How to Improve
Home Vineyard Soil Health for
Grape Quality and Climate Change

Master Gardener
UNIVERSITY OF CALIFORNIA
COOPERATIVE EXTENSION

UC Master Gardeners of Napa County

http://napamg.ucanr.edu/

Our mission: "To extend research-based knowledge and information on home horticulture, pest management, and sustainable landscape practices to the residents of California and be guided by our core values and strategic initiatives."


CLIMATE CHANGE IN THE VINEYARD
Cynthia Kerson
MG 2020

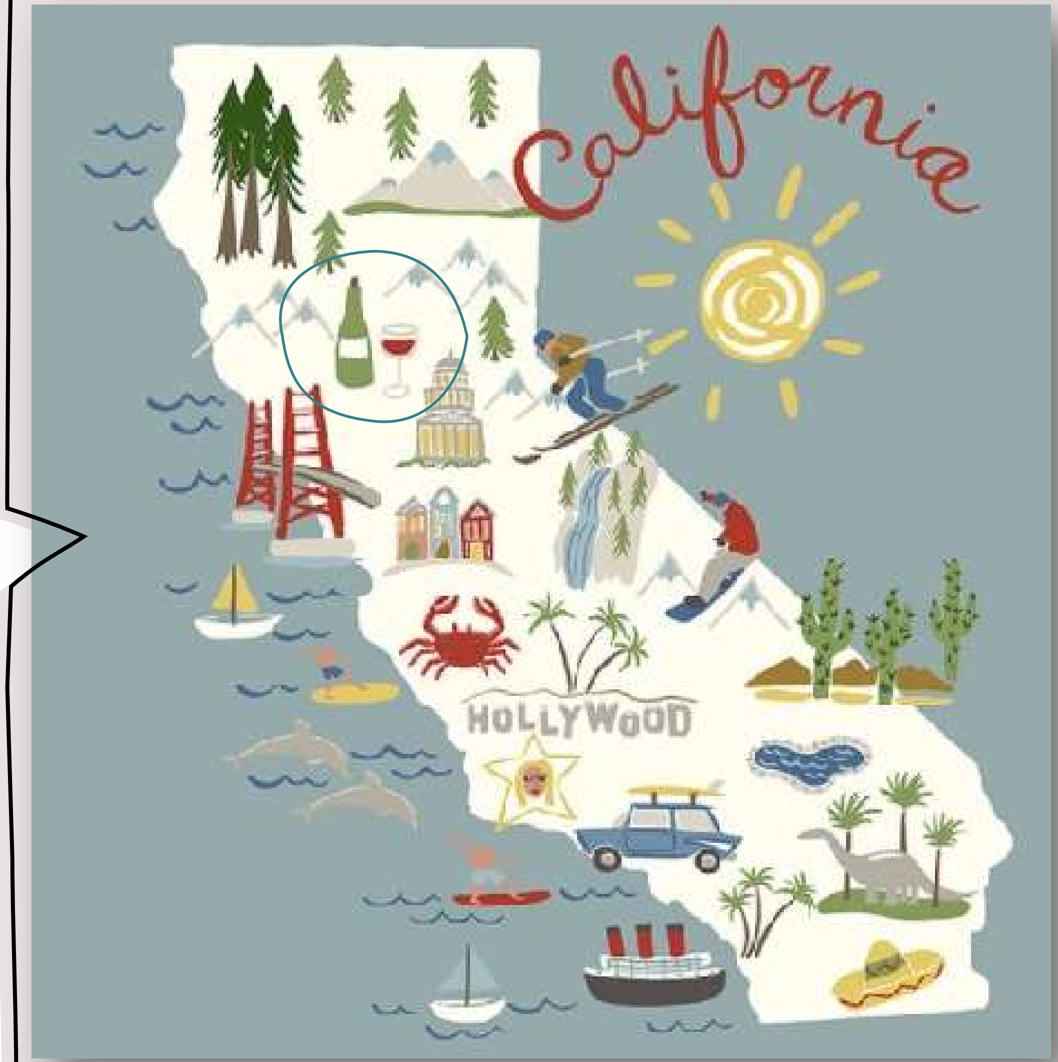
FEDERAL PROGRAMS

- State Water Efficiency and Enhancement Program (SWEEP) www.cdfa.ca.gov/oefi/sweep/
- Healthy Soils Program (HSP) www.cdfa.ca.gov/oefi/healthysoils/
- Conservation Agricultural Planning Grant Program www.cdfa.ca.gov/oefi/planning/
- (International level: Sustainable Wine Roundtable) https://swroundtable.org/

California, Oregon, New York, and Washington produce 95% of U.S. wine.

STATE LEVEL

- Healthy Soils Program (HSP)
- Testing 25,000 acres in CA
  - https://www.cdfa.ca.gov/oefi/healthysoils
  - Promotes farm management practices that include but are not limited to cover cropping, no-till/reduced-till, mulching, compost application, and conservation plantings.
  - Funding available: e-mail cdfa.hsp_tech@cdfa.ca.gov.
- UCDavis Viticulture and Enology Dept.



STATE LEVEL

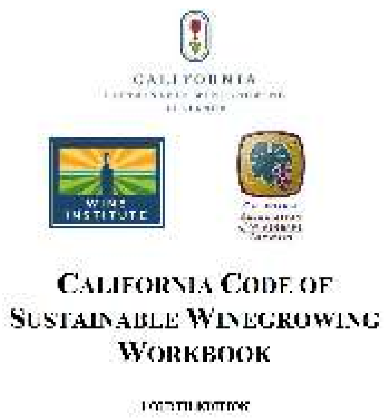
American Vineyard Foundation

https://www.avf.org/

voluntary industry support for research funding

CA Sustainable Winegrowing Alliance

www.sustainablewinegrowing.org



California Sustainable Wine

https://californiasustainablewine.com/

PROJECT TITLE: ASSESSMENT OF THE VARIABILITY IN SOIL HEALTH INDICATORS AND INCORPORATING HEALTHY SOIL MANAGEMENT PRACTICES INTO THE CONTEXT OF NAPA VALLEY TERROIRS

- 3 ways to measure soil health:
  - water retention,
  - nutrient supply,
  - carbon sequestration

- Goals:
  - establish a baseline of soil health indicators and disseminate information on their variability within the various Napa Valley soil types.
  - examine grower perception and comprehension of these indicators and the desired qualities of a healthy soil relative to production goals.
- Current actions::
  - Currently considering use of cover crops, reduced till, compost and other organic amendments. Even though all many studies show improvements on soil organic matter, the observed benefits for soil health, crop yield and final grape quality are highly variable between studies which prevents the establishment of guidelines and best management practices for wine grapes.
  - 'The research team is currently collecting soil samples to assess the variability and establish benchmarks for those soil health indicators that are desired for wine grape production. Furthermore, they will assess the role of soil organic matter and the soil microbiome with these indicators of soil health.'

Cristina Lazcano[1]. Asst. Professor.
(530) 754 1768. clazcano@ucdavis.edu.

Kerri Steenwerth[2]. Research Soil Scientist.
(530) 752-7535
kerri.steenwerth@usda.gov

Charlotte Decock[3]. Asst. Professor.
805-756-6360. cdecock@calpoly.edu

Toby O'Geen[1]. Soil Resource Specialist in Cooperative Extension (CE).
530-752-2155 atogeen@ucdavis.edu

Mallika Nocco[1]. Asst. Specialist in Soil-Plant-Water Relations in CE. 651-269-4587 manocco@ucdavis.edu

Kaan Kurtural[4]. Assoc. Viticulture Specialist in CE (Oakville). 707-944-0126
skkurtural@ucdavis.edu

1. Dept. of Land, Air and Water Resources. UC Davis, CA.
2. USDA-ARS, Crops Pathology and Genetics Research Unit, UC Davis, CA.
3. Dept. of Natural Resources Management & Environmental Sciences. Cal Poly, San Luis Obispo, CA
4. Dept of Viticulture & Enology, UC Davis, CA

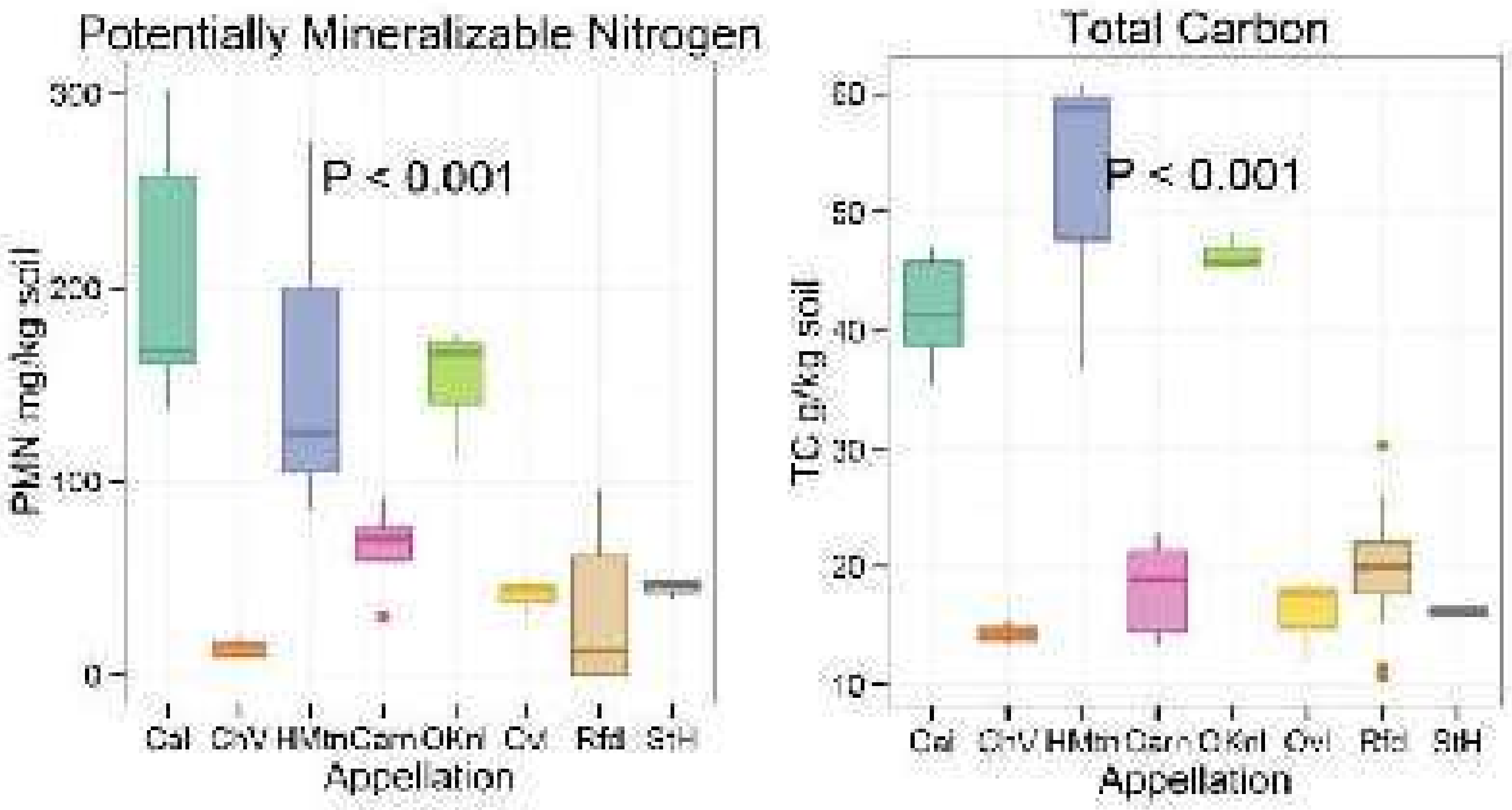
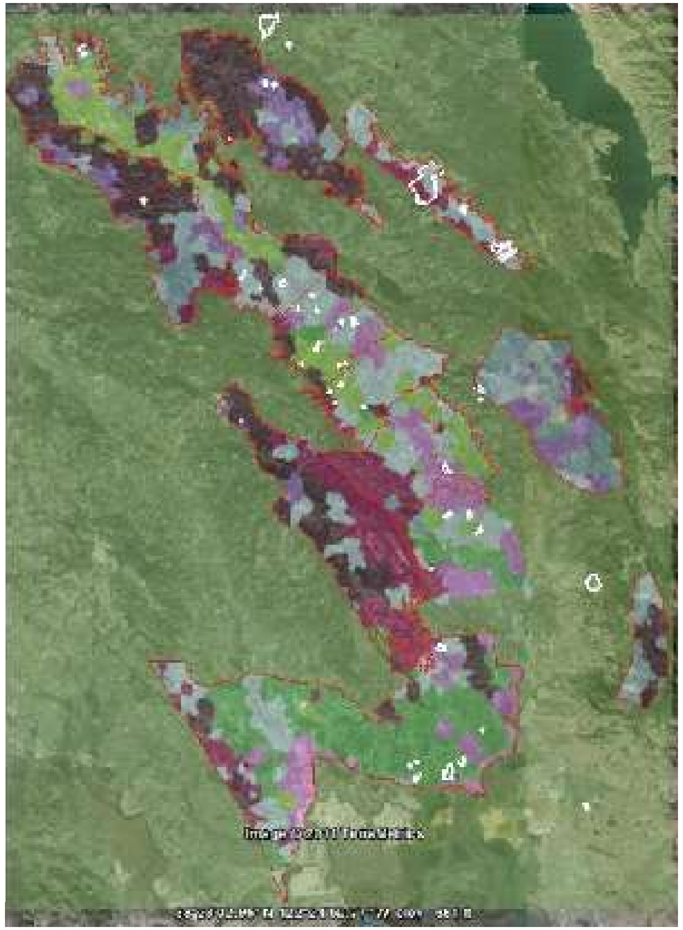
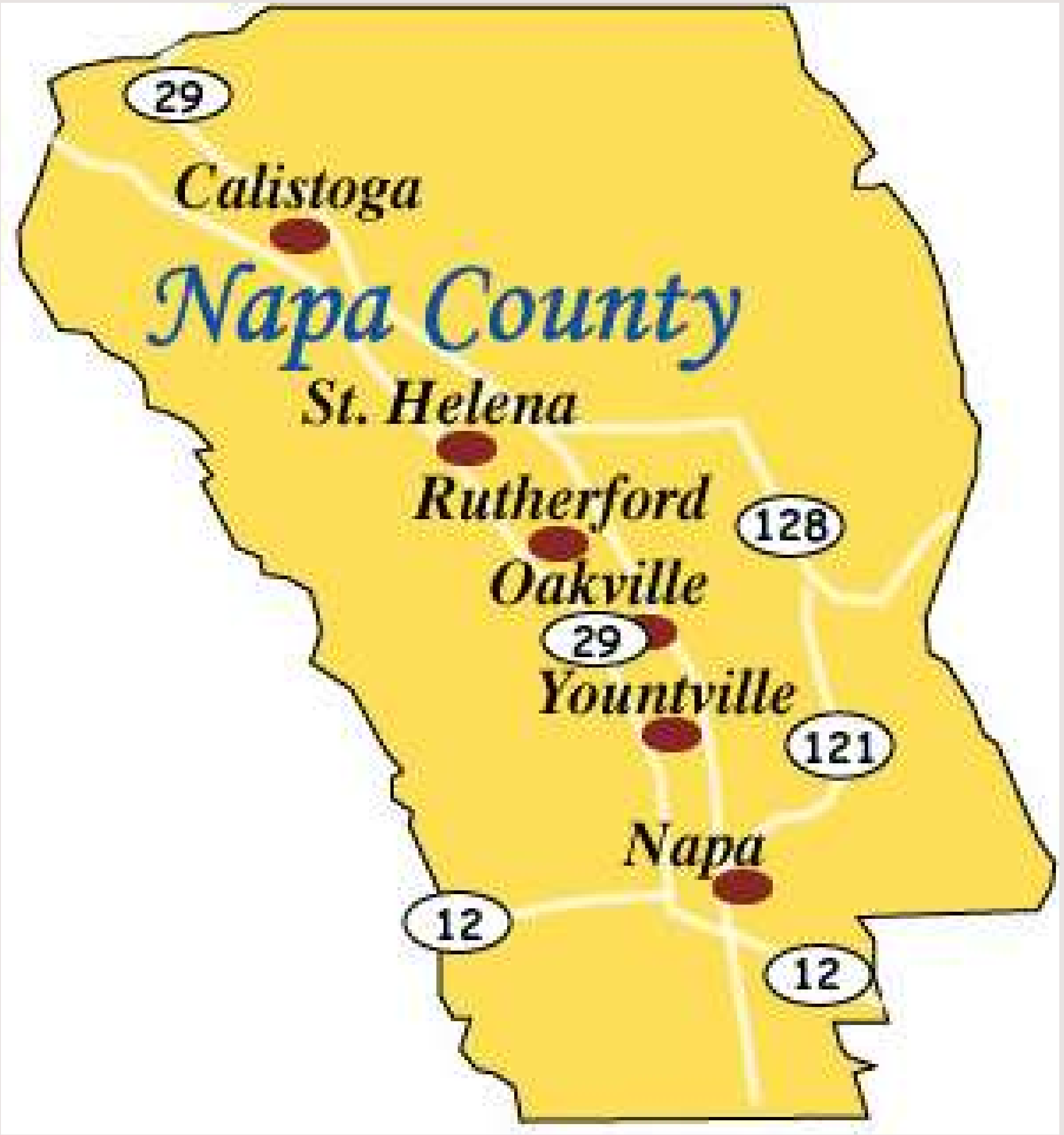


Figure 1. Values portrayed by American Vineyard Area, or Appellation. Abbreviations are as follows: Cal, Calistoga; ChV, Chiles Valley; HMtn, Howell Mountain; Carn, Los Carneros; OKnl, Oak Knoll; Ovl, Oakville; Rfd, Rutherford; StH, St. Helena.





LOCAL LEVEL

- Flip Your Strip
- $2/ft^2
- Cash for Grass
- $1/ft^2
  - Low-water-use, climate-appropriate plants (covering *at least 50%* of converted area once fully grown), and
  - *Permeable* hardscape (not exceeding 50% of converted area)

LOCAL LEVEL: HOW GROWERS CAN MAXIMIZE AND INCREASE CLIMATE BENEFITS OF VINEYARDS THROUGH BEST PRACTICES

- Building healthy soils and organic soil matter
- Permanent cover-cropping strategies
- Judicious use of compost
- Planting of native hedgerows and encouraging biodiversity
- Reducing vineyard waste and environmental practices for handling waste
- Reduction of water use
- Habitat restoration
- Monitoring soil carbon
- Monitoring and evaluating fuel use
- Workforce transportation solutions

From: https://napagrowers.org/climateresilience

Which one are you?

REGENERATIVE: FARM THE SOIL - NOT THE VINES

Regenerative agriculture, a term coined by organic farming researchers at the Rodale Institute in the 1980s, consists of holistic farming practices that aim to improve soil health and reverse climate change by expanding biodiversity, improving the water cycle, increasing organic matter in soil structure, and transferring carbon from the atmosphere to the soil. Proponents of regenerative agriculture avoid using chemical pesticides and advocate for methods like crop rotation, livestock rotation, composting, no-till farming, agroecology, and agroforestry. Regenerative agriculture increases the amount of arable topsoil, which results in a healthier, better food system.

https://www.masterclass.com/articles/regenerative-farming-practices

REGENERATIVE Feed the biology - not the vine. Till-out!

Promote biodiversity	Eliminate or reduce tillage	Reduce the use of artificial fertilizers
• cover crops • crop rotation	• tilling releases CO2 and disrupts soil bio systems • Regenerative livestock grazing (goats, sheep)	• junk food for vines and microbes

https://www.masterclass.com/articles/regenerative-farming-practices

SHEEP

https://www.winebusiness.com/news/?go=getArticle&dataId=251073

SUSTAINABLE

California Sustainable Winegrowing Alliance (CSWA)

https://www.sustainablewinegrowing.org

KEY AREAS OF WIDELY ADOPTED SUSTAINABLE PRACTICES:

https://library.sustainablewinegrowing.org/amass/doc-get-pub/resource/244/2020_California_Wine_Community_Sustainability_Report.pdf

https://www.sustainablewinegrowing.us suggests we only purchase wines from sustaining growers. In CA, NY, OR, and WA.

ORGANIC

- Organic agriculture is the practice of growing, raising, or processing goods using methods that do not use sewage sludge, bioengineering (GMOs), ionizing radiation, and most synthetic pesticides* and fertilizers is prohibited from organic production.
- Selling your grapes? USDA certification starts at the annual income of $5,000.

* examples include copper sulfate (which is considered acceptable in organic farming), alcohols, chlorine products, hydrogen peroxide, soaps, organochlorines, organophosphates, carbamates, and pyrethroids

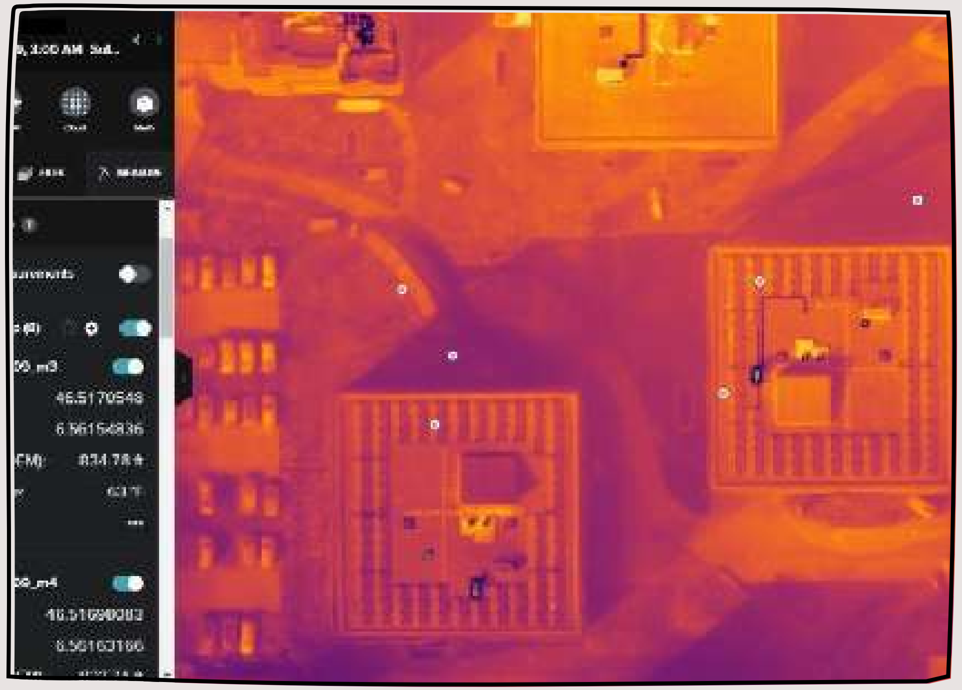
https://www.ccof.org/page/what-organic

DEFICIT/PRECISION FARMING

DEFICIT (PRECISION) FARMING

- Sap Flow Technology
  - Water deficit index (WDI)
- Thermal Imagery to map evapotranspiration
  - ArcGIS: use of drones
  - Drought tolerance indices (DTIs)

Biju S, Fuentes S, Gupta D. The use of infrared thermal imaging as a non-destructive screening tool for identifying drought-tolerant lentil genotypes. Plant Physiol Biochem. 2018 Jun;127:11-24. doi: 10.1016/j.plaphy.2018.03.005. Epub 2018 Mar 8. PMID: 29544209.



THANK YOU

Cynthia Kerson

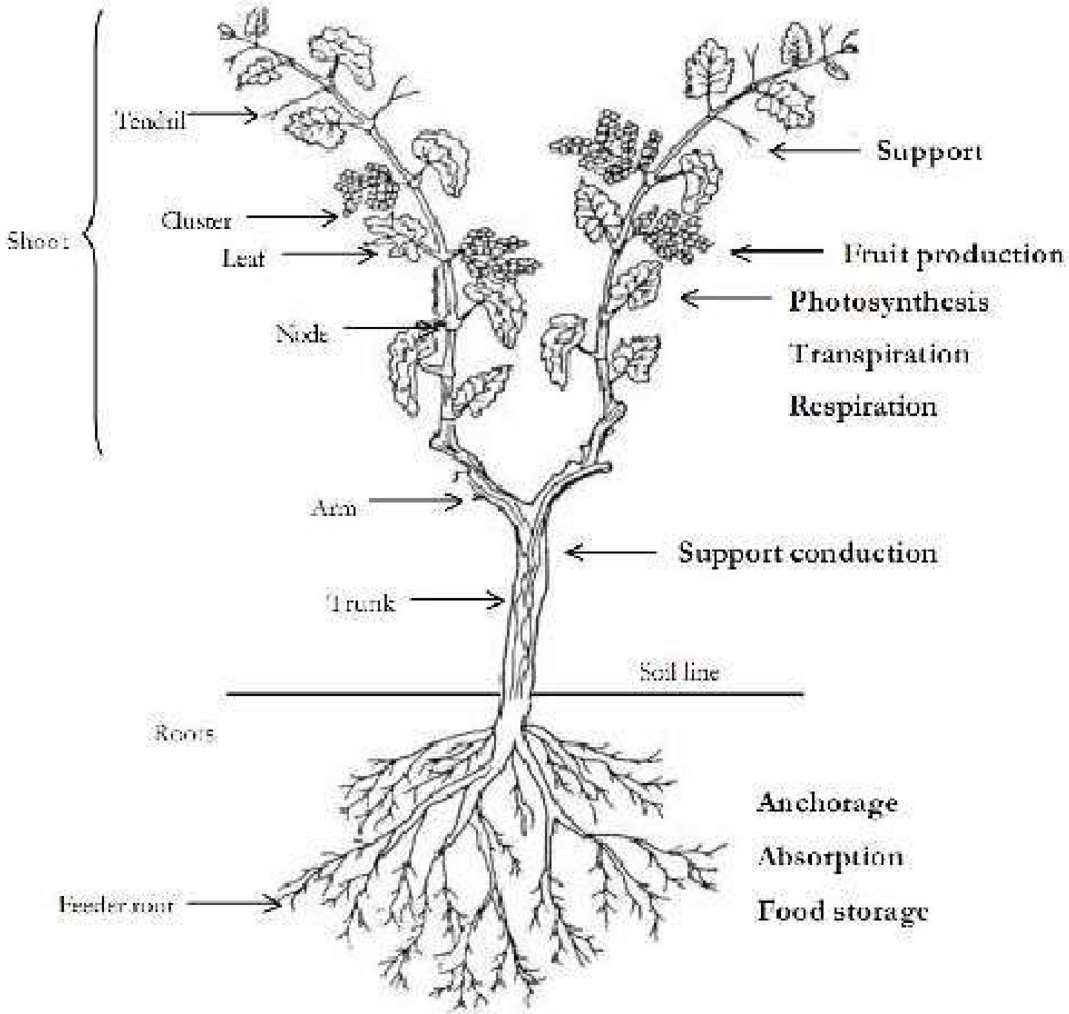
cynthiakerson@gmail.com

CARBON, PHOTOSYNTHESES

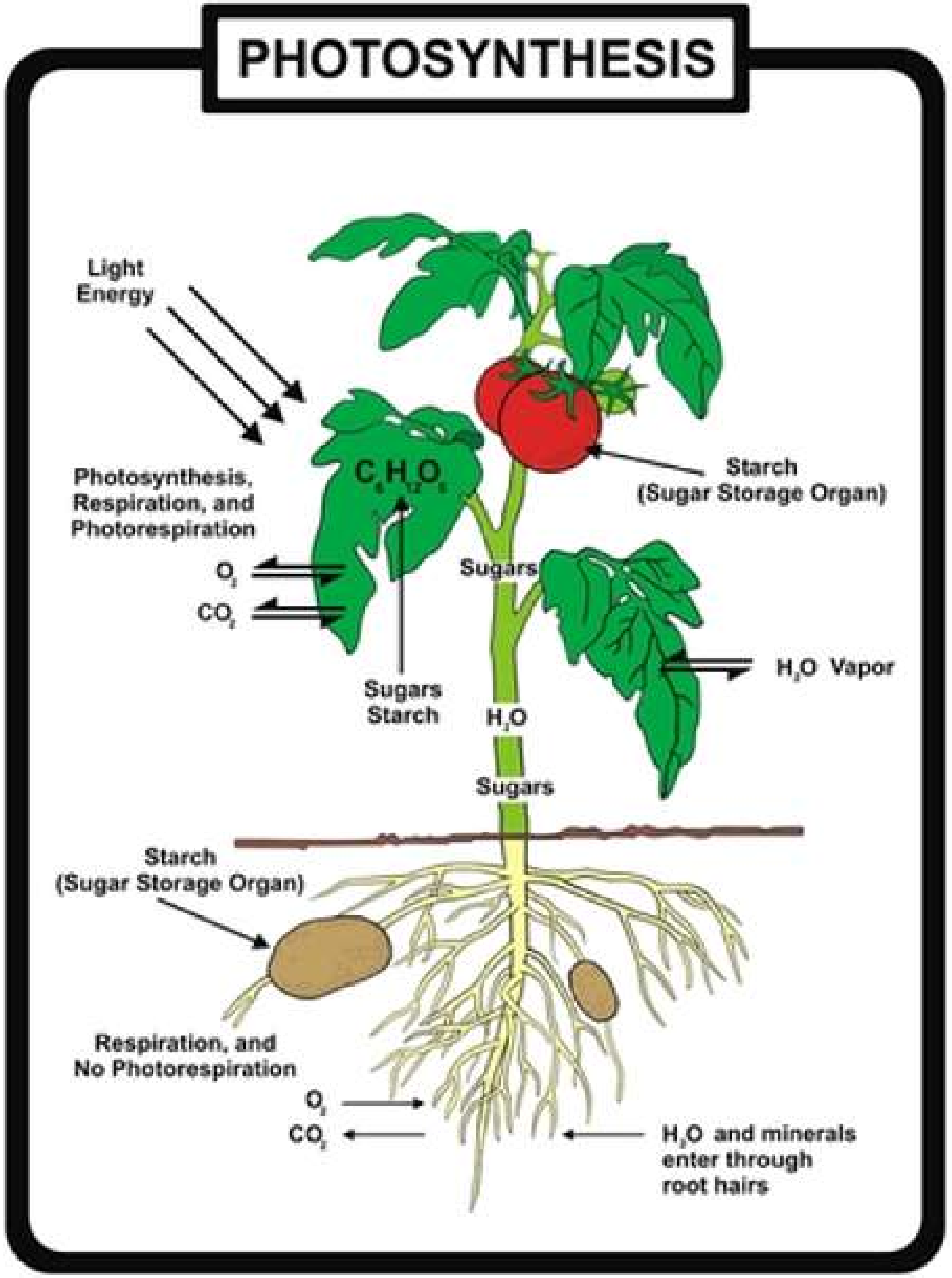
AND

SOIL FOOD WEB

Vine



Tendril
Cluster
Leaf
Shoot
Node
Support
Fruit production
Photosynthesis
Transpiration
Respiration
Arm
Support conduction
Trunk
Soil line
Roots
Anchorage
Absorption
Food storage
Feeder root

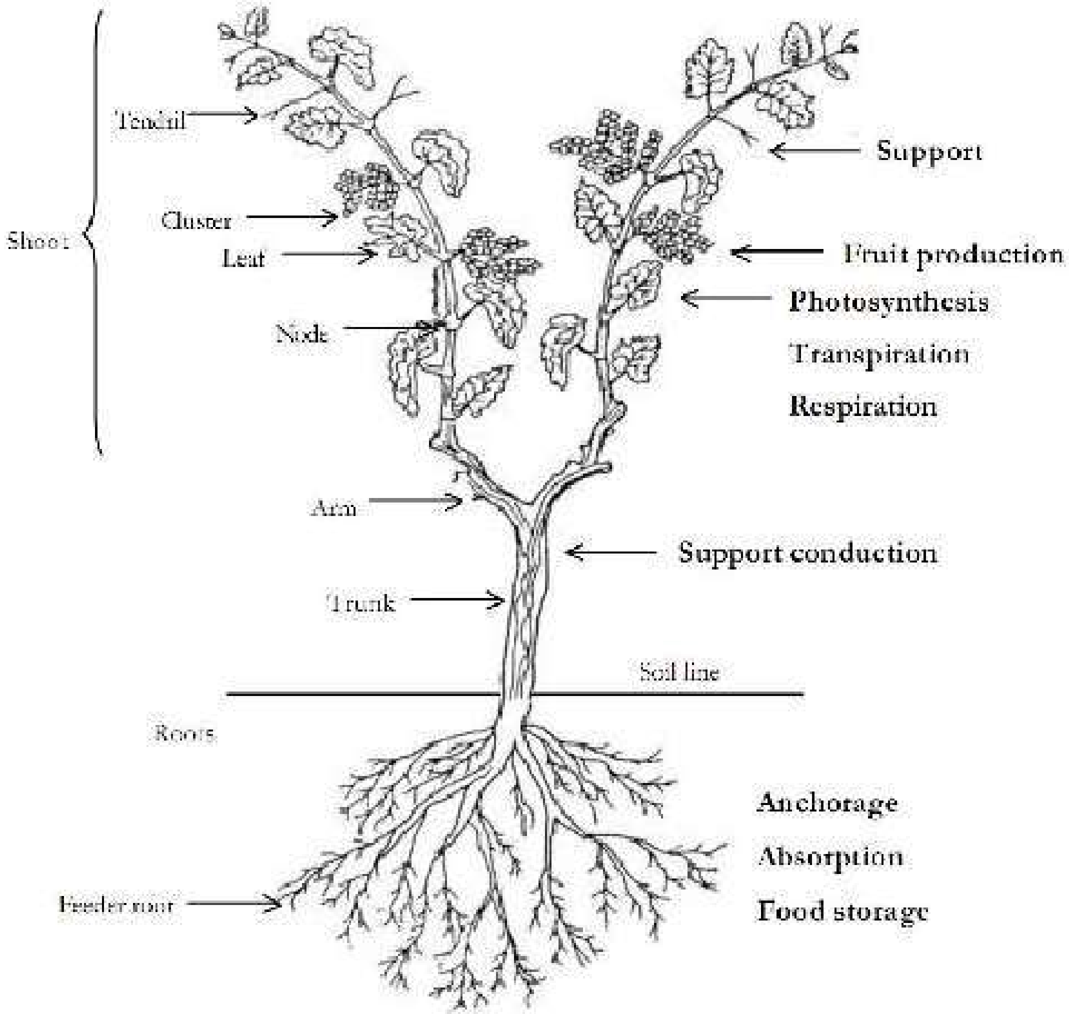


The Process:

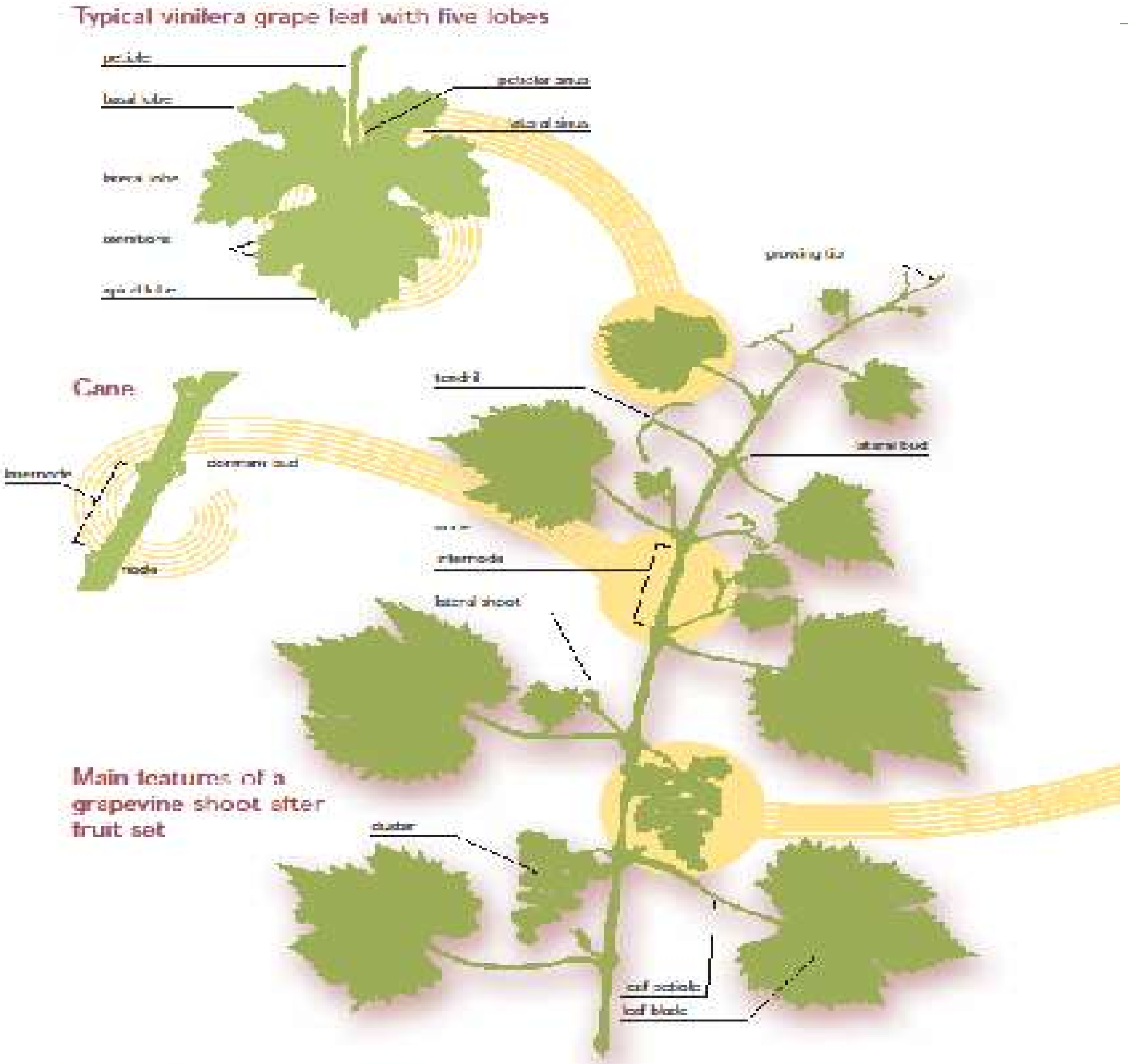
- Plant intakes 3 elements: carbon dioxide molecules, light energy and water
- Inside the plant cells, chemical reactions combine these elements
- Energy-rich glucose (sugar) and oxygen gas molecules are formed
- The glucose is stored and the oxygen gas is released into the atmosphere
- Glucose moves into the roots to feed soil microbes that in turn nourish the plant with minerals from the soil
- It’s a collaborative exchange underground

Graphic Diagram from CC (Creative Commons)

Vine


Tendril
Cluster
Shoot
Leaf
Node
Support
Fruit production
Photosynthesis
Transpiration
Respiration
Arm
Support conduction
Trunk
Soil line
Roots
Anchorage
Absorption
Food storage
Feeder root

Wine Grapevine Structure



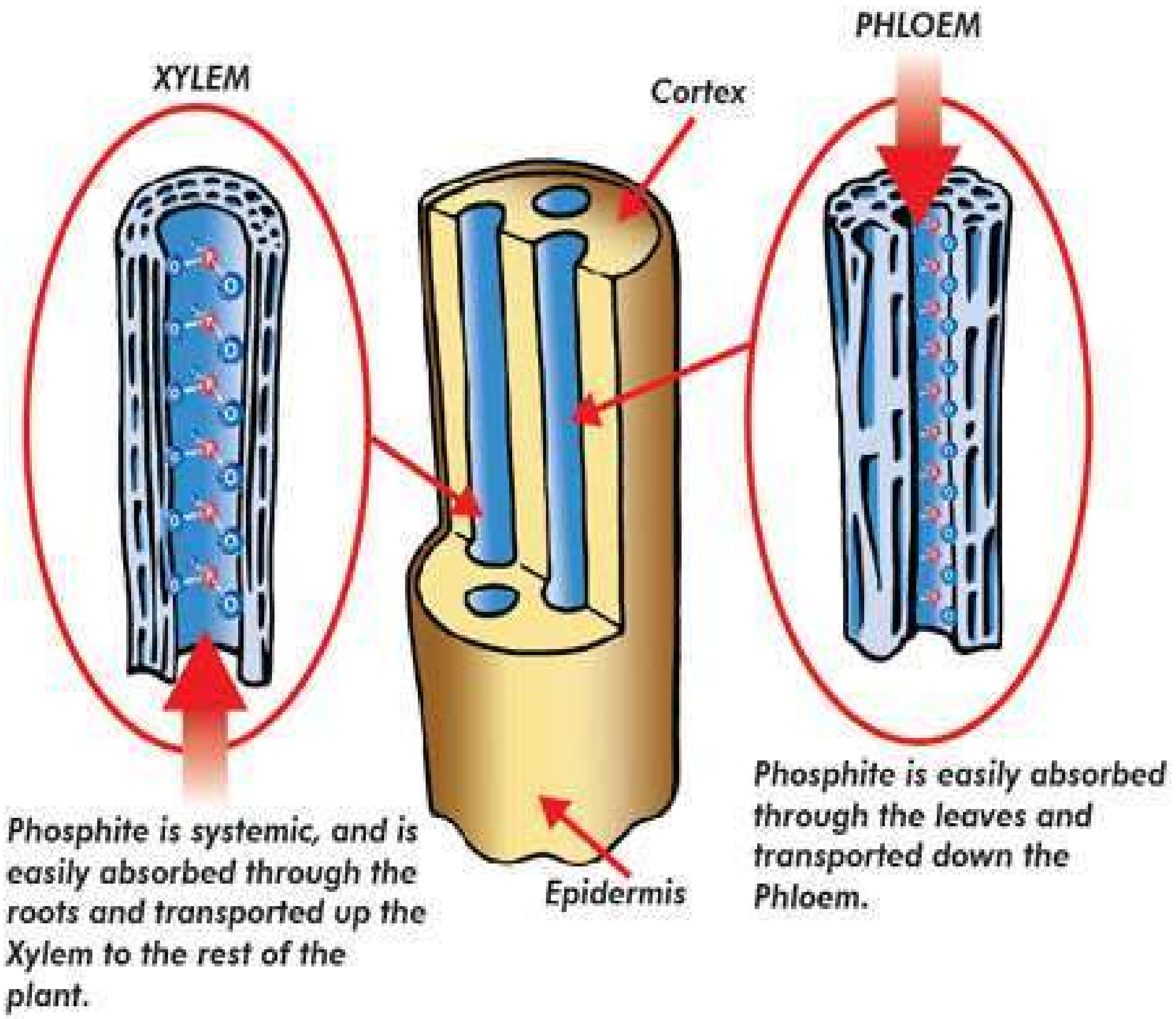
BASIC BOTANY

- What factors effect growth and ripening
- Temperature and light influences
- Carbohydrate nutrition
- Understand irrigation, nutrition, ripening and fruit quality

Vine Water Use

- *Transpiration* = water loss by plants through their stomata.
- *Evaporation* = Water loss from the leaf surface
- *Evapotranspiration* relates to the rate of water use. It includes the evaporation of water from the soil surface and the movement of water from the soil through the plant and out through the leaves.
- Vines are drought resistant plants. Water only when necessary.
- The best thing is to know your plants: make visual assessments

Food Flow



XYLEM
PHLOEM
Cortex
Epidermis
Phosphite is systemic, and is easily absorbed through the roots and transported up the Xylem to the rest of the plant.
Phosphite is easily absorbed through the leaves and transported down the Phloem.

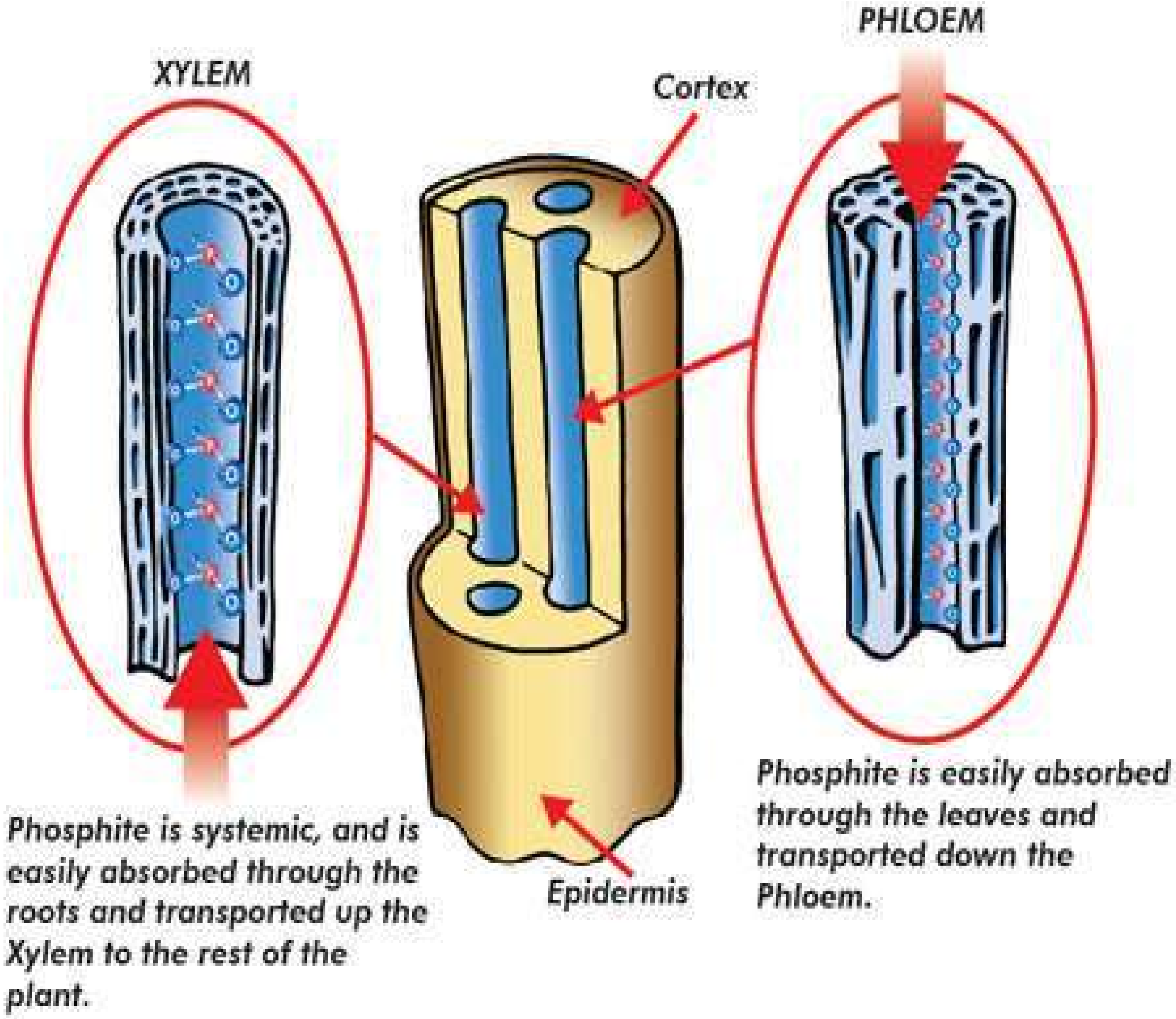
TRANSLOCATION

- Movement of carbohydrates, some nutrients and hormones in the plant
- Occurs in the phloem
- Phloem is made up of living plant cells
- Moves upward and downward in plant

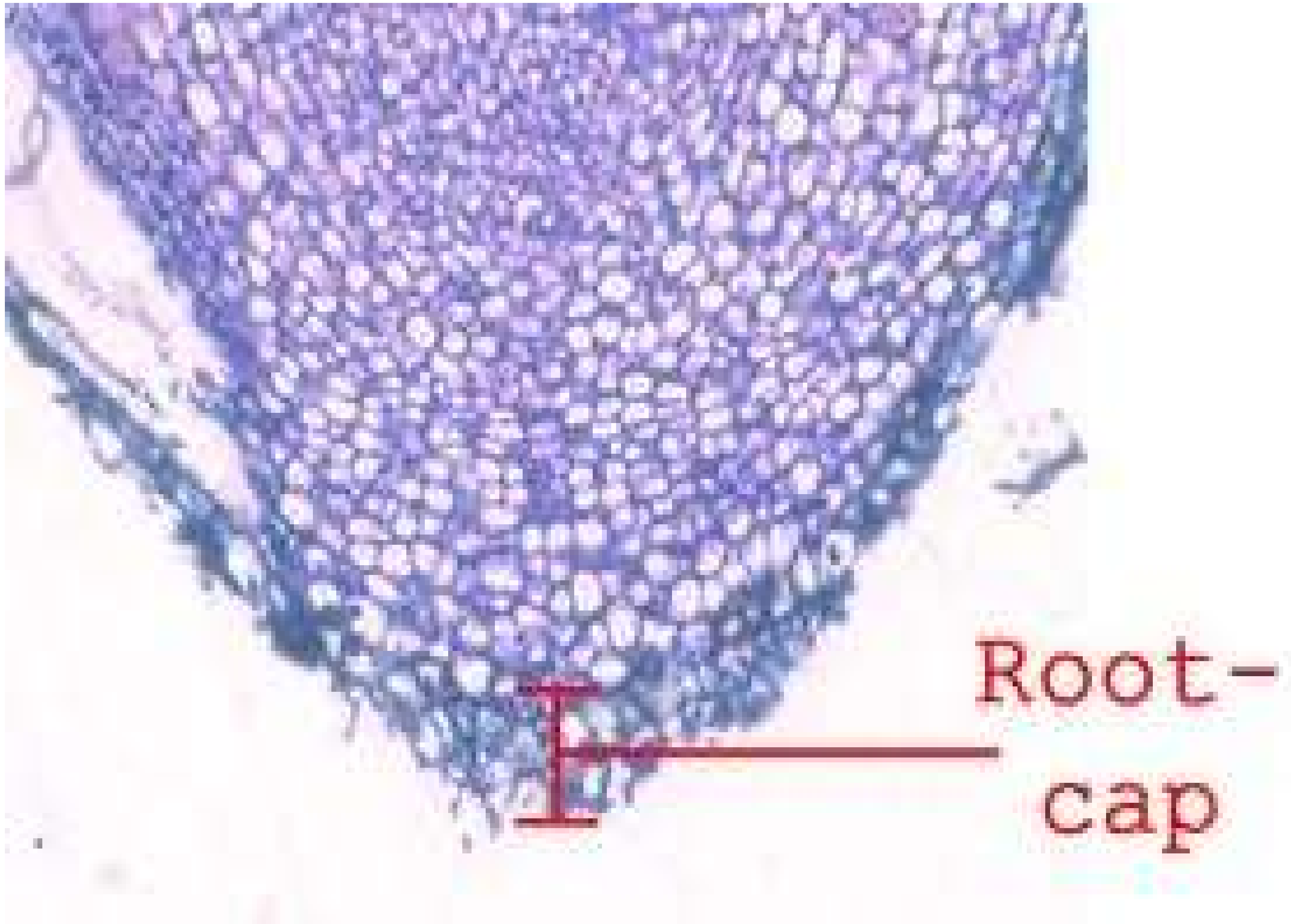
- PHLOEM = FOOD

- Sinks- food goes where needed- leaves, berries, roots

Food Flow


XYLEM
PHLOEM
Cortex
Epidermis
Phosphite is systemic, and is easily absorbed through the roots and transported up the Xylem to the rest of the plant.
Phosphite is easily absorbed through the leaves and transported down the Phloem.

Root Growing Point



Bud Break

Bloom


Copyright © 2013 The Regents of the University of California. All Rights Reserved.

Fruit Set

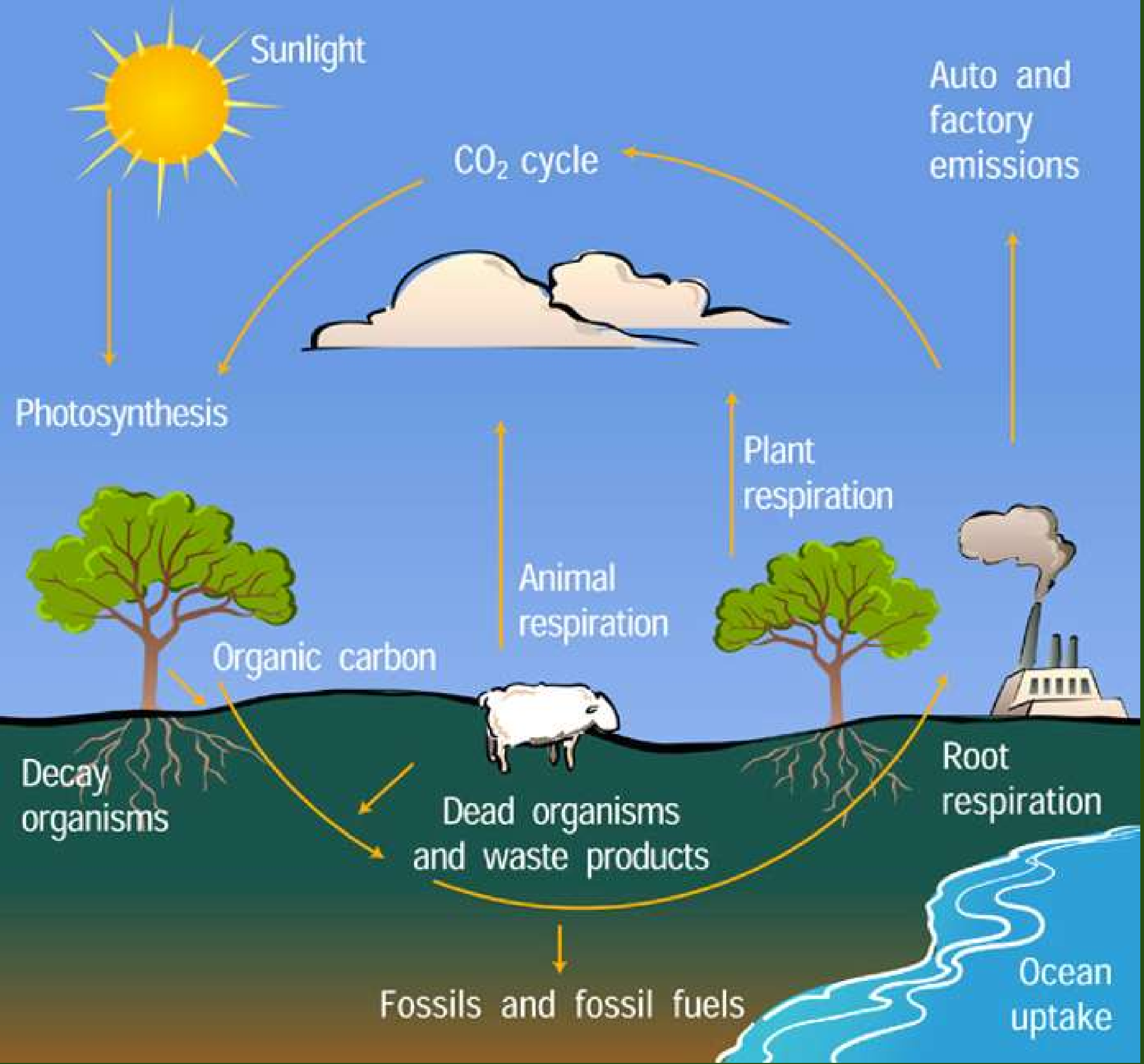
Carbon is Essential to Life

Human bodies are made up of 18.5% Carbon
Carbon is food for our trees, plants and soils

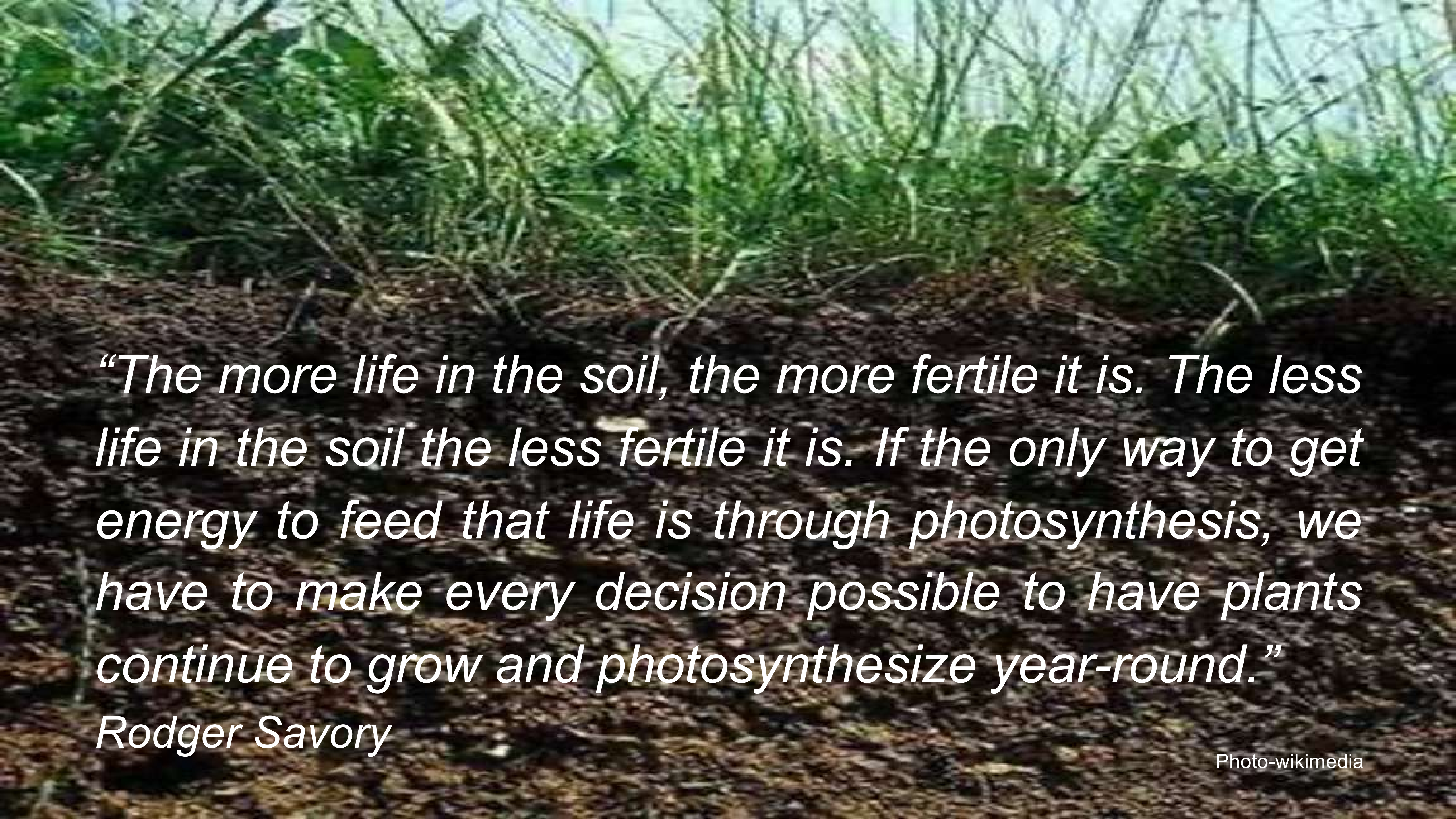
<u>Earth’s Carbon Sinks:</u>
> Oceans store 93%

> Soils hold 75%

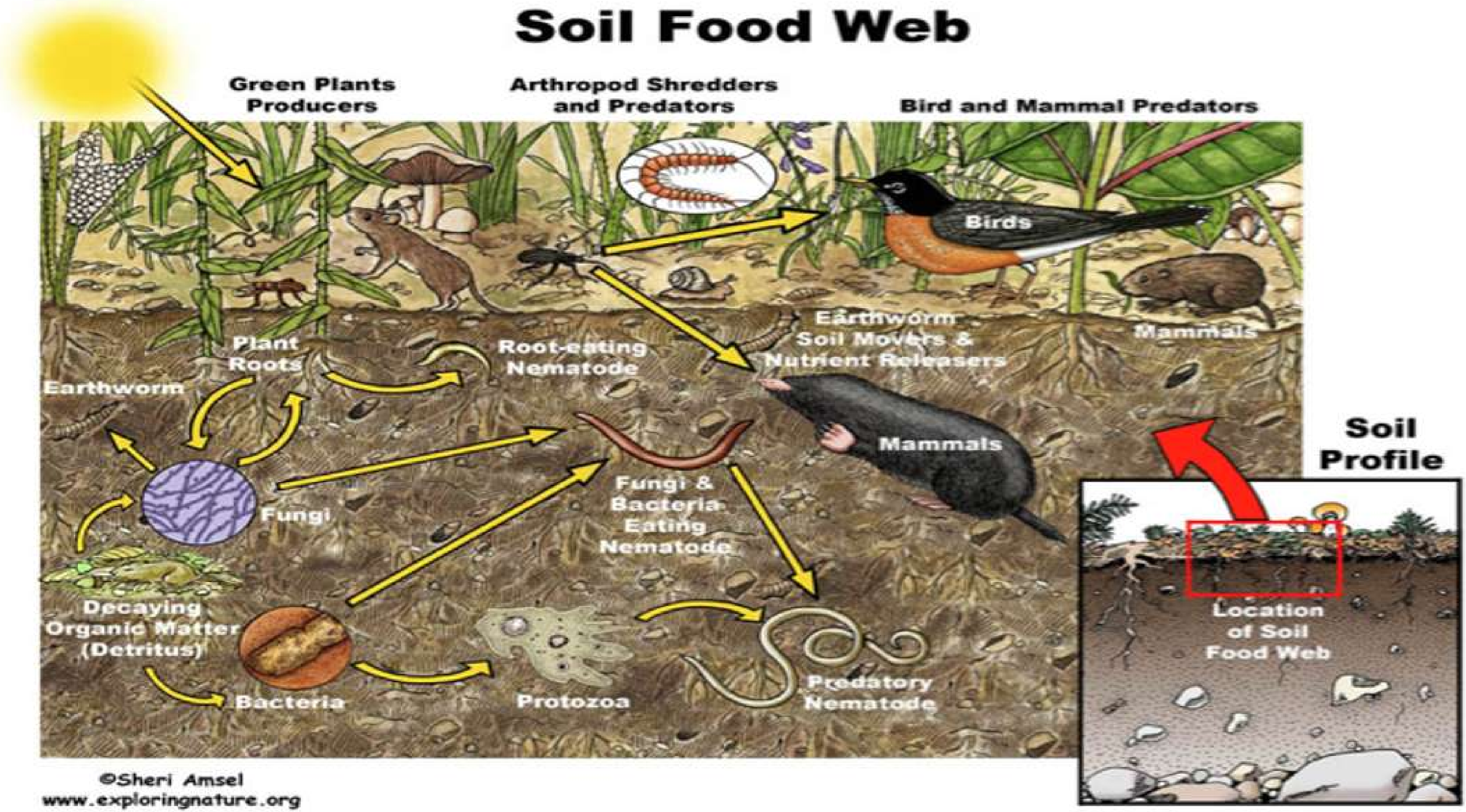
> Trees and plants contain 19%



Global Carbon Cycle


“The more life in the soil, the more fertile it is. The less life in the soil the less fertile it is. If the only way to get energy to feed that life is through photosynthesis, we have to make every decision possible to have plants continue to grow and photosynthesize year-round.”
Rodger Savory
Photo-wikimedia

Soil Food Web



ROOTS TAKE & GIVE BACK!

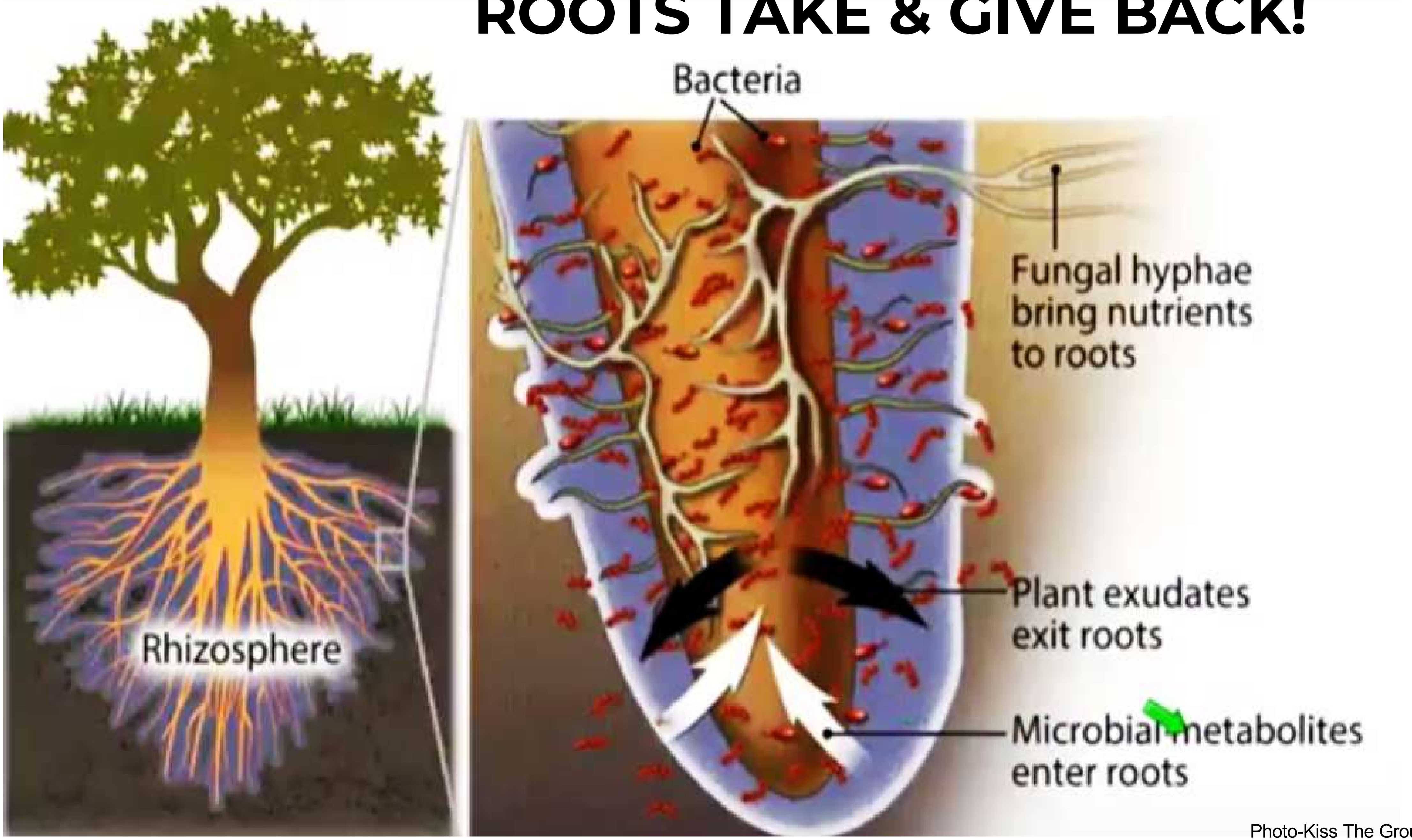
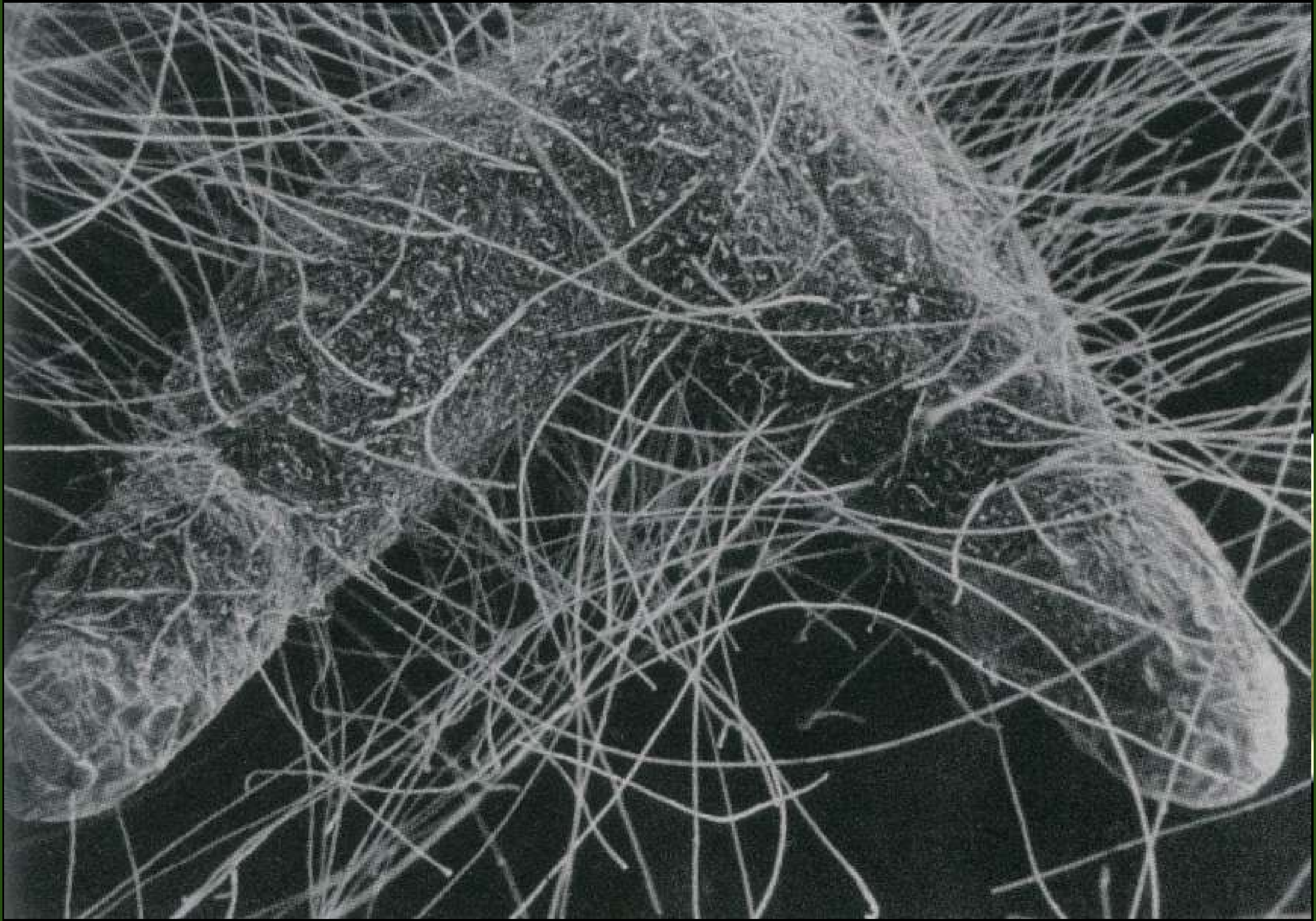
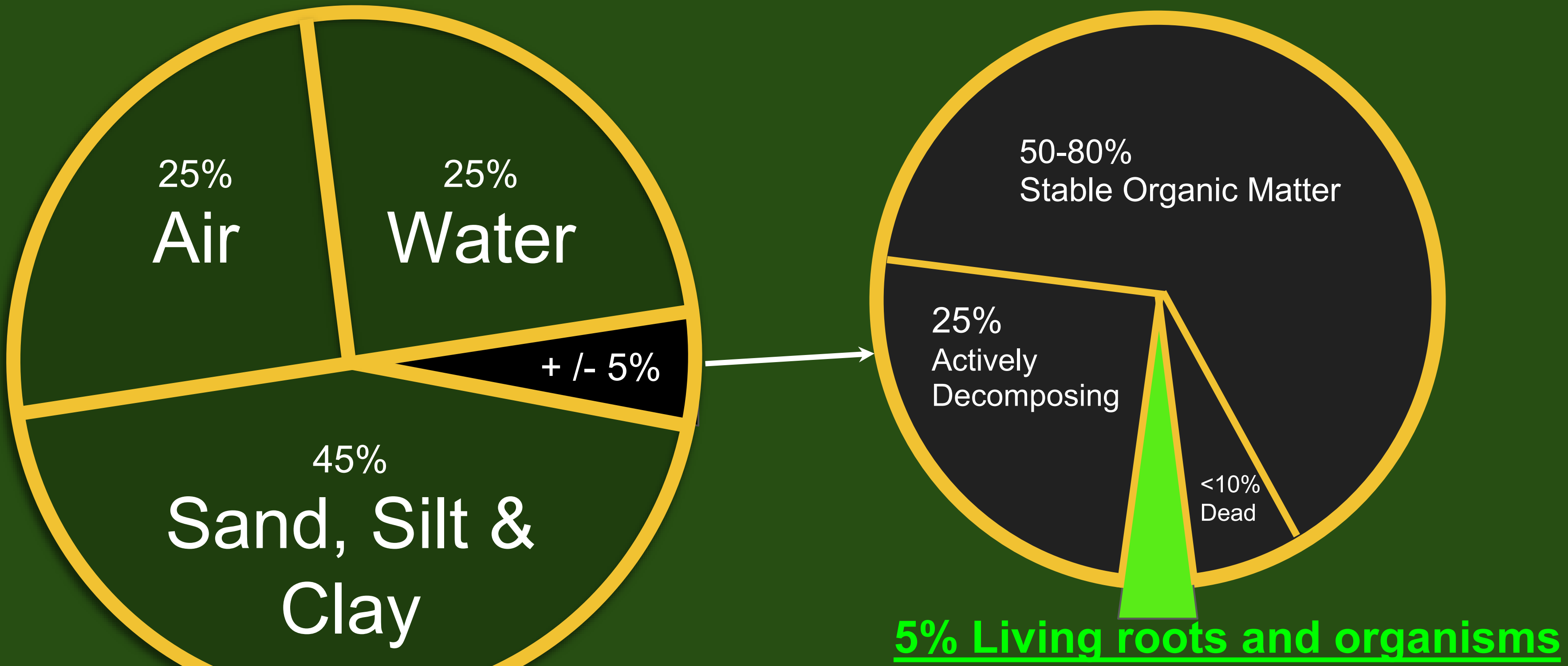


Photo-Kiss The Ground



SOIL



SOIL ORGANIC MATTER (SOM)

Simplified Soil Profile

Horizon Layers

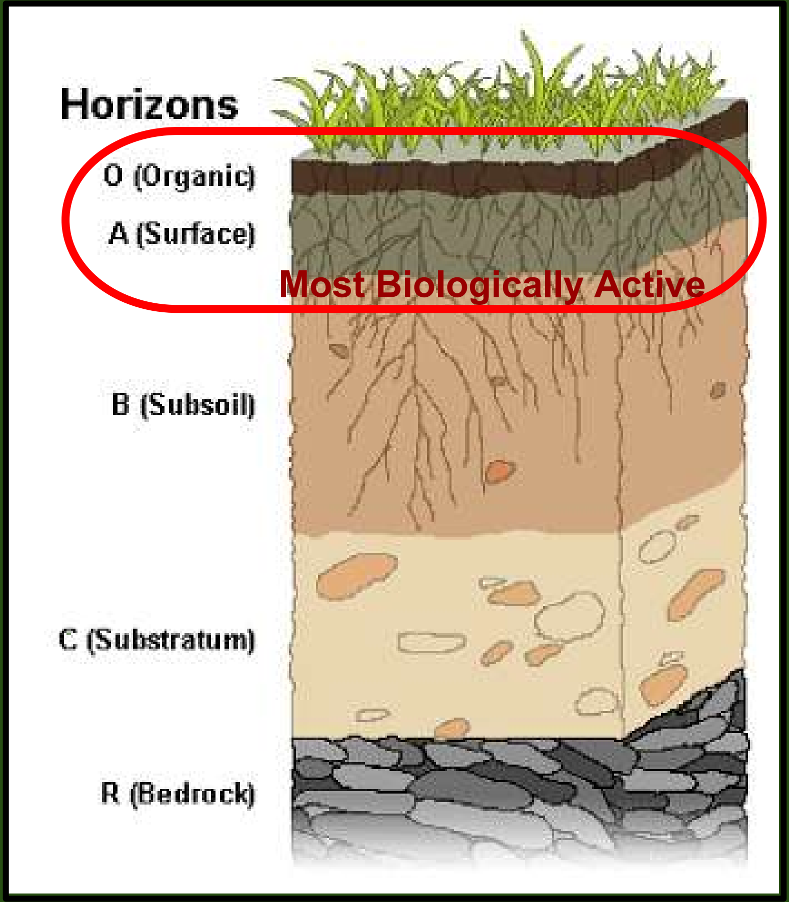
Organic - 2 inches

Surface (Topsoil) - 10 inches

Subsoil - 30 inches

Substratum - 48 inches (Parent Material - Alluvium, Residual,Colluvium, Marine)

Bedrock



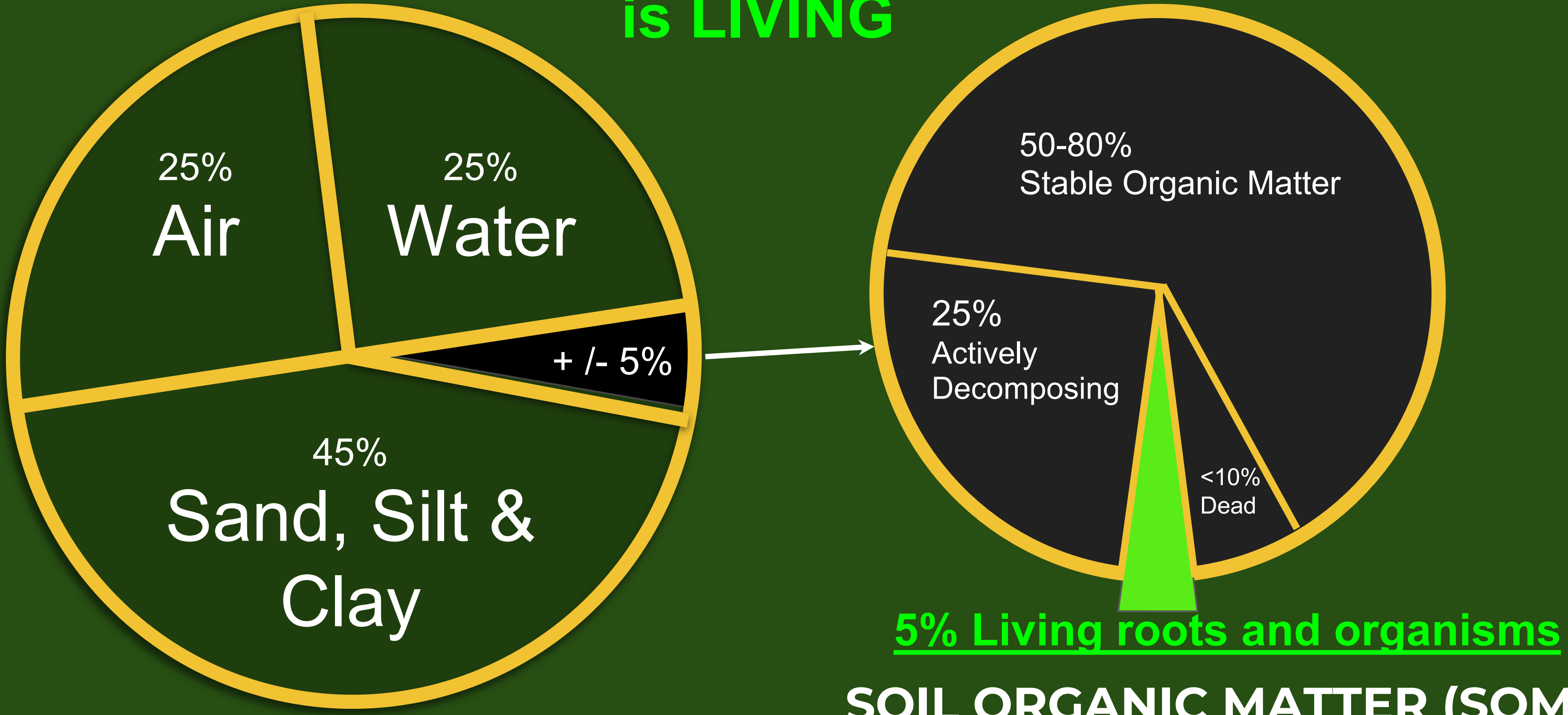
Soil Structure

Ray Archuleta's "Slake Test - Uncensored, No Frills" from the Soil Health Institute

Video included by permission from Dr. Buz Kloot, Soil Health Labs at South Carolina University and Mr. Ray Archuleta.

