Level 1
Site Assessment

Prepared for: Bridget and Rudy [redacted]
Site: [redacted] Family Homestead
[redacted] [redacted] Rd
Paso Robles, CA 93446
Site Visit Date(s): July 11, 2020

Prepared by:

7TH GENERATION DESIGN

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Context and Design Maps

7th Generation Design was invited by the [redacted] family to visit and conduct an assessment of their 6.3 acre homestead located in Paso Robles, CA. The [redacted] Family Homestead (WFH) currently has approximately 5,365 sq-ft of structures (roof area; including a main house and horse barn) and 12,700 sq-ft of paved access roads. The predominant land features include:

- Approximately 1.92 acres of southwest facing steeply sloped former almond orchard, separated by an internal fence from the rest of the property and located above the main residence.
- 2.44 of moderate to steeply sloped land, into which the pad for the main residence has been cut.
- Approximately 1.1 acres of moderate to shallow sloping land towards the valley bottom near [redacted] Road.
- A small .42 acre section with a northeasterly aspect across [redacted] road.

The [redacted] family moved to Paso Robles, and this piece of land in particular, in order to pursue a simpler, slower-paced, more healthy lifestyle. The [redacted] family's vision for their new home is to create an inviting and beautiful place to live, work and learn for current and future generations. Key aspects of their vision include an accessory dwelling for hosting family and friends and different ambience zones around the living areas that allow for as much outdoor living as possible - these include a meditation garden, food forests, home and market gardens, small pond with bamboo grove, and potentially an outdoor education and community gathering space.

A primary goal for their first year on the land is to have a successful homeschooling experience for their two children, [redacted] and [redacted]. Areas for play, exploration, creation, observation and solitude are a major design focus for the property. Some elements ideas the [redacted] family expressed interest in towards this end include a natural pool, children's garden, zip line, and treehouse. The outdoor classroom and learning space may also serve as a location to begin an outdoor education program for children from the surrounding community.

The [redacted] family would like to be as off-grid as possible with regards to their own energy use patterns. Additionally, they would like to cycle as much of their own waste streams on-site as possible. They envision creating a landscape that is abundant with food, wildlife and beauty for them to share with family, friends and their surrounding community for generations to come.

Report Organization

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

Climate and Geography > Water> Access > Structures>Living Systems>Boundaries>Energy>Economy

A detailed assessment of the climate and geography of the site, and an assessment of the existing conditions of Water, Access and Structures is provided in this Level 1 Site Assessment report, along with a summarized list of potential opportunities identified during the site visit that, if pursued, will bring the property to a greater state of wholeness. 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 a briefly summarized list of opportunities in the context of that topic that have been identified as high leverage-points for improving the function and health of the landscape.

An extensive and detailed design from a whole-site perspective of not only the water, access, and structures at the site but also living systems, boundaries, energy, and economy is included in a Level 2: Whole Site Design.


Horse Stalls
Driveway
Main Residence
Well House
Water Tank
Shed
Lower Unpaved Vehicle Access
Septic Leach Field*
Septic Line*
Water Supply Line*
Tractor/ATV Access
Perimeter Fencing
Internal Fencing
Parcel Boundaries
Gates
Gates
Gaps
0
100
200 ft
* indicates estimated element location
7TH GENERATION DESIGN
Basemap of Existing Conditions
[redacted] Family Homestead
[redacted] Road
Paso Robles, CA 93446
Date: July 25th, 2020

1 - Site Work Up

General Site Information

Client(s): Bridget and Rudy [redacted] - [redacted] Family Homestead (WFH)

Address: [redacted] [redacted] Road, Paso Robles, CA 93446

Parcel Number: [redacted]

Area: 6.32 acres

Latitude: 35°38'34.50"N

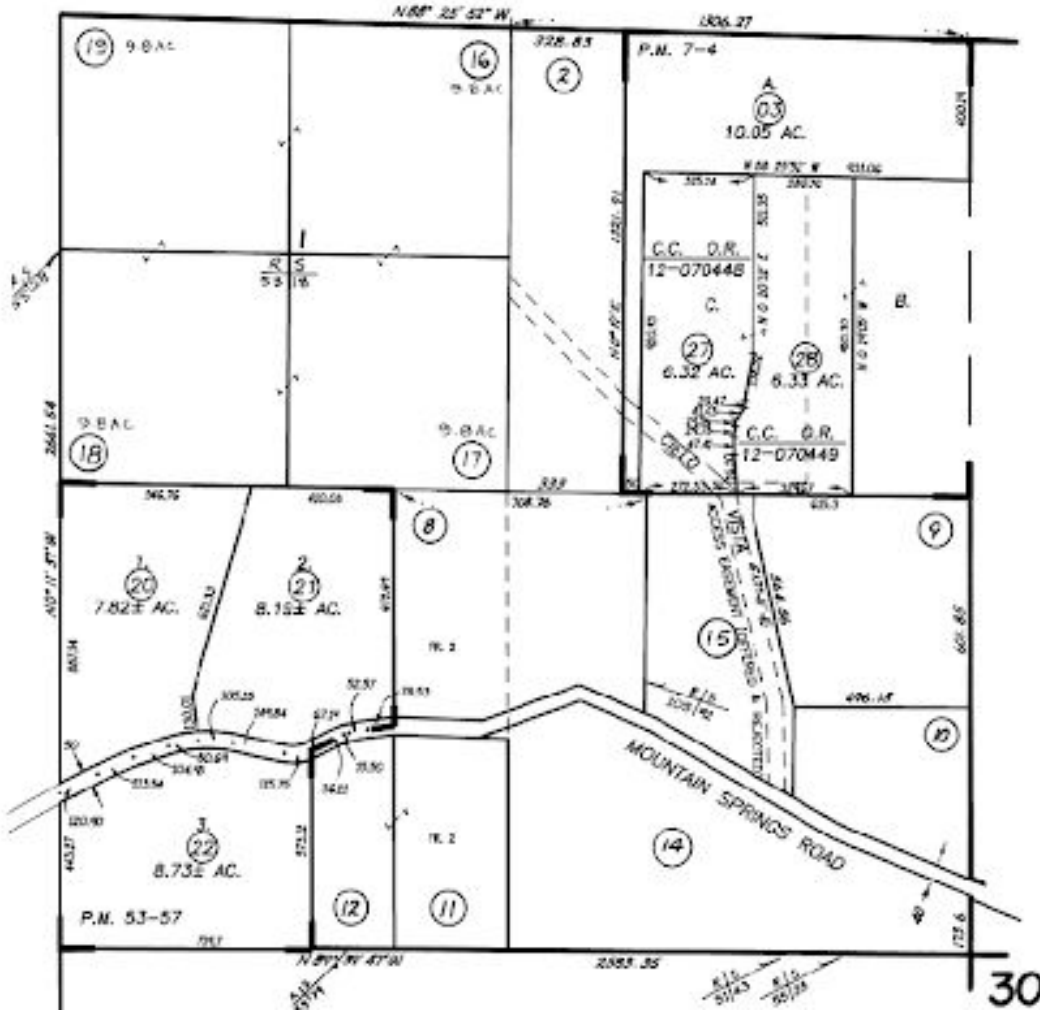
Longitude: 120°43'26.4"W

Altitude: 1,322'

Proximity to Ocean: ~ 16.6 miles as the crow flies

Figure 1-1
Satellite image of [redacted] Family Homestead

Figure 1-2
Parcel map of [redacted] [redacted] Road (Parcel [redacted])



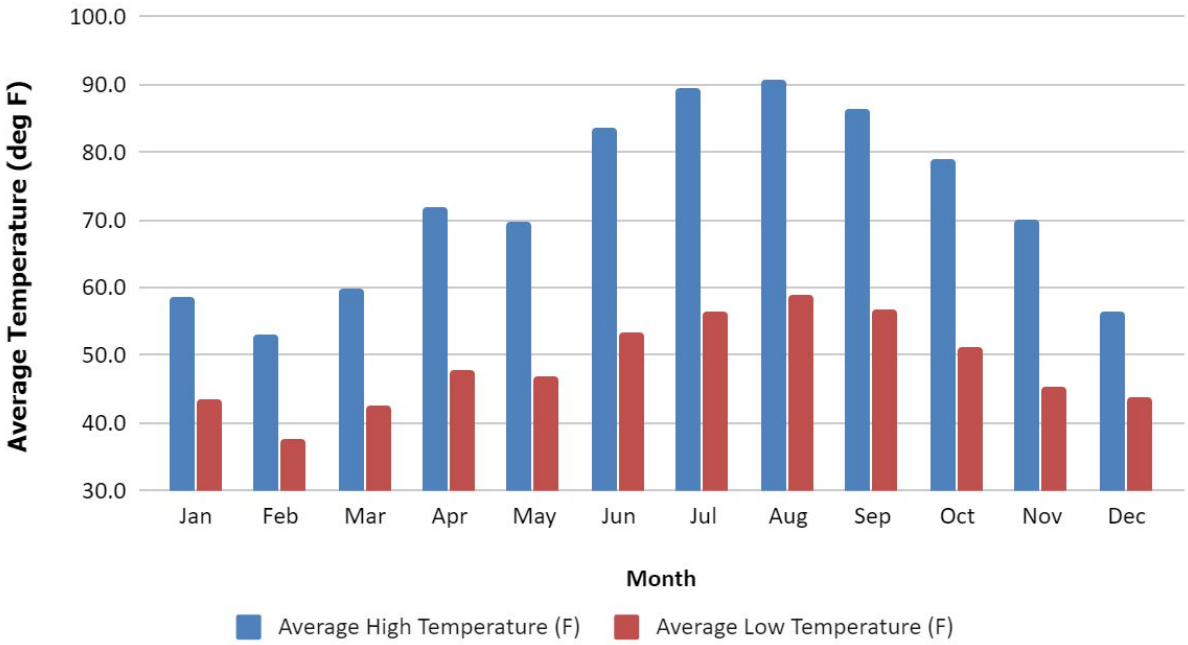
Climate

Temperature Data

The closest weather station to WFH with real-time and recorded daily temperature, humidity, wind speed, and precipitation weather data is Station KCAPASOR5 located at Radio Ranch Paso Robles, which is approximately 100 feet higher in elevation than and 1.3 miles away from WFH.

The monthly average high and low temperatures for 2019 at Radio Ranch Paso Robles are shown in Figure 1-3.

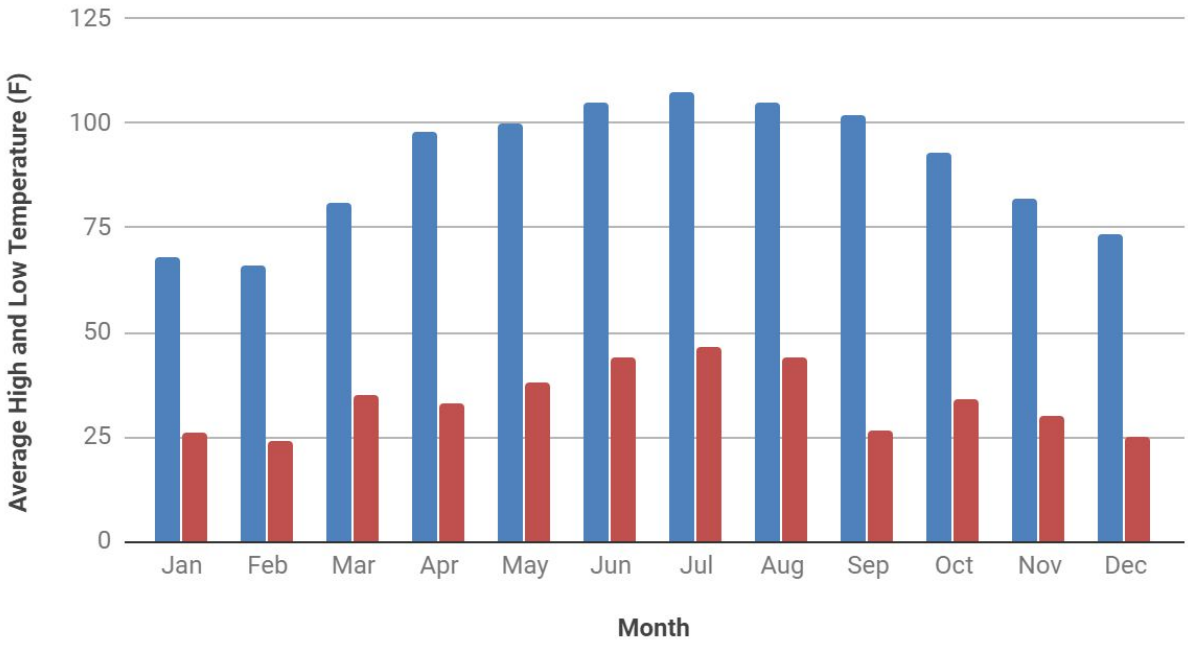
Figure 1-3
2019 average monthly temperatures for Radio Ranch Paso Robles (1.3 miles away from WFH)



The coldest months of the year were December through March; the hottest months were June through August.

For historical weather patterns beyond 2019, the closest source is the Paso Robles Regional Airport, 450 feet lower in elevation than and 5.2 miles away from WFH [Link 1, Link 2]. Annual temperature data for a typical meteorological year at the Paso Robles Regional Airport, developed from over 120 years of data, is shown in Figure 1-4. The record low is 0℉, 1913; the record high is 115℉.

Figure 1-4
Average monthly temperature data for Paso Robles Regional Airport (5.2 miles away from WFH)



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℉ accumulated each year while the tree is dormant. Paso Robles Regional Airport (5.2 miles away from WFH), the nearest location with historical hourly weather data, sees an average of **1,534 hours** below 45℉. The CIMIS weather station in Atascadero, CA (approximately 14 miles south of WFH) sees an average of 1,156 hours. A full chart of hourly temperature distribution for a typical meteorological year at Paso Robles Regional Airport is provided in Appendix C.

While the Paso Robles Regional Airport is located only 5.2 miles away from WFH, the elevations and surrounding topography of the two locations vary significantly and thus chill hours at WFH will

inevitably vary. Comparison of the monthly average lows between Radio Ranch Paso Robles, 1.3 miles away from and 100 feet higher in elevation than WFH, and Paso Robles Regional Airport indicate that the area surrounding WFH sees higher average low temperatures than Paso Robles Regional Airport. This makes sense, colder air typically sinks to the valley bottoms, resulting in colder temperatures than locations partway up the slope of neighboring foothills. 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 or orchard planting, 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 1,000 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 total precipitation that fell in 2019 as measured by Radio Ranch, approximately 100 feet higher in elevation than and 1.3 miles away from WFH, was 22.3 inches.

