east and south sides of the Forestry – W Hillside block, as shown in Figure 6-3. This fencing should be tied in with the existing property boundary fencing on the west side of the block (along Mission Rd), in order to completely enclose the area and prevent canine/squirrel interactions on the already eroding hillside. This fencing should be kept in place until the forestry recommendations outlined in Section 5.8 for that area are in place and have become established - once irrigation has been removed and the plants have grown

(approximately 2-3 years), the hillside should be vegetated enough that the dog activity in the area will not create major damage.

Figure 6-3
Semi-permanent fencing recommended to enclose Forestry – W Hillside block

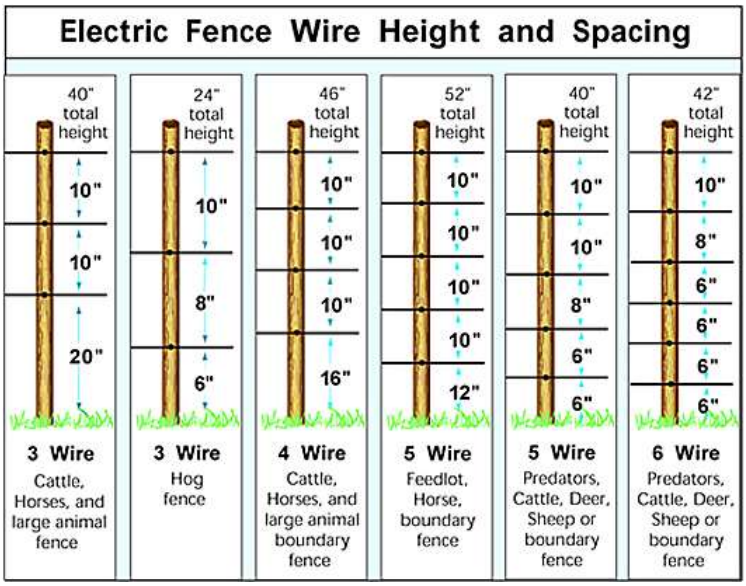


Livestock Fencing

For pigs and cattle, energized polywire with step-in fiberglass or rebar posts is recommended. This type of fencing is preferred because of its effectiveness and ease of relocation.

Figure 6-4
Polywire temporary electric fencing

Figure 6-5
Polywire fence spacing



For the chickens, energized mesh netting with build-in posts is recommended, as shown in Figure 6-6.

Figure 6-7
Energized mesh poultry netting

A note about electric fencing - weeds growing underneath the fencing can cause a short, rapidly draining the battery. Weeds growing underneath electric fencing should be manually cleared, or a flame weeder can also be used. An inexpensive fence tester should be used to make sure the fence is working properly.

NRCS Fencing Grant Information

Federal cost-share funding is available for internal fencing improvements through the NRCS Environment Quality Incentives Program (EQIP). Farmers or ranchers working to implement a Grazing Management Plan can submit their plan and apply for funding assistance with various types of fencing installation. For more information look up Code 110 - Grazing Management Plan.

7 - Energy Systems

Energy is a challenging concept to define. Attempts often start by listing specific energy *sources*: electricity, natural gas, propane, etc. These sources of energy do work: they move things, whether those things are people, electrons, water, heat, etc. **Energy is the ability to do work.**

Toby Hemenway, author of *The Permaculture City*, proposes that it is useful to think of energy as a sector - an influence coming from off the design site, as other influences from off-site such as road noise, winds, etc are similarly defined as sectors. There are three ways to interact with sectors: we can 1) harvest, collect, or store them, 2) deflect or block them, or 3) let them pass by unaltered. These three approaches to energy as a sector are a useful starting point for designing energy systems.

Another useful approach to designing energy systems outlined in *The Permaculture City*, that works well in conjunction with the sector approach above, is to start with what jobs the energy needs to do - what functions it will perform. This is a whole-systems, pattern-based approach, as opposed to the detail-centric approach that typically is used to design energy systems of listing the items that will need energy and then matching them to an energy source. There are three jobs that energy typically performs: **moving heat**, **moving things**, and **moving electrons**

This whole-systems approach to energy design provides a much greater opportunity to identify the ways that the energies already present on-site can be harvested and stored (such as sun, in the form of radiant heat and also in a condensed form like wood), deflected (such as wind), or left to pass by in order to meet an energy function like heating, as opposed to the modern approach of placing a gas-fired heater wherever heat may be required. This design approach has been utilized in preparing the energy recommendations at DFR.

Context

The long term vision of DFR is to be able to comfortably host students and guests and conduct on-site operational activities with a minimized requirement for grid-tied or imported energy sources. While there are already several elements in place on property that were not originally designed with this lens for minimizing energy consumption, maximizing efficiency, and matching energy sources to appropriate end-uses, there is still much that can be done to design, create, and support both highly efficient and specific energy end-use systems and an overall lower energy pattern of habitation.

Readily available energy sources already present on the land include sunshine, wood scraps from the shop and mill, and an electrical grid connection. The site a fair amount of solar insolation (163 sunny days per year, with an average annual solar insolation value of 6.2 kWh/m2/day). Average wind speeds are not high enough for wind energy production to be considered economically viable (average annual wind speed of 6.2 mph). There is no noteworthy geothermal activity at the site. There is a plethora of local diesel, gasoline and propane distributors.

Moving Heat

Moving heat is typically done in two ways: first, releasing and concentrating heat in furnaces, heaters, and stoves so that it can be delivered to living spaces, for household water, or for cooking food, and second, removing heat via cooling equipment such as air conditioners and refrigerators. This work can be done with a wide array of fuels and forces, including burning liquid and gas fuels, wood, or coal; by electricity; by expansion and compression of gas; via friction; and using the sun.

Existing Conditions

The existing systems for moving heat on-site include a propane-fired furnace, hot water heater, and range/oven in the Main Residence.

Recommendations

The anticipated heat transfer needs as DFR continues to develop the site include outdoor cooking equipment in the outdoor kitchen and hot water production for the bathhouse. The following systems are recommended to perform these functions:

- Propane cooking systems for the outdoor kitchen
- Alternatively, wood-fired cooking systems can be used for the outdoor kitchen
- Wood-fired rocket systems for Village Bathhouse and Shop space heating
- Wood-fired rocket mass systems for Village Bathhouse water heating

For any future structures built, including a future home, the following elements are recommended for moving heat:

- Wood-fired rocket cooking systems
- Passive solar strategies for space conditioning

Propane/Biogas-Fueled Cooking Systems

Cooking food in a timely manner requires a concentrated energy source. Wood, coal, liquid fuels, and gas fuels are the primary concentrated energy sources for residential and small-scale use. Of those, wood and biogas renew the most quickly, and thus are the best options in terms of sustainability. Eventually fueling cooking needs with locally-produced biogas would improve the environmental footprint at DFR.

Propane-fueled cooking appliances are recommended initially for cooking equipment at the outdoor kitchen, with the exception of the Argentine-style grill. Depending on the sustainability goals of the Doe family, there are also wood-fired options for all of the typical outdoor kitchen equipment, described below.

Wood-Fired Rocket Cooking Systems as Alternative for Outdoor Kitchen

Rocket stove technology is an important technology for maximizing the use of the energy contained in wood and making it a feasible replacement for the more modern conventions of gas-fired cooking. Rocket stoves burn wood at very high efficiency (generally 93 - 95%, meaning that 93 - 95% of the energy contained in the wood is converted to heat and transferred to the cooking vessel, and only 5 - 7% is lost as heat or unburned gasses to the surrounding environment) as opposed to traditional wood burning stoves burning larger logs that generally operate at 50% efficiency (and

this is under ideal laboratory conditions - if wood is wet and air flow is not managed properly, traditional wood stove systems can operate in the teens for efficiency). This high efficiency is the result of a design that creates both a high temperature burn and efficient air mixing and secondary combustion of wood gases (smoke). Rocket stoves are so efficient that they do not emit smoke when constructed and operated properly. Most of what leaves the chimney is CO2 and water, as all the smoke that would typically be visible coming out of a standard chimney has been combusted. Rocket stove technology can be utilized to replace the typical cooking appliances, including cooktops and ovens.