SOIL

Only ~0.25% of Healthy Soil is LIVING



SOIL ORGANIC MATTER (SOM)

Increase
Soil Organic Matter

“Soil health is defined as the continued capacity of soils to function as a vital living ecosystem that sustains plants, animals, and humans.”

Plant Cover Crops

Quintessential vineyard with mustard

Plant Cover Crops

Benefits

- Improves soil structure
- Improves mineral fertility
- Improves soil biological activity and organic matter content

Apply Compost

Benefits

- Provides nutrients
- Increases soil organic matter

Apply Compost

Contains

- Yard trimmings
- Food scraps
- Other organic material

Napa Recycling and Waste Services

Apply Compost

Upper Valley Disposal and Recycling

Harvest Compost

- Grape pomace
- Yard trimmings
- Food scraps

Community Compost

- Yard trimmings
- Food scraps

Apply Mulch

Straw

Leaves

Wood chips

Compost

No-Till Farming

Benefits of eliminating or reducing tillage….

- Increased soil organic matter
- Increased carbon sequestration
- Reduced soil erosion
- Eliminates wear and tear on your body

AVOIDING SYNTHETICS AND CHEMICALS

In other words the move to organic!

Right Plant, Right Place

PROS AND CONS OF MOVING TOWARD ORGANIC

- Pros - increase diversity, avoid synthetic chemicals being applied near your home and family, better for the planet…..

- Cons - more labor, increase sprays, costs (?)

MAIN PROBLEMS IN NAPA COUNTY VINEYARDS

- Powdery Mildew
- Botrytis
- Leafhoppers
- Mealybugs (grape and vine)
- Spider Mites
- Erineum mites
- Eutypa
- Virus
- Weeds
- Vertebrate Pests
- Drought

POWDERY MILDEW

- Plant less susceptible varietals
- Know your microclimate
- Monitor irrigation (vines as well as neighboring plants)
- Avoid too much shade
- Educate yourself and monitor for PM early
- Monitor the weather
- Use products only registered for use on grapevines and follow all label directions

POWDERY MILDEW INFECTIONS

PRODUCTS AVAILABLE FOR PREVENTION

- Sulfur (wettable and dust)
- Oils (mineral, paraffinic, neem)
- Biologicals (Serenade, Sonata, Regalia)

ERADICATION PRODUCTS

- Water
- Mineral Oils (JMS stylet oil, pure spray green)
- Potassium bicarbonate (kaligreen)
- Hydrogen Dioxide (Oxidate)

BOTRYTIS BUNCH ROT

- Botrytis cinerea
- Some varieties more susceptible

BOTRYTIS

- Cultural practices - leafing, fruit thinning, air movement
- Trellis/canopy design
- Flower debris removal at fruit set
- Serenade or stylet oil
- Harvest before the rains!

MEALYBUGS

- Creates sooty mold
- Spreads virus
- Pheromone sprays and lures
- Beneficial insect releases (mealybug destroyer)
- Control ants

VINE MEALYBUG

Vine mealybug, Planococcus ficus, honeydew and white wax on infested grapevine after mechanical harvest. *Photo by Larry L. Strand.*

GRAPE MEALYBUG

GRAPE, OBSCURE AND VINE MEALYBUG

Figure II. Reddish orange fluid excreted by grape mealybug (photo: JKC).

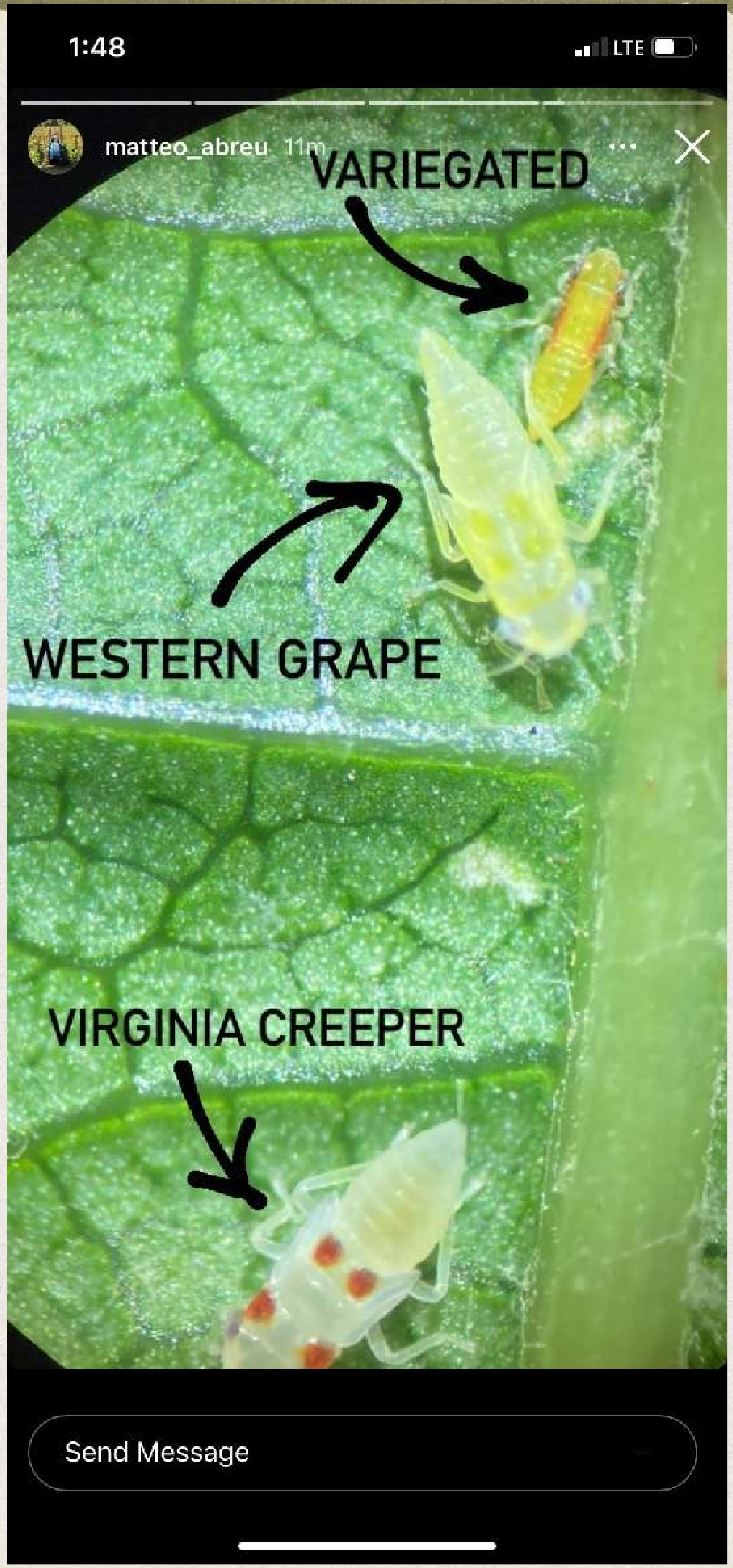
Figure III. Clear fluid excreted by obscure mealybug (photo: Kent M. Daane).

Figure IV. Vine mealybug colony in the axils of the petiole and cane (photo: Mark Battany).

LEAFHOPPERS

- Western grape leafhopper
- Variegated leafhopper
- Virginia creeper leafhopper
- Beneficial insect releases (lacewing eggs, ladybug larvae, anagrus species)
- Oil sprays to target nymph stage
- Pyganic spray


Virginia Creeper
Variegated leafhopper
Grape Leafhopper


1:48
LTE
matteo_abreu 11m
VARIEGATED
WESTERN GRAPE
VIRGINIA CREEPER
Send Message

NATURAL ENEMIES OF LEAFHOPPERS

- Lacewing

CONVERGENT LADY BEETLE

ANAGRUS WASP


PM Project
ts, University of California

SPIDER MITES

- Likes hot, dusty conditions and water stressed plants
- Oil sprays
- Beneficial mite releases

ERINEUM MITES

- Minor pest
- Wettable sulfur early or post harvest (white varieties)

TRUNK DISEASES

- #1 trunk disease - Eutypa lata
- Prune late
- Organic wound sealant


UC Statewide IPM Project

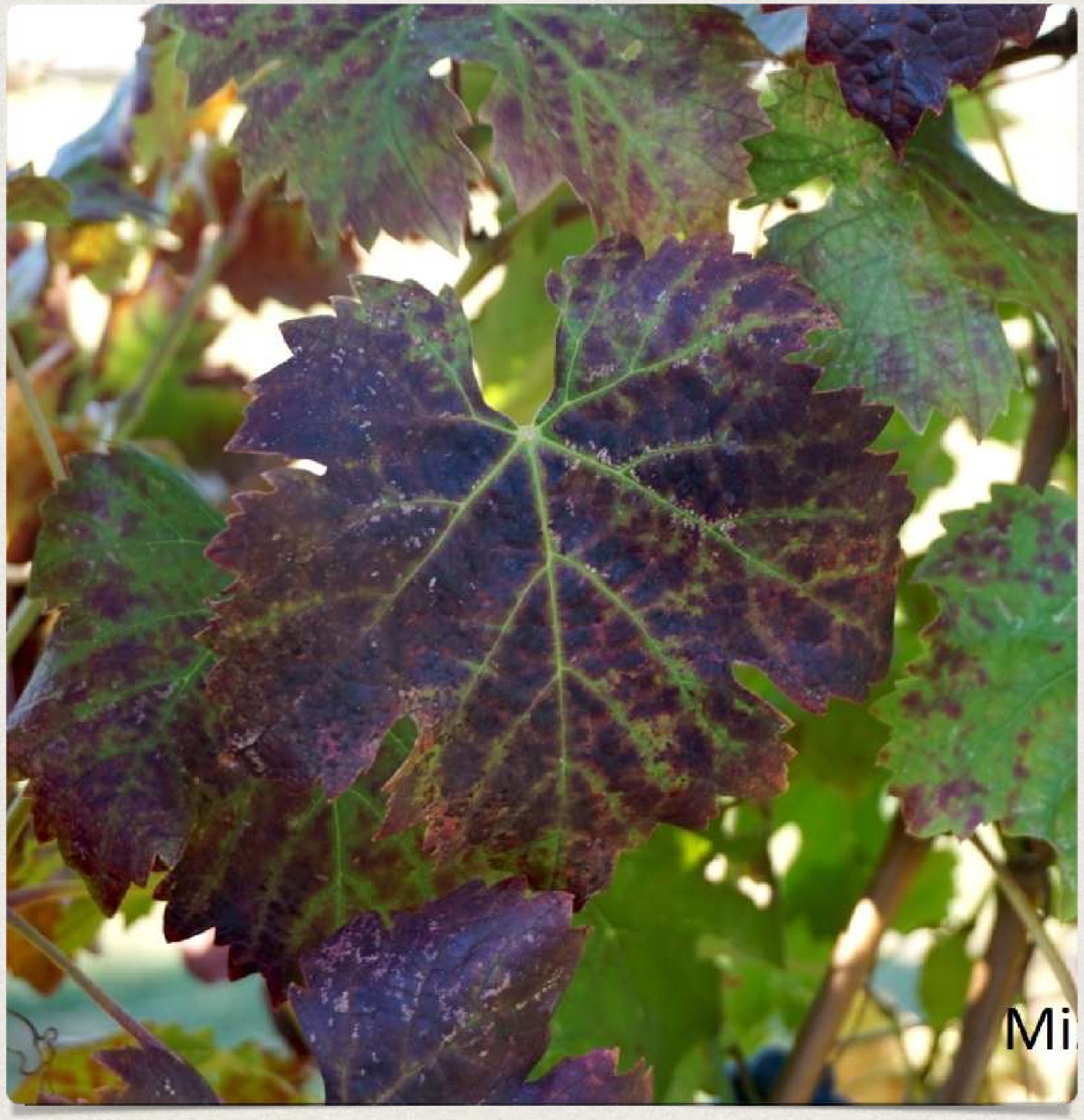
VIRUS

- Red blotch associated virus, Leaf roll viruses
- Test to confirm
- Rogue vines if under 25% of vineyard/block
- Clean plant material

RED BLOTCH

LEAF ROLL VIRUSES

- Delays maturity
- Spread by insect vectors
- Clean plant material



LEAF ROLL

White grape varietals


PIERCES DISEASE

PIERCES DISEASE

- Plant less susceptible varieties
- Kaolin clay application
- Barriers
- Remove overwintering plants for pest (riparian areas (?), landscape) ????

WEEDS

- Mowing
- Cultivation
- Flaming

VERTEBRATE PESTS

- Birds
- Deer
- Gophers
- Voles
- Ground squirrels
- Turkeys
- https://www2.ipm.ucanr.edu/agriculture/grape/managing-vertebrates/

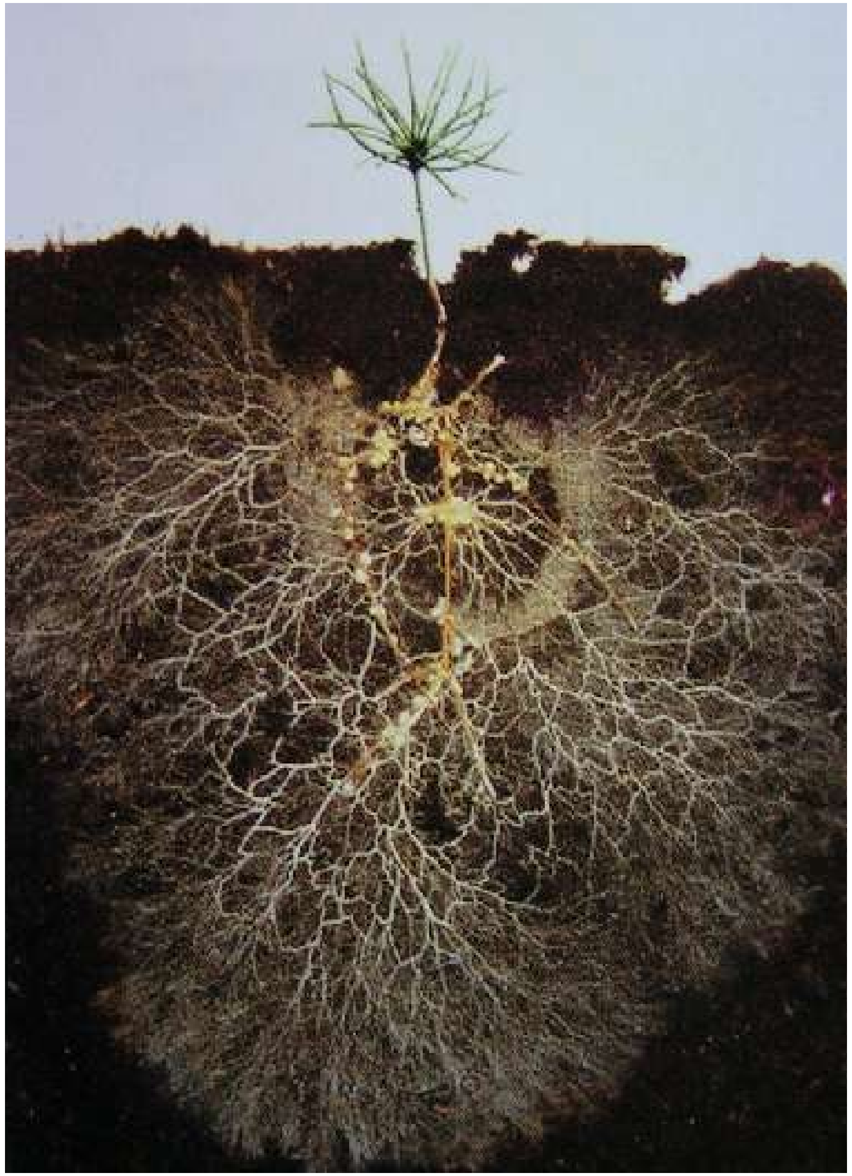
DROUGHT

- Increase organic matter
- Plant drought tolerant rootstocks
- Technology (soil moisture sensors, evapotranspiration sensors, sap flow)

RESOURCES

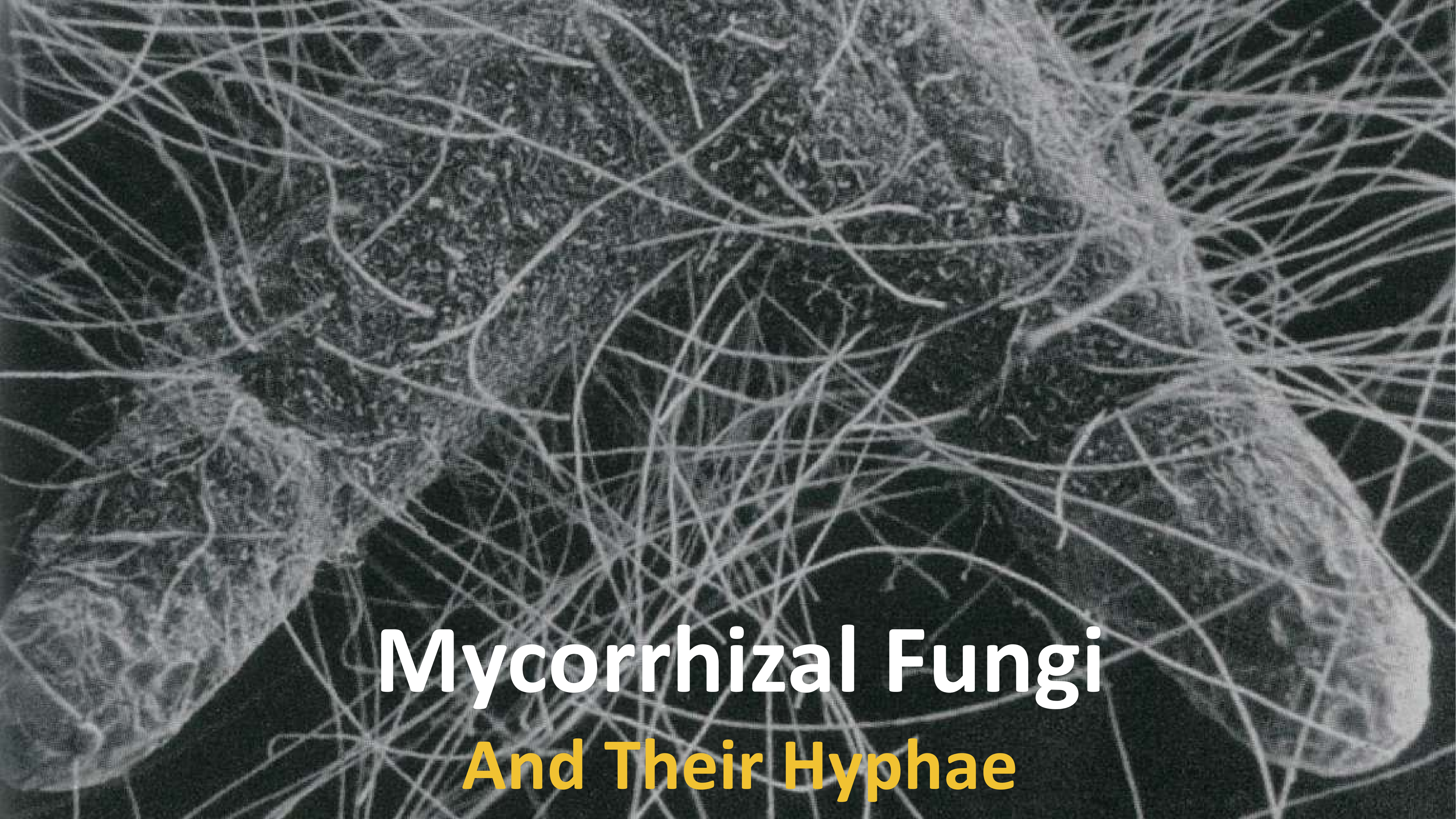
- https://winesvinesanalytics.com/sections/printout_article.cfm?content=58955&article=feature
- Organic Winegrowing Manual. anrcatalog.ucanr.edu
- ccof.org
- https://www2.ipm.ucanr.edu/agriculture/grape/

Maximize Living Roots



Small plant – big root system!


KISS the GROUND
THE BIG EXCHANGE



Mycorrhizal Fungi

And Their Hyphae

Soil Aggregate

Cover Crops in the Vineyard

THE BENEFITS ARE NUMEROUS

- Improved soil structure and water holding capacity
- Increased soil fertility
- Protection from soil erosion
- Improved vineyard floor environment
- Habitat for beneficial insects
- Weed suppression
- Regulate Vine Growth
- Carbon sequestration

IMPROVED SOIL STRUCTURE AND WATER HOLDING CAPICITY

Increased Soil Fertility

PROTECT SOIL FROM EROSION

IMPROVED VINEYARD FLOOR ENVIRONMENT

- No-till cover crops will provide firm footing for operations in wet Winter conditions…

- …and can help control dust during the dry season and in harvest.

HABITAT FOR BENEFICIAL INSECTS

Anystis Agillis

Green Lacewing Larva

Yellow Sac Spider

Anagrus Wasp

Convergent Lady Beetle

WEED SUPPRESSION

Regulate Vine Growth

- Cover Crops can be used to both invigorate and control vigor in vines.

Carbon sequestration

CONSIDERATIONS WHEN CHOOSING YOUR COVER CROP

The relative vigor of the vineyard

Soil moisture availability

Frost potential

Soil erosion considerations

Pest management objectives

Cost of seed and planting

Ease of maintenance

Aesthetics

COVER CROP SELECTIONS FOR NAPA COUNTY

- Annual Legumes
- Annual Forbs
- Annual Grasses and Grains
- Perennial Grasses

USDA COVER CROP PLANTING TIMES

Cool Season						Warm Season		
	Broadleaf							
		Legume						
Annual Grasses								Corn
Barley	Brassicas	Fava Bean						Japanese millet
Cereal Rye	Flax	Field pea	Balansa clover	Red clover	Common vetch	Chickpea	Amaranth	Proso millet
Oats	Phacelia	Lentil	Berseem clover	Rose clover	Hairy vetch	Cowpea	Buckwheat	Sorghum
Triticale	Radish	Lupine	Chrimson clover	Sweetclover	Purple vetch	Soybean	Safflower	Sudangrass
Wheat	White mustard	Medic/burr clover	Persian clover	Subterranean clover	Wollypod vetch	Sunnhemp	Sunflower	Teff

Maintenance and timing of operations

- Plant in the Fall
- Preparation of seed bed
- Rely on Fall rains
- Apply compost
- Mow in the Spring

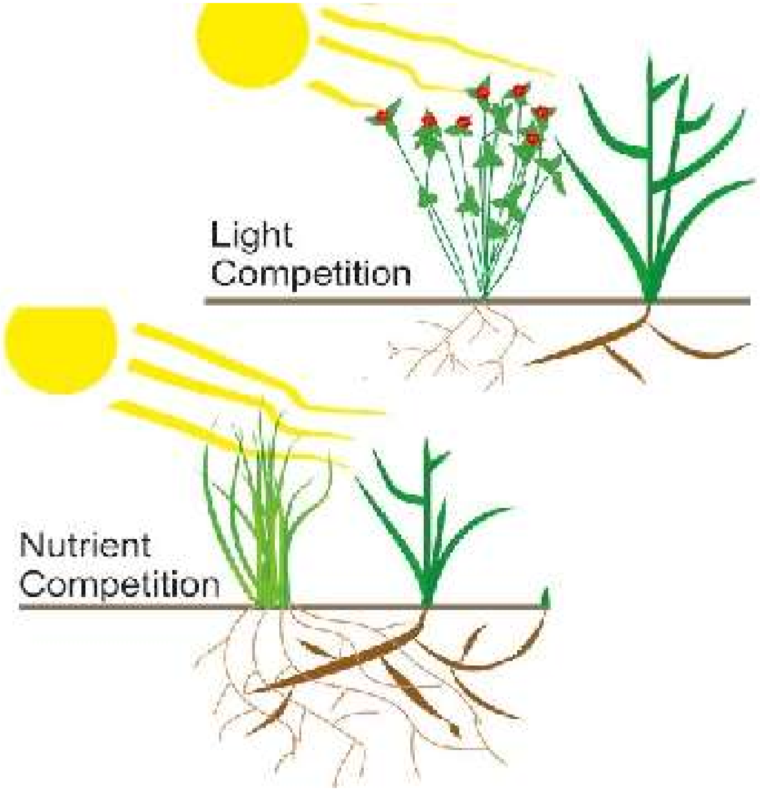
Keeping the soil covered is key to soil health

Tip: To Till, (Reduce Till), or Not to Till?

Tip: To Till, (Reduce Till), or Not to Till?

Old School

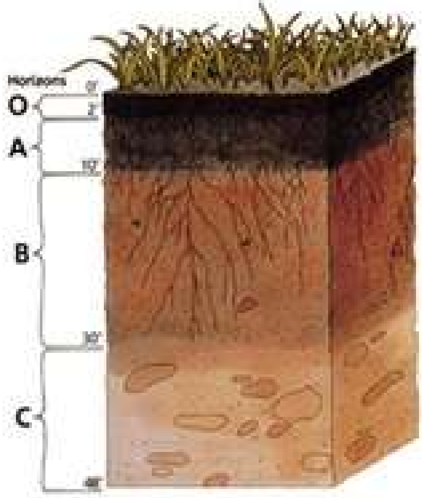
- Vegetation competes with vine needs (water & nutrients).
- Tilling uproots “weeds”
- Use of herbicides to reduce weeds
- Rejuvenates nutrients
- Oxygenates roots



New School

Tip: To Till, (Reduce Till), or Not to Till?

- Key features:
  - Minimizing soil disturbance
  - Protecting soil with cover crops
  - Rotating crops (not for vineyards!!)
- Carbon build-up in soil (sequestered) in top ~4” (layers O & A)
  - Crop rotation is a better idea*
- Increase in organic matter increases water-holding capacity by as much as 3%**
- Reduced energy and need for labor
- Every other row
- Tilling may actually spread weed seeds



Spottswoode Vineyard

* October 2010. Agriculture Ecosystems & Environment 139(1-2):224-231 DOI:10.1016/j.agee.2010.08.006

** Journal of Soil and Water Conservation


Reduce Till

Diversity in your vineyard

Ideas to grow with

Hedgerows

- Historically used as fences and property boundaries
- Plant along vineyard edges typically of trees and shrubs
- Benefits include :
  - Aesthetically pleasing
  - Reduce pesticide use
  - Increase pollination
  - Improve air and water quality
- Wildlife habitat
- Wind break
- Soil Protection

PRIMARILY NATIVE PLANTS

- Ceanothus
- Salvias
- Manzanita
- Native Grasses
- Coyote Bush

WHAT DO WE WANT TO ATTRACT?

Vineyard Beneficial Insects

- Green Lacewings
    - Gardens and landscape
    - Forest and woodlands
    - Orchards

Anagrus Wasp

- Parasitic wasp of Leahopper species

Cover Crops

- Insectary blends (phacelia, cilantro, California poppy, lupine, yarrow, flax)
- Clovers (crimson, rose, white)
- Mustard blends

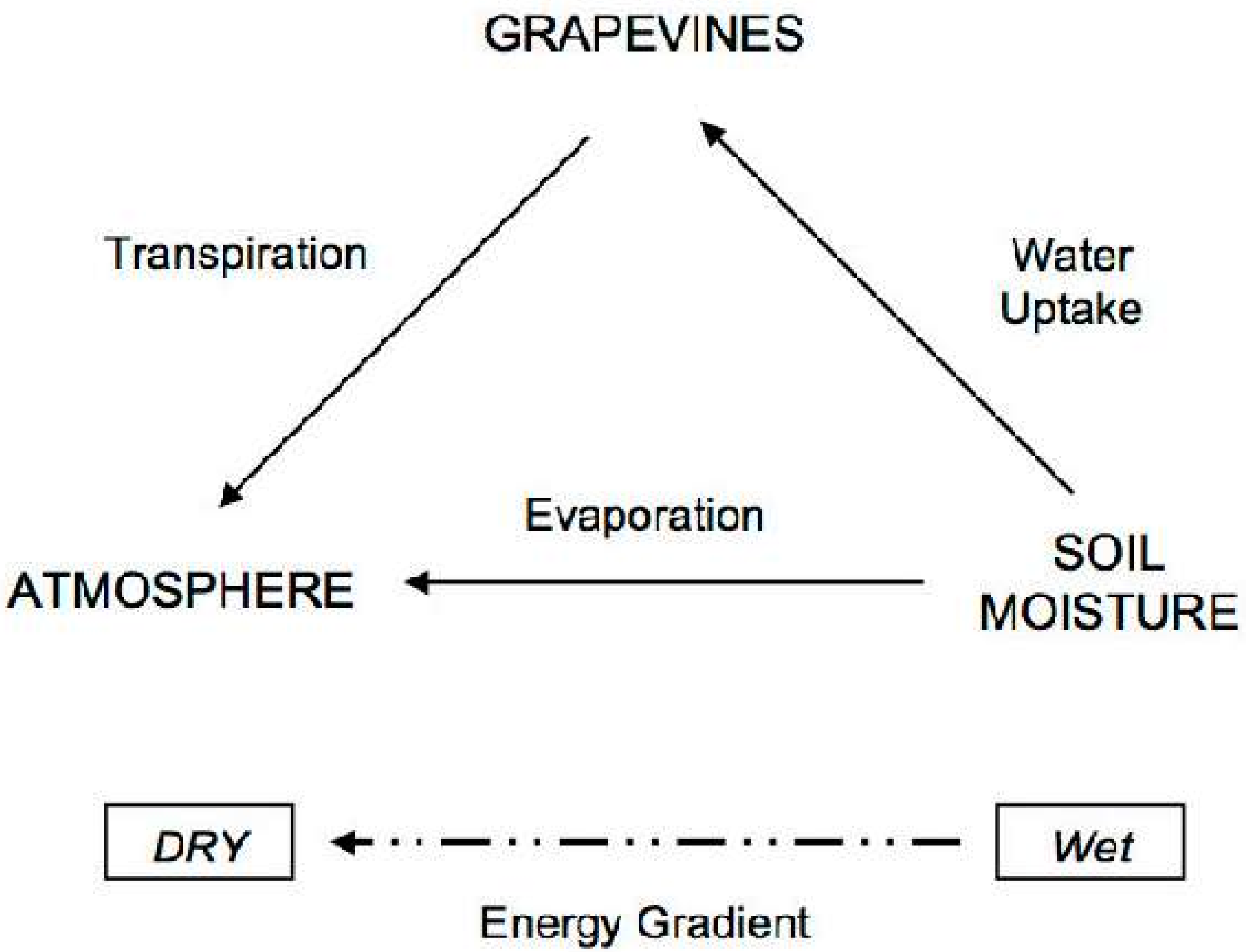
Bee gardens

- Provide nectar and floral resources for native and honey bees
- Beautiful and fun
- HONEY!

Resources

- https://ccpestmanagement.ucanr.edu/Hedgerows/
- https://ucanr.edu/blogs/TheBeeGardener/
- www.helpabee.org

DRY FARMING OR DEFICIT IRRIGATION


GRAPEVINES
Transpiration
Water
Uptake
Evaporation
ATMOSPHERE
SOIL
MOISTURE
DRY
Wet
Energy Gradient

Dry Farming

"Dry farming is more than just avoiding irrigation of the vines. It is an active form of preserving moisture in the ground through the use of cover crops and careful cultivation so that irrigation is not needed. The reward is wines that are deeply connected to the soil and complex in flavor."

http://dominusestate.com/mb/viticulture-and-enology/grapegrowing/dry-farming

"You're so much healthier to get the roots down deep past the [diseases] that inhabit the top 18 inches of soil."

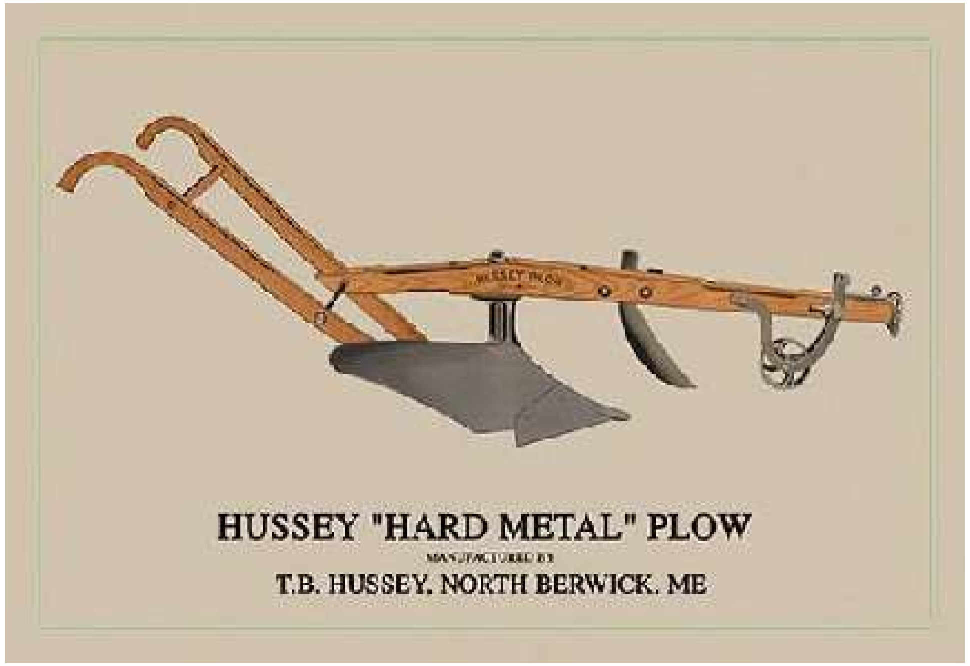
Frank Leeds on: https://www.arrowoodvineyards.com/blog/dry-farming-good-earth-good-wine

"For high-quality Cabernet, the goal is to farm for smaller berries." Small berries have a higher skin to juice ratio, so the wines have more complexity, concentration, and ability to age."

Kristina Shideler on: https://www.arrowoodvineyards.com/blog/dry-farming-good-earth-good-wine

Dry Farming

- During the winter season, precise cane pruning ensures ideal cluster spacing for optimal fruit ripening.
- Dry farming relies on a deep root system to take advantage of natural water sources from rain and underground supplies.
- The French plough removes invasive weeds and encourages deep root growth.
- Cluster thinning optimizes quality through yield regulation.
- Strategic trellising ensures perfect canopy management.
- Frequent grape sampling provides invaluable data for determining optimal ripeness.
- Rinsing the grapes 10 to 15 days before harvest removes dust and enhances the purity of the fruit.
- Hand-picking with small French shears instead of harvest knives minimizes bruising and vine damage.
- Small harvest baskets preserve the integrity of the clusters as they are transported to the winery.
- The sunny side of the vines is picked a few days before the shady side respecting perfect maturity.
- Changes in yield may be due to previous year's irrigation strategy.



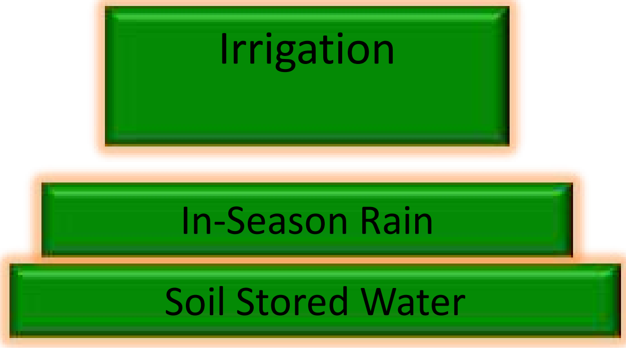
http://dominusestate.com/mb/viticulture-and-enology/grapegrowing/dry-farming/

Water Stress Signs

https://grapesandwine.cals.cornell.edu/newsletters/appellation-cornell/2016-newsletters/issue-26-august-2016/grapes-101/

Drought & Dry Farming

- We may need to start prior to bloom
- Check soil moisture levels now
- May need to adjust crop load to available water
- Dry Farming assumes rain!
- Dry farming is typically implemented over a number of years after vines are established



Water Supply

Practice Judicious Water Use

Importance of Moisture

Soil Organic Matter Increases:

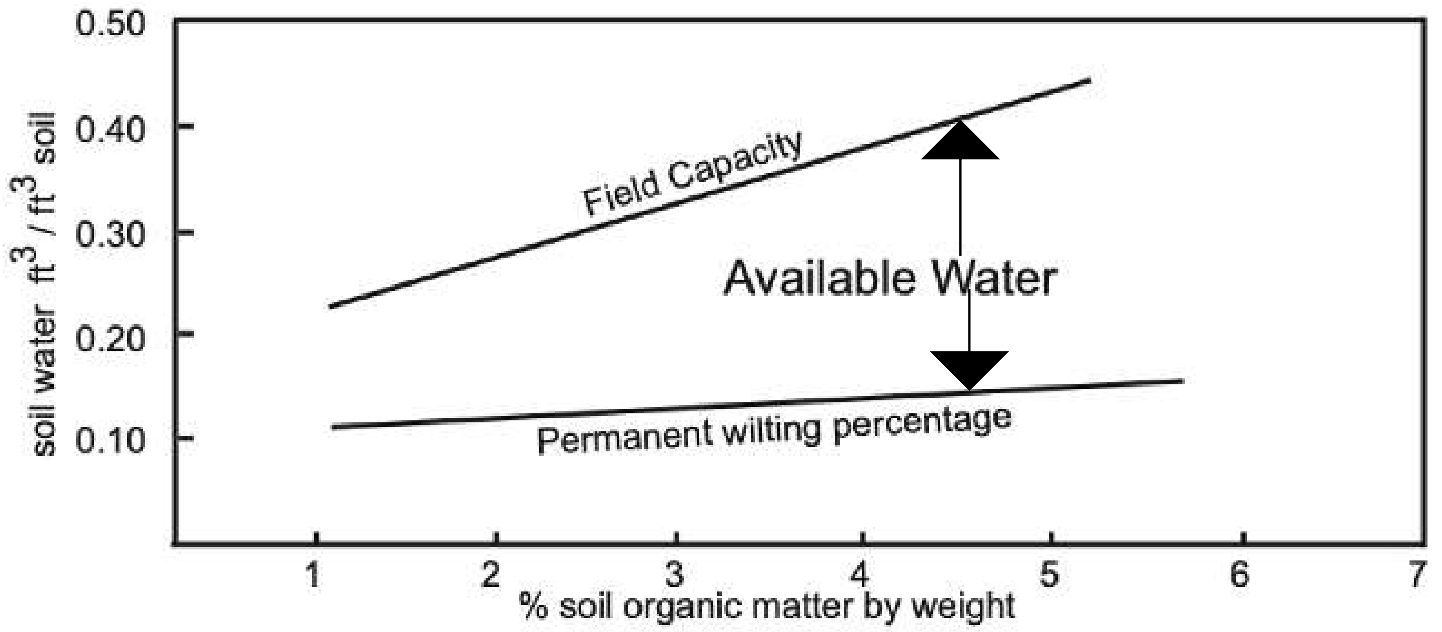


Figure 2. Effect of increasing organic matter on available water capacity of silt loam soils. Adapted from Hudson, SWCS, 1994.

For every 1% increase in Soil Organic Matter, soil can capture and store an additional 27000 gallons of water per acre!

Covered Soil

Drip Irrigation

Reduce
Energy Use

Powered
by
Fossil Fuel

Powered by Renewable Energy

The Ultimate in Renewable Energy!

CALIFORNIA CODE OF SUSTAINABLE WINEGROWING WORKBOOK

FOURTH EDITION

A PROJECT OF

CALIFORNIA SUSTAINABLE WINEGROWING ALLIANCE

WINE INSTITUTE

AND

CALIFORNIA ASSOCIATION OF WINEGRAPE GROWERS

TABLE OF CONTENTS

INITIAL SECTIONS

CHAPTER TABS

ADDITIONAL WORKBOOK MATERIAL

Editors and Authors

Editors

Fourth Edition

John Aguirre, President, California Association of Winegrape Growers

Joe Browde, Ph.D., Independent Consultant

Lisa Francioni-Hai, Program Director, California Sustainable Winegrowing Alliance

Allison Jordan, Executive Director, California Sustainable Winegrowing Alliance

Ryan Leininger, Principal, Ryan Leininger LLC

Josh Prigge, CEO, Sustridge

Third Edition

John Aguirre, President, California Association of Winegrape Growers

Joe Browde, Ph.D., former Professional Services Manager, SureHarvest

Lisa Francioni-Hai, Program Manager, California Sustainable Winegrowing Alliance

John Garn, Principal, ViewCraft

Allison Jordan, Executive Director, California Sustainable Winegrowing Alliance

Ryan Leininger, Principal, Ryan Leininger LLC

Second Edition

Joe Browde, Ph.D., former Senior Project Manager, California Sustainable Winegrowing Alliance

John Garn, Principal, ViewCraft

Allison Jordan, former Communications Manager, Wine Institute

Karen Ross, former President, California Association of Winegrape Growers

Lori Ann Thrupp, Ph.D., former Managing Director, California Sustainable Winegrowing Alliance

First Edition

Jeff Dlott, Ph.D., President, SureHarvest

Kari Birdseye, former Director of Communications, Wine Institute

John Garn, Principal, ViewCraft

Clifford P. Ohmart, Ph.D., former Research and IPM Director, Lodi Winegrape Commission

Karen Ross, former President, California Association of Winegrape Growers

CONTRIBUTING AUTHORS

KARI BIRDSEYE, former Director of Communications, Wine Institute

JOE BROWDE, Ph.D., former Professional Services Manager, SureHarvest and former Sr. Project Manager California Sustainable Winegrowing Alliance

CARLA M. DE LUCA, M.J., Principal, De Luca Communications and former consultant for SureHarvest

JEFF DLOTT, Ph.D., President, SureHarvest

JOHN GARN, Principal, ViewCraft and former consultant for SureHarvest and California Sustainable Winegrowing Alliance

LISA FRANCIONI-HAI, M.S., Program Director, California Sustainable Winegrowing Alliance

ALLISON JORDAN, M.P.P., Executive Director, California Sustainable Winegrowing Alliance

RYAN LEININGER, Principal, Ryan Leininger LLC

STEPHEN K. MATTHIASSON, M.S., former Viticulturist, Lodi Winegrape Commission

CLIFFORD P. OHMART, Ph.D., former Research and IPM Director, Lodi Winegrape Commission and consultant for SureHarvest

JOSH PRIGGE, CEO, Sustridge

KENT REEVES, M.S., Principal, The Whole Picture and former consultant for SureHarvest

KAREN ROSS, former President, California Association of Winegrape Growers

SUSTAINABLE WINEGROWING JOINT COMMITTEE (see list below)

LIZ THACH, Ph.D., Associate Professor, Wine Business Program, Sonoma State University and former consultant for SureHarvest

SUSTAINABLE WINEGROWING JOINT COMMITTEE

The Sustainable Winegrowing Joint Committee was first brought together in 2001 by Wine Institute and the California Association of Winegrape Growers (CAWG) to provide leadership and guidance for the development of the *California Code of Sustainable Winegrowing Workbook*. The Joint Committee has continued to provide technical guidance for the program over the past decade and has played an important role in the development of the fourth edition of the *Code* workbook. To date, the committee has included more than 150 grower and vintner members of Wine Institute and CAWG, along with representatives from the California Environmental Protection Agency and independent consultants. In addition to the countless hours contributed to the development and updating of the *Code* workbook, the Joint Committee provided technical guidance for the development of several other Sustainable Winegrowing Program projects, including the California Wine Community Sustainability Reports (2004, 2006, and 2009), Certified California Sustainable Winegrowing, and Performance Metrics.

SUSTAINABLE WINEGROWING JOINT COMMITTEE MEMBERS

The following list includes Joint Committee members since the program's inception in 2001. Those with one asterisk served on the Committee that contributed to the third edition of the *California Code of Sustainable Winegrowing Workbook*, and those with two asterisks served on the Committee that contributed to the fourth edition of the *Code Workbook*.

Don Ackerman, Director of Grower Relations, Central Coast, Constellation Brands
John Aguirre, President, California Association of Winegrape Growers*,**
Bryan Anthony, Grower Relations Manager, Fetzer Vineyards *
Rachael Ashley, SVP, Wine Production, Treasury Wine Estates*
Hector Bedolla, General Manager, Viticulturist
Kristin Belair, Winemaker, Honig Vineyard & Winery*,**
Paul Bement, former Environmental Engineer, The Wine Group*
Connor Bennett, Environmental Specialist , Trinchero Family Estates **
Alex Bisbikis, Environmental Supervisor, Trinchero Family Estates**
Jeff Bitter, President, Allied Grape Growers**
Mike Boer, Sales Manager PCA/CCA, GrowWest**
Rob Bolch, former VP Regional Supply Services, Treasury Wine Estates*
Robert Boller, former VP of Sustainability & Production, Jackson Family Wines*
Daniel Bosch, Director, Senior Viticulturalist, Constellation Brands**
Marsha Bradford, former Environmental Specialist, E&J Gallo Winery*
Keith Brandt, Compliance & Safety, Bella Vista Farming Company**
Laura Breyer, IPM Field Specialist, Dutton Ranch **
Ben Byczynski, Director, Grower Relations, Fetzer Vineyards**
Hampton Bynum, Vice President, Davis Bynum Winery
Christine Campbell, EHS Program Manager, G3**
Amigo Bob Cantisano, Ag Advisor, Organic Ag Advisors (deceased)
Art Caputi, Art of Winemaking, LLC (deceased)
Phil Castro, Project Engineer, O'Neill Vintners and Distillers**
Greg Coleman, Vice President, Grower Relations, E. & J. Gallo Winery
Jim Collins, Vice President Coastal GVI & Grower Relations, E. & J. Gallo**

Bill Cooper, Cooper-Garrod Estate Vineyards*,**
Brandon Costa, The Wine Group**
John Crossland, Founder, Vineyard Professional Services
Scott Curwood, former Senior Manager Environment & Sustainability, Treasury Wine Estates*
Stephen Dale, former Vice President & General Manager of Operations, Robledo Family Winery
Brad Damron, Cellar Master-Barrel Operations, **Wente Vineyards****
Christine De Loach, Hook and Ladder Winery
Josephine De Luca, former Chair & Member of the Board, San Francisco Bay Regional Water Quality Control Board
Nat DiBudio, former President, Allied Grape Growers*
Paul Dolan, former Partner, Dolan Family Ranches
Ben Drake, President, Drake Enterprises, Inc. (deceased)
Will Drayton, Director of Technical Viticulture and Research Winemaking, Treasury Wine Estates*
John Duarte, President, Duarte Nursery, Inc.
Haley Duncan, Safety & Sustainability Manager, Silver Oak Cellars & Twomey Cellars**
Cheryl Durzy, Chief Executive Officer at LibDib, LLC*
Ashley Egelhoff, Assistant Winemaker, Honig Vineyard & Winery**
Jim Flood, President, Rancho Sisquoc Winery
Louis M. Foppiano, former General Manager, Foppiano Vineyards
Matt Frank, formerly of Trefethen Wines**
Nick Frey, former President, Sonoma County Winegrape Commission*
Josie Frye, Lab Technician, J. Lohr Vineyards and Wines**
Robert Gallo, Co-President, E. & J. Gallo Winery
Wendy Garcia, former Senior Environmental Engineer, Constellations Brands*
Sue Giampietro, former Director of Environmental Services, The Wine Group*
Joey Giordano, Environmental Engineer, The Wine Group**
Greg Gonzales, Director of Vineyard Operations, Scheid Family Wines**
David Graves, Co-Founder and General Manager, Saintsbury
Dennis Groth, Chairman & Owner, Groth Vineyards and Winery
John Guilliams, former Owner, Guilliams Vineyards
Walter Hampe, formerly with Trinchero Family Estates (deceased)
Bart Haycraft, Jackson Family Wines**
Patrick Healy, former Environmental Manager, Fetzer Vineyards (deceased)
Shannon Holbrook, Environmental Specialist, E. & J. Gallo Winery**
Jon Holmquist, Manager Grower Relations, Constellation Wines US
Michael Honig, President, Honig Vineyard & Winery*
Ed Hughes, formerly with Dunnewood Vineyards - Constellation Wines US
Rick Irwin, Grower Relations Manager, Bronco Wine Company
Randle Johnson, Winemaker, The Hess Collection Winery
Stephen Kautz, President, Ironstone Vineyards
Leticia Kegler, Regional Human Resources Manager, E. & J. Gallo Winery*
Emily Knoles, Director & Senior Corporate Counsel-Employment and Litigation, Delicato Family Wines**
Aaron Lange, Vineyard Operations, LangeTwins Winery and Vineyards*,**
Randall Lange, President, LangeTwins Winery and Vineyards
Tom Lanphar, former Science, Pollution Prevention, and Technology Program, CAL/EPA
Sarah Lansing, Viticulture Technician, Hall Wines**

Kim Ledbetter Bronson, Executive Vice-President, Vino Farms*
Frank Leeds, Vice President, Vineyard Operations, Frog's Leap*,**
Cynthia Lohr, Co-Owner/Chief Brand Officer, J. Lohr Vineyard & Wines*
Jerry Lohr, President & Owner, J. Lohr Vineyard & Wines
Steve Lohr, Co-Owner/CEO, J. Lohr Vineyard & Wines*
David Lucas, Owner & Winemaker, The Lucas Winery*
Jeff Lyon, Vineyard Manager, E. & J. Gallo Winery
Michael Martini, former Winemaker, Louis M. Martini Winery
Oliver Matthews, Vineyard Manager, Vineyard Professional Services, Inc.**
Jacob Mauney, Environmental Health, Safety and Risk Manager, Duckhorn Wine Company**
Matt McGinness, VP, EH&S-Wine and Spirits Division, Constellation Brands**
Tim Mendonca, Grower Relations Rep., Vie-Del Company**
Emilio Miranda, former Viticulturalist, Allied Grape Growers*
Bill Misaki, Vie-Del Company**
Lindsay Moorhead, Staff Attorney, Contracts & Operations, Delicato Family Wines**
John Nagle, Environmental Manager, E. & J. Gallo Winery*,**
Julie Nord, Owner, Nord Vineyards Service*,**
Pete Opatz, Owner, WineDirt Advisors-
Bryan Osborn, former Director of Winegrowing, Diageo Chateau and Estate Wines
Harry R. Parsley, President & CEO, Silver Stag Winery
Anji Perry, Viticulturalist/Viticulture Research Director, J. Lohr Vineyards & Wines**
Brad Peterson, Vineyard Manager at lver Oak Cellars & Twomey Cellars**
Bill Petrovic, former Delicato/Monterey Sierra Farming Company (deceased)
Adam Popp, Lead Winemaker, O'Neill Vintners & Distillers**
Glenn Proctor, Partner Ciatti Co., LLC, Owner Puccioni Vineyards
Steve Quashnick, Owner, Quashnick Farms
Ralph Riva, former Vice President of Viticulture, Wente Family Estates
Neil Roberts, Viticulturist/President, Roberts Vineyard Services*
Michael Sangiacomo, Partner, Sangiacomo Vineyards*
Leon Santoro, General Manager & Winemaker, Orfila Vineyards & Winery(deceased)
Chris Savage, Senior Director Global EH&S and sustainability, E. & J. Gallo Winery*,**
Steve Schafer, Schafer Ranch and San Joaquin Wine Company
Kyle Schmidt, Sr. Director, EHSS, The Wine Group**
Tom Shelton, former President & CEO, Joseph Phelps Vineyards (deceased)
Brian Shepard, Walsh Vineyard Management, Inc.**
Padraic Sherlock, Pest Management Director, Beckstoffer Vineyards, Red Hills**
John W. Simpson, formerly with Simpson Meadow Winery
Steve Smit, former VP Vineyards and Grape Management, Constellation Brands*
Carson Smith, Owner, Carson Smith Farming Company*
Leon Sobon, Partner at Sobon Wine co LLC, Includes Shenandoah Vineyards/Sobon Estate*
Rob Sorenson, Director, North Coast Estate Vineyards, Duckhorn Wine Company*
Robert Stephens, former Assistant Secretary of Environmental Management and Sustainability Program, Cal/EPA
Chris Storm, Director of Viticulture, Vino Farms, Inc**
Keith Striegler, Grower Outreach Specialist, E. & J. Gallo Winery**
Mike Stutler, Senior Viticulturist, Constellation Brands*
Steven Sylvester, Director, Environmental Health & Safety, G3 Enterprises*
Kathryn Teissier du Cros, former Sustainability Coordinator, J. Lohr Vineyards & Wines*

Tim Thornhill, Owner-COO, Mendocino Wine Company*
Ann Thrupp, former Manager of Sustainability and Organic Development, Fetzer and Bonterra Vineyards*
Michael Topolos, Owner, Topolos at Russian River
Bob Torres, Principal, Vice Chariman & Director,, Trinchero Family Estates
Jim Unti, former Director of Grower Relations / Grape Management, Constellation Wines US
David Vanni, Owner, Solis Winery, Inc.
Andrea Vasquez, Environmental Manager, Delicato Family Wines**
Eric Vaughn, Operations Manager, E. & J. Gallo Winery*
Shawn Veysey, former Pest Control Advisor, Scheid Vineyards*
Don Wallace, Partner Dry Creek Vineyard
Ted Wells, Environmental Compliance Engineering Manager, Trinchero Family Estates**
Jefferson Wilkes, Owner, Santa Barbara Wine Partners, LLC
John Williams, Owner & Winemaker, Frog's Leap Winery
Cameron Wolfe, Vineyard Manager, Beckstoffer Vineyards**
Susanne Zechiel, Director, Environment, Health, and Safety, Jackson Family Wines**
Jeff Zucker, Environmental Compliance Manager, J. Lohr Vineyards & Wines**

*Joint Committee member during the development of the third edition workbook.
** Joint Committee member during the development of the fourth edition workbook.

About California Sustainable Winegrowing Alliance

The California Sustainable Winegrowing Alliance (CSWA) is a San Francisco-based 501(c)(3) nonprofit organization incorporated in 2003 by Wine Institute and the California Association of Winegrape Growers (CAWG). CSWA conducts public outreach on the benefits of widespread adoption of sustainable winegrowing practices, enlists industry commitment and involvement, and assists in effective implementation of the Sustainable Winegrowing Program (SWP).

CSWA's mission is to encourage adoption of sustainable winegrowing practices and communicate the California wine industry's leadership through education, outreach, certification and partnerships. CSWA collaborates closely with Wine Institute and CAWG, thousands of winegrape growers and vintners, and other stakeholders in California. CSWA also continues to develop partnerships for funding education and outreach to advance the adoption of sustainable practices. The result of this work will be a healthier environment, stronger communities, and vibrant businesses.

About Wine Institute

Established in 1934, Wine Institute is the public policy advocacy association of more than 1,000 California wineries and affiliated businesses working at the state, national and international levels to enhance the environment to responsibly produce, promote and enjoy wine. California wineries are responsible for 81% of U.S wine production and more than 95% of U.S. wine exports. They also contribute $114 billion annually to the U.S. economy and create 786,000 jobs across the country of which 325,000 are in California, bolstering economies through hospitality, taxes and tourism and enhancing communities through environmental and social sustainability.
See: www.wineinstitute.org.

About California Association of Winegrape Growers

The mission of the California Association of Winegrape Growers (CAWG) is to provide industry leadership to advocate public policies, research and education programs, sustainable practices, and trade positions to improve the viability of winegrape growing as an essential contributor to California's economy, culture, and landscape. CAWG's membership represents the growers of approximately 60 percent of the total annual grape crush.

CAWG co-hosts the annual Unified Wine & Grape Symposium to deliver information and ideas for continual improvement of the state's wine community, and sponsors research and development of publications such as *Growers' Guide to Environmental Regulations & Vineyard Development*, *California Vineyards & Wildlife Habitat, Summary of the Labor Law Requirements for Winegrape Growers,* and *The Winegrape Guidebook for Establishing Good Neighbor and Community Relations*. CAWG has also played a leading role in the National Grape & Wine Initiative, a strategic research, education, and outreach plan to stimulate innovation and accelerate best practices adoption to help the wine community increase market share and be a world leader in value and sustainability while contributing to quality of life in rural communities.

ACKNOWLEDGEMENTS

The *California Code of Sustainable Winegrowing*, a key component of the Sustainable Winegrowing Program, builds on the impressive work in sustainable practices by many regional winegrowing and vintner associations, wineries and vineyards, individual viticulturists and winemakers, industry professionals, researchers, government agencies, innovative regulators, and environmental organizations involved in the California wine community. Overall leadership and guidance for the program is provided by the CSWA board of directors, comprised of representatives from Wine Institute and CAWG.

The Joint Committee members dedicated a remarkable amount of expertise, experience, and time to the development and revision of this workbook, demonstrating a continued commitment to ensuring that California is the global leader in defining, implementing, and documenting adoption of sustainable winegrowing.

Robert P. Koch, President & CEO, Wine Institute and John Aguirre, President of CAWG, as well as John De Luca, former President of Wine Institute and Karen Ross, former President of CAWG, have shown extraordinary leadership through their vision, expertise, passion, and commitment to the program. These individuals, along with CSWA, Wine Institute, and CAWG board of directors, have demonstrated what can be accomplished through meaningful collaboration among the state's winegrape growers and vintners.

The expertise and dedication provided by the staff at CSWA, Wine Institute, and CAWG have also been outstanding. In particular, we would like to thank Gladys Horiuchi, Wine Institute Director of Media Relations, for reviewing, editing and production for the First Edition Code, and Jodi Wilson, CSWA Certification Manager, and Persis Johnson, Wine Institute Environmental Affairs Coordinator who have been instrumental in the production of the Code.

SureHarvest
Wine Institute and CAWG contracted SureHarvest (formerly *Real*Toolbox), a sustainability professional services and information technology firm, to help staff the Sustainable Winegrowing Joint Committee, coordinate the authoring and editing of the first edition of the workbook, design the implementation program, and design, build and maintain the software system used to manage the self-assessment data and generate benchmark reports for individual winegrowers, wineries, regional groups, and statewide reporting.

SureHarvest provides sustainability professional services and information technology to projects dedicated to the environmental, economic, and social sustainability of managed and natural ecosystems. The staff and consultants at SureHarvest possess broad expertise, knowledge, and relationships in sustainable agriculture, environmental issues, and software engineering. Project teams have solid field experience as well as broad academic scholarship that provides rigor and credibility to their approaches and outcomes. SureHarvest is now working with many other specialty crop producers to develop sustainability programs, demonstrating the potential for the Sustainable Winegrowing Program to be a model for other agricultural sectors.

Regional Participation
The first five self-assessment chapters (Viticulture, Soil Management, Water Management, Pest Management, and Wine Quality) were adapted from **Lodi Winegrape Commission's** *Lodi*

Winegrower's Workbook (Ohmart and Matthiasson, 2000). The Lodi Winegrape Commission combined elements of the Central Coast Vineyard Team's *Positive Points System*[1] (Central Coast Vineyard Team, 1996 and 1998), new winegrowing content, and a four-category self-assessment format developed by Farm*A*Syst[2] to produce the *Lodi Winegrower's Workbook*. We thank the Vineyard Team (formerly the Central Coast Vineyard Team) for their pioneering work on vineyard self-assessment and their willingness to share information contained in their *Positive Points System*.

We are especially thankful to the Lodi Winegrape Commission for allowing the Sustainable Winegrowing Joint Committee to directly adapt the chapter style and content from the *Lodi Winegrower's Workbook* for the *Code* workbook. This generous act demonstrates the Commission's commitment to cooperation with the California wine community and desire to see widespread adoption of sustainable winegrowing.

The process of adapting the Viticulture, Soil Management, Water Management, Pest Management, and Wine Quality chapters from the *Lodi Winegrower's Workbook* included extensive input from the Sustainable Winegrowing Joint Committee and regional grower and vintner associations and review groups. The regional grower and vintner groups and the individuals involved in the adaptation process are presented below. Many of these groups are also current partners in the program and co-host educational workshops for growers and vintners in their regions.

Sonoma County Winegrape Commission– Nick Frey, former Executive Director; Laura Breyer, vineyard consultant; Rhonda Smith, Viticulture Farm Advisor, Sonoma County; Duff Bevill, Bevill Vineyard Management; and Keith Horn, Clos Du Bois. **Santa Cruz Mountains Winegrowers Association** – anonymous comments. **Lake County Winegrape Commission** – Shannon Gunier, former Executive Director; Rick Gunier, Marketing Director; Frank Anderson, Beckstoffer Vineyards; Eric Seely, Amber Knolls Vineyard; Brian Greer, Rolling Knolls; and Glenn McGourty, Farm Advisor, Emeritus, Mendocino and Lake Counties. **Calaveras Grape Growers Association** – Steve Collum, Gerber Vineyards.

Napa Valley Grape Growers Association (NVGGA), Napa Valley Vintners (NVV), and **Napa Sustainable Winegrowing Group (NSWG) -** Sandra Ellis, former Executive Director, Napa Valley Farm Bureau; Becky Peterson and Jeri Hansen, NVV; Frank Leeds, Frog's Leap; Zack Berkowitz; Mitchell Klug, Premier Pacific Vineyards; Astrid C. Bock-Foster, Napa Valley Resource Conservation District; and Volker Eisele, Volker Eisele Vineyard Estate.

Central California Review Group – Jon Holmquist, Constellation Wines US; Bryan Anthony, formerly Gallo Vineyards; Ron Brase, AgQuest Consulting; Robert Wample, formerly Fresno State Department of Viticulture and Enology and the Viticulture and Enology Research Center; Carson Smith, Golden State Vintners; Gary Wilson, Wilson Ag; and Steve Schafer, Schafer Ranch, Inc.

Central Coast Review Group – Robert LaVine, formerly Fetzer Vineyards; Pebble Smith, James Berry Vineyard; George Donati, Pacific Vineyards; Doug Beck, Hampton Farming Company; Bob Johnson, Kendall-Jackson Wine Estates; Craig MacMillan, formerly MacMillan Wine Company; Matt Heil,

---

[1] Information about the Central Coast Vineyard Team and the *Positive Point System* can be found at http://www.vineyardteam.org.

[2] Information about Farm*A*Syst can be found at http://www.uwex.edu/farmasyst/.

Robert Mondavi Winery; John Crossland, Crossland Vineyards; Daryl Salm, Valley Farm Management; and Dan Lompa, Scheid Vineyards.

The remaining initial eight chapters (Ecosystems Management, Energy Efficiency, Winery Water Conservation and Quality, Material Handling, Solid Waste Reduction and Management, Environmentally Preferred Purchasing, Human Resources, and Neighbors and Communities) were developed for the Sustainable Winegrowing Program by gathering input from the Sustainable Winegrowing Joint Committee, conducting an extensive literature review, and drawing upon the expertise of the SureHarvest consulting team. Particularly useful sources of information on sustainable winery operations included the Sonoma County Green Business Program, Winery Eco-Efficiency Assessment Guide (Business for Social Responsibility, 1998), and the California EPA's Environmental Management Systems pilot project on wineries.

External Stakeholder Participation

First Edition

A draft of the initial 13 chapters was sent to more than 70 individuals representing a wide range of government agencies, academic institutions, nonprofit environmental and social equity organizations, and viticulture and winery owners, managers, and consultants. The Sustainable Winegrowing Joint Committee received comments back from 31 people. These comments have significantly improved the content and style of this workbook and we are very grateful for the time and attention that the reviewers dedicated.

External reviewers from the private sector included Matt Atkinson, Range Manager, Benziger Winery; Lisa Bishop Forbes, Winemaker, Chalk Hill Winery; Ron Brase, Consultant, AgQuest Consulting; and Julie Nord, Owner, Nord Coast Vineyard Services. All of these individuals provided extremely helpful and practical comments that have improved the usefulness of this workbook.

We thank Bill Lyons, former Secretary, California Department of Food and Agriculture (CDFA), for his support of the project and encouragement of senior managers and staff to review this workbook. Valerie Brown, former Deputy Secretary, CDFA, provided thoughtful and detailed comments on the entire workbook that improved the quality of information and overall workbook style. Steve Shaffer, former Director, Agriculture and Environmental Policy, CDFA, also submitted useful comments.

Cathy Bleier, Special Assistant on Salmon and Watersheds from the office of Mary Nichols, Secretary of Resources, provided targeted suggestions for improving sections dealing with the protection and conservation of natural resources, particularly aquatic habitats. Similar comments were received from Scott Gergus, Associate Engineering Geologist, North Coast Regional Water Quality Control Board.

Tom Lanphar, former Senior Hazardous Substance Scientist, from Cal/EPA Environmental Management and Sustainability Program, offered comments to increase the sustainability content of several sections. Mike Noggle, Winery Account Manager, PG&E, reviewed the Energy Efficiency chapter. Andy Parsons, Department of Emergency Services, Sonoma County, reviewed the Material Handling Chapter and provided additional material handing resources. JoAnne Dlott, Vice President of Human Resources, Seaside Company, reviewed and provided constructive comments on the Human Resources chapter.

At the federal level, Ann Thrupp, former Senior Scientist, Agricultural Initiative, US EPA Region 9, reviewed the entire workbook and submitted an excellent set of constructive comments. Kendra

Baumgartner, Researcher, USDA ARS, offered many helpful comments and updated the section on Armillaria root disease.

From the environmental nonprofit community, we were very fortunate to receive excellent technical comments, particularly on the ecosystem management chapter, from Mark Reynolds, Senior Project Ecologist, Emerging Projects, and Bill Leahy, Director, Monterey Office, of The Nature Conservancy. Gretchen LeBuhn, Assistant Professor, San Francisco State University, also contributed to this set of comments. Luis Arteaga, Associate Director, Latino Issues Forum, provided meaningful comments on the Sustainable Purchasing, Human Resources, and Neighbors and Community chapters.

We thank the University of California for their longstanding research and extension contributions to generating and extending knowledge on winegrowing and natural resource management. These contributions serve as the scientific foundation upon which much of the sustainable practices presented in this workbook are based. We are also very grateful for the excellent technical and editorial comments received from UC faculty, specialists, and farm advisors during the production of this workbook. These comments have strengthened the quality and rigor of this undertaking. In particular, we would like to thank Mark Battany, Viticulture Farm Advisor, San Luis Obispo County; Larry Bettiga, Viticulture Farm Advisor, Monterey/San Benito/Santa Cruz Counties; Jenny Broome, former Associate Director UC Sustainable Agriculture Research and Extension Program; Nick Dokoozlian, former Associate Viticulture Specialist and Chair of the UC Integrated Viticulture Production Workgroup now with Gallo Family Vineyards; Mary Louise Flint, Director, UC IPM Education and Publications; Kurt Hembre, Farm Advisor, Fresno County; George Leavitt, former Farm Advisor, Madera County; Jim Lyons, Interim Director, UC Statewide IPM Program; Glenn McGourty, Farm Advisor Emeritus, Mendocino and Lake Counties; Steven Nations, Executive Director, Government and External Affairs, Division of Agriculture and Natural Resources; Rhonda Smith, Viticulture Farm Advisor, Sonoma County; Ed Weber, former Viticulture Farm Advisor, Napa County; and other members of the UC Integrated Viticulture Production Workgroup that provided comments.

We would also like to thank W.R. Gomes, Vice President, UC Division of Agriculture and Natural Resources for his steadfast support of this program.

Faculty from the California State University system have provided excellent comments at several stages of the workbook development. In particular, we would like to thank Robert Wample, former Director, Viticulture and Enology Research Center (VERC) and former Chair, Department of Viticulture and Enology at CSU- Fresno. Sanliang Gu, Ricchiuti Chair of Viticulture Research and Ken Fugelsang, former Associate Professor and Winemaker at VERC, (deceased), also provided valuable comments.