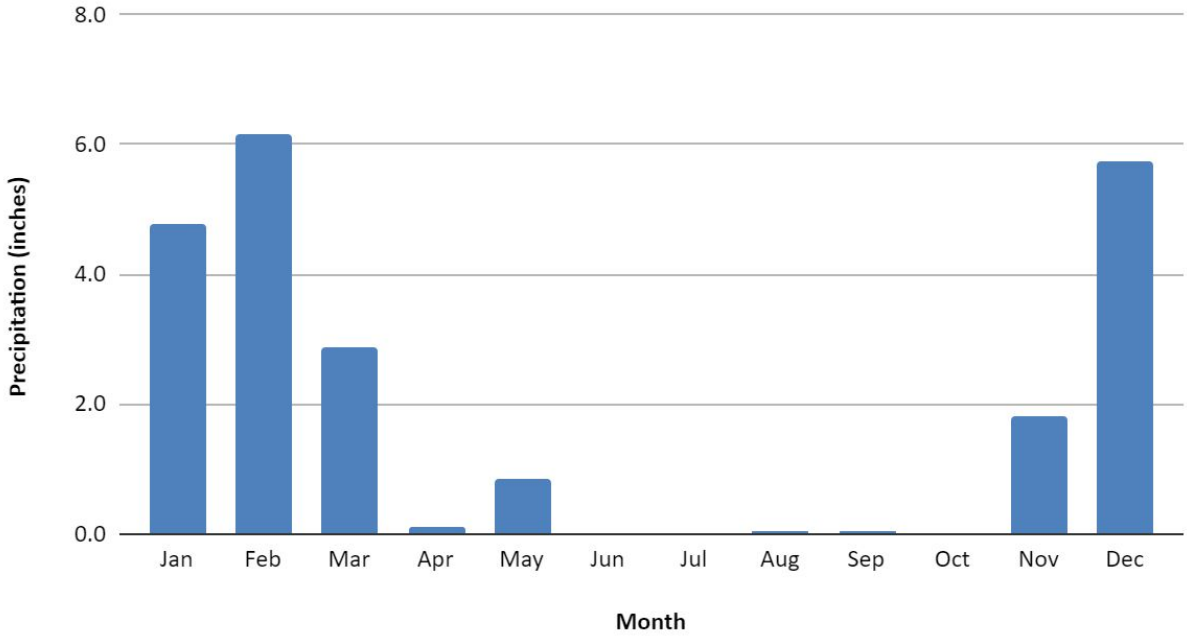
The average and mean amounts of annual rainfall recorded at Paso Robles Regional Airport (5.2 miles away from and 450 feet lower in elevation than WFH) from 1894-2016 are 15.21 inches and 14.77 inches, respectively [Link 1, Link 2]. The record high annual total during that period was 29.19 inches in 1941; the record low total was 2.78 inches in 2013.

Annual Distribution of Precipitation

There were 48 rainy days (>.1 inch) in 2019 at Radio Ranch Paso Robles, approximately 100 feet higher in elevation than and 1.3 miles away from WFH. Typically 80 - 90% of total annual rainfall falls between December and March, making this a brittle climate (see "Climate Brittleness", below).

The monthly distribution of rainfall at Radio Ranch Paso Robles in 2019 is shown in Figure 1-5.

Figure 1-5
2019 monthly rainfall totals for Radio Ranch Paso Robles (1.3 miles away from WFH)



The average number of rainy days (>.1 inch) recorded at Paso Robles Regional Airport (5.2 miles away from and 450 feet lower in elevation than WFH) from 1894-2016 is 42. 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 in 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 [redacted] Family Homestead

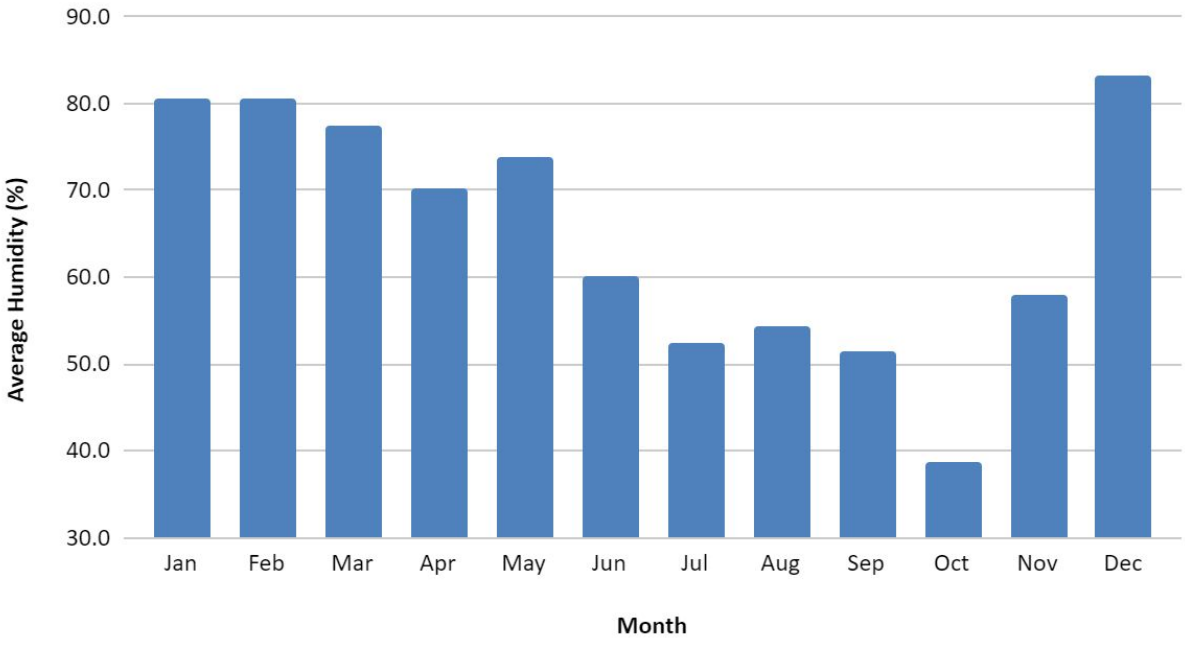
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.110 (0.095-0.129)	0.140 (0.120-0.165)	0.181 (0.155-0.213)	0.216 (0.183-0.257)	0.265 (0.215-0.329)	0.304 (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

The 2019 average monthly relative humidity measured at Radio Ranch Paso Robles, approximately 100 feet higher in elevation than and 1.3 miles away from WFH, is shown in Figure 1-6.

Figure 1-6
2019 Monthly average relative humidity at Radio Ranch Paso Robles (1.3 miles away from WFH)



Humidity is highest during the winter and early spring rainy season from December through May, with monthly averages ranging from 75-85%. Monthly average humidity levels during the summer and early fall months ranges between 40-60%.

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 WFH 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 WFH. A detailed solar aspect chart for WFH is included in Appendix B- Solar Charts. Additional charts are available through suncalc.org, sunearthtools.com.

Table 1-2
Solar aspect information for [redacted] Family Homestead

Season Change	Sun Angle*	Shadow Length**	Sunrise Location***	Sunset Location***
Winter Solstice	30.92°	1.67	118.62°	241.38°
Spring Equinox	55.42°	0.69	88.22°	272.03°
Summer Solstice	77.79°	0.22	60.01°	299.99°
Fall Equinox	55.03°	0.70	88.45°	271.43°

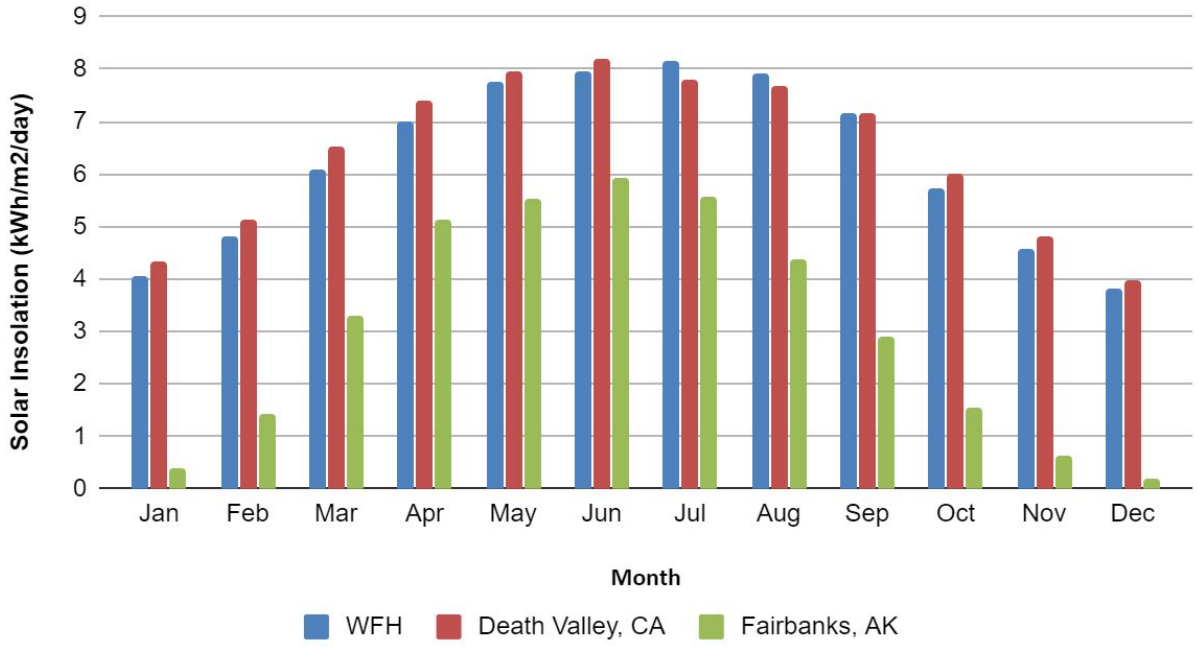
** Sun angles measured when highest in sky (peak solar activity) a.k.a. azimuth.*
*** Shadow length expressed as multiple of object height, taken at peak solar activity*
**** Exact locations of sunrise/sunset on the horizon from SET's Sunrise-Sunset Calendar - visit mooncalc.org to get similar data for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

The longest day length is 14h34m27s on the Summer Solstice, and the shortest day length is 9h44m44s 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 6.25 kWh/m^2/day, compared to that of Death Valley, CA at 6.4 kWh/m2/day, and Fairbanks, AK at 3.1

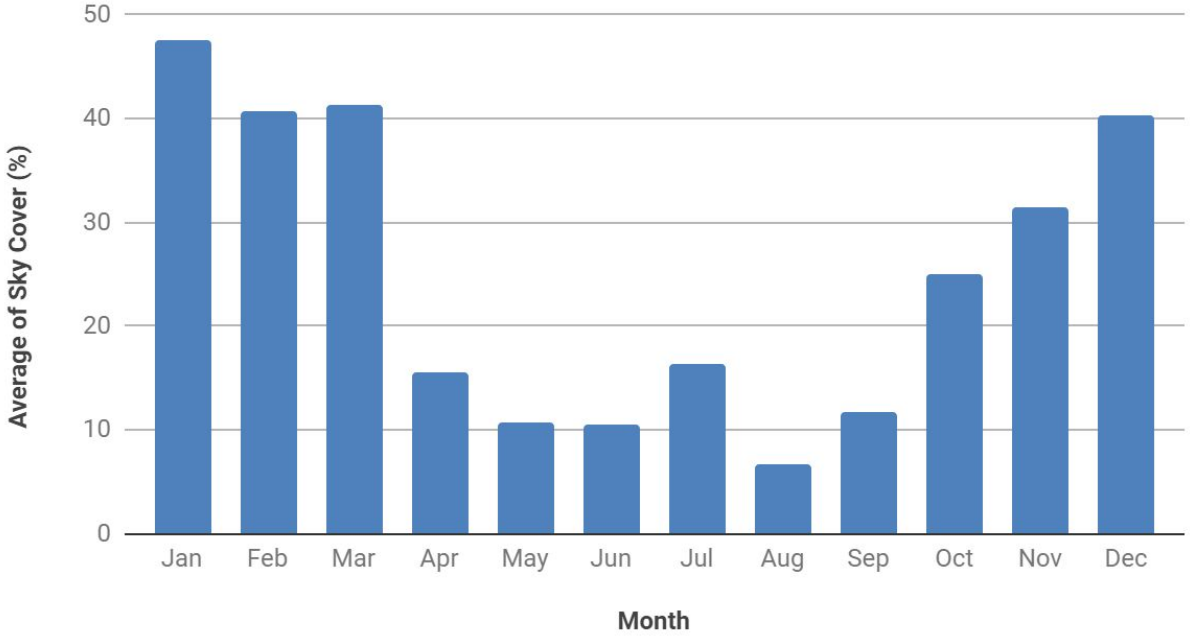
kWh/m2/day- considered to be among the sunniest and least sunny places in the US, respectively. The monthly average solar insolation at a location 1.0 miles away WFH is presented in Figure 1-7, and also compared with Death Valley, CA and Fairbanks, AK. It is clear from the data that WFH is ideally located for solar PV electricity generation and solar water heating.

Figure 1-7
Monthly average of solar insolation (kWh/m2/day) measured at a station 1.0 miles away from WFH



The monthly average percent of sky cover as measured at Paso Robles Regional Airport, 5.2 miles away from WFH, is shown in Figure 1-8. A chart of the hourly distribution of cloud cover for a typical meteorological year at Paso Robles Regional Airport (5.2 miles away) is provided in Appendix C, Figure C-2.