Walker Stove Riserless Core Rocket Cooktop

Recommended for use in the proposed Outdoor Kitchen, Matt Walker's riserless core rocket stove designs have enabled a flat metal cooktop to be the main radiative surface for the rocket stove while still maintaining the high efficiency burn characteristic of rocket stoves. The metal cooktop, on which pots, pans and kettles can be placed and moved around to find exactly the right temperature for the culinary task at hand, makes for a very flexible and easy to intuit cooking set up. Units can be quite small, and could be a good fit for some of the smaller spaces, and can also be quite large and capable of cooking for larger groups. Small and large versions are illustrated in Figure 7-1 below. A portable camp-style propane stove can also be placed on top and used whenever a quicker, more conventional cooktop is desired.

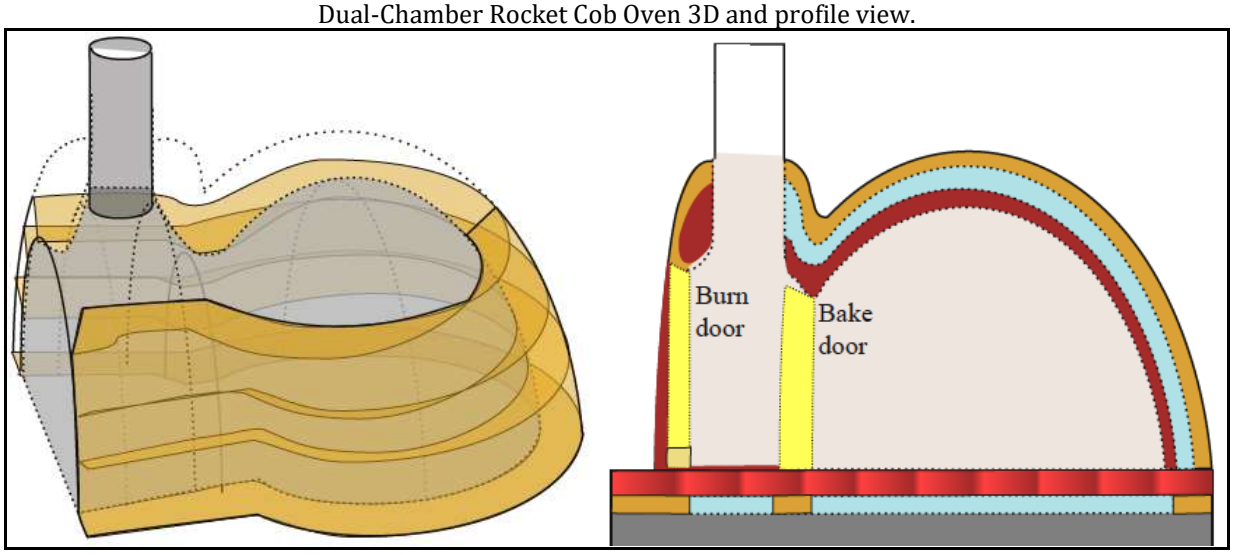
Figure 7-1
Left: Tiny Masonry Cookstove. Right: Full Size Masonry Cookstove.

For an in-depth dive into Matt's riserless core technology, performance reviews and DIY tips, visit Matt's YouTube video roll.

Dual-Chamber Rocket Cob Oven

Recommended for the Outdoor Kitchen, Dual-Chamber Rocket Cob Ovens like the one illustrated in Figure 7-2 eliminate the smokiness typically associated with these types of ovens, allowing the chef to breathe clean air while tending the fire. Essentially, these ovens employ a two-door system linked with a strategically placed chimney that improves draw and airflow and makes for a cleaner, hotter, faster burn. These ovens get up to temperature faster and have a four times cleaner burn that traditional cob ovens. Plans for making a dual chamber rocket cob oven are available through Permies.com. Watch Ernie Wisner's video walkthrough of this system to see it in action.

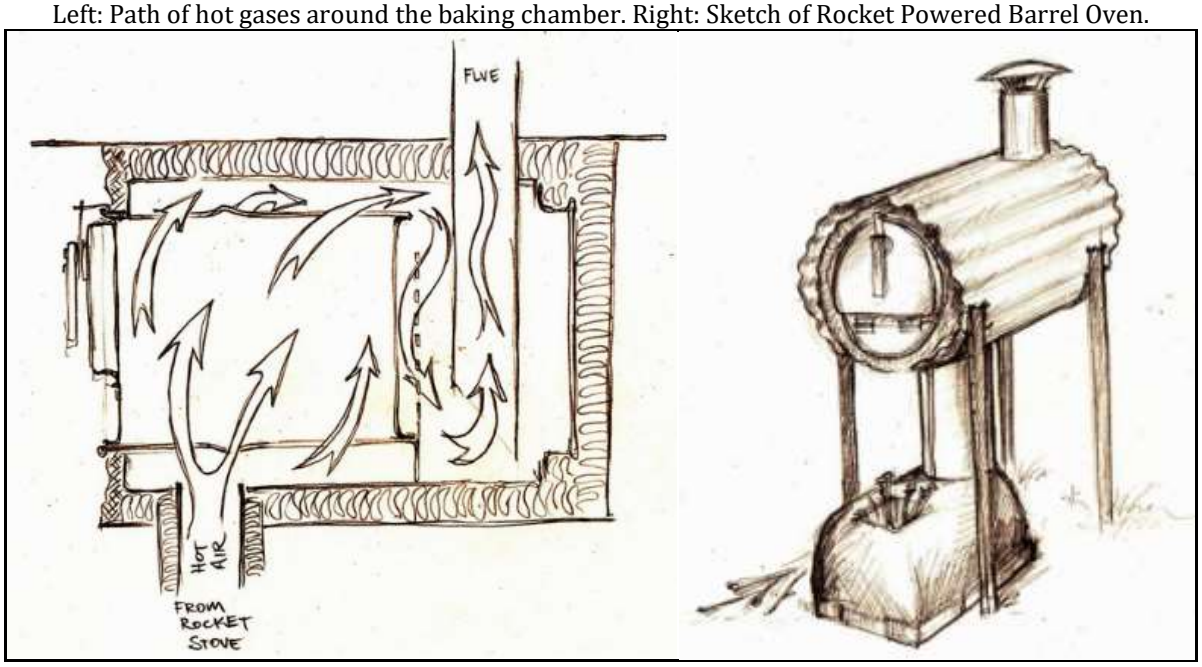
Figure 7-2
Dual-Chamber Rocket Cob Oven 3D and profile view.



Rocket Powered Barrel Oven

Recommended for the Outdoor Kitchen. Barrel ovens that utilize rocket designs, like the one shown in Figure 7-3, are quick to heat (unlike traditional cob ovens), entirely wood fired, excellent for baking, and cheap and inexpensive to build. These systems can be used indoors as well as outdoors.

Figure 7-3
Left: Path of hot gases around the baking chamber. Right: Sketch of Rocket Powered Barrel Oven.



Tim Barker's plans for constructing both a barrel style oven and converting a more typical oven to take advantage of a wood-burning rocket engine are excellent and very approachable for the DIY enthusiast. For the more visual DIYer, the Permies.com Rocket Ovens video manual will walk through all the steps to building one of these ovens start to finish.

Wood-Fired Rocket Systems for Supplemental Space Heating in Village Bathhouse and Shop

Interior space heating is typically needed quickly, and thus calls for a concentrated energy source. Conventional space-heating systems include wood stoves, liquid and gas fuel fired-heaters, and electric heaters. Of these options, electric-heating is the most inefficient, and should never be used at a site with sustainability goals. Wood renews more quickly than liquid or gas fuel, and as with cooking, can be maximized using rocket technology to improve combustion efficiency. At any site with a large supply of existing wood (like the scraps from the Shop), heating can be entirely supplied without the use of gas or liquid fuels.

Rocket Mass Heaters for Supplemental Interior Space Heating and Cooling

Currently recommended for use in the Village Bathhouse, this style of wood-fired rocket system helps to drastically lessen the inherent inefficiency of using high temperature flames to heat a relatively low-temperature space by employing an earthen mass in the form of a bench to both store and radiate heat. For spaces that are likely to be occupied frequently and for long durations, these mass benches provide an excellent thermal battery that can be used to moderate indoor temperatures for long periods of time, as explained wonderfully by Paul Wheaton on YouTube. They also help to keep a space cool – a bench thermal mass will act as a heat sink in the space on hot days.

Rocket mass heaters that feed into a mass like the one pictured below in Figure 7-4 typically employ a J-Tube design, but can also employ the Batch Box design as detailed in the following section. The wood pieces used to fuel a rocket mass heater can be relatively small, typically the size shown in the image below, and thus can be served well by scrap wood fuel.