Second Edition

As a key addition to the second edition of the workbook, which was released in 2006, a draft of the new Air Quality chapter was sent to 44 individuals and comments were received back from 22 people. We would like to thank the following organizations and individuals for their useful comments on improving this chapter. Faculty from the University of California include Tom Cahill, Professor Emeritus, Air Quality Group, UC Davis; Steve Vasquez, Farm Advisor, UC Cooperative Extension, Fresno County; Maxwell Norton, Farm Advisor, UC Cooperative Extension, Merced County; Larry Bettiga, Farm Advisor, UC Cooperative Extension, Monterey/San Benito/Santa Cruz Counties; Mark Battany, Farm Advisor, UC Cooperative Extension, Santa Barbara and San Luis Obispo Counties; Glenn McGourty, Farm Advisor Emeritus, UC Cooperative Extension, Mendocino and Lake Counties; and Rhonda Smith, Farm Advisor, UC Cooperative Extension, Sonoma County.

We thank the many Air Quality chapter external reviewers from multiple government agencies including the US Department of Agriculture-Natural Resources Conservation Service (USDA NRCS), US EPA, California Air Resources Board (CARB) and Air Districts, California Department of Pesticide Regulation (DPR), and CDFA. Specific reviewers include John Beyer, State Air Quality Coordinator, USDA NRCS; John Brenner, Air Quality Specialist, WNTSC, USDA NRCS; Kathy Taylor, Associate Director, Communities & Ecosystems Division, US EPA; Kerry Drake, Associate Director, Air Division, US EPA; Bob Fletcher, Chief, Planning and Technical Support Division, CARB; Lynn Terry, Deputy Executive Officer, CARB; David Crow, Air Pollution Control Officer, San Joaquin Valley Unified Air Pollution Control District; Randy Segawa, Senior Environmental Research Scientist, Environmental Monitoring Branch, DPR; Doug Okumura, Assistant Director, DPR; Steve Shaffer, Director, Office of Agriculture and Environmental Stewardship, CDFA; and John Steggall, Senior Environmental Research Scientist, CDFA.

From the nonprofit community, we would like to thank Cynthia Cory, Director of Environmental Affairs, California Farm Bureau Federation; Cindy Tuck, former General Counsel, California Council for Environmental and Economic Balance; Kimberly Cahill, Graduate Fellow, Stanford University; and Kathryn Phillips, Environmental Defense.

For improving the vineyard water quality and soil management elements of the second edition, we are especially grateful to Carson Cox, Project Manager, Sustainable Conservation and to the Sustainable Winegrowing Joint Committee. A number of reputable external reviewers also contributed to improving these elements including Carol Mandel, Phill Blake, Rich Casale, and Rebecca Challender formerly of USDA NRCS; Glenn McGourty and Ed Weber of UC Cooperative Extension (deceased); and Heather Shepherd, Wallace Group.

Third Edition

A draft of the third edition workbook was sent to more than sixty individuals representing a wide range of government agencies, academic institutions, nonprofit environmental and social equity organizations, viticulture and winery owners, managers, and consultants with expertise related to the workbook chapter content. Approximately half of these individuals responded with comments to the Sustainable Winegrowing Joint Committee, helping to significantly improve the content of this workbook. We are grateful for their contribution of time and expertise.

We would specifically like to acknowledge and thank Mark Greenspan, Advanced Viticulture; Bryan Rahn, Coastal Viticultural Consultants; and Laurel Marcus, Fish Friendly Farming & CA Land Stewardship Institute for providing useful content and feedback on the viticulture and vineyard water chapters. We also thank Andy Walker, Department of Viticulture and Enology, University of California, Davis for his feedback and comments to the Viticulture chapter.

We appreciate the review and feedback on multiple chapters from a number of reviewers including Kerri Steenwerth, USDA Agricultural Research Service (ARS); Hue Dang, USDA Natural Resources Conservation Services; and Laura Flanigan, formerly PE International. We also want to thank Joseph Dillon, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, who provided extensive comments on many chapters related to water conservation and quality, soil management, and habitat protection.

We were fortunate to receive excellent technical comments on the Pest Management chapter from a number of experts including: Monica L. Cooper, University of California Cooperative Extension Viticulture Farm Advisor; Doug Gubler, Department of Plant Pathology, University of California, Davis; David Haviland, University of California Cooperative Extension Entomology and Pest Management Farm Advisor; Patricia Matteson, Environmental Scientist, California Department of Pesticide Regulation (DPR); and Joyce Strand, University of California Statewide IPM Program.

We are thankful to Jeremy Howard and Keith Forsman, Pacific Gas & Electric Company for their review and feedback on the Energy Efficiency chapter. We also thank Tony Domingo, Tony Domingo Farming, for his contribution to irrigation efficiency resources.

Bob Chrobak and Susanne Zechiel (formerly) from Kennedy/Jenks Consultants contributed valuable information, resources, and feedback to the Winery Water chapter; and we would also like to thank Lisa Bodrogi, formerly Paso Robles Wine Country Alliance, who also provided comments to the chapter.

We thank James Stettler, Sonoma County Fire & Emergency Services Department and Andy Parsons, Sonoma County Fire & Emergency Services Department who provided extensive comments and feedback on the Material Handling chapter, and Tim Dewey-Matta, Napa Recycling & Waste Services who provided valuable feedback on the Solid Waste chapter.

George Daniels, Farm Employers Labor Service, Bryan Little, Farm Employers Labor Service (FELS), and Michael C. Saqui, The Saqui Law Group, contributed useful educational content to enhance the Human Resources chapter. We also want to thank Randy Segawa, California Department of Pesticide Regulation (DPR), Air Program for his review and comments on the Air Quality chapter.

All of these individuals and organizations, along with the reviewers for the first and second edition of the Code, have enabled the California wine community to leverage resources and expertise to improve both the Sustainable Winegrowing Program and the industry as a whole, as well as individual winery and vineyard practices. Thank you.

Fourth Edition

Building on the contributions, time and expertise of the many individuals who participated in the development and review of the first three editions of the Code, the fourth edition review continued to leverage the knowledge and expertise of many to deliver an up-to-date assessment workbook. Over more than a year, CSWA undertook a significant review process that included each chapter being initially reviewed by staff and consultants, reviewed twice by the Sustainable Winegrowing Joint Committee during 15 webinars and reviewed by subject matter experts upon request. In addition, there was a 40-day public comment period, which included sharing the final draft with 130 external stakeholders representing a wide range of government agencies, academic institutions, nonprofit environmental and social equity organizations, and consultants, and posting the draft on the CSWA website.

CSWA would like to thank the entire Sustainable Winegrowing Joint Committee for their participation and input during the many review meetings, the participants on CSWA's Pest Management Technical Advisory Group for review and feedback on the Integrated Pest Management chapter, and the members of Wine Institute's Environment Committee for review of the winery chapters. In addition, CSWA thanks other individuals that contributed their expertise to the fourth edition Integrated Pest

Management chapter, including Stephanie Bolton, PhD., from Lodi Winegrape Commission who assisted with the new virus management criterion and provided input into other pest criteria, Monica L. Cooper, University of California Cooperative Extension Viticulture Farm Advisor, and John Roncoroni, University of California Cooperative Extension Weed Science Farm Advisor. Bob Chrobak from Kennedy/Jenks Consultants contributed valuable information, resources, and feedback to the Winery Water chapter. Adam Kotin, formerly with Wine Institute, provided helpful input into many of the winery chapters.

CSWA is also thankful for the reviewers of the Human Resources chapter who all provided valuable updates and edits, including Tracy Genesen and Mary-Claire Rotticci from Wine Institute, Veronica Ospina from Stronger Together, Collin Cook and Brandon Kahoush from Fischer and Phillips LLP, and Liz Thach from Sonoma State University. In addition, we thank Keith Abeles from the Sonoma Resource Conservation District and Miguel Garcia from the Napa Resource Conservation District for their input on the new soil carbon sequestration criterion and education box, Stephanie Barger from the U.S. Green Building Council for input on the Solid Waste Chapter, and John Paine from CalEPA for review of the Material Handling Chapter.

Photo and Illustration Acknowledgements
We would like to thank the UC Board of Regents, UC Division of Agriculture and Natural Resources, and the UC Statewide Integrated Pest Management Program for granting us the permission to reprint 58 photographs in this workbook. Use of the photographs does not imply endorsement of the materials or recommendations in this workbook. The UC photographs appear in the Pest Management chapter. The photographs that appear in the other chapters are from Wine Institute, the California Sustainable Winegrowing Alliance, and the Lodi Winegrape Commission.

We would also like to thank Ann Thrupp for her original illustrations that appear in the Ecosystems Management chapter.

Disclaimer
While every effort has been made to provide the most accurate and current information available, CSWA, Wine Institute, and CAWG make no warranties regarding the information contained in this workbook or the applicability of such information to a particular grower, vintner, or situation. Moreover, while an attempt was made to note changes in titles and affiliations of individuals involved with the first, second, third and fourth editions of the workbook, others may have been inadvertently missed.

CSWA, Wine Institute, and CAWG specifically disclaim any and all warranties, express or implied, including but not limited to this workbook's fitness for a particular use. CSWA, Wine Institute, and CAWG do not warrant that the information contained in this workbook will be error-free or that defects will be corrected. This workbook is not intended as legal advice and you are advised to seek professional help as needed. Nothing in this workbook is intended to replace your own technical experts or legal advisors, and CSWA, Wine Institute, and CAWG encourage you to consult any professionals you believe are needed.

This workbook is not intended, nor should it be interpreted, to create an industry wide standard for winegrape growing or winemaking.

1. INTRODUCTION

Welcome to the fourth edition of the voluntary *California Code of Sustainable Winegrowing Workbook*. This introductory section provides background on the *California Code of Sustainable Winegrowing Workbook*, and key elements of the California Sustainable Winegrowing Program and Certified California Sustainable Winegrowing. Information on how to use the workbook is provided in the "How To" section beginning on Page 7.

ABOUT THE CALIFORNIA CODE OF SUSTAINABLE WINEGROWING WORKBOOK

Building on major trends and successful regional efforts, including the first five viticulture chapters of the Lodi Winegrape Commission's *Lodi Winegrower's Workbook*, Wine Institute and the California Association of Winegrape Growers (CAWG) published the first workbook in 2002 to promote continuous improvement in the adoption of sustainable practices from grapes to glass throughout California. Meeting over an 18-month period, the Sustainable Winegrowing Joint Committee – comprised of 50 members of the California Association of Winegrape Growers and Wine Institute – provided technical guidance and oversight for the development of the workbook. As indicated in the Acknowledgements section of the workbook, dozens of key internal and external stakeholders – from regional associations, academia, government, and non-profit organizations, among others – contributed expertise to enhance the effectiveness and credibility of the workbook.

Wine Institute and CAWG established the California Sustainable Winegrowing Alliance (CSWA), a 501(c)(3) non-profit organization in 2003 to promote adoption of sustainable winegrowing practices through the Sustainable Winegrowing Program (SWP), with the workbook as the foundation of the program. These three organizations published the second edition of the workbook in 2006, with clarified language, updated resources, and new content including an Air Quality Chapter, a criterion on erosion control, and an educational box on heat stress prevention. That same year, the workbook was integrated into an online self-assessment and reporting system.

Beginning in 2011, nearly a decade after the first workbook was published, the Sustainable Winegrowing Joint Committee again convened for dozens of meetings over a two-year period to thoroughly review the workbook. The third edition of the workbook accomplished the following objectives: further clarify criteria and bring it up-to-date; minimize duplication and enhance the user-friendliness of the workbook; and ensure workbook content is relevant, practicable, and useful to a wide range of California vineyards and wineries, reflecting the full diversity of the state's wine industry. In addition, a new chapter was added, Chapter 2 Sustainable Business Strategy, which utilized content from other chapters to highlight the importance of integrating sustainability into the overall business strategy for a vineyard and/or winery.

In 2019-2020, CSWA undertook another significant review process in preparation for publication of the 4th edition California Code of Sustainable Winegrowing. The Code content again was brought up-to-date with the latest best practices and educational resources. Changes include several new criteria addressing topics such as diversity, soil carbon sequestration, virus management and vineyard solid waste, as well as new prerequisites and educational content.

California winegrowers and vintners are the primary audience for this workbook; however, the workbook content may also be useful to a wider audience including winery and vineyard employees, suppliers, winegrape and wine buyers, neighbors and local community members, members of the environmental and social equity communities, policy makers, regulators, and the media.

It is important to note that this workbook is a **voluntary self-assessment tool**, and not a "how to" manual or set of "rules" for winegrape growing and winemaking. In addition, regulatory compliance for all practices is assumed. Category 1 is intended to meet or exceed legal requirements where they exist at the time of print; while Categories 2, 3 and 4 can move growers and vintners beyond compliance on a continuum towards increased sustainability. However, it is important to note that not all practices will make sense for all operations. The workbook also serves as the basis for the optional Certified California Sustainable Winegrowing, a third-party certification program. As demonstrated by the evolution of four editions, the workbook was created to be a "living document" that also reflects continuous improvement. As a living document, the workbook will continue to be updated over time to incorporate new and emerging best practices. Feedback and input on the workbook criteria and educational resources is always welcome; please use the **Corrections, Comments, and Suggestions** sheets in the back of the workbook or contact info@sustainablewinegrowing.org.

SUSTAINABILITY MISSION, VISION, AND VALUES

A key desired outcome of the *California Code of Sustainable Winegrowing Workbook,* and the broader Sustainable Winegrowing Program, is the widespread development and execution of sustainability strategies in the California winegrowing community. Business strategy is often defined in terms of an operation's **mission** (the business purpose and fundamental reason for existence), **vision** (future desire, long-term goals), and **values** (core ideals, beliefs, and actions). It is important for all businesses committed to sustainability, from the small family-operated vineyard and winery to the corporate organization, to clearly define and implement a sustainability strategy (see **Chapter 2 Sustainability Strategy** for more information). The following mission, vision, and values were used to guide the development of the *California Code of Sustainable Winegrowing Workbook*.

The **Mission** for the development of this workbook and implementation of the SWP is to provide winegrape growers and vintners with a tool to voluntarily:

- Assess the sustainability of current practices;
- Identify areas of excellence and areas where improvements can be made; and
- Develop action plans to increase an operation's sustainability.

The overall, long-term mission for the workbook, and broader SWP, includes:

- Identifying and promoting voluntary best practices in sustainable winegrowing to be followed and maintained by the California wine community;
- Enhancing winegrower-to-winegrower and vintner-to-vintner education on the importance of sustainable practices and how self-governing will enhance the economic viability and future of the wine community;

- Demonstrating how working closely with neighbors, communities, and other stakeholders to maintain an open dialogue can address concerns and enhance mutual respect and understanding; and
- Providing tools and resources for growers and vintners to enhance their business sustainability, such as the development and implementation of the voluntary Certified California Sustainable Winegrowing program.

The **Vision** of the *Code* and Sustainable Winegrowing Program is the sustainability of the California wine community for present and future generations. The program defines sustainable winegrowing as winegrape growing and winemaking practices that are sensitive to the environment (**E**nvironmentally Sound), responsive to the needs and interests of society-at-large (Socially **E**quitable), and economically feasible to implement and maintain (**E**conomically Feasible). The combination of these three principles is often referred to as the three "**E**'s" of sustainability (**Figure 1-a**).

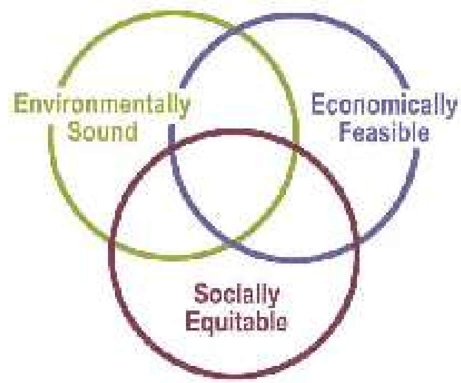


Figure 1-a Sustainability as defined by the three overlapping principles of **E**nvironmentally Sound, **E**conomically Feasible, and Socially **E**quitable.

These three overarching principles provide a general direction for pursuing sustainability. However, these important principles are not easily translated into the everyday operations of winegrape growing and winemaking. To bridge this gap between general principles and daily decision-making, the workbook's 15 self-assessment chapters translate the sustainability principles into specific winegrape growing and winemaking practices (**Figure 1-b**).

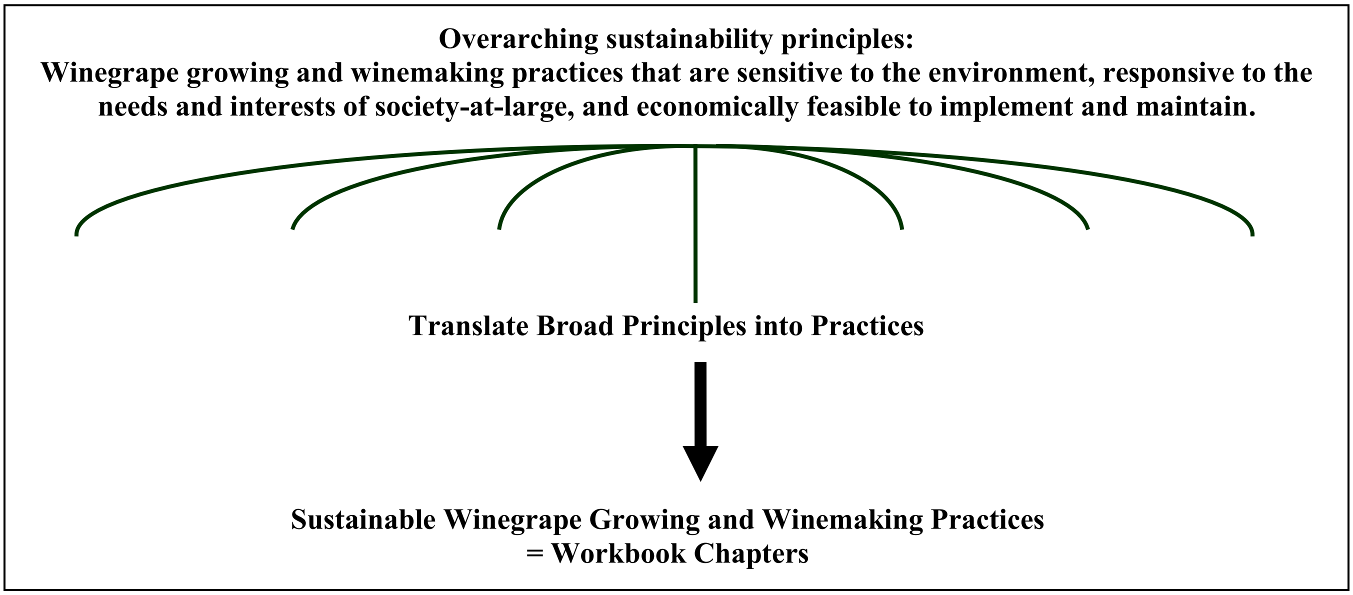


Figure 1-b The relationship between the winegrowing sustainability principles and the workbook chapters.

This workbook and the SWP are guided by the following set of **Sustainability Values**:

- Produce the best quality grapes and wine possible;
- Provide leadership in protecting the environment and conserving natural resources;
- Maintain the long-term viability of agricultural lands;
- Support the economic and social wellbeing of vineyard and winery employees;
- Respect and communicate with neighbors and community members; respond to their concerns in a considerate manner;
- Enhance local communities through job creation, supporting local business, and actively working on important community issues;
- Honor the California wine community's entrepreneurial spirit;
- Support research and education as well as monitor and evaluate existing practices to expedite continual improvements.

The concept of the sustainability mission, vision and values, along with more information specific to CSWA's organizational mission and vision is also addressed in **Chapter 2 Sustainability Strategy**.

ABOUT THE CALIFORNIA SUSTAINABLE WINEGROWING PROGRAM

The *California Code of Sustainable Winegrowing Workbook* is the centerpiece of the California Sustainable Winegrowing Program (SWP), an educational program to help growers and vintners increase adoption of sustainable practices and to measure and demonstrate continuous improvement. Although winegrape growers and vintners are widely using sustainable practices, the workbook's built-in measurement system enables winegrape growers and vintners to document and report on adoption of practices and continuous improvement. CSWA aggregates data for the statewide California Wine Community Sustainability Report, an important communications tool for public policy and stakeholder outreach.

The SWP has helped earned the California wine community a reputation as a leader in the adoption of sustainable practices. Through hundreds of workshops in winegrowing regions throughout the state, and by using the online self-assessment system, thousands of growers and vintners have evaluated their vineyard and winery operations using the workbook. In 2004, CSWA, Wine Institute, and CAWG issued the inaugural California Wine Community Sustainability Report that summarized participants' self-evaluation data to measure and document the level of sustainable practices among growers and vintners statewide and to set targets for continual improvement. In 2009, CSWA, Wine Institute, and CAWG released an updated 2009 Sustainability Report which showed an increase in performance in over 60% of the workbook criteria, and in 2015 released an updated Sustainability Report. The California Wine Community Sustainability Reports are available on the CSWA website at: http://www.sustainablewinegrowing.org/publications.php.

CSWA uses the lessons learned from the reports to improve program implementation, build new and existing partnerships, and continue measuring the adoption of best practices. In addition, CSWA secures grant funding from public and private sources to conduct targeted education workshops on topics such as integrated pest management, air and water quality, ecosystem management, and energy efficiency to help vintners and growers increase sustainable winegrowing adoption. CSWA collaborates closely with regional winegrower associations, scientists, UC Cooperative Extension, and other partners to undertake these educational events and the self-assessment workshops.

The SWP is designed to stimulate a "Cycle of Continuous Improvement" among growers and vintners, and the industry as a whole, by enabling them to evaluate their operations, learn about new approaches and innovations, develop action plans for improvements, and implement changes to increase their adoption of sustainable practices (**Figure 1-c**).

CSWA launched an online Performance Metrics tool in March 2012, where growers and vintners can enter data and calculate and store metrics related to sustainability, such as water and energy efficiency, greenhouse gas emissions related to energy, and applied nitrogen.

Figure 1-c The Cycle of Continuous Improvement.

ABOUT CERTIFIED CALIFORNIA SUSTAINABLE WINEGROWING

Introduced in January 2010, the workbook became the basis for a voluntary, third-party certification option, Certified California Sustainable Winegrowing (CCSW). With technical guidance and oversight by the Sustainable Winegrowing Joint Committee, CSWA developed the third-party certification program to increase the sustainability of the California wine industry by promoting the adoption of sustainable practices, ensuring continual improvement, and creating a verification process for vineyards and wineries. The goals of CCSW are to enhance transparency, encourage statewide participation, enhance credibility in the market and public policy arena, and advance the entire California wine industry toward best practices in environmental stewardship, conservation of natural resources, and socially equitable business practices.

All CCSW vineyards and wineries must meet the following requirements, which are verified during annual third-party audits:

- **Annual Self-Assessment:** Completion of an annual self-assessment of 144 vineyard & 105 winery best practices using the comprehensive California Code of Sustainable Winegrowing. Auditors verify that all self-assessment scores accurately reflect on-the-ground practices during the annual audit.
- **Minimum Score Threshold:** 85% of the total scores must be Category 2 or higher by Year Two of certification. Practices included in Category 2 and above are considered sustainable practices in the industry.
- **Prerequisite Practices:** There are 60 required prerequisite practices for vineyards, and 41 required prerequisite practices for wineries. (While prerequisites specify minimal scores, certified vineyards and wineries often score above these minimum practices.) For the complete list of prerequisite practices see the Certification Section.
- **Comply with Restrictions on Crop Protection Materials:** Crop protection materials on the CSWA Red List may not be used by Year Two of certification. If materials on the CSWA Yellow List are used, alternatives must first be tried or considered, and justification and mitigation of risk documented via a competed Use Form (see the Certification Resources page for additional details).
- **Sustainability Performance Metrics for Water, Energy, Nitrogen and GHGs:** Vineyards must measure, and record water use and nitrogen applied annually by Year Two of certification. Wineries must measure and record water use, energy use, and greenhouse gas emissions (GHGs) annually by Year Two of certification.
- **Continuous Improvement:** All certified vineyards and wineries must also demonstrate continuous improvement in the adoption of sustainable practices on an annual basis. Written action plans are created and audited to document the implementation of additional sustainable practices every year.
- **Annual 3rd Party Audit:** Participants must undergo an annual audit and submit an audit report each year that is reviewed by the Certification Review Panel, before the annual certification is awarded.
- **Chain of Custody Audits:** Wine bearing the CCSW logo or claims must be made in a certified winery, using at least 85% or higher grapes from certified vineyards and 100% California grapes. A winery that uses a certification claim or logo on a wine label is required to complete a Chain of Custody audit.

For more information about CCSW, see the CCSW **Certification Tab** at the back of the workbook, and visit https://www.sustainablewinegrowing.org/certified-sustainable-winegrowing.php.

Certification is a voluntary option; vintners and growers can still participate in the educational SWP and use the *California Code of Sustainable Winegrowing Workbook* to evaluate and improve their practices even if they do not choose to pursue certification.

HOW TO USE THIS WORKBOOK

This section presents five key steps as guidance for an effective way to use this workbook, particularly the first time that you undertake a self-assessment. The online system provides an opportunity to "clone" self-assessment data from year to year, which should speed the amount of time required to complete a self-assessment in subsequent years.

1. Familiarize Yourself with the Workbook

First, thumb through the workbook to get a feel for its scope and format. There are 144 self-assessment criteria for vineyards and 105 self-assessment criteria for wineries organized into the following 15 chapters beginning with chapter 2.

Chapter 2	Sustainable Business Strategy
Chapter 3	Viticulture
Chapter 4	Soil Management
Chapter 5	Vineyard Water Management
Chapter 6	Pest Management
Chapter 7	Wine Quality
Chapter 8	Ecosystem Management
Chapter 9	Energy Efficiency
Chapter 10	Winery Water Conservation and Water Quality
Chapter 11	Material Handling
Chapter 12	Solid Waste Reduction and Management
Chapter 13	Sustainable Purchasing
Chapter 14	Human Resources
Chapter 15	Neighbors and Community
Chapter 16	Air Quality and Climate Protection

Each chapter has a set of industry-specific criteria to self-assess the sustainability performance of vineyard and winery operations. Each criterion has four performance categories. The categories represent **increasing sustainability** moving from right to left (**Figure 1-d)**. Regulatory compliance for all practices is assumed. Category 1 is intended to meet or exceed legal requirements where they exist at the time of print; while Categories 2, 3 and 4 can move growers and vintners beyond compliance on a continuum towards increased sustainability. However, it is important to note that not all practices will make sense for all operations.

2. Decide What to Assess

Begin by selecting one or more vineyards and/or winery facilities to assess. If you manage multiple vineyards and/or winery facilities, you can assess all of your vineyards and/or winery facilities but choose one to start with. You will provide information about your vineyard(s) and/or winery(ies) when you complete the self-assessment forms if using the hard copy workbook, or as you get set up with an online account if using the online system to self-assess. Please contact info@sustainablewinegrowing.org if you would like to be set up in the online system.

3. Do Your Self-Assessment Online or With the Hardcopy Workbook

Read each question and decide if it is applicable to your vineyard and/or winery. **Not all the questions are applicable to every vineyard or winery operation**. After reading each category, decide which category best describes the operation you are assessing. (See **Figure 1-d** for an example of the categories.) You can use the confidential, online system to complete the self-assessment or the hard copy workbook. To get a password-protected userID to use the online system, contact info@sustainablewinegrowing.org.

CSWA recommends using the online system to complete the assessment as long as high-speed internet is available. The online system has many features that are beneficial when completing the assessment, such as displaying only the questions relevant to a vineyard or winery, tracking completion of the assessment, storing the data as it is entered, enabling more than one person to complete an assessment, etc. If you are using the hard copy version, the workbook includes sets of self-assessment evaluation sheets to keep track of your assessment (see the **Summary Evaluation Sheets** tab). Examples of evaluation sheets are provided in **Figure 1-e and Figure 1-f**.

Education boxes that contain supplemental information on specific sustainable practices follow many self-assessment criteria. Moreover, specific references, resources, and internet links are included for many criteria, and additional references are provided at the end of the workbook. For the most recent list of resources, please visit the CSWA website at http://www.sustainablewinegrowing.org/webresources.php.

5-6 Filters and Lines			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
The irrigation system was equipped with a properly operating flushing system for filters and lines and was monitored to maintain optimum operation multiple times per year *And* An inspection of the irrigation system was part of a regular maintenance program (i.e., conditions of screens and/or media checked at least twice per year).	Water filters in the irrigation system were inspected and cleaned when pressure differences were found, and irrigation lines were flushed multiple times per year to maintain proper irrigation system efficiency, if needed.	Water filters in the irrigation system were inspected and cleaned when pressure differences were found, and irrigation lines were flushed annually and on a regularly scheduled basis.	Water filters in the irrigation system were not regularly inspected and cleaned, and irrigation lines were not flushed on a regularly scheduled basis. *(Select N/A if the site was dry farmed during the assessment year)*

Increasing Sustainability

If the question is not applicable to your vineyard or winery operation, check the “not applicable” box.

Figure 1-d Example of the four-category self-assessment continuum of increasing sustainability.

Figure 1-e Example of online self-assessment system evaluation.

4. SOIL MANAGEMENT		V/W	4	3	2	1	N/A
4-8	Preserving or Increasing Organic Matter	V					
4-9	Soil Compaction	V					

9. ENERGY EFFICIENCY		V/W	4	3	2	1	N/A
9-4	Winery Motors, Drives, and Pumps	W					
9-5	Refrigeration System	W					

Figure 1-f Examples from self-assessment evaluation sheets for chapters 4 and 9.

To track your assessment using the hard copy workbook, you will find two separate sets of summary evaluation sheets near the end of the workbook (see **Summary Evaluation Sheets Tab**) one for vineyards and one for wineries. Each set of evaluation sheets have only self-assessment criteria pertinent to a vineyard or winery.

4. Develop Your Action Plan

Once you have completed the self-assessment portion of the workbook, the next step is developing an action plan for your vineyard and/or winery operation. Your evaluation sheets will show which areas of your vineyard and/or winery operation may need some changes in order to maximize performance or prevent environmental problems. Devote special attention to criteria that have a one or a two rating. These could be areas of potential concern. To develop an action plan, you will need to analyze your situation and then decide what to do and when it can be done. You decide what actions to take over the next five years. Remember, this is **your** action plan – it must suit you and your operation. The educational boxes and resource links in the workbook may be helpful in developing your action plan. You can also use a comparison report that can easily be generated in the online system, or by CSWA, that will compare your practices to the averages in your region and state to help identify which areas have the most opportunity for improvement to focus on with an action plan.

A detailed description of the process, examples, and blank action plan sheets are provided near the end of the workbook (see **Action Plans Tab**).

5. Submit Your Self-Assessment Evaluation and Provide Feedback

CSWA would like to **confidentially** receive your self-assessment evaluation sheets if you use the hard copy workbook. If you use the online system, your self-assessment evaluation is submitted to CSWA automatically. Your submission of this information is **voluntary**. This confidential information will be used by the Sustainable Winegrowing Program for the purposes described below.

- Create customized reports that show grower or vintner scores relative to aggregated state and regional averages;
- Provide regional assessment reports as feedback to regional winegrape grower and vintner associations to highlight areas of excellence and potential areas for improvement as a means to target educational programs and other resource investments;
- Improve the workbook self-assessment questions to accurately capture useful information on sustainable practices;
- Enable CSWA to aggregate data to demonstrate baselines and progress in the California Wine Community Sustainability Reports, a valuable public policy and outreach tool to communicate with key stakeholders; and
- Document beneficial sustainable practices and innovation that can be rapidly adopted by other vineyards and wineries.

Visit the CSWA website at http://www.sustainablewinegrowing.org to learn more about the online self-assessment system or contact info@sustainablewinegrowing.org to obtain a userID and password.

CSWA would also appreciate feedback on the workbook – both the hard copy and online editions. The workbook includes **Corrections, Comments, and Suggestions** sheets (see tab) to facilitate this feedback, and you may also submit feedback via email to info@sustainablewinegrowing.org.

2. SUSTAINABLE BUSINESS STRATEGY

Content originally appeared in Chapters 8 Ecosystem Management, 14 Human Resources, and 15 Neighbors and Community in first and second editions of workbook; Modified by the Sustainable Winegrowing Joint Committee

Strategy is often defined in terms of an operation's mission (what is your business), vision (what you want the business to be in the future), and values (what you believe and how you act). These components of strategy become the "why" for you, your family, and employees' future. In order to ensure that both sustainability and key business goals are met, a sustainability strategy should be fully aligned with and integrated into a company's business strategy. A well-defined sustainability strategy builds understanding, provides a framework for making wise decisions, gets work done, and provides a sense of community.

The California wine industry's definition of "sustainability" focuses on balancing economic profitability, environmental health, and social equity in the daily decisions made in winegrape growing and winemaking operations (see Chapter 1 Introduction for more details). Through the *California Code of Sustainable Winegrowing Workbook*, growers, vintners, and other industry experts translate this broad definition of sustainability into the set of practices that help further define sustainable winegrowing for the California wine industry.

Clearly defining your mission, vision, and values can be challenging. In our society we tend to be "doers" and this process may not seem like you are doing anything. But taking the time to develop a business strategy that integrates sustainability is important because it provides the ultimate foundation for making sustainable management decisions.

In addition, having compliance processes in place is foundational to sustainability. Category 1 in the workbook is considered to be the minimum level of sustainability for that criterion and within compliance, if regulations exist, with Categories 2-4 indicating increasing sustainability. The adoption of sustainable practices to drive continuous improvement can be an effective risk-management strategy and enhance the long-term viability of vineyards and wineries.

Sustainable Business Strategy was placed at the beginning of the workbook because it provides a framework and helps determine the practices that are used by vineyards and wineries. However, when completing the self-assessment, you may prefer to complete this chapter last, as responses to criteria in other chapters of the workbook may inform your sustainable business strategy.

The purpose of this chapter is to help growers and vintners integrate sustainability into their business strategy, if it is not already present. This also includes how growers and vintners address environmental compliance planning and how wineries integrate sustainability into communications.

List of Sustainable Business Strategy Criteria

2-1 Integrating Sustainability Into Business Strategy
2-2 Environmental Compliance Planning
2-3 Integrating Sustainability Into Communications Strategy

2-1 Integrating Sustainability Into Business Strategy* *Vineyard & Winery*

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation has formally integrated sustainability into the business strategy (e.g., company mission, vision, values, or equivalent documents) ***And*** These were shared with all employees and with external stakeholders such as neighbors, customers and others, as appropriate ***And*** The strategy was implemented consistently for at least one year and revised, if necessary.	The vineyard and/or winery operation has formally integrated sustainability into the business strategy (e.g., company mission, vision, values, or equivalent documents) ***And*** These were shared with appropriate employees.	The vineyard and/or winery operation has begun to integrate sustainability into the business strategy (e.g., company mission, vision, values, or equivalent documents).	The vineyard and/or winery operation has not yet integrated sustainability into the company mission, vision, values, or equivalent documents.

*The overall importance of a sustainability strategy and the mission, vision, and values of the Sustainable Winegrowing Program are presented in the Introduction of this workbook. For guidance on integrating sustainability into the company mission, vision, values see **Box 2-A through Box 2-D**.
**The entire self-assessment workbook can be used as tool to help develop your strategy. If you choose, you can revisit this first criterion after the rest of the self-assessment is completed.

BOX 2-A DEVELOPING A SUSTAINABILITY STRATEGY

It can be challenging to clearly define a sustainability strategy for your business that includes a mission (e.g., aim or purpose), vision (e.g., what you and your employees and colleagues envision for the future), and your values (e.g., your beliefs and principles that inform your actions).

Mission: The mission is an action statement that usually begins with the word "to". It is a very simple and direct statement about what you will achieve with your business that is easy to understand and remember.

Vision: A vision statement should include what you want to accomplish or achieve and be concise and easy to remember. Because it is easy to remember, it is easy for everyone to focus on the vision.

Values: Core values define the principles and values that the people carrying out the vision and mission will use while conducting their work.

For a useful guide on how to create a sustainability strategy that includes a mission, vision, and values statement, along with the goals and objectives to carry out the strategy, visit: http://www.extension.iastate.edu/agdm/wholefarm/html/c5-09.html.

Source: Hofstrand, D. Creating a Mission Statement, Setting Goals and Developing Strategies.

Sharing your sustainability mission, vision, and/or values with employees, neighbors, and community visitors can help build understanding and support for your vineyard and/or winery.

Box 2-B Examples of How to Include Sustainability in a Vision and Mission Statement

Whereas a mission statement describes your business and what you do, a vision statement announces to the outside world your goals and where your company is heading. The best vision statements are short, clear and concise, realistic and have measurable outcomes. Once the vision is set, it is helpful to set priorities or goals that work to implement the vision. You may choose to display the vineyard or winery's mission and vision prominently in the workplace for all employees to see.

Below are several examples of vision and mission statements.

Fetzer Vineyard's Vision/Mission

Our vision is to operate in a way that restores, revitalizes and regenerates ecosystems and communities, while producing premium quality wines, advancing the health and well-being of employees, and producing sustainable growth for shareholders. With the goal of not just sustaining the world around us, but enhancing it, we are committed to using regenerative and restorative business practices that not only reduce negative impacts, but work towards creating positive impacts on the environment, people and communities. To implement this vision, we look for opportunities in our business, from the vineyards to the winery to the bottling line, where we can drive change. We're poised to take bold steps towards this vision of regeneration and help catalyze the movement to redefine what responsible business is all about.

Wente Family Estates

Vision: We strive to be one of the most respected family-owned wineries in the world.

Mission: To inspire people to make time for what matters, by creating and delivering outstanding wine and wine country experiences.

Values: Respect, integrity, sustainability, excellence

California Sustainable Winegrowing Alliance's Vision/Mission

As described in Chapter 1 Introduction, Wine Institute, CAWG and the Sustainable Winegrowing Joint Committee developed a Mission, Vision and Values to help guide the development of this workbook. CSWA also created a mission and vision when the organization was first formed in 2003. In 2009, the mission and vision were reviewed and modified to reflect the changing needs and direction of the organization, so that it can best serve winegrape growers and vintners throughout California.

Vision: A successful California winegrower and vintner community, broadly recognized and accepted by all relevant stakeholders as a leader in sustainability, operating in an economically prosperous, socially and environmentally responsible manner. It is our belief this will result in vibrant businesses, stronger communities, and a healthier environment.

Mission: The California Sustainable Winegrowing Alliance will be recognized globally as the leader in sustainable winegrowing in the marketplace and public policy arena through the development and promotion of sustainable practices, tools for education and outreach, partnerships with key stakeholders, and priority research.

BOX 2-C CHECKING YOUR VALUES – A FIVE-STEP TEST

1. Am I producing the best quality wine and/or grapes possible?
2. Am I respecting the environment and using our natural resources wisely?
3. Have I considered my impact on our industry and my neighbors?
4. Am I doing my part to give back to the community?
5. Are high ethical standards being practiced in my place of business?

For more information on developing your values statement see *The Winegrape Guidebook for Establishing Good Neighbor and Community Relations,* developed by the California Association of Winegrape Growers, available in the CSWA Resource Library at https://library.sustainablewinegrowing.org/.

BOX 2-D SONOMA COUNTY WINEGRAPE COMMISSION – VALUES STATEMENT

OUR MISSION
The mission of the Sonoma County Winegrowers is to increase the value of Sonoma County winegrapes and to nurture and protect this agricultural resource for future generations.

Our Values
Sonoma County Winegrowers are family farmers who work hard every day to produce high quality grapes that are the foundation for world class wines. We are dedicated to sustaining our land for future generations. We preserve the land where we live and work and the water and air that we share with neighbors. We actively support our communities and are proud to be a part of Sonoma County.

For more information, visit: http://www.sonomawinegrape.org/.

2-2 Environmental Compliance Planning* *Vineyard & Winery*

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation had an established process to monitor and review environmental legal and regulatory requirements that pertain to the operation and, to the best of our relevant staff's knowledge, is in compliance** ***And*** The vineyard and/or winery operation had a compliance strategy that was reviewed at least annually to address legal and regulatory requirements that included a list of all relevant permits and licenses and a system for keeping abreast of permit renewal dates, any monitoring and reporting, and permit terms*** ***And*** All relevant employees were informed of the compliance requirements and understood the purpose of permits and knew which staff to contact when regulators visit the operation ***And*** We proactively interact with regulators affecting our business (e.g., submit public comments, participate in working groups, direct communication with regulators for permit clarification, etc.) ***And/Or*** We belong to an association that addressed regulatory and compliance issues.	The vineyard and/or winery operation had an established process to monitor and review environmental legal and regulatory requirements that pertain to the operation and, to the best of our relevant staff's knowledge, is in compliance** ***And*** The vineyard and/or winery operation had a compliance strategy that was reviewed at least annually to address legal and regulatory requirements that included a list of all relevant permits and licenses and a system for keeping abreast of permit renewal dates, any monitoring and reporting, and permit terms*** ***And*** All relevant employees were informed of the compliance requirements and understood the purpose of permits and knew which staff to contact when regulators visit the operation.	The vineyard and/or winery operation had an established process to monitor and review environmental legal and regulatory requirements that pertain to the operation and, to the best of our relevant staff's knowledge, is in compliance** ***And*** The vineyard and/or winery operation had a compliance strategy to address legal and regulatory requirements that included a list of all relevant permits and licenses and a system for keeping abreast of permit renewal dates, any monitoring and reporting, and permit terms.***	The vineyard and/or winery operation had an established process to monitor and review environmental legal and regulatory requirements that pertain to the operation and, to the best of our relevant staff's knowledge, is in compliance.**

*See **Chapter 14 Human Resources** for relevant sources and information about ensuring human resources compliance including **Criterion 14-1**.
Environmental legal and regulatory compliance requirements can include, but are not limited to, laws and regulations related to water quality, water supply, air quality, hazardous materials, hazardous wastes, etc. See **Box 2-E and **Box 2-F** for more information. When completing a self-assessment, a vineyard or winery that is actively responding to a regulatory non-compliance issue may still score themselves as "in compliance." E.g., if there is an active Notice of Violation at the vineyard and/or winery, the issue has been identified, corrective actions are in place, and the issue is being resolved with the oversight agency.
***A list of permits and licenses can be as simple as a list with expiration dates, renewal dates, purpose of permit and costs, and a system for keeping informed of renewal dates can vary from calendar reminders to compliance software systems. See **Box 2-F** for a template and for more information about the environmental permits that are commonly applicable to a winery or a vineyard. A list of permits, information on the applicable regulatory program area, legislation, and relevant regulatory agencies, and a simplified self-assessment form are available.
****See **Box 2-G** for a description of how environmental compliance planning can also be a risk mitigation measure.

BOX 2-E LEGAL AND REGULATORY COMPLIANCE PLANNING

Throughout the California Code of Sustainable Winegrowing, compliance is assumed for all practices where legal and regulatory requirements exist. As appropriate, Category 1 is intended to meet or exceed legal requirements (at the time of print); while Categories 2, 3 and 4 reflect practices that move beyond compliance on a continuum towards increased sustainability.

The United States of America has stringent environmental and social laws and regulations. The Clean Water Act, the Clean Air Act, the Endangered Species Act, and the National Environmental Quality Act are examples of some of the foundational laws for US environmental regulation; while the Fair Labor Standards Act, the National Labor Relations Act, the Civil Rights Act of 1964 and the Occupational Safety and Health Act are among the foundational US labor laws. These federal laws result in numerous compliance requirements for vineyards and wineries.

In addition to the federal requirements, California has an even stronger regulatory framework for both environmental (including land use, water use and quality, air quality, hazardous materials), and human resources (including employer requirements and worker health and safety). California's Environmental Quality Act, the California Air Resources Act, Health and Safety, the Porter-Cologne Water Quality Control Act, and Hazardous Materials Inventory and Reporting Requirements are some of the state-specific laws that form the basis for state and regional environmental regulations and ordinances. The Ag Labor Relations Act guarantees certain rights to California farmworkers and applies to all; while California's Division of Occupational Safety and Health (Cal/Osha) sets and enforces standards, issues permits/licenses/certifications/registrations/approvals, and provides outreach and education to protect and improve worker health and safety.

While the Code addresses legal requirements within 72 relevant criteria and educational content, the complex tapestry of federal, state and local laws, regulations and ordinances – which are only strengthening in stringency over time – requires planning to ensure on-going compliance. Criterion 2-2 and 14-1 lay out a continuum of practices to become more efficient and action-oriented in addressing these issues. See below for a list of resources and best practices, and a template for tracking permits and licenses.

Resources and Best Practices

- See the Code's Chapter 14 for laws and regulations, as well as best practices, related to Human Resources and health and safety.
- California Environmental Protection Agency - http://www.calepa.ca.gov/
- Local Agricultural Commissioner - https://www.cdfa.ca.gov/exec/county/countymap/
- Local Farm Advisors - https://wineserver.ucdavis.edu/person-type/46
- A Handbook on the California Agricultural Labor Relations Law - https://www.alrb.ca.gov/forms-publications/handbook/
- Winegrape, wine and agricultural associations:
    - California Association of Winegrape Growers - www.cawg.org
    - Wine Institute - www.wineinstitute.org
    - California Farm Bureau Federation - www.cfbf.com
    - California Farm Labor Contractor Association - www.calflca.org
    - CalChamber - https://www.calchamber.com/Pages/default.aspx and local Chambers of Commerce
- Safety, health and human resources training:
    - Farm Employers Labor Service - http://www.fels.net/1/labor-safety.html
    - AgSafe - www.agsafe.org
- Find your local Chamber of Commerce at: http://advocacy.calchamber.com/resources/local-chambers/
- Local Ag Commissioner Offices can be found at: https://www.cdfa.ca.gov/exec/county/countymap/

BOX 2-F ENVIRONMENTAL PERMITS FOR VINEYARDS AND WINERIES

California vineyards and wineries must comply with a myriad of environmental legal and regulatory requirements. They can cover areas such as water quality, water supply, air quality, hazardous materials, and hazardous wastes. Keeping a single list with all of the permits and licenses needed to remain in compliance is a simple way to keep track of expiration and renewal dates (see below for a list template).

Example Template for List of Permits and Licenses

Permit/License	Expiration Date	Renewal Date	Purpose of Permit	Cost	Person Responsible

Understanding which permits apply to the vineyard and/or winery is also essential for staying in compliance. CSWA has worked with experts to develop a list of the environmental permits that are commonly applicable to a California winery or vineyard that includes information about the applicable regulatory program area, legislation, and relevant regulatory agencies. A simplified questionnaire for determining which permits may be relevant is also provided. To see the latest list and questionnaire visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/.

Box 2-G Environmental Compliance Planning Helps Reduce Risk

Winegrape growers and vintners in California often confront significant challenges from unpredictable natural physical conditions and market factors. Moreover, unprecedented changes in local and global climate, as well as increased regulatory and economic pressures, have exacerbated risks. Having a strong environmental compliance planning process in place that include sustainable practices can help mitigate risks in numerous regulatory areas.

In collaboration with the USDA Risk Management Agency, CSWA created A Winegrowers' Guide to Navigating Risk to demonstrate how sustainable winegrowing practices can help to mitigate risk in the vineyard, winery and marketplace.

The guide addresses economic, environmental, and social risks; and reveals that these risks are often interrelated (e.g., environmental risks in farming often have financial implications for individual producers and/or to society). Effectively navigating the complexity of risks helps producers ensure their long-term business success by simultaneously achieving financial goals while benefiting human and natural resources.

Some examples of risks that can be mitigated through sustainable practices are referenced below:

Risks to California Winegrape Production:	Corresponding Mitigation (Sustainable Practices):
Water scarcity	Water conservation and efficiency
Impaired quality of water	Water quality protection
Decreased quality of soil	Soil conservation and management
Diminished air quality and climate change	Air quality protection
Outbreaks of pests	Integrated pest management
Rising cost of energy	Energy conservation and efficiency
Increased cost of labor and labor shortages	Human resource management
Aberrant weather and natural disasters	Weather monitoring and preventive planning
Unexpected market challenges	Selection of appropriate insurance policies and tools
Inadequate planning for succession	Proactive business planning and management

To download the Guide, visit: https://library.sustainablewinegrowing.org/.

2-3 Integrating Sustainability Into Communications Strategy			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
The winery operation has formally integrated sustainability into its communications and/or marketing strategy (e.g., website, promotional materials, vineyard/winery tours, tasting rooms) ***And*** Appropriate employees (e.g., tasting room staff, sales teams) were trained to communicate sustainability with customers (trade and consumers)* ***And*** Appropriate employees were aware of customer interest and marketplace trends in sustainability.**	The winery operation has formally integrated sustainability into its communications and/or marketing strategy (e.g., website, promotional materials, vineyard/winery tours, tasting rooms) ***And*** Appropriate employees (e.g., tasting room staff, sales teams) were trained to communicate sustainability with customers (trade and consumers).*	The winery operation has begun to integrate sustainability into its communications and/or marketing strategy (e.g., website, promotional materials, vineyard/winery tours, tasting rooms) ***And*** The winery's sustainability initiatives were shared with appropriate employees (e.g., tasting room staff, sales teams).	The winery operation has not yet integrated sustainability into its communications and/or marketing strategy.

*There are many ways to train employees about your sustainability, such as including sustainability information in team meetings, providing vineyard/winery tours about practices, and sharing written information about your practices and certification, if applicable. The **California Sustainable Winegrowing Ambassador** course is a free one-hour online course designed to educate wine professionals and others about sustainability practices and programs (see https://ambassador.discovercaliforniawines.com/.) Also see the Certification Communications Toolkit for other staff training resources: https://www.sustainablewinegrowing.org/certificationtoolkit/.
**Awareness of trends can include conversations with customers, reviewing sustainability trade and consumer research results, attending events where sustainability trends are discussed, etc. The Value of Certification handout includes trade and consumer research on sustainability, as well as information about other marketplace trends (visit the CSWA Resource Library at https://library.sustainablewinegrowing.org and search for Value of Certification).

3. VITICULTURE[1]

Original Chapter Authors: Clifford P. Ohmart and Stephen K. Matthiasson, formerly with Lodi Winegrape Commission; Modified by the Sustainable Winegrowing Joint Committee

California winegrape growers have a long history of producing excellent quality grapes for winemaking. They also have a great record of adapting to change and confronting challenges as they continue to improve the quality of winegrapes and wine throughout various regions in the state.

The intense international and domestic competition compels every California grower to be fully engaged in the quest for quality. Yet practices that may work well for one winegrowing region may not be ideal for another. Choosing the most appropriate vineyard locations and employing vineyard practices aimed at fulfilling these expectations will allow California growers to increase their share of the domestic and world markets and continue to enhance California's role as one of the finest wine regions in the world.

The other major trend facing growers is the emphasis on environmental quality and the long-term sustainability of our vineyards. Environmental regulations are a reality that the 21st century farmer faces every day. California winegrowers also want to ensure that future generations inherit viable and intact vineyard lands and are able to continue farming. Thinking ahead to anticipate and avoid problems is generally a more effective approach than mitigating the effects of problems caused by inappropriate vineyard development.

As noted in the Introduction, economic feasibility is one of the three tenets of sustainability. Therefore, when using this workbook, it is important to recognize that, because grape prices vary significantly by region and variety, economic constraints will influence the degree to which some of the practices discussed in this chapter, and throughout the workbook, can be implemented.

The purpose of this chapter is to help growers confidently address viticultural practices that affect both winegrape quality and environmental concerns. It includes 19 criteria to self-assess:

- Vine canopy management in your vineyard
- Crop development
- Important environmental constraints on vineyard establishment and development.

[1]This chapter has been adapted from Lodi Winegrape Commission's *Lodi Winegrower's Workbook* (Ohmart and Matthiasson, 2000). Many of the criteria in this chapter appeared as questions in the Central Coast Vineyard Team's Positive Points System, the first vineyard self-assessment system in California (CCVT, 1996 and 1998).

List of Viticulture Criteria

Selecting a trellis that will adequately support the vine and crop, while requiring the least inputs and maintenance is an important factor to achieving optimal wine quality.

3-1 Balanced Vines*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Vineyard design (spacing, trellising, and training), and pruning, crop load adjustments, irrigation, and cover cropping were implemented successfully to keep vines in balance (see **Boxes 3-A** and **3-B** for parameters) ***And*** Vine phenology was recorded using a method such as the modified E-L** scale, or by documenting various phenological dates.	Balanced vine growth stopped around veraison, and was hedged only on occasional years, the leaves remained large ***And*** Crop was adjusted at or near berry set and prior to veraison on weak shoots/weak vines.	Vines were vigorous, but growth was still slowed after the beginning of veraison ***Or*** Vines were hedged annually ***Or*** Vines were too weak to support the fruit load for balanced ripening, resulting in diminished fruit quality during harvest.	Vines were vigorous and strong growth continued after the beginning of veraison, resulting in fully shaded fruit ***Or*** Most vines were weak and many shoots lacked the vigor to ripen the clusters or prevent sunburn and were usually left behind at harvest.

*Balanced vine parameters are specific to the variety and site. The information provided here is simply a guide.
**Eichhorn and Lorenz (1977) uses a scale of 1 to 47 (dormancy to leaf fall) to record the grape phenological stages. Revised versions of this scale are also currently used.
http://www.winegrowers.info/spraying/development%20stages%20of%20the%20vine.htm.

Achieving balanced vines is ideal. If vines are balanced (based on proper rootstock, trellis, spacing, cover crop, irrigation, and fertilization), then leaf removal, shoot removal, etc. are unnecessary on a yearly basis.

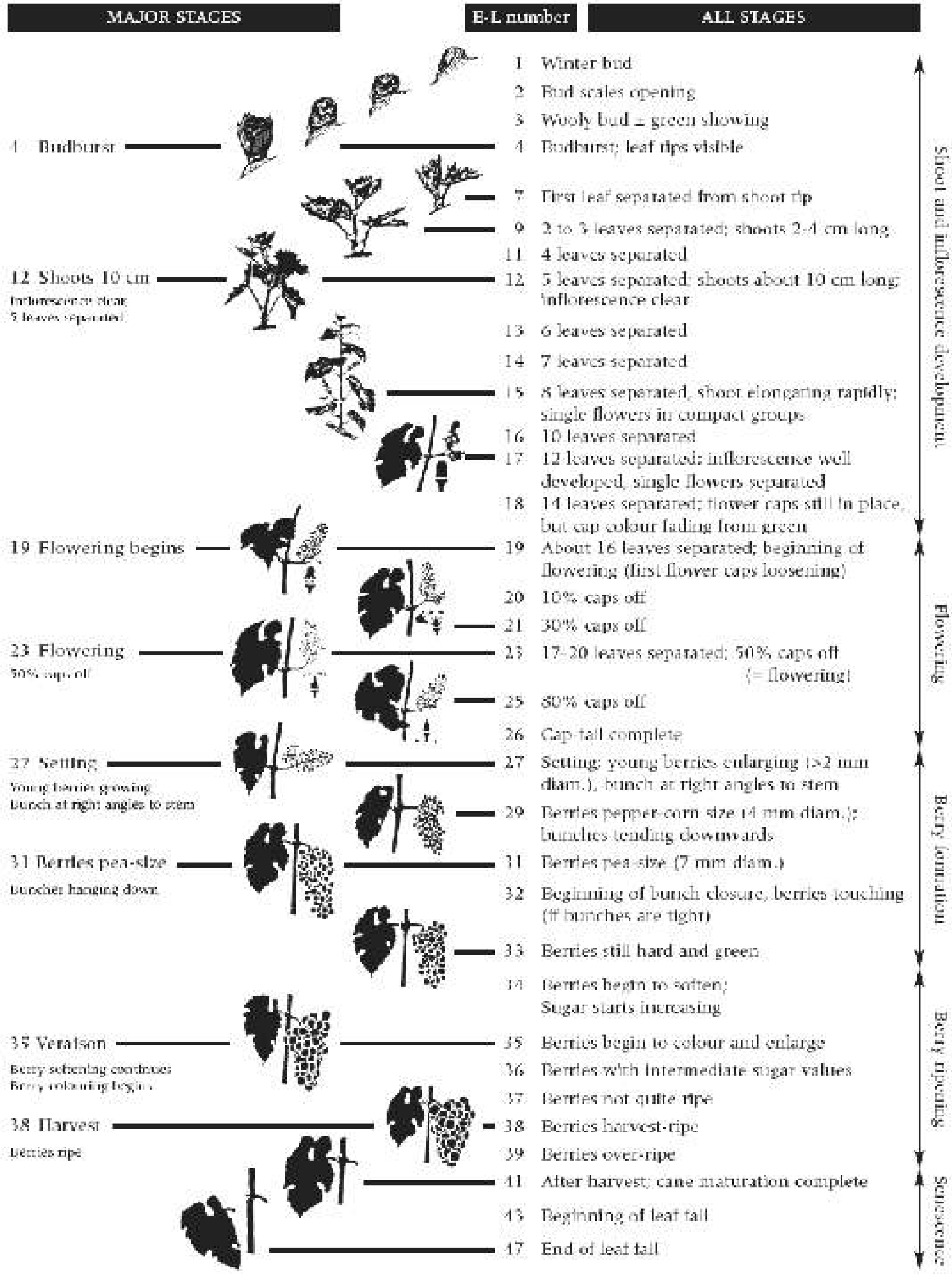


Figure 7.3 Modified E-L system for identifying major and intermediate grapevine growth stages (revised from Coombe 1995). Note that not all varieties show a woolly bud or a green tip stage (May 2000) hence the five budburst stages in the modified original 1995 system have been changed slightly by removing stage 4 and allocating the definition of budburst to what was formerly stage 5.
Revised version of 'Grapevine growth stages – The modified E-L system' Viticulture 1 – Resources. 2nd edition 2004. Eds. Dry, P. and Coombe, B. (Winetitles)

Box 3-A Some Features of a Balanced Vine for the Northern Interior and Central (Valley) California Winegrowing Regions

- Shoot or tip growth slows or is minimal around veraison.
- Shoots are 36-54 inches long (without any "bull canes" or long canes having an oval-shaped cross-section), but variety differences do exist and there is disagreement among some experts as to the importance and use of shoot length as an indication of vine balance. In any case, shoots need to be long enough to provide sufficient leaf area to mature the crop and to provide dappled shade on the fruit from excessive direct sunlight, but should not grow excessively, such as to require repeated trimming.
- Internodes should be typical of the variety and between 3 and 6 inches long.
- At least 50% of the fruit is visible (from the outside of the canopy) for Northern Interior and 20-40% for Central California – fruit sees some sunlight during the day, but is not directly exposed for long periods of time, especially during the hottest time of day, which is 3 to 4 pm.
- 60-80% of the leaves are exterior leaves.
- Leaves tend to be moderate in size (i.e., no "dinner plate" leaves).
- 20-40% gaps in the canopy (for sunlight and air penetration).
- All non-basal leaves are functional (green) through harvest, not abscising or burning off. Basal one or two leaves may be lost near harvest without detriment.
- Lateral shoots are rare.
- Leaves are layered 3-4 leaves deep between the canopy exterior and the fruit zone (for warmer weather and/or mechanized pruning).
- 20-24 nodes per cane exist, or 12 functional leaves per cluster, but variety differences do exist.
- 5-6 shoots per foot of cordon exist.

BOX 3-B SOME FEATURES OF A BALANCED VINE FOR THE COASTAL WINEGROWING REGIONS

- Shoot tips stop growing or growth has slowed considerably by veraison. Shoots should no longer be growing two weeks after the onset of veraison.
- Shoots are 38-42 inches long without any "bull canes" (long canes having an oval-shaped cross-section). In cool and windy areas, canes are longer than 38 inches (e.g., northern Salinas Valley). There is disagreement among some experts as to the importance and use of shoot length as an indication of vine balance. In any case, shoots need to be long enough to provide sufficient leaf area to mature the crop and to provide dappled shade on the fruit from excessive sunlight, but should not grow excessively, such as to require more than a single trimming pass.
- Internodes should be typical of the variety and between 3 and 5 inches long.
- Basal Shoot diameter is 1/2-5/8 inches.
- Approximately 50% of the fruit is visible from the outside of the canopy – fruit sees some sunlight during the day, but is not directly exposed for long periods of time, especially during the hottest time of day, which is 3 to 4 pm.
- 80-100% of the leaves are exterior leaves.
- Leaves tend to be moderate in size (i.e.,no "dinner plate" leaves).
- 20-40% gaps in the canopy (for sunlight and air penetration).
- All non-basal leaves are functional (green) through harvest. Basal one or two leaves may be lost near harvest without detriment.
- Lateral shoots are rare.
- Leaves are layered 1-2 leaves deep between the canopy exterior and the fruit zone.
- There are 18-22 nodes per cane, but variety differences do exist.
- Approximately 4-5 shoots exist per foot of cordon.
- Shoots and fruit are evenly distributed along the fruiting zone. Fruit is not clumped together or layered.

3-2 Shoot Density*

Vineyard

See ***Box 3-C*** *for comments on head-trained vines*

Category 4	Category 3	Category 2	Category 1
Shoots were thinned to the appropriate level for achieving an optimum number of shoots per foot of cordon appropriate for the variety and region* ***And*** If weak and non-fruiting shoots, shoots with late-ripening clusters, and shoots sprouting from the head of the vine existed, they were removed ***And*** Shoots and fruit were equally distributed along the fruiting zone.	Weak and non-fruiting shoots, shoots with late-ripening clusters, and shoots sprouting from the head of the vine were removed.	Shoots were removed from the head area or removed mechanically from more vigorous areas.	Undesirable high density shoots and/or weak shoots with late-ripening clusters existed, but shoot removal or positioning was not feasible. *(Select N/A if shoot thinning was not economically viable or desired in the vineyard or wine program)*

*E.g., approximately 5 shoots per foot of cordon for the Central Coast region (Larry Bettiga, UC Viticulture Farm Advisor, Monterey, San Benito, and Santa Cruz Counties), and 5-6 shoots per foot of cordon for Northern Interior and Central California regions (see **Boxes 3-A** and **3-B**). Check with an appropriate UC Farm Advisor for the appropriate shoot density for your vineyard.

3-3 Leaf Removal*

Vineyard

Category 4	Category 3	Category 2	Category 1
No leaf removal was necessary – the cluster zone was appropriately exposed to indirect light** and fruit temperature was optimum ***And*** Worked with grape buyer/winery to achieve desired goals based on target characteristics.	Leaves around the clusters were removed shortly after bloom to expose the clusters to the appropriate amount of indirect light**.	Leaf removal was sometimes done, or very lightly done, to minimize costs.	No leaf removal was done and the cluster zone was fully shaded. *(Select N/A if leaf removal was not permitted or leaf removal was inappropriate for your variety or region because of concerns about excessive fruit temperatures)*

*See **Box 3-C** for more information on how to do leaf removal.
**E.g., 20-40% exposed for the Interior regions and 50% for the Coastal regions. The goal is for vineyard design (in-row vine spacing, trellis configuration, and row orientation), irrigation, and nutrient management to result in appropriate fruit exposure, making leaf removal unnecessary.

Exposure of the clusters to light is one of the most important factors in wine quality – light on the berries enhances both color and flavor.

Box 3-C How to Do Leaf Removal

In general, the proper time for leaf removal is immediately after berry set, when berries are not quite pea-sized. If done before fruit set, berries may fail to set (shatter); too early after set, clusters may be accidentally removed while; too late, sunburn may occur more easily on the berries, which need time to acclimate before the summer sun gets too intense. Furthermore, earlier leaf removal reduces the accumulation of the "vegetal" pyrazine compounds in the fruit of some varieties. Only the leaves and lateral shoots around the clusters need to be removed (2-3 leaves per shoot) – the entire basal section of the cane does not need to be stripped. **To prevent sunburn in all but the coolest regions of the state, remove leaves from only one side**. This means that leaves should be removed only on the side of the canopy that is not illuminated during the afternoon heat (between 2:00 and 4:00 pm, usually). For example, in north/south-oriented vineyards, only leaves from the east side should be pulled, and in east/west-oriented vineyards, only leaves from the shaded north side should be pulled. For row orientations between those two extremes, consider where the sun will be shining during mid-afternoon and avoid leaf removal on that side. In hot-climate regions, leaf removal may cause excessive fruit temperatures, adversely affecting fruit quality and subjecting fruit to sunburn, shrivel, loss of acidity and color. For that reason, leaf removal may be undesirable for hot regions or regions that are frequently subjected to extreme changes in temperature.

In head-trained vines, crown suckering (removal of shoots sprouting from parts of the vine other than the spurs) is more important than leaf removal. Crown suckering is commonly done when shoots are 9-12 inches long. In younger, more vigorous, head-trained vines, or during years with more canopy growth than usual, leaf removal is also necessary. Lower leaves and lateral shoots should be removed from the northeast side. Top leaves should remain attached, acting as an umbrella over the fruit.

The above photo shows an example of excellent bunch exposure without leaf removal. This block of Merlot on Freedom rootstock with a two-wire bilateral trellis (typically a high-shade scenario) was managed with a permanent, native grass cover crop and regulated deficit irrigation. The only canopy management technique needed was weak-shoot removal. The clusters are loose, leaves are medium-sized, canes have 20-24 nodes, and bunches are properly exposed. Most vineyards can be managed to achieve balanced vines.

3-4 Crop-to-Pruning Weight Ratio*

Vineyard

Category 4	Category 3	Category 2	Category 1
Crop-to-pruning weight ratio was monitored and recorded, and adjustments were made to maintain the ratio in the regionally appropriate range* (e.g., via crop load adjustment, trellis retrofitting, differential pruning, and irrigation and nutrition management).	Crop-to-pruning weight ratio was monitored, and an attempt was made (e.g., via irrigation management) to achieve the range appropriate for the region*.	Techniques for monitoring crop-to-pruning weight ratios had been researched but not fully implemented.	There was no familiarity with the concept of crop-to-pruning weight ratios. *(Select N/A if hedging did not allow accurate data collection)*

*4:1 to 8:1 for the Northern Interior region; 5:1 to 10:1 for the Central Coast region; 4:1 to 10:1 for the Central California region, but 10:1 to 12:1 may be appropriate in some situations. In general, the ratio should be lower for red than white varieties. See **Box 3-D** for information on how to measure crop-to-pruning weight ratios.

BOX 3-D A SIMPLE METHOD TO MEASURE CROP-TO-PRUNING WEIGHT RATIOS

There are several ways to measure crop-to-pruning weight ratios. One easy method only requires a fish scale and record keeping. Designate 10 “count” vines for vineyards up to 20-40 acres. Record the weight of the crop from these vines at harvest and of the prunings in winter. The ratio tells you a great deal about your vine balance – low ratios indicate excessive vigor, while high ratios indicate over-cropping. To ensure accurate ratios, avoid trimming or hedging the “count” vines. It should be noted, however, that disagreement exists among some experts about whether hedging or not hedging the “count” vines is appropriate.

For more precise ways of measuring crop-to-pruning weight ratios, consult with an appropriate UC Viticulture Farm Advisor.

3-5 Vineyard Design and Trellis *Vineyard*

Category 4	Category 3	Category 2	Category 1
Trellis and vine spacing accommodated the vigor of the vines, providing an open canopy with appropriate exposure of the fruit zone to light without having required leaf removal ***And*** Shoots were positioned in the correct way for the trellis.	Trellis and vine spacing accommodated the vigor of the vines, providing an open canopy with moderate exposure of the fruit zone to light but still required leaf removal (by hand and/or machine) ***And*** Shoots were positioned in the correct way for the trellis.	Trellis and vine spacing spread the vine out but shaded the fruit even with leaf removal; or the trellis and vine spacing facilitated some overly exposed fruit ***And*** Shoots were positioned in the correct way for the trellis.	Trellis facilitated uncontrolled growth, which in turn resulted in a very shaded and hidden fruiting zone; or the trellis and vine spacing facilitated an overly exposed fruiting zone ***And*** No shoot positioning had been attempted. *(Select N/A if no trellis was used)*

In some regions such as the North Coast, a trellis retrofit can pay for itself in the first few years.

BOX 3-E THE RELATIONSHIP BETWEEN MECHANIZATION AND SUSTAINABILITY

One major goal of sustainability is input reduction. Manual labor is a significant input that has increased over the past decade in premium winegrape production. Labor costs continue to increase, impacting economic feasibility and labor availability can be another challege. Quality of life issues, as well as vineyard economics, make the reduction of manual labor in vineyards an increasingly important consideration for many operations. Mechanization of some vineyard activities, particularly canopy management practices such as pruning, trimming, wire-lifting in VSP trellis systems, and harvesting can significantly reduce labor needs. Furthermore, in regions of California where per-ton winegrape prices are low, mechanization enables growers to enhance their economic viability – one of the three "E"s of sustainability. Mechanization will continue to have an important and increasing role in certain aspects of sustainable winegrowing in all growing regions. Vineyard design, size, topography and choice of trellis are two factors that affect to what level mechanization can be used in a vineyard.

3-6 Vineyard Vigor Uniformity			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
To achieve uniform vegetative growth and fruit development in the vineyard block, vines were pruned differentially to match their vigor, weak shoots were removed, irrigation blocks and durations were tailored to the soil differences and rootstock requirements/ differences ***And*** A written pruning plan was implemented.*	To achieve uniform vegetative growth in the vineyard block, vines were pruned differentially to match their vigor, or weak shoots and crop were removed, and irrigation blocks and durations were tailored to the soil differences.	To achieve uniform vegetative growth in the vineyard block, vines were pruned to match their vigor.	No attempt was made to assure uniform vegetative growth and fruit development in the vineyard block.
*A written pruning plan can include cultural practices for achieving balanced vines, timing for pruning (e.g. when there is no threat of rain, as late in the season as possible), application of pruning-wound protectants, etc.			

3-7 Monitoring Canopy Density and Vigor			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
The canopy density and shoot-tip vigor were monitored by an objective method (e.g., visual assessment and point-quadrat, see **Box 3-F**) and recorded at various times throughout the growing season with corrective actions taken, if necessary.	The canopy density or shoot-tip vigor were monitored by an objective visual assessment (see visual assessment example in **Box 3-F**) at various times throughout the growing season with corrective actions taken, if necessary.	The canopy density and shoot-tip vigor were monitored by casual observation.	The canopy density and shoot-tip vigor were not monitored.

For optimum light and air exposure, a percentage of the fruit should be visible as regionally appropriate (e.g., 20-40% for Interior and 50% for Coastal regions), with most fruit seeing some sunlight during the day, but not directly exposed for long periods of time. Too much fruit exposure results in excessive fruit temperatures, causing lower quality, sunburn, etc. Be particularly careful in hot-climate regions.

Box 3-F Examples of Canopy Density and Visual Water Stress Monitoring Methods

Visual Assessment*: Done twice annually, once each at veraison and 10 days before harvest. The scorer stands with the sun at his/her back, first away from the canopy, and then next to the canopy. Three parameters are estimated while standing away from the canopy: percentage gaps (ability to see through the canopy), leaf size, and leaf color. Percentage gaps should be in the range of 30-40%; leaf size should be slightly small (not average, slightly large, very small, or very large); and leaf color should be green, healthy, and slightly dull (rather than bright green and shiny, yellowish, or otherwise unhealthy). Five parameters are assessed while standing alongside the canopy: canopy density (leaf layer number), fruit exposure, typical shoot length, lateral presence/absence and growth, and presence or absence of growing shoot tips. For optimum ranges for these and other parameters for balanced vines, see **Boxes 3-A** and **3-B**. Observations should be made and recorded each year, providing a valuable database for vine vigor and canopy management.

Point Quadrat Method*: A stick or rod is used to measure a canopy's density. The rod is pushed into the canopy at fixed points along the fruiting zone, such as every 6 inches, and the incidence of gaps, leaves, and clusters that the rod encounters is recorded. This should be a measurement made without bias, using a tape measure or jig to guide sampling locations. Ten insertions for each of 10 vines across a 20-40 acre block should be adequate. Measurements should be taken, recorded, and evaluated annually and will vary widely by variety and training system. However, to provide a starting point, some "ideal" numbers follow: there should be 40-50% gaps; leaves divided by insertions (leaf layer number) should be 1.5-2.0; interior leaves divided by total leaves (percent interior leaves) should be 8-10%; and interior clusters (clusters with no exterior surface) divided by total clusters (percent interior clusters) should be <25%. An overly vigorous canopy, for example, might have 0% gaps; a 3-5 leaf layer number; 40-50% interior leaves; and 80-100% interior clusters.

Shoot Tip Vigor**: Evaluation of shoot tip vigor is done to observe the rate of water stress developing throughout the season and to insure that shoot growth has slowed or has stopped at or near veraison. To assess shoot tip growth, it may be necessary to push leaves and tendrils toward the tip. Generally accepted methods include 4 to 6 levels of water stress with differences that can include:

(0) Tendrils are long and growing well over one inch past the shoot tip with long internodes
(1) Tendrils growing just past the shoot tip, one inch or less
(2) Tendrils even with the shoot tip and upper leaves
(3) The leaves extend past the shoot tip and new tendrils may be shriveling, drooping or may have fallen off
(4) The shoot tip is well inside the upper leaves with tendrils that have fallen off or shriveled
(5) The shoot tip is shriveled and dry.