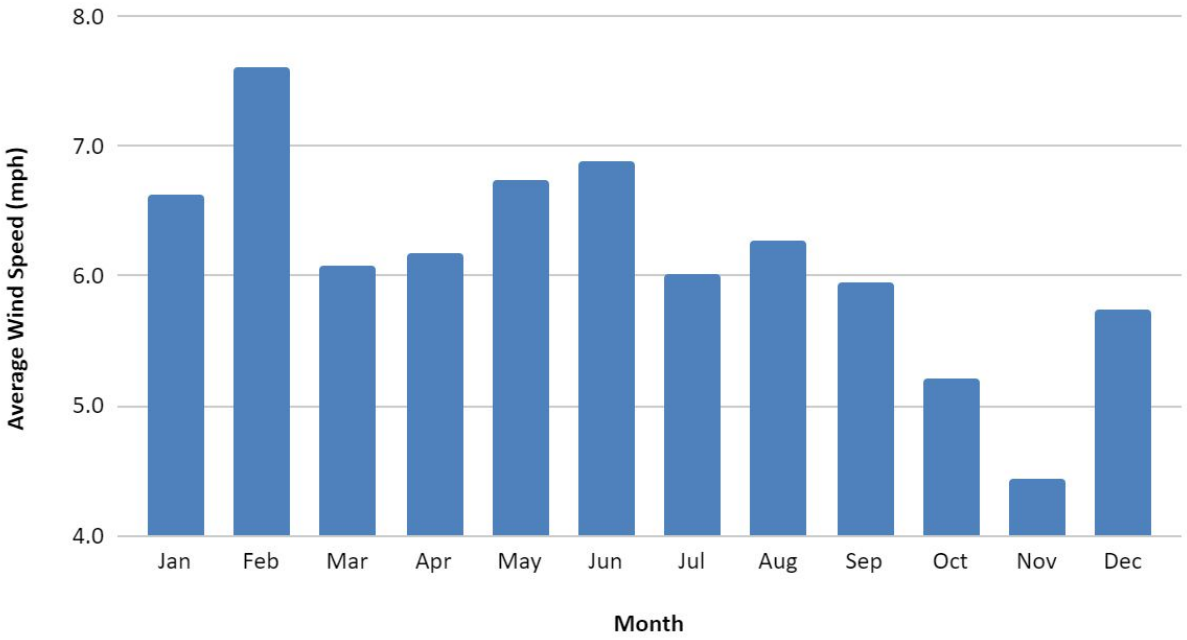
Figure 1-8
Monthly average of cloud cover, plotted over a typical meteorological year at Paso Robles Regional Airport (5.2 miles away)



Wind Data

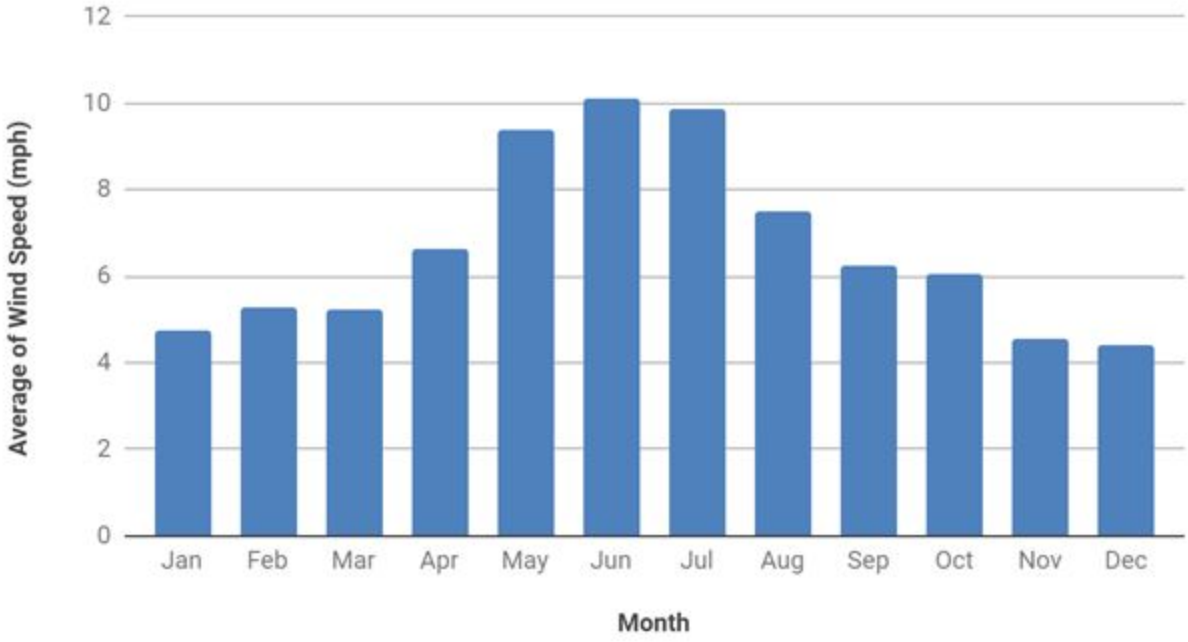
The monthly average wind speed from 2019 at Radio Ranch Paso Robles, approximately 100 feet higher in elevation than and 1.3 miles away from WFH, is shown in Figure 1-9. Average wind speed was highest during the winter and late spring months, the highest being 7.6 mph during the month of February. The lowest monthly average wind speed of 4.4 mph occurred during November.

Figure 1-9
2019 monthly average wind speed at Radio Ranch Paso Robles (1.3 miles away from WFH)



For more historical wind trends, the monthly average wind speed over the course of a typical meteorological year (developed from data compiled from 1894-2016) at Paso Robles Regional Airport, 5.2 miles away from and 450 lower in elevation than WFH, is shown in Figure 1-10. 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 1-10
Monthly average wind speed and wind direction, plotted over a typical meteorological year at Paso Robles Regional Airport (5.2 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.

Climate Zones

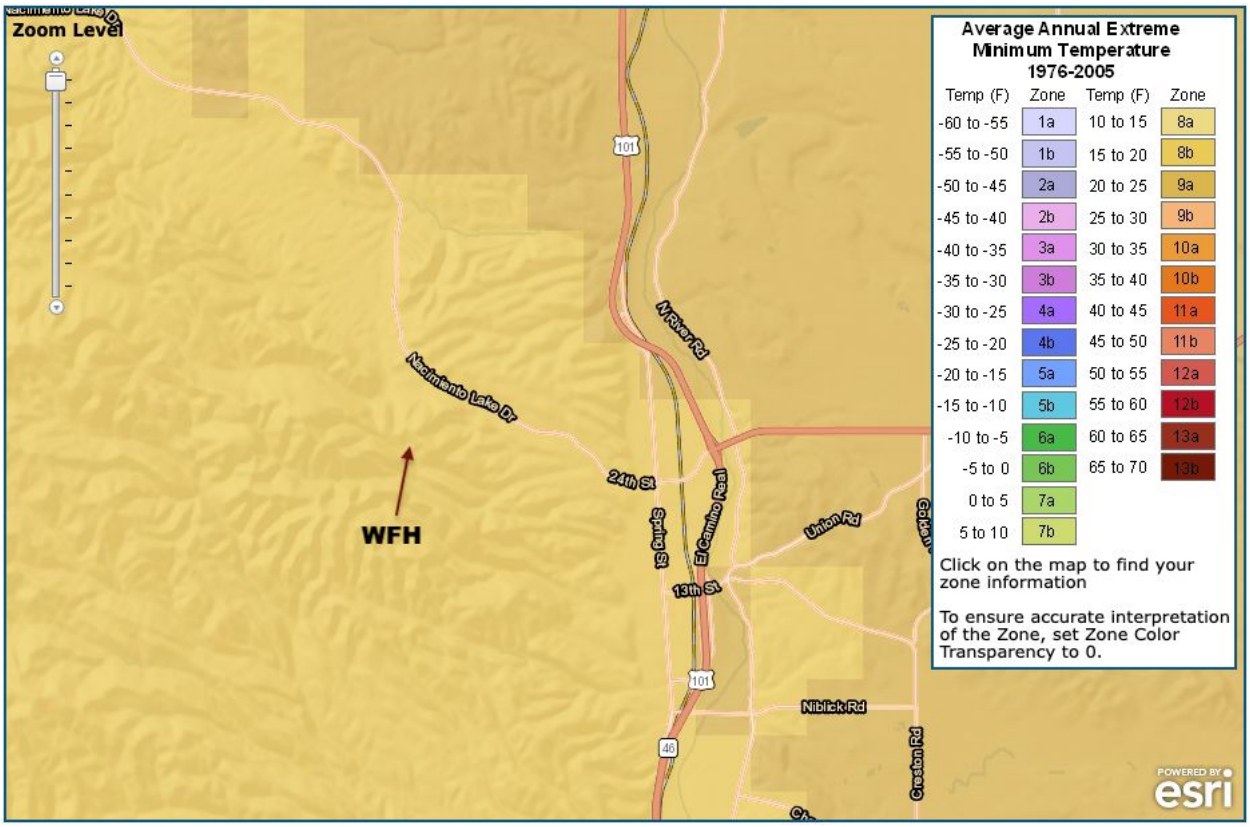
USDA Hardiness Zone

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 [redacted] Road, Paso Robles 93446 is **8b**. This zone is characterized by cold-season low temperatures that do not generally fall lower than 15-20ºF, 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 1-11 below presents a map of USDA hardiness zones for the general area.

Figure 1-11
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.

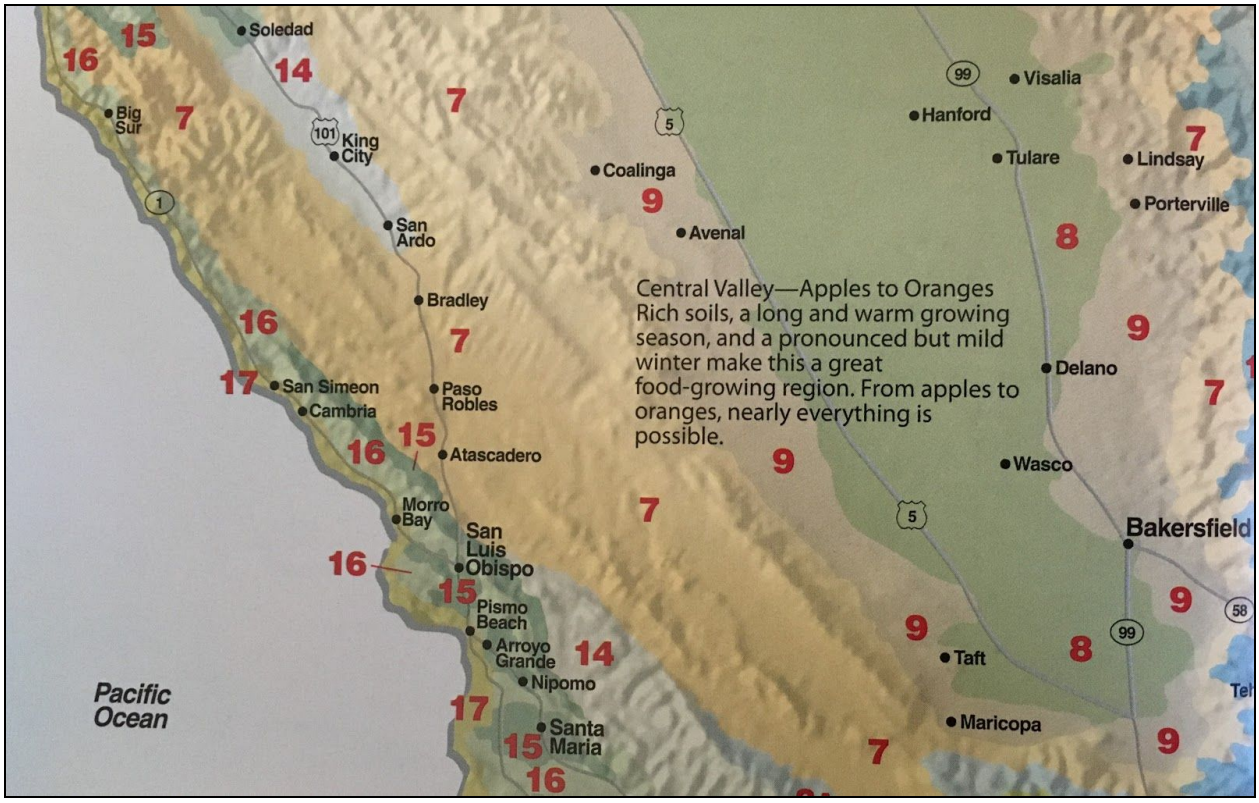
The Sunset Climate Zone(s) for WFH is Zone 7. Zone 7 encompasses several thousand square miles west of the Sierra Nevada and Cascade ranges, and in the mountains that separate the Southern California coast from interior deserts. Because of the influence of latitude, this climate lies mostly at low elevations 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—you can get away with growing borderline plants such as citrus, oleanders, and almonds if you choose a spot with good air drainage 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 1-12
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 Koppen 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.

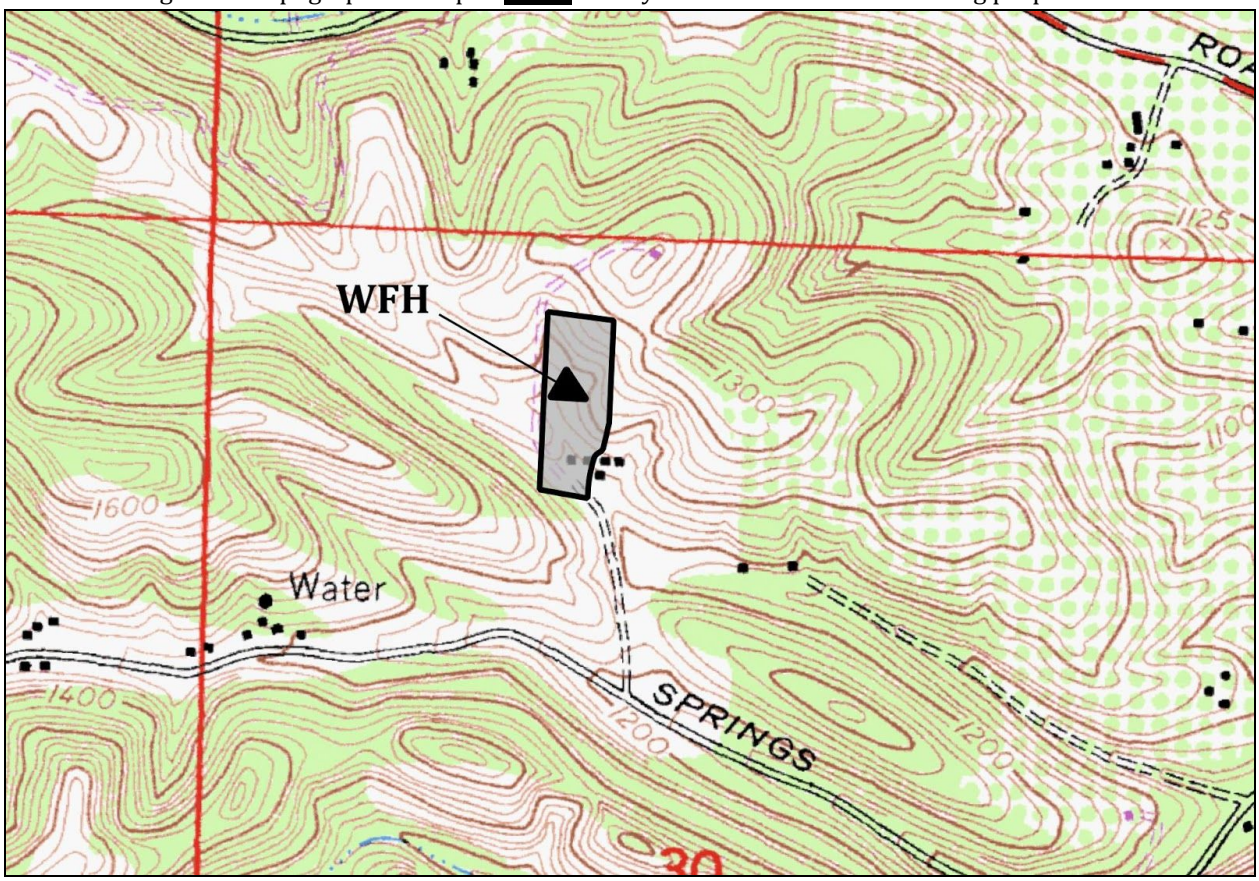
Topography

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 1-13 presents the high level topographical map for WFH and the surrounding properties of [redacted] Rd.