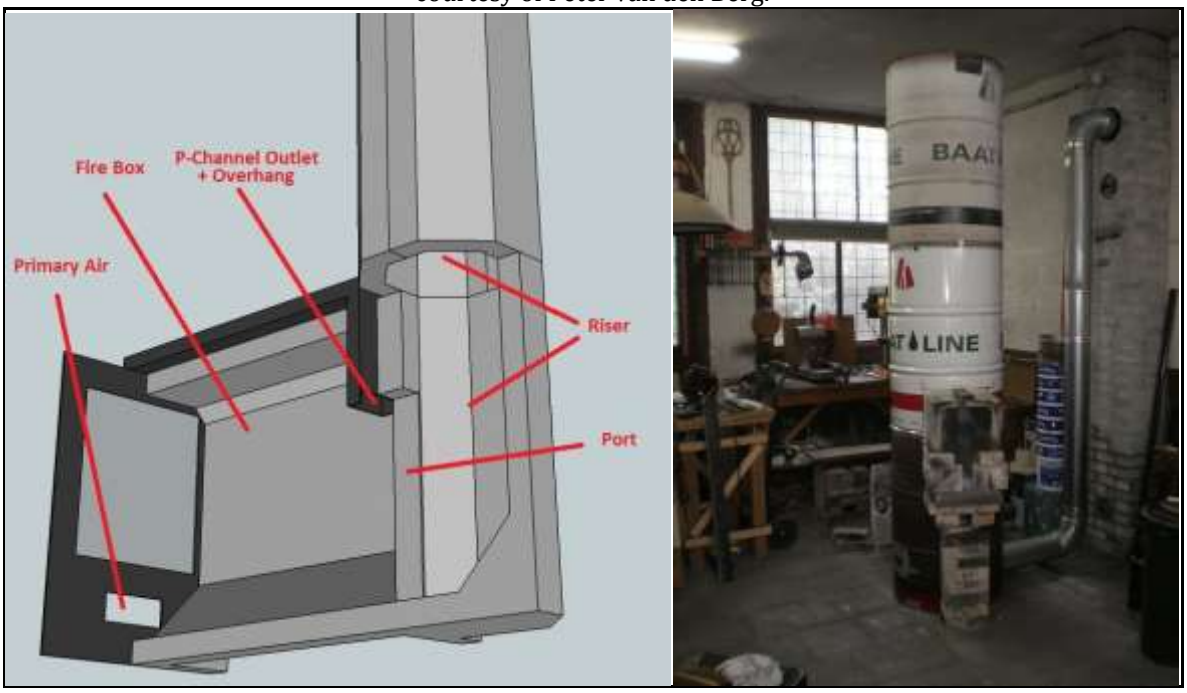
Figure 7-4
The rocket mass heater and earthen bench heated by hot flue gases faces in towards the center of the community kitchen and indoor dining area at Quail Springs Permaculture in Cuyama, CA. *Credit to Quail Springs Permaculture*.

The 55 gallon steel barrel seen commonly in this style of rocket mass heater design is known as the "bell", and provides a way to quickly heat a space in addition to functioning as part of the powerful draw mechanism of the chimney. The bench mass can take longer to warm up to a point where it is radiating heat, especially if it has not been utilized recently and has reached ambient temperatures, but will also continue radiating heat long after the fire has intentionally or unintentionally been extinguished. If a design like this is agreeable and a good fit within the recommended buildings, the Rocket Mass Heater Builder's Guide by Erica and Ernie Wisner is an excellent manual for DIY construction.

Batch Box Rocket Heater

A Batch Box style rocket-heating system is recommended for the shop(for space heating) and bath house (for hot water heating). The Batch Box style of rocket heater enables a larger load of wood to be set into the combustion chamber at a single given time, thus providing a longer total combustion window before the stove must again be fed. This design is very efficient and burns *very hot*. The shop heater application detailed on YouTube with the inventor Peter van den Berg shows the double bell system capable of heating a large space quickly. These systems can be engineered to release heat quickly into a space, as shown in Figure 7-5 on the right, or to charge a thermal mass for long term temperature moderation.

Figure 7-5
Schematic of the batch box rocket stove system and a double bell, massless batch box shop heater. Images courtesy of Peter van den Berg.

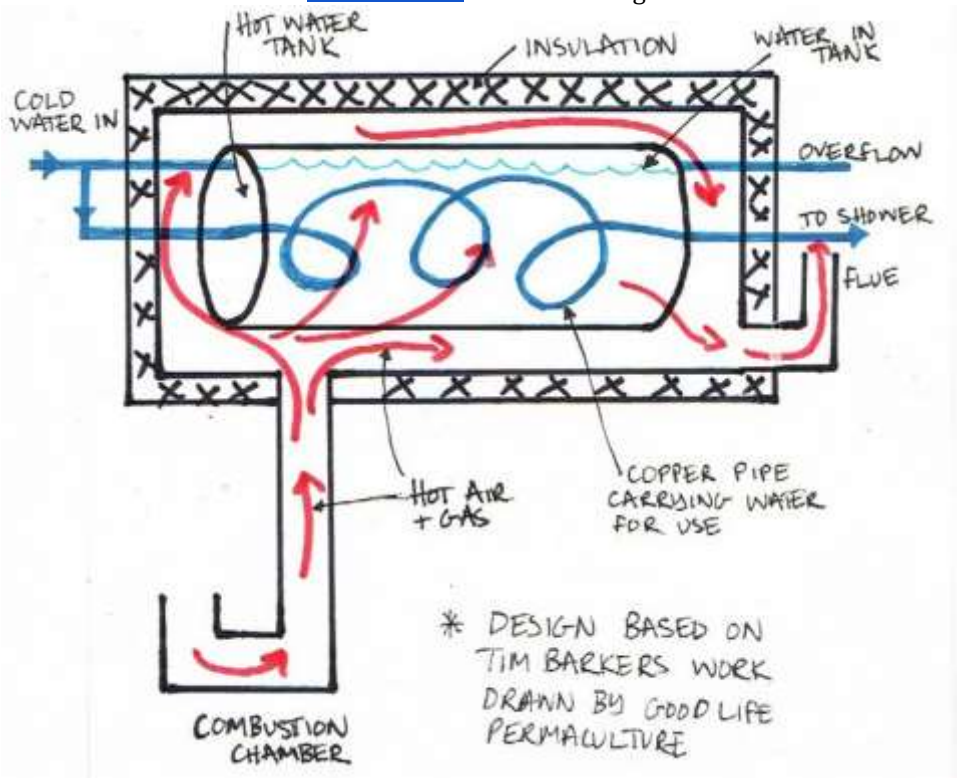


Critical to the Batch Box design's efficiency is the use of a secondary air injection channel that draws in and mixes pre-heated, oxygen rich air into a low-pressure zone at the exit from the burn chamber to the heat riser. Typically a metal tube called a P-Channel is used, although fire bricks can be utilized as well. This injection of oxygen creates a secondary combustion so complete that there is zero smoke when operating at design temperatures. Designs for Batch Box Rocket Heaters are available online for free as open source plans. Dimensions and ratios must be kept very exact in building a batch box chamber, lest the burn dynamics within the chamber be degraded.

Wood-Fired Rocket Mass Water Heater

Currently recommended for the Village Bathhouse. Rocket mass water heaters function by heating a large mass of unpressured water with the hot exhaust, then using this mass of water to transfer heat to pressurized water piped through the heated water mass, typically using a copper pipe. Figure 7-6 below details the schematic for such a system. Geoff Lawton's video walkthrough of the system in use at Zaytuna Farm provides an excellent overview of how the system work.

Figure 7-6
Rocket stove hot water heater schematic. Note how the heated water is contained in a non-pressurized container, thereby eliminating the risk of explosion. Credit to Tim Barker for the design and Good Life Permaculture for the drawing.



Passive Strategies for Space Conditioning in Future Structures

For any future structures built, like an additional home, passive strategies for space conditioning should be considered during the design phase. Passive strategies for influencing the temperature of an interior space are those that don't consume fuel. The main strategies for this include 1) keeping heat where it's wanted via insulation and leakproofing, 2) storing heat with thermal mass, and 3) controlling solar gain (how much sunlight gets inside).