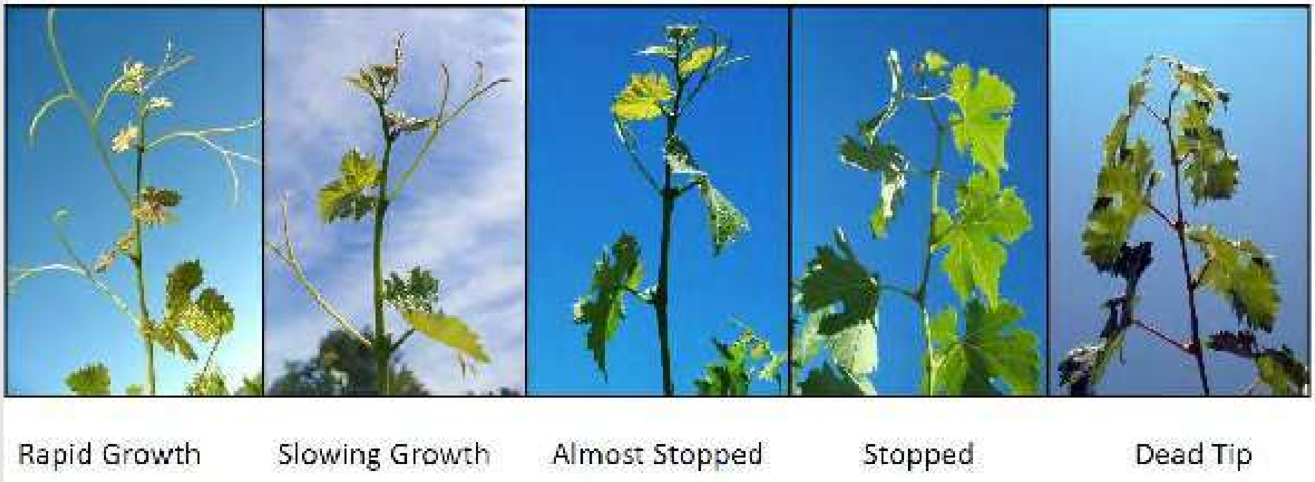


Photo source: Mark Greenspan,
http://advancedvit.com/wp-content/uploads/2017/04/Shoot_tip_indicators_2014a.pdf

*__Source:__ Andy Walker, Department of Viticulture and Enology, UC Davis; and Smart and Robinson, 1991.
**__Source:__ Bryan Rahn, Coastal Viticultural Consultants and Mark Greenspan, Advanced Viticulture

3-8 Environmental Due Diligence* for a New Vineyard Site or a Replanting (including conversion from other agricultural uses)			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Environmental due diligence was carried out before block replanting or purchasing the land (or after deciding to convert to a vineyard) to determine both the presence of environmental features which may affect farming (see **Box 3-G**) and farmable acreage ***And*** Environmental issues relevant to the site and region were researched ***And*** Appropriate public and private entities were contacted.	Environmental due diligence was carried out after purchasing the land (or after deciding to convert to a vineyard) but before establishing or replanting some or all of the vineyard ***And*** Environmental issues relevant to the site and region were researched ***Or*** Appropriate public and private entities were contacted.	Environmental due diligence was carried out while the vineyard was being established or during any block replanting, and adjustments were made at that time ***And*** Environmental issues relevant to the site and region were researched.	There was no documentation regarding environmental due diligence during the establishment or since. *(Select N/A if the vineyard was purchased in-tact and no block replanting has been done)* *(Select N/A if no environmental due diligence was needed, for example: This vineyard has changed management since the development and there is no documentation regarding environmental due diligence during the establishment or since)*
*See **Box 3-G** for a discussion of environmental due diligence.			

Box 3-G Environmental Due Diligence

Environmental due diligence includes a thorough survey of the property for physical characteristics that may affect farming and also may be subject to local, state, or federal regulations. Characteristics include driveway and road systems, water access rights, streams and riparian corridors, vernal pools, wet swales, drainages, degree of slope, existing erosion, and the presence of animal and plant species (e.g., oak trees, threatened or endangered species). Specific regulations and associated compliance measures vary regionally. See the CSWA Environmental Compliance Checklist for more details: https://www.sustainablewinegrowing.org/amass/library/7/docs/Vineyard%20Environmental%20Permits%20List%20&%20Questionnaire%20-%20Final.pdf. Another important resource, particularly for the North Coast region, is *Vineyard Site Assessment Guide* (Smith, 2002). This publication was produced by UC Cooperative Extension and is available at http://cesonoma.ucdavis.edu/files/27206.pdf.

To ensure compliance with current local ordinances and permitting requirements, due diligence also should include checking with staff at the County Agricultural Commissioner's office and/or other local authorities. Personnel with the US Department of Agriculture Natural Resources Conservation Service (NRCS) can help with environmental due diligence. Most counties have an NRCS office. See http://www.ca.nrcs.usda.gov to obtain contact information for the nearest NRCS office.

When doing environmental due diligence, GPS/GIS technology may be used to store and summarize collected information (see **Box 3-H**).

Box 3-H Using GPS and GIS Technology In Vineyard Management

Global Positioning System (GPS) and Geographic Information System (GIS) are technologies used to help manage and analyze data collected in and around vineyards. Some cell phones and other electronic devices have GPS capability and can help collect this information, depending on acceptable accuracy tolerances. GPS is a satellite-based location system that allows the pinpointing of exact locations at any place on the farm. A GPS unit, stand-alone or connected to a data-recording device, automatically determines each location based on latitude, longitude, and elevation. This location information can be recorded and used later by GIS programs to draw maps locating points where data has been collected, such as from leaf, soil, and pest samples. GPS information also can be useful when summarizing vineyard descriptor data. GIS is an assemblage of computer programs that can analyze complex sets of information based on spatial reference points. In other words, GIS can analyze any data that has been collected in conjunction with GPS locations. For example, if you have spatially (GPS) referenced soil, petiole, pest, and irrigation data, GIS software can analyze this information all at once by layering sets of data. GIS is a sophisticated database system and can be useful for interrelating vineyard parameters, such as soil variables, pest numbers, and vine nutritional measures. As more is learned about factors affecting winegrape quality, GPS and GIS technology will be increasingly important tools to help put it all together. Check with an appropriate UC Viticulture Farm Advisor and/or vineyard consultant for more information.

3-9 Soil Profile Inspection and Modification for Pre-Planting*

Vineyard

Category 4	Category 3	Category 2	Category 1
Backhoe pits were dug in enough locations to cover the variability of the site, and the soil profile was inspected for plowpan, hardpan, claypan, or other restricting layer ***And*** If appropriate, plowpan or hardpan was ripped, claypan was slip-plowed, or subsurface drainage was installed ***And*** An accurate soil map of the site was developed to determine where backhoe pits should be located (e.g., GIS/GPS technology).	Backhoe pits were dug in enough locations to cover the variability of the site, and the soil profile was inspected for plowpan, hardpan, claypan, or other restricting layer ***And*** If appropriate, plowpan or hardpan was ripped, claypan was slip-plowed, or subsurface drainage was installed.	Hand-augured holes were dug in enough locations to cover the variability of the site ***And*** If appropriate, plowpan or hardpan was ripped, claypan was slip-plowed, or subsurface drainage was installed.	Little digging was done, but soil maps and local knowledge were utilized ***And*** If appropriate, plowpan or hardpan was ripped, claypan was slip-plowed, or subsurface drainage was installed. *(Select N/A if no redevelopment has occurred since vineyard establishment, and/or if there are no development records due to ownership or management change)*

*Necessary soil amendments should be added before tillage is done to modify the soil profile (see **Criterion 3-10**). Cover cropping may be done before and/or after this tillage. Chemical and biological properties of soil are detailed in **Criteria 3-10** through **3-12**.

Digging backhoe pits ensure an accurate method to inspect the soil profile.

BOX 3-I PROS AND CONS OF TILLAGE TECHNIQUES FOR MODIFYING THE SOIL PROFILE*	
Ripping	This method cracks or shatters hard layers, but does not mix the soil. It is done at 2-7 feet, depending on soil depth and permanently improves soils with cemented hardpans. Examples include winged-tine ripping along vine rows to minimize destruction of soil structure. Ripping temporarily improves tight or compacted soil, but does not always improve claypan layers for long because they usually reseal. There is only a minor effect on sand or gravel layers using this method. Three-way cross ripping is another option, but may destroy soil structure.
Slip-Plowing	This method rips, but then lifts and mixes the soil and is done at 3-6 feet. It is effective on claypans and sand or gravel layers, because it mixes the soil as well as shattering it. This method makes a wide channel, creates some mixing of surface and subsoil layers, and causes more shattering than ripping because of the lifting action of soil sliding up the cross blade.
Chisel	Using a chisel relieves compaction and mixes the soil in the surface 2 feet and is best for loosening soil and breaking up surface compaction such as plowpans and wheel ruts. A chisel can be used instead of deep tillage on deep uniform soil.
No Deep Tillage	If the soil is deep and uniform, only surface tillage or disc plowing may be necessary. If the subsoil is a heavy clay and the surface soil an acceptable loam, mixing in the clay might degrade the loam. Likewise, soil analysis of the subsoil layer may indicate toxic levels of an element, such as boron, which should be left in place.
*Tillage operations should be done during late summer/early fall when soil moisture is lowest to maximize benefits and to ensure that tillage techniques do not increase erosion. (See **Chapter 4 Soil Management** and **Chapter 5 Vineyard Water Management** for more information).	

3-10 Soil Tested for Physical and Chemical Properties* and Amended Pre-Planting**

Vineyard

Category 4	Category 3	Category 2	Category 1
Pre-planting or recent soil structure was determined (e.g., rock content and percent sand, silt, and clay) ***And*** Soil was tested for pH, organic matter, cation exchange capacity (CEC), SAR, base saturation, water-holding capacity, and for deficiencies or toxicities (i.e., boron, sodium, chlorides, zinc, and phosphorus) ***And*** Soil was amended with limestone if acidic, sulfur (or acids in drip) if alkaline, gypsum if low in calcium, and compost/manure (or cover crop) if low in organic matter ***And*** Information was recorded for the site (i.e. using mapping such as GIS/GPS technology).	Pre-planting or recent soil structure was determined (e.g., rock content and percent sand, silt, and clay) ***And*** Soil was tested for pH, organic matter, cation exchange capacity (CEC), SAR, base saturation, water-holding capacity, and for deficiencies or toxicities (i.e., boron, sodium, chlorides, zinc, and phosphorus) ***And*** Soil was amended with limestone if acidic, sulfur (or acids in drip) if alkaline, gypsum if low in calcium ***And*** Soil was amended with compost/manure (or cover crop) if low in organic matter.	Pre-planting or recent soil structure was determined (e.g., rock content and percent sand, silt, and clay) ***And*** Soil was tested for pH, organic matter, cation exchange capacity (CEC), SAR, base saturation, water-holding capacity, and for deficiencies or toxicities (i.e., boron, sodium, chlorides, zinc, and phosphorus) ***And*** Soil was amended with limestone if acidic, sulfur (or acids in drip) if alkaline, and gypsum if low in calcium.	There has been no documentation regarding the soil structure during pre-planting or since. *(Select N/A if there were no development records due to ownership or management change)*

*Many of these measures will indicate the site drainage and erosion potential.
Necessary soil amendments should be added before tillage is done to modify the soil profile (see **Criterion 3-9). Cover cropping may be done before and/or after this tillage.

3-11 Soil Sampled for Biological Problems Pre-Planting			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Soil has been sampled for nematodes (see **Box 3-K**) and phylloxera pre-planting – samples included the roots of the previous crop or cover vegetation, especially if grapes or trees* ***And*** Separate samples were taken to account for soil variation.	One or two general samples for nematodes had been taken (see **Box 3-K**) and phylloxera pre-planting – samples included no roots, but the previous crop or cover vegetation was considered when planting and managing the new vineyard.	No soil samples were taken for biological problems during pre-planting, but the previous crop or cover vegetation was considered when planting and managing the new vineyard.	No record was made of samples being taken for biological problems during pre-planting ***And*** No record was made of any previous crop or cover vegetation. *(Select N/A if there were no development records due to ownership or management change)*
*If forest trees or oaks are present, they likely harbor *Armillaria* (see **Box 3-J**). See **Criterion 3-12** for addressing biological problems.			

BOX 3-J ARMILLARIA ROOT DISEASE AND CALIFORNIA WOODLANDS

Armillaria root disease is caused by the fungus *Armillaria mellea*. Although commonly known as oak root fungus, *Armillaria* infects the roots of many native trees, including black oak, coast live oak, tanoak, madrone, California laurel, Douglas fir, and incense cedar (Baumgartner and Rizzo, 2000, 2001a, and 2001b). *Armillaria* can survive on woody roots long after its host dies. Its vegetative fungal tissue (mycelium) decomposes woody roots for nutrients, thereby decaying the root wood. When forest trees with Armillaria root disease are cut down, infected roots remaining below ground may serve as a source of inoculum for infecting grapevines planted in place of the trees. *Armillaria* mycelia can colonize grapevine roots that directly contact partially decayed, infected tree roots. The most effective control of Armillaria root disease is the pre-plant removal of partially decayed tree roots. If tree clearing occurs, rip the soil in more than one direction to bring large roots to the surface and remove them. See **Criterion 8-3** in the Ecosystem Management chapter for a discussion of tree removal in native woodlands.

Source: Kendra Baumgartner, US Department of Agriculture Agricultural Research Service Crops Pathology/Genetics Research Unit, Department of Plant Pathology, UC Davis.

BOX 3-K DESCRIPTION OF NEMATODES AND TAKING NEMATODE SAMPLES

Nematodes are microscopic worms of which there are many different types. Most nematodes are beneficial, eating decaying plant matter or other soil organisms such as bacteria, fungi, or other nematodes. But some species eat plant roots and are called plant parasitic nematodes. Roots of nematode-infected vines are unable to absorb adequate nutrients and water, especially during high-demand periods. Therefore, these vines typically are first to display symptoms of nitrogen or water deficiency. Unfortunately, symptoms of infestation and visual damage often are nonspecific, so lab analyses of soil and root samples are necessary to determine species of nematodes present and their population levels. Each species of plant parasitic nematode differs in its feeding habits and how it affects the various rootstocks, so samples must be taken before planting a vineyard to make the correct rootstock decision.

Samples should be taken when the soil is moist and **include healthy roots of the previous crop**, if possible. Samples should be taken to a 3-foot depth. At least 15-20 samples from an average-sized block should be taken and mixed together, from which a 5-pound sub-sample should be removed and placed in a plastic bag in an ice chest (ideal temperature is 40º-50ºF – not too cold, not too warm). Distinctly different vineyard areas should be sampled separately. The samples should be kept cool and mailed to a lab as soon as possible. Nematodes of concern for grape are root knot (*Meloidogyne spp*.), dagger (*Xiphinema americanum* is less of a problem than *X. index* which can spread fanleaf virus), ring (*Criconemoides* and *Hemicriconeoides spp*.), lesion (*Pratylenchus spp*.), stubby root (*Trichodorus spp*.), and citrus (*Tylenchulus semipenetrans*).

Source: Flaherty et al., 1992.

TABLE 3-a A RELATIVE RATING OF NEMATODE DENSITIES FOUND IN CALIFORNIA VINEYARDS

	Nematodes present in 1 kg of soil*					
	Low population		Medium population		High population	
Nematode species	**Oct-Mar**	**Mar-Oct**	**Oct-Mar**	**Mar-Oct**	**Oct-Mar**	**Mar-Oct**
Root knot	<75	<25	75-500	25-200	>500	>200
X. americanum	<20		20-200	20-100	>200	>100
Pratylenchus vulnus	<20		20-100		>100	
Citrus	<50		50-500		>500	
Stubby root	<20		20-200		>200	
Ring	<50		50-500		>500	
Pin	<100		100-1,000		>1,000	
X. index	<20		20-200		>200	
Needle	<20		20-200		>200	
Helicotlylenchus (spiral)	<50		50-500		>500	

*Numbers adjusted to 100% nematode extraction efficiency.

Source: Flaherty et al., 1992.

3-12 Addressing Biological Problems *Vineyard*

Category 4	Category 3	Category 2	Category 1
Soil was tested prior to planting and the presence or absence of harmful biological activity was determined ***And*** To mitigate any biological problems, strategies were used during development or redevelopment (e.g., removing as many roots as possible from the previous (perennial) crop, using resistant rootstocks, using non-host cover crops) ***And*** Soil was fallowed or rotated to a non-host crop for more than one year, as determined by biological activity and testing.	Soil was tested and the presence or absence of harmful biological activity was determined ***And*** To mitigate any biological problems, strategies were used during development or redevelopment (e.g., removing as many roots as possible from the previous (perennial) crop, using resistant rootstocks, using non-host cover crops ***Or*** Soil was fallowed or rotated to a non-host crop for more than one year.	To mitigate potential biological problems strategies were used during development or redevelopment such as removing as many roots as possible from the previous (perennial) crop, using resistant rootstocks, using non-host cover crops.	Soil was fumigated without testing for biological problems ***Or*** Biological problems may exist and no fumigation, fallowing or remedial action was taken. *(Select N/A if soil was tested and no biological problems existed or if the development or redevelopment history is not available)*

Box 3-L The Importance of Fallowing

Fallowing is the traditional technique of leaving a planting site bare of vegetation for a period of time. This causes soil pest numbers to decline from predation by natural enemies and/or an absence of host plant material. Fallowing, overall, is beneficial and is a more sustainable method of reducing plant parasitic nematodes (or other soil pests) than fumigation. But, currently, there is no definitive information about optimal lengths of time for fallowing. Grape roots left behind after vineyard clearing can remain alive for 8-10 years, and nematodes can survive on these roots. Similar numbers of *X. index* were found in soils sampled after either five years or five months of fallowing. Furthermore, *Armillaria* has survived up to 40 years in dead oak roots rotting at deep soil depths.

Source: Mike McKenry, UC Cooperative Extension, Kearney Agricultural Center, Parlier.

3-13 Rootstocks			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Rootstocks were chosen to resist the soil-borne pests present in the vineyard or region ***And*** Rootstocks were certified virus free and tested by an independent lab to confirm negative* ***And*** Rootstocks were chosen to deal with chemical and physical soil variability, rainfall patterns, and separate irrigation blocks ***And*** Rootstocks were chosen to provide adequate vigor when matched with the soil and scion, aiming for optimum wine quality ***And*** Advice was sought from a UC Farm Advisor and/or consultant.	Rootstocks were chosen to resist the soil-borne pests present in the vineyard or region ***And*** Rootstocks were certified virus free, or were tested for viruses and confirmed negative ***And*** Rootstocks were chosen to provide adequate vigor when matched with the soil and scion, aiming for optimum production for wine quality.	Rootstocks were chosen solely because of availability or were customary for major establishment or replanting projects.	All vines were planted on their own roots by the current owner or management team. *(Select N/A if no vines have been planted since the current owner or management team has been in place)*

*For virus management resources, visit: https://www.lodigrowers.com/growereducation/viruses/
For a list of independent labs visit: https://www.lodigrowers.com/wp-content/uploads/2020/01/virus-resources-January-2020.pdf

BOX 3-M COMMON ROOTSTOCKS

Freedom (Dog Ridge seedling x 1613 seedling with possible *Vitis vinifera* in each parent): Good root knot nematode resistance. High to very high vigor. Often produces high pH fruit. Strong nitrogen and potassium forager. Takes up zinc poorly, often leading to deficiency symptoms (e.g., poor berry set). Potentially phylloxera-susceptible. Very sensitive to all viruses.

110 Richter (*V. berlandieri x V. rupestris*): Excellent phylloxera resistance. Good drought tolerance. Moderate vigor when deficit irrigated, high vigor otherwise in some regions but low vigor in Central Coast region. Can produce vegetative, high pH wines on fertile, deep soil. Well-suited to gravelly or low vigor sites.

1103 Paulsen (*V. berlandieri x V. rupestris*): Excellent phylloxera resistance. Excellent drought tolerance. Moderate vigor when deficit irrigated, high vigor otherwise. May have some root knot nematode tolerance. May be more susceptible to dagger nematode than other rootstocks.

140 Ruggeri (*V. berlandieri x V. rupestris*): Excellent phylloxera resistance. Excellent drought tolerance. High vigor. Late ripening. Little field experience. Well-suited to gravelly or low vigor sites.

St. George (*V. rupestris*): Excellent phylloxera resistance. High vigor. Deep root system. Drought tolerant. Does not like wet feet. Excellent for infertile hillsides. Can set poor crops where vigor is high. Poor nematode resistance.

Teleki 5C (*V. berlandieri x V. riparia*): Good phylloxera resistance. Sensitive to drought. Moderate vigor (low if deficit irrigated). Good nematode resistance. Some wet-foot tolerance. Previously confused with SO4 – SO4 plantings before the early 1990s are probably 5C.

Kober 5BB (*V. berlandieri x V. riparia*): Similar to 5C but slightly more vigorous and more drought tolerant. Good nematode resistance.

SO4 (*V. berlandieri x V. riparia*): Similar to Kober 5BB or Teleki 5C. May set more fruit. May have earlier ripening, better drought tolerance, and more vigor than Teleki 5C.

3309 Couderc (*V. riparia x V. rupestris*): Excellent phylloxera resistance. Tolerates wet feet. Low to moderate vigor (particularly if deficit irrigated). Susceptible to high nematode populations. Very sensitive to viruses. Should not be over-cropped.

101-14 Mgt (*V. riparia x V. rupestris*): Good phylloxera resistance. May have moderate nematode resistance. Moderate vigor.

039-16 (*V. vinifera x V. rotundifolia*): Only for use where grapevine fanleaf virus is a problem. High vigor. Good dagger nematode resistance. Susceptible to root knot nematode. Poor drought tolerance. Potentially phylloxera-susceptible.

1616 Couderc (*V. solonis* x *V. riparia*): Good general nematode resistance. Good phylloxera resistance. Low to moderate vigor. Well suited to high vigor soils where vine growth will be controlled. Not for extremely low vigor sites.

Sources: Andy Walker, Department of Enology and Viticulture, UC Davis; and Larry Bettiga, UC Viticulture Farm Advisor, Monterey, San Benito, and Santa Cruz Counties.

3-14 Vineyard Layout			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Vineyard layout was designed according to patterns of soil types and operational efficiencies ***And*** The vineyard rows were oriented with consideration made to prevailing wind (if severe), sunlight angle (for thermal-balance and heat avoidance), side-slope minimization (for safety and erosion prevention) ***And*** Vineyard rows were oriented or sized to minimize erosion potential and damage to infrastructure ***And*** Buffer zones were created around riparian habitat, native vegetation or sensitive areas, as well as to allow ample turn-around space.	Patterns of soil types and operational efficiencies were considered when vineyard layout was designed ***And*** Vineyard rows were oriented or sized to minimize erosion potential and damage to infrastructure ***And*** Buffer zones were created around riparian habitat, native vegetation (e.g., oaks) or sensitive areas, as well as to allow ample turn-around space.	The vineyard layout was designed based on the previous vineyard layout ***Or*** The vineyard layout was designed according to the property boundaries ***Or*** The vineyard layout was designed based on existing irrigation systems.	The vineyard layout was designed to maximize planted area and minimize non-productive space ***Or*** The vineyard design was based on operational efficiency. *(Select N/A if there are no development records due to ownership or management change)*

3-15 Row and Vine Spacing *Vineyard*

Category 4	Category 3	Category 2	Category 1
Row and vine spacing were chosen to accommodate site vigor potential and maximize vine balance and fruit quality (see **Criterion 3-1**).	Row and vine spacing were based equally on fruit quality and quantity.	Row and vine spacing were based on the size of the equipment to be used while farming and on fruit quantity.	Row and vine spacing were based solely on the size of the equipment to be used while farming. *(Select N/A if no vines had been planted since the owner or current management team has been in place)*

3-16 Scion/Cultivar *Vineyard*

Category 4	Category 3	Category 2	Category 1
The scion is appropriate for climate, soil, and rootstock ***And*** The scion was chosen after consultation with the winery and/or UC Farm Advisor and/or nursery ***And*** The scion was certified virus- ree and tested by independent laboratory and confirmed negative.*	The scion is appropriate for climate, soil, and rootstock ***And*** The scion was either certified virus free, or has been tested for viruses and confirmed negative ***And*** The scion was chosen with the best available information (e.g.,consultation with the winery, UC Farm Advisor, and/or nursery).	The scion was not tested for viruses, but some production history was known ***And*** Consideration was given to the appropriateness of scion for climate, soil, and rootstock.*	The scion was not tested for viruses, and no production history was known ***And*** No consideration was given for climate, soil, or rootstock. *(Select N/A if no vines have been planted since the owner or current management team has been in place)*

*For virus management resources, visit: https://www.lodigrowers.com/groweducation/viruses/
For a list of independent labs visit: https://www.lodigrowers.com/wp-content/uploads/2020/01/virus-resources-January-2020.pdf

Box 3-N Vine Selection And Clones

As selections of the same variety from different sources are compared, subtle performance differences between selections of the same wine grape variety become apparent. These differences are caused by mutations in genes that control characters such as leaf lobing, berry color, disease resistance, and ripening date. Over time, mutations accumulate and lead to greater diversity in older varieties. Selections that differ in these ways and have been evaluated are known as “clones” of a variety. Planting superior clones can improve a variety’s production and winemaking characteristics.

Today, with increasingly diverse plant materials available, growers planting new vineyards need to consider choice of clone as well choice of variety. New clones of the major wine grape varieties are added to the Foundation Plant Service’s Foundation Vineyard frequently. Researchers, viticulturists, and winemakers around the state work to ensure that valuable “heritage” field selections – those collected from premier vineyards with a reputation for quality wine – are available as certified selections. In some of California’s oldest vineyards, these selections represent pre-1900 European introductions that may contribute greatly to varietal clonal diversity.

An additional complication results from the intellectual property issues that have developed around wine grape clones. Some clones are trademarked and/or proprietary while others are in the public domain.

As in other wine regions, California growers want to know how clones might enhance viticultural performance and wine quality or help create a particular wine style. Along with this heightened interest in clones, several important points must be kept in mind:

- **Clone choice is only one of many important decisions when establishing a vineyard.**
- **There is no one “best” clone.**
- **A clone selected in another country is not necessarily superior to what is available locally.**
- **Virus infections can compromise even the best clones.**

For further information on clones, please access: http://iv.ucdavis.edu/files/24346.pdf.

Source: Deborah A. Golino, Director of Foundation Plant Services, UC Davis; and James A. Wolpert, Viticulture Extension Specialist, UC Davis

3-17 Trellis Selection and Design

Vineyard

Category 4	Category 3	Category 2	Category 1
Wine quality was the foundation for selecting the trellis and for managing vigor ***And*** The trellis adequately supported the vine and required the least inputs (i.e., accommodates mechanization) and maintenance (components to last the life of vineyard) ***And*** The trellis was chosen based on the vigor potential of the soil, rootstock, and scion to achieve balance (see **Criterion 3-1**) ***And*** The trellis system could accommodate the vine capacity and still maintain a canopy microclimate that optimized fruit exposure.	The trellis selection resulted in a trellis that adequately supported the crop and vigor and required the least inputs (i.e., accommodates mechanization) and maintenance (components to last the life of vineyard) ***But*** Spacing or rootstock was considered as a means to mitigate expected vigor or lack thereof.	The trellis was chosen based on its ability to support the crop and vigor of the vine.	The trellis was chosen based on price. *(Select N/A if no vines had been planted since the owner or current management team has been in place)*

3-18 Conservation of Habitat for Wildlife and Pest Predators*

Vineyard

Category 4	Category 3	Category 2	Category 1
During initial vineyard establishment and/or development, habitat was assessed, enhanced, and maintained to minimize the disruption ***And*** Hedgerows, shrubs, or grasses with native and, if appropriate, non-native flowering plants were maintained throughout the property ***And*** Where appropriate, fenced wildlife corridors have allowed movement around and/or through the vineyard, and any waterways were shaded in part by trees and shrubs to help minimize elevating the water temperature in support of salmon, steelhead and other fish life cycles.	During initial vineyard establishment and/or development, habitat was impacted but enhanced to minimize the disruption.	During initial vineyard establishment and/or development, efforts were made to understand and protect important habitat.	During initial vineyard establishment and/or development maximum planted acreage was considered, not the type of habitat being replaced. *(Select N/A if no virgin ground has been planted since the current management team or owner has been in place)*

*This relates to the establishment of new vineyard projects (virgin ground, converting from native habitat to vineyard). See **Chapter 8 Ecosystem Management** for more details.

3-19 Creation of Habitat for Wildlife and Pest Natural Enemies*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Native plants were established or already present in difficult-to-farm (e.g., wet swales) and non-crop areas (e.g., fence lines, ditch banks) ***And*** If present, non-native plants were removed to enhance native habitat using any required permits (e.g., Fish and Game Code § 1600) ***And*** Ponds or other water sources were provided for birds and other wildlife, if appropriate.	Some native plants were established or present and resident vegetation was allowed to grow in non-crop areas (e.g., fence lines, ditch banks).	Resident, native, or non-native vegetation was allowed to grow without mowing or disking in some non-crop areas (e.g., fence lines, ditch banks).	Buffer zones or perimeters around vineyards were devoid of vegetative growth or contained minimal amounts of vegetative growth due to natural or cultural practices.
*The California Environmental Quality Act (CEQA) dictates what is or is not possible regarding vineyard development in relation to habitat. Specifics for compliance with habitat issues are in flux in many regions, and local agencies such as the NRCS (http://www.ca.nrcs.usda.gov) should be contacted to determine the latest regulations and requirements. See **Chapter 8 Ecosystem Management** for more details on habitat.			

Vegetation is allowed to grow along a ditch bank, providing habitat alongside the vineyard.

BOX 3-O BENEFITS OF NATIVE GRASSES FOR AGRICULTURE

The primary reason that a number of growers use clean farming practices is to eliminate weeds, which thereby eliminates wildlife habitat. However, establishing a complex of native perennial grasses in upland and non-farmed areas (e.g., roadsides, canal banks, levees, sloughs, drainage ditches, hard-to-farm corners, borders, and equipment yards) can eliminate many weed problems while providing permanent wildlife habitat. A number of resources show that leaving wildlife corridors and habitat alone, or establishing new habitat can have beneficial impacts. First-hand experience with these practices are detailed in a CSWA report *Biodiversity Conservation Practices in California Vineyards:Learning from Experiences* at: http://www.sustainablewinegrowing.org/docs/2008-Biodiversity_in_Vineyards.pdf.

A single plant may live 10-20 years, thus, after established, the grasses are easily managed by occasional mowing. Native grasses provide superior erosion control and are tolerant of drought, roadside traffic, and grazing. Although most native grasses are dormant during the summer, many species begin to green up well before winter rains because of their massive root systems that can reach deep ground moisture. For information on establishing and maintaining hedgerows, see https://www.caff.org/ecologicalfarming/hedgerows/, which includes a link to Hedgerows and Farmscaping for California Agriculture – 2nd Edition (2018). This manual will help you choose and care for regionally appropriate plants that attract beneficial insects and prevent erosion.

An established complex of native grasses sustains a wide variety of wildlife by providing excellent nesting cover in the spring. During the fall and winter, these grasses maintain their upright structure providing escape, loafing, and roosting cover for wildlife. The food value of native grasses for both seed and green forage is excellent. Many insect species also use the grasses and provide important food for pheasant, quail, and turkey chicks. Many of these insects are beneficial to the farmer because they provide biological control of agricultural pests.

Source: *Establishing Permanent Grassland Habitat with California Native Perennial Grasses* (Anderson and Anderson, 1996). This publication can be obtained by contacting the Western Regional Office of Ducks Unlimited, 9823 Old Winery Pl., #16, Sacramento, CA 95827 at (916) 363-8257 or http://www.ducks.org.

Box 3-P Importance of Maintaining Habitat

Vernal Pools
Vernal pools occur only where a narrow range of favorable conditions exist. They are found only in a Mediterranean climate where most of the rainfall occurs from October to April followed by a hot, dry season when the pools completely dry out. A shallow depression is required, underlain by some soil substrate such as clay or basalt that is impervious to water percolation. In California, there are three geomorphological situations where these circumstances exist: coastal terraces, broad alluvial valleys such as the San Joaquin and Sacramento valleys, and ancient basaltic lava flows. Soils of vernal pools are typically very high in clay but can be derived from a variety of parent materials.

Hydrology is another key ingredient to the formation of a vernal pool. Specifically, water depth and duration of standing water play an important part in determining whether these areas can function as vernal pools. Water depths typically range from 10-60 cm (4 inches -2 feet) deep. Pools need to remain inundated long enough to allow associated plants, invertebrates, and amphibians to complete their life cycles. Inundation can begin as early as November and go all the way until June in a very wet year. Shallow pools can fill with water, dry up, and then refill again several times during a season. Typically, a vernal pool is filled with water for only 3-4 months, from about December through March. Vernal pools can be found from southern Oregon to just south of San Diego in Mexico, but the majority of vernal pools occur on California's coastal terraces and in the Central Valley.

Riparian Habitat and Bird Conservation
Riparian birds use every part of the habitat. Some birds prefer the canopy for nesting and foraging while others specialize on low shrubs on the ground. A healthy system needs diverse vegetative structure to best support birds. For more information, see *Riparian Bird Conservation Plan: A Strategy for Reversing the Decline of Riparian Associated Bird Species in California* published by the California Partners in Flight and The Riparian Habitat Joint Venture: http://www.prbo.org/calpif/htmldocs/riparian.html.

Economic Values of Riparian Habitat
Riparian habitat provides many benefits to streamside landowners. For example a wide strip of riparian vegetation can offset flood damage to vineyards by acting as a "sieve" for trees and other debris that may wash in during large floods. Riparian vegetation also traps fine sediments and other pollutants, thereby preserving water quality. Because of their deep roots and dense growth habit, riparian trees, shrubs, and grasses provide excellent protection against bank erosion, helping to stabilize streambanks.

In addition to assisting with flood protection and erosion control, riparian vegetation may play a role in integrated pest management. Cavity nesting riparian bird species, such as kestrels and owls, prey on rodents in vineyards. Barn Owls were even named the 2010 Bird of the Year by the Audubon Society, which have been known to prey on gophers. Other cavity nesting birds, such as wrens, tree swallows, oak titmice, and bluebirds, may help reduce populations of pest insects. For more information on the California avian population visit the Audubon California website at http://ca.audubon.org. Bobcats, coyotes and foxes also use riparian areas to prey on rodents.

Riparian vegetation management should foster a diverse, functioning natural plant community, while creating unfavorable conditions for the blue-green and glassy-winged sharpshooter, thereby reducing the incidence of Pierce's Disease in nearby vineyards. While certain native and non-native plants may need to be removed, they should be replaced with other native species that will fill the ecological role of the removed plants. Information on native grasses is available from the California Native Grasslands Association website at http://www.cnga.org.

4. SOIL MANAGEMENT[1]

Original Chapter Authors: Clifford P. Ohmart and Stephen K. Matthiasson, formerly with Lodi Winegrape Commission; Modified by the Sustainable Winegrowing Joint Committee

Soil is the foundation of winegrape production. A third of the grapevine lives underground in the form of roots. Leaves feed vines sugar but roots feed vines everything else. The soil provides roots with three vital resources: water, nutrients, and air. These three elements are best provided by a soil with good structure, i.e., soil particles are bound together into small clumps (aggregates) of varying size which store water and facilitate gas movement. Roots, soil organisms, and microbes help create and stabilize soil particles. A well-structured soil permits rapid drainage and root growth, but improper or excessive tillage, compaction, and lack of organic matter all reduce soil quality. With soil structure being an important factor in vineyard root health, there should be a goal to minimize soil erosion. In this effort, minimizing soil erosion can help maintain vineyard sustainability.

Cover crops are featured prominently in this chapter since they provide the simplest and most cost-effective means of protecting and improving soil structure. Because of variances in soil biological activity in differing regional climates of California, it can be difficult to increase the percentage of soil organic matter in some regions. However, the rate of organic matter turnover can be adjusted through farming practices, which is perhaps even more important. Cover crops and other plant residue provide the organic matter for soil microorganisms to decompose and create the “cement” to bind and aggregate soil particles. Practices that conserve soil organic matter (e.g., no till or conservation tillage) build and maintain desired structure and soil fertility. Many of these soil health practices have an important co-benefit of soil carbon sequestration.

Soil and plant monitoring can facilitate judicious application of fertilizers and soil amendments, thereby reducing excess expenditures on fertility management and minimizing the potential for nitrogen leaching into groundwater. Thus, this chapter includes a short guide on the basic interpretation of soil and plant lab test results to help growers make informed decisions about applying fertilizers and soil amendments.

The purpose of this chapter is to help growers identify and improve management practices that can help protect and enhance soil health, and prevent erosion and non-point source pollution. It includes 14 criteria to self-assess:

- Monitoring of soil and plant nutrient status in your vineyard
- Fertility of your vineyard’s soil
- Soil tilth in your vineyard
- Soil erosion of your vineyard site
- The role of cover crops in your vineyard
- Soil practices that capture and store carbon.

[1]This chapter has been adapted from Lodi Winegrape Commission’s *Lodi Winegrower’s Workbook* (Ohmart and Matthiasson, 2000). Many of the criteria in this chapter appeared as questions in the Central Coast Vineyard Team’s Positive Points System, the first vineyard self-assessment system in California (CCVT, 1996 and 1998).

List of Soil Management Criteria

Cover crops provide the simplest and most cost-effective means of protecting and improving soil structure.

Performance Metrics – Applied Nitrogen

Using Performance Metrics

1. Collect
Identify and gather data needed to calculate the metric

2. Measure
Calculate metrics and determine your baseline

3. Track
Track your metrics calculations from year to year

4. Manage
Set targets for improvement and identify action plans

Why are Performance Metrics important?
Knowing and understanding the actual use of resources is an important aspect of controlling costs and increasing the profitability for any business. Including the relationship between practices and measurable outcomes allows you to accurately benchmark your performance so that you set achievable targets for improvement using actual and not perceived outcomes. Whereas the practice-based self-assessment helps determine what winery or vineyard practices affect energy or fuel use and related greenhouse gas emissions, for example, performance metrics calculations provides a baseline and the rational for setting targets based on real measurements. As the adage says, “You can’t manage what you don’t measure.”

The Applied Nitrogen Metric is used to track the most significant sources of nitrogen being added to the vineyard. It includes nitrogen from synthetic and organic fertilizers, nitrates dissolved in irrigation water, and nitrogen in compost and manure. By accounting for these significant sources of nitrogen, a grower can track and potentially increase the efficiency of nutrient use over time.

How do you calculate Applied Nitrogen Efficiency?
Applied nitrogen for vineyards can be calculated as pounds applied per acre or per ton of grapes (see below for calculation examples).

Metric Area	Metric Calculation	Data Elements	Data Sources
Nitrogen Use (Vineyard)	**Nitrogen Applied Efficiency** = Pounds Applied / Acre Pounds Applied / Ton of Grapes	• Synthetic & organic fertilizer • Compost • Manure • Irrigation water N • Acreage • Yield (total tons)	Fertilizer application records; compost & manure applications; irrigation N content; Vineyard management company

How do I start tracking my Performance Metrics?
To get started tracking and recording applied nitrogen metrics, as well as other performance metrics (e.g., greenhouse gas emissions, water and energy use), visit http://www.sustainablewinegrowing.org/metrics.php or click on the “Metrics” tab within the SWP Online System.

4-1 Plant Tissue Analysis *Vineyard*

Category 4	Category 3	Category 2	Category 1
A sample (bloom-time/petiole or leaf blade) was taken and sent for lab analysis every 1-2 years in select critical areas ***And*** Detected nutritional problems in any area were followed up with an additional sample(s) following all soil treatments to check for changes (e.g., multiple sampling in problem areas or sampling at different times of the year).	A sample (bloom-time/petiole or leaf blade) was taken and sent for lab analysis every 2-3 years in select critical areas.	A sample (bloom-time/petiole or leaf blade) was taken and sent for lab analysis only when there was a suspected nutritional problem.	No plant tissue samples have been taken in the last 3 years in any of the vineyards.

BOX 4-A PLANT TISSUE SAMPLING

Traditionally, the sampling of petioles (leaf stems) has been the accepted method for determining grapevine nutrient status. Because nutrient levels in petioles and other vine tissues change over the growing season and to ensure consistency in sampling technique, these samples generally are taken at bloom and consist of petioles extracted from leaves opposite clusters. During sampling, leaf blades should be immediately snapped off petioles. Depending on the variety and diameter of petioles, a total of 75-100 petioles should constitute an adequate sample for an average-sized vineyard block. Petioles should be selected in even proportions from both sides of the vines, from various locations within the canopy, and from the desired representative area of the block. Samples should be stored in a breathable paper bag in a dry place, and then mailed or delivered as soon as possible to a reputable analytical lab. Some growers take samples from the same vines each year. If a petiole sample is taken after a nutrient spray, the lab results for that nutrient should be disregarded. For post-bloom sampling, petioles should be extracted from a recently matured leaf above the cluster. Some growers and consultants take a petiole sample at veraison as a follow-up to the bloom-time sample.

Leaf blade sampling is becoming more common, although there is disagreement as to whether it is more accurate than petiole sampling for assessing nutrient status. Sampling leaf blades may be more accurate for assessing nitrogen levels (see **Box 4-C**). Check with an appropriate UC Farm Advisor about the status of research for using leaf blade samples to determine vine nutrient status.

4-2 Soil Nutrient Analysis

Vineyard

Category 4	Category 3	Category 2	Category 1
Many soil samples* have been taken and sent to a lab for analysis within the last 4 years, or within 2 years if undergoing a soil amendment program ***And*** Soil variations were considered when collecting the samples ***And*** Lab analyses were interpreted and applied to vineyard management decisions ***And*** Records of test locations and results were kept (e.g., GPS maps, hand drawn maps, etc.).	A soil sample* has been taken and sent to a lab for analysis within the last 6 years, or within 3 years if undergoing a soil amendment program ***And*** Soil variations were considered when collecting the samples and different soils were sampled separately ***And*** Lab analyses were interpreted and applied to vineyard management decisions.	Some soil samples* have been taken and sent to a lab for analysis within the last 6 years, or every 3-5 years if undergoing a soil amendment program.	A soil sample* was rarely taken, or only taken during replanting.

*See **Box 4-B** for information on how many samples should be taken.

BOX 4-B SOIL SAMPLING

A soil sample should include at least 15-20 cores from a 20-40 acre block. Soil cores are most frequently taken from a depth of 12-18 inches, but may be taken up to 64 inches for deep soils in certain circumstances (e.g., when diagnosing a problem or developing a vineyard). Cores should be taken from areas where roots are concentrated (i.e., under drip emitters or furrows depending on the irrigation system). Plant residues and other materials on the soil surface should be moved aside before inserting core samplers. If the physical soil characteristics significantly vary across the block, a separate sample should be taken for each distinct soil type. If cores are combined across the block despite significant variation, ensure that the proportion of soil types in the sample is representative of that in the block. The cores for each sample should be mixed thoroughly in a bucket, from which a 1.0 lb. (3 cups) sub-sample is extracted and bagged. Samples should be kept cool and mailed or delivered to a reputable soils lab as soon as possible for analysis.

When soil samples are taken, it is very important to properly label the sample bag. For example, list the location (ideally using GPS/GIS technology), time and date collected, person taking the sample, and recent vineyard management history.

Box 4-C Interpreting Petiole Test Results*

If foliar nutrients were sprayed before petiole sampling, the lab results for those nutrients will be invalid because of existing spray residues. The most important nutrients and associated guidelines for interpreting lab test results are characterized below.

Nitrate-nitrogen (NO_3-N)**: Nitrate-N is highest at bloom, and then progressively decreases until essentially stabilizing at several weeks after bloom. Consequently, the timing of sampling is critical for proper interpretation and should be done at full bloom. Vine nitrogen tends to be deficient below 350 ppm, adequate above 500 ppm, and excessive above 2000 ppm**. If vines display high vigor, no additional nitrogen is needed, regardless of the reported Nitrate-N**.

Total nitrogen**: Given the uncertainty of Nitrate-N critical values, you may want to use percent total N as a guide to determining adequate vine nitrogen. Less than 0.9% total N is probably too low, 1.0-1.6% is probably adequate, while greater than 1.6% is probably excessive.

Phosphorus: For phosphorus, less than 0.1% is probably deficient, 0.1-0.15% is questionable, while equal to or greater than 0.15% is probably adequate.

Potassium: Potassium levels are highest at bloom, then decline rapidly until leveling off in midsummer. At bloom, vines are deficient below 1.0%, marginal at 1.0-1.5%, and adequate above 1.5%. In midsummer, less than 0.7% is deficient, while greater than 1.0% is adequate. If potassium is deficient at bloom, a follow-up sample at veraison may be recommended.

Calcium: Critical calcium levels are not established, but should exceed 0.5% for normal physiological function.

Zinc: For most varieties, zinc concentrations greater than 26 ppm are adequate, while concentrations less than 15 ppm are inadequate. Because zinc directly impacts berry set, it is most critical that adequate zinc is available for vines at pre-bloom and bloom.

Boron: Boron is deficient below 25 ppm, while generally adequate over 30 ppm (however, possibly toxic over 100-150 ppm).

*Since nutritional requirements can vary among varieties, variety appropriate critical values should be used for fertilization decisions. Furthermore, necessary amounts of fertilizer depend on the capacity of the specific rootstock to absorb soil nutrients.
**Nitrate N and total N values should only be used as general guidelines along with observations of vineyard growth for vine nutrition decisions.

Source: partially from Christensen et al., 1978.

BOX 4-D INTERPRETING SOIL TEST RESULTS*

Soil tests are not reliable for determining fertilizer requirements because of the tremendous volume of soil that grapevines can mine, differences in nutrient uptake rates among rootstocks, soil variability, root health, nutrient interactions, and other factors. The results of petiole tests are the best tool for making decisions on whether to add nutrients to the vineyard. Soil tests are useful to identify problems, to decide which form of a nutrient/fertilizer to apply (e.g., sulfate or muriate of potash), and to track changes in soil parameters over time. Some of the most important soil parameters are listed below.

Soil pH: pH is the measure of acidity and alkalinity. Soil pH affects nutrient availability. Vines will grow at soil pH values ranging from 4.0 to 8.5, but a pH below 5.5 or above 8.0 will most likely result in depressed yields (depending on the rootstock) and predispose vines to other problems. Years of fertilizer and sulfur use often make soils more acidic (lower pH). The soil pH may need to be amended if nutritional or toxicity issues arise.

Electroconductivity (ECe): ECe is the measure of soil salinity. Values under 0.7 mmho/cm are recommended, and values from 0.7 to 2.0 mmho/cm are potentially problematic.

Chlorides: Chlorides are essential nutrients for grapevines but can be toxic at low concentrations. Chloride concentrations under 350 ppm are good, from 350 to 700 ppm are acceptable, and over 700 ppm can be problematic.

Cation Exchange Capacity (CEC): CEC, also termed the "buffer index", dependent primarily on the type and quantity of clay in the soil and is a measure of the electrical charge of the soil and varies widely among soil types. As the charge becomes more negative, soils have greater capacity to attract and hold positively charged ions, termed cations which affect the fertility of the soil [e.g., magnesium (Mg^{++}), calcium (Ca^{++}), potassium (K^{+})]. When the CEC is known via soil analysis, the amount of lime necessary to appropriately raise the soil pH can be calculated.

Base Saturation: Base saturation is a measure of the percentage of soil exchange sites occupied by a specific cation. As general guidelines to support decisions for applying fertilizers and soil amendments, base saturation should be less than 5% for sodium (below 2% is optimum), 2-7% for potassium, 10-15% for magnesium, 65-75% for calcium, and under 5% for hydrogen.

Source: partially from Christensen et al., 1978 and University of California Division of Agriculture and Natural Resources publication 21056.

*Since nutritional requirements can vary among varieties, variety appropriate critical values should be used for fertilization decisions. Furthermore, necessary amounts of fertilizer depend on the capacity of the specific rootstock to absorb soil nutrients.

4-3 Nutrient Management

Vineyard

Category 4	Category 3	Category 2	Category 1
Vine vigor, fruit quality, leaf symptoms, vineyard history, wine quality, and water quality test results were factored into decisions made for nutrient applications ***And*** Results of plant tissue analysis were used as a guide for nutrient application decisions ***And*** Site-specific nutrient applications (i.e., content and amounts) were made if necessary.	Vine vigor, fruit quality, leaf symptoms, and vineyard history were factored into decisions made for nutrient applications ***And*** Results of plant tissue analysis were used as a guide for nutrient application decisions.	Vine vigor, fruit quality, leaf symptoms, and vineyard history were factored into decisions made for nutrient applications.	Nutrient applications were based on the time of year or on another established program(s) that does not incorporate site-specific information, unless required by local regulations.*

*Some regions in California require nutrient management plans. Check with local water agencies for requirements.

The results of petiole tests are the best tool for making decisions on whether to add nutrients to the vineyard. Some growers and consultants take a petiole sample at veraison or a leaf-blade sample later in the season as a follow-up to the bloom-time sample.

4-4 Nitrogen Management*

Vineyard

Category 4	Category 3	Category 2	Category 1
Soil analysis was done within the last 3 years and plant tissue analysis had been done within the last year ***And*** Nitrogen was applied only if justified by plant tissue analysis and inadequate vine vigor*, and preventative measures were taken to limit volatilization such as watering in, disking, or applied before rainfall ***And*** Nitrogen was only applied when vines can best utilize it ***And*** Local conditions and water quality were considered in deciding which form of nitrogen to apply ***And*** If plant tissue analysis and vine vigor showed that nitrogen applications were not necessary, none was applied, but cover crops may have been used to either increase or decrease long term nitrogen needs.	Soil or plant tissue analysis was done within the last 3 years ***And*** Nitrogen was applied only if justified by plant tissue analysis and inadequate vine vigor*, and preventative measures were taken to limit volatilization such as watering in, disking, or applied before rainfall ***And*** Nitrogen was only applied when vines can best utilize it ***And*** Local conditions (e.g., weather, rainfall, operational activities - frost protection) and water quality were considered in deciding which form of nitrogen to apply.	Soil or plant tissue analysis was done within the last 6 years ***And*** Nitrogen was applied only if justified by plant tissue analysis, inadequate vine vigor* and/or balanced with nutrients removed by the crop ***And*** Nitrogen was only applied when vines can best utilize it.	Soil or plant tissue analysis was not done within the last 6 years ***Or*** Nitrogen was applied every year without prior analysis or regardless of vine vigor.

*If nitrogen is applied, irrigation must be managed to ensure that applied nitrogen does not leach below the vine rooting zone and possibly contaminate groundwater.
See **Box 4-E** for information on nitrogen application, and related **Box 4-L** and **Table 4-c** on cover crops.
The CSWA Irrigation and Nitrogen Management Plan (INMP) Regulatory Reporting Tool is available in the SWP Online System can be used to help track nitrogen use and assist with Irrigation and Nitrogen Management Plan (INMP) reporting requirements for growers in the Central Valley (Region 5).

BOX 4-E APPLICATION OF NITROGEN

Nitrogen Utilization is Dynamic

- Vines store and remobilize nitrogen
- Stored nitrogen contributes 30% nitrogen utilized between budbreak and bloom
- Spring levels are strongly influenced by the nitrogen status in the previous summer and fall
- Post-harvest applications provide for the most stored nitrogen at bud break

Nitrogen Application Timing

- Spring to early summer
  - Apply in increments over time
  - Irrigate at ≤ ET to avoid leaching
- Post-harvest
  - Intact, healthy leaf area
  - > 3 weeks before leaf fall

Nitrogen Fertilization Rates – Drip Irrigation

Rates, lbs N/acre*:

(0) If there is existing high to excess vigor
(10-20) If there is high to medium vigor
(20-30) If there is medium vigor
(30-40) If there is medium-low to low vigor

*APPLY IN INCREMENTS OVER TIME

Source: Pete Christensen, UC Viticulture Extension Specialist Emeritus, Kearny Agricultural Center, Parlier.

BOX 4-F REASONS TO AVOID EXCESS NITROGEN

1. Higher fertilizer cost
2. Potential groundwater contamination
3. Increased powdery mildew
4. Increased bunch rot
5. Increased Phomopsis
6. More required canopy management/leaf removal
7. Growth interference with harvesting
8. Delayed maturation
9. Potential ethyl carbamate problems in wine
10. Lower phenolics in juice
11. Lower anthocyanins in juice
12. Higher malate in juice
13. Higher pH in juice
14. Higher pruning costs
15. More grape leafhopper problems
16. Inadequate wood dormancy in late fall
17. Increased GHG emissions when applied nitrogen is converted to N_2O

Source: Pete Christensen, UC Viticulture Extension Specialist Emeritus, Kearny Agricultural Center, Parlier

BOX 4-F1 NITROGEN AS A GREENHOUSE GAS

An important source of vineyard greenhouse gas (GHG) emissions is the use of nitrogen fertilizers. The importance of N_2O comes from its strong ability to act as a GHG. N_2O is roughly 300 times more effective than CO_2 at trapping heat in the Earth's atmosphere, so a small amount of N_2O can cause as much warming as a very large amount of CO_2.

When any nitrogen is added to soil, some of the applied nitrogen can be converted to N_2O. This can happen to any nitrogen-containing additive including synthetic fertilizers (e.g. nitrate and ammonium) and organic materials (e.g. green manures and pomace). All N_2O production associated with vineyards results from soil microbes using the nitrogen instead of the vines. Moreover, some added nitrogen can leach into groundwater and subsequently be converted to N_2O. Minimizing N_2O emissions may be challenging. For instance, in winegrapes where little fertilizer generally is used, it may be difficult to further decrease emissions of N_2O. Use of organic fertilizers and cover crops instead of synthetic fertilizers to supply necessary nitrogen may limit emissions. Timing nitrogen applications to ensure maximum uptake by roots may decrease N_2O emissions and nitrogen leaching.

Source: California Sustainable Winegrowing Alliance, Vineyard Management Practices and Carbon Footprints

4-5 Fertigation*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Fertilization was done by fertigation if necessary** based on soil and vine nutrient status ***And*** The frequency and timing of applications were calculated to meet vine demand, prevent leaching of fertilizer below the root zone, and for what was seasonally correct and justified for the operation.	Fertilization was done by fertigation if necessary** based on soil or vine nutrient status ***And*** Timing of applications was seasonally correct.	Fertigation was done without first checking the soil or vine nutrient status ***And*** Timing of applications was seasonally correct.	Fertigation was done without first checking the soil or vine nutrient status ***And*** Timing of applications was based on convenience rather than best practice. *(Select "N/A" if there is no irrigation system or fertigation was never used for applying fertilizers)*

*Fertigation is the use of the irrigation system (e.g., furrow, sprinkler, drip) to deliver fertilizers and amendments.
**In this context, necessary fertilization implies fertilization warranted for nutritional maintenance. In some situations where a significant nutrient deficiency is being corrected, it is necessary to make single applications of fertilizers at quantities that cannot be applied through drip irrigation (for which this criterion does not apply). Also, please note that soil nutrition critical values can be difficult to define in permanent crops.
See **Criteria 4-3** and **4-4** for practices pertinent to vineyard nutrition management, and **Box 4-G** for examples of good fertigation practices.

BOX 4-G EXAMPLES OF GOOD FERTIGATION PRACTICES

- Keep materials in root zone. Soil moisture monitoring may be used to verify depth of irrigations/fertigations.
- First analyze the quality of irrigation water for existing levels of nutrients and water chemistry (see **Criteria 5-2**).
- Avoid large applications of materials in favor of smaller applications made over the course of the growing season.
- Ensure materials to be fertigated are compatible with irrigation water quality, soil chemistry and with one another (no precipitation).
- Use proper worker safety and system maintenance.
- Use proper injection rates.
- Flush the system following a fertigation enough to clean the water lines, but not enough to cause leaching.

4-6 Amendments for Water Penetration

Vineyard

Category 4	Category 3	Category 2	Category 1
If water penetration was poor (water puddles and runs off when subsurface soil was dry), a long-term plan to correct the problem was developed and recorded ***And*** Appropriate amendments were added annually*, and/or a cover crop was grown at least until the problem was corrected, helping to reduce concentrated flows and stabilize sediment delivery sites ***And*** Irrigation water pH was tested as necessary and adjusted accordingly.	If water penetration was poor (water puddles and runs off when subsurface soil was dry), appropriate amendments were added, under emitter water basins were created, or a cover crop was grown for at least one year ***And*** Irrigation water pH was tested as necessary and adjusted accordingly.	If water penetration was poor (water puddles and runs off when subsurface soil was dry), appropriate amendments were added to the soil.	Water penetration was poor (water puddles and runs off when subsurface soil was dry), but no corrective action was taken. *(Select N/A if water penetration was not a problem)*

*If compost is added to the soil, be sure to determine its nutrient content and account for this amount in your vineyard nutrition program.

4-7 Soil pH Adjustments in an Existing Vineyard*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
If soil pH was less than 5.5 (i.e., acidic) limestone was added, and if the pH was above 8.5 (i.e., alkaline) an acidifying agent (e.g., sulfuric acid or soil sulfur) was added; amendments were applied at recommended levels ***And*** Soil pH was tested within the last 3 years.	If soil pH was less than 5.5 (i.e., acidic) limestone was added, and if the pH was above 8.5 (i.e., alkaline) an acidifying agent (e.g., sulfuric acid or soil sulfur) was added.	Soil pH was less than 5.5 (i.e., acidic) or above 8.5 (i.e., alkaline), but no corrective action was taken.	Soil pH was not known. *(Select N/A if soil analysis indicated pH was not a problem)*
*Soil pH can be difficult to change because of the large volume of soil that needs to be amended due to the buffering capacity of some soils.			

TABLE 4-a FEATURES OF SELECTED SOIL AMENDMENTS	
Limestone ($CaCO_3$)	Raises pH (counteracts acidity). Sugar beet lime has 80-90% Calcium carbonate equivalence. The amount of limestone to add for raising the pH to the correct level is based on the cation exchange capacity (CEC) and buffering capacity of the soil. This can be analyzed or calculated by the soil-testing lab and is called the "lime requirement". Percent moisture will greatly affect the calcium equivalence of liming materials and should be used when comparing materials and determining field application rates.
Dolomite ($CaCO_3$ + $MgCO_3$)	Raises pH. Dolomite has 110% calcium carbonate equivalence. It should not be applied when the soil has excess magnesium (Mg^{++} content greater than 20% of the base saturation) or is deficient in potassium. In these situations, dolomite additions can cause poor water penetration or potassium deficiency.
Elemental sulfur (S; must be finely ground to be effective)	Lowers pH (increases acidity). Elemental sulfur works best when applied and incorporated in the fall, but this process must be repeated over many years.
Gypsum ($CaSO_4$ + $2H_2O$)	Does not change pH. Gypsum improves water penetration and tilth in low calcium soils and in soils with excess magnesium or sodium.

4-8 Preserving or Increasing Organic Matter *Vineyard*

Category 4	Category 3	Category 2	Category 1
Soil analysis was done within the past 3 years for organic matter*, and inputs and outputs were monitored and recorded ***And*** Practices were implemented to increase nutrient cycling (e.g., composting**, cover cropping, use of suitable treated water from ponds, etc.) as part of standard procedures ***And*** Practices were implemented to prevent the off-site loss of nutrients including the use of buffer strips, and vegetation along roads and ditches ***And*** Tillage was eliminated to lower the rate of organic matter breakdown.	Soil analysis was done for organic matter*, and inputs and outputs were monitored ***And*** Practices were implemented to increase nutrient cycling (e.g., composting**, cover cropping, use of suitable treated water from ponds, etc.) as part of standard procedures ***And*** Tillage was reduced or eliminated to lower the rate of organic matter breakdown.	There was an awareness of inputs and outputs for organic matter ***And*** Resident vegetation was allowed to grow in the vineyard during the winter to encourage nutrient cycling.	Our operation did not monitor nutrient inputs and outputs in an effort to develop nutrient budgets.

*The ideal organic matter content is 1-3% for most vineyard soils. An exception is for the Central Valley, where warmer soil temperatures result in more rapid breakdown of organic matter by soil microbes, generally maintaining organic matter content at 0.2–0.3% despite best efforts to increase it (Ron Brase, AqQuest, Inc., Fresno, CA). Importantly, the byproducts of organic matter decomposition are crucial precursors for the production of soil aggregates. Consequently, even in regions and soils with low organic matter content, the continuous cycle of adding organic matter to soils followed by decomposition by microbes enhances soil structure.

**When adding compost or manure, its quality should be verified (e.g., no excess salts and heavy metals), its nutrient content should be determined and accounted for in the vineyard nutrition budget, and all relevant regulations were followed.

Table 4-b Compost and Manure Pros and Cons (characteristics may vary per product, especially if from mixed sources)	
Green waste compost	High carbon and low nitrogen, potassium, and phosphorus. Good choice for building stable organic matter. May immobilize nitrogen if incorporated. Recycles urban yard wastes. Source and quality is important because it can be a source for undesirable chemical residues.
Dairy manure compost	High nitrogen (slow release) and low carbon.
Steer manure compost	High nitrogen (slow release) and low carbon. May contain high levels of salts.
Grape pomace compost	High potassium and nitrogen (slow release). Recycles winery waste products.
Chicken manure compost	High nitrogen (slow release) and very high phosphorus.
Dairy manure	Moderate nitrogen, but needs incorporation for maximum contribution because of ammonia volatilization. May contain numerous weed seeds.
Steer manure	Moderate nitrogen, but needs incorporation for maximum contribution because of ammonia volatilization. May contain numerous weed seeds and high levels of salts.
Chicken manure	Very high nitrogen and phosphorus, but needs incorporation for maximum contribution because of ammonia volatilization. Has strong odor, can burn young vines, and can tie up zinc if includes bedding.
Raw grape pomace	High potassium and moderate nitrogen. Recycles winery waste. May reduce pH for alkaline soils.
Source: Ohmart and Matthiasson, 2000.	

Box 4-H Benefits of Soil Organic Matter

- Attracts and holds nutrients in an available state, reducing leaching losses.
- Soaks up and holds water.
- Binds soil particles into crumbs (aggregates), producing a granular structure which promotes the availability of air to roots, the capillary movement of water, and the penetration of roots through soil.
- Is transformed into vitamins, hormones, and other substances which stimulate growth in plants.
- Serves as food for soil organisms, which in turn, are consumed by some soil predators that feed on root pests
- Stores more carbon in the soil.

Organic matter is increased more rapidly when organic material is left on the soil surface, not tilled in. Tillage mixes additional oxygen into the soil, enhancing microbial activity and consumption (i.e., "burning off") of the organic matter. In untilled soils, the natural process is for organic material to be transported by soil organisms and water movement into the soil over time.

4-9 Soil Compaction

Vineyard

Category 4	Category 3	Category 2	Category 1
Equipment was chosen or modified to minimize soil compaction* (e.g., operated lightest equipment possible, used track-layers, installed wider or greater-diameter tires, and reduced tire pressure as much as possible) ***And*** Equipment operators refrained from driving in the vineyard during rain or muddy conditions, and equipment generally does not enter the vineyard during saturated soil conditions ***And*** Some permanent, non-tilled vineyard row cover crop or resident vegetation was maintained at least every other row.	Equipment was chosen or modified to minimize soil compaction* (e.g., operated lightest equipment possible, used track-layers, installed wider or greater-diameter tires, and reduced tire pressure as much as possible) ***And*** Equipment use was minimized in the vineyard during saturated soil conditions ***And*** Some permanent cover crop, annual cover crop, or resident vegetation crop existed (mowed or not) at least every other row during the springtime spray season.	Equipment was chosen or modified to minimize soil compaction* (e.g., operated lightest equipment possible, used track-layers, installed wider or greater-diameter tires, and reduced tire pressure as much as possible).	Soil compaction was not considered when choosing equipment* ***Or*** Equipment was driven in the vineyard regardless of soil moisture (including when there was the possibility of getting stuck).

*Tractor width also is an important factor in soil compaction. Compaction of rooting zones in aboveground drip-irrigated vineyards is greater with tractors having tires/tracks only a foot or so away from the vine row compared to that with relatively narrower tractors.

4-10 Surface Water Diversions for Erodible Sites

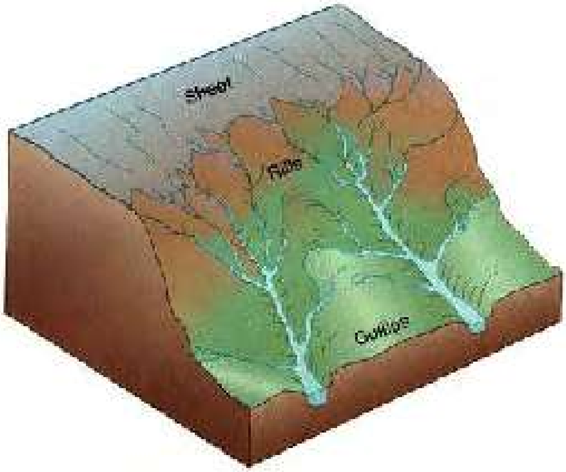
Vineyard

Category 4	Category 3	Category 2	Category 1
There was minimal evidence of rills or gullies ***And*** Erosion was controlled to prevent water quality degradation by sediment delivery sites (e.g., cover crops, buffer/filter strips, setbacks from stream areas where appropriate, etc.) ***And*** An engineered drainage system was present if needed and maintained if the erosion potential for the vineyard was high ***And*** Maintenance and repair materials were available for emergency repair.	Permanent drainage systems and waterways were present and maintained in the vineyard ***And*** Maintenance and repair materials were available for emergency repair.	Temporary drainage structures such as hay bales or shoveled diversion ditches were utilized during the winter.	Installed or maintained water diversion devices were not used to control erosion. *(Select N/A if less than 2% slope and site has never been prone to erosion)*

For more off-site water movement issues, see **Criteria 5-1** and **5-3** in **Chapter 5 Vineyard Water Management** and **Chapter 8 Ecosystem Management**.

BOX 4-I RILLS AND GULLIES

Rills and gullies vary only in severity of erosion, with both having the ability to transport sediment. Rills are generally less than 4 inches deep and gullies have well defined side-walls. There are various erosion control methods that can be used to lessen the effects of sediment transport by slowing water runoff and/or redirecting flows using engineered drainage systems.



Organic matter improves soil tilth, structure, aeration, and water-holding capacity; and increases water infiltration, buffers soil pH, enhances micronutrient availability, and provides a source of nutrients for plants and beneficial microorganisms.

4-11 Management of Erosion from Roads, Ditches, and Culverts *Vineyard*

Category 4	Category 3	Category 2	Category 1
A comprehensive erosion control plan customized for the vineyard roads, ditches, and culverts was implemented ***And*** Site-appropriate measures for roads were in place to prevent erosion (e.g., paved, vegetated, or outsloped roads; rolling dips, water bars) ***And*** Ditches were appropriately managed to prevent erosion, downcutting, or sedimentation (e.g., an adequate amount of vegetated or hardened**, ditch relief culverts installed) ***And*** Culverts were properly sized, positioned, and managed (e.g., inlets and outlets hardened to prevent scour, energy dissipators*** incorporated into outflows) to prevent erosion during high-flow events ***And*** Road maintenance was regularly scheduled and effective while repairs were made to any poorly functioning road drainages or waterway crossings.	Action(s) were taken to eliminate obvious sources of erosion (e.g., outsloped or vegetated roads, vegetated or hardened** ditches, incorporated riprap*** into culvert outflows) ***And*** A comprehensive erosion control plan customized for the vineyard roads, ditches, and culverts was developed ***And*** Road maintenance was regularly scheduled ***But*** During large storm events, heavy use roads may have continued to erode, downcutting of ditches remained evident, sheet erosion may have been evident, and/or visible scouring continued at culvert inflows or outflows.	Action(s) were taken to eliminate obvious sources of erosion (e.g., outsloped or vegetated roads, vegetated or hardened** ditches, incorporated riprap*** into culvert outflows) ***But*** A comprehensive erosion control plan customized for the roads, ditches, and culverts was not developed ***And*** Road maintenance was sporadic (i.e., as needed) rather than preventive and regularly scheduled.	Erosion had occurred on roads, in ditches, or at culverts associated with the vineyard ***But*** No corrective action(s) were taken and no erosion control plan was developed for roads, ditches, and culverts. *(Select N/A if site was never prone to erosion due to minimal or lack of sloping*)*

*Erosion may occur even when not obvious, especially during sheet flows across the ground surface.
**Hardening of ditches means the incorporation of rock and/or other erosion control fabrics and liners into the ditch surface.
***Rock and riprap are examples of energy dissipaters that are used to dissipate water energy and prevent erosion.

BOX 4-J REDUCING EROSION AND SEDIMENT TRANSPORT FROM ROADS

Vineyard roads can be a major source of sediment pollution to streams – delivering damaging nutrient loads, smothering fish eggs, and reducing the variability in stream habitats (which, in turn, can reduce the number of plant and animal species a stream can support). It is important, therefore, to limit erosion associated with roads, and prevent erosion that does occur from reaching streams and other water bodies. Important road-related sediment reduction measures* include:

Outsloping Unpaved Roads: Because roadbed erosion can only be completely abated through paving, management of unpaved roads should focus both on reducing erosion rates and preventing sediment that does erode from leaving the vineyard. Like insloping, outsloping roads (where appropriate) minimizes surface erosion by rapidly moving water from the roadbed. However, outsloping has the benefit of dispersing eroded sediments along the hill-slope (where it can be filtered out by cover crops or natural vegetation), rather than concentrating sediment in the ditch (where it can be delivered to nearby water bodies). In addition, by reducing or eliminating the need for ditches, outsloped roads are among the least expensive road types to build and maintain.

Vegetating Unpaved Roads: Vegetating unpaved surfaces in or around vineyards (where feasible and includes a high percentage cover) can be a reasonable solution for reducing erosion and dust (see **Chapter 16 Air Quality and Climate Protection** for more detail on dust mitigation).

Seeding and Hardening Ditches: Depending on the degree of slope, ditches should be vegetated or hardened to prevent erosion. There should be an adequate number of ditch relief culverts to reduce the flow in the ditch. Outsloping ditches wouldn't require ditch relief culverts. For low to moderate slopes, vegetation (e.g., perennial grasses) can be used to stabilize ditch surfaces and filter sediments from unpaved road surfaces. For steeper slopes and points of potential high scour, hardening ditch surfaces with stone and/or other erosion control fabrics and liners may prevent ditch erosion and downcutting as long as the carrying capacity of the ditch isn't compromised and flows are contained to the ditch.

Stabilizing Culverts: Sediment erosion can occur at the culvert inlet and/or outlet. At the inlet, culverts (especially if undersized) can impede the free flow of water and associated debris and result in upstream deposition, often redirecting flows and causing erosion. At the outlet, concentrated flows can lead to downcutting and the development of a "perched" or "hanging" culvert, which, in turn, can cause greater erosion of the downstream slope as water falls farther from the outlet. To stabilize a stream crossing culvert opening, soil around inlets and outlets should be well compacted and points of scour hardened (e.g., with riprap). In addition, culverts should be sized to accommodate high flow events and installed at slopes matching downstream grades.

NRCS staff can help greatly in developing erosion control plans for vineyard roads, ditches, and culverts and in implementing necessary erosion control practices. NRCS may be able to offer free project planning and engineering consultation, and, depending on local funding priorities and the practices to be implemented, may cover up to 75% of the project cost through the Environmental Quality Incentives Program (EQIP). To learn more about available resources from NRCS or locate their local office, visit http://www.ca.nrcs.usda.gov.

*Permits may be required for work on roads or culverts that require the grading of slopes, potentially deliver significant sediment to water bodies, or modify the bed or bank of streams. NRCS, Resource Conservation District, or CA Department of Fish and Game staff can provide information on necessary permits and related project requirements.

4-12 **Non-Point Source (NPS) Pollution Prevention* within the Vineyard Block (e.g., soil, water, biological, bacteriological, chemical runoff)**			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
A site-specific NPS Pollution Prevention Plan existed (see **Box 4-K**) and included a Land Use Inventory, a Watershed Survey (sediment, nutrient, and chemical), water quality monitoring, and adoption of Best Management Practices (BMPs) to help protect the waters of the state (surface or groundwater) ***And*** The strategy involved cooperation and follow-up with regulatory agencies, and local or regional associations (e.g., watershed working group)*** ***And*** A map was created showing stormwater runoff direction with potential pollutant locations (e.g., sediment, nutrients, and chemicals).	A winter annual cover crop or resident vegetation was maintained in the vineyard ***And*** Water diversions were used if longer slopes exist to safely transport runoff ***And*** A floor management strategy to reduce runoff was developed (such as reducing tillage, permanent cover crops**) ***And*** A NPS pollution prevention plan was being researched and planned (see **Box 4-K**).	A winter annual cover crop or resident vegetation was maintained in the vineyard ***And*** A floor management strategy to reduce runoff was developed (such as reducing tillage, permanent cover crops).	A cover crop or resident vegetation was never present in the vineyard.

*Not following local ordinances for minimizing erosion may result in criminal or civil charges. Check with local agencies for requirements (e.g., NRCS at http://www.ca.nrcs.usda.gov/).
**Permanent cover crops and/or no tillage (including under the vine) may not be advisable for all vineyards because of low site vigor, restricted water availability, organic production constraints, etc. However, these two practices greatly reduce erosion and runoff. Often, there are trade-offs when deciding what is best for your farm.
***E.g., Fish Friendly Farming® (North Coast region) and Lower Mokelumne River Watershed Stewardship Program (Northern Interior region).
To help determine the slope of the property, contact your local USDA/NRCS Service Center at http://offices.sc.egov.usda.gov/locator/app?state=CA

Box 4-K Creating a Non-Point Source Pollution Prevention Plan

"Non-point source" (NPS) pollution originates from many diffuse sources all over the watershed and is the main cause of water pollution in waterways. One of the major contributors to nonpoint source pollution is stormwater runoff, surface runoff, yards, streets, parking lots, and buildings. NPS pollution is not limited to water. In fact, wind can also be a source of NPS pollution. An NPS pollution prevention plan should include a Land Use Inventory and a Watershed Survey.

The following information should be included for a Land Use Inventory:

- List of potential chemicals or materials that could be transported offsite (paint, sewage, trash, cleaning products, oils, powders)
- List of potential sources of stormwater that could transport chemicals or materials offsite (drains, creeks, roadways)
- Mitigation methods used to prevent or minimize NPS pollution transfer (cover crops, water catch basins, wind breaks, closed-containment systems)
- Conservation methods used to minimize chemical or material use (shut-off valves, nozzles)
- Response plans to any potential problems including clean up and evacuation routes
- Awareness of neighboring properties and how material transfer may have an impact.