Figure 1-13
High-level topographical map of [redacted] Family Homestead and surrounding properties



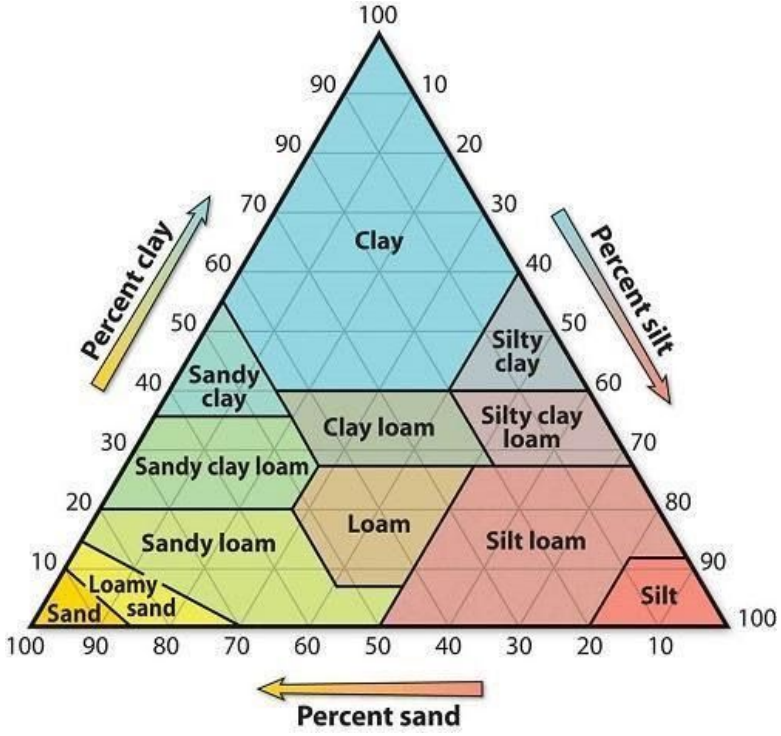
WFH lies in a valley bowl, with a large portion of the property on a southwest-facing slope. Natural grades are as steep as 35-40%. Some of the machined-made slopes are steeper at 44-60%.

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 1-14, 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 1-14
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 in order 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 WFH is provided in Figure 1-15. Detailed descriptions of the soil classifications shown on the map follow.

Figure 1-15
NRCS Web Soil Survey Data for [redacted] Family Homestead and surrounding areas

198—Santa Lucia-Lopez Complex

15-50 percent slopes - shallow soils, very high run-off, low infiltration rate once thoroughly wetted, low water storage capacity.

Composition:

- Santa Lucia and similar soils: 30 percent
- Lopez and similar soils: 25 percent
- Minor components: 45 percent

- **Santa Lucia:** Composed of residuum weathered from shale, typically 21-25" to unweathered bedrock, good capacity for infiltration (0.57 to 1.98" /hr) in most limiting layer, run-off is high, not considered prime agricultural soil, has very low ability to store water in the soil profile (~ 2.3").
  - 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: **6e**
    - **Class 6** soils have severe limitations that make them generally unsuited to cultivation and that limit their use mainly to pasture, range, forestland, or wildlife food and cover.
    - **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.
- **Lopez:** Composed of residuum weathered from shale, typically 14-18" to weathered bedrock, moderately high to high capacity for infiltration (0.57 to 1.98" /hr) in most limiting layer, run-off is very high, not considered prime agricultural soil, has very low ability to store water in the soil profile (~ 1.6").
  - 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* (as is the case at WFH).
  - Landscape Capability Classification: **6e**
    - **Class 6** soils have severe limitations that make them generally unsuited to cultivation and that limit their use mainly to pasture, range, forestland, or wildlife food and cover.
    - **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.

199—Santa Lucia-Gazos Complex

50-70 percent slopes - shallow soils, very high run-off, low infiltration rate once thoroughly wetted, low water storage capacity.

Composition:

- *Santa Lucia and similar soils:* 30 percent
- *Gazos and similar soils:* 20 percent
- *Minor components:* 46 percent

- **Santa Lucia:** Composed of residuum weathered from shale, typically 21-25" to unweathered bedrock, good capacity for infiltration (0.57 to 1.98" /hr) in most limiting layer, run-off is high, not considered prime agricultural soil, has very low ability to store water in the soil profile (~ 2.3").
    - 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.
- **Gazos:** composed of residuum weathered from shale, typically 28-32" to weathered bedrock, moderately high capacity for infiltration (0.20 to 0.57 inches/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: 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.

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 WFH Water Catchment Calculator Google Spreadsheet.

Table 1-3
Infiltration test results for various locations at WFH.

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
Perc 1 - Lower Pasture	240	0.45	0.72	19,480	1,168,815
Perc 2 - Fill Slope	110	0.98	1.57	42,502	2,550,142
Perc 3 - West Upland Drainage	5	21.47	34.44	935,052	56,103,116

*NOTE: The infiltration rate values are very high due to the exceedingly low water retention capacity of the native soil profile. Once the thin surface soil layer is saturated, the infiltration rate would effectively be zero and then surface sheet flow would begin, increasing risk of erosion damage depending on the intensity of the precipitation event.

Figure 1-16
Locations of the infiltration tests performed on the WFH property.

Existing Vegetation

Existing Vegetation - Wild / Nativized		
Common Name	**Scientific Name**	**Notes**
Coyote Brush	*Baccharis pilularis*	CA native, excellent habitat, viewscreen, low-level windbreak, very fire-resistant
Milk Thistle	*Silybum marianum*	Invasive, medicinal seeds, edible stalks and roots, highly flammable when dry
Star Thistle - Yellow star thistle, geeldissel, golden star thistle, St. Barnaby's thistle	*Centaurea solstitialis*	Invasive, crowds out native grasses, toxic to horses, highly flammable when dry
Black Mustard	*Brassica nigra*	Invasive, tall, yellow flowers, early season growth before other plants, seeds can be used to make mustard, highly flammable when dry
Doveweed, Turkey Mullein	*Croton setiger*	CA native, indicative of low nutrient soils, drought tolerant, native people used it to stupefy fish
Kotolo / CA Monarch / Woolly Pod Milkweed	*Asclepias eriocarpa*	CA native, food for Monarch butterflies, perennial herb, hairy leaves, produces large woolly fruit, toxic if ingested.
White Horehound	*Marrubium vulgare*	Non-native, medicinal, pollinator attractor, drought hardy, beautiful,
Narrow Leaf Milkweed	*Asclepias fascicularis*	Food for Monarch butterflies, poisonous if ingested, flowering perennial, beautiful in dried arrangements
Black Locust	*Robinia pseudoacacia*	Thorny, nitrogen-fixing, prolific spring blooms that are edible and fragrant

Mexican Elderberry	*Sambucus mexicana*	Medicinal, beautiful blooms, important bird food source - a great ally in the landscape!
Coast Live Oak	*Quercus agrifolia*	CA native oak, mast producer, attracts a variety of birds and butterflies
Blue Oak / Iron Oak / Mountain Oak	*Quercus douglasii*	Most drought-tolerant deciduous oak in CA, produces acorns with a slight sweetness
Woodbine / False Virginia Creeper / Thicket Creeper	*Parthenocissus vitacea*	CA native, mature fruit looks like a grape but is toxic, climbing vine, drought hardy, invasive
Loblolly Pine	*Pinus taeda*	East coast native, blooms in late winter, early spring
CA Black Walnut	*Juglans californica*	CA native, deciduous, fragrant, nuts edible but difficult to extract from thick shell, traditionally used to make Nocino and black dyes

Existing Vegetation - Planted		
Common Name	**Scientific Name**	**Notes**
Oleander	*Nerium oleander*	Very drought hardy, beautiful blooms, all parts poisonous - will affect horses, cattle, sheep, dogs, humans, goats
Thornless Honey Locust	*Gleditsia triacanthos*	Nitrogen-fixing, edible as browse for grazing animals, creates light dappled shade, deciduous
Magnolia	*Magnolia grandiflora*	Requires irrigation in this climate, intensely fragrant, evergreen
Fruitless Plum	*Prunus spp.*	Dark purple foliage, ornamental specimen

White Mulberry	*Morus alba*	Heavy producer, can be propagated from cuttings, good high-protein browse for grazing animals, berries can be dried or eaten fresh
Almond	*Prunus dulcis, Prunus amygdalus*	Annual nut producer, same family as peaches and other stonefruit, can be dry farmed
Callery Pear / Bradford Pear	*Pyrus calleryana*	Adapted to wide variety of soils, inedible fruit taken by birds after frost
Carob (fruitless variety)	*Ceratonia siliqua*	Slow growing, very drought adapted, evergreen foliage

Based on the existing vegetation found during the Level 1 Site Survey, it can be broadly concluded that much of the property at one time had unrestricted grazing animal access. The fact that the broad, open areas of the Upper and Lower Paddocks are both dominated by annual grasses and a variety of "invasive" and "non-native" plant species - Yellow Thistle, Milk Thistle, Black Mustard - indicate that these areas experienced persistent grazing pressure without adequate recovery. The few perennial plants that are present in these areas - Coyote Brush, Doveweed, both Milkweeds - further indicate the low organic matter and low nutrient levels of the soil.

A number of very valuable trees and plants already exist on the property. Elderberry is a potent medicinal and can be propagated from cuttings and seed. Similarly, the fallen White Mulberry in the south east corner of the Lower Paddock can be propagated from cuttings and seed and is an amazing plant for browsing animals, birds, critters and humans alike. The Oaks and Black Walnut can also provide excellent seedstock for longer-term reforestation with locally adapted species.

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 today is 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. The General History of Mission System from the Native American Heritage Commission of California is well worth reading .

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.

Property Specific

Due to the presence of the horse stalls and the high and very well-built fencing around the lower portion of the property, it is assumed that the land was used as a horse paddock for some time by prior owners (most likely before the main residence was built in 2004). There are a number of deceased almond trees located in the upper pasture, and some closer to the house that are still producing. This pattern is evident on the surrounding properties as well, indicating at one time a large portion of the southwest facing slopes within the small valley in which WFH is located was in almond production. Given the past (and unfortunately still current) practice of tilling the ground in and amongst these old almond trees to reduce weed pressure, the land has likely suffered a severe loss of top soil over the past 100+ years in particular. Rebuilding this living layer via soil and water-centric management practices will be a key factor in creating an abundant and beautiful home landscape at WFH for current and future generations.

The scar on the fill slope due south of the house (where the giant thistle patch is) had what appears to be a trench running through it during the construction of the home, as visible in the images below taken in March of 2004. By August of the same year both this trench and a similar one near the animal housing have been filled in, though the scald is still clearly visible in the landscape.

Figure 1-17
Past Google Earth satellite photos taken of WFH home shortly after construction. Left: March 2004. Right: August 2004.

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.

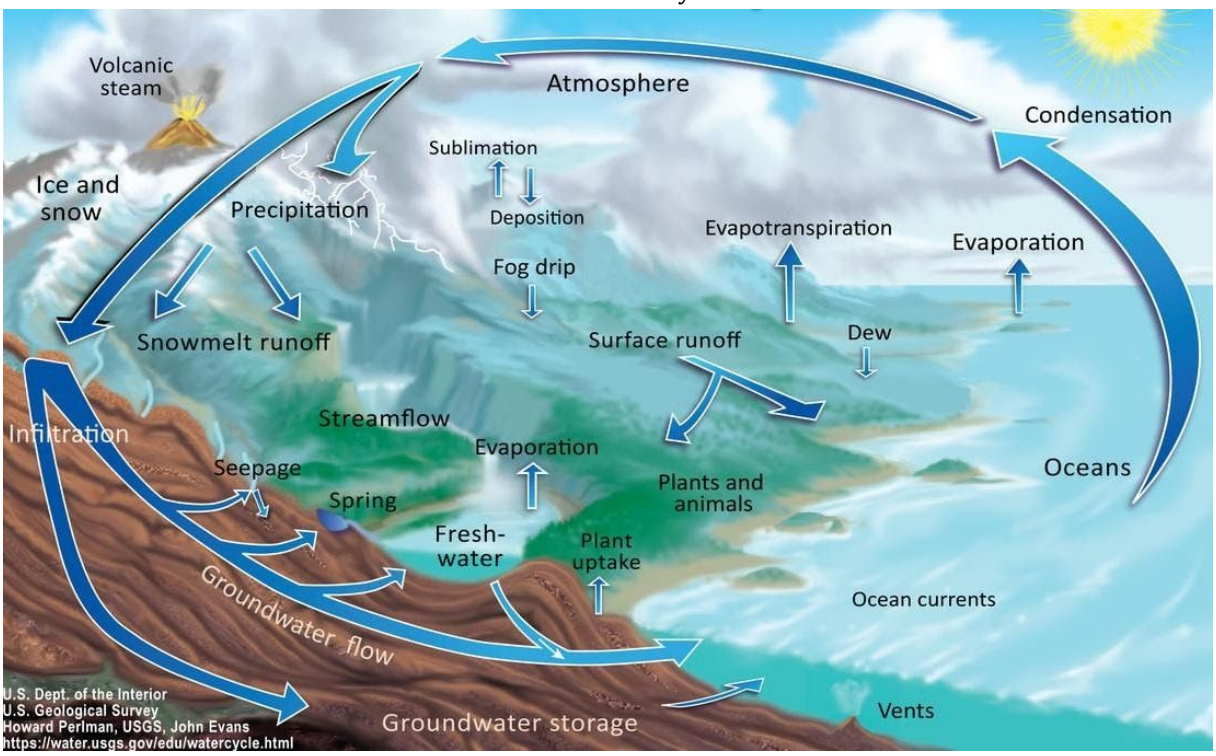
Additionally, conventional property development in the past century was geared towards moving rainwater away from structures and off-property as quickly as possible in an effort to prevent damage. While this seemed to work at first, unfortunately in the long-term this has resulted in major erosion issues (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 evapo-transpiration by 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 WFH 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.

[redacted] Family Homestead is located at the bottom of a larger valley bowl. The property has 6.3 acres of on-property catchment area comprised of built structures, hardscape, and softscape summarized in Table 2-1. The total effective catchment for the property (on-property catchment + off-property run-on) is ~ 10.7 acres (464,350 sq. ft.), with run on coming from the surrounding uphill properties to the North and West and the old tractor road cut on the property to the east. An additional ~131 acres of up-canyon catchment is located above the WFH property but does not provide any run-on potential to the majority of the property (though some could be harvested via curb cuts in the lower south east corner of the property).