Keeping Heat Where It's Wanted

Ensuring that any existing and future structures are properly insulated and leak-proofed is hands down the biggest bang-for-the-buck strategy for controlling the temperature of indoor spaces. In modern construction methods, this is typically done using batts of insulative material held against the roof, floor, and exterior walls. In natural construction, this involves selecting natural construction materials and methods that are insulative. Cob and clay-straw slip wall construction are both highly insulative natural building techniques, while polewood wall construction (log-cabin style, etc) is among the least. Double-pane windows should be utilized, especially in new construction, where the payback is much more attractive than upgrading from existing single pane windows to double pane. In terms of leak-proofing, doors and windows are the primary offenders. The small cracks around the windows and under the doors add up - older structures often have enough leaks to amount to several square feet, which is the same as having a fair-sized window

open all of the time. Windows should be properly sealed, and weather-stripping used to seal any door leaks.

Storing Solar Heat with Thermal Mass

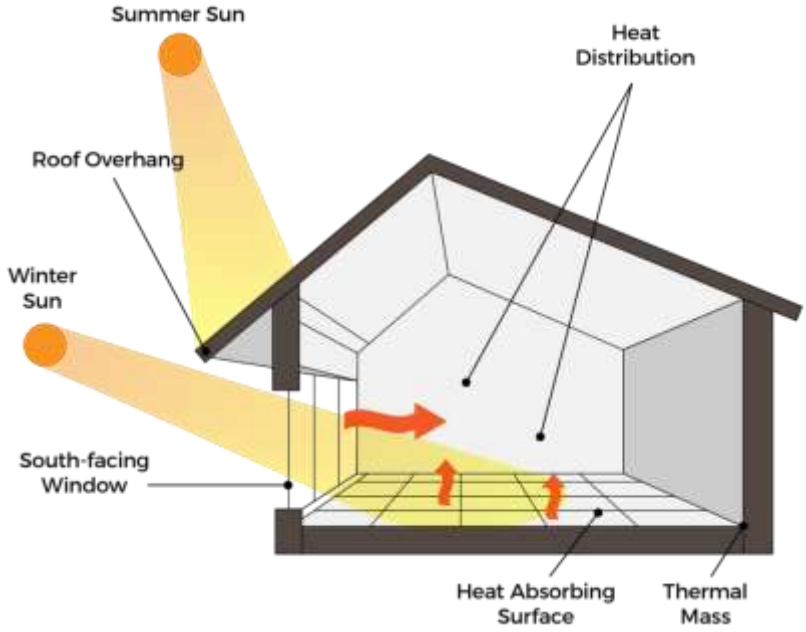
A material that has thermal mass is one that has the capacity to absorb, store and release heat energy. Its density and levels of conductivity help to keep the internal temperature of a building stable. They are generally dense materials, such as concrete, stone, brick, cob, ceramics, and water.

Objects that have thermal mass have inherent qualities for both heating and cooling. When thermal mass is used for its heating capacity, when exposed to sunlight, the thermal mass absorbs the sun's heat energy. The heat energy that is absorbed will slowly spread (conductivity) through the mass and then radiate or release the heat energy throughout the evening and night - particularly nice during the winter months. If dense objects with thermal mass are kept out of the sun, they will absorb the warmth from the surrounding air, helping to cool a space. Getting sunlight onto thermal masses during the winter months and keeping it off of them during the summer - "controlling solar gain" - are described below.

Controlling Solar Gain

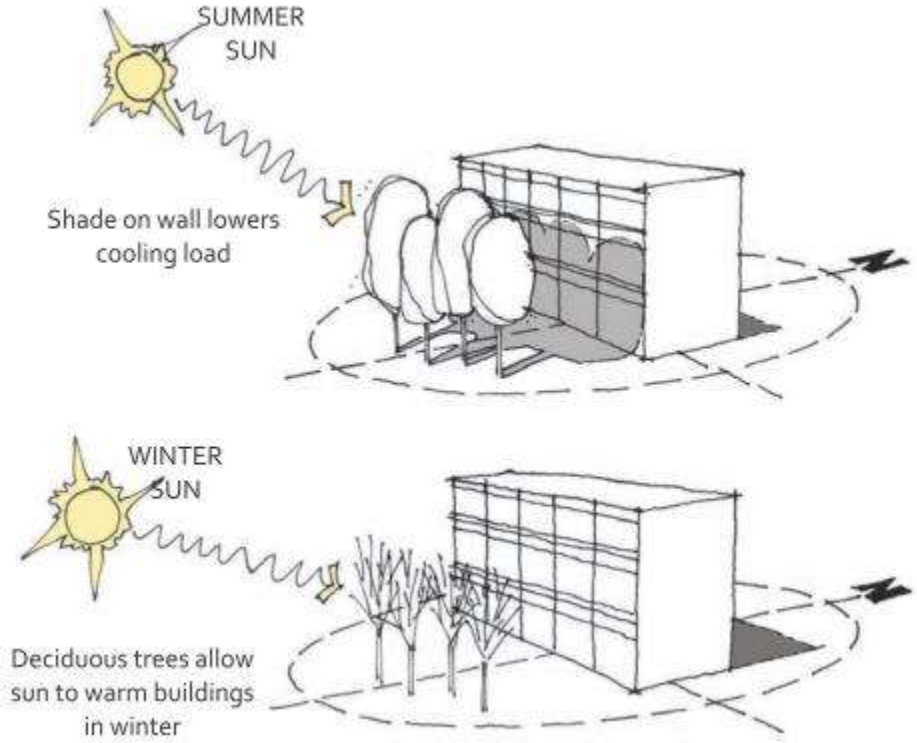
In order to get sun on interior thermal masses during the winter but keep it off during the summer, roof overhangs can be utilized to take advantage of the sun's seasonal angles. This is shown in the figure below.

Figure 7-7
Utilizing architecture to provide summer cooling and winter heating



One design challenge here is that the sun is at the same angle in the spring and fall, but the fall is warmer in many areas than the spring. Deciduous trees on the south side of the structure, or a trellis over the south-facing windows with a deciduous vining plant, can be utilized here to provide sun during the spring and shade during the fall, as shown in Figure 7-7.

Figure 7-7
Using deciduous plants to provide summer cooling and winter heating



Another design approach here is to control the size and placement of windows. Most passive solar experts recommend that the glassed area equal no more than 8 to 12% of structure's total floor area, with 70-85% of that on the south-facing wall, 10-15% on the east wall to catch morning sun, and 5-10% on the west wall to avoid overheating on hot afternoons.

More extensive resources on passive solar design are available, including the National Institute of Building Sciences web page on passive solar design.

Moving Things

Moving things typically includes spinning fans and motor parts, compressing gases in refrigerators, pumping water, and raising and lowering objects. This is most often achieved by making a shaft spin in a motor or pump, and then translating that rotational energy into linear force or a pressure change. Electricity is the most common power source for this, but fluids (liquid and gaseous) such as water, compressed air, or wind will also do the job. Internal combustion engines, steam, and other turbines are also commonly used to move things, as well as human and animal muscles.

Existing Conditions

There are several systems designed for moving things at DFR – gas and diesel-powered vehicles, electric woodworking tools and air compressors, and an electric well pump, among others.

Recommendations

The anticipated needs for moving things as DFR continues to develop the site include water pumping and pressurization, tool powering, air compression, land maintenance and development tasks like materials relocation and mowing, and personnel transit. The following systems are recommended to perform these functions:

- Install solar PV system on Shop roof, and tie to existing grid connection

Solar PV System on Shop Roof

The existing systems for moving things that utilize electricity are already integrated into the grid connection. To offset or altogether eliminate the cost of this energy use, a solar PV system should be installed and net-metered with the grid connection.

The shop roof is very large, and is well-situated for the installation of a solar PV system. This solar PV system should be installed and integrated with the existing grid connection to offset or bring the property to net-zero, eliminating electricity cost (and perhaps even earning income for the Doe family).

Moving Electrons

Electricity is the primary energy form here, and it's doing tasks that are almost impossible to do in other ways, such as computing and communicating over long distances.

Existing Conditions

There is varied communications and computing equipment at DFR.

Recommendations

The following is recommended at DFR:

- Replace any existing incandescent and flourescent lighting with LEDs
- Install solar PV system on Shop roof, and tie to existing grid connection

Replace Incandescent and Fluorescent Lighting with LEDs

The outdated and energy-inefficient incandescent lamps remaining in the various lighting systems at DFR should be replaced with LEDs. Even fluorescent lamps, including typical Shop lamps, are far less efficient than LED lamps. Retrofitting existing lamps with LEDs typically pays for itself in 2-5 with the reduced utility costs.