The following information should be included for a Watershed Survey (maps may be created using GIS software or hand drawn over USGS topographic quadrangle maps with detail):

- Identified and marked property lines for the assessed property
- Mapping of waterway routes within the watershed including water diversions, drop inlets/outlets, drains, sumps, drain tile, waterway crossings, ponds, reservoirs, and septic tanks
- Maps include arrows showing directions of waterway flow, underground drainpipe, tributaries, and potential flooding impacts
- Wind direction map showing impacts on machinery, chemical/fuel storage, employees, and/or neighbors (map with arrows showing predominant wind direction and may be on the same map as the waterways).

4-13 Cover Crops

Vineyard

Category 4	Category 3	Category 2	Category 1
A permanent cover crop* (seeded or resident) or an annual re-seeding non-tilled (or tilled every other row) cover crop was managed between vine rows, unless not appropriate for vineyard site (e.g., dry farming, water availability) ***And*** The type of cover crop planted was based on specific goals for the vineyard (e.g., site vigor adjustments, erosion and runoff concerns, improve soil structure, enhance biodiversity, etc.) ***And*** Either a vigor-reducing or vigor-enhancing (e.g., nitrogen-fixing legumes) cover crop is planted, as appropriate ***And*** Data on interactions between the cover crop chosen and the vineyard rootstock are reviewed to ensure no undesirable outcomes.	A seeded annual cover crop was managed between vine rows during winter ***And*** The type of cover crop planted was based on specific goals for the vineyard (e.g., site vigor adjustments, erosion and runoff concerns, improve soil structure, enhance biodiversity, etc.).	An annual resident cover crop (non-seeded) was managed between vine rows during winter.	No cover crop was planted or allowed to grow between vine rows.

*Permanent cover crops may not be advisable for all vineyards because of low site vigor, restricted water availability, if the site is dry farmed, etc. However, permanent cover crops enhance soil quality and greatly reduce erosion, runoff, and PM10. Often, there are trade-offs when deciding what is best for your vineyard.

Cover crops do not need to be worked into the soil – you keep more organic matter by mowing and letting the residue lay on the surface. The aeration of the soil from disking burns off organic matter roughly as fast as it is being added.

Box 4-L Cover Crop Points To Remember

- Cover crops offer the most practical and cost-effective means of supplying the organic matter needed to maintain and improve soils.
- A permanent cover crop (seeded or resident) or an annual re-seeding non-tilled cover crop is managed between vine rows.
- Cultivation decreases soil organic matter.
- Decaying cover crop residues release nutrients for grapevines.
- Most winter cover crops should be seeded before the first of November, using appropriate seedbed preparation and seeding depth.
- Grass cover crops usually require additions of nitrogen (20-40 lbs per acre), whereas leguminous cover crops may require phosphorus and sulfur but no nitrogen.
- Depending on composition, cover crops can reduce or enhance vine growth and can help mitigate erosion concerns.
- Cover crops tend to use more water than that lost through clean cultivation. However, cover crops increase water infiltration, potentially offsetting this difference during winters with high rainfall.
- Depending on their composition and the duration grown, there is a chance that cover crops may decrease or increase problems with nematodes. One way to minimize risks from nematodes is to alternate the cover crop species every 5 years or so. Check with an appropriate UC Farm Advisor or cover crop specialist for more information.
- Data on the interactions between the cover crop chosen and the vineyard rootstock should be reviewed to ensure no undesirable outcomes.

Table 4-c Cover Crop Options for Vineyard Management Systems

Systems excluding tillage (no-till)		**Systems including tillage**	
To maintain vigor:	**To decrease vigor:**	**To increase vigor:**	**To decrease vigor:**
Vetches (woollypod or common). Less than 10-15% annual grasses (e.g., blando brome, zorro fescue). Mow early (before winter rains end).	Perennial grasses (Big 3 or Little 3 native grass blends, turf-type fescues, or ryes).	Annual legumes (bell beans, peas, or vetch). Less than 10-15% annual grasses (e.g., oats, triticale, barley, wheat). Incorporate early.	50-100% annual grasses (e.g., oats, triticale, barley, wheat, rye). Incorporate late.

Source: Ohmart and Matthiasson, 2000.

Besides affecting vine vigor, cover crops can variably impact erosion, water infiltration, etc. Check with an appropriate UC Farm Advisor or cover crop specialist for site-specific recommendations.

4-14 Soil Carbon Sequestration			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
There was knowledge about the link between specific soil health practices and carbon sequestration ***And*** Practices with soil carbon sequestration potential were identified* and implemented ***And*** The soil carbon sequestration potential of the vineyard was estimated using the DNDC model in the CSWA Metrics Center, COMET-Planner, COMET-Farm or other calculator/tool** ***And*** Opportunities for carbon sequestration were evaluated using a carbon farm plan (e.g., the Resource Conservation District's LandSmart Carbon Farm Plan) or the CSWA Climate Smart Report, and some relevant practices were implemented. ***	There was knowledge about the link between specific soil health practices and carbon sequestration ***And*** Practices with soil carbon sequestration potential were identified* and implemented ***And*** The soil carbon sequestration potential of the vineyard was estimated using the DNDC model in the CSWA Metrics Center, COMET-Planner, COMET-Farm or other calculator/tool.**	There was awareness of the link between specific soil health practices and carbon sequestration ***And*** Practices with soil carbon sequestration potential were identified.*	The relationship between soil health practices and carbon sequestration was not known.

*See **Box 4-M** for information about practices that increase soil carbon sequestration.

** There are several tools available to help quantify soil carbon sequestration potential available to winegrowers, outlined below:

- DNDC (DeNitrification-DeComposition) is a computer model that simulates carbon and nitrogen cycling among soil, air, and crops. CSWA has incorporated a simplified DNDC model into the CSWA Metrics Center to enable any California vineyard to get estimates of the total soil-related greenhouse gas emissions and sequestered carbon after entering a few required inputs (vineyard location, row spacing, tillage practices, use and type of cover crop, amount of compost applied and amount of nitrogen applied as fertilizer). Access the CSWA Metrics Center here: https://metrics.sustainablewinegrowing.org/ For more information on the DNDC model and vineyard greenhouse gases download the **DNDC Greenhouse Gas Modeling for California Vineyards** handout from the Resource Library: https://library.sustainablewinegrowing.org/
- COMET-Planner http://www.comet-planner.com/
- COMET-Farm http://cometfarm.nrel.colostate.edu/

***The **LandSmart Carbon Farm Plan** is a tool that assists landowners in identifying practices, currently in use or recommended for implementation, that reduce greenhouse gas emissions, improve soil health, and sequester carbon. For more information visit: http://landsmart.org/programs-services/landsmart-carbon-farm-plans/

The **CSWA Climate Smart Report** is a customized report that summarizes the climate beneficial practices included in the Code. The report can be generated in the SWP Online System after a vineyard or winery self-assessment is completed and highlights the 71 climate smart practices that increase carbon sequestration and reduce greenhouse gas emissions while providing a roadmap to improve practices. A companion handout to the report, **Climate Smart Winegrowing**, provides background and includes a list of the 71 climate smart practices, available in the Resource Library: https://library.sustainablewinegrowing.org/

BOX 4-M SOIL CARBON SEQUESTRATION

What is Soil Carbon Sequestration?

Soil carbon sequestration is the long-term storage of stable forms of carbon in the soil. Carbon farming is a term used to describe practices that promote long-term carbon sequestration by capturing carbon in the soil and plant material.

Practices that enhance soil carbon sequestration:

- Reduce soil compaction
- Increase soil organic matter (e.g., through compost and/or cover crops)
- Reduce tillage or eliminate tillage
- Cover the soil with annual or perennial cover crops/resident vegetation, and/or mulch
- Prevent off-site soil loss through vegetation management
- Keep pruning materials in the vineyard
- Increase woody plants in and around the vineyard (e.g., hedgerows, riparian vegetation, trees)
- Integrate animals into the vineyard for weed management and manure deposition

Vineyard Soil Carbon Sequestration Resources:

- The **CSWA Climate Smart Report** is a customized report that summarizes the climate beneficial practices included in the Code. The report can be generated in the SWP Online

System after a vineyard or winery self-assessment is completed and highlights the 71 climate smart practices that increase carbon sequestration and reduce greenhouse gas emissions while providing a roadmap to improve practices. For more information, see the companion handout to the report, **Climate Smart Winegrowing**, for background and a list of the 71 climate smart practices, available in the Resource Library: https://library.sustainablewinegrowing.org/

- The **LandSmart Carbon Farm Plan** is a tool that assists landowners in identifying site-specific practices, currently in use or recommended for implementation, that reduce greenhouse gas emissions, improve soil health, and sequester carbon. For more information visit: http://landsmart.org/programs-services/landsmart-carbon-farm-plans/

- For resources and factsheets on increasing soil health in vineyards, visit the Resource Library on the **North Coast Soil Health Hub** website: http://soilhub.org/

- See the **Vineyard Management Practices and Carbon Footprints** handout available in the CSWA Resource Library: https://library.sustainablewinegrowing.org/

Cost Share Opportunities:
The **CDFA Healthy Soils Program** provides funding for implementation of conservation management practices that improve soil health, sequester carbon and reduce greenhouse gas (GHG) emissions. For more visit: https://www.cdfa.ca.gov/oefi/healthysoils/

The Natural Resources Conservation Service **(NRCS) Environmental Quality Incentives Program** (EQIP) provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits such as increased soil health. Many soil health practices are covered by NRCS Conservation Practices, for more visit: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

5. VINEYARD WATER MANAGEMENT[1]

Original Chapter Authors: Clifford P. Ohmart and Stephen K. Matthiasson, formerly with Lodi Winegrape Commission; Modified by the Sustainable Winegrowing Joint Committee

In describing the demand for water in California, Mark Twain said, "Whiskey's for drinkin', and water's for fightin' over." Winegrapes use less water than most crops, but practitioners still must wisely manage water, a precious and limited resource. Because of population growth in California and the potential effects of climate change, a more comprehensive approach to long-term water management is best addressed through effective land management planning. This chapter focuses on the day-to-day aspects of water management at the vineyard level and how it can reduce input costs while improving wine quality. It also touches on the high level of planning and assessment.

In some areas of California, particularly grape growing areas of the north coast valleys, winegrape growers practice dry farming, the ultimate agricultural approach to water conservation. The phrase dry farming however is a verb not a noun. It is used to describe all the activities needed to store the winter rains in the soil and make them available to the vines during the growing season. Done properly, in an appropriate vineyard, dry farming can deliver full crops from deep-rooted, long-lived vines.

The conversion from flood to drip irrigation revolutionized viticulture in many regions of the state. Drip-irrigated vineyards can produce healthier vines with more uniform growth and yield, leading to better wine. Drip irrigation systems should be managed to maximize efficiency while improving winegrape quality. It is important that growers diligently monitor and maintain their irrigation systems. Problems such as clogged emitters rob you of the full benefits of drip irrigation.

The great boon of drip irrigation is the control it gives growers in deciding exactly how much water to apply and when. This flexibility brings the responsibility to efficiently schedule and deliver only necessary amounts of water. Numerous methods for monitoring water use and irrigation scheduling are available. The water budget method is described in this chapter.

Proper water management, regardless of irrigation system, probably impacts wine quality more than any other practice. Regulated deficit irrigation (RDI) enhances grape and wine quality in some regions of California. To remain competitive, winegrape growers must strive to improve fruit quality and maintain economic viability. RDI is an important tool to use for achieving this in many vineyards and is characterized at the end of the chapter.

The purpose of this chapter is to help growers identify and improve management practices that can help conserve water, protect water quality, and enhance winegrape quality. It includes 11 criteria to self-assess:

- The water management strategy for the vineyard
- The water quality of irrigation water
- Off-site water movement from the vineyard
- Irrigation system setup and maintenance
- Irrigation scheduling and quantity.

[1]This chapter has been adapted from Lodi Winegrape Commission's *Lodi Winegrower's Workbook* (Ohmart and Matthiasson, 2000). Many of the criteria in this chapter appeared as questions in the Central Coast Vineyard Team's Positive Points System, the first vineyard self-assessment system in California (CCVT, 1996 and 1998).

List of Vineyard Water Management Criteria

Moderate water stress, particularly between bloom and veraison, can have significant positive impact on wine quality by increasing total acidity, decreasing pH and malate, and enhancing color.

Performance Metrics – Vineyard Water

Why are Performance Metrics important?

Knowing and understanding the actual use of resources is an important aspect of controlling costs and increasing the profitability for any business. Including the relationship between practices and measurable outcomes allows you to accurately benchmark your performance so that you set achievable targets for improvement using actual and not perceived outcomes. Whereas the practice-based self-assessment helps determine what winery or vineyard practices affect energy or fuel use, for example, performance metrics calculations provides a baseline and the rational for setting targets based on real measurements. As the adage says, “You can’t manage what you don’t measure.”

The Water Efficiency Metric is used to track the total amount of water used in the vineyard to produce the crop. By tracking water use, growers can monitor their water use over time.

How do you Calculate Water Efficiency Metrics?

Vineyard water metrics include acre inches applied per acre and per tons of grapes (see below for calculation examples).

Using Performance Metrics

1. Collect
Identify and gather data needed to calculate the metric

2. Measure
Calculate metrics and determine your baseline

3. Track
Track your metrics calculations from year to year

4. Manage
Set targets for improvement and identify action plans

Metric Area	Metric Calculation	Data Elements	Data Sources
Water Use (Vineyard)	**Water Use Efficiency** = $\frac{\text{Acre-inches Applied}}{\text{Acre}}$ $\frac{\text{Acre-inches Applied}}{\text{Ton of Grapes}}$	• Applied water (including for frost protection) • Acreage • Yield (total tons)	Utility records; Flow meter readings

How do I start tracking my Performance Metrics?

To get started tracking and recording vineyard water use, as well as other performance metrics (e.g., greenhouse gas emissions, energy, and applied nitrogen) visit http://www.sustainablewinegrowing.org/metrics.php or click on the “Metrics” tab within the SWP Online System.

5-1 Water Management Strategy *Vineyard*

Category 4	Category 3	Category 2	Category 1
The documented water management plan** identified the designated beneficial use of the water body and was based on grape-growing goals set before the growing season and accounted for soil types, slopes, irrigation water availability and quality, and energy efficiency*** ***And*** Tools were in place to accomplish these goals (soil monitoring devices, weather stations, etc.) ***And*** At least three documented parameters supported water management decisions in addition to visual plant stress (e.g., evapotranspiration (ET), leaf water potential via pressure bomb, stomatal conductance via porometer, soil moisture).	The documented water management plan** was based on grape-growing goals set before the growing season and accounted for soil types, slopes, irrigation water availability and quality, and energy efficiency*** ***And*** Tools were in place to accomplish these goals (soil monitoring devices, weather stations, etc.) ***And*** Water management decisions were supported by visual plant stress and documented parameters (e.g., evapotranspiration (ET), leaf water potential via pressure bomb, stomatal conductance via porometer, soil moisture).	The water management strategy* was based on grape-growing goals set before the growing season (yield, fruit quality, water quality/quantity, canopy characteristics, floor management, and/or fertility requirements) and accounted for soil types, slopes, and irrigation water availability, cost and quality.	A water management strategy for the vineyard was not developed.

*Examples of water management strategies are delayed onset of irrigation, dry farming, regulated deficit irrigation, partial root zone drying and the potential for ground water recharge. Strategies should consider potential impacts of pests, such as root-damaging nematodes or phylloxera, on the capacity for vines to uptake water, and seasonal availability of water in the larger watershed.
**A water management plan can include software that includes thresholds and trigger points for irrigation scheduling, the CSWA Vineyard Sustainable Water Management Water Tool, and forms of written plans.
***E.g., irrigating during off-peak hours.
The CSWA **Vineyard Sustainable Water Management Tool** is an excel-based tool that can be used to establish a baseline for tracking decisions over time to better understand the economic impact of different water management decisions. The tool includes sections on vineyard layout, irrigation scheduling, monitoring (water quality, irrigation system, moisture), and other water uses (frost protection, dust control, cover crops, and summer cooling). Available at: https://library.sustainablewinegrowing.org/

BOX 5-A1 IRRIGATION AND CLIMATE CHANGE

Vineyard water use can impact greenhouse gas (GHG) emissions and carbon sequestration. While, the energy used during irrigation to pump water results in GHG emissions, a correlation also exists between increased irrigation and GHG emissions from soil. At higher moisture, soils have minimal oxygen content and microbes produce more N_2O. Anaerobic soils are optimal environments for microbial production of N_2O (and CH_4 though less important for vineyards). Wet soils, especially when warm, can also increase CO_2 emissions through increased microbial activity and decomposition of organic matter. In contrast, increasing irrigation can offset some GHG emissions by stimulating vines to grow and store carbon in permanent structures. This is a form of above-ground carbon sequestration that is especially effective if vines live for a long time and much of the removed vine biomass is incorporated into the soil to increase organic matter. Various irrigation systems and patterns may differently impact GHG emissions from soils. Drip irrigation is thought to produce less N_2O than flood or furrow irrigation at the vineyard level but more research is needed.

Source: Vineyard Management Practices and Carbon Footprints, California Sustainable Winegrowing Alliance, May 2009

5-2 Monitoring and Amending Quality of Irrigation Water *Vineyard*

Category 4	Category 3	Category 2	Category 1
Irrigation water was tested annually* and simultaneously for pH, salinity or total dissolved solids (electrical conductivity), nitrate, bicarbonate, suspended solids, chlorides, boron, manganese, and magnesium (as appropriate for the site and region**) ***And*** If problems with quality of irrigation water existed, water was amended and/or managed (e.g., via sulfuric acid, gypsum, polymers, root-zone leaching).	Irrigation water was tested at least once every three years or annually* if the water quality changed frequently and simultaneously for pH, salinity or total dissolved solids (electrical conductivity), and nitrate ***And*** If problems with quality of irrigation water existed, water was amended and/or managed (e.g., via sulfuric acid, gypsum, polymers, root-zone leaching).	Irrigation water was tested at least once every three years for at least pH, salinity or total dissolved solids (electrical conductivity), and nitrate.	There were no records of water quality testing within the past three years. *(Select N/A if the site was dry farmed during the assessment year)*

*Testing may need to occur more often where water quality (e.g., nitrate levels, salinity) fluctuates over time.
**There may be important regional issues about the quality of irrigation water. For example, high levels of iron can lead to the formation of precipitates in irrigation lines that can plug emitters. Contact local experts such as an appropriate UC Farm Advisor, irrigation company, or analytical laboratory for more information.

Box 5-A2 Dry Farming Vineyards

In some areas of California, particularly grape growing areas of the North coast valleys, winegrape growers practice dry farming, the ultimate agricultural approach to water conservation. The phrase dry farming however is a verb not a noun. It is used to describe all the activities needed to store the winter rains in the soil and make them available to the vines during the growing season. Dry farmed crops rely on the moisture held in the soils from winter rains to meet their water requirements for growth. Done properly, in an appropriate vineyard, dry farming can deliver full crops from deep-rooted, long-lived vines.

For more information visit: Dry Farming Wine Grapes A Best Management Practice Guide for California Growers, created by the Community Alliance with Family Farmers, available at: http://agwaterstewards.org/wp-content/uploads/2016/08/CAFF-Dry-Farming-BMP-Guide-final.pdf

BOX 5-A NITRATE CALCULATIONS

There are two measures for reporting nitrate in a water sample: NO_3 or NO_3-N. NO_3 is a measure of the concentration of nitrate (e.g., via labs), while NO_3-N is a measure of the concentration of nitrogen in the nitrate form (e.g., via Cardy meter or EM Quant strip).

To convert to pounds of nitrogen applied per acre-foot of water,

multiply
ppm NO_3 by 0.614
or
ppm NO_3-N by 2.72

5-3 Off-Site Water Movement *Vineyard*

Category 4	Category 3	Category 2	Category 1
Irrigation practices and/or property location or design caused few or no rills or gullies due to concentrated flows from rainfall or applied water ***And*** Preventive techniques (e.g., cover crops) were in place to slow and prevent most rainfall runoff from becoming concentrated flows ***And*** If runoff could occur during some high rainfall events, drainage systems (e.g., proper and adequate ditch relief culverts) were in place* to minimize off-site movement of silt, pesticides, and/or fertilizers.	Irrigation practices and/or property location or design caused few or no rills or gullies to form due to concentrated flows from rainfall or applied water ***And*** Preventive techniques (e.g., cover crops, vegetated, rocked, or solid surfaced ditches) were in place* to reduce rainfall runoff, minimizing off-site movement of silt, pesticides, and/or fertilizers ***And/Or*** If applicable, engineered drainage systems (culverts, drop inlets, diversions) were in place for hillside or terraced sites to minimize off-site movement of silt, pesticides, and/or fertilizers.	Irrigation practices caused no runoff, but runoff may have occurred during high rainfall events ***And*** If applicable, engineered drainage systems (culverts, drop inlets, diversions) were not in place for hillside or terraced sites to minimize off-site movement of silt, pesticides, and/or fertilizers.	Runoff occurred when the vineyard was irrigated and during rainfall events ***And*** Engineered drainage systems (culverts, drop inlets, diversions) were not in place for hillside or terraced sites to minimize off-site movement of silt, pesticides, and/or fertilizers ***And*** Drainage waterways were kept free of vegetative growth and sediment may have been lost.

*It is important to be aware of the dynamics of groundwater recharge from rain falling on a slope. If vineyards occupy a significant portion of a hillside landscape and have drainage systems which quickly divert rainfall, it is important to know how drainage patterns will affect long-term groundwater recharge and to mitigate significant negative impacts.

See **Box 5-B** and **Criteria 4-10** through **4-12** and **Boxes 4-I** and **4-J** in **Chapter 4 Soil Management** for additional erosion-prevention practices and information.

BOX 5-B INTERCEPTING SURFACE WATER AND SEDIMENT MOVEMENT

There are several techniques for intercepting surface water and sediment movement resulting from off-site water flow. Some techniques provide seasonal solutions, often used for new vineyards or in emergency situations, while some are permanent. Seasonal solutions should be followed-up on annually to evaluate if it should be made a permanent solution. Steep hillside vineyards should have several permanent erosion control measures in place, such as permanent cover crops, appropriate terracing, adequate filter strips between the vineyard and waterways, and permanent sediment basins. Any practice to reduce movement of sediment and/or water should be properly engineered and/or installed. Also, vineyards without cover crops that have very slight slopes can have significant movement of soil. Measures should be in place to counteract any form of erosion.

Seasonal Measures:

- **Filter fabric fencing**: A barrier of filter fabric cloth with woven wire stretched between temporary fence posts across a slope to reduce soil movement.
- **Straw bale check dam**: Bales of clean straw bound with wire or plastic twine placed across an area of surface sheet flow or gully erosion and anchored into the soil surface with rebar or stakes.
- **Wattles/Straw bale water bars**: Straw bales used to create a temporary water bar across a road or a temporary sediment barrier to protect drop inlets. A series of straw bale water bars may be needed for a long slope.
- **Temporary sediment basin**: Used to catch and settle-out sediment before it can enter a waterway. Sediment basins usually are placed at the base of a slope or drainage area. A small basin can be created by forming an embankment (not to exceed 4 feet in height) from compacted soil and rocks or straw bales. A drain or outlet should restrict flow from the basin to allow for sediment to be trapped.
- **Plastic-lined ditch**: When a vineyard road or road ditch begins to erode, plastic can be placed over the eroding portion to temporarily reduce soil loss. Strong plastic should be used to avoid puncture by rocks and sticks.

Permanent Measures:

- **Filter strip**: A strip of dense grass or other vegetation separating the vineyard from a waterway. Runoff entering the strip is slowed by the dense vegetation and transported sediment is filtered and captured. The recommended width of the filter strip is proportional to the slope of the source draining area. Widths should range from at least 10 feet for slopes of less than 1% to 25 feet for slopes of 30%. Filter strips can also be positioned across a vineyard slope between blocks to reduce sediment movement by sheet flow.
- **Sediment basin**: The basin is created by constructing an embankment, a release structure (e.g., perforated pipe riser), and an emergency spillway. The basin may be located at the bottom of a vineyard slope where drainage enters a swale or waterway. These basins should be designed on a site-specific basis by the US Department of Agriculture Natural Resources Conservation Service (NRCS) or a civil engineer and constructed using appropriate materials, dimensions, and techniques.

For more information visit the Resource Conservation District LandSmart program available at http://landsmart.org/ and the CSWA erosion control webpage at: https://www.sustainablewinegrowing.org/webresource/21/Erosion_Control.html

Source: Marcus et al., 1999. For information about the Fish Friendly Farming® program and associated practices, see **Box 8-L** in **Chapter 8 Ecosystem Management**.

5-4 Irrigation System

Vineyard

Category 4	Category 3	Category 2	Category 1
An engineered* micro-irrigation system (including drip irrigation or micro sprinklers) was installed in the vineyard.	A low-flow engineered* sprinkler irrigation system was installed in the vineyard.	A high-flow engineered* sprinkler irrigation system was installed as the only method of irrigation in the vineyard.	A non-engineered or flood irrigation system was present in the vineyard. *(Select N/A if the site was dry farmed during the assessment year)*

*A well-engineered irrigation system consists of components such as flow meters, back-flow prevention devices, flow controls, flush valves, and filtration and injection equipment. The system should have energy efficient features to accommodate for site variation and may have engineered pressure compensation devices where needed.

5-5 Distribution Uniformity for Irrigation Systems *Vineyard*

Category 4	Category 3	Category 2	Category 1
The distribution uniformity of the irrigation system was tested within the last 3 years and recorded by monitoring both emitter outflows and pressure differences across the block (or furrow distribution was checked visually if applicable) ***And*** Necessary corrections were made to ensure **Table 5-a** guidelines were met, if applicable, and improvements were confirmed ***And*** For water sources high in carbonates, bicarbonates, iron or organic matter, an annual distribution uniformity test was done.	The distribution uniformity of the irrigation system was tested within the last 5 years and recorded by monitoring emitter outflows or furrow distribution was checked visually across the block ***And*** Necessary corrections were made to ensure **Table 5-a** guidelines were met, if applicable ***And*** For water sources high in carbonates, bicarbonates, iron or organic matter, a bi-annual distribution uniformity test was done.	The distribution uniformity of the irrigation system was tested within the last 7 years by monitoring outflows, or furrow distribution was checked visually.	The distribution uniformity was not checked for the irrigation or furrow system. *(Select N/A if the site was dry farmed during the assessment year)*

See **Table 5-a** for information on evaluating micro-irrigation systems if used.
Learn how to conduct a distribution uniformity (DU) test with just a few simple tools and learn about the many benefits of conducting regular DU field tests by viewing the **How to Conduct an Irrigation Uniformity Test** handout and videos at the CSWA Resource Library: https://library.sustainablewinegrowing.org/

Distribution uniformity is usually much worse than most growers believe. A difference of 2:1 within a block is not uncommon.

TABLE 5-a QUICK FIELD EVALUATION OF IRRIGATION SYSTEMS		
Concerns	**Acceptable Ranges**	**Focus and Resolution**
There is a pressure difference between the pump discharge and the downstream side of the filters.	It is good to see less than a 6-10 psi drop between these locations.	A large drop in pressure indicates: -Excessive pressure being consumed by a pressure regulator -Dirty filters -Large losses through valves and fittings *The pressure drop does not directly impact irrigation efficiency or uniformity but does impact the energy bill.*
There is a different pressure in the first hose immediately downstream of each pressure regulator in the field.	Pressures in these locations should vary no more than 1 psi unless pressure compensating emitters are used.	Pressure regulators get out of adjustment easily. This is easily overcome by measuring pressure using a pressure gauge with a pilot tube poked into the hose while water is running.
There is inadequate or high pressure in the first hose immediately downstream of each pressure regulator in the field.	Appropriate pressures are typically 15-30 psi for aboveground drip, 10-12 psi for tape, and 10-15 psi for subsurface drip irrigation (SDI).	Extremely low pressures cause non-uniformity. Higher than desired pressures for SDI cause water to bubble to the surface, while excessively high pressures cause fitting problems and leaks for other systems.
Pressures at the risers of many hoses in each block vary (downstream of a pressure regulator).	Pressures should be within 5-10% unless pressure compensating emitters are used.	Ensure all valves are open to the appropriate level.
Dirty water is flushed from the ends of hoses (the furthest hoses are worst).	The water should be slightly dirty for no more than 5 seconds (catch water in a sock to evaluate color, i.e., plugging potential).	This is an excellent indication of the overall success of avoidance maintenance, i.e., chlorine injection, good filtration, and frequent hose flushing.
Times required for single emitters to fill small containers vary (sample 20-40 emitters throughout the field for at least 30-seconds, including those from the head and tail ends of blocks and hoses and from hose middles).	Times should be within 5-10%.	Differences can be caused by: -Plugging -Wear -Pressure variation -Manufacturing variation Plugging and wear can be identified by cutting and examining emitters or sprayers. Pressures must be measured while water is flowing, using a 0-30 psi pressure gauge if pressures are 10-25 psi.
CSWA provides how-to guides for conducting distribution uniformity tests, available at the CSWA Resource Library at: https://library.sustainablewinegrowing.org/ **Source:** Adapted from Charles M. Burt, Cal Poly Irrigation Training and Research Center (ITRC), San Luis Obispo, CA.		

5-6 Filters and Lines			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
The irrigation system was equipped with a properly operating flushing system for filters and lines and was monitored to maintain optimum operation multiple times per year ***And*** An inspection of the irrigation system was part of a regular maintenance program (i.e., conditions of screens and/or media checked at least twice per year).	Water filters in the irrigation system were inspected and cleaned when pressure differences were found, and irrigation lines were flushed multiple times per year to maintain proper irrigation system efficiency, if needed.	Water filters in the irrigation system were inspected and cleaned when pressure differences were found, and irrigation lines (main lines and drip lines) were flushed annually and on a regularly scheduled basis.	Water filters in the irrigation system were not regularly inspected and cleaned, and irrigation lines were not flushed on a regularly scheduled basis. *(Select N/A if the site was dry farmed during the assessment year)*

Drip-irrigated vineyards can produce healthier vines with more uniform growth and yield, leading to better wine quality. Drip irrigation systems should be managed to maximize efficiency; problems such as clogged emitters rob you of the full benefits of drip irrigation.

5-7 Water Budget *Vineyard*

Category 4	Category 3	Category 2	Category 1
The amount of water used by the vineyard between each irrigation (cumulative crop ET [ET_c] or similar method) was known and only water that was used by the vineyard (or less if deficit irrigating) was replaced. Amounts used were verified by assessing soil moisture status and vine response following applications ***And*** Plant moisture status (as described in Category 4 of **Criteria 5-10**) was used to modify the irrigation applications as necessary ***And*** If soil salinity was believed to be an issue, it was confirmed annually (by analysis) and managed appropriately.	The amount of water used by the vineyard between each irrigation (cumulative crop ET [ET_c] or similar method) was determined, and only water that is used by the vineyard (or less if deficit irrigating) was replaced. Amounts used and application volumes were verified by assessing soil or plant moisture status and vine response following irrigation applications ***And*** If soil salinity was believed to be an issue, it was confirmed annually (by analysis) and managed appropriately.	The amount of water applied at each irrigation was applied at the optimized amount based on goals (e.g., yield, vine appearance) and general weather conditions ***And*** If soil salinity was believed to be an issue, it was confirmed annually (by analysis) and managed appropriately.	Water was applied to the vineyard on a calendar basis (e.g., the same amount each week or year regardless of ET_c, or soil or plant moisture status for irrigation purposes or salinity reduction efforts).

See **Box 5-D** for information on soil salinity.
See **Box 5-F** for a description of the water budget approach.

BOX 5-D SOIL SALINITY ISSUES IN SOME AREAS OF CALIFORNIA

All water supplies contain some salt. Salts come in different chemical forms and from different sources, but all are difficult to remove once in the water. Water as rain and snow falls almost free of salt but begins picking up salts from the ground. Plants and other life extract the water but leave the salt in the remaining water. When water is used for any purpose, urban or agricultural or others, salt is added. Much of the precious water in California is used more than once as it moves through the natural watersheds and the salts increase with each usage. Depending on the source of the water it may start out with more or less salt. Water transported through the San Francisco Bay Delta picks up salts from seawater and other sources in the Delta and those salts then become stranded in inland basins.

High concentrations of salts in the soil can affect crop growth and damage water delivery, conveyance, and treatment systems. High salinity levels in the soils impair the ability to farm thousands of acres throughout California. The environment is also vulnerable to salt impacts - increasing salts in rivers and streams can alter the plants and fish that can survive there.

Source: CV-SALTS: http://cvsalinity.org.

5-8 Measuring Water Use

Vineyard

Category 4	Category 3	Category 2	Category 1
Flow meters were installed on lines from the wells or other pumps, and flows were monitored and recorded during each irrigation or frost sprinkler application to help document the beneficial uses of water ***And*** Inspecting flow meters was part of regular maintenance (e.g., checked and/or calibrated at least every two years).	Flow meters were installed on lines from the wells or other pumps, and flows were monitored during each irrigation or frost sprinkler application ***And*** Inspecting flow meters was part of regular maintenance (e.g., checked and/or calibrated at least every two years).	Flow meters were installed on lines from the wells or other pumps, but flows were not monitored during each irrigation or frost sprinkler application ***Or*** Other methods to measure water were used (e.g., calculation based on duration, date, energy use, weir, reservoir gauges).	Irrigation or frost sprinkler applications were not measured. *(Select N/A if no water was applied for irrigation or frost during the assessment year)*

5-9 Soil Water-Infiltration Rates and Water-Holding Capacity *Vineyard*

Category 4	Category 3	Category 2	Category 1
The infiltration rates and water-holding capacity of the vineyard soil(s) were known (based on soil type and rooting depth) ***And*** This information was used for developing a written annual irrigation plan based on the water budget, schedule, and duration. It also helped in adjusting the start date for spring/summer irrigation and helped with scheduling subsequent irrigation applications.	The infiltration rates and water-holding capacity of the vineyard soil(s) were known (based on soil type and rooting depth) ***And*** This information was used for estimating necessary irrigation volume per application and to support overall water management.	The infiltration rates and water-holding capacity of the vineyard soil(s) were approximated (based on soil type) ***And*** This information was used for estimating necessary irrigation volume per application and to support overall water management.	The infiltration rates and water-holding capacity of the vineyard soil(s) were not known.

Soil moisture monitoring devices are used to accurately schedule irrigation for efficient water use.

5-10 Soil Moisture and Plant Water Status Monitoring Methods *Vineyard*

Category 4	Category 3	Category 2	Category 1
Plant water status was monitored and recorded by visually or mechanically assessing shoot tips and tendrils **_And_** Weather station data were used to schedule irrigation **_And_** Soil moisture monitoring devices (e.g., gypsum blocks, tensiometers, capacitance sensors, neutron probe) were used to track water availability (and/or depletion) and used to schedule irrigation for the vineyard **_And/Or_** Soil moisture was measured and used to determine the start date for spring/summer irrigation **_And/Or_** A plant water status measurement tool was used (e.g., pressure chamber, porometer, leaf temperature, or other technology such as aerial monitoring).	Plant water status was monitored by visually assessing shoot tips, leaves and tendrils* and using evapotranspiration (ET) to inform irrigation decisions** **_And/Or_** Soil moisture monitoring devices (e.g., gypsum blocks, tensiometers, capacitance sensors, neutron probe) were installed and used to track water availability (and/or depletion) and used to schedule irrigation for the vineyard **_And/Or_** A plant water status measurement tool was used (e.g., pressure chamber, porometer, leaf temperature, or other technology such as aerial monitoring).	A shovel or bucket auger and the "squeeze test" was used to estimate the amount of available water in the vineyard soil and schedule irrigation **_Or_** Plant water status was monitored by visually assessing shoot tips, leaves and tendrils*.	Soil moisture and plant water status was not measured or used to schedule irrigation.

*See **Box 5-E** for information on visually assessing plant water status.
See **Box 5-F for information on evapotranspiration (ET), irrigation scheduling and estimating crop water use.

BOX 5-E QUALITATIVE INDICATORS OF VINE MOISTURE STATUS

Numbers, or steps, within each of the following indicator methods progress from no vine moisture stress to severe stress. Identical numbers among groups do not necessarily correspond to the same levels of stress. Variations could be regionally dependent or seasonal. Other methods of vine moisture status may include measuring shoot growth (length) weekly during the growing season to help monitor the rate of growth.

Shoot Tip Vigor**: Evaluation of shoot tip vigor is done to observe the rate of water stress developing throughout the vegetative-growth portion of the season. It may be necessary to lightly grasp the leaves and tendrils to extend them towards the shoot tip for this evaluation. The accuracy of this method may be impacted during extreme fluctuations in weather or available water. Additions to this method may include shoot tip length and growth rate. Generally accepted methods include 4 to 6 levels of water stress with differences that can include:
(0) Tendrils are long and growing over an inch past the shoot tip
(1) Tendrils growing one inch or less past the shoot tip
(2) Tendrils and newer leaves even with the shoot tip
(3) The leaves extend slightly past the shoot tip and new tendrils may be drooping or gone
(4) The leaves extend over an inch past the shoot tip
(5) The shoot tip has dried up and may have fallen off

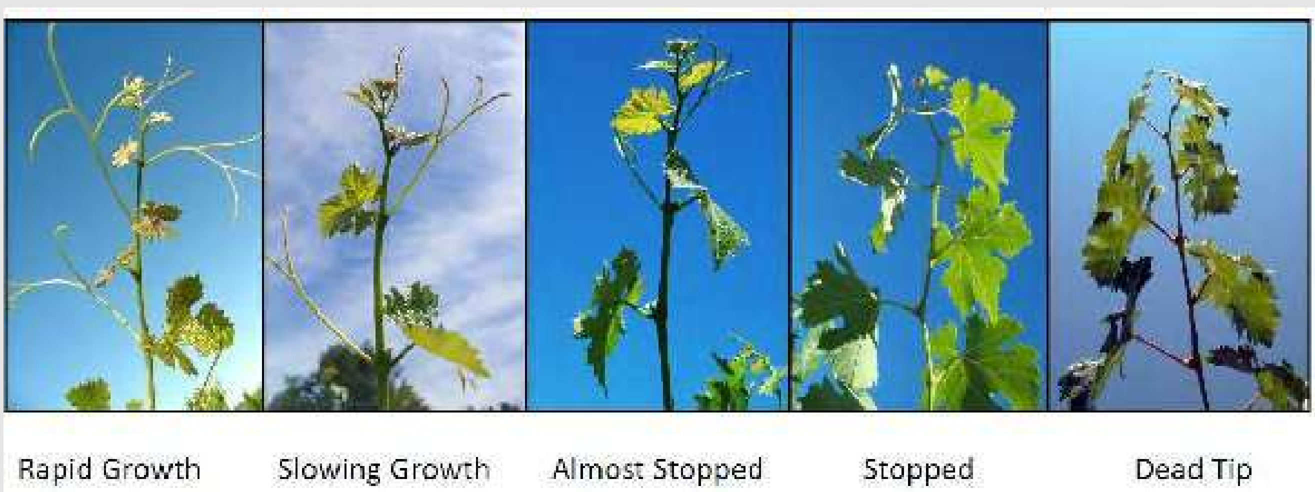


Photo source: Mark Greenspan, http://advancedvit.com/wp-content/uploads/2017/04/Shoot_tip_indicators_2014a.pdf

Leaf Abscission*
1. No leaf loss from moisture stress
2. 2-10 leaves lost or yellowed per vine
3. 10-30 leaves lost or yellow per vine
4. Leaf loss up to and within the fruit zone
5. Leaf loss above the fruit zone

Leaf Color and Behavior
1. Leaves are green and facing the sunlight and petiole/blade angles are approximately 90 degrees (varietal-dependent)

2. Less than 25% of leaves are turning away from the sun, have acute petiole/blade angles or have a dull green cast
3. Between 25% and 50% of leaves are turning away from the sun, have acute petiole/blade angles or have a dull green cast
4. Over 50% of leaves are turning away from the sun, have acute petiole/blade angles or have a dull green cast

Leaf Temperature**

Feeling non-exposed leaves for signs of relatively high heat (on the leaf surface) due to lack of respiration can help determine the immediate status of the stomatal conductance activity. To note temperature variation, this can be compared to that of exposed leaves. Sampling can be done by "sandwiching" the leaf between your hands. Excess heat can be the result of many factors, but the bottom line is that the leaves don't have the ability to cool themselves, usually due to long durations of heat.

Stomatal conductance can also be measured using a handheld device to track the physiological response to water stress. Grapevines will close their stomata (leaf pores) in response to various stress events and tracking this over the season can help show when the plant may require additional water. In order to develop valuable data, proper timing and protocols should be followed when using a leaf porometer.

***Source**: Robert Mondavi Family of Fine Wines, Statewide Grower Relations.
****Source:** Bryan Rahn, Coastal Viticultural Consultants and Mark Greenspan, Advanced Viticulture

Box 5-F Irrigation Scheduling Using Evapotranspiration (ET)

The water budget approach to irrigation scheduling is based on monitoring and calculating the additions and losses of water for a field. The most important component is an accurate estimate of crop water use, or ET. A generic reference ET figure (ET_o), the acre-inches of water used per day by a field of 4-6 inch tall grass, is recorded statewide by the California Irrigation Management Information Service (CIMIS). CIMIS can be accessed at http://www.cimis.water.ca.gov. To account for differences in ET between crops and the grass, each crop is assigned a specific conversion coefficient (K_c) that changes over the season. The table below displays crop coefficients for a typical vineyard having a canopy shading 50-60% of the vineyard floor during solar noon. Evapotranspiration for the vineyard (ET_c) is calculated by multiplying ET_o by K_c. Using the example of a 2-week interval that began May 16 and had a cumulative ET_o of 1.0 and K_c of 0.54, the grapes would have used 0.54 acre-inches of water (i.e., evapotranspiration by the crop or ET_c). Accordingly, 0.54 inches of water would need to be added to the soil by irrigation to replace full ET_c.. The water-holding capacity of the soil, depletion rate, and the winter rainfall also need to be known, recorded, and factored into the water budget to allow calculation of the amount of soil water available before spring growth begins. For example, a vineyard with 4-foot-deep roots in a typical sandy soil holding approximately 1 inch of water for every foot of soil should have 4 inches of water available in the spring. A good field-check program incorporating soil moisture and plant water status monitoring is essential to ensure calculations are correct. This conventional water budget approach to irrigation scheduling is appropriate for most crops, but grapes actually benefit from less water. When vines are under even mild stress (desirable for almost all vineyards to reduce vegetative growth), they will use less than full ET_c, so irrigation applications should be reduced by some fraction of full ET_c, even if water stress is not desired for the vineyard. Review **Box 5-G** on regulated deficit irrigation for a discussion about irrigation scheduling for wine quality.

Using ET For Water Budgeting

The water budget method is simply an accounting procedure similar to the bookkeeping required to balance a checking account. If the balance on a given date and the amounts of transactions are known, the balance can be calculated at any time. In addition, the time when all funds would be withdrawn can be determined so that an overdraft is avoided.

For irrigation scheduling, soil water content is balanced. The amount of water that is lost as crop evapotranspiration (ET_c) is analogous to writing checks. The water that enters the soil reservoir (as rain or irrigation) is analogous to depositing funds in a checking account. By keeping records of these transactions, it is possible to know how much water is in the soil reservoir at anytime.

Crop water use can be calculated with reference evapotranspiration (ET_o) from CIMIS and a crop coefficient (K_c) as $ET_c = ET_o \times K_c$. These ET_c estimates can be used to determine day by day soil water depletions from field capacity and thus can be used to schedule irrigations.

Vineyard water use is driven by atmospheric factors that include solar radiation, air temperature, vapor pressure, and wind speed. These and other variables are measured and used as terms in a model that calculates relative water demand known as reference evapotranspiration (ET_o).

Vineyard irrigation requirement can be determined and scheduled based in part on online ET_o data available for specific locations in California from the CIMIS or UC IPM websites.

Regulated deficit irrigation (RDI) strategies are commonly employed in winegrape vineyards to reduce irrigation volume from approximately 35% to 60% of full potential water use to reduce water consumption, control vegetative growth, and improve fruit and wine quality. **Source:** Adapted from http://cesonoma.ucdavis.edu/viticulture717/Vineyard_Irrigation/Interactive_Irrigation_Scheduling_Worksheet_using_Current_and_Hi/.

Table I — Crop coefficients for a VSP trellis as a function of degree-days (DDs) from budbreak and row spacing. Degree-days (DDs) are expressed in Centigrade (C) and Fahrenheit (F). Base temperatures used in calculating DDs are 10°C and 50°F.

DDs (C)	DDs (F)	k_c 6 ft*	k_c 7 ft	k_c 8 ft	k_c 9 ft	k_c 10 ft
100	180	0.17	0.15	0.13	0.12	0.10
200	360	0.22	0.19	0.17	0.15	0.13
300	540	0.28	0.24	0.21	0.19	0.17
400	720	0.35	0.30	0.26	0.23	0.21
500	900	0.42	0.36	0.31	0.28	0.25
600	1080	0.49	0.42	0.37	0.33	0.29
700	1260	0.56	0.48	0.42	0.37	0.33
800	1440	0.62	0.53	0.46	0.41	0.37
900	1620	0.67	0.58	0.51	0.45	0.40
1000	1800	0.72	0.62	0.54	0.48	0.43
1100	1980	0.76	0.65	0.57	0.50	0.45
1200	2160	0.79	0.67	0.59	0.52	0.47
1300	2340	0.81	0.69	0.61	0.54	0.48
1400	2520	0.82	0.71	0.62	0.55	0.49
1500	2700	0.82	0.71	0.62	0.55	0.49

*The equation used to calculate kcs for the 6-foot row was:

$$k_c = 0.87/(1 + e^{-(x-525)/301.9})$$

where x is degree-days in centigrade.

Table II — The effect of trellis type and row spacing on estimated vine water use of grapevines assuming an ET_o of 1.5 inches for the time frame used. HD stands for a high density planting, 1 m x 1 m, using a smaller version of a VSP trellis.

Trellis Type	Row Spacing	ET_o (inches)	k_c	ET_c (inches)	ET_c (gal / acre)	ET_c (gal / vine)
VSP	6 ft.	1.5	0.81	1.22	33,550	27.8
VSP	9 ft.	1.5	0.54	0.81	22,275	27.6
Lyre	9 ft	1.5	0.83	1.25	34,375	42.5
HD	1 m	1.5	0.91	1.37	37,675	9.3
GDC	12 ft.	1.5	0.75	1.13	31,075	51.4

Assumptions: Vine spacing for all trellises is 6 ft., except in the HD vineyard. Therefore vine density is 1,208, 808, 808, 604, and 4,049 vines per acre for the VSP 6 ft. row, VSP 9 ft. row, Lyre, and GDC trellis and HD planting, respectively. The k_cs used for the VSP 6 and 9 ft. rows is from DDs (C) 1300 row in Table I. Other k_cs used are from L.E. Williams, unpublished data. ET_c in inches was obtained by multiplying ET_o by the k_c. It was assumed that there is 27,500 gallons per acre-inch of water.

Source: Williams, Larry E. 2001. Irrigation of Winegrapes in California. Practical Winery, Nov-Dec.

Table 5-b Typical Winegrape Biweekly Crop Coefficients (K_C) for Canopies Shading 50-60% of Vineyard Floor at Mid Day		
Days after budbreak	**1999 example of 2-week period start date**	**K_c**
1-15	1-April	0.13
16-30	15-April	0.28
31-45	1-May	0.42
46-61	16-May	0.54
62-76	1-June	0.65
77-91	16-June	0.73
92-106	1-July	0.79
107-122	16-July	0.83
123-137	1-August	0.85
138-153	16-August	0.86
154-168	1-September	0.84
169-183	16-September	0.81
184-198	1-October	0.75
199-214	16-October	0.68
215-229	1-November	0.58
Multiply cumulative ET_o (sum of daily values) by the appropriate two-week K_c to get ET_c (full potential water use for grapevines in acre-inches). 1 acre-inch (amount of water needed to cover 1 acre 1 inch deep) = 27,154 gallons.		
Source: Prichard et al, 2004. For further information on K_c values: http://www.avf.org/wp-content/uploads/2017/10/87e125d35d5ac0e189659f23da49eee0cd4ea4.pdf		

5-11 Planned Deficit Irrigation through Regulated Deficit Irrigation (RDI)*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
A predetermined level of RDI and plant water stress was used to improve wine quality and conserve water and energy and vine water status was monitored by instruments or visually ***And*** The irrigation amount (deficit irrigation percentage) and starting date was reevaluated and adjusted (if needed) every season.	RDI was experimented with and the vines were watered at less than full ET_c and vine water status was monitored by instruments or visually.	Irrigation was restricted so that some level of water stress was applied to the vines and monitored using plant water status instruments or visual symptoms.	Irrigation was done to ensure no vine water stress occurred in established vines, producing as lush and healthy a canopy as possible. *(Select N/A if no water was applied for irrigation during the assessment year)*
*Not applicable for all regions, varieties, or for new plantings – consult your UC Farm Advisor or vineyard consultant.			

BOX 5-G REGULATED DEFICIT IRRIGATION (RDI)

The concept of RDI originated in Australia (Hardie and Considine, 1976). Based on considerable relevant research in California, moderate water stress, particularly between bloom and veraison, has a significant positive impact on wine quality (Prichard et al., 1995; and Prichard et al., 2004)* by increasing total acidity, decreasing pH and malate, and enhancing color. Also, moderate water stress may reduce bunch rot by producing looser clusters. However, there is still a lot to learn about successfully applying RDI concepts to different regions, sites, and varieties. Because of rapid growth, the bloom-to-veraison period is the most critical for wine quality enhancement. Mild water stress during this interval results in smaller leaves, less laterals, and smaller berries, and facilitates the desired cessation of shoot-tip growth near veraison. The reduction in foliage allows more light and air to penetrate the fruiting zone, the smaller berries increase the skin to juice ratio, and the cessation of shoot-tip growth stimulates the vine to mature the seeds (and flavors) for a less herbaceous wine. Furthermore, stress hormones in the vines also stimulate the ripening processes that begin at veraison, so mild stress at veraison enhances those processes. After veraison, the stress may be reduced to permit adequate photosynthesis and fruit ripening, while preventing fruit shrivel due to dehydration. For winegrapes, the two most common RDI methods are the Volume Balance Approach (**Box 5-H**) and the Deficit Threshold Plus RDI Method (**Box 5-I**). Both methods work equally well but differ in that the former is more complex but requires no special equipment, while the latter is simple but requires the use of a pressure chamber.

*See also http://www.wineinstitute.org/files/DeficitIrregationMar2002.pdf.

BOX 5-H VOLUME BALANCE APPROACH

For this method, the vineyard water-holding capacity and cumulative rainfall must be known and applied to determine the quantity of soil water available before annual growth begins. UC Farm Advisors or NRCS staff can help determine the water-holding capacity of soils. Additionally, the daily grapevine ET_c must be tracked in order to calculate the cumulative amount of water being used (see **Box 5-F** for calculating ET_c from ET_o and K_c). Spring/summer irrigation commences only after a portion of predetermined soil water is used. A neutron probe or equivalent device is handy for making more accurate determinations of stored soil water. Irrigation then begins at less than full ET_c (within 30-66% of full ET_c is ideal; adjusted based on extent of crop canopy per acre). If the canopy is heavier than average (e.g., quadrilateral trellis, narrow rows), 66% of ET_c is applied; if the canopy is lighter than average (e.g., vertical shoot positioning, wide rows), 30% of ET_c is applied. Exact percentages can be fine-tuned with experience. After veraison and up to harvest, irrigation is increased slightly to help ripen the grapes – but still maintained below full ET_c. After harvest, vines are irrigated at full vine water use levels.

BOX 5-I DEFICIT THRESHOLD PLUS RDI METHOD

This method entails waiting to irrigate until a predetermined level of plant water stress (the trigger threshold) is measured, after which, irrigation commences at a reduced (deficit) rate. Rather than monitoring soil water, vine water status is measured with a pressure chamber, sap flowmeter, dendrometer, or other technology, making for a simpler system. The pressure chamber is used by removing a leaf at midday and placing it in the pressure chamber with its petiole extending from a silicone grommet. Pressure is applied to the chamber until a bead of moisture appears on the cut end of the petiole. The measured pressure required to force-out the sap (leaf water potential) reflects the level of vine water stress experienced by the plant. As stored soil water is used in the spring, monitoring with the pressure chamber will detect increasing levels of vine water stress. Experiments in Lodi and the North Coast with Merlot, Cabernet Sauvignon, and Zinfandel varieties have shown that starting irrigation when leaf water potential reaches -12 bars and irrigating at 60% of ET_c (identical to the Volume Balance Approach) is successful but conservative. In practice, the threshold trigger used for first irrigation is above or below -12 bars and deficit irrigation commences at or below 60% ET_c. As more growers apply this method of RDI, it is clear that the precise trigger threshold and extent of deficit irrigation depends on region, soil type, variety, and rootstock. Also, more research needs to be done to standardize the appropriate routine for sampling leaves. It is recommended that additional measures, such as vine appearance and soil moisture, are used to confirm vine moisture status.

Source: Terry Prichard, Irrigation and Water Management Specialist, UC Cooperative Extension, San Joaquin County; and Prichard et al., 2004.

BOX 5-J QUANTITATIVE MEASUREMENTS OF SOIL MOISTURE STATUS AND REGULATED STRESS IRRIGATION*

This method relies on measurements of soil moisture at several depths within the profile, to depths of at least the bottom of the rooting zone. Measurements may be made using any number of sensors or soil probes, but it may work best when using volumetric soil moisture measurements (e.g., capacitance sensors or neutron probe). This method also relies on plant moisture status measurements, as well as visual assessment of water status, especially with regard to shoot tip growth as discussed in **Box 5-E**. Irrigation begins when a combination of factors is reached: soil moisture levels reach a given threshold (usually site-calibrated from experience), plant moisture status reaches a given threshold and/or shoot tip growth slows down or stops. Irrigation is applied and the depth of irrigation noted by observing the response at the various depths. Irrigation volume is adjusted in an iterative manner such that moisture reaches the bottom of the rootzone (if possible) and not any further. This may take several iterations and soil moisture must return to the pre-irrigated level before subsequent irrigations are applied. The volume of irrigation, thus determined, is used for subsequent irrigations during the season, though it may be necessary to modify it at times. Using a chart of total (or average) soil moisture in the profile (this only works when using volumetric measurements, not matric potential measurements), the depletion pattern is monitored over time. The shape of the curve is indicative of extraction rate, and when the slope of the curve begins to "flatten out" (i.e., daily depletion is reduced), it is an indication of water stress. The desired level of water stress should be ground-truthed using the pressure chamber or porometer instruments. (For a tutorial on porometers visit: http://advancedvit.com/wp-content/uploads/2017/04/Using_the_leaf_porometer_in_grapes.pdf) Again, some iteration is required where the desired refill point is chosen based on the desired level of water stress that occurs between irrigation events. This may range from no stress to severe stress. The refill point is chosen and noted. This will be unique to the specific site/block being monitored. Subsequent irrigation events are triggered whenever the total (or average) soil moisture level returns to the refill point, after which the irrigation volume, previously determined, is applied to refill the root zone once again.

*May not apply to all regions, soil types, or varietals, but could help serve as a guide.

6. Pest Management[1,2]

Original Chapter Authors: Clifford P. Ohmart and Stephen K. Matthiasson, formerly with Lodi Winegrape Commission; Modified by the Sustainable Winegrowing Joint Committee

Integrated Pest Management (IPM) is an integral part of any sustainable farming program. IPM is a cost-effective and reliable approach that has withstood the test of time. It was developed in response to problems associated with pesticide use in the 1950s and 1960s. Based on issues such as pesticide resistance, secondary pest outbreaks, and environmental contamination, forward-looking entomologists at the University of California concluded that agriculture was headed toward a pest management crisis. These visionaries knew that pest problems result from complex ecological interactions and that appropriate solutions must be broad-based and account for the vineyard ecology. Accordingly, they developed the concept of IPM, first known as integrated control (Stern et al., 1959), as a multi-tactical, sustainable approach to managing pests.

IPM is a sustainable approach to managing pests by combining biological, cultural, and chemical tools in a way that minimizes economic, health, and environmental risks.[3]

Practices used for pest management should be sustainable to ensure that farming remains a sustainable endeavor. By judiciously integrating biological, cultural, and chemical controls, growers and pest control specialists commit to a broad-based, balanced strategy that reduces economic risks by sustaining effectiveness, as well as reducing risks to the environment and human health.

Five Essential Components of an IPM Program

1. **Understand the ecology and dynamics of the crop**. It is important to synthesize available knowledge about the crop. Many grape pest problems directly relate to the condition of the crop. Improved understandings of crop ecology lead to better pest management decisions. For example, it is well known that overly vigorous grapevines encourage larger leafhopper populations than do less vigorous vines. Therefore, maintaining proper vine vigor is one way to keep leafhopper populations at acceptable levels (and to accomplish many other goals, too).

2. **Understand the ecology and dynamics of the pests and their natural enemies**. It is not only important to know what pests are present (including weeds), but also to know details of their life cycles and what influences their population levels. In addition, it is important to know if natural enemies are present and their potential impacts. A thorough knowledge about the pest and its susceptibilities can reveal weak points to be exploited with management.

3. **Institute a monitoring program to assess levels of pests and beneficials**. It is vitally important to routinely monitor pest population levels in the field. This is a crucial tenet of IPM. An understanding

---

[1]This chapter has been adapted from Lodi Winegrape Commission's *Lodi Winegrower's Workbook* (Ohmart and Matthiasson, 2000; and Ohmart et al., 2008). Many of the criteria in this chapter appeared as questions in the Central Coast Vineyard Team's Positive Points System, the first vineyard self-assessment system in California (CCVT, 1996 and 1998).

[2]We thank the UC Board of Regents, UC Division of Agriculture and Natural Resources, and the UC Statewide Integrated Pest Management Program for granting permission to reprint the photographs that appear in this chapter. Use of the photographs does not imply endorsement of the materials or recommendations in this workbook.

[3]**Source**: National Coalition on Integrated Pest Management (1994).

of pest density enables an estimate of potential crop damage. Additionally, it is important to monitor population densities of natural enemies to account for their capacity to suppress pest populations and use the monitoring information to make pest management decisions.

4. **Establish an economic threshold for each pest**. Using effective monitoring and associated economic thresholds makes up the core of any IPM program. What is an economic threshold? It is the level of a pest population above which, if a control action is not taken, the value of crop damage will exceed the cost of treatment. In other words, it is that pest density at which the control measure pays for itself. Ideally, costs associated with factors such as paperwork time, interference with operations due to re-entry intervals, and possible secondary pest outbreaks should be included in the cost estimate for treatment.

5. **Consider available control techniques and determine which are most appropriate**. A wide range of control techniques is available for many crop pests. These can be divided into five broad categories: varietal and rootstock selection (e.g., resistant rootstocks, loose-clustered clones), cultural control (e.g., leaf removal, manipulation of vine vigor, cultivation), biological control (e.g., releases or conservation of natural enemies), behavioral control (e.g., insect pheromones), and chemical control (e.g., pesticides). It is important to carefully consider and balance the three "E's" of sustainability when selecting pest control options. Is the control strategy economically viable, ecologically sound, and socially equitable?

IPM is an 'Approach' and Changes with Time
IPM is not a technique or a recipe, but rather an approach to identifying and solving pest problems. The control techniques used may vary by grower, crop, field, and year, but the overall management approach remains constant, applying the five essential components of an IPM program. Importantly, each IPM program should be flexible and adjusted based on new understandings and circumstances. It would be easiest to resolve a pest problem the same way every time, but history has shown that this will not work.

An IPM program is never complete; it is a process of continuous improvement. Over time, more is learned about crops, pests, and natural enemies. Additionally, monitoring programs are refined, economic thresholds are improved, and new control strategies and techniques are developed. Furthermore, new pest problems emerge. The increase in knowledge and practical experience should be used to refine IPM programs, making them more effective and sustainable. Such continuous improvement is essential for minimizing economic impacts of pests as well as environmental and human health risks.

The purpose of this chapter is to help growers implement and improve an effective IPM program. It includes 35 criteria to self-assess:

- Insect and mite monitoring and management in the vineyard
- Soil-borne pest monitoring and management (post-planting) in the vineyard
- Disease monitoring and management in the vineyard
- Weed monitoring and management in the vineyard
- Vertebrate pest monitoring and management in the vineyard
- Pesticide applications and safety in the farming operation.
- Pest management in the winery

Box 6-A University of California Pest Management Publications

In addition to the information presented in this chapter, below is a list of UC pest management publications to use as companion sources of information.

Bettiga, L.J., (Ed.). 2013. *Grape Pest Management*. Third Edition. University of California ANR Publication 3343.

DiTomaso, J.M., and E.A. Healy. 2007. *Weeds of California and Other Western States*. University of California ANR Publication 3488.

Fischer, B.B. (Ed.). 1998. *Grower's Weed Identification Handbook*. University of California ANR Publication 4030. (no longer in print)

Flaherty, D.L., L.P. Christensen, W.T. Lanini, J.J. Marois, P.A. Phillips, and L.T. Wilson (Eds.). 1992. *Grape Pest Management*. Second Edition. University of California ANR Publication 3343.

Haviland D.R., L.J. Bettiga, L.G. Varela, R.A. Baldwin, J.A. Roncoroni, R.J. Smith, B.B. Westerdahl, W.J. Bentley, K.M. Daane, H. Ferris, W.D. Gubler, K.J. Hembree, C.A. Ingels, F.G. Zalom, and I. Zasada. Revised continuously. *UC IPM Pest Management Guidelines Grape.* UC ANR Publication 3448. Updates available at http://ipm.ucanr.edu/PMG/pmgchanges.html.

Ingels, C.A., R.L. Bugg, G.T. McGourty, and L.P. Christensen (Eds.). 1988. *Cover Cropping in Vineyards*. University of California ANR Publication 3338.

O’Connor-Marer, P.J. 2000. *The Safe and Effective Use of Pesticides*. Second Edition. University of California ANR Publication 3324.

O'Connor-Marer, P.J. 2006. *Pesticide Safety: A Reference Manual for Private Applicators.* Second Edition. University of California ANR publication 3383.

O'Connor-Marer, P.J. 2007. *Pesticide Safety: A Reference Manual for Private Applicators.* Second Edition (Spanish version). University of California ANR publication 3383.

Varela, L.G., W.J. Bentley, J.K. Clark, and L.L. Strand. 2011. *Vineyard Pest Identification and Monitoring Cards*. University of California ANR publication 3532.

Whithaus, S., and L. Blecker. 2016. *The Safe and Effective Use of Pesticide (Pesticide Application Compendium)*. Third Edition. University of California ANR Publication 3324.

List of Pest Management Criteria

Pest Identification, Pest Damage, and Ecology

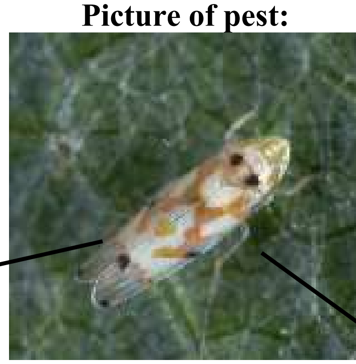
Some issues in this workbook, such as knowledge of pest identification, pest damage, and over-wintering sites, are best dealt with using pictures. By completing pictured worksheets, knowledge of these issues is reinforced. For each pictured worksheet hereafter, draw a line with a pencil from each name or picture to the matching picture in the next column. For example (see below), on the first worksheet for insect and mite pests, draw a line from the pest name in the left column to its picture in the middle column and finally to the picture in the right column that illustrates the damage caused by that pest. More than one correct answer is possible in some cases. An answer key is on the back of each worksheet.

Pictured worksheets are found at the start of the sections on insect and mite monitoring and management (pages 6 to 11), disease monitoring and management (pages 33 to 36), and vertebrate pest monitoring and management (pages 54 to 55).

Example:

Name of pest:

Picture of pest:



Grape Leafhopper

Damage pest causes:

Draw lines between the name of the pest, the picture of the pest, and the damage that the pest causes.

Actual Size:

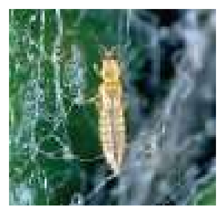
Grape Leafhopper

Variegated Leafhopper

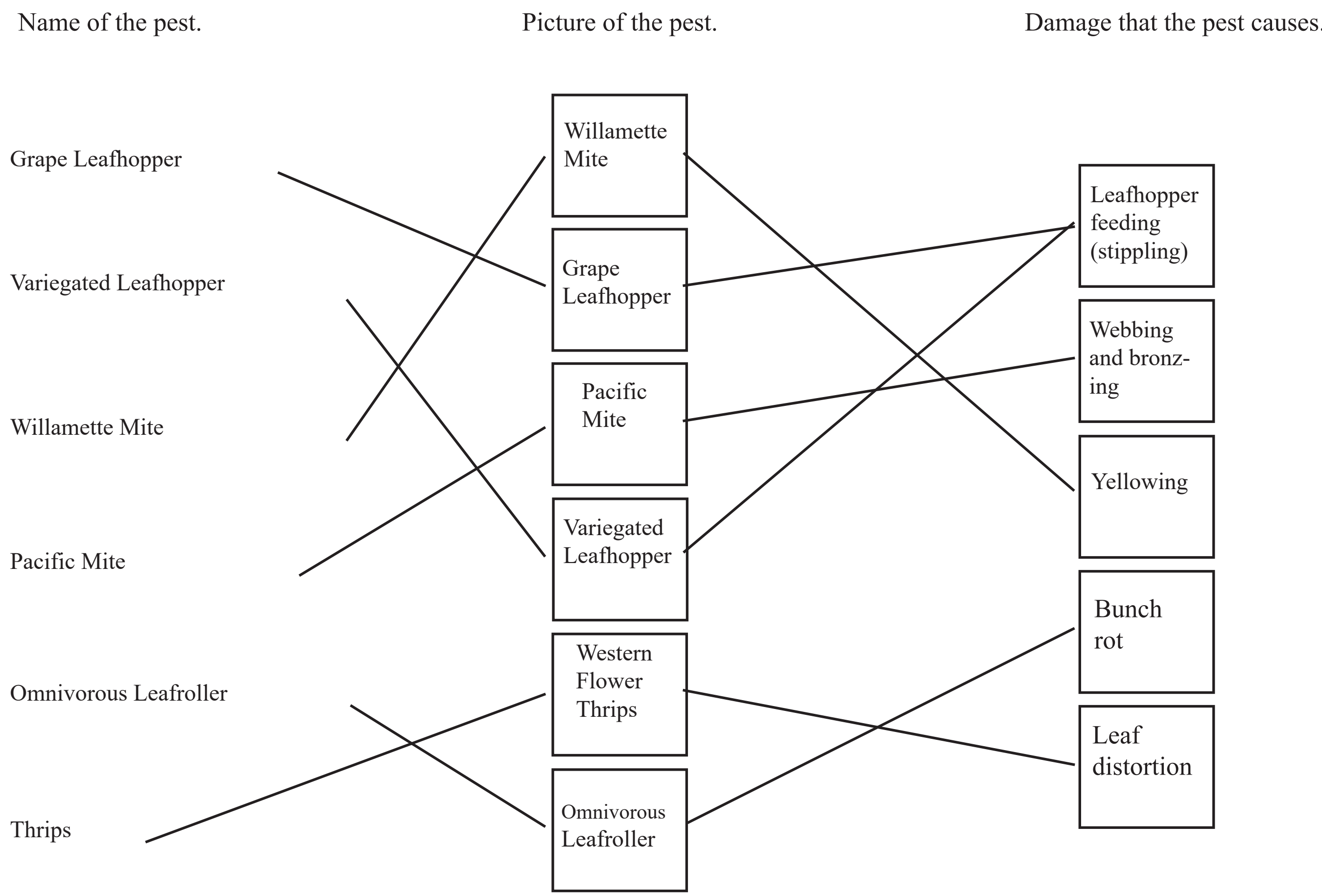
Willamette Mite

Pacific Mite

Omnivorous Leafroller



Thrips


Name of the pest.
Picture of the pest.
Damage that the pest causes.
Grape Leafhopper
Variegated Leafhopper
Willamette Mite
Pacific Mite
Omnivorous Leafroller
Thrips
Willamette Mite
Grape Leafhopper
Pacific Mite
Variegated Leafhopper
Western Flower Thrips
Omnivorous Leafroller
Leafhopper feeding (stippling)
Webbing and bronz-ing
Yellowing
Bunch rot
Leaf distortion

Draw lines between the pests and their over-wintering sites.



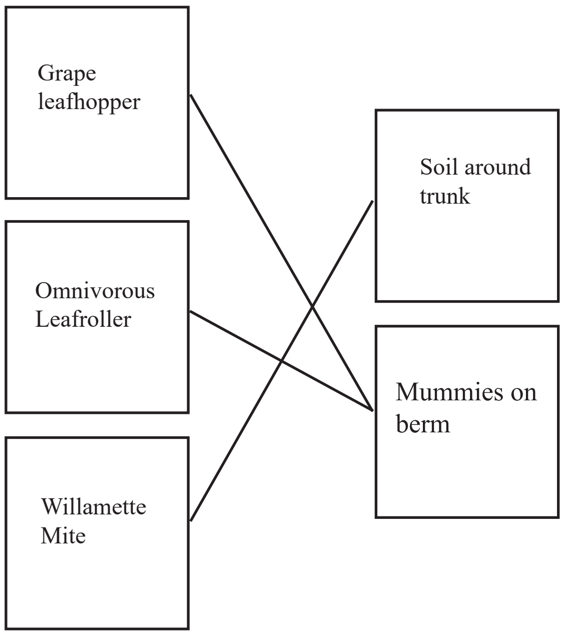


Draw lines between the pests and their egg-laying sites.

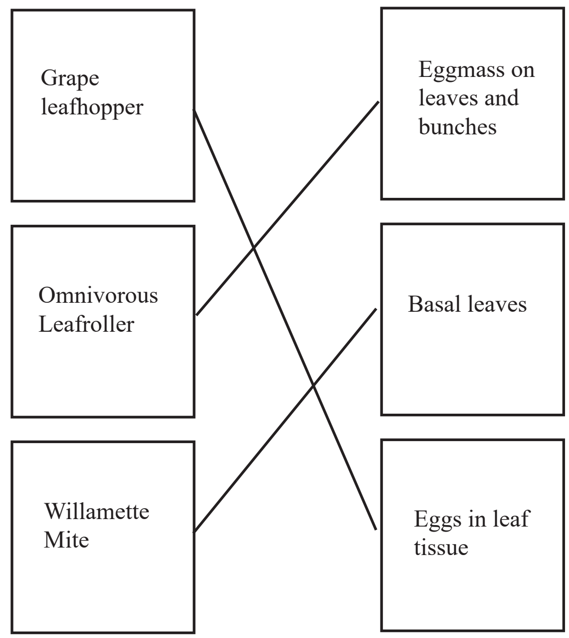





Pests and their over-wintering sites.



Pests and their egg-laying sites.



Draw lines between the pests and the cultural practices that reduce the pests.



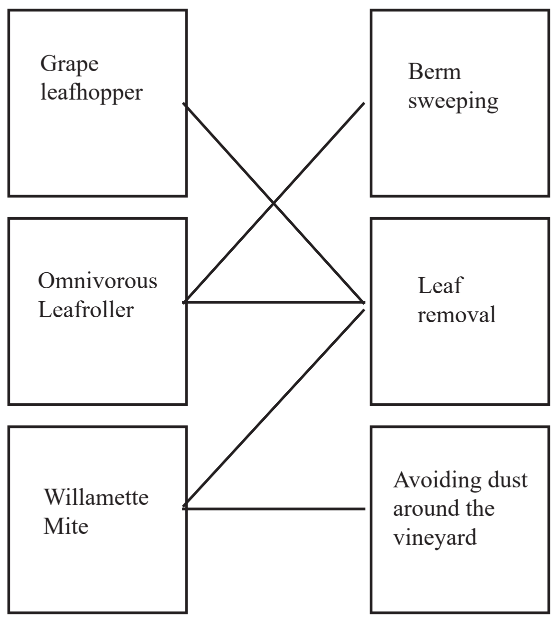



Draw lines between the pests and their natural enemies.

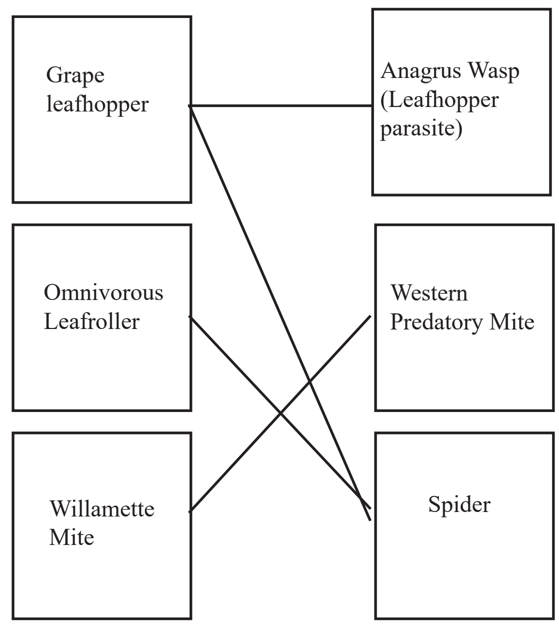





Pests and cultural practice.



Pests and natural enemies.



6-1 Vineyard Monitoring for Insect and Mite Pests

Vineyard

Category 4	Category 3	Category 2	Category 1
The vineyard was monitored at least weekly for insect and mite pests during the growing season ***And*** A written or electronic record of results was kept for the season ***And*** This information was analyzed and used for management decisions.	The vineyard was monitored as needed and at least every 14 days for insect and mite pests during the growing season ***And*** A written or electronic record of results was kept for the season ***And*** This information was analyzed and used for management decisions.	The vineyard was monitored periodically for insect and mite pests during the growing season.	The vineyard was never or rarely monitored for insect and mite pests.