Table 2-1
Summary of catchment areas within WFH boundaries

Catchment Name	Area (sq. ft.)	Surface Type
Structures - House Roof	4,718	Roofs
Structures – Barn Roof	647	Roofs
Total Effective Catchment	464,350	Ag/Bare-Packed Soil/Rough

During a mean rain year of 14.77 inches, the total volume of rainfall that lands within WFH property lines is 2.53 million gallons; the total volume that lands on structure roofs (Main Residence + Animal Housing) is 47,414 gallons. The Total Effective Catchment (illustrated in Fig. 2-2 below) of 10.7 acres receives an estimated 4.29 million gallons of direct rainfall each year. Based on runoff estimates for the terrain, an estimated 900,000 - 2,140,000 gallons of this water is lost to runoff during an average rain year from the Total Effective Catchment. Detailed calculations are available on the Catchment and Runoff Calculation spreadsheet.

Figure 2-2
Primary watershed feeding into WFH property

In a mean rainfall year of 14.77 inches, over 52.5 million gallons of rain falls on the 131 acres up-canyon from WFH. Based on runoff estimates for the terrain, an estimated 10.5 - 26.2 million gallons of this water is lost to runoff during an average rain year, which ultimately passes through WFH land via the [redacted] road easement. 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
WFH location within the Mustard Creek - Salinas River Watershed.

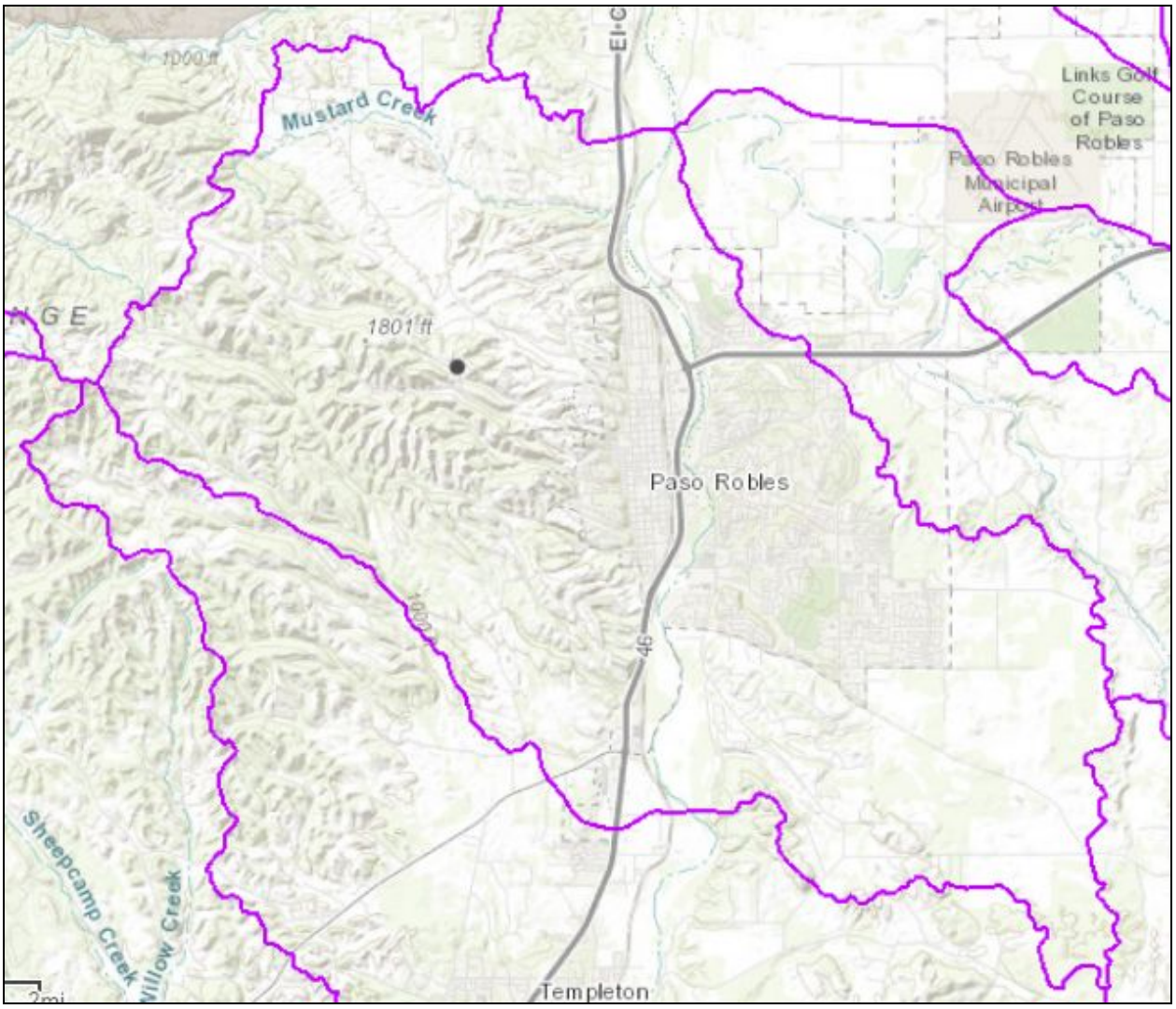


Figure 2-4
WFH Subcatchment location within the Mustard Creek Subwatershed within the Salinas River Watershed.

Aquifer

Additional information about the aquifer underneath [redacted] Family Homestead 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 2-5
WFH's location within larger Salinas Valley Groundwater Basin (black dot to the left of blue polygon).

WFH is located just adjacent to the boundary of the Salinas Valley Groundwater Basin, which 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

WFH has a dedicated well, located near the existing house. The well depth is currently unknown, though should be available for look up soon via the California Department of Water Resources Digitized Well Database[1]. The well had a recorded sustained flow rate of 14.7 gpm in April of 2019 . During the course of the 4 hour pump test, the pumping level dropped from 83'0" to 95'4". Within 17 minutes of the cessation of pumping the water level had risen back to 85'. The well is configured with a 2,500 gallon storage tank located adjacent to the pump house by the main entry gate. The most recent water quality test for *E. coli* bacteria performed in April of 2019 came back absent the presence of colony forming units (<1 CFU/100mL). Additional information regarding well water tests can be found at: California State Water Resources Control Board - Private Well Water Quality Testing Resources[2]. The well is located approximately 150' uphill from and west of the leach field serving the Main Residence.

Municipal Water

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

[1] https://www.waterboards.ca.gov/water_issues/programs/gama/online_tools.html
[2] https://www.waterboards.ca.gov/gama/well_owners.html

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 of course, healthy, humus rich soils. They are typically less expensive, simpler to build, lower maintenance, and longer lasting than active water harvesting systems.

Existing Conditions

While over 4.29 million gallons of water falls within the Total Effective Catchment for WFH during an average rain year, a large percentage of this water (estimated 21-50%) exits the property via runoff or evaporates before being able to be utilized by living systems due to the predominance of thin absorptive soil layers, fast-growing, short-lived annual grasses and a lack of tree cover. The infiltration rate of the soil is quite high, but its capacity to hold water is very low. 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 possible opportunities have been identified:

- Reforestation of areas currently dominated by annual grasses utilizing contour plantings and small scale (hand implemented) earthworks when feasible. The shade, impedance, and living roots of trees will all serve to prevent evapotranspirative loss from the soil surface, reduce the erosive potential of rain drops hitting bare soil, and actively "bank" water into deeper soil strata for use throughout the long dry season.
- Remodeling of the curtain drain above the house (just below the newly planted orchard) to slow and spread some inbound water by connecting it on contour with the Old Tractor Road Cut to the west. This will create a small zone where the drain functions like a swale and will help to take erosive pressure off of the current outlet onto the cut slope and hardscape below.

Figure 2-6
Curtain drain remodel to keep water off of eroding cut slope and sediment off driveway.

- Contour plantings of soil-stabilizing, deep rooted perennial grasses along the southern face of the fill slope to the south and southwest of the house to reduce the chance of future slope erosion. Vetiver grass would be an excellent candidate for the areas that receive a full day's sun with no shade. CA native grasses will also perform this function, and can tolerate some shade as experienced on the more westerly aspects.

Figure 2-7
Contour planting slope stabilization zone of deep-rooted clumping grasses (Vetiver or specific CA natives). Switchback access path can be integrated within contour rows, anchored by grasses (see Thousand Oaks Vetiver Grass Slope Stabilization Project[3]).

- Rolling dip installation across the driveway above the pump house to redirect run-off coming down the driveway and West Valley drainage across the landscape and into the Lower Pasture.
- Swale across the toe of the fill slope at the base of the Main Residence pad connecting driveway rollin dip with Lower Paddock.

[3] https://www.7thgenerationdesign.com/biological-erosion-control-with-vetiver-grass/

Figure 2-8
Updated water flow pattern with proposed rolling dip and swale installation.

- Monitoring of run-off flows down [redacted] Road during the next rainy season. There may be a possibility of intercepting some of this water along the southern fenceline of the Lower Paddock of the property below the fallen white mulberry tree via an infiltration basin fed by a curb cut before discharging back to the roadway.
- Lawn re-model with a slight depression (3") and replanting with a drought tolerant, slow-growing (i.e. less mowing) grass like UC Verde Buffalograss[4],[5].

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.

[4] https://ucverdebuffalograss.com/
[5] http://www.ucverdeplugs.com/

Existing Conditions

The only water storage on-site is the 2,500 gallon tank 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:

- The Main Residence will see over 40,000 gallons of rain water fall on it during an average rain year. There are numerous potential avenues for active water harvesting.
    - Storage in rainwater tanks located along back patio, on the paved parking area, or somewhere on the slopes below the Main Residence.
    - Redirecting downspouts via seasonal extensions through wicking beds (more on these in the Additional Opportunities section at the end of the report) and then into the lawn or planted basins.
    - Redirecting downspouts directly to lawn and/or planted basins.
- Relocate water tank to highest point on property to provide gravity-pressurized water to house, future ADU, plantings, etc. A new higher capacity well pump will likely be needed, but having the gravity pressurized water will eliminate the need for any secondary pumping (currently required). A direct current (DC) well pump integrated with batteries charged by a solar PV system should be considered, with backup grid power via an automatic transfer switch for increased resilience.

Figure 2-9
Ideal water tank locations for maximum resilience in the event of fire or power loss.

- The horse stalls will shed nearly 6,000 gallons of water during an average rain year. This water can be stored in a daisy chain of small tanks, which themselves can overflow into wicking beds, tree basins, or other vegetative elements. This catchment, paired with some tank storage, should be enough to keep an appropriately sized wicking bed garden (more on this in Chapter 5) watered year round without supplemental water from the well.

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[6], 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:

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

- 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.

Existing Conditions

The greywater produced at the Main Residence is currently piped into the septic system.

Recommendations

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

- First, a monthly water use log should be kept to identify patterns of use. This will help to identify peaks in use throughout the year as the seasons change. Even a gross gallonage total from the well head will be helpful.
- Perform a greywater site assessment to identify the various options available and how much you are willing to invest in greywater harvesting (in both physical systems and/or lifestyle change).
    - NOTE: If pipes are embedded within the foundation (as they are likely to be) then an application of greywater in the landscape , provided it can be separated from blackwater before reaching the septic tank, will have to occur downslope from the house.
    - We recommend Art Ludwig's OasisDesign.net[7] as an excellent starting place for all things greywater. Excellent information is provided on conducting your own greywater site assessment[8], Laundry To Landscape[9] systems, and water wisdom in general.

[7] http://oasisdesign.net/
[8] Greywater Site Assessment Form: http://oasisdesign.net/greywater/createanoasis/GWSiteAssessmentForm.pdf
[9] Art Ludwig's Laundry To Landscape systems: https://youtu.be/eaHgvPj9_nA

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 flows 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 Homestead and farm roads still utilize dirt and gravel road surfaces.

Existing Conditions

Figure 3-1
Existing access routes for [redacted] Family Homestead

Recommendations

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

- No recommendations at this time for modifying vehicle access routes.

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 dedicated footpaths on the property at present. The steep natural grades present in the Upper Paddock and the steep machined grades on the fill slope of the house pad would all benefit from improved footpath access to make for easier tending and interaction.

Recommendations

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

- Switchback footpaths for steep slope access.
    - Leading from south edge of lawn down the fill slope towards the lower paddock. Due to the existing grade of the slope (~44%) a stepped pathway is recommended to shorten the overall distance to be traveled while also ensuring safety (an unstepped pathway would need to have much longer switchbacks in order to provide a sufficiently gentle grade for relaxed walking). A natural rock pathway integrated with vetiver grass for slope stabilization, similar to the one shown on this project write up page[10], could be an excellent solution.
    - Leading from west side of upper driveway/parking area (adjacent to the Magnolia tree) down towards the horse stalls.
    - Leading from the southeast corner of the lawn through the dog gate up to newly planted orchard zone.
- Paths along existing animal trails in the Upper Paddock, starting at the tractor gate on the west end of the internal fence and switchbacking when necessary up to the top of the property (potential path for checking on water tanks located at top of property).

[10] https://www.7thgenerationdesign.com/biological-erosion-control-with-vetiver-grass/

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 WFH 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 [redacted] Family Homestead

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. 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.

Washing Machine Greywater

SLO County does have a recommended system for greywater disposal from a washing machine[11], the designers at 7th Generation Design view it as simplistic while simultaneously overengineered. A more nuanced approach as outlined at OasisDesign.net[12] is highly recommended.

Zoning ordinances

[redacted] Family Homestead is zoned as Residential Rural (RR). Further information regarding the various types of allowed land uses for RR land and the requisite permits that need to be filed with the county can be found starting on page 45 of the SLO County Land Use Ordinance document. Specific information about the RR zoning category is found in Section 22.22.060 of the Land Use Ordinance document (pg 286).

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.

Additional zoning and regulatory requirements can be looked up using the SLO County GIS Viewer[13] and typing in your parcel number 026-302-027.