Solar PV System on Shop Roof

The same solar PV system recommended in the previous section will also offset the energy used to power the lighting and computing equipment at DFR.

8 - Economy

This chapter explores additional elements and systems that can play a supportive role in the success of Doe Family Ranch as it evolves into a rich, multi-layered eco-system of enterprises that serves the Doe family's holistic vision and quality of life.

Nursery Establishment

The task of planting out ~13 acres at DFR is large, with thousands of trees and shrubs required to create the system as currently designed. In addition to (or in place of) utilizing the previously mentioned Groasis Waterboxxes, propagating stock on-site is not only a low to no-cost way to create thousands of valuable plants, but can also become a micro-enterprise within itself by selling starts and seedlings to neighbors and the local community, ideally paying for itself and any new genetic diversity that might be bought in.

There are two systems that will be essential to propagating trees and plants in a cost effective manner. First is the tree nursery system centered around Air Pruning Pots and Air Pruning Beds, and second is the Automated Misting Bed system for propagation via cuttings and division.

Air Pruning Beds and Pioneer Pots

An air pruning bed paired with RootMaker air-pruning pots is an excellent system for producing tree seedlings. Air pruned plants have healthy, non-circling fibrous root balls that are primed to do very well once planted in their permanent location, as opposed to plants grown in conventional pots that have a circling root. The root ball of a Sequoia tree grown in an air prune pot vs a conventional pot is shown in Figure 8-1.

Figure 8-1
Air pruned root ball vs conventionally potted root ball

An air pruning bed need be no deeper than 12" to allow for easy removal of seedlings when they are ready to be potted up. The sides of the bed can be made with 2x12" boards, and should be around 36" wide to allow for easy access to the whole bed. The bottom soil holding layer is shade cloth laid over 1/2" hardware cloth laid over 6x6" concrete wire remesh, stapled on top of a table frame onto which the soil containing box is set. This will help to ensure that the mesh will not tear from its

attachments when under load with wet soil. For a video walkthrough of an air prune bed system and a deep dive into the science behind air pruning techniques see the DIY Air Prune Beds post on the 7th Generation Design blog.

Figure 8-2

Air pruning bed construction and operation. Left to Right: Footings and frame with (2) 2x6" soil containing boxes stacked on to; bottom soil holding layer of shade cloth over ½" mesh over 6" remesh; bed filled with soil, seeded, covered with mulch and protected with a squirrel excluder; mid-summer growth.

Tree seeds can be planted as close as 1 - 2" apart depending on seed size. Some may need scarification or stratification prior to germination, but once this process is completed they can be set into the bed to a depth of about 3 times the width of the seed and lightly covered with soil or wood chip mulch. A mist based irrigation system can be used until sprouts emerge, at which point it may be beneficial to switch irrigation to ¼" drip lines with emitters every 6" laid at the soil surface or even beneath the mulch to help prevent any potential for molding from excessive moisture on the young stems and leaves.

An 18 - 24" high wire mesh cage should be set on top of the air pruning bed frame until seedlings have set several sets of true leaves and the trunk has hardened somewhat (see Figure 8-2 above). Lots of critters love tender tree sprouts (not to mentioned buried tree seeds)! This cage can be removed once they are tougher and less tasty.

Once the seedlings are ready to be potted up or planted out, they can be gently but firmly shaken out of the air pruning bed. For trees that go dormant this would be easiest to do when they have entered dormancy. Keep the soil medium light and friable so they can be shaken out even when not dormant. The soil medium can be a range of different substrates, and should be tailored to whatever variety of tree(s) is being grown in the bed.

Below is a rack of RootMaker pots - specially designed air pruning pots that create the maximal density of active root tips while eliminating risk of circling roots. For more information on the science behind RootMaker air pruning pots, watch Root System Basics.

Figure 8-3
Rootmaker Pots

Automated Misting Bed for Propagation by Cuttings and Divisions

Many plants can be propagated from cuttings if environmental conditions are amenable. Generally a section of stem (hardwood or softwood, depending on time of year and species) is cut with at least two nodes on it. The stem section is placed upright, with at least one node below the surface of the rooting medium, and if kept adequately moist (but not too wet) in an environment with low evapotranspirative stress (shaded, no wind, gentle airflow) the cutting will strike root and grow as a new plant.

Because the genetics of a stem cutting are the exact same as the parent plant from which the cutting was taken, plants grown from stem cuttings are also called clones. The entire process is called cloning, or clonal propagation.

Taking cuttings is a commonly used method to propagate many woody plants, especially shrubs. Typically, stem cuttings of tree species are more difficult to root. The four main types of stem cuttings are herbaceous, softwood, semi-hardwood, and hardwood. These terms reflect the growth stage of the stock plant from which the cutting is taken. Cuttings require consistent moisture and protection from temperature extremes, as they have no roots (at least initially) by which to take in water. The rooting media also needs to drain well in order to prevent the growth of fungus, molds and other anaerobic pathogens while the cuttings are at their most vulnerable.

The automated misting bed allows for mass propagation by cutting or root division of valuable plants without creating a concomitant linear increase in the amount of time needed to tend to them.

The DIY Automated Mist Propagation post on the 7th Generation Design website explains the broad concept and details the nuts and bolts of this system. Essentially the goal is to create a consistently moist Goldilocks soil medium that is just right for encouraging young cutting to strike roots. Grow lights and bottom heat could be added to allow for off season and early season propagation in a colder climate.

Depending on the time of year during which this system is being operated, it may be helpful to be able to move the automated irrigation timer (see below) and valves from inside the greenhouse for early shoulder season propagation to outdoor shaded mist beds for continued propagation during the heat of summer (greenhouses can get rather hot during the summer for fresh cuttings). Having mist beds in both locations and a timer and valve manifold that can be unscrewed and moved based on temperature and season will be helpful in lengthening the productive season for plant propagation. Figure 8-XX proposes misting beds be located in the greenhouse for colder season propagation and with the Air Prune beds along the northern fenceline of the Village Garden for summer time propagation.

Subterranean Tree Seed Stratification Chambers

Many tree seeds native or adapted to life in temperate forests require stratification prior to germination - i.e. exposure to a long period of cold that signals the arrival of spring. The simplest, lowest-tech way to do this is with 5 gallons buckets buried in the ground. This provides a way to keep the seeds moist but not damp, protect them from ground vermin, and to have a lot of seeds in a very small footprint.

The system works by cutting off the bottom of a 5 gallon bucket and placing a mesh or screen in its place. These buckets are then filled with layers of the desired tree seed (chestnuts, black walnuts, beach nuts, hickories etc) and a fast draining, low-moisture retentive media (like sandy soil). Once full, the bucket is placed in a hole in the ground just slightly less deep than the bucket is tall. The bucket top is screwed or pressed on, weighted with a rock or brick to prevent vermin from gaining access, and mulched heavily with leaves or wood chips. These buckets can be left to sit outside over the winter, and be accessed once the required amount of cold exposure has passed (based on what types of tree seeds are being stratified). Tree seeds can then be set out in air pruning beds to await germination.

Figure 8-4
Buried 5-gallon bucket seed stratification method

Watch Akiva Silver's short video on the above method, as well as this blog post. For a video walkthrough of a system similar to the one described above, watch Edible Acres video on outdoor tree seed stratification.

Off-Grid, Solar-Powered, Automated Irrigation Systems

An automated, weather-sensing irrigation system is recommended to minimize (and ideally eliminate) time spent on repetitive tasks (like watering veggie starts). The system can be best designed once the following information is known:

- Number of different watering regimens required.
    - i.e.) Water amounts and application frequency are different for veggie starts compared to establishing trees in air pruning beds.
- Number of different application points and their water needs.
- Standing pressure of supply water and flow rates, distance from supply to point of use (for calculating pressure loss).
- Degree of control required (Manual program adjustment at controller, WiFi, smart sensor integration etc).

If all that is needed is a single valve in a location to run an automated irrigation system of some type, and there is no power nearby, the DIG LEIT Solar Valve and Timer unit is highly recommended. It can be attached to a hose bib, hose or other water source, and is fully programmable.

If multiple different irrigation zones require tending, then the use of an Off-Grid Irrigation System (OGIS) using a small solar panel unit and DC timers and valves is recommended. The system that 7th Generation Design uses for tending a remote patch of shiitake mushroom logs is one such example of an off-grid irrigation system. For a detailed walk through on how to build a system like this, see the step-by-step YouTube tutorial. The system shown in the video was built for application in a Mediterranean climate that rarely freezes, and then only lightly. A system with similar components can be designed for use in the much colder temperate climates of Michigan provided that the system is insulated and low-pressure drains are built into the system to drain irrigation lines following each use.