For an excel-based IPM scouting template for recording insect and mite monitoring results, and a handout on identifying and treating hot spots and using economic thresholds, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **Economic Thresholds and IPM Scouting Template**.

BOX 6-B MONITORING TIPS FOR LEAFHOPPERS, MEALYBUGS, AND MITES

- Be consistent.
- Divide the vineyard block into 4 quadrants (e.g., northwest, northeast, southwest, southeast) and sample each quadrant each week. This spatial and temporal distribution of sampling minimizes the possibility of missing problems.
- Quantify the monitoring. Pick 10 leaves per quadrant and count leafhopper nymphs and leaves with mites. A sample size of 10 makes subsequent calculations easy. If 35 leafhopper nymphs are found, then the average is 3.5 per leaf; if 4 leaves have mites, then 40% of leaves have mites. Quantification is important for effectively comparing results over weeks, months, and years.
- If the vineyard had an infestation of grape mealybug at harvest, monitor for mealybugs in late February to early March. Peel back the thin bark on spurs in the current season's prunings and look for the presence of crawlers. For wine and raisin grapes, if an average of 1 spur or cane of every 5 sampled (i.e., 20% or more) has crawlers, an insecticide treatment may be warranted (in some circumstances the threshold may be higher). For table grapes, the threshold is an average of 1 spur or cane of every 10 sampled (i.e., 10% or more). Note that these guidelines are for *Pseudococcus* mealybugs only (grape, obscure, and longtailed), not vine mealybug, and are not reliable when monitoring for mealybugs as a vector of leafroll-associated viruses (see **Box 6-L**)).
- Record monitoring results for easy reference later.
- Direct monitoring to where pests likely will be found. Leafhoppers and Willamette mites are on basal leaves from the beginning of the growing season to about the end of June and on leaves farther out on canes thereafter. Be sure to sample known hotspots.
- Pheromone-baited traps can be used to monitor mealybugs; select lures that are specific to the target species (*Pseudococcus* mealybug species or vine mealybug).

6-2 Training for Pest and DiseaseMonitoring *Vineyard*

Category 4	Category 3	Category 2	Category 1
A majority of people working in the vineyard were trained annually and encouraged to monitor for pests and diseases ***And*** Their skill was sufficient for passing the pest ID quiz at the beginning of this chapter ***And*** Bilingual training and printed information on pest and disease monitoring was provided, if needed.	Key vineyard employees* were trained and encouraged to monitor for pests and diseases ***And*** Their skill was sufficient for passing the pest ID quiz at the beginning of this chapter.	Vineyard employees* were trained and encouraged to draw attention to pests and diseases problems but could not accurately identify key pest species and diseases.	Vineyard employees* were not trained or encouraged to monitor for pests and diseases.

*In this context, vineyard employees include employees of the vineyard ownership, owners, employees of vineyard management companies and farm labor contractors, and pest control advisers (PCAs).

6-3 Economic Thresholds and Pest-Natural Enemy Ratios for Leafhoppers, Mites, and Thrips

Vineyard

Category 4	Category 3	Category 2	Category 1
Control decisions for leafhoppers, mites, and thrips were based on economic thresholds* (e.g., leafhopper nymphs per leaf, number of leafhopper adults, percent leaves with mites, leaf damage) ***And*** Control decisions were also based on the amount of egg parasitism for leafhoppers (see **Box 6-D**), and the frequency of predators for mites (see **Table 6-a**).	Control decisions for leafhoppers, mites, and thrips were based on economic thresholds* (e.g., leafhopper nymphs per leaf, number of leafhopper adults, percent leaves with mites, leaf damage).	Control decisions for leafhoppers, mites, and thrips were based on the presence of these pests in the vineyard.	Control decisions for leafhoppers, mites, and thrips were based on the time of the year and/or past problems with these pests (calendar spraying). (*Select N/A if no problems with leafhoppers, mites, or thrips)*

*Growers are encouraged to develop more accurate and cost-effective economic thresholds for important pests in their vineyards, e.g., by quantifying relationships among pest densities, damage, and yield quantity and quality. Unfortunately, research-proven economic thresholds do not exist specifically for winegrape pests. Nevertheless, the concept of economic threshold should be applied to reduce unnecessary spraying. General thresholds developed for leafhoppers (**Box 6-C**) and Pacific mites (**Table 6-a**) on Thompson seedless grapes can be used as a guide (see http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html for additional details and recommendations).

BOX 6-C ECONOMIC THRESHOLDS FOR LEAFHOPPERS

Grape Pest Management (Flaherty et al., 1992) lists the economic threshold for western grape leafhoppers on Thompson seedless grapes as 20 nymphs per leaf. When applying an economic threshold for leafhoppers to winegrapes, the species of leafhopper, the time of year, health of the vineyard, canopy size, variety, trellis system, existing leaf damage, and the number of leafhopper adults also should be taken into account. If little leaf damage exists early in the season (i.e., May-June), then 10 to 15 nymphs per leaf probably is tolerable for western grape leafhopper. However, the economic threshold likely has been exceeded if a similar density of second-generation nymphs (July-August) coincides with significant leaf damage. Growers should consider developing leafhopper economic thresholds for their vineyards based on the aforementioned variables and experience.

BOX 6-D *ANAGRUS* AND WESTERN GRAPE LEAFHOPPER ECONOMIC THRESHOLDS

Anagrus is a wasp that parasitizes western grape leafhoppers by laying a single egg inside a leafhopper egg. After the wasp egg hatches, the wasp larva consumes the contents of the leafhopper egg. An adult *Anagrus* then emerges, leaving a characteristic round hole in the top of the parasitized egg (see photo below), and flies on to seek other leafhopper hosts. *Anagrus* is the most effective and important natural enemy of the grape leafhopper. *Anagrus* can complete three to four generations for each leafhopper generation, allowing the wasp population to increase rapidly. Accordingly, *Anagrus* parasitism rates as low as 30% during the first leafhopper generation can nearly eliminate leafhoppers by harvest (Murphy et al., 1996).

***Anagrus* parasitism rates do not need to be determined if first-generation (May-June) leafhopper densities are at tolerable levels**. However, if 10 or more first-generation leafhopper nymphs per leaf exist and a pesticide application is being considered, monitoring and decision making should include: 1) sampling leaves from several parts of the vineyard (total of 30 to 40 leaves); 2) calculating the percent parasitism based on counts of the total leafhopper eggs and total parasitized leafhopper eggs (see photos below) made using a dissecting microscope or hand lens; and 3) not making a pesticide application if parasitism is at least 30%, as *Anagrus* populations should suppress leafhoppers to non-economic levels by the end of the second generation (Murphy et al., 1996).

Parasitized leafhopper egg

Exit hole left by parasite

TABLE 6-a ECONOMIC THRESHOLDS FOR SPIDER MITES, ACCOUNTING FOR PREDATORS*				
Mite injury levels (percent of leaves with spider mites)	**FREQUENCY OF MITE PREDATORS ON LEAVES**			
	RARE (predators on less than 1 of 30 leaves)	**OCCASIONAL (predators on 1 of 30 to 1 of 10 leaves)**	**FREQUENT (predators on 1 of 10 to 1 of 2 leaves)**	**NUMEROUS (predators on at least 1 of 2 leaves)**
Light (<50%)	Delay treatment to increase predators or consider releasing predators (see **Box 6-F**)	Delay treatment or consider releasing predators (see **Box 6-F**)	Treatment not likely necessary	Treatment not necessary
Moderate (50 to 65%)	Treat if spider mite population is increasing rapidly	May delay treatment to increase predation	Treatment may not be needed if the frequency of mite predators is increasing rapidly	Treatment not needed
Heavy (65 to 75%)	Treat immediately	May delay treatment a few days to take advantage of increasing predation	Treatment may not be needed if predators are becoming numerous	Treatment not needed if damage is not increasing
Very heavy (>75%)	Treat immediately	Treat immediately	Treat immediately unless the frequency of predators is increasing very rapidly; carefully evaluate damage	Treatment may not be necessary if mite population is dropping because of very high numbers of predators; carefully evaluate damage
*These thresholds were developed for Pacific mite on Thompson seedless grapes but can be used to support treatment decisions for spider mites on winegrapes. It is important to remember, however, that thresholds vary by time of year, vineyard health, canopy size, variety, trellis system, and existing leaf damage. **Source**: Modified from Flaherty et al., 1992.				

BOX 6-E MITE PREDATORS

The two most important predators of spider mites are the **western predatory mite** and the **six-spotted thrips**. When present in sufficient numbers, both species can reduce pest mites to sub-economic levels (Flaherty et al., 1992). Although the western predatory mite resembles both Pacific and Willamette mites, it can be distinguished with practice. The western predatory mite usually is pear-shaped with a fat rear end; has a translucent, shiny, or wet sheen; and often rests by leaf veins (especially where veins adjoin near the petiole). When the western predatory mite does move, it moves quickly. The six-spotted thrips is of similar size to other thrips found on grapes but is easily recognized, using a 10X hand lens, by the six brown spots on its wings.

'Presence-absence' sampling is a quick and effective method for monitoring spider mites and their predators. Instead of counts of pests and predators, this method simply relies on distinguishing numbers of leaves with any pest mites or predators. A 10-leaf sample with one or more spider mites on four leaves and one or more predators on two leaves, for example, has 40% of leaves with pest mites and 20% with predators. The economic thresholds developed for Pacific mites and predatory mites on Thompson seedless grapes (**Table 6-a**) can be used as a guide for treatment decisions involving Willamette and Pacific mites on winegrapes in most regions.

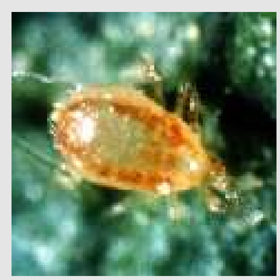
When predatory mites are present and well distributed, low rates of selective miticides can leave enough predatory mites unharmed to prevent resurgence of the pest mite population (Flaherty et al., 1992).

Six-Spotted Thrips nymph eating a mite

Western Predatory Mite eating a mite egg

Six-Spotted Thrips adult eating a mite

Classic oval-shaped predatory mite egg



Western Predatory Mite

6-4 Minimizing Risks from Insecticides and Miticides *Vineyard*

Category 4	Category 3	Category 2	Category 1
No insecticides or miticides were necessary because pests were maintained below economic thresholds by natural processes (e.g., natural enemies) and cultural controls ***Or*** A pesticide risk model (e.g., PEAS)* was used to assess non-target risks, and insecticide or miticide treatments categorized as high risk** were not used.***	Non-target risks (e.g., impacts to beneficial insects and mites and environmental and human health) were considered when selecting and using insecticides or miticides ***And*** Pesticides were compared for risks, cost and efficacy, and lower risk pesticides were used when possible.	Non-target risks (e.g., impacts to beneficial insects and mites and environmental and human health) were considered when selecting and using insecticides or miticides.	Insecticides and miticides were primarily selected and used based on cost and efficacy.

*PEAS = Pesticide Environmental Assessment System. Note: PEAS is no longer being updated for new pesticides and therefore will become out of date if pesticides used are not accounted for in PEAS.
**Treatments with high risks for any category if using PRT, or having more than 3 PEAS Impact Index Points.
***Except for emergencies such as an exotic pest introduction where regulations and/or university protocols require a specific pesticide(s).
See **Box 6-G** for more detail about reducing risks from pesticides.

BOX 6-F HOW EFFECTIVE IS THE RELEASE OF BENEFICIAL INSECTS AND MITES?

Historically, the western predatory mite (*Galendromus occidentalis*) has been the primary mite predator released to control spider mites in vineyards. Unfortunately, releases have not always proven successful, noted by experienced university researchers, PCAs, and growers. Work suggests that success may be improved in some circumstances, based on expected temperatures, by releasing an alternative species, the ‘Cali mite’ (*Neoseiulus californicus*). Both predators eat all spider mites. However, the western mite seems more effective in hot temperatures, while the ‘Cali mite’ seems more effective in relatively cooler circumstances (Kim Gallagher, formerly of Sterling Insectary, McFarland, CA).

Sixspotted thrips are important predators of web-spinning spider mites and are widely distributed through California’s agricultural regions. Their populations should be conserved through avoidance of disruptive insecticides, or enhanced through inoculative or inundative releases of commercially produced insects. Sixspotted thrips are a good fit for biological control programs because they are voracious predators (eating up to 50 spider mite eggs per day at 86F) that feed almost exclusively on spider mites, thrive under hot, dry conditions, are highly maneuverable in tight spaces, such as those created by mite webbing, and can experience rapid population increases (quadrupling in one week under ideal conditions).

Predatory mites should never be released if dense populations of spider mites already exist, because it is impossible to release enough predators to have an immediate effect. Releases in vineyards may be considered (e.g., in traditional hotspots and along upwind edges) to re-establish populations when no predatory mites can be detected or when there is an unfavorable ratio of prey to predator mites. However, releases must be made well before spider mites reach damaging levels. The viability and density of the to-be-released mites also needs to be verified. Consider consulting with an experienced practitioner who knows the proper protocol for predatory mite releases and has had success.

BOX 6-G PESTICIDE USE AND REDUCING RISKS FOR WINEGRAPES

The goal of the Sustainable Winegrowing Program is to ensure that pesticides are used only when necessary, not to eliminate pesticide use. The goal is to manage pests using IPM – a sustainable approach that combines biological, cultural, and chemical tools to minimize economic, environmental, and health risks. Pesticides remain an important tool and are used in most California vineyards, including for organic production. The key is to choose and carefully apply the lowest effective rates of cost-effective pesticides which pose minimal human and environmental risks. Regulations restrict some uses and users of products. See **Box 6-H** about the use of lower-than-label rates, and http://www.cdpr.ca.gov/docs/emon/ehap.htm for information and resources about agricultural pesticide regulations. See **Box 6-FF** for information about the CSWA Red and Yellow List for Crop Protection Materials and to see which materials are restricted for certified vineyards in the second year of certification and beyond.

Certain pesticides registered for grapes cause higher risks than others. Many organophosphates and carbamates, for example, have higher risks because of their broad-spectrum toxicity and long persistence. Pyrethroids pose risks to natural enemies, aquatic organisms, and water quality; while some neonicotinoids pose risks to water quality. Various sources can be used to determine risks. Pesticide labels and recommendations by the UC Statewide IPM Program identify certain risks associated with specific products. Environmental risks include potential impacts to natural enemies or environmental (e.g., surface or ground water) contamination. Also, newer products meeting designated criteria may be registered as "reduced risk" materials by the US Environmental Protection Agency (US EPA); see http://www.epa.gov/pesticides/health/reducing.htm.

Pesticide risk models are increasingly being used by winegrape growers to quantify and compare risks among pesticides. The Pesticide Environmental Assessment System (PEAS), developed for Lodi growers, calculates non-target risks associated with each application as PEAS Impact Index Points. Measurements are influenced by five different indices – worker acute risks, human dietary risks from acute and chronic exposure, acute risks to small aquatic invertebrates, acute risks to birds, and acute risks to honey bees and pest natural enemies. The PEAs model and its PEAS Impact Index Points account for differences in amounts of pesticides applied and how and where they are applied. However, PEAS is no longer being updated for new pesticides and therefore will become out of date if pesticides used are not accounted for in PEAS. For instructions about using PEAS and a list of Impact Index Points per pesticide, see https://www.lodigrowers.com/wp-content/uploads/2019/03/Tab-7-PEAS-Instructions-and-List-by-Name.pdf.

The Pesticide Risk Tool or PRT (IPM Institute of North America, Inc.) is another model that quantifies and categorizes (low, moderate, and high) non-target risks from pesticide applications according to a comprehensive set of indices. PRT is fee-based and can be accessed at http://www.pesticiderisk.org.

Box 6-H Pesticide Resistance and Label Rates

It is illegal to apply pesticides at rates exceeding those listed on the label. However, it is legal to use a pesticide at less than the recommended label rate, although some labels specify that a rate below a certain amount should not be used. Specific conditions should be considered any time a rate that is less than the recommended label rate is used to reduce the likelihood of pesticide resistance. Conditions such as vineyard location, weather, pest pressure, etc. should all be considered. If a label only includes a not to exceed rate, consult a Pesticide Control Advisor (PCA) if assistance is needed determining the optimal application rate.

Pest populations can respond to the selection pressure imposed by pesticides when rare individuals able to survive the pesticide treatment reproduce and those resistant progeny become a larger proportion of the population. In the field several mechanisms of resistance have been identified that confer resistance to pesticides in some pest species. These can include changes at the pesticide's target site, changes in the pest's ability to metabolize the pesticide, or changes affecting movement of the pesticide to the active site in the pest.

Some resistance mechanisms can confer very high levels of resistance; many of these are related to single-gene mutations affecting the pesticide target enzyme. This type of resistance is sometimes called monogenic or qualitative. It tends to be promoted by highly effective pesticides and to a lesser extent by relatively high label use rates.

Conversely, some resistance mechanisms confer lower levels of resistance. At relatively low use rates or with somewhat less effective pesticides some individuals may be injured by the pesticide but still survive and reproduce. Over time, the population may accumulate several of these minor resistance mechanisms that, together, result in resistance levels that are serious management issues. This type of resistance is sometimes called polygenic or quantitative resistance and tends to be promoted by pesticide rates on the margin of efficacy.

Learn more about resistance management BMPs:
UC Statewide IPM Program provides a free online training module for pesticide resistance:
https://campus.extension.org/course/view.php?id=1579

Herbicide Resistance Action Committee: Guideline to the Management of Herbicide Resistance:
https://hracglobal.com/files/Management-of-Herbicide-Resistance.pdf

General Principles of Insecticide Resistance Management from IRAC: https://irac-online.org/documents/principles-of-irm/

Fungicide Resistance in Crop Pathogens: How Can it be Managed? www.frac.info/docs/default-source/publications/monographs/monograph-1.pdf

6-5 Cultural Practices for Insect and Mite Management* *Vineyard*

Category 4	Category 3	Category 2	Category 1
Cultural practices (e.g., leaf removal*, cover crops, hedgerows, sanitation, dust control, irrigation) were the primary methods for managing insect and mite pests in the vineyard ***And*** Cultural practices were timed to reduce insect and mite pests ***And*** Cultural practices were intentionally used to promote beneficial insects and mites ***And*** Vine vigor was maintained at a level appropriate for reducing pest pressure.	Cultural practices (e.g., leaf removal*, cover crops, hedgerows, sanitation, dust control, irrigation) were used for managing insect and mite pests in the vineyard ***And*** Vine vigor was maintained at a level appropriate for reducing pest pressure.	Cultural practices (e.g., leaf removal*, cover crops, hedgerows, sanitation, dust control, irrigation) were considered for managing insect and mite pests in the vineyard ***Or*** Vine vigor was maintained at a level appropriate for reducing pest pressure.	Cultural practices were not used to manage insect and mite pests in the vineyard. *(Select N/A if no problems with insects or mites)*

*Leaf removal may be inappropriate for some varieties or regions because of concerns about excessive fruit temperatures.

Cultural practices such as cover cropping and owl boxes are an important part of an integrated pest management program.

6-6 Dust Abatement in and around Vineyards for Mite Management*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
A permanent cover crop** (annual or perennial on all rows) was maintained in and around the vineyard, vehicle speed was controlled on any surrounding unpaved roads, and vineyard traffic was limited ***And*** Vineyard practices that create dust were identified and their impact was minimized ***And*** Any surrounding unpaved roads were managed by watering or with environmentally acceptable sealants, vegetative groundcover, or other appropriate measures to suppress dust.*	Vehicle speed was controlled on any surrounding unpaved roads and vineyard traffic was limited ***And*** Vineyard practices that create dust were identified and their impact was minimized ***And*** Any surrounding unpaved roads were managed by watering or with environmentally acceptable sealants, vegetative groundcover, or other appropriate measures to suppress dust.*	Vehicle speed was controlled on any unpaved roads surrounding the vineyard and vineyard traffic was limited ***And*** Vineyard practices that create dust were identified and their impact was minimized.	Vehicle speed was not controlled nor was dust suppressed on any unpaved roads surrounding the vineyard. *(Select N/A if no mite problems existed; however, note that dust abatement is still crucial for air quality problems)*

*See **Box 16-I** in the **Air Quality and Climate Protection Chapter** for details about anti-dust materials for unpaved surfaces.
**If cover crops reduce the vigor of the vines, this could increase mite issues.
Visit the CSWA Resoure Library at https://library.sustainablewinegrowing.org/ and search "**Dust Mitigation Methods Comparison Tool**" for a tool that provides helpful information on different dust control techniques and a cost comparison calculator.

6-7 Use of Weather Data and Degree-Days for Managing Moth Pests (e.g., omnivorous leafroller (OLR) and/or orange tortrix) *Vineyard*

Category 4	Category 3	Category 2	Category 1
Necessary treatments for moth pests were based on accumulated degree-days* (see **Box 6-I**), initiated by pheromone trap counts and calculated using weather station data and computerized insect-growth models** ***And*** Problematic populations and growth stages were confirmed by in-field monitoring and use of economic thresholds.	Necessary treatments for moth pests were based on the time of year or vine development, and past experience ***And*** Problematic populations and growth stages were confirmed by in-field monitoring and use of economic thresholds.	Treatments for moth pests were based on the time of year or vine development, and past experience.	Treatments for moth pests were made when convenient. *(Select N/A if no treatments were applied for moth pests during the assessment year)*

*700-900 and 1000 degree-days after biofix for OLR (see **Box 6-J**) and orange tortrix (see **Box 6-K**), respectively (Flaherty et al., 1992).
**OLR and orange tortrix computerized growth models can be accessed via the UC Statewide IPM Program at http://www.ipm.ucdavis.edu/WEATHER/index.html or via http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html.

Box 6-I Degree-Days and Their Use in Predicting Spray Timing for OLR and Orange Tortrix

Degree-days: Insects are cold-blooded animals. Therefore, their growth rates are strictly controlled by temperature (i.e., the warmer the temperature, the faster they grow). It is important to realize that insect growth cannot be measured accurately by calendar time. Research demonstrates that insect growth rates are correlated to the time spent between species-specific lower and upper threshold temperatures, with no growth occurring outside these ranges. Insect-growth units, termed degree-days, are calculated from mathematical models accounting for time and temperature. For grape pests, degree-day models have been developed for grape leafhopper, OLR, and orange tortrix**.**

Degree-days and spray timing: Using degree-days to track growth and development of OLR and orange tortrix is useful for timing treatments. OLR is a problem in the warmer inland grape-growing regions, while orange tortrix is a problem in the cooler coastal regions. For vineyards historically having problems with either pest, a recommended management strategy is to minimize early season numbers so populations do not exceed economic thresholds later in the season after two or three additional generations. Treatment of economically important early season populations also is key because OLR and orange tortrix subsequently infest grape bunches where spray coverage and control is poor.

OLR larvae are most susceptible to control during the first or second larval stages. For first-generation OLR, these stages generally coincide with bloom. Thus, most treatments are made at this time. Because of annual weather differences, however, degree-day accumulations should be used to precisely identify when these most susceptible life stages are present.

See **Box 6-J** (OLR) and **Box 6-K** (orange tortrix) for suggested steps for timing sprays using degree-days.

BOX 6-J SUGGESTED STEPS FOR TIMING OLR SPRAYS USING DEGREE-DAYS

1. Position OLR pheromone traps in problem vineyards in early March and record catches once a week (change pheromone caps and trap bottoms at recommended intervals or less, as necessary).
2. After catching the first moth, check traps every other day until two or three moths are caught on a single day. This date is considered the biofix, the date of the first 'significant' moth catch.
3. Access and run the computerized OLR growth model, such as from http://www.ipm.ucdavis.edu/WEATHER/index.html or via http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html.
4. When requested to select a weather station for temperature inputs, choose the station closest to your vineyard.
5. When requested for the starting date of the measurement period, enter the biofix.
6. When requested for the ending date of the measurement period, enter the current date (generally). The program then will calculate OLR degree-days for the time interval. Necessary sprays should be made between 700 and 900 degree-days.

The option may exist to enter future dates for the end of the measurement period for some programs using the OLR growth model. In this instance, the model uses temperature averages over a 30-year interval for the days without real-time temperatures. This manipulation can be useful for roughly predicting when the window of 700-900 degree-days will occur.

Source: Flaherty et al., 1992.

BOX 6-K SUGGESTED STEPS FOR TIMING ORANGE TORTRIX SPRAYS USING DEGREE-DAYS

1. Position orange tortrix pheromone traps in problem vineyards by December and record catches once a week (change pheromone caps and trap bottoms at recommended intervals or less, as necessary).
2. Low trap catches during the interval from the end of January to early February represent the beginning of adult emergence for the first generation. The date of the lowest catch should be considered the biofix.
3. Follow steps 3-6 in **Box 6-J**, with the exception of using the orange tortrix growth model.

Necessary sprays should be made when 1000±50 degree-days have accumulated.

Source: Flaherty et al., 1992.

6-8 Portion of Vineyard Treated for Mites or Leafhoppers *Vineyard*

Category 4	Category 3	Category 2	Category 1
Pest hotspots were identified ***And*** Necessary treatments for mites or leafhoppers were made only to portions of the vineyard exceeding economic thresholds (e.g., edges and/or hotspots) ***And*** Any treatment efficacy was verified by monitoring.	Pest hotspots were identified ***And*** Necessary treatments for mites or leafhoppers were made only to portions of the vineyard exceeding economic thresholds (e.g., edges and/or hotspots) as well as extra buffer strips around hotspots.	Pest hotspots were identified only as an indicator of a problem ***And*** The entire block or vineyard was treated when controlling mites or leafhoppers.	Pest hotspots were not identified ***And*** The entire block or vineyard was treated when controlling mites or leafhoppers. *(Select N/A if no treatments were applied for mites or leafhoppers during the assessment year)*

BOX 6-L MEALYBUGS AND TRANSMISSION OF GRAPEVINE LEAFROLL-ASSOCIATED VIRUSES

All key species of mealybugs (vine, grape, obscure, Gill's and long-tailed mealybugs) found on California winegrapes transmit viruses causing grapevine leafroll disease. Viticulturists in California have battled the spread of grapevine leafroll viruses in vineyards since 2002. Grapevine leafroll viruses are members of the *Closteroviridae* family, for which numerous distinct viruses have been identified. The viruses are systemic in the vine, but generally localized in vascular tissues (phloem). Vine-to-vine transmission occurs through the planting of infected cuttings, the grafting of clean scions onto infected rootstocks or infected scions onto healthy rootstocks, and mealybug transmission to previously uninfected vines. Symptoms of infection include general decreases in vine health and appearance, delayed bud break and shorter shoots, leaf discoloration and curling, loose and small fruit clusters, poor color development in berries and delayed ripening, and decreased quantity and quality of yield. There is no known cure for leafroll disease, so prevention is crucial. Prevention includes the planting of clean nursery stock, controlling the mealybug vectors, and the early recognition and removal of infected vines.

Sources: Skinkis et al., 2009; Tsai et al., 2010; and UC IPM Pest Management Guidelines (http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html).

6-9 Mealybug Management (vine, grape, obscure, and long-tailed) *Vineyard*

Category 4	Category 3	Category 2	Category 1
Comprehensive IPM for mealybugs was followed by monitoring the vineyard throughout the year for signs of mealybugs (e.g., pheromone lures) and parasitism/natural enemies, mapping infested areas, only treating infested areas as well as extra buffer strips around hotspots as necessary, and marking hotspots to closely monitor locations the following year ***And*** Equipment was cleaned of vine debris when moving from infested to non-infested areas* ***And*** Workers did not work in infested and non-infested areas during the same day, or they work infested areas last ***And*** Ants were managed, if necessary, using materials and methods that do not interfere with other pest management programs ***And*** Mating disruption or biological control releases were used, if needed** ***And*** Communications with neighbors included information about the presence of mealybugs, if applicable.	Signs of mealybugs and their natural enemies were monitored throughout the year in the vineyard and infested areas were mapped ***And*** Ants were managed, if necessary ***And*** If mealybug treatments were necessary, only infested areas were treated as well as extra buffer strips around hotspots as necessary.	Signs of mealybugs were monitored annually in the vineyard ***And*** If found, infested and non-infested areas were treated.	Mealybugs were not monitored in the vineyard.

See **Box 6-M** for information specific to vine mealybug. Also, see **Viticulture Chapter Criteria 3-13 Rootstocks** and **3-16 Scion/Cultivar** for information about the importance of selection and use of clean plant material.

*Cleaning of equipment is not always effective and is most relevant for vine mealybug.

** Pheromone mating disruption is applied as a vine mealybug preventative measure if the vineyard is at risk for infestations, as a treatment if the vineyard has low populations of vine mealybugs, or as a spread mitigation strategy if the vines are infected with leafroll virus and/or vitiviruses.

Box 6-M The Vine Mealybug

The vine mealybug, *Planococcus ficus*, is a relatively new pest to California. It is native to the Mediterranean region and was first found in California in 1994 in the Coachella Valley. In 1998, it was first discovered in vineyards in the southern San Joaquin Valley. This initial spread to vineyards is thought to have occurred from the transfer of contaminated farm equipment. Soon after, it was found in Santa Barbara County and the Paso Robles area. In August 2002, vine mealybug was identified in vineyards in Sacramento, Napa, and Sonoma Counties, likely brought in on contaminated planting stock from nurseries in infested areas of the southern San Joaquin Valley. Subsequent research showed that 5-minute hot water immersion of dormant grapevine cuttings at 51ºC can reduce incidence of vine mealybug by 99%. Vine mealybug presently is established in parts of the Coachella Valley, San Joaquin Valley, Central Coast, North Coast, and Sierra Foothills. Because of the risk of additional spread to new areas, growers need to be aware of vine mealybug, how to identify it, and what to do if it is found. See http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html for more information.

All or most life stages of vine mealybug can be present on vines year-round, except for the North Coast where they have not been found on roots. **Other mealybug species on California winegrapes do not infest roots of grapevines, although obscure mealybugs have been found on roots of cover crops. Unlike grape mealybug, vine and obscure mealybugs are likely to be on leaves during the growing season**. During the winter in the North Coast, vine mealybug are found under the bark predominantly on the permanent vine structures, especially on the trunk at or below the graft union. Vine mealybugs become more visible as populations increase with warm spring temperatures. By late spring and summer, the pest is found on all parts of the vine, including leaves and grape clusters. Ant-tending of vine mealybugs is common, especially where Argentine ants are present in coastal vineyards. Argentine ants protect vine mealybug from natural enemies while feeding on mealybug honeydew. Toxic baits are an important tool in vineyards to reduce populations of mealybug-tending ants and support biological control of mealybugs. Immature and female mealybugs produce waxy filaments that cause colonies to appear ‘mealy’ or fluffy. Besides infesting roots, vine mealybug can be distinguished from other mealybugs on grapes (see following photographs) because colonies produce excessive honeydew (resembles candle wax) and all life stages have a much shorter ‘tail’ than other mealybug species. However, if ants are present, the candlewax honeydew will be absent, and the longer tails of non-VMB species are often broken off.Vine mealybug also can cause significantly more damage by reducing yield, as well as reducing quality via honeydew-contaminated berries (see photograph below) and subsequent invasion by sooty mold and bunch rots.

Immature and female vine mealybug do not have wings. Therefore, spread occurs through movement of contaminated material, such as leaves, canes, and bunches or equipment, such as harvesters. Birds may also spread vine mealybug from one vineyard to another; young nymphs (especially 1st and 2nd instar) may move independently among adjacent vines or may be wind-blown a greater distance. **Although use of sanitary measures, mating distruption and biological control are important for preventing the spread of all mealybugs, these practices are crucial for vine mealybug. Equipment must be cleaned prior to leaving infested vineyards. Vine cuttings should not be taken from infested to non-infested areas. Purchase nursery stock that was treated with hot water immersion, following developed protocols. Furthermore, employees should not work in infested and non-infested vineyards during the same day or should work infested areas last**.

Sources: Peacock et al., 2000; Godfrey et al., 2002; Haviland et al., 2005; and UC IPM Pest Management Guidelines (http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html).

Photographs of Vine Mealybug on Grapes

Vine Mealybug on cane – note short 'tail'

Crystallized honeydew on cane – note white waxy filaments

Vine Mealybug damage to grape bunch

BOX 6-N EXOTIC PESTS AND PREVENTING THEIR INTRODUCTION AND ESTABLISHMENT

Exotic pests are plants or animals that occur in non-native areas and cause, or have the potential to cause, problems. Generally, these pests are accidentally introduced by the transfer of infested plant material or soil from one area to another. Exotic pests are of significant agricultural concern because their natural enemies are not present and/or plants do not have natural defenses in the newly infested areas. Key exotic pests in California vineyards include vine mealybug, grape phylloxera, glassy-winged sharpshooter, and the relatively new invaders Virginia creeper leafhopper, brown marmorated stink bug and light brown apple moth (LBAM; *Epiphyas postvittana*). Current threat of introduction of spotted lanternfly. It is crucial that winegrowers follow regulations and take all precautions to prevent the introduction and establishment of exotic pests, and report any new detections to their County Agricultural Commissioner office.

For additional and updated general and regulatory information about exotic agricultural pests in California, see http://www.cdfa.ca.gov/plant/.

Check with your local Agricultural Commissioner's office to see if there are restrictions in your area, and if so, what compliance is required. To find contact information for your County Agricultural Commissioner visit the California Department of Food and Agriculture's website at: http://www.cdfa.ca.gov/exec/county/countymap/.

6-10 Soil-Borne Pest Management after Planting*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
A written soil-borne pest management plan has been developed ***And*** The plan includes sampling the vineyard soil at least once every 3 years for soil-borne pests such as phylloxera and/or parasitic nematodes if soil-borne pests were an ongoing isssue ***And*** Sampling results were used to determine and take appropriate management action(s)**.	A soil-borne pest management strategy has been developed ***And*** The strategy includes sampling the vineyard soil at least once every 3 years for soil-borne pests such as phylloxera and/or parasitic nematodes if soil-borne pests were an ongoing issue ***And*** Sampling results were used to determine and take appropriate management action(s)**.	A soil-borne pest management strategy has been developed ***And*** The strategy includes sampling the vineyard soil at least once every 5 years for soil-borne pests such as phylloxera and/or parasitic nematodes ***And*** Sampling results were used to determine and take appropriate management action(s)**.	No soil sampling for soil-borne pests has occurred in the last 5 years although management action(s) may have been taken specifically for them.

*Modified from the Lodi Winegrape Commission's *Lodi Winegrower's Workbook 2nd Edition* (Ohmart et al., 2008).

**Management actions can include nematicides, fertilization, irrigation, and/or vine replacement. Actions should depend on post-plant soil sampling and analyses for soil-borne pests done on a routine basis. Because nematodes often recolonize rapidly following incomplete fumigation, Armillaria root disease can remain undetected in decaying roots in the soil for many years, and new phylloxera problems need to be identified early.

Draw lines between the name of the disease, the symptoms of the disease, and where the disease over-winters.

Powdery Mildew

Botrytis

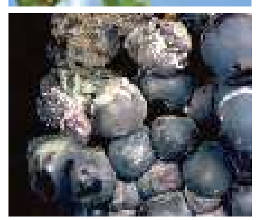
Sour Rot

Eutypa Dieback

Phomopsis Cane and Leaf Spot

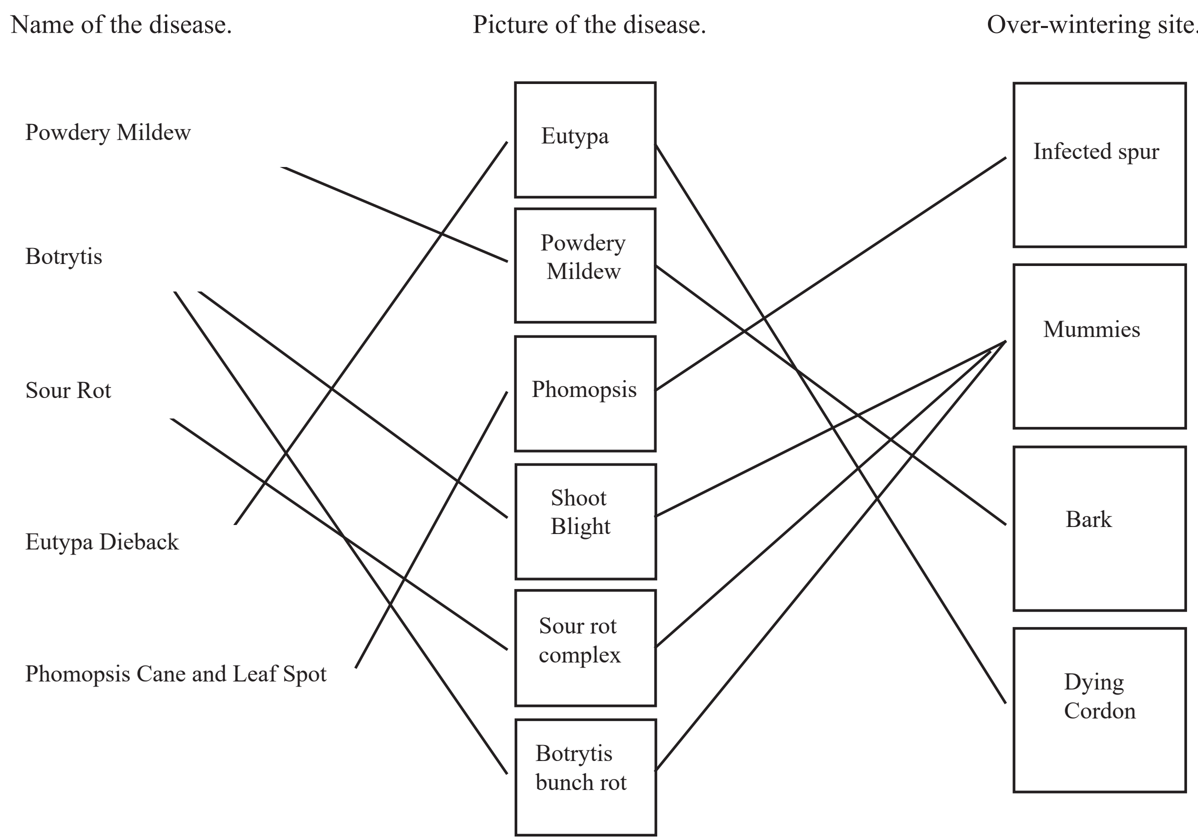






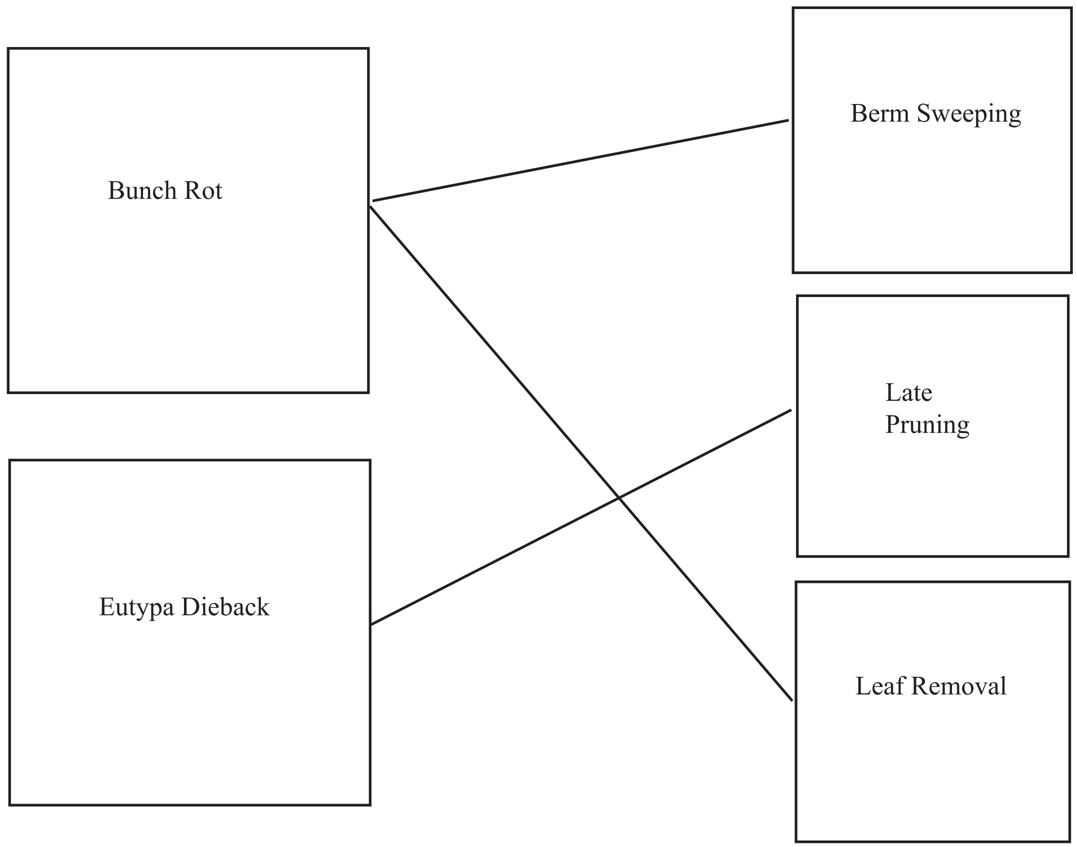





Name of the disease.
Picture of the disease.
Over-wintering site.
Powdery Mildew
Botrytis
Sour Rot
Eutypa Dieback
Phomopsis Cane and Leaf Spot
Eutypa
Powdery Mildew
Phomopsis
Shoot Blight
Sour rot complex
Botrytis bunch rot
Infected spur
Mummies
Bark
Dying Cordon

Draw lines between the disease and the management practice.

Draw lines between the disease and the management practice



6-11 Vineyard Monitoring for Disease *Vineyard*

Category 4	Category 3	Category 2	Category 1
The vineyard was monitored at least weekly for diseases during critical periods ***And*** A written or electronic record of results was kept for the season ***And*** This information was analyzed and used for management decisions.	The vineyard was monitored as needed and at least every 14 days for diseases during critical periods ***And*** A written or electronic record of results was kept for the season ***And*** This information was analyzed and used for management decisions.	The vineyard was monitored periodically for diseases during critical periods.	The vineyard was never or rarely monitored for diseases.

For an excel-based IPM scouting template for recording disease monitoring results, and a handout on identifying and treating hot spots and using economic thresholds, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **Economic Thresholds and IPM Scouting Template**.

BOX 6-O SUSCEPTIBILITY OF VARIETIES TO IMPORTANT VINEYARD DISEASES

A disease does not affect all winegrape varieties similarly. Some varieties are more susceptible to a specific disease(s). Listed below are some important vineyard diseases and the more susceptible varieties. The exclusion of a variety does not imply immunity.

- **Powdery mildew**: Carignane, Chardonnay, Cabernet Sauvignon, Fiesta, and Chenin Blanc
- **Bunch rot**: Tight-bunched, thin-skinned varieties such as Chardonnay, Zinfandel, Chenin Blanc, Pinot Grigio, Pinot Noir, Riesling, and Sauvignon Blanc
- **Eutypa dieback**: Chenin Blanc, Sauvignon Blanc, Cabernet Sauvignon, Chardonnay, Petit Sirah, French Colombard, Syrah, and Zinfandel
- **Botryosphaeria canker**: All varieties are susceptible
- **Pierce's disease**: Particularly sensitive varieties are Chardonnay, Pinot Noir, French Colombard, Barbera, and Sauvignon Blanc

Source: Modified from Flaherty et al., 1992.

6-12 Powdery Mildew Management *Vineyard*

Category 4	Category 3	Category 2	Category 1
A written powdery mildew management plan* was used that considers cultural practices such as irrigation and canopy management (e.g., leaf removal, shoot thinning, shoot positioning) to limit powdery mildew development and/or improve application coverage (includes level of disease pressure, spore trap observations, weather, and use of disease location history, etc.) ***And*** Application decisions were based on (the Gubler-Thomas powdery mildew forecasting model or spore trap observations (e.g., Grape Powdery Mildew Index – see **Box 6-P**), with no applications at or after veraison if no mildew was found ***And*** Fungicides with different modes of action were 'rotated' throughout the season.	Cultural practices such as irrigation and canopy management (e.g., leaf removal, shoot thinning, shoot positioning) were considered to limit powdery mildew development and/or improve application coverage ***And*** Application decisions were based on weather patterns, with no applications made at or after veraison if no mildew was found ***And*** Fungicides with different modes of action were 'rotated' throughout the season ***Or*** only sulfur products were used.	Application decisions for powdery mildew were based on an established calendar program ***And*** Fungicide rates were altered based on vineyard conditions and/or monitoring ***And*** Fungicides with different modes of action were 'rotated' at least once within the season ***Or*** only sulfur products were used.	Application decisions for powdery mildew were based on an established calendar program ***And*** Fungicides were applied at highest label rates (never altered based on vineyard conditions or monitoring) ***And*** Fungicides with different modes of action were not 'rotated' within the season ***Or*** only sulfur products were used.

*The powdery mildew management plan can be a stand-alone document or included as part of a comprehensive IPM plan. For a template for a comprehensive IPM plan, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **IPM Plan Template**.

BOX 6-P THE GRAPE POWDERY MILDEW DISEASE INDEX

The development of powdery mildew (*Uncinula necator*) on grapes in California is affected primarily by temperature. The fungus can complete an infection cycle in five days when temperatures in the grape canopy are between 70^{o} and 85^{o} F but takes as many as 15 days when temperatures are less than 70^{o} or exceed 85^{o} F. Temperatures above 95^{o} F stop fungal growth and reproduction, slowing the rate of disease increase. Powdery mildew epidemics generally begin after three consecutive days with six or more continuous hours of temperatures between 70 and 85^{o} F.

The grape powdery mildew disease index (Gubler-Thomas or GT model) was designed for growers to accurately assess mildew increase, allowing for more judicious and timely fungicide applications. The index is based on a model of the biology of the pathogen. **Temperature data from within the grape canopy** is averaged over 15-minute intervals, downloaded into a computer, and processed according to parameters of the model. Within canopy temperatures can be monitored on site (produces most accurate results) or accessed from a proximal weather station via http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html.

Calculation of the index involves adding 20 points for each day with six or more continuous hours between 70^{o} and 85^{o} F. If there are less than six continuous hours between 70^{o} and 85^{o} F or the maximum temperature reaches or exceeds 95^{o} F for a day, 10 points are subtracted from the index. The index also is reduced by 10 points if a day has six or more continuous hours between 70^{o} and 85^{o} F but the maximum temperature reaches or exceeds 95^{o} F. The index never goes above 100 or below zero**. The index is used to determine mildew pressure and suggested frequencies of fungicide applications. The length of the suggested application interval is inversely proportional to the value of the index**. For example, intervals are lengthened when the index is low, normal when intermediate, and shortened when high. For suggested intervals for various fungicides based on values of the index, see http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html. **Since berries are not susceptible to infection after 8 ^{o}Brix and spores cannot be produced from established infections after 12-15 ^{o}Brix, the use of the index and treatments may be discontinued after grapes reach 12 ^{o}Brix**.

The index also may be used to help determine when to start applying fungicides in the spring. After bud break, the model initiates when there are temperatures of 70^{o} to 85^{o} F for six continuous hours for three consecutive days. At this point, the first treatment should be made within seven days.

The index is also used to dictate what fungicides are used. Under low and moderate pressure, the biological and soft chemistry products can be used effectively and under high pressure, synthetic chemistry is best used.

Temperature monitoring devices are available from a number of suppliers and range from $50 to $5,000, depending on their sophistication and ease of use. As a service, some agricultural product suppliers provide the index, but values based on data calculated from more distant weather stations should be used cautiously.

For more information, see http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html, http://www.ipm.ucdavis.edu/DISEASE/DATABASE/grapepowderymildew.html, and http://www.ipm.ucdavis.edu/WEATHER/index.html.

Sources: W.D. Gubler, Department of Plant Pathology, UC Davis; and UC IPM Pest Management Guidelines (http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html).

Box 6-Q Resistance Management for Powdery Mildew

Resistance management is the responsibility of each grower. If the same pesticide or those with similar modes of action are used often and repeatedly against a pest, pesticide resistance will likely develop. Resistance management is practiced by alternating applications of pesticides from one group of active ingredients or products with those from other groups (sorted by mode of action). Because many diverse fungicides exist for powdery mildew, growers can effectively practice resistance management. Listed below are most registered powdery mildew fungicides by mode of action.

Sulfur: Sulfur has been used for over 170 years with no evidence of resistance. Sulfur products (dust, wettable, flowable, and micronized) remain relatively cost-effective and environmentally benign materials for use against powdery mildew. The exact mode of action is not known.

Sterol Inhibitors (also known as SI's, DMI's, SBI's, and EBI's): This group includes Rally, Rubigan, Procure, and Elite. These products act by weakening fungal cell walls, ultimately causing mortality.

Contacts: This group is represented by light oils, fatty acids, and formulations of potassium or sodium bicarbonate. Products include JMS Stylet Oil, Trilogy, M-Pede, and Kaligreen. Contact materials kill the fungus by direct contact. However, some drawbacks are short residuals and the need for complete coverage for control. Water-based mixes of these materials, wettable sulfur, and wetting agents often are applied for eradicating powdery mildew.

Fermentation Products: This group includes Serenade and Sonata. These products from different naturally occuring *Baccillus* species affect mildew by preventing spores from germinating, disrupting germ tubes, and inhibiting the fungus from attaching to the leaf.

Cell-Signaling Interferers: This group is represented by Quintec, a product that prohibits mildew spores from recognizing, and therefore infecting, grape tissue.

Strobilurins: This group includes Abound, Flint, and Sovran. These products consist of synthetic molecules based on extracts of a wood-rotting fungus and act by inhibiting fungal respiration. Pristine also is included here despite consisting of two reduced-risk active ingredients, pyraclostrobin (a strobilurin) and boscalid.

Systemic Acquired Resistance Elicitors (SARs): This group includes Messenger, AuxiGro, and Elexa. These products help prevent mildew infection by inducing an immune response in vines leading to the production of anti-fungal enzymes, thicker cell walls, and other defenses.

See http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html for more information about uses, efficacies, and properties of fungicides for grapes.

Source: UC IPM Pest Management Guidelines (http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html).

6-13 Minimizing Risks from Fungicides for Powdery Mildew and Botrytis Control

Vineyard

Category 4	Category 3	Category 2	Category 1
A pesticide risk model (e.g. PEAS)* was used to assess non-target risks, and powdery mildew and Botrytis treatments categorized as high risk** were not used*** ***And*** If synthetic fungicides were needed, fungicides with similar modes of action were rotated.	Non-target risks (e.g., impacts to beneficial organisms and human and environmental health) were considered when selecting and using fungicides for powdery mildew and Botrytis control ***And*** Fungicides were compared for risks, cost and efficacy, and lower risk fungicides were used when possible ***And*** If synthetic fungicides were needed, fungicides with similar modes of action were rotated.	Non-target risks (e.g., impacts to beneficial organisms and human and environmental health) were considered when selecting and using fungicides for powdery mildew and Botrytis control ***But*** Products were not intentionally rotated by mode of action.	Fungicides for powdery mildew and Botrytis control were primarily selected and used based on cost and efficacy.

* PEAS = Pesticide Environmental Assessment System.
**Treatments with high risks for any category if using PRT, or having more than 3 PEAS Impact Index Points. Note: PEAS is no longer being updated for new pesticides and therefore will become out of date if pesticides used are not accounted for in PEAS.
***Except for emergencies such as an exotic pest introduction where regulations and/or university protocols require a specific pesticide(s).
See **Box 6-G** for more detail about reducing risks from pesticides.

When pesticides are overused, they often are lost, either to resistance or regulators.

6-14 Pruning for Canker Management (Eutypa dieback and Bot canker) *Vineyard*

Category 4	Category 3	Category 2	Category 1
Susceptible varieties were pruned late during dormancy* and only small cuts were made (when possible) ***And*** Diseased wood was identified, pruned-off, removed from the vineyard, and destroyed ***And*** Pruning-wound protectants were used, if needed ***And*** If fruit was mechanically harvested, machine adjustments were made to minimize spur damage.	Susceptible varieties were pruned late during dormancy* ***And*** Diseased wood was pruned-off ***And*** Pruning-wound protectants were used, if needed ***And*** If fruit was mechanically harvested, machine adjustments were made to minimize spur damage.	Susceptible varieties were pruned late during dormancy.*	A specific canker management strategy was not implemented for the vineyard. *(Select N/A if no problems with canker diseases)*

*By pruning vines, especially susceptible varieties, as late during dormancy as possible, the threat of infection associated with rain is relatively lower (Flaherty et al., 1992) and pruning wounds heal rapidly (http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html). The most susceptible varieties for Eutypa are Chenin Blanc, Sauvignon Blanc, Cabernet Sauvignon, Chardonnay, Petit Sirah, French Colombard, Syrah, and Zinfandel.

For a web-based tool to help assess the costs and economic benefits of implementing various preventative practices for trunk diease management at different ages of vineyard maturity, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **Trunk Disease Management Tool**.

See the educational handout **Prevention and Treatment of Trunk Disease** in the CSWA Resource Library at: https://library.sustainablewinegrowing.org/.

6-15 Bunch Rot Management *Vineyard*

Category 4	Category 3	Category 2	Category 1
Canopy air circulation was optimized (making conditions less conducive to bunch rot) by implementing practices such as appropriate trellis selection, shoot thinning, and leaf removal ***And*** Practices were used to reduce physical fruit damage (predisposes berries to bunch rots) such as adjusting irrigation to limit berry size and splitting, and controlling feeding by OLR, orange tortrix, and birds ***And*** Old, dried grape clusters on vines and the soil surface were destroyed during the dormant season ***And*** The causal agent of bunch rot was identified as *Botrytis* or *Aspergillus* spp. (initates the sour rot complex), and if needed, appropriate fungicides were applied.	Canopy air circulation was optimized (making conditions less conducive to bunch rot) by either appropriately removing leaves from the fruiting zone or by ensuring air circulation already was optimized without leaf removal ***And*** Practices were used to reduce physical fruit damage (predisposes berries to bunch rot) such as adjusting irrigation to limit berry size and splitting, and controlling feeding by OLR, orange tortrix, and birds ***And*** The causal agent of bunch rot was identified as *Botrytis* or *Aspergillus* spp. (initiates the sour rot complex), and if needed, appropriate fungicides were applied.	Fungicides for bunch rot were applied only between bloom and bunch closure, unless prolonged wet weather necessitated applications to protect shoots or ripe fruit ***And*** Practices were used to reduce physical fruit damage (predisposes berries to bunch rot) such as adjusting irrigation to limit berry size and splitting, and controlling feeding by OLR, orange tortrix, and birds.	Fungicides for bunch rot were applied on a calendar basis, typically treating more often than only at bloom and bunch closure. *(Select N/A if bunch rot was not a problem)*

BOX 6-R MANAGING BOTRYTIS BUNCH ROT AND THE SOUR ROT COMPLEX

Bunch rot of winegrapes is a more serious concern for tight-bunched varieties such as Zinfandel, Riesling, Chardonnay, Pinot, and Chenin Blanc. There are two types of bunch rot, Botrytis bunch rot and sour rot. A single fungus, *Botrytis cinerea*, causes Botrytis bunch rot. Sour rot, however, is caused by a complex of bacteria and fungi including *Aspergillus niger, Alternaria tenuis, Penicillium spp*., *Botrytis cinerea,* and others. Botrytis bunch rot is distinguished by the characteristic brown, fuzzy fungal mycelia that grow on infected grapes. In contrast, the surface of sour rot-infected grapes appears black, brown, or green and less fuzzy than Botrytis-infected grapes. Also, grapes infected with sour rot can produce a pungent, vinegary odor. Botrytis bunch rot is more common during cool wet periods, while sour rot is more common during hot periods. **It is important to diagnose which pathogen(s) caused the rot because most fungicides are not equally effective against Botrytis bunch rot and sour rot**. Another important fact about both bunch rots is that they often are associated with berries previously damaged by insect feeding (e.g., OLR or orange tortrix) or by rupturing from excessive growth in tight clusters. **Minimizing berry physical damage minimizes bunch rots**. This can be achieved by reducing moth pest populations (e.g., via *Bacillus thuringiensis* or mating disruption), and/or carefully managing irrigation and fertilization. **Excessive vigor often is a critical factor in bunch rot problems** (Flaherty et al., 1992). Recent research also implies that infection by powdery mildew may increase subsequent bunch rot development (Gadoury et al., 2007).

The results of field experimentation in 1997 for evaluating 27 fungicides and other treatments against high pressure from bunch rots demonstrated that all treatments significantly reduced Botrytis bunch rot but only half significantly reduced sour rot. Importantly, the most effective single practice was leaf removal, reducing Botrytis bunch rot by 70% and sour rot by 73%. No chemical treatment approached these levels of control, substantiating the importance of canopy management and increased air circulation in the cluster zone for limiting bunch rots. Results also confirmed that OLR and/or orange tortirx control significantly reduced both bunch rots (Roger Duncan, UC Viticulture Farm Advisor, Stanislaus County; and Stapleton and Grant, 1992).

Low levels of gibberellic acid applied pre-bloom to Zinfandel and Chenin Blanc varieties can restrict berry size, resulting in looser clusters, less berry spitting, and decreased bunch rots. However, an appropriate UC Farm Advisor should be consulted before applying gibberellic acid to ensure it is registered for use in the specific region.

6-16 Pierce's Disease (PD) Management where Blue-Green Sharpshooter is the Primary Vector*

Vineyard

Category 4	Category 3	Category 2	Category 1
A written PD management plan** has been developed and includes managing riparian habitat to minimize blue-green sharpshooter populations*** ***And*** Diseased vines were removed as soon as detected ***And*** Yellow sticky traps were used to monitor blue-green sharpshooter populations in and along vineyards adjacent to riparian habitat ***And*** If trap counts increase sharply after several successive warm days or more than one sharpshooter per vine was observed, the only vines treated were those bordering sharpshooter breeding habitat.	A written PD management plan** has been developed ***And*** Diseased vines were removed as soon as detected ***And*** Yellow sticky traps were used to monitor blue-green sharpshooter populations in and along vineyards adjacent to riparian habitat ***And*** If trap counts increase sharply after several successive warm days or more than one sharpshooter per vine was observed, the only vines treated were those bordering sharpshooter breeding habitat.	A strategy for PD management has been developed and includes monitoring of blue-green sharpshooters ***And*** Management of PD consists of insecticide applications for blue-green sharpshooter, if necessary.	No management plan for PD has been developed despite PD being a problem in or around the vineyard ***And*** Pesticides may be applied without information on vector and disease presence. *(Select N/A if PD vectored by blue-green sharpshooter was not a problem in or around the vineyard)*

*Blue-green sharpshooters primarily occur in coastal regions. Where glassy-winged sharpshooter does not exist in the San Joaquin Valley, green and red-headed sharpshooters, found in adjacent hay fields, pastures, and lush-growing perennial grasses and sedges along ditches, are the primary vectors of PD but seldom cause problems because grape is not their preferred host. Vegetation management can be used to manage green and red-headed sharpshooters, if necessary (Flaherty et al., 1992).

The PD management plan can be a stand-alone document or included as part of a comprehensive IPM plan. For a template for a comprehensive IPM plan, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **IPM Plan Template.

***Consideration should be given to removing key sharpshooter breeding hosts (e.g., Himalayan blackberry, California blackberry, wild grape, periwinkle, California mugwort, stinging nettle, mulefat) and systemic hosts of *X. fastidiosa* (e.g., wild grape) from riparian areas and replacing them with native, non-host plants (Flaherty et al., 1992). However, riparian corridors are ecologically sensitive areas, regulated by federal, state, and local authorities, where the unauthorized removal of vegetation is prohibited. Contact local Resource Conservation Districts to determine pertinent regulations.

BOX 6-S THE GLASSY-WINGED SHARPSHOOTER AND PIERCE'S DISEASE

The glassy-winged sharpshooter (GWSS; *Homalodisca vitripennis*) is native to the southeastern United States. This pest was first observed in California in 1990 and currently is established throughout southern California as far north as Fresno and Santa Barbara counties. Small infestations have been found in Northern California. The GWSS vectors the bacterium *Xylella fastidiosa*, which causes Pierce's disease (PD), a lethal grapevine disease for which there is no known cure.

The GWSS is a large insect – almost ½ inch long – and is dark brown to black with a lighter underside. The upper parts of its head and back are stippled (speckled) with ivory or yellowish spots, and its wings are partly transparent with reddish veins.

Monitoring for GWSS involves the use of yellow sticky traps and also should include the direct observation of plants or sampling with a sweep net. Traps should be placed in the vineyard at a density of one or more for each 20 acres. Additional traps should be positioned in adjacent areas with alternate hosts (e.g., riparian citrus, wholesale nursery). Traps should be checked weekly.

Because PD potentially can devastate the wine industry, it is crucial that all winegrape growers and their employees, even in non-infested areas, can identify and look for GWSS. Moreover, growers should educate the general public to recognize the pest if found in yards or gardens. Due to the economic significance of GWSS and PD, government-based trapping and areawide treatment programs are established in many California regions where winegrapes are grown.

It is important not to make rash decisions out of fear of a potential problem – extensive research is being conducted to improve methods for managing GWSS and PD. The implementation of effective monitoring programs continues to be the primary objective. If a GWSS is detected, a record of when and where it was found should be made and a specimen taken immediately to the Agricultural Commissioner's office. At the county level, agricultural commissioners are the key contacts for issues and information relating to GWSS.

For more detail on PD and GWSS in California and associated recommended management practices, see *Pierce's Disease* (Varela et al., 2001); http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html; http://www.piercesdisease.org; and http://www.cdfa.ca.gov/pdcp/.

Egg mass on a leaf

Nymphs

Adult on leaf

Actual Size

6-17 Vineyard Monitoring for Weeds

Vineyard

Category 4	Category 3	Category 2	Category 1
The vineyard was monitored at least every other month for weeds ***And*** The vineyard was monitored once post-harvest, if logistics allow ***And*** A written or electronic record of results was kept for the season ***And*** This information was analyzed and used for management decisions.	The vineyard was monitored quarterly for weeds ***And*** A written or electronic record of results was kept for the season ***And*** This information was analyzed and used for management decisions.	The vineyard was monitored periodically* (e.g., at least twice a year) for weeds.	The vineyard was never or rarely monitored for weeds.

For optimal control of weed seedlings, management tactics should be applied as soon as possible. Moreover, if using post-emergent herbicides, less active ingredient may be required to kill very young weeds.
*Vineyards should be monitored for weeds at least twice a year, once in late winter and again in late spring or summer. Depending on the vineyard, it is usually most efficient to monitor for weeds when monitoring for pests and diseases.
For an excel-based weed scouting template for recording weed monitoring results, and handout to help assess and identify weeds, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **Weed Scouting Template.**

Box 6-T Under-the-Vine Weed Management Strategies

Under-the-vine weed management is practiced to reduce the competition with vines for water and nutrients. Furthermore, under-the-vine management is important for preventing weeds from reaching the vine canopy, where they can increase the humidity and subsequent risk of bunch rots, disrupt irrigation patterns from emitters, and interfere with harvest. Use of pre-emergent herbicides for under-the-vine weed management is a common and cost-effective strategy. However, environmental risks associated with the use of pre-emergent herbicides include the contamination of ground and surface water, damage to vine roots, and deleterious effects on soil microorganisms. The costs and benefits (economic, ecological, and social) of various under-the-vine weed management strategies should be carefully considered and appropriately balanced. Strategies for under-the-vine weed management can be broadly classified as listed below.

- Cover cropping to compete with weeds
- Tillage or mowing
- Mulching with organic or synthetic materials
- Flaming or steaming

- Application of postemergence (foliar-applied) herbicides
- Application of preemergence (soil-applied) herbicides

6-18 Weed Knowledge

Vineyard

Category 4	Category 3	Category 2	Category 1
The person(s) making pest management decisions knew the names of the weeds in the vineyard and which were noxious, invasive and/or herbicide-resistant and/or potential disease, virus or insect host ***And*** Knew the life cycles of common vineyard weeds and which growth stages were best for effective control ***And*** Used an identification book such as the Weeds of California and Other Western States (DiTomaso and Healy 2007) ***And/Or*** Used the UC IPM Program weed photo gallery or Weed ID tool.*	The person(s) making pest management decisions knew the names of the weeds in the vineyard and which were noxious, and/or invasive and/or herbicide-resistant and/or potential disease, virus or insect host ***And*** Used an identification book such as the Weeds of California and Other Western States (DiTomaso and Healy 2007) ***And/Or*** Used the UC IPM Program weed photo gallery or the Weed ID tool.*	The person(s) making pest management decisions could identify the weeds in the vineyard which were targeted for control.	The person(s) making pest management decisions did not know the names of the weeds in the vineyard.

*See UC IPM Program Pest Management Guidelines at http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html or the UC Weed ID tool at https://wric.ucdavis.edu/information/weedid.htm

6-19 Weed Management

Vineyard

Category 4	Category 3	Category 2	Category 1
A written integrated weed management plan* has been implemented and addressed: 1) monitoring procedures and targeted species and growth stages, 2) control costs and efficacy, 3) control timing, 4) soil type implications, 5) resistance management (rotating control tactics), 6) reducing passes, 7) minimizing environmental risks (e.g., water contamination, PM_{10}, soil erosion), and 8) worker safety.	A written integrated weed management plan* has been implemented and addressed at least 5 elements in category 4, including minimizing environmental risks.	Cost, efficacy, and timing were considered when selecting control tactics.	Cost was the primary consideration when selecting control tactics.

See http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html for updated weed susceptibility charts.
*The integrated weed management plan can be a stand-alone document or included as part of a comprehensive IPM plan. For a template for a comprehensive IPM plan, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **IPM Plan Template**.

6-20 Herbicide Leaching Potential			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
The person(s) making pest management decisions knew if the vineyard was in a ground water protection area* and the restrictions for herbicide use in these areas ***And*** Applications were not made when herbicides may migrate from the application area (e.g., runoff from rain, spray drift from wind) ***And*** Herbicides with high leaching potential**, such as simazine (e.g., Princep, Caliber), diuron (e.g., Karmex, Direx), or norflurazon (Solicam), were not used in the vineyard.	The person(s) making pest management decisions knew if the vineyard was in a ground water protection area* and the restrictions for herbicide use in these areas ***And*** Applications were not made when herbicides may migrate from the application area (e.g., runoff from rain, spray drift from wind).	The person(s) making pest management decisions was aware of ground water protection areas*, where applicable, and associated restrictions for herbicide use ***And*** Pest management decisions were made with awareness of herbicide leaching potential.	The person(s) making pest management decisions was aware of ground water protection areas*, where applicable, and associated restrictions for herbicide use. *(Select N/A if no herbicides were applied during the assessment year; although still ideal to be alert to ground water protection areas and associated restrictions)*

*A ground water protection area is defined by the California Department of Pesticide Regulation (DPR). A ground water protection area is a one-square mile section of land that is sensitive to the movement of pesticides and has specific restrictions on pesticide use. Visit DPR’s website to find the locations of ground water protection areas: http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpa_locations.htm or contact your County Agricultural Commissioner.
**Because herbicides, such as simazine, diuron and norflurazon, have been found in California’s ground water, herbicide leaching is an important water quality concern. Moreover, because of their high solubility in water, these herbicides can contaminate surface waters through drainage systems or natural water movement patterns.

BOX 6-U USING POSTEMERGENCE HERBICIDES MORE EFFICIENTLY

- **Spray annuals early.** Spray annual weeds after a substantial amount have germinated and most are between the cotyledon and second true leaf growth stages.
- **Spray when the weeds are happy.** Tender, lush leaves absorb herbicide better than dry, stressed leaves and cuticle may thicken. Spray after irrigating/fertilizing.
- We should take this out because it often rains right after its cloudy and since we are taking about postemergence herbicides rain is not good. **Know the activity of your herbicides** Applications of some systemic foliar-applied herbicides (e.g., Roundup,) are most effective when weeds are moving sugars to roots. Perennials move sugars to roots after vegetative growth slows and flowering begins or in the fall when preparing for winter. Others (e.g., Poast) move with the sugars but also in the plants water system and may be effective at earlier stages.
- **Use clean water for the spray mixture.** Contaminants in water (e.g., clay particles) can disrupt the integrity of the spray mixture by binding with the herbicide and decrease efficacy. Water conditioners, often containing ammonium sulfate, can help mitigate high mineral content of the water carrier and make herbicide applications more effective.
- **Use adjuvants according to label.** Adjuvants (surfactants) can help reduce water tension, spreading herbicide on leaves. Some help plants enter leaves. Not all surfactants are the same- follow label directions.
- **Apply herbicides in appropriate volumes of water.** Use low volumes of water for systemic foliar-applied herbicides (e.g., Roundup, Touchdown, Poast) when applying to broadleaf weeds, large grasses and higher volumes for non-systemic foliar-applied herbicides (e.g., Goal) or when applying systemic herbicides to small broadleaf or grass weeds.

* All herbicides can move in fog.

6-21 Area Treated with Herbicides

Vineyard

Category 4	Category 3	Category 2	Category 1
Instead of treating the entire berm or vine row, weeds were spot-treated with foliar-applied herbicides (when possible) using a handgun, Herbi, wicking wand, Patchen Weedseeker, or other equipment ***And*** A narrow treated berm (e.g., less than 50") was maintained ***And*** Some weeds were tolerated.	The entire berm or vine row was treated with herbicides ***And*** A narrow treated berm (e.g., less than 50") was maintained ***And*** Some weeds were tolerated.	The entire berm or vine row was treated with herbicides ***And*** Some weeds were tolerated.	The entire berm or vine row was treated with herbicides ***And*** Very few weeds were tolerated. *(Select N/A if no herbicides were applied during the assessment year)*

Box 6-V Tips on Chemical Weed Control

Summer weeds usually first germinate in late February and often are treated with foliar-applied herbicides. Herbicide use is encouraged early in the season (before budbreak if possible) because the chance of contact with green vine tissues (e.g., leaves, stems) increases after canes begin to drop, often during May Foliar-applied herbicides must be used with extra care at and after this time.. Drift-reducing nozzles should also be used. The systemic foliar-applied herbicides Roundup and Touchdown, in particular, cause significant damage if contacting green vine tissues. Consequently, it is best not to spray Roundup or Touchdown after canes drop, although the careful rope-wicking of these products by hand may be acceptable. Other foliar-applied herbicides may be relatively safer for use on grapes after canes drop (See updated weed susceptibility charts for recommended options at http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html).

Late summer weeds. Changing viticultural practices such as delayed harvest and the use of short-residual preemergence herbicides, or postemergence only weed control have resulted in the development of a late season summer weeds problem. These weeds often develop in the period between verasion and harvest when drip irrigation is at its peak and postemergence herbicide applications are discouraged. These weeds will become a major problem if left until winter weed control begins after vine dormancy. If these weeds have become a problem in your vineyard consider delaying preemergence herbicide applications until closer to bud break (but with sufficient precipitation for incorporation still expected), using herbicides that are register for use in drip irrigation late in season (check pre-harvest interval), or if possible consider other weed control methods such as cultivation. If none of those options are available post-harvest weed control should be done- see precautions below in Winter weeds.

Winter weeds usually begin to germinate after the first fall rains, before vines go dormant. After harvest but before dormancy, vines are extremely susceptible to damage from Roundup or Touchdown. Small amounts of spray mist from these products on not yet dormant leaves cause substantial visible symptoms during the following spring at bud break. The careful rope-wicking of Roundup or Touchdown by hand may be acceptable, but other uses are not recommended unless extreme care is taken. Contact type herbicides can be used at this time. Drift may damage leaves and canes, but will not be translocated into the vine. Any damage will be pruned during winter. For recommended options for use on grapes in the fall, see updated weed susceptibility charts at http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html.

Perennial weeds require special efforts for control. For eradicating established bermudagrass, johnsongrass, or field bindweed, do not use foliar-applied herbicides or cultivation when these problematic weeds first emerge in the early spring. Instead, high rates of Roundup or Touchdown (do not allow drift) should be applied after these weeds have grown vigorously and grape shoots begin to bend downwards. Follow-up spot treatments or rope-wick applications by hand of these products likely will be necessary. Because the selective (grasses only) foliar-applied herbicide Poast does not harm vines, it can be used to control perennial grasses in summer and fall (Always refer to label – especially the pre-harvest interval).

Special Considerations for Using Herbicides in Newly Planted Grapes

Many herbicides that can be safely used on mature more than 3 year old) grapevines can severely damage young vines. Read all label instructions including the use of protective covers for vines, and soil settling after planting. Many postemergence herbicide require that the vines possess a 'mature brown bark' for safe applications, regardless of the age of the vine for use without protective cover.

For detailed and updated information, consult an appropriate UC Farm Advisor. The Sustainable Winegrowing Program is not responsible for the accuracy of information presented here.

Sources: Kempen, 1993; Elmore et al., 1996; Gubler et al., 2002; Kurt Hembree, UC Farm Advisor, Fresno County, and John Roncoroni, Napa County UC Cooperative Extension.