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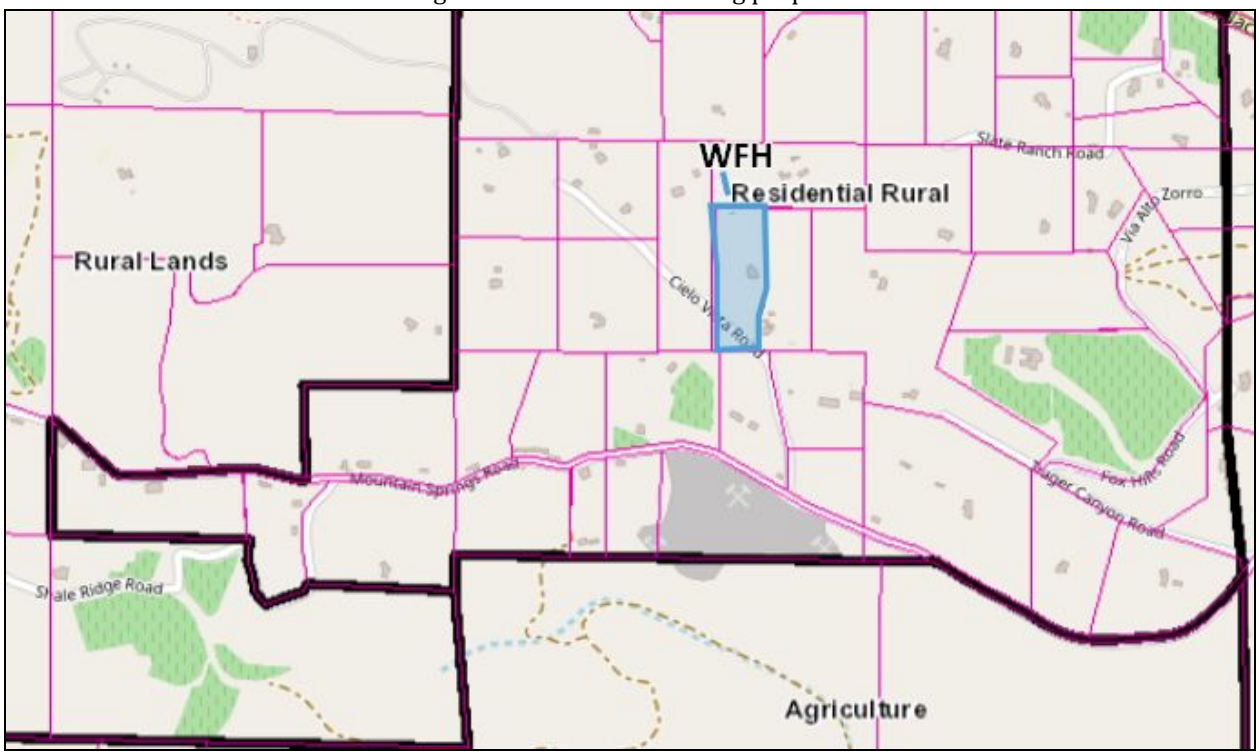
[11] https://www.slocounty.ca.gov/Departments/Planning-Building/Building/Building-Forms-Documents/Onsite-Wastewater-Treatment-Systems-(Septic-System/Washing-Machine-Greywater-Disposal-Guide.aspx

[12] http://oasisdesign.net/greywater/

[13] WFH Parcel Map SLO GIS Viewer: https://gis.slocounty.ca.gov/Html5Viewer/Index.html?configBase=/Geocortex/Essentials/REST/sites/PL_LandUseView/viewers/PL_LandUseView/virtualdirectory/Resources/Config/Default&apn=026-302-027

Figure 4-2
Zoning for WFH and surrounding properties.



Easements

The following easements exist at WFH:

- [redacted] Road passes through the southwest corner of the property.

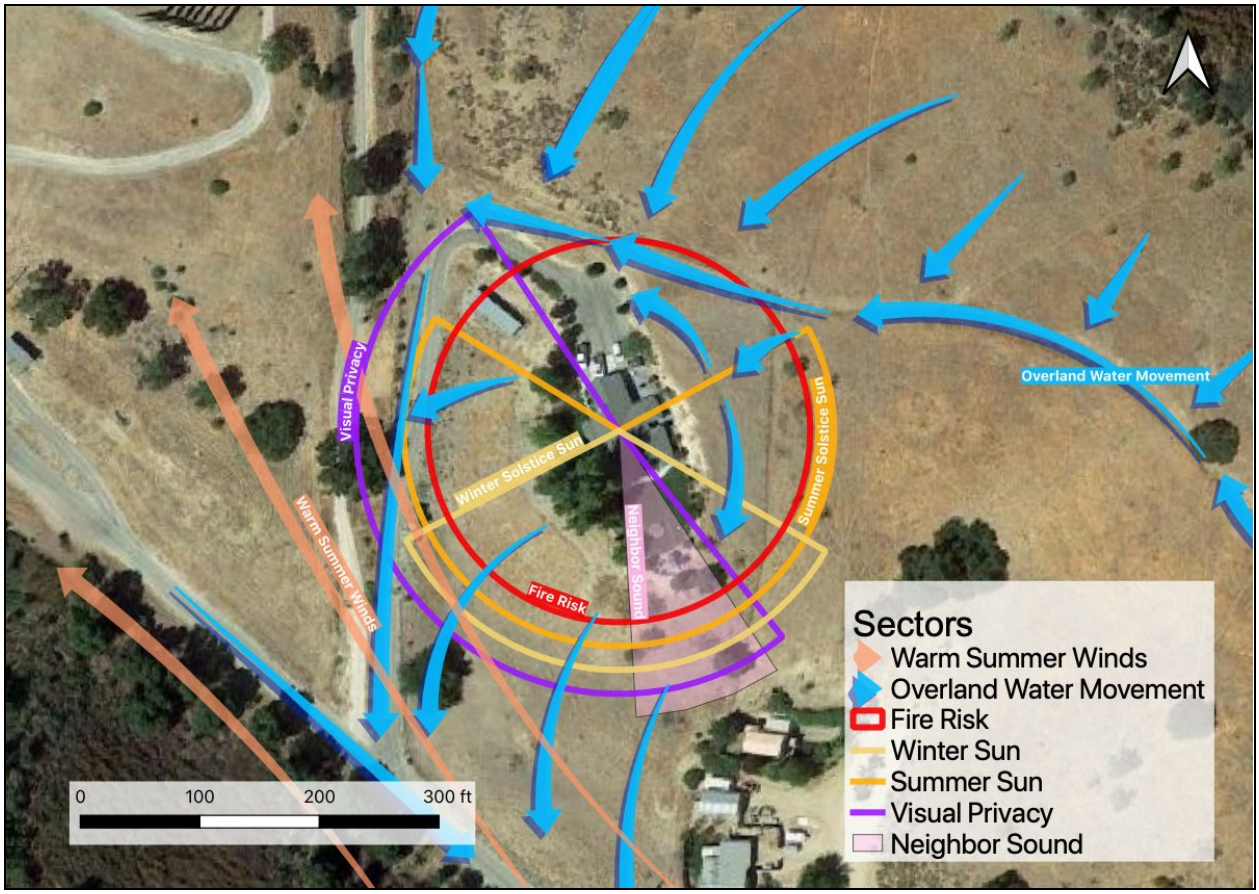
Home-Owners Associations

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 [redacted] Family Homestead is provided below.

Figure 4-3
Total sector analysis of [redacted] Family Homestead



Solar Aspect & Access

- Sunrise and sunset angles are shown for Summer and Winter solstices respectively. Additional solar aspect data (azimuths, day length, specific sunrise/sunset headings) can be found in the Solar Data section and in Appendix C - Solar Aspect Charts.
- Main house is oriented northwest by southeast lengthwise. Opportunities for solar thermal water heating are available on the home roof. Solar PV electricity generation would be best located above the house just below where the new orchard has been planted.

Overland Water Movement

- Evidence of overland water movement was found in the West Valley Drainage, indicating that despite high infiltration rates, significant amounts of water can move over the surface once the thin soil layers become saturated (which can happen quite suddenly). Based on

visual inspection and existing contour maps, overland water movement is likely to follow the broad pattern laid out in Figure 4-4 below.

Physical Access

- [redacted] Road approaches the property from the southeast. This is the sole way in and out of the valley by vehicle at this time.

Visual Privacy / Exposure

- Neighbors with direct lines of sight onto the WFH property to the northwest, west, southwest and southeast, totaling approximately 180 degrees of view in which visual privacy is a design consideration. The neighboring homes to the north and northeast do not look directly onto the WFH property, but their property lines do.

Wind

See Wind Data section for detailed seasonal wind information.

Fire Risk

- 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

- Vehicles are able to access the property via [redacted] road, which passes through the lower portion via easement, and then the private driveway leading to the Main Residence.
- The entire lower perimeter of the property is fenced with 6' tall horse fencing.
- A vehicle gate is located midway up the private driveway and is controlled by remote access code or from within the Main Residence. A manually opened vehicle access gate is located at the bottom of the driveway at the southwest corner of the Lower Paddock.
- The main residence is elevated well over 50' above Cielo Vista Road and the lower driveway, and has excellent lines of sight from edges of the Main Residence pad.

Neighbor Sounds

- Sound from the air conditioning units attached to structures on the property to the southeast was readily audible down in the Lower Paddock during the site visit. It is unknown to the design team if typical conversation level voices will carry up the hill to the Main Residence and surrounding outdoor areas.

Homes

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

Existing Conditions

The single-story Main Residence has a roof area of approximately 3,930 square feet. It is oriented along a northwest by southeast axis lengthwise. The south facing wall adjacent to the lawn area has minimal roof eave overhang, and consequently has significant exposure to high-intensity summer sun. The cut slope that was formed when the home site was excavated is down to bare rock, which is currently uncovered by vegetation and exposed to the sun for most of the day, creating a thermal gain that may be influencing the lack of use of the northeast side of the house.

Recommendations

South Wall Shade

The south wall of the Main Residence would benefit from shade to mitigate thermal gain during the first half of the day during the warmer season. This could come in the form of a trellised walkway growing seasonally deciduous vines, a constructed eave extension to prevent sunlight from directly hitting the wall for a desired portion of the year, or even by trellising dense vine plantings along this edge of the home. Gardening in wicking beds or other raised containers could be integrated with a shade structure that would enable vertical growing of annual crops.

East Patio Trellis

To limit some of the thermal gain from the exposed rock cut slope, a trellis could be constructed along the eave of the eastern patio overhang that would curve down into the raised planting strip behind the cinder block retaining wall. Deciduous vining plants should be used for this trellis to provide summer shade and allow in more light to the patio area during the winter. A similar concept is shown in the figure below.

Figure 4-4
Green seasonal screen attached to existing eaves creates a pleasant place to be during the heat of the day.

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

A small pump house located adjacent to the remote operated gate on the driveway houses the well head and pumping equipment. A small garden shed is located on the pad of the Main Residence beyond the southeast corner of the lawn.

Recommendations

There are no recommendations for these structures 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 a horse barn with three horse stalls location southwest of the Main Residence. The stalls each have their own wide gate to the Lower Paddock, and a slightly narrower gate leading to a chute on the north side of the structure.

Recommendations

There are no recommendations at this time for retrofitting or modifying the structure.

5. Additional Opportunities

This section provides a briefly-summarized list of suggestions, design elements and areas deserving of further exploration as they pertain to the development of the homestead in accordance with the landowners' shared vision that have not already been discussed in preceding sections.

Structures

Accessory Dwelling Unit

Potential locations for the Accessory Dwelling Unit (ADU) are limited by a 250' radius, either emanating from the center of the Main Residence or from any particular edge of it (consultation with building department necessary to be sure which exactly). We have included an image below of two development radii - magenta emanating from the center of the Main Residence and red emanating from the southernmost corner of the Main Residence.

Figure 5-1

Green seasonal screen attached to existing eaves creates a pleasant place to be during the heat of the day.

Worth examining at this early phase of planning for some sort of guest house or second dwelling is the functions it needs to perform.

- How many people will be staying in it at any given time? For how long? What will be the nature of their stay (visiting the area, or family time focused, lots of interaction vs. little)?
- What amenities will you prefer they have access to in the ADU versus the Main Residence?
    - Will they need their own kitchen space, or will meals be shared in the Main Residence kitchen?
    - Separate bathing and toilet facilities needed or shared with Main Residence?
        - Perhaps a small "under the radar" outdoor shower or shower hut down the line can add this amenity to the ADU without increasing your construction or regulator footprint?
- Would a smaller structure, below permitting size (120' square feet) work for providing a sleeping space if the rest of guest activity will be centered around the Main Residence and other parts of the landscape?
    - Yurts, converted sheds, and tiny homes can be assembled/disassembled in short windows or transported quickly should the need arise.
    - If a smaller structure meets the desired needs, then expensive and restricting septic integration can be foregone in favor of a composting toilet, which can further reduce resource use and create soil for use on the property.
    - Could this small structure also serve as meditation space / yoga room and be integrated within a future small garden pond and bamboo grove, to be converted for guest use when the need arises?

Classroom / Outdoor Learning Space

If the vision is to potentially expand to offering supplemental nature-based education services to the local community, having the classroom structure separate from the Main Residence will help to maintain the distinction between the private and more public spaces on the homestead.

The place that stood out to the design team during the assessment site visit was the east side of the black walnut tree in the Lower Paddock. Whatever the structure type, it would be able to benefit from the varying solar exposures over the course of a day and the seasons to always allow for comfortable indoor and outdoor spaces for the kids to be and do. Having the classroom in the Lower Paddock adjacent to the walnut tree would also allow for use of the lower vehicle gate as the public entry and exit should parents be dropping off and picking up kids.

Figure 5-2
Potential classroom location.

In addition to pre-built solutions, such as a yurt or converted shed, the climate and fire risk profiles at WFH indicate that a mass-based system, such as earth bag building, may be well-suited to the landscape. Earth bag construction has been around for over 4 decades, has a precedent history of permitting in a number of locales, including California, is seismically stable, fireproof, and has excellent thermal performance when sited correctly in Mediterranean climates such as this one. Additionally, earth bag structures are beautiful, artistic, and emanate a sort of magnetism that draws young and old alike to them. Construction is very approachable, requires no dangerous or high-powered equipment, and all ages and abilities can participate. Learn more at CalEarth.org or just type in "earth bag homes" on YouTube to get started down a fun rabbit hole!

Living Systems

Agroforestry and Food Forests

Agroforestry is the integration of trees and tree-based products (fruit, mast, timber, leaves, bark, roots, animal browse etc) into broadacre agricultural systems (generally grazing and rangeland). Food forestry is a more deliberate mimicking of natural ecosystem function and layering with deliberate integration of yield-producing species that will fulfill those ecological roles.

There is ample opportunity for both types of systems at WFH. The system, species selection, and management styles and tools will need to be tailored to the unique needs of the WFH property and the arid Mediterranean steppe climate of Paso Robles. There are many existing dryland agroforestry systems around the world in analogous climates to WFH. Designing these systems to the smallest detail is a level of information included in a Level 2 - Whole Site Design[14].

Privacy Screens

Privacy screen plantings along the southern edge of the Lower Paddock along the fence are recommended as a quick way to create visual privacy from [redacted] road. A mix of hardy growing natives like coyote brush, toyon, coffeeberry, sages and others can create a thick visual screen in relatively short order while also providing excellent habitat for quail and endemic wildlife. Grapevines could be incorporated, along with succulents like Opuntia, to create additional harvestable yields from the screen planting.