Using the timer detailed in the OGIS video linked above, these systems are capable of down to the second irrigation window lengths, making them perfect for mist bed propagation systems as well as overhead mist watering systems for vegetable starts within the greenhouse.

Enterprise Planning

Below are some of the different methods for visioning, planning and organizing enterprises that abide by the permaculture ethics; Care for the Earth, Care for People, and Reinvestment Of Surplus Towards The First Two.

The Chaordic Stepping Stones

Chaordic Stepping Stones is a cyclical planning process that helps create the minimal structure needed to complete a given task. Excess structure often retards innovation and contribution, overloads certain individuals/components, and stifles learning, while too little structure can lead to

ineffective and uncoordinated action, overwhelm and frustration. Both too little and too much structure can mean the end of even the most well-intentioned project. There are 9 steps within the Chaordic Process, each with its own clear objective building upon that of the previous step.

Cynefin Management Model

A helpful tool for conceptualizing the why and how of adopting different management styles for different contexts. Included in the link above are a few videos that do a great job of visually demonstrating the model with concise, clear narration. This is more of a high level tool, but it can be quickly employed to help grasp the nature of a given situation and which management approach, if adopted, will have the greatest likelihood of success.

Holistic Management

Holistic Management begins with a Minimum Holistic Goal and grows from there into an entire management discipline. This path can get very technical, or can be utilized at a conceptual level, whichever is appropriate to the situational context and people involved.

Memorandums of Understanding

An excellent book about the people side of regenerative agriculture is **Joel Salatin's 'Fields of Farmers'.** In the book Joel details complete set ups for establishing Memorandums of Understanding with 'vested entrepreneurs' within the Polyface ecosystem. Joel's process provides an excellent starting place for constructing working agreements that are clear, concise and win-win-win - for the owners, partners on the land, and of course the land itself.

New Technology, New Money, New Economy

Doe Family Ranch is being born during an era characterized by rapid change in all things. There are many emerging and already present protocols, technologies and trends that could prove incredibly valuable if employed appropriately within a developing ecosystem of regenerative enterprises such as the one beginning at DFR. This section provides a surface level introduction to a few of these protocols, platforms and technologies, enough to illustrate basic concepts and broad potentials, as well provides links for further learning should any of them be of interest.

Cryptocurrencies

Cryptocurrencies and their underlying distributed ledger technology (i.e. "blockchain") are revolutionizing the world of money, finance, and commerce, from the local to the global scale. Cryptocurrencies, like Bitcoin (the most well known and largest), Bitcoin Cash (a fork of Bitcoin that is faster and cheaper to use), DASH (a relative of Bitcoin that is faster, cheaper and allows for true privacy and anonymity) and many others with different use cases represent a real-time, open-source experiment in allowing individuals to declare financial sovereignty from national currencies and take full control of their financial future.

Why mention cryptocurrencies as part of a permaculture system?

The old financial paradigm is crumbling beneath the weight of mal-incentives, centralization and money creation methods that quite literally create money out of thin air, vampirically drawing value from all of the current holders of that currency. National fiat currencies are opaque in their

creation, centralized in their control and governance, and act as a wealth transfer mechanism from the many to the few. They are inflatable (lose value over time), non-fungible (certain units of the same nominal value may not be exchanged for other units of the same value - i.e. "dirty money"), censorable (rules set on how they can be accepted and for what), and backed only by debt (i.e. the unrealistic prospect of exponential growth, indebting future generations etc.).

Old-paradigm debt-backed national fiat currencies are antithetical to the permaculture ethics; care for the earth, care for people, and reinvestment of surplus back to the first two.

Society is in the beginning phases of a global financial revolution that is not yet a decade old. Cryptocurrencies empower individuals to become their own sovereign banker. As an example comparison, the characteristics of DASH (stands for Digital Cash) alongside a Federal Reserve Note (the U.S. Dollar) are presented in Table 8-1.

Table 8-1
DASH (Digital Cash) vs. U.S. Federal Reserve Note

Characteristics	U.S. Federal Reserve Note	DASH - Digital Cash
Fixed currency supply?	NO - The Fed creates more dollars whenever it wants by purchasing government-issued debt	YES - only 18.9 million DASH will ever exist
Fungible? (every unit is the same as every other unit)	NO - physical bills are marked, traceable, can be tied to certain individuals, digital dollars are one of the most monitored currencies in the world	YES - any unit of Dash is the same as any other unit of DASH (cannot be blacklisted)
Transparent?	NO - The Federal Reserve is a private bank unbeholden to oversight	YES - entire financial eco-system is on a public blockchain, anyone can verify transactions occurred as they were meant to
Divisible?	YES - down to 1/100th of a unit (a penny)	YES - DASH is divisible out to 1/millionth of a unit, allowing for micro-transactions and access no matter the currency price
Secure?	NO - the money in your bank account does not technically belong to you (see Cyprus bail ins), current legislation has paved the way for future bail-ins	YES - Only you control the private keys to your DASH, far greater security available through cold storage, 2 Factor Authentication, hardware wallets and more.
Fast?	NO - it still takes days to transfer from bank to bank, or to wait for a check to clear	YES - DASH supports InstantSend functionality, block times are 2.5 minutes, avg. transaction time is 1.3

Characteristics	U.S. Federal Reserve Note	DASH - Digital Cash
		seconds
Store of Value?	SORT OF - The dollar is the slowest falling currency currently of all national fiat currencies, therefore it has the appearance of strength, but ultimately the purchasing power of the dollar declines every year - this is by design, it has to function this way	YES - DASH is capped at 18.9 million DASH that will ever exist. It is a deflationary currency, over time it will appreciate in value instead of depreciate.
Private?	PARTIALLY - Only cash-based peer-to-peer transactions are private. Digital dollar transactions are not private, heavily tracked, and rely upon 3rd parties that we are forced to trust.	YES - DASH is completely peer-to-peer (P2P), and gives the individual user the choice of transacting transparently, privately, or anonymously.
Anonymous?	NO - forced trust of 3rd parties or P2P cash transactions prohibit anonymity	YES - Transact securely across the globe with anyone in the world, neither individual has to know the other.
Fee For Use	HIGH - transaction fees are high (3% credit cards, up to 10%+ for remittance, every movement is taxed)	VERY LOW - Send $.10 or $10,000,000 worth of DASH across the planet in seconds for a few pennies.

In summary, cryptocurrencies have the potential to enable new types of commerce, quite literally the construction of "parallel economic eco-systems" that can exist amidst and interact with the current dominant paradigm, while also allowing for the creation of new economic models and new ways of relating to one another that are aligned with the permaculture ethics.

More Resources for Continued Learning

- Introduction to Cryptocurrencies and Blockchain Technology
    - How Do Cryptocurrencies Work? - excellent YouTube video describing how blockchain technology works to create secure, trusted and distributed (decentralized) networks.
    - DASH School - hosted by Amanda B. Johnson, this video series breaks down how cryptocurrencies, and DASH in particular, work. There are hundreds of cryptocurrencies out there - the 7th Generation Design team believes DASH is one to watch (along with others) due to its focus on fast, inexpensive transactions (thereby not pricing out the rest of the world) with privacy and anonymity as options. It is also aiming directly at business adoption (POS systems, payment gateways,

remittance systems etc.) and will be releasing a new interface soon called Evolution that will make interfacing with cryptocurrencies as simple and familiar as PayPal or Venmo - i.e. they are focusing on mass adoption.
        - Dash.org - main website, wallet downloads, links to resources etc.
- Where Are We In The Larger Story?
    - Mike Maloney's Hidden Secrets of Money - Excellent multi-part series on the history of money and debt and how modern society got where it is.
    - Peak Prosperity's Crash Course - Chris Martenson's Crash Course takes a very data-based look at the intersection of economy, energy and environment in the age of limits. This course does an excellent job illustrating where American society is in the narrative of debt-backed national fiat money, resource depletion and energy complexity. He advocates for the 8 Forms of Capital model as a needed change to the current financial paradigm.