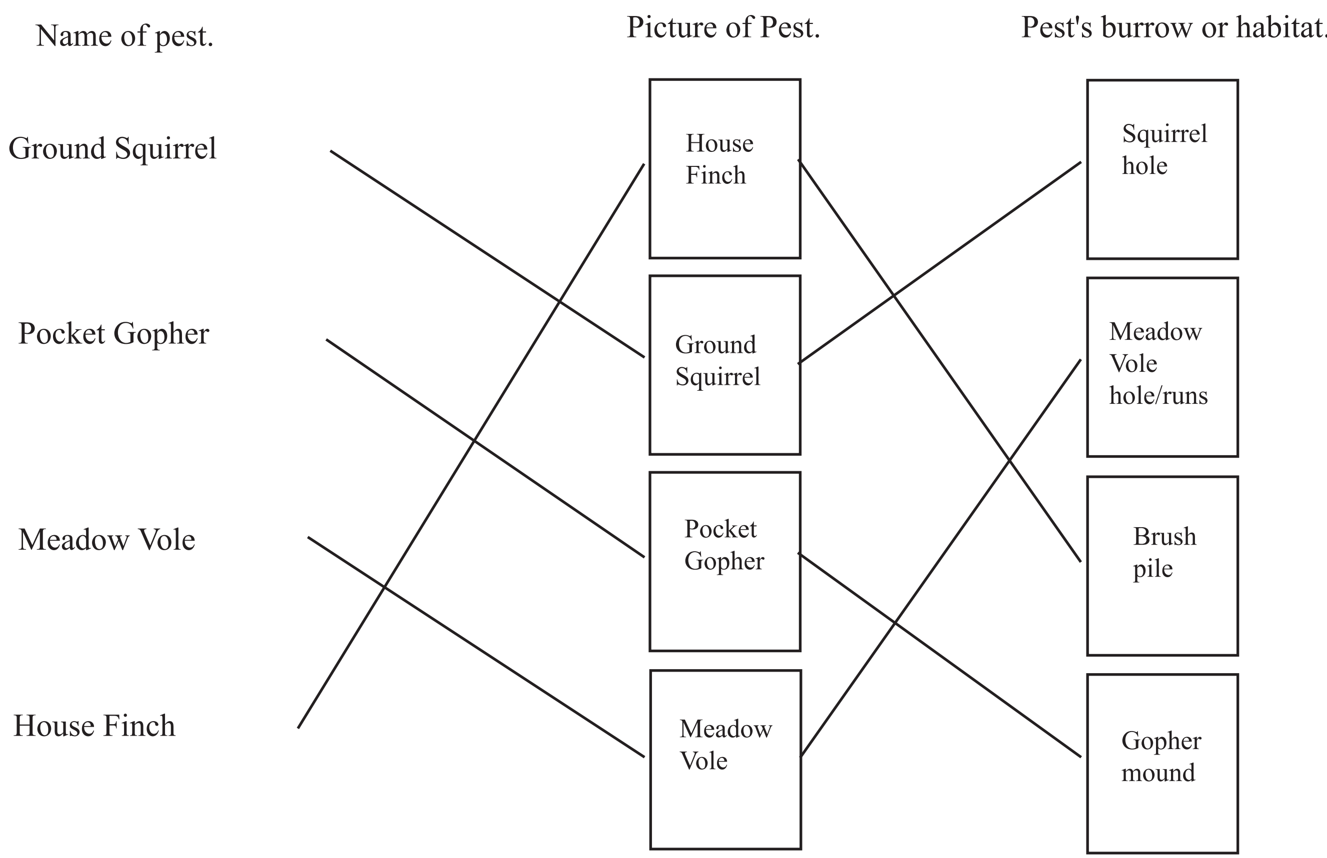
Draw lines between the name of the pest, the picture of the pest, and picture of the pest's burrow or habitat

Ground Squirrel

Pocket Gopher

Meadow Vole

House Finch


Name of pest.
Picture of Pest.
Pest's burrow or habitat.
Ground Squirrel
Pocket Gopher
Meadow Vole
House Finch
House Finch
Ground Squirrel
Pocket Gopher
Meadow Vole
Squirrel hole
Meadow Vole hole/runs
Brush pile
Gopher mound

6-22 Vineyard Monitoring for Vertebrate Pests *Vineyard*

Category 4	Category 3	Category 2	Category 1
The vineyard was monitored at least every 14 days * for vertebrate pests (as appropriate based on species/lifecycles present) ***And*** A written or electronic record of results was kept for the season ***And*** This information was analyzed and used for management decisions. ***And*** Employees** were trained to identify vertebrate pest activity and damage.	The vineyard was monitored monthly for vertebrate pests (as appropriate based on species/lifecycles present) ***And*** A written or electronic record of results was kept for the season ***And*** This information was analyzed and used for management decisions ***And*** Employees** were trained to identify vertebrate pest activity and damage.	The vineyard was monitored at least quarterly for vertebrate pests (as appropriate based on species/lifecycles present).	The vineyard was never or rarely monitored for vertebrate pests.

*Some growers on the North Coast monitor vineyards weekly for vertebrate pests, especially gophers.
**In this context, vineyard employees include employees of the vineyard ownership, owners, employees of vineyard management companies and farm labor contractors, and pest control advisers (PCAs).
For an excel-based IPM scouting template for recording vertebrate pest monitoring results, and a handout on identifying and treating hot spots and using economic thresholds, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **Economic Thresholds and IPM Scouting Template**.

6-23 Vertebrate Pest Management

Vineyard

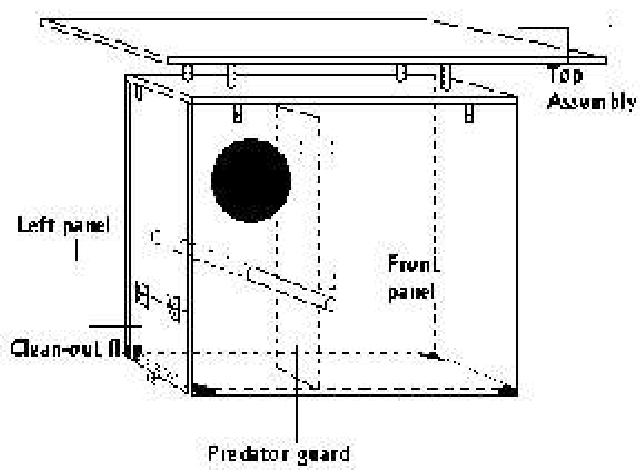
Category 4	Category 3	Category 2	Category 1
No toxic baits or fumigants were used to control vertebrate pests ***And*** Problems were managed by habitat modification (e.g., brush minimization for finches, under-the-vine sanitation for voles, antagonistic cover crops); exclusion (e.g., sound repellants or netting for birds, grow tubes or chicken wire for rabbits); or trapping that protects non-target animals (e.g., cinch or Macabee traps in tunnels for gophers) ***And*** Any exclusion fencing was directed only at the target pest (e.g., deer, pig, bear) and allows smaller animals to pass.	Habitat modification and/or exclusion techniques were generally used to manage vertebrate pests ***But*** During outbreaks, anticoagulant baits were used timely (e.g., late spring or fall for ground squirrels) and safely (no ingestion by non-target animals) ***Or*** Strychnine bait for gophers was placed in artificially made burrows to prevent ingestion by non-target animals ***And*** Explosive devices may have been used.	Anticoagulant and/or strychnine baits were regularly used to control vertebrate pests but extra precautions were taken to ensure non-target animals cannot ingest them ***And/Or*** Fumigants or explosive devices may have been used.	Toxic baits and fumigants were used to control vertebrate pests according to legal guidelines. *(Select N/A if no problems with vertebrates)*

6-24 Predation by Vertebrates *Vineyard*

Category 4	Category 3	Category 2	Category 1
One or more maintained owl boxes* existed for every 40 or less vineyard acres ***And*** Kestrel boxes and natural or installed raptor perches were provided ***And*** Bat and/or blue bird boxes were installed for insect control.	One maintained owl box* existed for every 41-99 vineyard acres ***And*** Natural or installed raptor perches were provided.	One maintained owl box* existed for every 100 or more vineyard acres.	No nest boxes for birds of prey were provided.

*Owl box occupancy rates may be lower where numerous nearby trees or other nesting structures exist. If owl boxes are positioned in trees, occupancy rates may be higher when placed in the upper third of the tree.
See **Boxes 6-W, 6-X** and **6-Y** for more information on owl boxes.

Owl Box



Drawing and photo courtesy of Tom Hoffman, formely with Bio-Diversity Products, Lodi, CA.

BOX 6-W USING BARN OWLS FOR RODENT MANAGEMENT IN VINEYARDS

Barn owls can consume numerous mice, rats, and gophers. Each night, an adult owl may eat one gopher, and a clutch of seven-week-old young may eat two to five gophers. In total, parents and chicks may consume as many as 1,000 rodents before the young leave the nest.

Nest boxes accommodate barn owls well, especially if the box design includes protection from the sun. Listed below are some recommendations for designing and using owl boxes based on the experience of practitioners in the Lodi area.

- Boxes should be positioned in areas of low human activity, if possible.
- Boxes ideally should be mounted on poles, not trees, to protect owl chicks from predators.
- Boxes should be built at least 24” x 12” x 24” high and painted white.
- Plywood sunshields should be installed on the back and top of the box.
- Boxes should include one or two long perches so young owls can exercise their wings – perches should not be included if boxes are within 70 feet of a large tree or if predation of barn owls by great horned owls is a concern.
- The entrance hole to the box should be no more than six inches in diameter.
- The box design should include a clean-out door, allowing for annual cleaning (prior to December).
- The box should be mounted approximately 12 feet above the ground on a 16-foot redwood 4 x 4 post.
- The box doorway should be located (where possible) away from prevailing winds.
- Wood shavings at a depth of ¼ inch should be used in the box to keep eggs from rolling during incubation.
- Resident owls should not be disturbed while females are incubating, i.e., from early February to late March.
- Soiled entrance ways indicate that owls probably are using boxes.

Source: Tom Hoffman, formerly with Bio-Diversity Products, Lodi, CA.

BOX 6-X PLAN FOR VINEYARD OWL BOX

Parts list:

1. One sheet of ½-inch CDX (5-ply) plywood.
2. One 16-foot 4 x 4 post (12 feet to extend above ground).
3. One 1-inch dowel 4 feet long.
4. Four 1-inch L-brackets with screws.
5. Two ½ x 4-½-inch hex-head bolts with nuts and washers.
6. Four ¼ x 3-½-inch carriage bolts with nuts and washers.
7. Two 2-inch hinges with screws.
8. Two 13-inch 2 x 2’s for spacers.
9. One 1-inch hook and eye for clean-out doors.

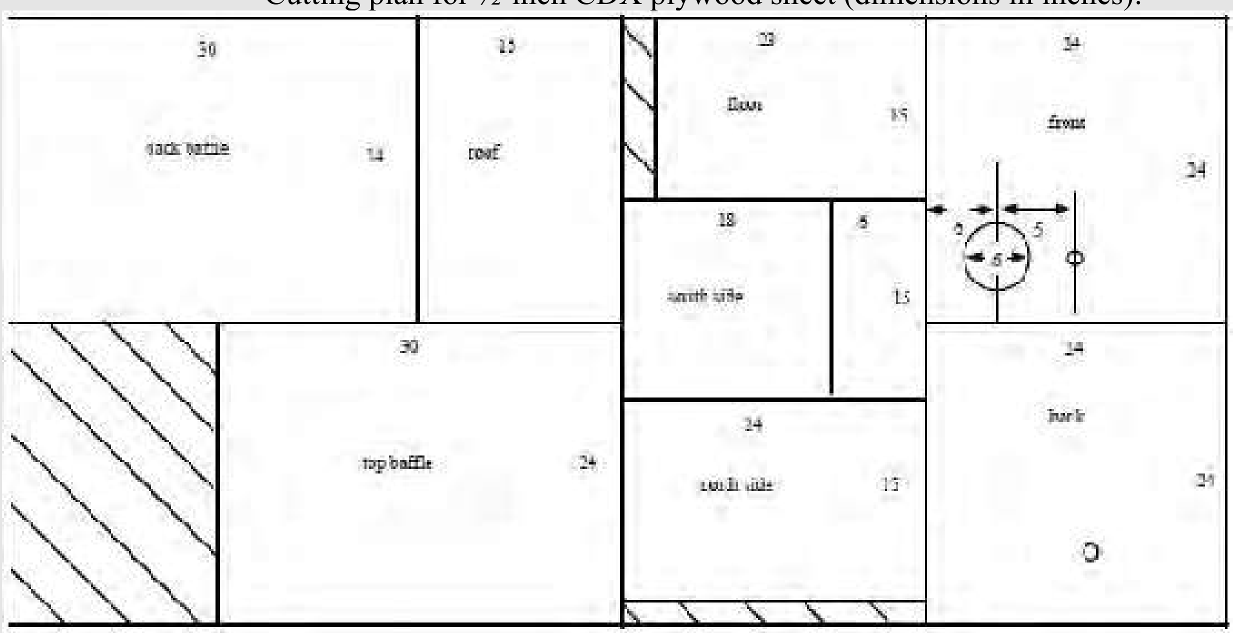
Cleaning Out Owl Boxes

Rubber gloves and a dust mask should be worn while cleaning owl boxes to reduce the risk of exposure to pathogens in owl pellets or droppings. There are no documented cases of people getting sick from cleaning owl boxes, but it is wise to take precautions.

BOX 6-Y OWL BOX ASSEMBLY DIRECTIONS

1. Cut front, back, and sides from plywood. Cut entrance hole, then drill 1-inch hole for dowel with front and back clamped together. Using nails or screws and glue, assemble as shown in the diagram. Attach the hinged clean-out door last.
2. Cut roof and top baffle. Using 13-inch-long 2 x 2's, center baffle on roof panel and fasten baffle and roof to the 2 x 2's with ¼" carriage bolts. On the underside of the roof panel, position two L-brackets so that they will fit over the box during final assembly.
3. Cut the back baffle. After painting the box and panels white, drill and bolt the box, post, and back baffle together using ½" bolts. The tops of the post and box should be flush, while the back baffle should extend by 2 inches to align with the top baffle.
4. Attach the roof assembly to the box with screws through the L-brackets. Insert the dowel through the holes and glue into place.
5. Erect the post with the box facing away from prevailing winds and storms. Mount additional perches (dowels or tree limbs) on the post.

Cutting plan for ½-inch CDX plywood sheet (dimensions in inches):



Source: Tom Hoffman, formerly with Bio-Diversity Products, Lodi, CA.

6-25 Low-Volume Vine Canopy Sprayers *Vineyard*

Category 4	Category 3	Category 2	Category 1
Low-volume (e.g., 20 gal or less per acre) electrostatic* or low-volume conventional sprayers were predominantly used, if appropriate.	Conventional dilute sprayers with air induction nozzles were predominantly used.	Conventional dilute sprayers were predominantly used and produce large droplets but without air induction nozzles.	Conventional dilute sprayers were predominantly used without knowing the size of droplets produced. *(Select N/A if no canopy pesticide sprays were made during the assessment year)*

*Before using electrostatic sprayers, verify that nozzles are charging.
For a decision support tool to help compare the cost of air blast dilute sprayers (fan assisted) and electrostatic sprayers, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **Sprayer Decision Tool**.

6-26 Sprayer Calibration and Maintenance *Vineyard*

Category 4	Category 3	Category 2	Category 1
The sprayer was calibrated and coverage was checked (e.g., with water sensitive paper, dye, kaolin, or visual verification) throughout the season as spray volume was adjusted (based on canopy size and density) and row spacing changes ***And*** Recalibration was done if there was a change in tractor or tractor tires or a dramatic change in soil conditions or slope ***And*** Nozzle discharge* rates were monitored and nozzles were replaced as soon as rates change from specification (i.e., when worn) ***And*** Sprayer components were checked yearly as part of scheduled maintenance.	The sprayer was calibrated and coverage was checked (e.g., with water sensitive paper, dye, kaolin, or visual verification) every year ***And*** Recalibration was done if there was a change in tractor or tractor tires or a dramatic change in soil conditions ***And*** Worn nozzles were replaced every year ***And*** Sprayer components were checked yearly as part of scheduled maintenance.	The sprayer was calibrated every year ***And*** Nozzle wear, nozzle variation, and spray coverage were checked at least every other year.	Nozzle wear, nozzle variation, and spray coverage were checked infrequently.

*Before using electrostatic sprayers, verify that nozzles are charging.

If spraying is done by a custom applicator following sprayer calibration and maintenance practices in Categories 1 or 2, discuss with them the importance and means for improving calibration methods.

6-27 Spray Coverage

Vineyard

Category 4	Category 3	Category 2	Category 1
Tractor speeds and nozzles position were adjusted as canopy size and density changed during the season to ensure good coverage and no drift* ***And*** Tractor speed and sprayer pressure were attained prior to entering the row and maintained until exiting the row ***And*** Spray coverage was verified (e.g., with water sensitive paper, dye, kaolin, or visual verification) ***And*** Employees were trained in the safe and effective operation of equipment and evaluation techniques to ensure spray coverage.	Tractor speed and nozzle position were adjusted as canopy size and density changed during the season to ensure good coverage and no drift* ***And*** Tractor speed and sprayer pressure were attained prior to entering the row and maintained until exiting the row.	Nozzles were positioned and adjusted as canopy size and density changed during the season.	The sprayer(s) was driven as fast as ground conditions allow ***And/Or*** Nozzles were not positioned and adjusted as canopy size and density changed during the season.

Water sensitive cards, available from your chemical supplier, are an invaluable tool for evaluating spray coverage and should be placed throughout the canopy.
*The speed and volume of air leaving the sprayer is also important to monitor. Too much speed and volume results in shingling (leaves plastered onto each other and onto grape clusters) and spray material exiting the canopy. For more information see: https://www.lodigrowers.com/spray-rig-air-pressure-calibration-possible-ways-to-improve-our-practices/

Box 6-Z Sprayer Calibration Guidelines

Similar methods are used to calibrate most sprayers, since all have nozzles that spray known volumes based on nozzle size and tank pressure. There usually is a list of known factors and a list of unknown factors that must be considered when calibrating.

Known Factors

1. Gallons of water per acre to be used
2. Pounds per square inch (psi) of sprayer tank pressure
3. Spray rig ground speed in miles per hour (mph)
4. Number of nozzles on the sprayer
5. Vine row spacing (i.e., distance between vine rows)

Unknown Factors (to be determined)

1. Simple way to gauge sprayer ground speed
2. Gallons per minute (gpm) output of spray boom
3. Nozzle sizes and placement on the spray boom

Measuring Ground Speed

Sprayer travel speed must be measured under field and tractor operating conditions. Values measured from engine tachometers can have significant errors because of tire size and inflation differences and wheel slipping. Before doing calculations to determine nozzle selection and placement, the sprayer's actual ground speed at given throttle settings should be determined.

Method # 1 (if vine spacing is not reliable) Mark a known distance in the vineyard, e.g., 100 or 200 feet. Fill the sprayer at least half full and set the engine rpm and gear selection on the settings to be used during the spray. With a stopwatch, measure the time required to cover the known distance. Make at least two passes and average the times. $\frac{\textbf{100 feet}}{\textbf{seconds}} \times \frac{\textbf{1 mile}}{\textbf{5,280 ft}} \times \frac{\textbf{3,600 seconds}}{\textbf{1 hour}} = \textbf{mph}$	**Method #1 Example:** Two passes (25 and 26 seconds) average 25.5 seconds. $\frac{\textbf{100 feet}}{\textbf{25.5}} \times \frac{\textbf{1 mile}}{\textbf{5,280 ft}} \times \frac{\textbf{3,600 seconds}}{\textbf{1 hour}} = \textbf{2.67 mph}$
Method # 2 (if vine spacing is reliable) Count vines while driving. $\textbf{vines/min} = \frac{\textbf{tractor mph x 88 ft/min}}{\textbf{vine spacing in feet}}$	**Method #2 Example:** To travel 3 mph in a vineyard with 8-ft vine spacing, the number of vines passed per minute would be: $\frac{\textbf{3 mph x 88 ft/min}}{\textbf{8-ft vine spacing}} = \textbf{33 vines/min}$

Source: Flaherty et al., 1992.

BOX 6-AA DETERMINING GALLONS PER MINUTE (GPM) FOR THE SPRAYER

To calculate the sprayer output in gallons per minute (gpm) based on a known ground speed and gallons of spray per acre, use the following formula.

$$\textbf{gpm} = \frac{\textbf{gpa} \times \textbf{mph} \times \textbf{vine row spacing}}{\textbf{495 (conversion factor)}}$$

Example:
An air-blast sprayer that sprays two half-rows in a single pass will be used in a vineyard with 12-ft row spacing.

Knowns

- 100 gallons of spray per acre
- 3 mph ground speed
- 12-ft vine row spacing

$$\frac{\textbf{100 gpa spray} \times \textbf{3 mph} \times \textbf{12 ft row spacing}}{\textbf{495}} = \frac{\textbf{3600}}{\textbf{495}} = \textbf{7.27 gpm}$$

Note: If row spacing is 12 ft and a single-row sprayer is used, 12 ft is entered for vine row spacing; however, if row spacing is 12 ft and a two-row sprayer is used, 24 ft is entered for vine row spacing.

Source: Flaherty et al., 1992.

BOX 6-BB DETERMINING NOZZLE SIZE AND DISTRIBUTION ON THE SPRAY MANIFOLD OR BOOM

The density of the vine canopy can vary from top to bottom, depending on the trellis system. For example, vertical trellises generally have uniform canopies, but canopies on single-wire T trellises are thicker at the shoulders. If the canopy density varies, more spray should be directed to thicker parts. Nozzle manufacturers provide charts that list nozzle sizes and outputs under different spray pressures. Based on these nozzle charts and the correct pressure for the spray rig, determinations can be made for the appropriate nozzle sizes and distribution on the manifold or boom to achieve the desired spray distribution and volume output (calculated using methods in **Boxes 6-Z** and **6-AA**).

6-28 Spray Buffer Zone

Vineyard

Category 4	Category 3	Category 2	Category 1
Reasonable buffer zones* were established near any sensitive areas** ***And*** Applications were not made when winds were blowing toward any sensitive areas ***And*** The timing and within-field sequences for applications were adjusted to ensure minimal human activity and disturbance in sensitive areas.	Reasonable buffer zones* were established near any sensitive areas** ***And*** Applications were not made when winds were blowing toward any sensitive areas.	Reasonable buffer zones* were established near any sensitive areas** ***Or*** Applications were avoided when winds were blowing toward any sensitive areas.	Little consideration was given to establishing buffer zones* near sensitive areas**, other than as required by the pesticide label.

*Distances or widths for "reasonable" buffer zones depend on weather conditions, application method, toxicity of the pesticide and its susceptibility to drift, presence of barriers between vineyard rows and sensitive areas, and specific characteristics of each sensitive area. Applications must be managed to prevent drift onto sensitive areas.

**Sensitive areas are locations surrounding vineyards where people, organisms, or structures could be exposed to pesticides. These can include residences, busy roadways, schools, bus stops, and other areas of human activity, as well as waterways and nearby crops.

6-29 Spray Drift*

Vineyard

Category 4	Category 3	Category 2	Category 1
A written spray drift management plan** has been developed, and pesticide applications were avoided when conditions would lead to drift (e.g., winds exceed 7 mph, inversion conditions) ***And*** Lowest effective rates were used and nozzles were selected and maintained to deliver the largest recommended droplets of uniform size ***And*** Sprayers and dusters were shutoff at row ends near sensitive areas ***And*** Additional low-drift spray technology was used (e.g., low-drift sprayers, drift reduction agents, drift-reducing nozzles).	Pesticide applications were avoided when conditions would lead to drift (e.g., winds exceed 7 mph, inversion conditions) ***And*** Lowest effective rates were used and nozzles were selected and maintained to deliver the largest recommended droplets of uniform size ***And*** Sprayers and dusters were shutoff at row ends near sensitive areas.	Pesticide applications were avoided when conditions would lead to drift (e.g., winds exceed 7 mph, inversion conditions) ***And*** Low effective rates were used and nozzles were selected and maintained to deliver the largest recommended droplets of uniform size.	Pesticides were not applied when winds exceeded or were below legal limits, which were determined by checking each label for federal and state limits and with staff at the County Agricultural Commissioner's office for additional restrictions.

*For preventing sulfur drift to sensitive areas, see **Box 6-DD** and also related publications and videos at http://www.curesworks.org/best-management-practices/

The spray drift management plan can be a stand-alone document or included as part of a comprehensive IPM plan. It is helpful to include third-party sprayer training in the spray drift management plan. For a template for a comprehensive IPM plan, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **IPM Plan Template.

"Dead calm" air often is associated with a temperature inversion. Pesticides applied during this atmospheric condition can drift slowly off-site onto sensitive areas. The chance that a temperature inversion exists is minimized by making applications during a minimum of 2 mph winds.

BOX 6-CC ESTIMATING WIND VELOCITY

The most accurate way to measure wind velocity is with an anemometer. Costs for anemometers range from inexpensive (e.g., $15) to expensive, depending on degree of accuracy. Less accurate estimates can be obtained by tossing a handful of dust in the air. If the dust cloud moves laterally at about the same rate as a slow walk and ordinary wind vanes do not move, the wind is approximately 2 mph. If the dust cloud moves laterally at about the same rate as a fast walk, the wind is approximately 4 mph. When the wind can be felt on the face and leaves rustle and wind vanes move, the wind velocity is 5 mph or greater.

BOX 6-DD SULFUR APPLICATION CHECK-LIST

- Check wind speed and direction
- Create a buffer zone between applications and sensitive areas
- Look for people moving around buildings near application site
- Shutoff equipment when making row turns
- Never apply in winds above 10 mph (and below 2 mph where inversion layers are known to exist)

Low-drift spray technology can help reduce drift by pesticides.

6-30 Pesticide Storage (excludes herbicides)*,** *Vineyard*

Category 4	Category 3	Category 2	Category 1
No pesticides were stored during the winter since an inventory control process was used to balance amounts ordered and seasonal need ***And*** Pesticides were rarely stored at other times since only necessary amounts were ordered before each application ***And*** When stored, best practices for pesticide storage were used – dry products were stored above liquid products, the distance between the storage site and the nearest pond, stream or well prevents contamination. Storage is located in a place where flooding is not a concern and the storage area had an impermeable floor and a sump to contain leaks, and only undamaged original containers were stored.	A minimal amount of pesticides were stored during the winter since an inventory control process was used to balance amounts ordered and seasonal need and, if appropriate, unopened containers were returned to the supplier ***And*** Best practices for pesticide storage were used – dry products were stored above liquid products, the distance between the storage site and the nearest pond, stream or well prevents contamination. Storage is located in a place where flooding is not a concern and the storage area had an impermeable floor to contain leaks, and only undamaged original containers were stored.	Some pesticides were stored during the winter ***And*** Best practices for pesticide storage were used – dry products were stored above liquid products, the distance between the storage site and the nearest pond, stream or well prevents contamination. Storage is located in a place where flooding is not a concern and the storage area had an impermeable floor to contain leaks, and only undamaged original containers were stored.	Legal requirements for pesticide storage were followed.

*For detailed information on pesticide safety, see O'Connor-Marer, 2006 and 2007, and Whithaus and Blecker, 2016.

**Buildings used for pesticide storage in Lake County must be inspected. Check with staff at the Agricultural Commissioner's office to determine if a similar requirement exists for your county.

6-31 Pesticide Mixing and Loading*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
All workers were provided with pesticide safety training and required personal protective equipment (PPE) and instructed to stay with the equipment to prevent spills while mixing and loading ***And*** The mixing/loading area was more than 100 feet from any well, which has a berm around the wellhead to prevent contamination ***And*** Either a double-check valve was used when filling spray tanks with water or a six-inch air gap was maintained between the spray tank and water source.	All workers were provided with pesticide safety training and required personal protective equipment (PPE) and instructed to stay with the equipment to prevent spills while mixing and loading ***And*** The mixing/loading area was at least 30 feet from any well, which has a berm around the wellhead to prevent contamination ***And*** Either a double-check valve was used when filling spray tanks with water or a six-inch air gap was maintained between the spray tank and water source.	All workers were provided with pesticide safety training and required personal protective equipment (PPE) ***And*** Either a double-check valve was used when filling spray tanks with water or a six-inch air gap was maintained between the spray tank and water source.	Legal requirements for pesticide safety training and personal protective equipment (PPE) were provided to workers.
*For detailed information on pesticide safety, see O'Connor-Marer, 2006 and 2007, and Whithaus and Blecker, 2016.			

Most accidents involving pesticide poisoning happen when mixing and loading. Are your mixing and loading procedures safe?

BOX 6-EE ADD PESTICIDES IN THE RIGHT ORDER

Pesticides should be added to tank mixes in the appropriate order, according to formulation. Using the wrong sequence can result in the formation of gunk in the bottom of the tank. Moreover, even when appropriate sequences are used during tank mixing, compatibility agents may be needed to prevent settling-out effects and to obtain the desired distribution of components. Follow instructions on pesticide labels for adding and mixing components but the general order for adding and mixing components is listed below.

- Adjust pH as necessary (the optimum pH for mixing most pesticides is about 6.0)
- Add any necessary compatibility agents
- Add wettable powders (may first require mixing with water in a bucket to form a slurry)
- Add dry flowables or water-dispersible granules
- Add liquids (these are true liquids and will not turn solutions white when added to water)
- Add emulsifiable concentrates (turn solutions white when added to water)
- Add any necessary surfactants or crop oil

Keep in mind that there are always exceptions! When in doubt about the appropriate order, test mix in a small jar (i.e., a jar test).

A jar test is useful for evaluating the integrity of the mix and determining the need for compatibility agents before mixing on a larger scale for field application. Fill a pint jar half full of the carrier (water or fertilizer). Based on proportions to be used in the spray tank, calculate the amount of each ingredient (i.e., water, liquid fertilizer, and pesticides) to add to the jar. For instance, **the addition of a one tablespoon of a dry pesticide formulation to a pint jar proportionally is the same as adding one pound to a 100-gallon spray tank**. Likewise, **a liquid formulation at one teaspoon in a pint jar is the same as one pint per 100 gallons**. Add pesticides separately in the recommended sequence, gently shaking the jar after each addition. After all ingredients have been added, fill the jar with water and give it a final shaking. Let the jar sit for about ten minutes and look for the formation of large flakes, sludge, gels, or precipitates and severe separation or rapid settling out. Evaluations of mixtures with and without compatibility agents can be done simultaneously by using two jars.

Always wear a waterproof apron, gloves, eye protection, and if necessary, respiratory protection when pouring or mixing pesticides. Perform jar tests in a safe area away from food and sources of ignition. When tests are completed, pesticides used for tests should be added to the spray tank. Rinse all utensils and jars and pour the rinsate into the spray tank. Do not use utensils and jars for any other purpose after contacting pesticides.

Source: Ohmart and Matthiasson, 2000.

6-32 Pesticide Emergency Response Plan* *Vineyard*

Category 4	Category 3	Category 2	Category 1
A pesticide emergency response plan was posted or binders are available in vehicles ***And*** Pesticide spill cleanup materials, first-aid equipment, and emergency wash facilities were available ***And*** Workers were trained to follow the plan.	A pesticide emergency response plan was posted or binders are available in vehicles ***And*** Pesticide spill cleanup materials, first-aid equipment, and emergency wash facilities were available.	A pesticide emergency response plan was posted or binders are available in vehicles ***Or*** Pesticide spill cleanup materials and first-aid equipment were available.	Legal requirements were maintained for a pesticide emergency response plan.

*For detailed information on pesticide safety, see O'Connor-Marer, 2000 and 2006.

6-33 Winery Pest Management

Winery

Category 4	Category 3	Category 2	Category 1
A written plan to prevent and manage pests in and around the winery was used ***And*** The plan included regular monitoring and record keeping (at least weekly within and monthly outside) ***And*** Exclusion and sanitation were prioritized (e.g., sealing areas of pest entry, minimizing sites for food/breeding, cleaning floors and limiting standing water, maintaining clean dining and food storage areas, reducing clutter and overgrown vegetation) ***And*** Any necessary remedial control involved the use of the lowest-risk, cost-effective option(s) ***And*** Employees were trained to identify and report pest issues.*	A written plan to prevent and manage pests in and around the winery was used ***And*** The plan included monitoring and record keeping ***And*** Exclusion and sanitation were prioritized (e.g., sealing areas of pest entry, minimizing sites for food/breeding, cleaning floors and limiting standing water, maintaining clean dining and food storage areas, reducing clutter and overgrown vegetation) ***And*** Any necessary remedial control involved the use of the lowest-risk, cost-effective option(s) ***And*** Employees were asked to look for and report possible pest issues.*	A strategy to prevent and manage pests in and around the winery was used ***And*** The strategy prioritized exclusion and sanitation (e.g., sealing areas of pest entry, minimizing sites for food/breeding, cleaning floors and limiting standing water, maintaining clean dining and food storage areas, reducing clutter and overgrown vegetation).	No strategy to prevent and manage pests in and around the winery was used.

*Employees receiving grapes should also be trained on pertinent invasive species potentially associated with grapes during delivery or processing including European grapevine moth, glassy-winged sharpshooter, mealybugs (various), and light brown apple moth. Concerns about, effects of, and regulations for invasive species may differ by region. Regulations involving quarantines, treatment, and/or other practices must be strictly followed.

6-34 Using Lower Risk Crop Protection Materials			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Red List and Yellow List materials were not used.*	Red List materials were not used* ***And*** Yellow List materials were used* ***And*** Lower risk alternatives (materials and cultural practices) were first used or considered as part of an Integrated Pest Management approach, and the justification for the use of Yellow List material(s) was documented, as needed.**	Red or Yellow List materials may have been used* ***And*** Lower risk alternatives (materials and cultural practices) to Red and Yellow List materials were considered for use.	Crop protection materials were primarily selected and used based on cost and efficacy.

*See **Box 6-FF** for more information on the Red List and Yellow List materials.
** See **Box 6-GG** for more information on the documentation requirements for vineyards certified to the Certified California Sustainable Winegrowing program.

BOX 6-FF RED AND YELLOW LIST CROP PROTECTION MATERIALS

The Sustainable Winegrowing Program encourages growers to use an Integrated Pest Management approach that combines biological, cultural, mechanical and chemical tools to minimize economic, environmental and human health risks when controlling pestsand disease. For many growers, including organic growers, crop protection materials (e.g., insecticides, fungicides, herbicides) are an important tool. However, uses of certain crop protection materials can pose relatively higher risks than other materials. For example, many older broad-spectrum pesticides also have long residuals, persisting in the environment much longer than more modern reduced-risk pesticides. (See **Box 6-G** for more information on reducing risks from pesticides.)

While many criteria and practices included in this chapter help ensure that growers manage pests, disease and weeds using a comprehensive IPM approach and only use pesticides when necessary, criterion 6-34 is intended to help winegrowers identify specific active ingredients that are considered higher risk and offer information about lower risk alternatives to drive continuous improvement.

In 2016, CSWA created a Pest Management Technical Advisory Group – comprised of winegrowers, Pest Control Advisors and UC Cooperative Extension advisors – to help provide guidance on the use of crop protection materials that limit risks. The following Red and Yellow Lists were developed by the Technical Advisory Group to help encourage growers to use lower risk materials when viable and available alternatives exist. The group will meet annually to review and recommend adjustments to these lists as needed.

Red List (2020)[4]
CSWA's Red List is comprised of materials which are regulated as restricted materials by the US Environmental Protection Agency and/or the California Department of Pesticide Regulation and which winegrowers are typically not using, and materials which are disallowed by wineries that produce the vast majority of California wine for reasons related to wine quality and export restrictions. In the event the California Department of Pesticide Regulation or the US Environmental Protection Agency has announced publicly the intent to initiate regulatory action to cancel most or all uses of an active ingredient due to human health risks, then such active ingredient may be included on the Red List based on the recommendation of the Pest Management Technical Advisory Group and subject to approval by the California Sustainable Winegrowing Alliance's Board of Directors.

Vineyards that are Certified California Sustainable Winegrowing may not use Red List materials by their second year of certification.

Red List Material (Active Ingredient)	Type of Pesticide
(S)-CYPERMETHRIN	Insecticide
BENOMYL	Fungicide
BETA-CYFLUTHRIN	Insecticide
BIFENTHRIN	Insecticide
CAPTAN	Fungicide
CARBARYL	Insecticide
CHLOROPICRIN	Insecticide
CHLORPYRIFOS	Insecticide
CRYOLITE/KRYOCIDE	Insecticide
DIAZINON	Insecticide
ENDOSULFAN	Insecticide
FENBUTATIN-OXIDE	Miticide
HYDROGEN CYANAMIDE	Growth Regulator
MAGNESIUM PHOSPHIDE	Insecticide
MANCOZEB	Fungicide
MANEB	Fungicide
METHIOCARB	Insecticide
METHOMYL	Insecticide
METHYL BROMIDE	Insecticide, Fungicide, Vertebrate Control
NALED	Insecticide
NORFLURAZON	Herbicide
OXYDEMETON-METHYL	Insecticide

[4] To find the most up-to-date Red and Yellow List visit: http://www.sustainablewinegrowing.org/certifiedsustainable_redandyellowlist.pdf

POTASSIUM N-METHYLDITHIOCARBAMATE	Nematicide
PROPARGITE	Insecticide
PROPYLENE OXIDE	Insecticide, Fungicide
PROPYZAMIDE	Herbicide
SULFURYL FLUORIDE	Insecticide, Vertebrate Control
TRIADIMEFON	Fungicide
ZINC PHOSPHIDE	Vertebrate Control

Yellow List
CSWA's Yellow List is comprised of materials that are regulated as restricted use by the US Environmental Protection Agency and/or the California Department of Pesticide Regulation. While these federally and California restricted materials may be used legally, and with limited impacts, when specific requirements are followed, winegrowers are nonetheless encouraged to consider other lower risk alternatives: cultural practices, lower risk pesticides, biological controls, etc. Yellow List materials are allowed for use in certified vineyards after alternatives are first used and/or investigated, primarily so winegrowers have options so they can rotate modes of action for resistance management and can control exotic pests that do not have effective alternatives.

Vineyards that are Certified California Sustainable Winegrowing that are using materials on the Yellow List must document: justification for the use of these materials, the alternatives used or investigated first, and risk mitigation measures taken (see **Box 6-GG**).

Yellow List Material (Active Ingredient)	**Type of Pesticide**
2,4-D, DIMETHYLAMINE SALT	Herbicide
ABAMECTIN	Insecticide
ALUMINUM PHOSPHIDE	Insecticide
CYFLUTHRIN	Insecticide
DIPHACINONE	Vertebrate Control
DIURON	Herbicide
FENPROPATHRIN	Insecticide
PARAQUAT DICHLORIDE	Herbicide
SIMAZINE	Herbicide

Reduced Risk Materials: See http://www.epa.gov/pesticide-registration/conventional-reduced-risk-pesticide-program for description of the "reduced risk" program and products that meet designated US EPA criteria.

Box 6-GG Documentation Requirements for Use of Yellow List Materials for Certified California Sustainable Winegrowing

Growers with vineyards certified to the Certified California Sustainable Winegrowing program are required to complete a Use Form for any Yellow List material used in a certified vineyard. (See **Box 6-FF** for the materials on the Yellow List.) The form(s) must be provided to the auditor during the annual audit. Below is an example form. An electronic version of the form is available within the SWP Online System in the certification section.

Use Form for the Application of Yellow List Materials:
Complete the below form for any Yellow List material applied in a certified vineyard. Growers are highly encouraged to use cultural practices and/or alternative materials before applying any Yellow List material.

Attach a copy of your relevant monthly Pesticide Use Report (PUR)

Yellow List Material (Active Ingredient): __________________

Total Acreage where Yellow List Material was applied: ________________

Was the use based on the recommendation of a Pest Control Advisor (PCA)? __________

If so, is your PCA aware of the pesticide requirements for obtaining and retaining certification? __________

What was the target pest or disease (briefly describe the pest problem)?

____

____

What specific alternatives were tried or considered by you or your PCA (e.g., cultural practices, non-restricted use materials, lower risk materials)?

____

____

If lower risk alternatives were available, why was the Yellow List material used?

____

____

Are there features or conditions found on your vineyard or specific measures you take that limit known risks associated with the use of a yellow list material? (e.g., material is known to pose a risk to aquatic species but risk of run off to surface waters is minimal or nonexistent).

____

____

Has the material been used in successive years? If so, why?

____

____

6-35 Virus Management

Vineyard

gory 4	Category 3	Category 2	Category 1
A written virus management plan* was used that included monitoring for symptoms, testing, mapping, vine removal, and prevention of spread to other vineyards ***And*** The vineyard had been tested for the presence of economically important viruses (e.g., leafroll, fanleaf, and red blotch) within the past three years, and virus testing samples were taken following lab sampling protocols ***And*** When vines test positive, they were removed from the vineyard as soon as was economically feasible** ***And*** Plant material was tested for viruses before planting or grafting and confirmed negative ***And*** Communications with neighbors included information about any transmissible viruses, if applicable.***	Virus symptoms (e.g., reduced yield, leaf discoloration, poor ripening) were monitored during the fall in the vineyard and infected areas were mapped, if applicable ***And*** The vineyard had been tested for the presence of economically important viruses (e.g., leafroll, fanleaf, and red blotch) within the past three years, and virus testing samples were taken following lab sampling protocols ***And*** When vines test positive, they were removed from the vineyard as soon as was economically feasible** ***And*** Plant material was tested for viruses before planting or grafting and confirmed negative.	Virus symptoms (e.g., reduced yield, leaf discoloration, poor ripening) were monitored during the fall in the vineyard and infected areas were mapped, if applicable ***And*** The vineyard had been tested for the presence of economically important viruses (e.g., leafroll, fanleaf, and red blotch) within the past three years, and virus testing samples were taken following lab sampling protocols ***And*** The economically important viruses in my region were known (e.g., leafroll, fanleaf, and red blotch).	Virus symptoms (e.g., reduced yield, leaf discoloration, poor ripening) were not monitored in the vineyard, and viruses may or may not have been known to exist in the area.

*The virus management plan can be a stand-alone document or included as part of a comprehensive IPM plan. For a template for a comprehensive IPM plan, visit the CSWA Resource Library at https://library.sustainablewinegrowing.org/ and search for **IPM Plan Template**.
Learn more about grapevine virus management for leafroll virus, red blotch virus, fanleaf virus, vitiviruses/sudden vine collapse, etc. at: https://www.lodigrowers.com/groweducation/viruses/
**If the nematode vector is present, fanleaf infested vines should only be replaced if they are planted on fanleaf resistant rootstock (e.g., 039-16).
***If a virus is found in vines from a nursery, the county should also be notified.

7. WINE QUALITY[1]

Original Chapter Authors: Clifford P. Ohmart and Stephen K. Matthiasson, formerly with Lodi Winegrape Commission; Modified by the Sustainable Winegrowing Joint Committee

"Wine quality" is mentioned frequently throughout this workbook, including within those chapters specifically addressing grape growing. In fact, characteristics of wine are affected by numerous factors, such as variety, clone, rootstock, site, trellis system, and irrigation. However, how is wine quality defined? It is defined by the individual. To a grower, high quality may reflect that the harvested grapes met targeted sugar levels and contained little material other than grapes (MOG). To a winemaker, quality may be based on tons of fruit produced per acre and the flavor, pH, and titratable acidity (TA) of grapes at harvest. To a retailer, quality may relate to the unique representation of the source vineyard's appellation and terroir. To a restaurateur, quality may be proportionate to the capacity of a wine to accompany a wide variety of foods because of its up-front fruit, low alcohol, and good acidity. And, to a consumer, quality may be based on a third-party endorsement or simply that the wine tastes good.

Overall quality is a subjective measure affected by both personal experience and preference. However, some aspects of quality, such as color, flavor, malic acid, and pH, can be measured objectively. In today's extremely competitive wine market, expectations for wine quality constantly increase to satisfy consumer demand. Understanding wine quality and how it is interpreted and measured throughout the wine industry is critical to the success of the modern-day winegrape grower and winemaker.

Indeed, many aspects of wine quality can be directly traced back to the vineyard. Wine is an expression of where and how the winegrapes were grown. Understanding the components that constitute a high-quality wine and how those components are influenced by traits of the vineyard and associated production practices is essential for increasing winegrape value.

An enhanced focus on and comprehension of wine quality also will improve your ability to appreciate wine diversity and recognize and optimize quality by region, helping to better position winegrapes and wines in the global wine market.

The purpose of this chapter is to provide you with 9 criteria to self-assess:

- The quality of the fruit in your vineyard
- Your knowledge of the wine produced from the vineyard
- Your knowledge of the wine industry.

[1]This chapter has been adapted from Lodi-Woodbridge Winegrape Commission's *Lodi Winegrower's Workbook* (Ohmart and Matthiasson, 2000). Many of the criteria in this chapter appeared as questions in the Central Coast Vineyard Team's Positive Points System, the first vineyard self-assessment system in California (CCVT, 1996 and 1998).

List of Wine Quality Criteria

Understanding components of wine quality and how they can be traced back to the vineyard is essential for increasing winegrape quality.

7-1 Field Fruit Maturity*			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Fruit was considered mature when juice Brix, pH and TA reached the level targeted for harvest, and for red grapes canes were more than 80% lignified (woody), and seeds were completely brown ***And*** Shoot growth had stopped or slowed.	Fruit was considered mature when juice Brix reached the level targeted for harvest, and for red grapes canes were 50-80% lignified (woody), and seeds were mostly brown ***And*** Shoot growth had stopped or slowed.	Fruit was considered mature when juice Brix reached the level targeted for harvest, and canes were less than half lignified (hardened-off).	Fruit was considered mature when juice Brix reached the level targeted for harvest.
*This criterion deals primarily with winegrapes produced for table wines. Other wine styles such as blushes and cuvees have other recommended levels for parameters.			

Maturity should mean more than sugar levels – it signifies that berries were ripe and fully developed in all flavor aspects.

7-2 Tasting Grapes with the Winery Representative			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Grapes were frequently tasted by the grower or by a winery representative as they matured for each vineyard block.	Several times before harvest, most vineyard blocks were walked and the grapes were tasted by the grower or with a winery representative.	Grapes were tasted with a winery representative or by the grower prior to harvest.	The winery representative or the grower had not seen the vineyard since the contract was signed or since the season started. *(Select N/A if a winery representative never visited the vineyard)*

7-3 Juice Chemistry			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
Pre-harvest berry analysis was done and recorded in most blocks to confirm adequate maturity ***And*** Feedback from the winery on juice chemistry (such as Brix, TA, pH, malic acid, ammonia, potassium, tartaric acid) was recorded and available for post-harvest juice. *	Pre-harvest berry analysis was done in most blocks to confirm adequate maturity ***And*** Brix, TA, and pH were measured, recorded, and were available for post-harvest juice.	Brix was measured, recorded, and was available.	Records of juice chemistry were not kept ***Or*** The winery representative was solely relied on for analyses and record keeping for juice chemistry and this information was not always shared.
*Additional analyses may be required (e.g., color, phenolic content, arginine, total free amino nitrogen).			

Juice chemistry provides invaluable information. Tracking it from year to year aids in understanding and improving wine quality, and selling grapes.

7-4 Tasting Wine Made from the Grapes			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
There was an annual meeting with each winemaker to taste and compare wine made from these grapes to other wines made with similar grapes from other vineyards in the region.	There was at least one previous meeting with a winemaker to taste wines and learn differences between wine made from these grapes and wines from other vineyards or regions.	There was informal feedback from the winery representative about the quality of the grapes.	There was no feedback from the winery representative about the quality of the grapes.

7-5 Knowledge of Wine Quality

Vineyard

Category 4	Category 3	Category 2	Category 1
Tastings of domestic and international wines were regularly attended or classes on wine appreciation had been taken ***And*** Components of wine quality and how they can be traced back to the vineyard were understood ***And*** Wine regions elsewhere in the state and internationally had been visited and toured.	Tastings of domestic and international wines were attended or classes on wine appreciation had been taken ***And*** Components of wine quality and how they can be traced back to the vineyard were understood.	Domestic or international wines were tasted.	Knowledge of wine quality consisted of only tasting local wines or none at all. *(Select N/A if personal concerns prohibit you from tasting alcoholic beverages; however, you should still understand the components of wine quality and how they can be traced back to the vineyard)*

7-6 Knowledge of Wine Industry Marketing and Trends

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The participant* was fully aware of trends** and prices in local grapes, bulk wine and cased goods wine markets for California ***And*** The participant* was fully aware of trends** and prices in the bulk wine and cased goods wine markets for other parts of the world (e.g., Chile, Australia, Europe).	The participant* was fully aware of trends** and prices in local grapes, bulk wine and cased goods wine markets for California ***And*** The participant* was aware of trends** (but not prices) in the bulk wine and cased goods wine markets for other parts of the world (e.g., Chile, Australia, Europe).	The participant* was aware of trends** (but not prices) in the bulk wine and cased goods wine markets for California and some other parts of the world.	The participant* was not aware of trends** or prices in the bulk wine or cased goods wine markets.

*The term "participant" can include the appropriate person within the operation responsible for knowing trends (and prices).

**Trends for the bulk wine and cased goods wine markets include relevant acreage and harvest information, consumer consumption, current regulatory issues, and other market forces.

7-7 Viticultural Improvement *Vineyard*

Category 4	Category 3	Category 2	Category 1
Within the last year, a trial had been done with specific viticultural practice(s) to see if there was any effect on wine quality or economic viability ***And*** This wine or vineyard practices were compared to a "control" of the same vineyard and vintage.	Within the last 3 years, a trial had been done with specific viticultural practice(s) to see if there was any effect on wine quality or economic viability ***Or*** Another vineyard trial in the area was reviewed.	External suggestions about general viticultural practices were considered and a process was in place for assessing and, where appropriate, implementing suggestions.	External suggestions about general viticultural practices were considered.

Juice chemistry provides invaluable information. Tracking it from year to year aids in understanding and improving wine quality, and selling grapes.

7-8 Planning, Monitoring, Goals, and Results for Food Safety *Winery*

Category 4	Category 3	Category 2	Category 1
A written food safety plan* and strategy was developed and implemented that focused on preventive measures to minimize food safety risks for winegrapes and/or wine ***And*** A monitoring and review process was in place for over one year to ensure that the strategy implementation was meeting set goals ***And*** Based on results, changes were made to improve strategy implementation.	A written food safety plan* and strategy was developed, and started to be implemented that focused on preventive measures to minimize food safety risks for winegrapes and/or wine ***And*** A monitoring and review process was put in place to ensure that strategy implementation was meeting set goals.	A food safety strategy was being investigated or developed that focused on preventive measures to minimize food safety risks for winegrapes and/or wine.	No plans were in place to investigate and develop a food safety strategy that focused on preventive measures to minimize food safety risks for winegrapes and/or wine.

*U.S. Food and Drug Administration's (FDA) Food Safety Plan Builder is a tool designed to assist owners/operators of food facilities with the development of food safety plans that are specific to their facilities and meet the requirements of the Current Good Manufacturing Practice, Hazard Analysis, and Risk-Based Preventive Controls for Human Food regulation FDA Food Safety Plan Builder. The tool is available at: https://www.fda.gov/food/food-safety-modernization-act-fsma/food-safety-plan-builder

See **Box 7-A** for more information on minimizing food safety risks.

7-9 Planning, Monitoring, Goals, and Results for Security *Winery*

Category 4	Category 3	Category 2	Category 1
A written security or defense plan and strategy was developed and implemented that focused on preventive measures to minimize security risks for winegrapes and/or wine* ***And*** A monitoring and review process was in place for over one year to ensure that plan implementation was meeting set goals ***And*** Based on results, changes were made if needed to improve plan implementation.	A written security or defense plan and strategy was developed, and started to be implemented that focused on preventive measures to minimize security risks for winegrapes and/or wine* ***And*** A monitoring and review process was put in place to ensure that plan implementation was meeting set goals.	A security or defense strategy was being investigated or developed that focused on preventive measures to minimize security risks for winegrapes and/or wine. *	No plans were in place to investigate and develop a security or defense strategy that focused on preventive measures to minimize security risks for winegrapes and/or wine, except to the extent necessary to meet related regulatory requirements. *

*Security risks are defined as intentional adulteration which causes harm to the winegrapes or to the public that interacts with the winegrapes or wine as well as economic disruption to the business. In 2016, the Food and Drug Administration published a final rule, Mitigation Strategies to Protect Food Against Intentional Adulteration (IA rule) (81 FR 34165), that creates new requirements for the production of food by registered food facilities to protect the food supply against intentional adulteration. The final rule is available at: https://www.fda.gov/food/food-safety-modernization-act-fsma/fsma-final-rule-mitigation-strategies-protect-food-against-intentional-adulteration
See **Box 7-A** for more information on minimizing security risks.

BOX 7-A RESOURCES FOR ASSESSMENT AND MINIMIZATION OF SAFETY AND SECURITY RISKS

What is a food security or defense plan for food processors and distributors? Food defense refers to the prevention of intentional attacks on the food supply. Food defense plans assess the risk of an attack and identify control measures to minimize the risks. All food processors and distributors should prepare a food defense plan specific to their product(s) and facility. Processors and distributors should review all components below and implement those measures appropriate for their facilities.

The food safety plan should outline your commitment to food safety; how it is implemented and communicated to employees and list corrective actions for personnel who violate your food safety policies and procedures. Having a food safety policy helps remind you, your family, employees, customers, and auditors, of why you are doing what you do. This statement should address your company's commitment to food safety, food quality, food sanitation, and worker hygiene. For example: *"Management and employees at [insert your company name here] are committed to producing and marketing a safe product through good agricultural and handling practices that focus on food safety and quality."*

Some sources of detailed information for assessing preventive measures to minimize risks from safety and security for winegrapes and wine are:

- US Food and Drug Administration's Food Safety and Modernization webpage: https://www.fda.gov/food/guidance-regulation-food-and-dietary-supplements/food-safety-modernization-act-fsma
- Ensuring Food Safety in the Vineyard: Wine Grapes published by Iowa State Extension https://store.extension.iastate.edu/product/15677
- Wine Production Safety guidelines are the same as found in the Current Good Manufacturing Practice in Manufacturing, Packing, Or Holding Human Food. For the Code of Regulations: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?cfrpart=110.
- California Department of Public Health's *Food Defense: Your Responsibility, A Guide to Food Defense for Food Processors and Distributors* https://www.cdph.ca.gov/Programs/CEH/DFDCS/CDPH%20Document%20Library/FDB/FoodSafetyProgram/FoodDefenseAndSecurity/YourResponsibilityEN.pdf
- Department of Health and Human Services, US Food and Drug Administration and Center for Food Safety and Applied Nutrition, *Food Safety and Security: Operational Risk Management Systems Approach*, November 2001 https://www.cdph.ca.gov/Programs/CEH/DFDCS/CDPH%20Document%20Library/FDB/FoodSafetyProgram/FoodDefenseAndSecurity/ORMSA.pdf

8. ECOSYSTEM MANAGEMENT

Original Chapter Authors: Kent Reeves and Jeff Dlott; Modified by the Sustainable Winegrowing Joint Committee

Agricultural systems and the environment are intertwined, dynamic, and often symbiotic. Stepping back from an individual vineyard or winery facility and viewing the landscape as a mosaic of biological areas, agricultural lands, rural, suburban, and urban living environments it becomes apparent that ecological processes are underway at all levels. Many of these ecological processes function at the watershed or regional level, at a larger scale than individual vineyards and ranches.

This chapter places these ecological processes into an "Ecosystem Management" perspective for winegrowers and winemakers. Ecosystem management is defined as the application of ecological science to resource management to promote the long-term sustainability of landscapes and the delivery of essential goods and services produced in them to society (Chapin et al., 2001).

Just what are the ecologists talking about when they say, "essential ecosystem goods and services"? The "goods" are the very things that growers, winemakers, ranchers, foresters, fishers, and others produce: food and wine, fiber, timber, biomass fuels, and industrial ingredients like essential oils (Daily et al., 1997; Naeem, et al., 1999). Examples of "ecosystem services" include cleansing of water and air, storing and cycling nutrients, pollination of crops and natural vegetation, generation and maintenance of soils, detoxification and decomposition of wastes, and natural beauty – a key component of California's tourism and recreation industries. The long-term viability of California's wine community is linked to the long-term stability of ecological processes, which are constantly changing.

An ecosystem management approach acknowledges that people are a part of and have a significant impact on ecosystem structures and processes. This approach also recognizes that people depend on and interact with ecological, economic, and social systems where they live. The primary goals of an ecosystem management approach are to:

- Maintain ecosystem integrity
- Sustain biodiversity at a regional scale
- Incorporate distinct community values in the design and implementation of a sustainability strategy.

As stated in the Introduction of this workbook, a desired outcome for the Sustainable Winegrowing Program is the widespread development and execution of sustainable business strategies (mission, vision, and values) by vineyard and winery operations.

Ecosystem management is currently being encouraged and implemented by communities, government agencies, businesses, academics, and various conservation organizations throughout the world. Examples of ecosystem management efforts that have been undertaken around the world can be found through the IUCN's Commission on Ecosystem Management website at www.iucn.org/about/union/commissions/cem/.

This chapter draws on the ecosystem management approach described and defined by the Keystone Center (1996) as well as other key publications on ecosystem management, agricultural ecology, and sustainable development provided in the References sections of this workbook and in the SWP Resources, available online at www.sustainablewinegrowing.org.

While many relevant topics are covered in other chapters of the Code workbook, the purpose of this chapter is to help growers identify management practices that can help protect and enhance the ecosystems in which they operate. It includes 9 criteria to self-assess:

- The integration of ecosystem processes with winegrowing practices
- How specific habitats are influenced by the vineyard and/or winery
- The opportunities in your operation to identify and prioritize options to implement ecosystem management.

List of Ecosystem Management Criteria

8-1 Ecosystem Processes – Resource Base Ecosystem Biodiversity
8-2 Watershed Management – Watershed Awareness
8-3 Ecosystem Management – Native Woodlands
8-4 Ecosystem Management – Riparian Habitat
8-5 Ecosystem Management – Aquatic Habitats: Streams, Rivers, and Wetlands
8-6 Habitat Enhancement for Wildlife
8-7 Conservation Easements
8-8 Sensitive Species
8-9 Sensitive Species and Collaboration with Partners

Vineyards can provide many "ecosystem services" such as cleansing of water and air, storing and cycling nutrients, pollination of crops and natural vegetation, generation and maintenance of soils, detoxification and decomposition of wastes, and natural beauty.

BOX 8-A UNDERSTANDING ECOLOGICAL CONCEPTS

Understanding fundamental ecological concepts and definitions is important for ecosystem management planning and decision-making. **If you are already familiar with the ecological sciences, please skip this section.**

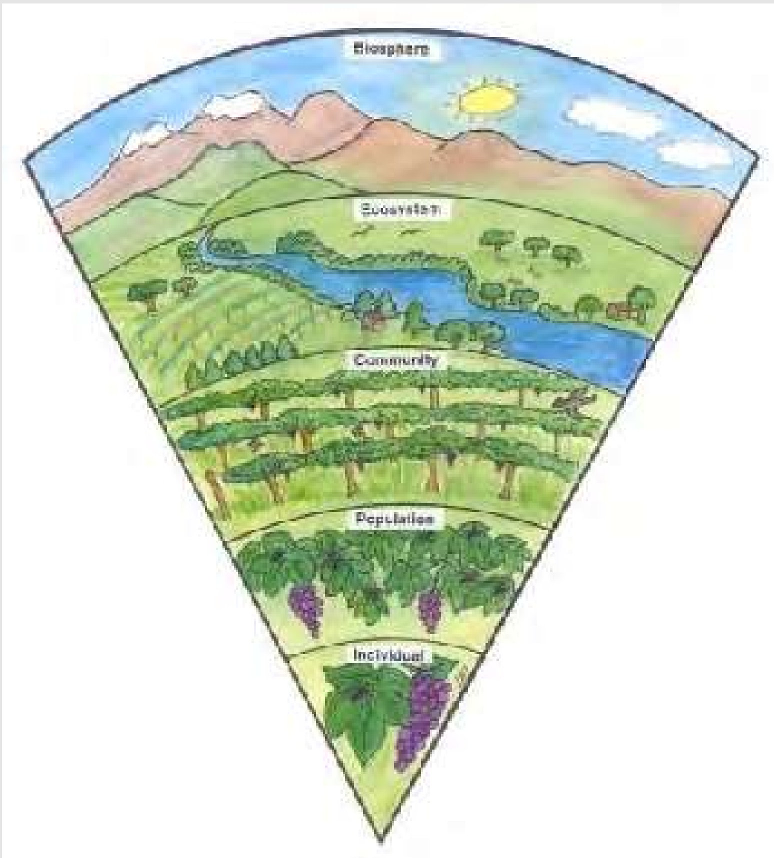


Figure 8-a A hierarchical view of ecosystem and biosphere components (Thrupp, 2002, adapted from Flint and Van den Bosch, 1981).

Ecosystem and agricultural ecologists typically view biological structures and functions in a hierarchy moving from individual organisms to populations, communities, ecosystems, and finally the biosphere (**Figure 8-a**).

In this example, the **individual** spider on the grape leaf is part of a spider **population** (groups of individuals that can breed in a given area) living in the grapevine canopy. The spiders, grapevines, cover crop, soil microorganisms, and other plants and animals that co-exist in the vineyard make up a **community** (a group of organisms that co-exist in an ecosystem). The vineyard community is part of a larger **ecosystem –** the complexes of plants and animals that occur together on the landscape that are linked by similar ecological processes (e.g., hydrology), environmental features (e.g., soils, geology), and form a cohesive and distinguishable unit (e.g., vineyards in an oak woodland landscape) (Poiani et al., 2000). The largest biological unit is the **biosphere**, or global ecosystem, that includes all living organisms and ecological processes (e.g., global water cycle, global carbon cycle).

These definitions provide a framework to think about ecological components. In reality, it is often difficult to define where a community or ecosystem starts and stops. Even if we define a vineyard community by where the vines start and stop, many organisms move in and out of the vineyard (insect, birds, mammals, etc.), and many processes, like the local water and nutrient cycles, occur at a larger scale than an individual vineyard.

From an ecosystems management viewpoint, a goal of the successful winegrape grower is to optimize the combination of individual, population, community, and ecosystem conditions, resources, interactions, and processes to produce acceptable yields of quality fruit. Ideally, this is done while minimizing negative impacts, and maximizing positive impacts on ecological inputs. Examples of impacts include maintaining and enhancing soil structure and functions, cleansing water and air, maintaining hydrological cycles, storing, and cycling nutrients, and creating optimal conditions and resources for complex food webs. There are positive benefits that can be obtained from a variety of vineyard and winery practices to enhance the local ecosystem.

Box 8-B Ecosystem Management – Function and Processes

Four fundamental ecosystem processes and their health determine the overall sustainability of the land. These four processes are the water cycle, ecosystem biodiversity, nutrient cycles, and energy cycle.

Water Cycle
Water enters the landscape through rainfall and is stored in the soil profile, as surface water or as ground water in aquifers. Water cycles out of the landscape through runoff, evaporation, and transpiration; these three processes are strongly affected by the plants that cover the soil surface in natural and agricultural ecosystems. You can optimize your on-site water resources by reducing runoff, improving infiltration, and increasing soil water-holding capacity. Similarly, you can conserve water and protect water quality by minimizing off-site impacts, particularly the off-site movement of sediment. (See **Criteria 8-1** and **Chapter 5 Vineyard Water Management** and **Chapter 10 Winery Water Conservation and Water Quality** for more information.)

Ecosystem Biodiversity
Biodiversity is the variety of life and its processes. It includes the variety of living organisms, the genetic differences among them, the communities and environment in which they occur, and the ecological and evolutionary processes that keep them functioning. Winegrowing practices that change the resources and conditions in a vineyard ecosystem, such as managing water and nutrient levels, adding compost, cover cropping, pulling leaves, planting hedgerows, creating buffer strips, and installing bird boxes, influence the structure and function of the vineyard ecosystem by directly impacting the populations of and interactions among insects, diseases, desired plants, weeds, birds, soil micro-organisms, etc. The combination of applied winegrowing practices greatly influences the biodiversity in and around your property. (See **Criteria 8-1** and **Box 8-C**. For more information on practices that can enhance biodiversity see http://www.sustainablewinegrowing.org/docs/2008-Biodiversity_in_Vineyards.pdf.)

Nutrient Cycle
A vineyard and/or winery operation can influence the nutrient cycle by having a comprehensive strategy to balance nutrient budgets and prevent off-site nutrient losses. Developing nutrient budgets can be done by monitoring nutrient inputs and outputs in the vineyard and/or winery operations. Additionally, implementing practices to increase nutrient cycling (e.g., composting, cover cropping, use of treated water from ponds, etc.) are included as part of standard operating procedures. Soil organic matter is the storehouse for the energy and nutrients used by plants and other organisms. Bacteria, fungi, and other soil dwellers transform and release nutrients from organic matter. Implementing practices throughout the property can prevent the off-site loss of nutrients. Examples include the use of buffer strips, vegetation along roads and ditches, and where appropriate, engineered solutions to reduce erosion. (See **Figure 8-b**, **Figure 8-d** and **Chapter 4 Soil Management** for more information.)

Energy Cycle
In ecosystems, energy is a key "currency" that largely shapes how ecosystems are structured and function. The use and management of energy clearly affects the sustainability and overall productivity of winery and vineyard operations. Plants capture light energy, and through the process of photosynthesis, convert that light energy into stored chemical energy. The careful manipulation of vine canopies through the combination of practices winegrowers use (site selection, rootstock, trellis

system, watering regime, nutrients, etc.) is all about managing energy flows to produce the desired yields and fruit quality. (**See Figure 8-c** and **Chapter 3 Viticulture** for more information.)

8-1 Ecosystem Processes – Resource Base Ecosystem Biodiversity*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Vineyard or winery operations enhanced ecosystem biodiversity ***And*** Species, habitat types, and indicators of plant and animal diversity were monitored and recorded in and around the vineyard or winery. ***And*** Measures have been taken to promote biodiversity. *	Vineyard or winery operations enhanced ecosystem biodiversity ***And*** Species, habitat types, and indicators of plant and animal diversity were monitored in and around the vineyard or winery.	The vineyard or winery's role in a diverse and healthy ecosystem is understood. ***And*** There was an understanding of which practices promote ecosystem biodiversity.	There was generally little to no awareness of how the vineyard or winery affects ecosystem biodiversity.

*For more information on practices that can enhance biodiversity see **Box 8-C**.

BOX 8-C PRACTICES FOR BIODIVERSITY MANAGEMENT IN AND AROUND VINEYARDS

A. Conservation and Management of Existing Biodiversity

- Protection and conservation of native trees in and around vineyards
- Protection and conservation of vernal pools
- Conservation of native habitat and plant species and/or oak woodlands
- Protection of riparian habitat (including trees) along rivers or streams
- Maintenance or mowing of native vegetation between vine rows, serving as cover crops
- Maintenance of native vegetation on vineyard edges and landscaping
- Protection of native birds and wildlife (e.g., avoid fencing, etc.)

B. Enhancement of Biodiversity (Planned)

- Planting trees in/around vineyards
- Planting vegetation in or around vineyards
  - Habitat corridors or hedgerows
  - "Islands of flowers/vegetation"
  - Insectaries and/or landscaping on edges
  - Planting diverse cover crops
- Use of compost or other soil amendments to enhance soil biodiversity
- Practices to attract birds (e.g., birdboxes, perches)
- Practices to attract wildlife (e.g., planting hedgerows, slash piles, providing food sources)
- Incorporating sheep, goats, or chickens for weed control or cover crop management

Source: *Biodiversity Conservation Practices in California Vineyards: Learning from Experiences* (http://www.sustainablewinegrowing.org/docs/2008-Biodiversity_in_Vineyards.pdf).

For more information about planting hedgerows, search for **Planting Hedgerows on North Coast Vineyards** in the CSWA Online Resource Library (https://library.sustainablewinegrowing.org/).

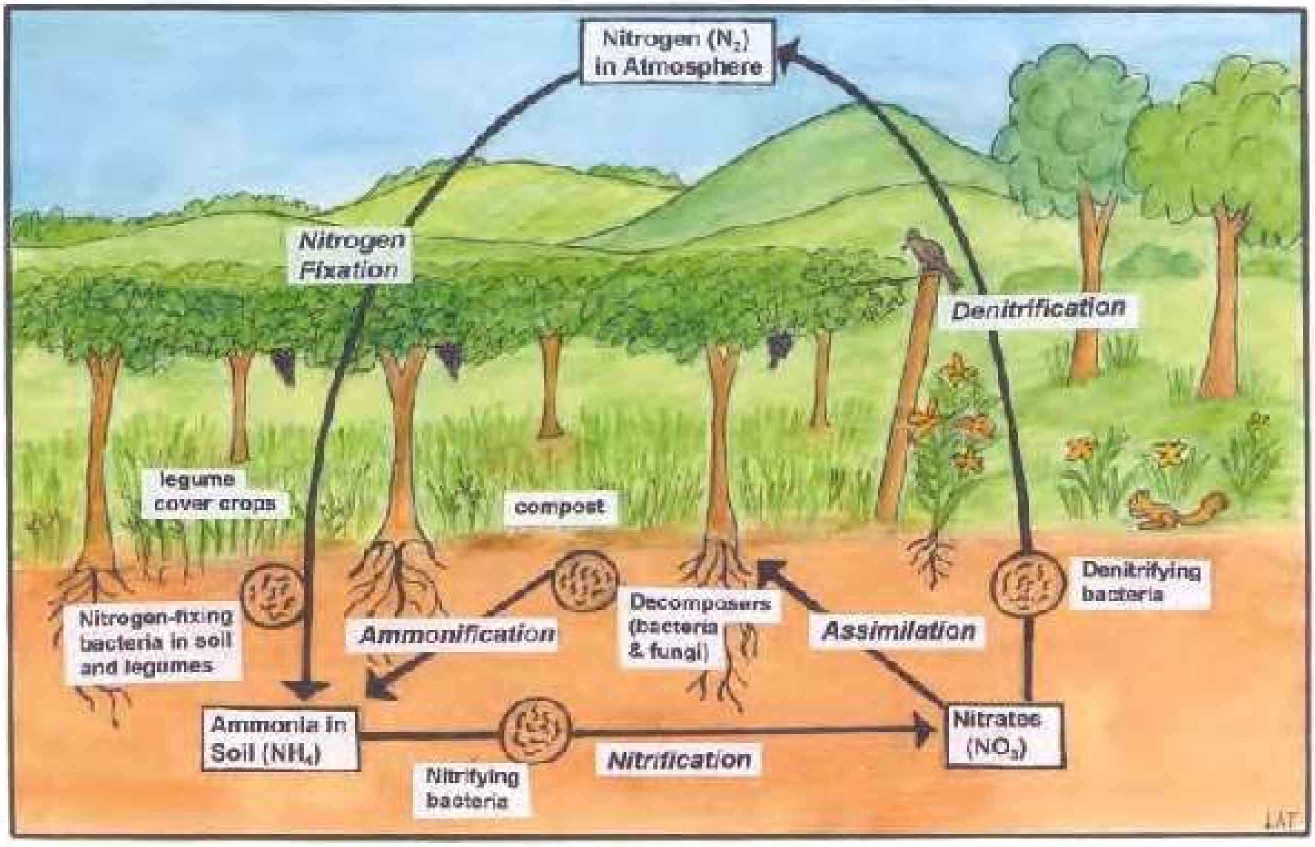


Figure 8-b The nitrogen cycle from the perspective of a grapevine (illustrated by Thrupp, 2002). Nitrogen in relation to water quality and fertigation is also discussed in **Chapter 5 Vineyard Water Management** and nitrogen management is discussed further in **Chapter 4 Soil Management**.

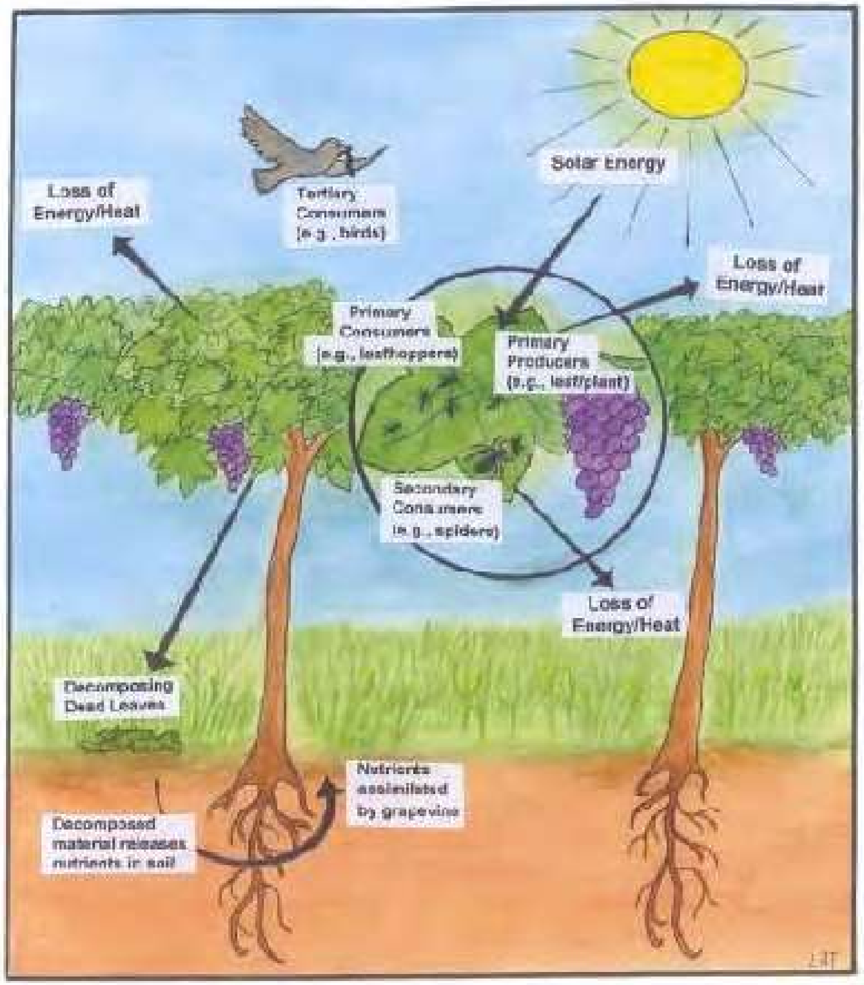


Figure 8-c Energy cycle in a vineyard ecosystem for a simple food chain. At the base of the food chain are the grape plants (primary producers) that capture sunlight, which fuels the growth and development of leaves, shoots, roots, and fruit. The leafhoppers (primary consumers) capture some of the plant's stored energy by feeding on the leaves. Some of this captured energy then flows to the spiders (secondary consumer) feeding on the leafhopper. As spiders are eaten by other predators, energy continues to flow through the ecosystem. The illustration also shows that energy stored in dead plant matter fuels decomposers that also release stored nutrients making them available to cycle back into the ecosystem (Thrupp, 2002).