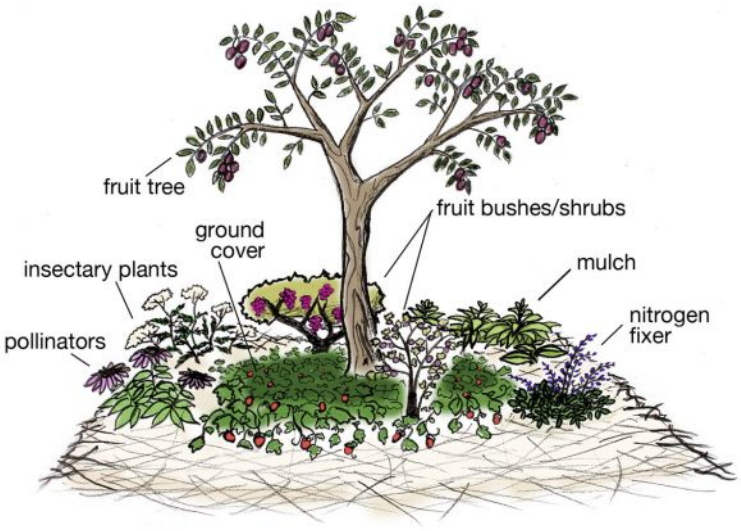
Companion Planting (Guilds)

The newly planted orchard trees, as well as the trees currently on order for the Fall/Winter of 2020/2021 would all benefit greatly from guild plantings. Dense underplanting of complementary support species, known as a "guild", provides numerous beneficial functions such as:

- 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).

[14] https://www.7thgenerationdesign.com/level-2-whole-site-design/

Figure 5-3
Fruit Tree Guild



There are two physically distinct plant profiles that will perform all of the above functions. Firstly, 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.

Pond

Given the highly evaporative climatic conditions at WFH, if a pond is to be constructed it is recommended that it be small (more for viewing and aesthetic enjoyment than banking large amounts of water), relatively deep (to keep water cooler, and thus slow evaporative loss), well-shaded (avoid direct sunlight onto water's surface, have dappled shade at most and late day sun should be completely shielded), and half of the surface covered with floating aquatic vegetation (further reduces water temperatures and slow evaporation).

Overland water flows should not be directly fed into a small garden pond - the high nutrient inflows will lead to algal blooms and sediment build up that can create anoxic conditions and kill desired species of plants, fish and other aquatic creatures.

Integrating the pond within the desired bamboo garden would leverage the shade and windbreak provided by a dense bamboo stand. For more on constructing a small water garden we recommend Deep Green Permaculture's DIY article[15] on the subject. A good local resource for bamboo is Paso Bamboo[16].

[15] https://deepgreenpermaculture.com/diy-instructions/building-a-small-water-garden/
[16] https://pasobamboo.com/

Depending on the size of the pond, floating islands may be an applicable element for nutrient reduction, shading the water surface and maximizing habitat and planted edge. These can be particularly useful for occupying sections of the pond that may experience higher light conditions, and can even be used to grow annual and perennial crops in a beautiful way. There are many ways to construct floating islands - from entirely natural materials (bamboo culms lashed together as flotation, hessian bags to hold soil) to industrial materials (corrugated drain pipe filled with empty plastic bottles tied into a desired shape). For pre-made options we recommend Floating Islands West.

Any body of water in a dry landscape such as that of the California Central Coast is going to become a magnet for wildlife - some desired and some not so much. Make sure there are variable edge and grades to the pond (to allow for bees, insects, lizards and other creatures to self rescue when they inevitably fall in). Wire mesh laid 6" above the water surface, perhaps over sections of the pond, may be required to keep raccoons, skunks and other creatures from harvesting any desired fish species.

Aquatic ecosystems are a true joy and a tremendous ecological boon to any landscape. Starting small and learning what works and what doesn't with a system that can be intensively managed (wine/whiskey barrel or cattle trough sized) before expanding to a potentially larger, in-ground garden pond is recommended.

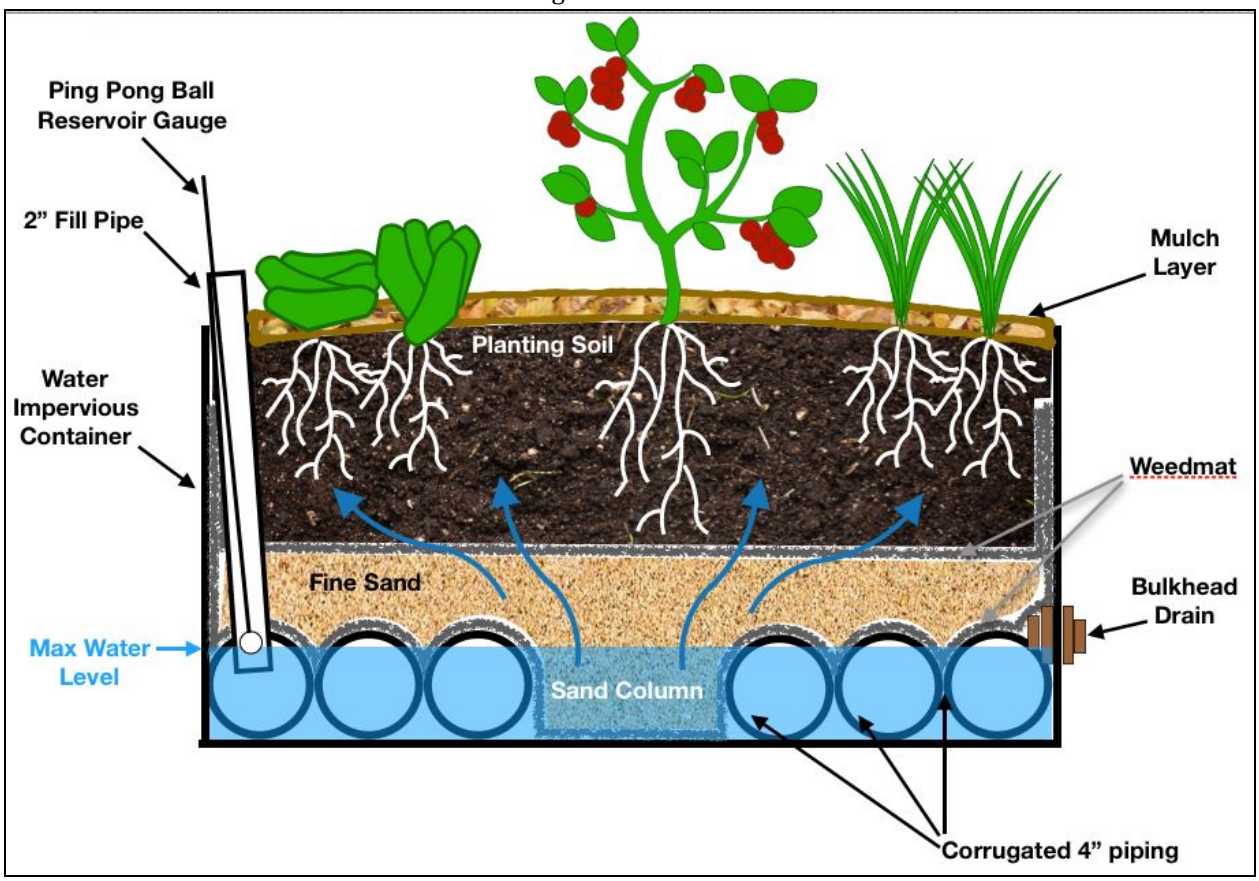
Wicking Beds

An excellent technology for climates with long, hot, arid summers, wicking beds are a type of bottom watered raised planter that utilizes the natural wicking capacity of soils to maintain even soil moisture for successful growing in harsh climates. Wicking beds can be integrated into downspout rain collection systems, and are an easy way to protect high-value crops from subterranean vermin (gophers, squirrels, voles etc).

DIY Wicking Bed articles available on the 7th Generation Design website[17] as well as others such as Deep Green Permaculture[18] provide an introduction to the concept and the range of possible applications.

[17] https://www.7thgenerationdesign.com/wicking-bed-construction-and-performance/
[18] https://deepgreenpermaculture.com/diy-instructions/wicking-bed-construction/

Figure 5-4
Wicking bed cross section.



Animals

Livestock can be tremendous allies in managing a broadacre landscape. Initially, setting up a vermicompost system (excellent DIY and animal tending experience for the kids) will help to process kitchen waste and unbleached paper products into a high-value nutrient input for kitchen garden crops. Nutrient Cycling For Homesteads - Part 1: Vermicomposting[19] on the 7th Generation Design website provides an introduction to several different modes of vermicomposting.

Chickens are also incredibly helpful as nutrient cyclers. Their innate scratching action can be leveraged to create piles of materials (scratched material will always, eventually, move downhill) which can be used in the garden as an excellent fertilizer. The chickens could also be tractored throughout the flatter parts of the landscape, perhaps to prepare future garden beds in the more levels areas of the Lower Paddock. Given the intense predator pressure chickens would be under in this region, a completely fenced chicken tractor, coop and run is recommended to protected from aerial and burrowing predators.

[19] https://www.7thgenerationdesign.com/nutrient-cycling-for-homesteads-part-1-vermicompost/

The old horse barn can easily be adjusted to house goats or sheep. The different stalls and the loading chute could be very helpful in separating individual animals and for birthing. Both goats and sheep would require substantial imported feed if brought to the land at this time given the scarcity of food available to them. This will change over time however, as food forests mature and palatable grasses are re-established. Goats prefer to browse, and are excellent for maintaining open understory under established canopies (food forests and agroforestry systems), while sheep are more focused on grazing (though they do some browse as well). Either way, larger livestock deserve careful and meticulous planning prior to bringing them onto the landscape and into the family. Regular paddock rotation will be necessary to prevent overgrazing and damage to high value trees and plants, and this regularity of interaction and intensive management needs to be taken into account based on desired quality of life, for humans and grazing animals alike.

Appendix A - Water Catchment Calculations

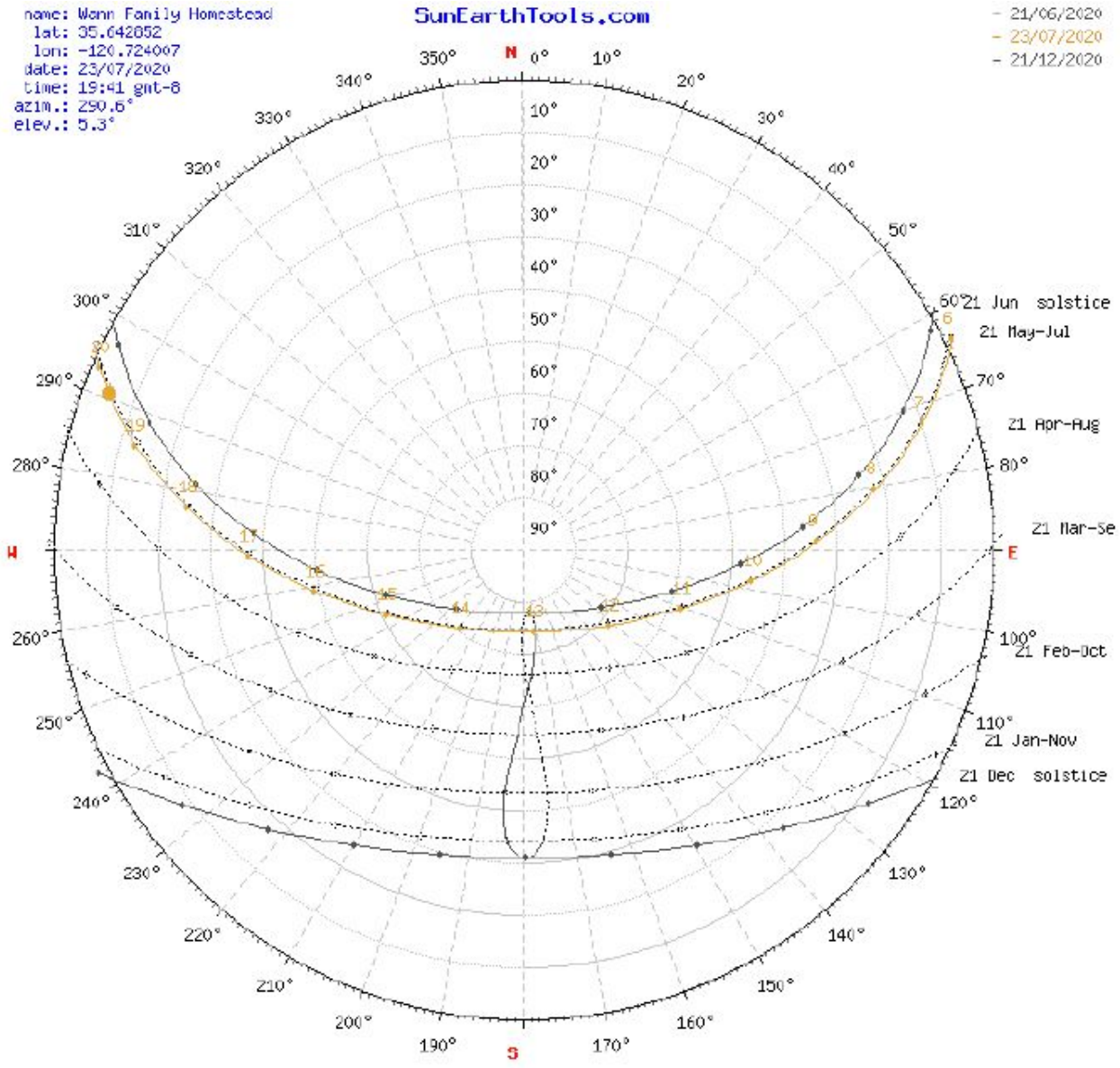
Table A-1
Rainfall totals for various catchments at WFH in an average rain year of 14.77 inches.