Appendix A – Plant Guild Details

Guild Name	Guild Unit (GU) Dimensions		Area (ft2)	GU Member Common Name	# ea. Member Species / GU	# ea. Species Needed For All Plantings Of This Guild	Guild Notes
	Length (ft)	Width (ft)					
***Moringa* Livestock Fodder Guild**	3	3	9	Moringa	1	33	Moringa planted every 3' for coppiced animal fodder source. Leucaena and Dwarf Koa planted downhill of Moringa, off set 18" from Moringa center and ~ 2' downhill. Three comfreys planted interstitially amongst the other plants. All plants can be cut repeatedly for animal fodder, and will respond well plantd atop the swale berm where the greywater from the house exits. Guild provides food for humans, rabbits, chickens, ducks, goats, sheep, cows and pigs.
				Leucaena	1	33	
				Dwarf Koa	1	33	
				Comfrey	3	99	
Totals					6	198	
Main Residence Privacy Fedge	128	12	1,454	Brown Turkey Fig	1	1	Tree species for slope between west side of Main Residence and Garage access road (area approximately 125' long and 15' wide). Drought-tolerant trees, shrubs, vines, brambles, and groundcovers. Recommended trees average approximately 15' in height x 15' in width, planted next to each other in narrower part of strip closer to parking lot and staggered as the area widens closer to proposed compost toilet.
				Pineapple Guava	1	1	
				Fuyu Persimmon	1	1	
				Pomegranate	1	1	
				Shinsheiki Asian Pear	1	1	
				All-in-one Almond	1	1	
				Pink Lady	1	1	
				Blue Elderberry	1	1	
Totals					9	9	
Main Residence Privacy Fedge	128	12	1454	Dwarf Yaupon	3	3	Understory species for fedge on slope between west side of Main Residence and Garage access road (area approximately 125' long and 15' wide).

Guild Name	Guild Unit (GU) Dimensions		Area (ft2)	GU Member Common Name	# ea. Member Species / GU	# ea. Species Needed For All Plantings Of This Guild	Guild Notes
	Length (ft)	Width (ft)					
Understory				Golden Currant	3	3	Drought-tolerant trees, shrubs, vines, brambles, and groundcovers. Recommended shrubs should be interplanted between recommended trees, and planted on the margins on the west and east side of the area. Edibles include Golden Currant and Dwarf Yaupon (caffeinated leaves used for tea); Nitrogen fixers include False Indigo Bush, Goumi (also edible), and Silver Bush Lupine (native); brambles include thornless Blackberry (edible); vines include Perlette Grape (edible); herb layer includes Comfrey (medicinal, mulch producer), Yarrow (native, insectary), and Woodland Strawberry (groundcover).
				False Indigo Bush	3	3	
				Silver Bush Lupine	4	4	
				Goumi	3	3	
				Blackberry - Triple Crown Thornless	3	3	
				Perlette Grape	3	3	
				Comfrey	8	8	
				Yarrow	8	8	
				Woodland Strawberry	24	24	
Totals					62	62	

Guild Name	Guild Unit (GU) Dimensions		Area (ft2)	GU Member Common Name	# ea. Member Species / GU	# ea. Species Needed For All Plantings Of This Guild	Guild Notes
	Length (ft)	Width (ft)					
Black Walnut Guilds	50	50	2500	California Black Walnut	1	10	(1) California black walnut tree as guild centerpiece. (1) Black locust tree planted approximately 4' away to southwest to serve as nurse tree for walnut tree. The locust tree can be coppiced seasonally at the end of the summer to provide nitrogen, and will then re-sprout vigorously to provide shade to root zone for young walnut trees. Eventually the walnut trees will shade out the locust trees, at which points they will no longer be needed. Once walnut trees are established and cast a decent shade canopy (~3-5 years), under-plantings of other high-value plants can be made, such as elderberry, California woodland strawberry, raspberry, black raspberry, currants and gooseberries. Additional companion plants include yarrow, holly hock, bee balm, miner's lettuce, Calendula, iris, daffodil, and Crocus. Once walnut trees are of decent size - 5-10 years - vines like Clematis and Wisteria can be planted in the understory to run through the trees.
				Black Locust	1	10	
Totals					2	20	
Black Walnut Interplanting	30	30	900	Mulberry - White	1	26	The following trees are juglone-tolerant and will do well planted adjacent to walnuts: sycamore, elderberry, persimmon, white mulberry, catalpa, callery pear, black locust, hawthorne, thornless honey locust. Recommend planting one of these speceies 1:1 with walnut plantings to create a more diverse tree stand and eventual intact shade canopy over the West Valley bottom. Smaller-sized fruit trees from the Prunus genus (plums, peaches, cherries, apricots) are also juglone-tolerant and can be interplanted amongst the walnut trees to create additional fruit yields, either for human or livestock consumption.
Totals					1	26	

Guild Name	Guild Unit (GU) Dimensions		Area (ft2)	GU Member Common Name	# ea. Member Species / GU	# ea. Species Needed For All Plantings Of This Guild	Guild Notes
	Length (ft)	Width (ft)					
Orchard Apple Guild	25	25	625	Mollie's Delicious Apple	1	9	(1) Apple as guild centerpiece, planted on 25' centers. Recommend apple be on full-sized rootstock for added drought hardiness in a hot climate like Paso Robles. Semi-dwarfing rootstock is ok, though may require more supplemental irrigation. Apple variety may be substituted with any from the list of apple cultivars included in this report. (1) Silver Bush Lupine for nitrogen fixation and pollinator attraction. (2) Comfrey cuttings planted in the hole with the apple, to be chopped and dropped for surface mulch and fertilizer while also shading the trunk prior to development of a fully canopy. Yarrow, Salad Burnet, Lemon Balm and Tansy can be all sown from seed, amidst the mulch is apple is planted in fall, if planted as starts they will require irrigation to establish. CA Woodland Strawberry is a shade, drought and neglect loving groundcover that produces tiny alpine strawberries (more for wildlife than for humans, though very beautiful), and it does an excellent job of spreading via runners wherever there is bare soil. Additional helpful companion plants include chives, Salvias, Agastaches, Daffodils, Irises, Naked Ladies and bulbing onions.
				Comfrey	2	18	
				Yarrow	2	18	
				Salad Burnett	3	27	
				Lemon Balm	1	9	
				Tansy	1	9	
				Woodland Strawberry	3	27	
				Silver Bush Lupine	1	9	
Totals					14	126	
Orchard *Prunus* Guild	20	20	400	Santa Rosa Plum	1	13	(1) Prunus species (peach, plum, cherry, apricot) – Santa Rosa plum recommended in this specific guild, other species or varieties may also be suitable. Plant on 20' centers. (2) Comfrey cuttings in the planting hole with the tree for chop and drop fertility and surface mulch, as well as trunk sun protection while canopy forms. (1) Lemon balm to attract pollinators, parasitoid wasps. (4) Woolly
				Comfrey	2	26	
				Lemon Balm	1	13	

Guild Name	Guild Unit (GU) Dimensions		Area (ft2)	GU Member Common Name	# ea. Member Species / GU	# ea. Species Needed For All Plantings Of This Guild	Guild Notes
	Length (ft)	Width (ft)					
				Woolly Yarrow	4	52	yarrow plants planted 2' from trunk to create drought resistant ground cover (this could be substituted with woodland strawberry, creeping thyme, Greek oregano, green carpet rupturewort, or Baby Sun Rose). Full size yarrow can be sown from seed around tree, for chop and drop, insectary and groundcover purposes. Bulbs like daffodil, iris and naked lady can be planted in arcs several feet off the trunk.
				Yarrow	2	26	
				Naked Lady	10	130	
Totals					20	260	
Chestnut Agroforestry Guild	80	80	6400	Chinese Chestnut	1	13	(1) Chestnut, planted on 80' centers. Chinese x American crosses are recommended. Chestnuts can be planted as 1 year whips with the Groasis Waterboxx to help them establish, or from seed, in which case the Waterboxx would likely need to be in place for 2 years. (1) Black locust planted 6-8' off-center to the southwest, to be coppiced in the late autumn / early winter each year beginning in year 3, will block the most intense sun aspect experienced by the chestnut tree and serve as nurse plant, nitrogen-fixer, mulch and shade producer to aid chestnut tree establishment. Will eventually be shaded out by chestnut trees. (1) Southern California grape planted by seed downhill 10' from each chestnut, allowed to sprawl on the ground, provides wildlife food and groundcover. (8) Perennial sweet pea sown in autumn in octagonal formation around the chestnut tree for living mulch, nitrogen-fixation, groundcover, and soil temperature moderation around the developing root zone. Perennial sweet pea can be chopped and dropped if and when it grows and spreads large enough to climb into the chestnut. Eventually it will be shaded out by the chestnut after 5-8 years.
				Southern California Grape	1	13	
				Perennial Sweet Pea	8	104	
				Black Locust	1	13	

Guild Name	Guild Unit (GU) Dimensions		Area (ft2)	GU Member Common Name	# ea. Member Species / GU	# ea. Species Needed For All Plantings Of This Guild	Guild Notes
	Length (ft)	Width (ft)					
Totals					11	143	
SW Fence Privacy Screen				Coffee Berry	1	13	
				Toyon	1	13	
				Ceanothus 'Ray Hartman'	1	13	
				Silver Bush Lupine	2	26	
				Holly Leaf Cherry	1	13	
Totals					6	0	
Vetiver Erosion Control Strips	1	1	1	Vetiver Grass	3	4275	Vetiver Grass tillers planted on 4" centers on contour, every 18 - 24" vertical inches along the road cut. Irrigation lines places just uphill of the planted vetiver. Trenches dug with pick, kept narrow (3" wide) and up to 6" deep, filled with composted steer manure. Can be lined first with burlap if ground vermin are an issue (burlap will provide immediate deterrence and will decay in time). Plant in spring when temperatures have warmed and danger of frosts have passed. Irrigate twice daily for 5-10 minutes each time for first several weeks, then taper to once daily for 15 minutes, then every other day etc. on up to irrigating once every 1-2 weeks for an hour based on performance and climate conditions.
Totals					3	4275	
Orchard Mulberry Guild	18	18	324	Mulberry - Black	1	14	(1) Black Mulberry centerpiece, planted on 18-20 foot centers. Black Mulberry may be substituted with Pakistani Mulberry as well. (2) Comfrey cuttings in the hole with the tree. (1) 16x16" tray of
				Comfrey	2	28	

Guild Name	Guild Unit (GU) Dimensions		Area (ft2)	GU Member Common Name	# ea. Member Species / GU	# ea. Species Needed For All Plantings Of This Guild	Guild Notes
	Length (ft)	Width (ft)					
				Baby Sun Rose	1	14	Baby Sun Rose planted in clumps around the developing root zone for drought tolerant ground cover that bees will enjoy. (2) Yarrow plants planted within 3' of tree, to the sunny south side, for trunk shading, insectary, chop and drop mulch and fertility. Lemon Balm planted on East side for insectary, herb harvest, chop and drop. False Indigo Bush as main nitrogen fixer, to be chopped and dropped several times per annum as needed to feed the developing mulberry. Plant within 3' of mulberry..
				Yarrow	2	28	
				Lemon Balm	1	14	
				False Indigo Bush	1	14	
Totals					8	112	
Dryland Fodder Guild	100	60	6000	Honey Mesquite	1	5	Alternating randomized patterns of honey mesquite, Fuyu or American persimmon, white mulberry, carob, and thornless honey locust planted at 80% mature canopy diameter of one another to one day create closed canopy effect and maximize ground shade. Black locust and Leucaena can be interplanted throughout and coppiced or grazed annually to help build soil. These trees will ultimately be shaded out by mature overstory or can be manually removed prior to that time. This guild grouping will provide both late-dry season and late-winter forages for pigs should they end up being a part of the vision for the property. Fuyu persimmon, white mulberry and carob also make excellent food for humans as well.
				Fuyu Persimmon	1	5	
				Mulberry - White	1	5	
				Black Locust	1	5	
				Carob	1	5	
				Thornless Honey Locust	1	5	
				Leucaena	6	30	
Totals					12	60	
Carob & Mesquite Guild	70	40	2800	Carob	1	17	Carob and mesquite trees alternate in a dense planting ideal for higher elevation sites that get minimal water. Both trees yield high-quality and carbohydrate-rich pods - mesquite early in summer and both in the early-to-mid autumn when

Guild Name	Guild Unit (GU) Dimensions		Area (ft2)	GU Member Common Name	# ea. Member Species / GU	# ea. Species Needed For All Plantings Of This Guild	Guild Notes
	Length (ft)	Width (ft)					
				Honey Mesquite	1	17	conditions are most dry. Both trees fix nitrogen and have extremely deep root systems (mesquite roots have been found 175' deep at pit mines). Understory can be grazed during pod-fall when other forages are not present in abundance, or pods can be collected and stored or processed for feed supplement.
Totals					2	34	
Central Oak Woodland	35	35	1256	Big Berry Manzanita	4	696	Central oak woodland native plant community for establishment of "resource islands". (3) Big berry manzanita and (2) buckbrush lilac are the largest at 8' mature diameter; (5) coyote brush with a 6' mature diameter; and (3) California sagebrush, (4) California buckwheat, (3) black sage, and (10) silver bush lupine with a 4-5' mature diameter. Select a location about 100' from an existing valley oak tree in the forestry blocks, and mark off a 40' diameter at that point that can be covered by a single rotary sprinkler placed in the middle. Plant the guild in a randomized and evenly spaced pattern within that circle (leave a little extra space around the manzanita and lilac, 1-2'), all the way out to the outer radius. Provide periodic deep watering during the first year. If deer, rabbits, or squirrels become an issue, place a fence around the outer radius. After the first year, the plants will have established, and the sprinkler (and fence, if needed) can be removed and used in the next location. In time, the animals enjoying their new habitat will inadvertently help plant new oak trees within the guild when they forget about some of their acorn hiding spots.
				Coyote Brush	5	870	
				Buckbrush Lilac	4	696	
				California Sagebrush	5	870	
				California Buckwheat	5	870	
				Silver Bush Lupine	12	2088	
				Black Sage	5	870	
Totals					40	6960	

Appendix B – Planting Areas

Agroforestry Planting Zone	Acronym	% Coverage	Guild	Guild Units / Planting	Area Specific Guild Notes
Privacy - Main Residence	P-MR	100%	Main Residence Privacy Fedge	1	
Privacy - Main Residence	P-MR	100%	Main Residence Privacy Fedge Understory	1	
Greywater Swale - Main Residence	GS-MR	60%	Moringa Livestock Fodder Guild	21	This is the swale located within O-WVS. Planted at 60% density to allow for other orchard crop recommendations within this block
Greywater Swale - Village Bathhouse	GS-VB	100%	Moringa Livestock Fodder Guild	12	
Privacy - SW Fence	P-SWF	100%	SW Fence Privacy Screen	13	
Erosion Control - West Hillside	EC-WH	100%	Vetiver Erosion Control Strips	1425	Numbers are based upon doing 3 separate lines of vetiver plantings, assuming a total length of 475' for each - this will need to be remeasured on the ground for accurate cost projection.
Agroforestry - N Ridge	AF-NR	100%	Chestnut Agroforestry Guild	6	
Agroforestry - Shop	AF-S	100%	Chestnut Agroforestry Guild	7	
Agroforestry - E Valley	AF-EV	100%	Dryland Fodder Guild	5	
Orchard - West Valley N	O-WVN	100%	Orchard Prunus Guild	5	
Orchard - West Valley S	O-WVS	60%	Orchard Apple Guild	4	60% because GS-MR takes up estimated 40% of block space.
Orchard - West Valley E	O-WVE	100%	Orchard Mulberry Guild	6	
Orchard - West Valley Middle	O-WVM	50%	Orchard Prunus Guild	3	
Orchard - West Valley Middle	O-WVM	50%	Orchard Apple Guild	2	
Orchard - Residence Hillside	O-RH	30%	Orchard Prunus Guild	5	
Orchard - Residence Hillside	O-RH	30%	Orchard Apple Guild	3	
Orchard - Residence Hillside	O-RH	40%	Orchard Mulberry Guild	8	

Agroforestry Planting Zone	Acronym	% Coverage	Guild	Guild Units / Planting	Area Specific Guild Notes
Agroforestry - West Valley Lower	AF-WVL	50%	Black Walnut Guilds	10	
Agroforestry - West Valley Lower	AF-WVL	50%	Black Walnut Interplanting	26	
Agroforestry - West Valley Upper	AF-WVU	100%	Carob & Mesquite Guild	17	
Forestry - N Ridge	F-NR	100%	Central Oak Woodland	106	
Forestry - W Hillside	F-WH	100%	Central Oak Woodland	49	
Forestry - E Valley	F-EV	100%	Central Oak Woodland	18	
Forestry - Shop Entrance	F-SE	100%	Central Oak Woodland	1	