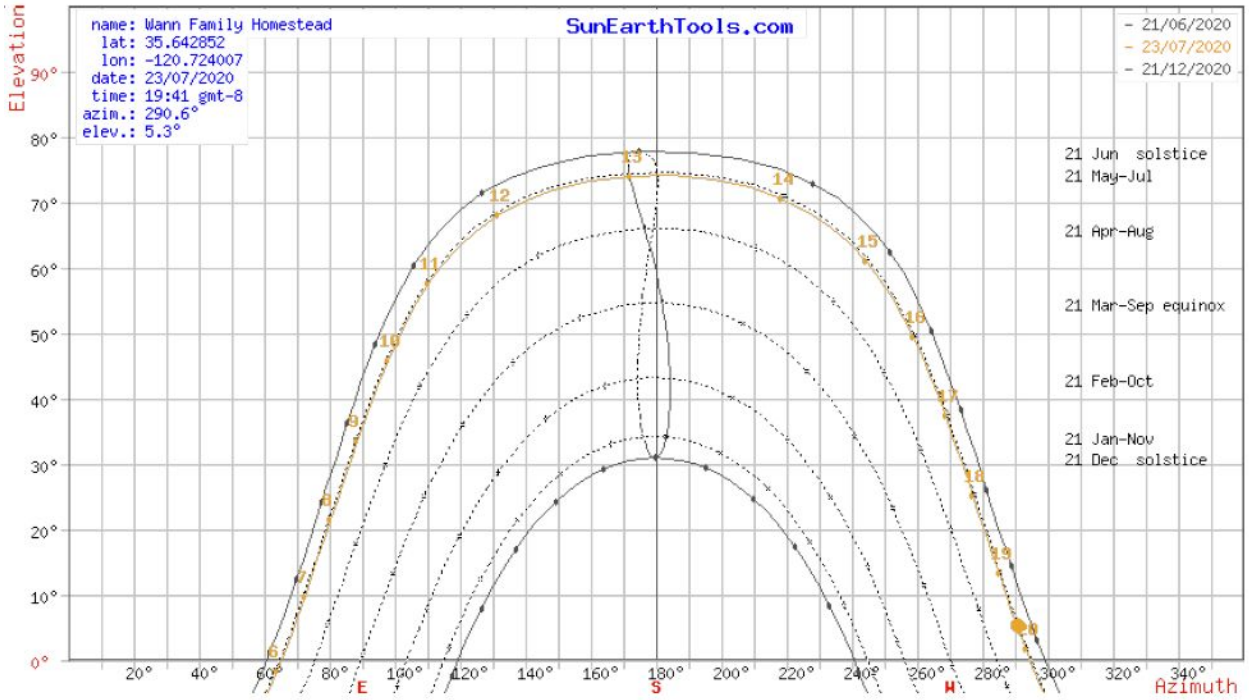
Catchment Name	Area (sq. ft.)	Run-off Coefficient	Direct Precipitation Totals (gal)	Low Run-Off Estimate (gal)	High Run-Off Estimate (gal)
Driveway	12,672	Drives and Walks	116,666	87,500	99,166
Main Residence	3,930	Roofs	36,182	27,137	34,373
Barn	650	Roofs	5,984	4,488	5,685
Total Effective Catchment	464,350	Ag - Bare Packed Soil/Rough	4,275,100	855,020	2,137,550
Upper Catchment	306,228	Ag - Bare Packed Soil/Rough	2,819,329	563,866	1,409,664
Up Canyon Catchment	5,706,360	Ag - Bare Packed Soil/Rough	52,536,364	10,507,273	26,268,182

Table A-2
Infiltration rates from three testing sites across WFH property.

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	Infiltration Per Acre Per Hour (Acre feet / hour)
Roof	NA	0.00	0.00	0	0	0.0
Concrete Pad	NA	0.00	0.00	0	0	0.0
Perc 1 - Lower Pasture	240	0.45	0.72	19,480	1,168,815	3.6
Perc 2 - Fill Slope	110	0.98	1.57	42,502	2,550,142	7.8
Perc 3 - West Upland Drainage	5	21.47	34.44	935,052	56,103,116	172.2

Appendix B - Solar Aspect Charts

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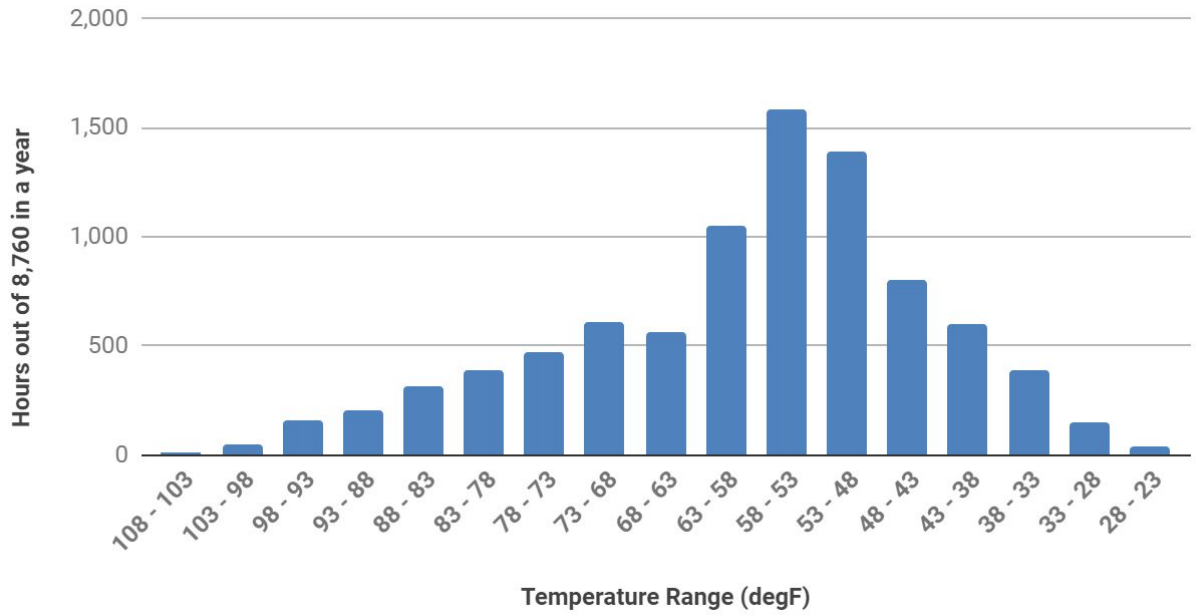
date: 23/07/2020
time: 19:41 gmt-8
azim.: 290.6°
elev.: 5.3°
SunEarthTools.com
- 21/06/2020
- 23/07/2020
- 21/12/2020
21 Jun solstice
21 May-Jul
21 Apr-Aug
21 Mar-Sep equinox
21 Feb-Oct
21 Jan-Nov
21 Dec solstice
Elevation
Azimuth
E
S
W

Appendix C - Additional Climate Information

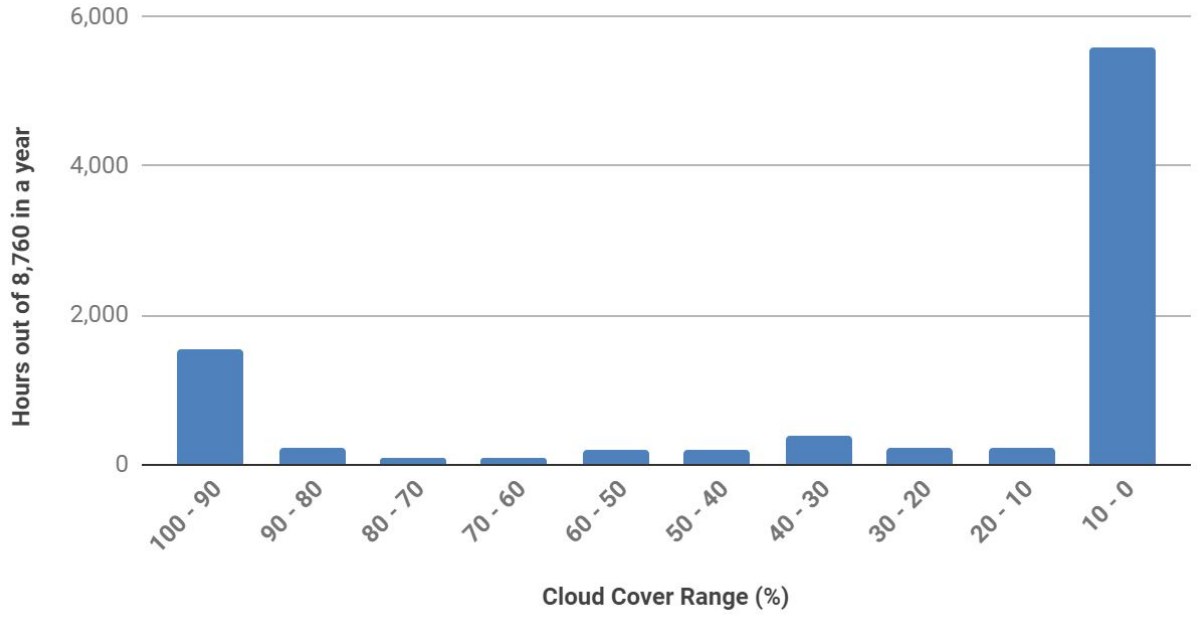
The hourly distribution of temperature for a typical meteorological year at Paso Robles Regional Airport (5.2 miles away from WFH) is provided in Table C-1. This chart shows how many hours of a typical meteorological year fall within certain temperatures ranges, which is helpful in determining which plant species are most suitable for the climate in a given area, or in designing for the heating/cooling needs of a home.

Figure C-1
Hourly temperature distribution for typical meteorological year at Paso Robles Regional Airport (5.2 miles away from WFH)



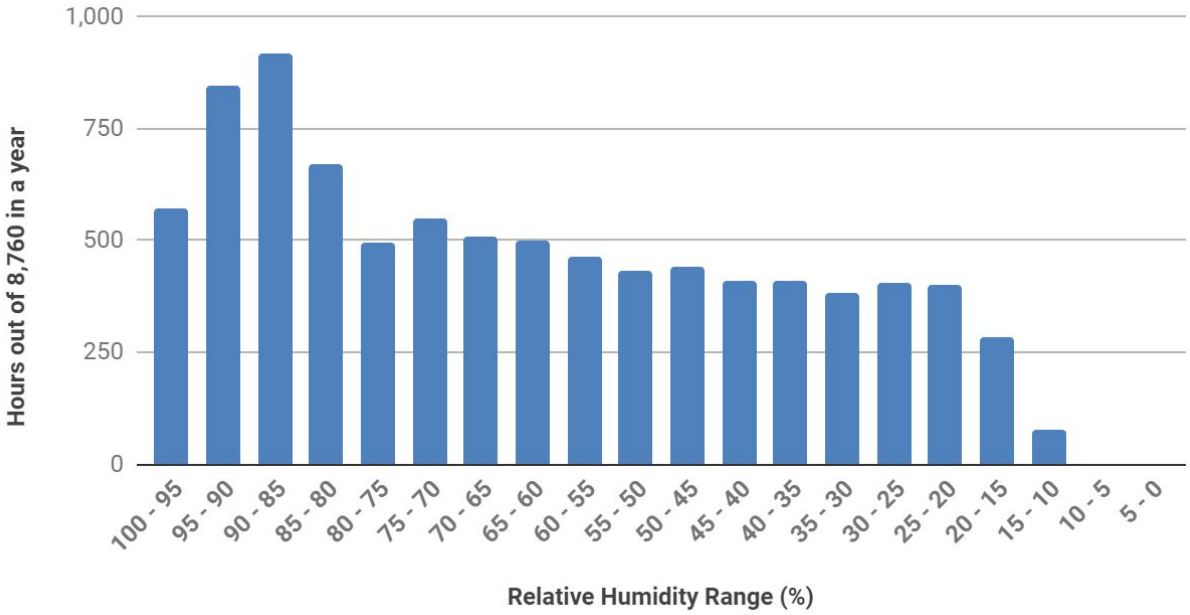
A chart of the hourly distribution of cloud cover for a typical meteorological year at Paso Robles Regional Airport is provided in Figure C-2. This chart shows how many hours of a typical meteorological year fall within certain a certain percentage range of cloud cover (for example, how many hours of the year the sky is 40-50% covered with clouds), which is helpful in determining the number of sunny days an area sees each year and thus which plant species are most suitable.

Figure A-2
Hourly cloud cover distribution at a percentage of sky covered for typical meteorological year at Paso Robles Regional Airport (5.2 miles away from WFH)



The hourly distribution of relative humidity in 5% ranges is provided in Figure C-3. This information is helpful in selecting plant species that are well adapted for the climate at WFH, as well as home and structure design for indoor climate control.

Figure C-3
Hourly relative humidity distribution (5% ranges) for typical meteorological year at Paso Robles Regional Airport (5.2 miles away)



The hourly distributions for wind direction and wind speed for a typical meteorological year at Paso Robles Regional Airport is provided in Figures C-4 and C-5, respectively.

Figure C-4
Hourly wind direction distribution for typical meteorological year at Paso Robles Regional Airport (5.2 miles away)

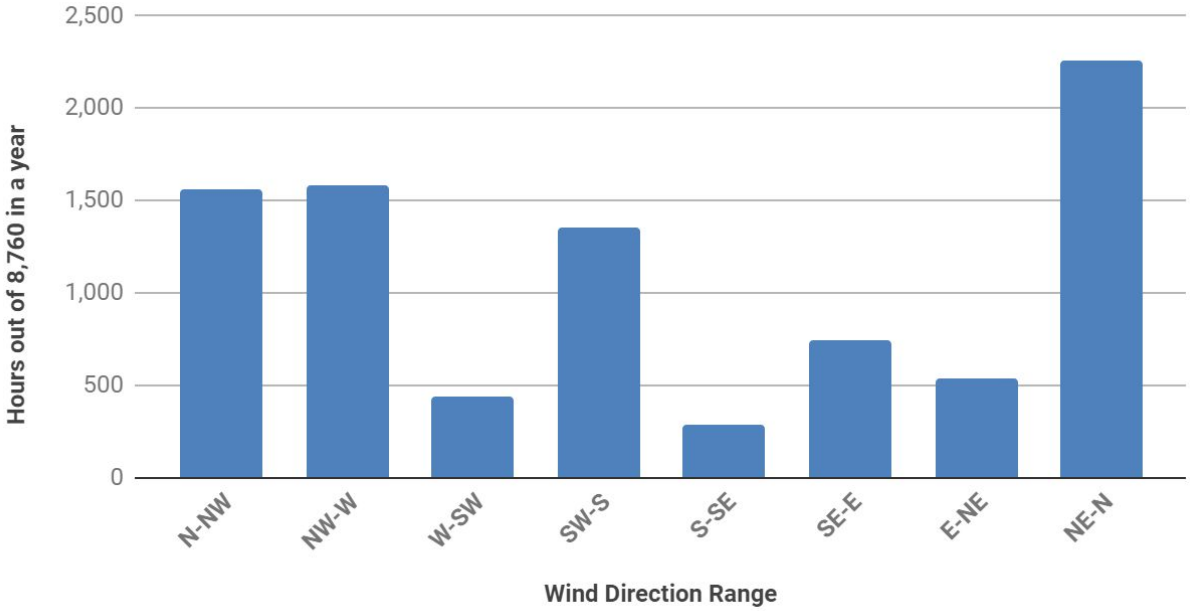


Figure C-5
Hourly wind speed distribution (5% ranges) for typical meteorological year at Paso Robles Regional Airport (5.2 miles away)