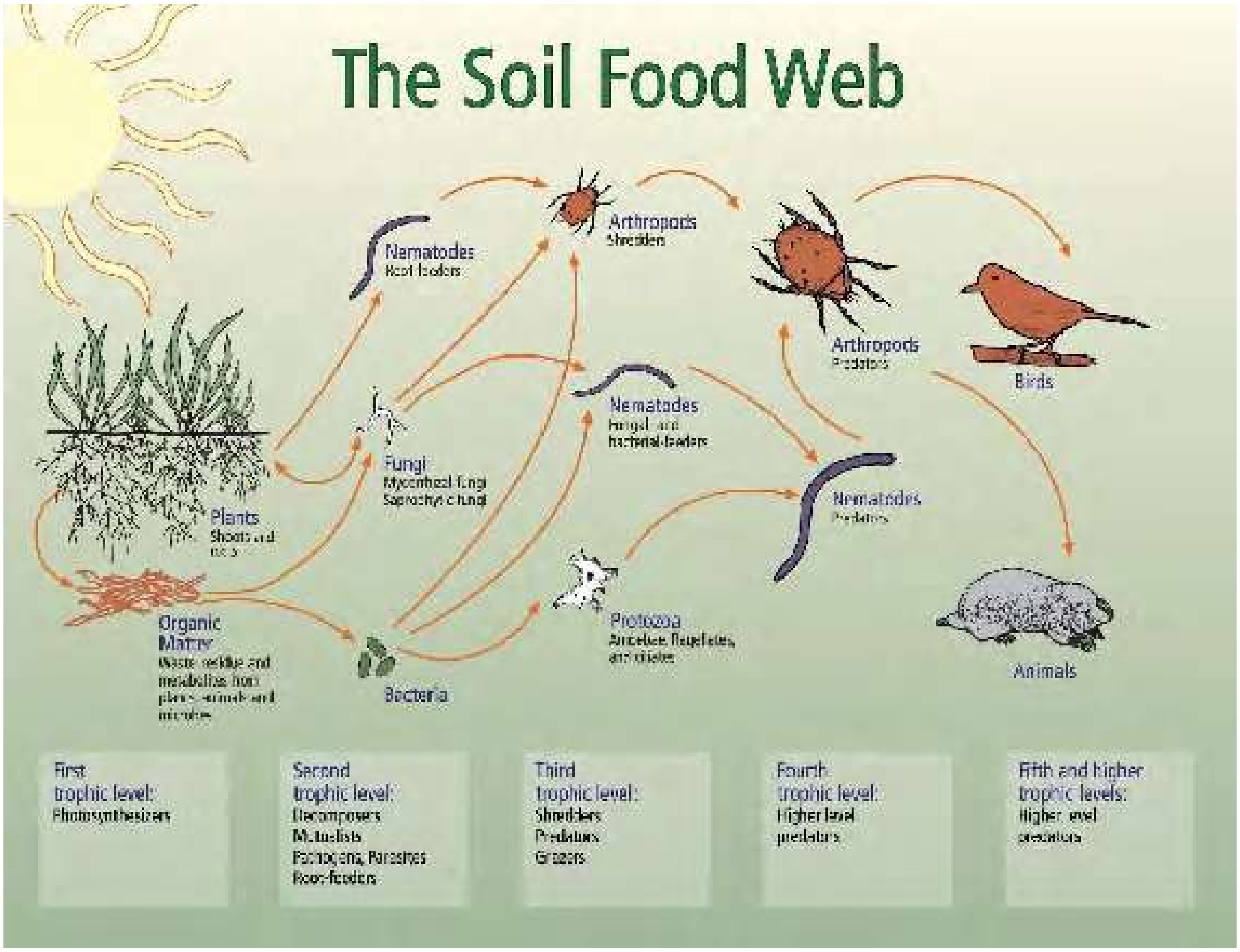


Figure 8-d The soil food web is complex and fed by organic matter such as decaying plants, animals, and microbes as well as nutrients released by living plant roots. The organic material is digested by bacteria, fungi, and other life forms, which are in turn eaten by worms, insects, and spiders. Finally, larger animals such as mice and moles live in the soil and eat the bugs. **Sources:** Tugel and Happe-vonArb. eds., 2000 and Center for Food Safety, https://soilsolution.org/the-soil-food-web/

Box 8-D Bioregions and American Vineyard Areas of California

The California Biodiversity Council recognizes 10 bioregions in the state (See **Figure 8-e**). Winegrapes are grown in virtually all of these regions. Each bioregion is unique with regard to physical, climatic, and biological characteristics. It is important to understand those features that make a bioregion unique because the same features contribute to the creation of American Viticultural Areas (AVAs) making the fruit and wine from each area unique. This information will also provide insight into how some state and federal agencies and many conservation groups think about important landscape, ecosystem, and sensitive species issues.

An American Vineyard Area (AVA) is a designated wine grape-growing region in the United States distinguishable by geographic features, with boundaries defined by the Alcohol and Tobacco Tax and Trade Bureau (TTB), United States Department of the Treasury. Current regulations impose the following additional requirements on an AVA:

- Evidence that the name of the proposed new AVA is locally or nationally known as referring to the area.
- Historical or current evidence that the boundaries are legitimate.
- Evidence that growing conditions such as climate, soil, elevation, and physical features are distinctive.

Source: California Biodiversity Council (http://biodiversity.ca.gov).

Figure 8-e California bioregions (http://calag.ucanr.edu/Archive/?article=ca.v049n06p10).

BOX 8-E WATERSHEDS

A watershed refers to the entirety of a basin that includes the drainage of streams or rivers. Every stream, tributary, or river has an associated watershed, and small watersheds aggregate together to become larger watersheds. It is important to know what watershed your vineyard and/or winery is located in and to be aware of the key watershed issues important in your area such as water quality, quantity, pollution, and/or the presences of endangered or threatened aquatic species.

Visit https://www.conservation.ca.gov/cgs/Pages/Program-FWGP/maps_data.aspx to see a map of California's watersheds.

Source: California Department of Conservation http://www.conservation.ca.gov

8-2 Watershed Management – Watershed Awareness*			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Pertinent watershed issues were known (e.g., water quality, quantity, pollution, and/or endangered or threatened aquatic species) ***And*** Site specific efforts were made to minimize negative impacts on pertinent watershed issues ***And*** If available, there was involvement in a watershed program that discussed stewardship issues and conservation.	Pertinent watershed issues were known (e.g., water quality, quantity, pollution, and/or endangered or threatened aquatic species) ***And*** Site specific efforts were made to minimize negative impacts on pertinent watershed issues.	The main watershed in which the vineyard and/or winery is located was known ***And*** If applicable, the tributary watershed to which the vineyard and/or winery is connected was known.	The main watershed in which the vineyard and/or winery is located was not known.

*See **Chapter 4 Soil Management Boxes 4-I, 4-J, and 4-K; Chapter 5 Vineyard Water Management Boxes 5-B** and **5-C;** and **Chapter 10 Winery Water Conservation and Quality** for relevant sources and information about specific soil management, cover cropping, and water conservation and quality practices relevant to watershed issues.

Box 8-F Habitat Definition and Types

Often what is labeled as a "habitat" is really a vegetation community. However, because lots of people from different professions, agencies, and organizations talk about habitat, it is important to use an accurate and consistent definition to facilitate effective communication among different professions, agencies, and organizations. This workbook uses the following definition of habitat by Hall et al. (1997):

"…the resources and conditions present in an area that produce occupancy – including survival and reproduction – by a given organism. Habitat implies more than vegetation or vegetation structure; it is the sum of the specific resources that are needed by organisms. Wherever an organism is provided with resources that allow it to survive, that is habitat."

Within the California Wildlife Habitat Relationships (CWHR) classification system, there are 50 natural habitats (Mayer and Laudenslayer, 1988) and eight agricultural habitats (https://www.wildlife.ca.gov/Data/CWHR/Wildlife-Habitats) recognized in the state. In *A Manual of California Vegetation* (Sawyer and Keeler-Wolf, 1995), the California Native Plant Society (CNPS) recognizes 275 vegetation stands, series, and habitats for the state. Vegetation communities can be managed, enhanced, and sometimes restored in order to benefit an organism's overall habitat. You are encouraged to learn the habitats and vegetation communities on your property and how your activities may influence them. Carefully selecting new vineyard sites and using practices such as cover cropping, hedgerows, and buffer strips can significantly minimize adverse impacts to surrounding native habitat. These practices can also enhance the habitat quality of vineyards.

The following are several types of habitat and vegetation communities found in and around vineyards:

Oak Woodlands
Eighteen species of oak enrich the California landscape. They occur in all bioregions and cover over a third of California, ranging from the high desert slopes to the Pacific shoreline. The Mediterranean climate strongly associated with California oak woodlands is important for winegrowing. The Mediterranean region in the "old world" where many of the winegrape varieties originate is also associated with oaks. Plant and animals that share the oak woodland community are important influences for oaks. Oak woodlands in California host 313 species of amphibians, reptiles, birds, and mammals. (See **Criteria 8-3**).

Other Woodlands
Other than oak, there are many other species of plants and trees that occur throughout the state and could combine to create woodlands. These include Western Sycamore, Fremont Cottonwood, California Buckeye, California Bay, and various cedars, willows, and chaparral.

Riparian
Riparian vegetation serves as a filter, preventing sediments and nutrients in surface runoff from entering waterways. The dense matrix of roots and organic surface litter can therefore improve water quality. Vegetation on the banks of waterways helps prevent bank erosion. Furthermore, vegetated riparian areas and floodplains act as a sponge by absorbing floodwater and then slowly releasing it over time, maintaining stream flows later in the summer. Shrubs and trees that shade the watercourse

maintain cooler water temperatures, which are good for maintaining a diversity of aquatic life. Riparian vegetation also provides habitat for wildlife. (See **Criteria 8-4).**

Aquatic Habitat
Aquatic habitats, such as streams, rivers, and wetlands, are often overlooked in natural resource planning and management. These habitats can occur in association with many terrestrial habitats. Sometimes aquatic habitats are also found connected to one another, such as a wetland adjacent to a stream or river. Besides providing important habitat for fish, aquatic habitats host a variety of wildlife species including amphibians, reptiles, birds, and mammals. Aquatic habitats are important to species such as Chinook salmon, steelhead, red-legged frog, California tiger salamander, giant garter snake, western pond turtle, waterfowl, herons, shorebirds, river otter, mink, and beaver. (See **Criteria 8-5).** To maintain healthy aquatic habitats for species such as Chinook salmon and steelhead, both water quality and water quantity prove to be important factors**.**

Vernal Pools
Vernal pools occur only where a narrow range of favorable conditions exist. They are found only in a Mediterranean climate where most of the rainfall occurs from October to April followed by a hot, dry season when the pools completely dry out. A shallow depression is required, underlain by some soil substrate such as clay or basalt that is impervious to water percolation. In California, there are three geomorphological situations where these circumstances exist: coastal terraces, broad alluvial valleys such as the San Joaquin and Sacramento valleys, and ancient basaltic lava flows. Soils of vernal pools are typically very high in clay but can be derived from a variety of parent materials.

Hydrology is another key ingredient to the formation of a vernal pool. Specifically, water depth and duration of standing water play an important part in determining whether these areas can function as vernal pools. Water depths typically range from 10-60 cm (4 inches - 2 feet) deep. Pools need to remain inundated long enough to allow associated plants, invertebrates, and amphibians to complete their life cycles. Inundation can begin as early as November and go all the way until June in a very wet year. Shallow pools can fill with water, dry up, and then refill again several times during a season. Typically, a vernal pool is filled with water for only 3-4 months, from about December through March. Vernal pools can be found from southern Oregon to just south of San Diego in Mexico, but the majority of vernal pools occur on California's coastal terraces and in the Central Valley.

Buffer Strips
Conservation buffers are small areas or strips of land in permanent vegetation, designed to intercept pollutants and manage other environmental concerns. Buffers include riparian buffers, filter strips, grassed waterways, shelterbelts, windbreaks, living snow fences, contour grass strips, cross-wind trap strips, shallow water areas for wildlife, field borders, alley cropping, herbaceous wind barriers, and vegetative barriers.

Strategically placed buffer strips in the agricultural landscape can effectively mitigate the movement of sediment, nutrients, and pesticides within farm fields and from farm fields. When coupled with appropriate upland treatments, including crop residue management, nutrient management, integrated pest management, winter cover crops, and similar management practices and technologies, buffer strips should allow farmers to achieve a measure of economic and environmental sustainability in their operations. Buffer strips can also enhance wildlife habitat and protect biodiversity.

Source: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=nrcs143_023568

BOX 8-G THE VINEYARD AS HABITAT

Vineyards provide habitat for a variety of wildlife. Because they can feed on grapes and damage vineyards, some vertebrate species are considered pests and therefore undesirable (see **Criteria 6-23 and 6-24** in the **Pest Management chapter** for relevant information and practices on vertebrate pest management). However, pest species may attract other more valuable wildlife that prey on them. Vertebrate predators observed in and adjacent to vineyards include striped skunk, raccoon, gray fox, coyote, bobcat, and mountain lion. Vineyards with cover crops can be islands for wildlife on California's agricultural landscapes. They are attractive to wildlife for the same reason that alfalfa is in the Sacramento Valley. Cover crops and alfalfa are resource-rich and available to wildlife for many years. Cover crops and other non-crop vegetation in and around vineyards such as buffer strips, hedgerows, natural woodlands, and riparian flora that provide habitat for wildlife also serve to connect habitat patches on agricultural landscapes. In addition, numerous bird species found in vineyards provide benefits by feeding on insect pests.

Results from raptor surveys conducted in 1998-2002 in the lower Mokelumne River watershed in San Joaquin County indicate that a variety of hawks hunt in vineyards, including red-tailed hawk, American kestrel, white-tailed kite, northern harrier, and Swainson's hawk. Information is based on published data collected by Craig Swolgaard (CSU-Sacramento) and Kent Reeves (while working for East Bay Municipal Utility District). For further details, see *Nesting Density and Habitat Use of Swainson's Hawk in a Vineyard Landscape in Northern San Joaquin County, California* (Swolgaard, 2004) and *Survey of Falcons, Kites, Hawks, and Owls in the Lower Mokelumne River Watershed, Sacramento and San Joaquin Counties, California (*Reeves and Smith, 2004).

For more information, see *Farming for Wildlife* (Clark and Rollins, 1996) and *Farming with the Wild: Enhancing Biodiversity on Farms and Ranches* (Imhoff and Carra, 2003).

8-3 Ecosystem Management – Native Woodlands*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Native woodlands were present before establishment or expansion, but the vineyard and/or winery was laid out without removing them, farming was not done directly under tree canopies, and native vegetation was maintained around the trees ***Or*** It was necessary to remove some woodlands and shrubs**, but this was offset by mitigation banking or other permanent mitigation/protection of nearby woodlands ***And*** The operation was working with conservation groups on landscape-level conservation planning of woodland ecosystems in the region.	Native woodlands were present before establishment or expansion, but the vineyard and/or winery was laid out without removing them ***Or*** It was necessary to remove some woodlands and shrubs**, but this was offset by mitigation banking or other permanent mitigation/protection of nearby woodlands.	Native woodlands were removed before establishment or expansion, but replacement trees and shrubs were planted around the outside of the vineyard and/or winery (using appropriate seeds/saplings).	If native woodlands were present before vineyard and/or winery establishment or expansion, they were removed to maximize the land area used for growing winegrapes or winemaking (in accordance with legal requirements). *(Select N/A if there was no native woodland habitat or if there are no development records due to ownership or management change)*

*For information on oak woodland conservation, see the California Oak Foundation at http://www.californiaoaks.org. For information on oak woodlands and bird conservation, see the Oak Woodland Bird Conservation Plan at http://www.prbo.org/calpif/htmldocs/oaks.html.

8-4 Ecosystem Management – Riparian Habitat

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Banks of water courses have vegetated buffer strips adjacent to the waterway ***And*** Outside the buffer strip is a row of trees and shrubs that shade at least part of the water course.	Banks of watercourses have vegetated buffer strips adjacent to the waterway.	Vines are not planted up to the edge of the watercourse, but no vegetated buffer exists, or there are areas without buffer strips between the winery and waterways	The winery is located or the vineyard is planted up to the edge of the watercourse to maximize the land area used (in accordance with legal requirements). *(Select N/A if there was no riparian habitat or waterway)*

Box 8-H Economic Values of Riparian Habitat

Riparian habitat provides many benefits to streamside landowners. For example, a wide strip of riparian vegetation can offset flood damage to vineyards by acting as a "sieve" for trees and other debris that may wash in during large floods. Riparian vegetation also traps fine sediments and other pollutants, thereby preserving water quality. Because of their deep roots and dense growth habit, riparian trees, shrubs, and grasses provide excellent protection against bank erosion, helping to stabilize streambanks.

In addition to assisting with flood protection and erosion control, riparian vegetation may play a role in integrated pest management. Cavity nesting riparian bird species, such as kestrels and owls, prey on rodents in vineyards. Other cavity nesting birds, such as wrens, tree swallows, oak titmice, and bluebirds, may help reduce populations of pest insects. Bobcats, coyotes, and foxes also use riparian areas to prey on rodents.

Riparian vegetation management should foster a diverse, functioning natural plant community, while creating unfavorable conditions for the blue-green and glassy-winged sharpshooter, thereby reducing the incidence of Pierce's disease in nearby vineyards. While certain native and non-native plants may need to be removed, they should be replaced with other native species that will fill the ecological role of the removed plants.

BOX 8-I RIPARIAN HABITAT REVEGETATION AND REDUCTION OF PIERCE'S DISEASE*

A successful Pierce's Disease revegetation project will:

- Establish a diversity of native plant types (such as trees, shrubs, and vines) and plant species in the riparian area
- Provide wildlife habitat
- Minimize erosion
- Resist re-invasion by weeds and blue-green sharpshooter host plants
- Require minimal annual management

Source: Information Manual – Riparian Vegetation Management for Pierce's Disease in North Coast California Vineyards (Pierce's Disease /Riparian Habitat Workgroup, 2000). *For additional information relevant to managing vectors of Pierce's Disease, see **Criteria 6-16** (blue-green sharpshooter) and **Box 6-S** (glassy-winged sharpshooter) in **Chapter 6 Pest Management**.

Winery process water treatment ponds can include wetlands, which can further clarify the water to improve water quality while also providing important habitat for wildlife.

8-5 Ecosystem Management – Aquatic Habitats: Streams, Rivers, and Wetlands*			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Aquatic habitats near the vineyard or winery were considered in site selection and planning and/or management (e.g., soil type and erosion ratings, slope of area, natural vegetation, and drainage were all considered to prevent off-site movement of sediments) ***And*** Adequate buffer strips were left or created between vineyards or winery and aquatic habitats ***And*** Roads were kept to a minimum around vineyards or winery adjacent to aquatic habitats and repairs had been made to any poorly functioning road drainages or waterway crossings ***And*** If appropriate, the buffer strip included a zone of trees and shrubs that shaded – or has the potential to shade - part or the entire water course to minimize elevating water temperatures.	Aquatic habitats near the vineyard or winery were considered in site selection and/or management (e.g., soil type and erosion ratings, slope of area, natural vegetation, and drainage were all considered to prevent off-site movement of sediments) ***And*** Adequate buffer strips were left or created between vineyards or winery and aquatic habitats.	Aquatic habitats near the vineyard or winery were considered in site selection and/or management (e.g., soil type and erosion ratings, slope of area, natural vegetation, and drainage were all considered to prevent off-site movement of sediments).	If nearby aquatic habitats were present, they were not considered in vineyard and/or winery planning or management (except for complying with legal requirements). *(Select N/A if there are no aquatic habitats on the property)*

*See **Chapter 4 Soil Management Boxes 4-H, 4-I, 4-J, and 4-K, and Table 4-c; Chapter 5 Vineyard Water Management Boxes 5-B and 5-C; Chapter 10 Winery Water Conservation and Quality**; and **Criterion 8-3** for relevant sources and information on specific soil management, cover cropping, and water conservation and quality practices.

BOX 8-J SOURCES OF INFORMATION ON HABITAT ENHANCEMENT AND RESTORATION

California Native Grass Association
P.O. Box 8327
Woodland, CA 95776
(530) 297-0500
www.cnga.org
e-mail: admin@cnga.org

Wild Farm Alliance
PO Box 2570
Watsonville, CA 95077
(831) 761-8408
www.wildfarmalliance.org
e-mail: info@wildfarmalliance.org

California Native Plant Society
2707 K St., Suite 1
Sacramento, CA 95816
(916) 447-2677
www.cnps.org
e-mail: cnps@cnps.org

Yolo County Resource Conservation District
221 W. Court St., Suite 1
Woodland, CA 95695
(530) 661-1688
www.yolorcd.org
e-mail: info@yolorcd.org

Ducks Unlimited, Inc.
Western Regional Office
3074 Gold Canal Dr.
Rancho Cordova, CA 95670
(916) 852-2000
www.ducks.org

California Society for Ecological Restoration
2701 20th St.,
Bakersfield, CA 93301
(661) 634 –9228
www.sercal.org
e-mail: info@ser.org

University of California Sustainable Agriculture Research and Education Program
One Shields Ave.
Davis, CA 95616
(530) 752-3915
sarep.ucdavis.edu
e-mail: asi@ucdavis.edu

California Fish and Wildlife
1416 9th St., 12th Floor
Sacramento, CA 95814
(916) 445-0411
https://www.wildlife.ca.gov/

Salmonid Restoration Federation
P.O. Box 4260
Arcata, CA 95518
(707) 268-8182
www.calsalmon.org
e-mail: srf@northcoast.com

Nesting boxes placed in or around a vineyard provide additional habitat for various species of birds that can act as predators to rodents or insect pests in the vineyard.

8-6 Habitat Enhancement for Wildlife*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Nesting boxes or other nesting habitat were placed in and/or around the vineyard and/or winery ***And*** Natural nesting sites and perches were maintained in and/or around the vineyard and/or winery (e.g., leave oak trees in vineyard) ***And*** Nest sites and perches were monitored and maintained ***And*** Hedgerows, cover crops, native grasses, or, if appropriate, non-native plants were maintained on the property ***And*** Native plants were established that provide shelter and/or food for wildlife (e.g., shrubs).	Nesting boxes or other nesting habitat were placed in and/or around the vineyard and/or winery ***And*** Natural nesting sites and perches were maintained in and/or around the vineyard and/or winery (e.g., leave oak trees in vineyard) ***And*** Hedgerows, cover crops, native grasses, or, if appropriate, non-native plants were maintained on the property.	Nesting boxes or other nesting habitat were placed in and/or around the vineyard and/or winery ***Or*** Natural nesting sites and perches were maintained in and/or around the vineyard and/or winery (e.g., leave oak trees in vineyard) ***Or*** Measures were taken to enhance biodiversity in an urban environment (e.g., addition of landscaping, use of native plants, green roof).**	No habitat enhancement was done on or around the vineyard and/or winery. *(Select N/A if the winery is in a location where environmental changes cannot be made)*

*See **Box 8-K** for nest box dimensions for common cavity-nesting birds.
See **Box 8-J1 for more information on biodiversity in an urban environment.

BOX 8-J1 ENHANCING BIODIVERSITY IN URBAN ENVIRONMENTS

Enhancing and maintaining biodiversity in urban environments is also important, especially as urbanization continues to increase. Vegetation in cities is often call "urban green space" and can include porches, balconies, rooftops, private gardens, parks, and river and creek corridors. Wineries in urban settings can play a part in providing urban green spaces as a refuge for biodiversity through landscaping, building design and community stewardship.

Landscaping
The addition of landscaping onsite (e.g., potted gardens, vegetable boxes, green roofs, green walls, trees, etc.) can provide habitat for wildlife and many ecosystem services for the community, including

micro-climate regulation, noise reduction, rainwater drainage, sewage treatment and recreational activities. In addition, using native plants has many additional benefits such as providing food and protective cover for wildlife and native plants are often lower maintenance and can be drought tolerant (see www.ncsu.edu/goingnative for more about using native plants and www.cnps.org/cnps/grownative/lists.php for a list of California natives by region).

Building Design
Integrating vegetation and trees into the building design can provide many benefits ranging from energy reduction due to shade provided by trees or building insulation from green roofs to enhancing biodiversity and providing a more enjoyable environment for employees and visitors. For a list of the benefits to green roofs visit: http://www.greenroofs.org/index.php/about/greenroofbenefits.

Community Stewardship
Looking beyond the winery boundary, employees can also take part in local restoration projects, park clean-up days and other events that work to enhance and protect urban green spaces.

BOX 8-K NEST BOXES FOR COMMON CAVITY-NESTING BIRDS

Cavity-nesting birds can be very beneficial to the vineyard and act as natural pest-control and help with pollination. The primary species in California that use boxes include Barn Owls and Western Bluebirds.

Find tips for building and installing nest boxes at: https://ca.audubon.org/installing-bird-boxes

BOX 8-L FISH FRIENDLY FARMING PROGRAM

The Fish Friendly Farming program is a voluntary certification program for grape growers who implement land management practices that restore and sustain water quality and fish habitat on their property. The Fish Friendly Farming program is incentive based. The Fish Friendly Farming program uses a workbook for the landowner or manager to evaluate their property and current practices, and then create a farm conservation plan focusing on resource concerns including fish habitat.

For detailed information, go to http://www.fishfriendlyfarming.org.

Source: Marcus et al., 2012.

BOX 8-M INCENTIVE AND COST-SHARING PROGRAMS FOR WILDLIFE HABITAT RESTORATION, ENHANCEMENT, AND PROTECTION

Environmental Quality Incentives Program (EQIP)*
EQIP replaced the Agricultural Conservation Program and Long-Term Agreement Program in 1997. One key goal of EQIP is to reduce sediment, nitrate, and pesticides from entering surface or ground water within designated geographic areas. For successful applications, the NRCS has shared the following practices: structural methods, such as pipelines, land leveling, return systems, and capping abandoned wells; vegetative methods, such as cover crops and windbreaks; and new technology, such as irrigation scheduling and pesticide and nutrient management. Payments have been up to 75% of the project cost. If you are interested in WHIP or EQIP, contact your local NRCS District Conservationist. For a complete list of California NRCS employees, access the directory at http://www.ca.nrcs.usda.gov/contact/directory.

Conservation Technical Assistance Program
This program has been maintained by the NRCS and provides land users with proven conservation technology and the delivery system needed to achieve the benefits of a healthy and productive landscape. More information is available at the NRCS website.

The Conservation Reserve Program
This program has provided both annual rental payments and cost-share assistance for the establishment of resource conservation practices on farmland. More information is available at: http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp.

Partners for Fish and Wildlife Program
The Partners for Fish and Wildlife program has been the US Fish and Wildlife Service's habitat restoration cost-sharing program for private landowners. It offers technical and financial assistance to landowners who wish to restore and enhance wildlife habitat on their property.

Projects include restoration of wildlife habitat on:
- degraded or converted wetlands
- riparian areas
- native grasslands
- streams
- endangered species habitat.

The assistance provided by the US Fish and Wildlife Service can range from giving informal advice on the design and location of potential restoration projects, to designing a project and funding up to 50% of the implementation cost under a formal cooperative agreement with the landowner.

Projects with the highest priorities are those that re-establish the natural historical communities and provide benefits to migratory birds, anadromous fish, and threatened and endangered species.

Projects include efforts such as, but not limited to:
- creating shallow water areas
- revegetating native plants
- erecting fences along riparian areas to create riparian pastures.

If you are interested in participating in the Partners for Fish and Wildlife program, contact the program coordinators at (916) 414-6456. There is more information on the program at https://www.fws.gov/partners/.

California Department of Fish and Wildlife (CDFW) Private Lands Management (PLM) Program
This program offers ranchers and farmers an opportunity to increase their profits by improving habitat for wildlife. The economic incentive provided is in the form of offering fishing and hunting opportunity to the public beyond the traditional seasons and issuing tags or permits directly to individuals you allow to hunt or fish. The landowner sets and collects whatever access and service fees they wish. The landowner pays a fee to be in the program, pays for the tags/permits, develops an approved management plan, and implements the agreed wildlife habitat improvements. If you would like information about the PLM program, please contact Victoria Barr at Victoria.Barr@wildlife.ca.gov or dial (916) 445-0411.

Other Opportunities:
The **Agricultural Land Stewardship Program** is a voluntary program administered by the California Department of Conservation to encourage long-term, private stewardship of agricultural lands; protect continuation of farming and ranching operations; protect the agricultural economy of rural communities; encourage orderly and efficient urban growth; and encourage improvements to enhance long-term sustainable agricultural uses. https://www.conservation.ca.gov/dlrp/grant-programs/cfcp

Private, small-scale (500 employees or less), "for profit" companies, are also eligible for funding from the **Environmental Protection Agency** and eleven other federal agencies for environmental innovation and to strengthen the role of small businesses in federally funded research and development through the SBIR or Small Business Innovation and Research program. More information available at http://www.epa.gov/ncer/sbir/

Value-Added Producer Grants may be used for planning activities and for working capital for marketing value-added agricultural products and for farm-based renewable energy. Eligible applicants are independent producers, farmer and rancher cooperatives, agricultural producer groups, and majority-controlled producer-based business ventures. For more information see http://www.rurdev.usda.gov/BCP_VAPG.html.

8-7 Conservation Easements*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Some or all of the property is protected with an agricultural conservation easement ***And/Or*** The natural areas on the property were protected by a natural resource conservation easement.	An agricultural conservation easement or natural resource conservation easement was being considered for the property ***And*** An assessment of the property had been conducted and areas were identified where easements were appropriate.	An agriculture conservation easement or natural resource conservation easement program existed, and it was known how it could have been used on the property ***Or*** An assessment of the property was conducted and a conservation easement was not appropriate.	The existence of conservation easements was unknown.

*See **Box 8-N** and **Box 8-O** for more information on conservation easements. Check to see what easement programs are available in your area.

Box 8-N Conservation Easements

Conservation easements for protection of natural resources are legal agreements that allow landowners to donate or sell some "rights" on portions of their land to a public agency, land trust, or conservation organization. In exchange, the owner agrees to restrict development and farming in natural habitat and assures the easement land remains protected in perpetuity. A 1996 study conducted by the National Wetlands Conservation Alliance indicated that the leading reasons landowners restored wetlands were to provide habitat for wildlife; leave something to future generations; and preserve natural beauty. Only 10% of landowners surveyed in the study restored wetlands solely for financial profit. This would also apply to other habitats besides wetlands. A conservation easement can provide you with financial benefits for the protection, enhancement, and restoration efforts for the natural environments on your property. The belief that natural resources such as wildlife, especially sensitive species, will reduce your land value is not true. Many easement programs include some sort of cash payment for a portion of the costs associated with habitat restoration and enhancement.

Agricultural conservation easements are for the explicit purpose of keeping farmland in production. They are similar to natural resource conservation easements, but, unfortunately, cropland easements tend to be seen as incompatible with natural resource purposes (Sokolow and Lemp, 2002). In 1996, the state established the California Farmland Conservancy Program to protect farmland by buying easements. Based on a study conducted by UC Cooperative Extension, there are currently 34 local conservation organizations, land trusts, and open space districts that seek to specifically protect farmland through conservation easements (see: *Agricultural Easements: New Tool for Farmland Protection,* 2002).

Opportunities may exist for one or both kinds of conservation easements on your property.

Box 8-O Agricultural and Conservation Easement Information Sources

- The Land Trust Alliance, http://www.landtrustalliance.org
- American Farmland Trust, http://www.farmland.org
- California Farmland Conservancy Program, https://www.conservation.ca.gov/dlrp/grant-programs/cfcp Farmland Mapping and Monitoring Program, https://www.conservation.ca.gov/dlrp/fmmp American Leadership Forum: Great Valley, http://www.greatvalley.org
- Planning and Conservation League, http://www.pcl.org
- UC Agricultural Issues Center/Land-Use and Farmland Conversion, http://aic.ucdavis.edu/research1/land.html
- Ducks Unlimited, Inc., Western Regional Office, http://www.ducks.org/conservation/wro-regional-office-contacts/western-regional-office
- The Nature Conservancy, http://www.nature.org

8-8 Sensitive Species* *Vineyard & Winery*

Category 4	Category 3	Category 2	Category 1
Most of the sensitive species that have occurred in the region were known ***And*** It was known whether any of these species occurred on the property ***And*** The property was managed to protect and enhance habitat for these species.	Most of the sensitive species that have occurred in the region were known ***And*** The property was managed to protect habitat for these species.	Most of the sensitive species that have occurred in the region were known.	Sensitive species in the winegrowing and/or winemaking region were unknown.
*See **Box 8-P** for definition of sensitive species.			

BOX 8-P SENSITIVE SPECIES

The term "Sensitive Species" covers all rare, threatened, protected, endangered, and/or of special concern species, along with other policy related species. There are approximately 360 plants and animals listed under the Federal and State Endangered Species Acts in California. According to a 1993 study by the Association for Biodiversity Information and The Nature Conservancy, half of listed species have approximately 80% of their habitat on private lands. Because of listed species' dependence on private lands, private landowner participation in endangered species conservation is critical to successful species recovery and their eventual delisting. Several state and federal programs provide mechanisms to protect landowners' interests in their land, while providing incentives to manage lands in ways that benefit endangered species.

A Species of Special Concern (SSC) is a species, subspecies, or distinct population of an animal* native to California that currently satisfies one or more of the following (not necessarily mutually exclusive) criteria:

- is extirpated from the State or, in the case of birds, in its primary seasonal or breeding role;
- is listed as Federally-, but not State-, threatened or endangered;
  meets the State definition of threatened or endangered but has not formally been listed;
- is experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (not reversed) that, if continued or resumed, could qualify it for State threatened or endangered status;
- has naturally small populations exhibiting high susceptibility to risk from any factor(s), that if realized, could lead to declines that would qualify it for State threatened or endangered status.

The PRESCRIBE online database application was developed to help pesticide applicators find out if they have any endangered species in the vicinity of their application site, and the use limitations

applicable to the pesticide product(s) they intend to use. Visit the DPR database at: http://www.cdpr.ca.gov/docs/endspec/prescint.htm *For the purposes of this discussion, "animal" means fish, amphibian, reptile, bird and mammal.

8-9 Sensitive Species and Collaboration with Partners*			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Qualified experts, familiar with sensitive species, were consulted to inform vineyard and/or winery operation management decisions that may affect sensitive species ***And*** Where available, there was participation in incentive or other programs for private landowners offered by state and federal agencies that protected the interest in the assessed land while benefiting sensitive species.	Qualified experts, familiar with sensitive species, were consulted to inform vineyard and/or winery operation management decisions that may affect sensitive species.	Information developed by qualified experts was used to determine how best to address the presence of sensitive species known to exist on the property.	Aside from regulatory requirements, input had not been sought from outside sources when dealing with sensitive species. *(Select N/A if it could be verified that no sensitive species were on the property during the assessment year or the winery is in an urban environment)*
*Partners/qualified experts can include government agencies (such as NRCS, local RCDs) or non-profit organizations (such as Trout Unlimited, California Land Stewardship Institute/Fish Friendly Farming).			

BOX 8-Q SENSITIVE SPECIES AND PRIVATE LAND OWNERS

Many federally listed species occur partially, extensively, or, in some cases, exclusively on private lands, so private lands are often essential in protecting and recovering endangered species. To meet this challenge, the US Fish and Wildlife Service is developing policies that protect landowners' interests in their land, while providing them with incentives to manage lands in ways that benefit endangered species.

Programs for Private Landowners Assistance offered by the US Fish and Wildlife Service include:

- **Safe Harbor Policy**. This policy encourages voluntary management of listed species to promote their recovery on non-federal lands by giving assurances to landowners that no additional future regulatory restrictions will be imposed.
- **Candidate Conservation Agreements with Assurances Policy**. These agreements provide incentives for non-Federal property owners to conserve candidate species, thus potentially making their listing unnecessary.
- **Habitat Conservation Planning**. This process allows private landowners to develop land that supports listed species provided conservation measures are taken.
- **No Surprises Policy**. This policy assures participating landowners that they will incur no additional mitigation requirements beyond those agreed to in their Habitat Conservation Plans, even if circumstances change.

For more information contact:

Sacramento Fish and Wildlife Office, 2800 Cottage Way, Room W-2605, Sacramento, California 95825. Phone (916) 414-6600, Fax (916) 414-6710, Web site: http://www.fws.gov/sacramento/

Ventura Fish and Wildlife Office, 2493 Portola Road, Suite B, Ventura, CA 93003.
Phone (805) 644-1766, Fax (805) 644-3958, Web site: http://ventura.fws.gov

Source: USFWS – Our Endangered Species Program and How It Works with Landowners (http://www.fws.gov/endangered/esa-library/pdf/landowners.pdf).

9. ENERGY EFFICIENCY

Original Chapter Authors: Jeff Dlott and John Garn; Modified by the Sustainable Winegrowing Joint Committee

In today's energy environment, in addition to increased attention to climate change, it is essential to have a comprehensive energy management plan that includes conservation, energy efficiency, investigation and utilization of renewable energy sources and reduction of greenhouse gas emissions. A comprehensive energy management plan should also contain contingency options in order to meet energy needs at critical times, such as on-site generation capabilities during crush, particularly in the era of Public Safety Power Shut-Offs as a wildfire prevention strategy.

The drive to save money by conserving natural resources and the uncertainty related to the availability and costs of electricity and fuel have compelled many vintners and growers to invest in energy efficiency measures, such as upgrading lighting, insulating tanks and piping, installing variable frequency drives on pumps and motors, installing dissolved oxygen sensors for process water treatment and engaging employees in energy conservation efforts. These measures have been enhanced through complementary internal actions such as energy conservation training (implementing policies to turn off equipment and lighting when not in use), shifting to night harvesting to reduce the ambient heat stored in grapes and thus cooling requirements and the appointment of staff or teams to investigate, implement, monitor and further improve energy efficiency practices and equipment. Many wineries and vineyards are also installing solar panels as part of their renewable energy strategies, with a growing number adding batteries for storage.

These combined efforts have resulted in measureable reductions in energy consumption and related energy costs, but ongoing and additional measures need to be implemented to maintain and improve the sustainability of the California wine industry, including its economic viability.

The purpose of this chapter is to help growers and vintners improve their understanding of energy use in their operations and their ability to identify and implement prioritized energy saving measures. This chapter is linked to a performance metric for energy use that gives growers and vintners the ability to monitor and record energy use by production unit (e.g., acre/tons of grapes per kilowatt hour and/or gallons/cases of wine per kilowatt hour). Growers and vintners can use a DIY Winery Energy Audit Guide and DIY Energy Audit for Vineyards Guide to conduct their own internal energy audits and develop energy management plans (available from the CSWA Resource Library). This chapter, combined with the energy performance metric and DIY Energy Audit Guides, will help growers and vintners target specific energy saving opportunities, while monitoring and documenting improvement in the overall efficiency of operations and the California wine industry as a whole. This chapter includes 12 criteria to self-assess:

- The state of your energy efficiency planning, monitoring, goals, and results
- The total energy consumed per acre or ton of grapes and/or energy consumed per gallon or case of wine produced using an energy performance metric
- The extent of energy efficiency per major operation
- The extent of management support and employee training efforts to improve energy efficiency
- The opportunities in your operation to identify and prioritize options to improve energy efficient practices.

List of Energy Efficiency Criteria

Before installing a renewable energy system such as solar, it is important to implement as many energy efficiency measures as possible so that you are right-sizing the solar PV system and not paying for a larger system than you need. The capital expenditure required for energy efficiency measures is much smaller than for a renewable energy system to power those inefficiencies.

Performance Metrics – Energy

Why are Performance Metrics important?
Knowing and understanding the actual use of resources is an important aspect for controlling costs and increasing the profitability for any business. Including the relationship between practices and measurable outcomes allows your business to accurately benchmark its performance and set achievable targets for improvement using actual, not perceived, measurements. Whereas the practice-based self-assessment helps determine what winery or vineyard practices affect energy or fuel use, for example, performance metrics calculations provide the rationale for setting targets based on real measurements. As the adage goes, "You can't manage what you don't measure."

The Energy Metric is used to track the direct energy from fuel and electricity to power farm and winery equipment and irrigation systems. By accounting for energy use, wineries and vineyards can track and monitor energy usage over time, set reduction targets and potentially decrease energy.

How to calculate Energy Metrics?
The energy metrics for vineyards and wineries include total kWh and kWh per unit of production (see below for calculation examples).

Using Performance Metrics

1. Collect
Identify and gather data needed to calculate the metric

2. Measure
Calculate metrics and determine your baseline

3. Track
Track your metrics calculations from year to year

4. Manage
Set targets for improvement and identify action plans

Metric Area	Metric Calculation	Data Elements	Data Sources
Energy Use (Vineyard)	**Energy Use** = $\frac{\text{kWh}}{\text{unit of production}}$	• Fuel usage • Electricity usage • Acreage • Crop yield (total tons)	• Utility records • Fuel receipts • Meter/equipment readings
Energy Use (Winery)	**Total Energy Use =** Total kWh *Or* **Energy Use (per unit)** = $\frac{\text{kWh}}{\text{unit of production}}$	• Fuel usage • Electricity usage • Gallons and cases produced	• Utility records • Fuel receipts • Meter/equipment readings

How do I start tracking my Performance Metrics?
To get started tracking and recording energy metrics, as well as other performance metrics (e.g., greenhouse gas emissions, water, and applied nitrogen) visit http://www.sustainablewinegrowing.org/metrics.php or click on the "Metrics" tab within the SWP Online System.

9-1 Planning, Monitoring, Goals, and Results

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
An energy audit* of the overall winery operation or vineyard (including testing of irrigation pumps than five years old, equipment, office building, etc.) was conducted in the last 5 years and was reviewed annually ***And*** A documented energy management plan was developed that includes elements such as lighting, pumps, tanks, refrigeration, motors, drives, etc. ***And*** Most cost effective measures from the audit were implemented ***And*** Total energy use was monitored and recorded throughout the year and used to calculate performance metrics for energy and greenhouse gases related to energy use ***And*** Goals for efficiency were set for overall energy use ***And*** Energy metrics and conservation were incorporated into an energy awareness training program for employees.	An energy audit* of the overall winery operation or vineyard (including testing of irrigation pumps than five years old, equipment, office building, etc.) was conducted in the last 5 years and was reviewed annually ***And*** An energy management plan was developed that includes elements such as lighting, pumps, tanks, refrigeration, motors, drives, etc. ***And*** Some cost effective measures from the audit were implemented ***And*** Total energy use was monitored and recorded throughout the year ***And*** Goals for efficiency were set for overall energy use.	An energy audit* of the overall winery operation or vineyard irrigation pump(s) was conducted in the last 5 years** ***And*** The rate schedule for cost of electricity was recently reviewed ***And*** Results from the audit and/or pump efficiency test were considered when making decisions on maintenance, capital improvements, and employee training.	There was a general idea of total energy use (electricity, natural gas, propane, diesel and unleaded gasoline) per year within the vineyard and/or winery operation ***And*** The rate schedule for cost of electricity was not reviewed.

*An energy audit can be accomplished with outside expertise or by operations staff conducting a self-audit (See **Box 9-A** for information on winery energy audits and *How to Conduct a DIY Vineyard Energy Audit* is available from the CSWA Resource Library at: https://library.sustainablewinegrowing.org/. Many utilities offer energy audit assistance – check with your local provider for available services. The Natural Resources Conservation Service (NRCS) provides technical information and financial assistance for energy audits through the EQIP On-Farm Energy Initiative – contact your local NRCS office for more information. See **Box 9-C** for information on agricultural pump efficiency audits.
**If the vineyard irrigation pump is less then 5 years old an energy audit is not needed.
***See **Box 9-B** for information about peak/off-peak rates.

Box 9-A DIY Winery Energy Audit

A winery energy audit is designed to identify where energy is being used and what changes could improve overall efficiency. This can result in immediate cost savings for any winery. However, the longer-term value of performing energy audits is that the information gathered during this process provides greater insight into production operations. A better understanding of how interrelated systems work together unlocks insights into process optimization and is helpful for designing future growth, changes in infrastructure or modifications to existing Standard Operating Procedures (SOPs).

CSWA's DIY Winery Energy Audit Guide includes three complimentary steps all designed to identify, implement and manage energy efficiency opportunities within a winery. Although a winery can complete only the first step and gain better insights into their operation, completing all three steps will provide the most value and results in the most potential savings and opportunities.

1. DIY Winery Energy Audit Checklist
2. Equipment Inventory
3. Energy Management Plan Guide

CSWA's DIY Winery Energy Audit Guide can be downloaded at:
https://library.sustainablewinegrowing.org/

Box 9-B Peak and Off-Peak Rates

Electric utilities offer reduced rates for commercial facilities and agriculture operators to run more power during off peak hours instead of during peak hours. Changing the timing of certain functions of your operations throughout the day can lead to cost savings.

For PG&E customers, starting November 2020, peak hours for commercial facilities is 4-9 p.m. every day. Agriculture peak hours are noon-6 p.m. and as of March 2021, the agriculture peak hours will change to 5-8 p.m. every day.

Information on PG&E peak and off-peak hours can be found at: https://www.pge.com/en_US/small-medium-business/your-account/rates-and-rate-options/time-of-use-rates.page

Information on SoCal Edison peak and off-peak hours can be found at:
https://www.sce.com/business/rates/time-of-use/Time-of-Use-Rates-FAQs

Information on San Diego Gas and electric peak and off-peak hours can be found at:
https://www.sdge.com/whenmatters

A list of all other California electric utilities and links toi their websites can be found at:
https://ww2.energy.ca.gov/almanac/electricity_data/utilities.html

9-2 Vineyard Pump Efficiency

Vineyard

Category 4	Category 3	Category 2	Category 1
Pumps were tested for efficiency and results used for maintenance and replacement decisions ***And*** If new pumps were required, "right sized" pumps and variable speed drives were implemented ***And*** Integrity of irrigation infrastructure (distribution pressure, emitter flow, water table level, recharge rates) and all elements of vineyard irrigation management (soil water retention, ET, irrigation system, water table level, water recharge and well integrity) were considered ***And*** Pump repairs and replacements were documented and tracked.	Pump efficiency was considered as one element of vineyard irrigation management ***And*** Pumps were tested for efficiency ***And*** If new pumps were required, "right sized" pumps and variable speed drives were considered ***And*** Integrity of irrigation infrastructure was reviewed (distribution pressure, emitter flow, water table level, recharge rates) and taken into consideration.	Pump efficiency was considered as one element of vineyard irrigation management ***And*** Efforts were made to improve the energy efficiency of vineyard pumps.	The pumps were operated and maintained much as they have been since installation. *(Select N/A if no pumps exisit on the property)*

See **Box 9-C** for more information on irrigation efficiency.

BOX 9-C IRRIGATION EFFICIENCY

Energy use in the vineyard is tied to a large extent to the pumping of water. Using water efficiently saves water, energy, and money. Here is a checklist to help you get started with irrigation efficiency:

- Whether you are pumping with electricity, natural gas, propane, or diesel, perform well performance tests to determine if well is pumping efficiently or not. Flows and pressures are reduced when water levels drop and there can be inefficiencies. To find out about pump efficiency programs in your area visit http://www.pumpefficiency.org/pump-testing/pump-testers/ or http://www.pumpefficiency.org/.
- Options to deal with decreased well performance:
  - Video the casing to determine if reduced flow is due to perforation plugging; if so, the casing can be jetted, pressure washed and/or scrubbed to remove scaling. If well is relatively new, this will most likely not be the case.
  - If decreased flows are seasonal and due to lower pumping levels, consider reducing the size of irrigation sets.
  - Shorter duration and increased frequency of irrigations will also help to improve performance.
  - Alternating days between irrigations will allow the aquifer to recover.
  - Consult with neighbors and try to schedule irrigations at different times.
- Once your well performance has been stabilized you need to look at energy costs and how to lower them. Examples include the following:
  - Install a time-of-use meter on your well. Time-of-Use (TOU) meters allow you to pay a reduced rate for “off-peak” pumping hours. Off-peak hours change throughout the year but generally occur during the night (e.g., after 9pm). Pumping off-peak will reduce electric charges by approximately 60%. A special meter is required.
  - Install automatic timers on wells to ensure desired run times.
  - If your vineyard has irrigation sets that vary in size and flow, a variable speed drive will significantly increase efficiency.
  - The key is to match flow and pressure with the irrigation design.
    - Too much pressure results in increased pumping costs and too low of pressure results in poor distribution uniformity.
- Know how long and how often to irrigate:
  - Know the depth of your effective root zone
  - Install sensors in the key locations
  - Record soil moisture over time

Source: Tony Domingos of Tony Domingos Farming, Paso Robles, CA.

9-3 Vineyard Vehicles			*Vineyard*
Category 4	**Category 3**	**Category 2**	**Category 1**
The amount of fuel used in the vineyard was known and tracked ***And*** Practices and technological impacts on fuel consumption (e.g., tractor passes, engine maintenance and efficiency, age of equipment) were addressed to increase fuel efficiency ***And*** At least one alternative fuel (e.g., biodiesel, propane, methane) was used.	The amount of fuel used in the vineyard was known and tracked ***And*** Practices and technological impacts on fuel consumption (e.g., tractor passes, engine maintenance and efficiency, age of equipment) were addressed to increase fuel efficiency.	The amount of fuel used in the vineyard was known.	The amount of fuel used in the vineyard was not known.

Night harvesting reduces the ambient heat stored in grapes and therefore reduces cooling requirements at the winery. It also allows vineyard workers to pick grapes while avoiding the hottest parts of the day.

9-4 Winery Motors, Drives, and Pumps *Winery*

Category 4	Category 3	Category 2	Category 1
Existing equipment was maintained for optimal performance, and results of a comprehensive energy audit were used to review capacity and performance requirements before equipment replacement ***And*** Energy efficient technologies and designs were used throughout the operation such as sloped floors, stacked tanks, smaller diameter pipes*, and software for monitoring equipment performance ***And*** When new equipment purchases were made, variable frequency drives, multi-speed motors, and "right sized" pumps were selected.	Existing equipment was maintained for optimal performance, and results of a comprehensive energy audit were used to review capacity and performance requirements before equipment replacement ***And*** New technologies were investigated to improve the energy efficiency of motors, drives, and pumps ***And*** When new equipment purchases were made variable frequency drives, multi-speed motors, and "right sized" pumps were considered.	Efforts were made to improve the energy efficiency of the motors, drives, and pumps system.	The motors, drives, and pumps were operated and maintained much as they have been since installation.

*Make sure that smaller diameter pipes are not undersized for their specific tasks or they may increase required pump horsepower.
For detailed information on motor effieceny, you can reference the U.S. Department of Energy's Premium Efficiency Motor Selection and Aplication Guide:
https://www.energy.gov/sites/prod/files/2014/04/f15/amo_motors_handbook_web.pdf.

9-5 Refrigeration System *Winery*

Category 4	Category 3	Category 2	Category 1
Technologies were selected, implemented and maintained for optimal performance ***And*** Chiller loads were reduced by building insulation, night air cooling, and off-peak evaporative cooling and/or ice making ***And*** Energy efficient technologies were used throughout the refrigeration system such as extra heat exchange surfaces, condensers fitted with flow-control valves to reduce pressure and temperature, chillers that can operate at moderate or high cooling stages, variable frequency drives on glycol pumps and variable-speed fans for cooling towers.	Technologies were selected and implemented for optimal performance ***And*** Chiller loads were reduced by building insulation, night air cooling, and off-peak evaporative cooling and/or ice making ***And*** Existing equipment was maintained for optimal performance, such as using properly sized evaporators and condensers, high suction pressure to reduce compressor energy use, and keeping refrigerant fluid temperature as low as possible after it is cooled.	Efforts were made to improve the energy efficiency of the refrigeration system and the refrigeration system was targeted for future energy efficiency upgrades.**	The refrigeration system was operated and maintained much as it has been since installation ***And*** The system was in compliance with all applicable refrigerant regulations and refrigerant material phase-outs.*

* For more information about phase-outs visit: https://www.epa.gov/ods-phaseout
**If the refigeration system is less then 5 years old energy efficiency upgrades are not needed. Efforts to improve the energy efficiency of the system can include work that occurred prior to the latest assessment year (e.g., efforts that occurred several years ago).

9-6 Tanks and Lines

Winery

Category 4	Category 3	Category 2	Category 1
Vendors and suppliers had been invited to demonstrate new technologies that improve the energy efficiency of cooling and heating tanks ***And*** 80% or more of tanks were equipped with insulated jackets or the building(s) they are located in is enclosed and insulated ***And*** Glycol lines were insulated.*	Research was done to improve the energy efficiency of cooling and heating tanks ***And*** 50% or more of tanks were equipped with insulated jackets or the building(s) they are located in is enclosed and insulated, and methods were used to ensure even cooling/heating to reduce thermal stratification ***And*** Glycol lines were insulated.*	Efforts were made to improve the energy efficiency of cooling and heating tanks ***And*** Some tanks were equipped with insulated jackets and methods were used to ensure even cooling/heating to reduce thermal stratification ***And*** Some tanks were located to reduce cooling or heating needs, including being shaded from direct sun and/or housed in an area that benefits from night air cooling ***And*** Glycol lines were insulated.*	The tank system was operated and maintained much as it had been since installation.

*Insulated tanks with insulated chillers are viable alternatives to glycol jackets for cooling product.

Insulating outdoor tanks reduces tank refrigeration and energy costs, while helping to maintain a consistent temperature for better wine quality.

9-7 Heating Ventilation and Air Conditioning (HVAC)*

Winery

Category 4	Category 3	Category 2	Category 1
Existing equipment was maintained for optimal performance, including insulation, weather stripping, and window film in all buildings to reduce demand ***And*** Heating and cooling loads for the facility were reduced (e.g., by insulation, temperature controlled cellars, louvered roof panels, and timed automatic door openers) ***And*** New technologies were investigated to improve the energy efficiency of the HVAC system ***And*** Energy efficient technologies and designs were used throughout the operation.	Existing equipment was maintained for optimal performance, including insulation, weather stripping, and window film in all buildings to reduce demand ***And*** Heating and cooling loads for the facility were reduced (e.g., by insulation, temperature controlled cellars, louvered roof panels, and timed automatic door openers).	Efforts were made to improve the energy efficiency of the HVAC system ***And*** Regularly scheduled maintenance included checking insulation, weather stripping, and window film.	The HVAC system was operated and maintained much as it has been since installation.

*A good source for information on certified energy efficient HVAC systems is http://www.energystar.gov/index.cfm?c=heat_cool.pr_hvac.

Box 9-D Radiant Barriers

Radiant barriers work by reducing heat transfer by thermal radiation across the air space between the roof deck and the attic floor, where conventional insulation is usually placed. Radiant barriers can help reduce air conditioning loads and heat loss. Visit Oak Ridge National Laboratory’s Building Technologies Research and Integration Center (BTRIC) to learn more about thermal barriers and energy conservation relating to the building envelope at https://www.ornl.gov/facility/btric.

9-8 Lighting – Offices and Labs

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Compact fluorescent lights or LEDs were used in all appropriate locations ***And*** Light fixtures were inspected and cleaned if needed ***And*** Lighting was designed to illuminate areas needed at the time (task lighting) and was complemented with natural light (if possible) ***And*** Energy efficient lighting technologies and designs were used (e.g., automatic room lighting controls installed to turn lights on or off, skylights or natural light tubes installed) throughout the operation ***And*** New lighting technologies to improve energy efficiency were tested.	Compact fluorescent lights or LEDs were used in all appropriate locations ***And*** Light fixtures were inspected and cleaned if needed ***And*** Lighting was designed to illuminate areas needed at the time (task lighting) and was complemented with natural light (if possible) ***Or*** Energy efficient lighting technologies and designs were used (e.g., automatic room lighting controls installed to turn lights on or off, skylights or natural light tubes installed) ***And*** New lighting technologies were investigated.	Efforts were made to improve lighting energy efficiency ***And*** Compact fluorescent lights or LEDs were used in some locations ***And*** Light fixtures were not inspected as part of cleaning procedures.	The lighting system was operated and maintained much as it has been since installation.

9-9 Lighting – Shops and Facilities*			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Compact fluorescent lights or LEDs were used in all locations ***And*** Light fixtures were inspected and cleaned if needed ***And*** Lighting was designed to illuminate areas needed at the time (task lighting) and was complemented with natural light (if possible); unnecessary lamps and fluorescent ballasts were disconnected ***And*** Energy efficient lighting technologies and designs were used throughout the operation (e.g., automatic room lighting controls, mercury vapor, sodium and sulfur lamps, natural light tubes) ***And*** New lighting technologies to improve energy efficiency were tested.	Compact fluorescent lights or LEDs were used in most locations ***And*** Light fixtures were inspected and cleaned if needed ***And*** Lighting was designed to illuminate areas needed at the time (task lighting) and was complemented with natural light (if possible); unnecessary lamps and fluorescent ballasts were disconnected ***Or*** Energy efficient lighting technologies and designs were used (e.g., automatic room lighting controls, mercury vapor, sodium and sulfur lamps, natural light tubes) ***And*** New lighting technologies were investigated.	Efforts were made to improve lighting energy efficiency ***And*** Compact fluorescent lights or LEDs were used in some locations ***And*** Light fixtures were not inspected as part of cleaning procedures.	The lighting system was operated and maintained much as it has been since installation.
*A good source for information on certified energy efficient lighting systems is http://www.energystar.gov/index.cfm?c=products.pr_find_es_products.			

9-10 Lighting – Outdoor and Security

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Sodium, LEDs and/or sulfur lamps (or other high efficiency solutions) were installed for outdoor lighting ***And*** Light fixtures were inspected and cleaned if needed ***And*** Lighting was designed to illuminate key security areas at all times, motion detectors were used in other areas, unnecessary lamps and fluorescent ballasts were disconnected ***And*** New lighting technologies were tested to improve energy efficiency ***And*** Night lighting impacts were mitigated when using new technologies ***And*** Employees were trained to turn off lights during their rounds, if applicable.	Sodium, LEDs and/or sulfur lamps (or other high efficiency solutions) were considered for outdoor lighting ***And*** Light fixtures were inspected and cleaned if needed ***And*** Lighting was designed to illuminate key security areas at all times, motion detectors were used in other areas, unnecessary lamps and fluorescent ballasts were disconnected ***And*** New lighting technologies were investigated to improve energy efficiency ***And*** Night lighting impacts were considered when using new technologies.	Efforts were made to improve lighting energy efficiency ***And*** Light fixtures were not inspected as part of cleaning procedures.	The lighting system was operated and maintained much as it has been since installation.

To learn more about outdoor lighting and the Dark Sky protocol go to http://www.darksky.org/.

BOX 9-E LIGHTING ENERGY EFFICIENCY EXAMPLES

NO-COST:
- Turn off lights when not in use
- Make sure lighting fixtures are clean

LOW-COST:
- Replace incandescent light bulbs with compact fluorescent light bulbs (save up to 10%)
- Install automatic room lighting controls to turn lights on or off, depending on occupancy or time of day (save 1-3%)
- Install task lighting as opposed to overhead lights – light only areas needed at the time (save up to 7%)
- Disconnect unnecessary lamps and fluorescent ballasts (save up to 8%)
- Retrofit T12 lights and magnetic ballasts to T8 or T5 lights and electronic ballasts (save 10-15%)

For more ideas on no-cost and low-cost energy efficiency, go to https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/stamp-out-energy-waste.

9-11 Office Equipment*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Office equipment was turned off or in standby mode when not in use ***And*** Energy consumption was considered if office equipment was upgraded or replaced ***And*** New or replacement office equipment was Energy Star® certified.	Office equipment was turned off or in standby mode when not in use ***And*** Energy consumption was considered if office equipment was upgraded or replaced.	Efforts were made to improve office equipment energy efficiency ***And*** Office equipment was turned off or in standby mode when not in use.	Office equipment was operated and maintained much as it has been since installation.

*A good source for information on certified energy efficient office equipment is http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductCategory&pcw_code=OEF.

9-12 Renewable Sources of Power

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The source(s) for electricity supplied to the vineyard and/or winery was known* ***And*** One third-party provided renewable power source for the vineyard and/or winery was selected ***And/Or*** A renewable energy system, such as wind, solar photovoltaic, passive solar thermal, methane digesters, biodiesel, fuel cells, geothermal, green power or other form of renewable energy was implemented.	The source(s) for electricity supplied to the vineyard and/or winery was known* ***And*** A renewable energy assessment was completed for solar photovoltaic, passive solar thermal or green power.	The source(s) for electricity supplied to the vineyard and/or winery was known* ***And*** Potential renewable energy options (such as solar, wind, methane digesters, fuel cells, geothermal heat pumps, solar powered wastewater aerators or solar powered pumps, a third-party provided renewable power source) had been researched (e.g., via case studies, videos or site visit).	The source(s) for electricity supplied to the vineyard and/or winery was unknown ***And*** Awareness of potential renewable energy options was limited.

*To find a breakdown of your sources of energy and energy usage, contact your service provider or utility company.

BOX 9-F SOLAR POWERED WASTEWATER AERATORS AND PUMPS

There are more options for incorporating renewable energy into your operations than rooftop solar panels. You can also explore innovative technologies powered by the sun to aerate wastewater ponds and to pump water.

Solar powered wastewater aeration in Dickinson, ND:
https://www.waterworld.com/technologies/aeration/article/16203626/solarpowered-aerator-reduces-energy-drain-on-north-dakota-wastewater-lagoon

Solar powered wastewater aeration in St. Helens, Oregon:
https://www.wwdmag.com/channel/casestudies/solar-powered-circulation

Solar Pumps Save Vineyard 75 Percent on Installation Costs:
https://www.pumpsandsystems.com/solar-pumps-save-vineyard-75-percent-installation-costs

Solar pump case study at Hacienda Araucano Vineyard:
https://partnernet.lorentz.de/files/lorentz_casestudy_vineyardlurton_chile_en.pdf

10. WINERY WATER CONSERVATION AND WATER QUALITY

Original Chapter Authors: John Garn and Jeff Dlott; Modified by the Sustainable Winegrowing Joint Committee

California winegrape growers and vintners recognize the need to conserve water and improve efficiency to ensure the future availability of quality water – for agriculture, communities, and the environment. A critical element to the sustainability of the wine community is the ability to affordably acquire, use, process, and discharge water of high quality back into the environment. At every step of the winemaking process, from crushing and pressing through fermentation and aging to the bottling of the finished product, water is required. Water is also at the heart of the cleaning and sanitizing system, making sure tanks, barrels, and the bottling line are properly clean and sanitized.

The water cycle is just that, a cycle, where water comes in and flows through, with some water stored and some moved out. The amount and quality of the water entering and discharging from the winery is all a part of this cycle. As a steward and user of water resources, it is important to monitor and record the amount and quality of water coming into the operation from wells, surface water, and/or municipalities. Some wineries have installed water meters at key operational points to monitor water use during specific activities like crush, fermentation, and bottling. In addition, collecting this type of information and measuring water supplied, estimating losses, and understanding the amount used within the winery or discharged from the winery facilitates the development of a water balance (sum of inputs and sum of outputs) and an opportunity for the winery to develop improvements in water efficiencies. Tools and information on developing water balances and assessing water usage are described below. The documentation of this information has allowed operations personnel to monitor, analyze, and thus fine-tune water conservation practices at key points during the production process.

The purpose of this chapter is to help vintners improve their understanding of water use, conservation and water quality in their operations, as well as their ability to identify and implement prioritized water saving measures as well as practices that improve water quality. This chapter is linked to a performance metric for water use that gives vintners the ability to monitor and record water use by production unit (e.g., gallon of water per gallon or case of wine). The water performance metric will help vintners target specific water saving opportunities, while monitoring and documenting improvement in the overall efficiency of operations and the California wine industry as a whole.

This chapter provides 15 criteria to self-assess:

- The state of your winery water use, conservation and water quality planning, monitoring, goals, and results
- The total water consumed per gallon or case of wine produced
- The extent of water conservation practices per major operation
- The extent of management support and employee training efforts to improve water conservation
- The opportunities in your operation to identify and prioritize options to improve water conservation
- The opportunities in your operation to identify and prioritize options to improve discharged water quality.

List of Winery Water Conservation and Water Quality Criteria

Installing timers for barrel washing, along with using a high pressure/low volume nozzle, helps conserve water needed for barrel sanitation.

Performance Metrics – Winery Water

Using Performance Metrics

1. Collect
Identify and gather data needed to calculate the metric

2. Measure
Calculate metrics and determine your baseline

3. Track
Track your metrics calculations from year to year

4. Manage
Set targets for improvement and identify action plans

Why are Performance Metrics Important?
Knowing and understanding the actual use of resources is an important aspect for controlling costs and increasing the profitability for any business. Including the relationship between practices and measurable outcomes allows your business to accurately benchmark its performance and set achievable targets for improvement using actual, not perceived, outcomes. Whereas the practice-based self-assessment helps determine what winery or vineyard practices affect energy or fuel use (for example), performance metrics calculations provide the rationale for setting targets based on real measurements. As the adage goes, "You can't manage what you don't measure."

The Winery Water Metric is used to track total water used per case or gallon of wine. Tracking the metric from year to year allows a winery to track overall water efficiency, benchmark the water efficiency of the facility, establish water reduction goals and monitor the winery's progress towards those goals.

Continually tracking and monitoring water use is important to making reductions in water use, because a winery cannot manage what it doesn't measure. Communicating these metrics to employees can also help them understand the winery's water use and encourage them to engage in water reduction practices. Communicating water usage in your employee's relevant language also helps to ensure the water usage information is getting clearly communicated and understood.

It is also important to know that tracking and monitoring your water use annually is a good start but tracking monthly is even better and allows wineries to more quickly identify and address leaks that may have gone undetected for long periods of time. Best practice is to assess your pipes and water infrastructure monthly for leaks and monitor usage to identify any unusual water usage.

How to Calculate Water Efficiency Metrics?
Water use for wineries can be calculated as gallons of water used per gallon or case of wine produced over a twelve-month period (see below for calculation examples).

Metric Area	Metric Calculation	Data Elements	Data Sources
Water Use (Winery)	**Total Water Use =** Gallons of Water Used / Gallon of wine *Or* Gallons of Water Used / Case of Wine	• Water usage • Gallons and cases produced	Utility records; Flow meter readings

How do I start tracking my Performance Metrics?
To get started tracking and recording winery water use, as well as other performance metrics (e.g., greenhouse gas emissions, applied nitrogen and energy use) visit http://www.sustainablewinegrowing.org/metrics.php or click on the "Metrics" tab within the SWP Online System.

10-1 Water Conservation Planning, Monitoring, Goals, and Results *Winery*

Category 4	Category 3	Category 2	Category 1
Total water use was monitored, recorded and tracked throughout the year ***And*** A comprehensive water assessment was conducted in the last 5 years* ***And*** Water use data and assessment results were used to make decisions on maintenance, capital improvements, employee training, and reducing water use ***And*** Yearly goals were revised for the continuous improvement of overall water use ***And*** A comprehensive water conservation program, including a water performance metric, person(s) responsible for water conservation, and implementation of cleaning and sanitizing procedures was implemented.	Total water use was monitored and recorded throughout the year ***And*** A comprehensive water assessment was conducted in the last 5 years* ***And*** Water use data and assessment results were used to make decisions on maintenance, capital improvements, employee training, and reducing water use ***And*** Water use data and assessment results were used to set yearly goals for overall water use from a production baseline.	Total water use per year was known ***And*** Total water use was monitored throughout the year ***And*** The data was used to begin development of a water conservation program.	Total winery water use per year was estimated.

*A water assessment can be accomplished with complementary approaches such as combining input from operations staff with specialist outside expertise. See **Box 10-A** for more on water assessments. Visit the CSWA Resource Library to download the *Comprehensive Guide to Sustainable Management of Winery Water and Associated Energy*. This document gives wineries the tools for self-assessment of winery water and provides guidance on making improvements in environmental performance. Smaller wineries may find the *Sustainable Water Management Handbook for Small Wineries* most helpful – available in the CSWA Resources Library at https://library.sustainablewinegrowing.org/. Other useful tools include the Winery Water Efficiency and Hot Spots Tool and Winery Water Budgeting Tool, also available in the Resource Library.

BOX 10-A CONDUCTING A WATER ASSESSMENT

A winery water assessment increases the potential for saving water by identifying areas where water is not used efficiently or could be reused before final discharge. The Comprehensive Guide to Sustainable Management of Winery Water and Associated Energy and related excel worksheets (available at: https://library.sustainablewinegrowing.org/) provide the tools needed to conduct a water assessment. The document includes guidelines to help wineries collect and evaluate data on their water use and includes a step-by-step process to self-assess water use within a winery.

Step 1 – **Planning and Program Organization**: The purpose of this step is to set goals and expectations and to ensure management's buy-in.

Step 2 – **Winery Self-Assessment**: During this step, the winery inventories water using activities including estimates of the amount of water used, chemicals, and other constituents in that water (i.e., crushing and pressing operations, wine/juice ion exchange regeneration, tank washing, filtration activities, centrifuge, stillage, barrel washing, bottling, etc.). Some data might not be available and some additional data may need to be collected.

Step 3 – **Data Evaluation and Option Identification**: Based on the data collected in Step 2 and the goals established in Step 1, the facility identifies all possible options to improve overall water use efficiency. This includes generating ideas for source reduction, recycling or treatment, where source reduction is the most desirable.

Step 4 – **Feasibility Analysis**: The document provides tools to conduct a technical and economic evaluation of the options generated in Step 3. This allows the winery to identify the preferred options from which to develop an action plan.

Step 5 – **Program Implementation**: This step recommends a "plan-do-check-act" cycle. This is a structured approach for planning a project to meet defined specification, executing the project, monitoring the results against the specification, and acting to make adjustments.

Box 10-A1 Winery Water Tools

CSWA worked with experts to create the following winery water tools to help vintners self-assess their winery water uses, identify "hot spots" and to identify the complete cost of water. All tools are available from the CSWA Resource Library at https://library.sustainablewinegrowing.org/.

- **Winery Water Efficiency and Hot Spots Tool:** This tool walks users through the steps needed to identify the highest water using activities ("hot spots") at the winery, and results in a conceptual facility water balance to understand where water is being used throughout the winery. The tool also helps users consider the tangible and intangible costs of water and the multiple benefits of improving water use efficiency. (To see a video demonstration on how to use the tool, go to: https://vimeo.com/227814995.)

- **Winery Water Budgeting Tool:** After first completing the Hot Spots tool, this tool can be used to estimate your current cost of water, including the costs of acquiring water, using the water, and disposing of that water. (To see a video demonstration on how to use the tool, go to (starts at 4:15)**:** https://vimeo.com/227814995.)

- **Comprehensive Guide to Sustainable Management of Winery Water and Associated Energy:** The document gives wineries the tools for self-assessment of winery water and provides guidance on making improvements in environmental performance.

- **Sustainable Water Management Handbook for Small Wineries:** The handbook helps small wineries conduct a self-assessment of their water use.

10-2 Source Water Quality Planning, Monitoring, Goals, and Results *Winery*

Category 4	Category 3	Category 2	Category 1
The water quality used in winemaking operations was tested and results recorded according to the schedule set out in permit requirements or as needed by water system user ***And*** Results from the testing were used for making decisions on capital improvements, maintenance, and employee training ***And*** Water quality was monitored and recorded throughout the year and compared to the industry operational usage guidelines (e.g., following specifications, BMPs and guidelines for boiler, cooling tower, water softener or other operation using water within the winery) ***And*** Water quality was improved over the baseline testing year, if necessary.	The water quality used in winemaking operations was tested according to the schedule set out in permit requirements or as needed by water system user ***And*** Results from the testing were used for making decisions on capital improvements, maintenance, and employee training ***And*** Water quality was monitored and recorded throughout the year.	The water quality used in winemaking operations was tested according to the schedule set out in permit requirements or as needed by water system user (boiler feed, bottling, etc.) ***And*** Results from the testing were used for making decisions on capital improvements, maintenance, and employee training.	Water used in winemaking operations was known to be safe for the intended use.*

*The various water usage needs within the facility need to be considered including the following: water used for drinking or food preparation in the tasting room will need to meet certain regulatory requirements related to health and safety; water used for boiler feed water needs to meet the equipment manufacturer's specifications to function properly; and water used for bottling and rinsing may need to meet aesthetic requirements to minimize scale formation.

BOX 10-B WATER PRETREATMENT OPTIONS*

Depending on the quality of the feed water used in your various operations, pretreatment of water may be needed. Pretreatment systems are specifically designed to remove contaminants in the feed water that can affect winery processes and equipment downstream.

Examples of pretreatment systems are:

- Carbon filters for the removal of chlorine
- Ultraviolet light, Chlorination, Ozonation, and Chlorine Dioxide for disinfection of supply water
- Particulate filters for the removal of sediment and silt
- Softening agents to remove minerals that cause "hard" water
- High pressure membrane separation such as reverse osmosis or nanofiltration

*Appendix B (Source Water Quality and Treatment) in the *Comprehensive Guide to Sustainable Management of Winery Water* includes an overview of water quality requirements in the winery as well as treatment options for disinfection, inorganics (e.g., iron and manganese) removal, and softening hard water. Available at: https://library.sustainablewinegrowing.org/.

Treated process water can often be reused for vineyard and/or landscape irrigation.

10-3 Water Supply

Winery

Category 4	Category 3	Category 2	Category 1
Meters are installed on wells and water use was monitored monthly throughout the year and at least weekly during high-demand periods ***And*** This monitoring information was recorded for tracking total water use ***And*** A separate meter was installed if wells were also used for irrigation and/or landscaping or the amount of water used for landscaping was known ***And*** Water use information was provided in employee training and made publicly available as appropriate (e.g., through websites, newsletters, and/or annual reports).	Meters were installed on wells or water use was measured and water use was monitored monthly throughout the year ***And*** This monitoring information was recorded for tracking total water use ***And*** Total water use was known ***And*** The total water use information was used as part of a water conservation program.	Meters were installed on wells or water use was measured but water use was not regularly monitored throughout the year ***And*** Total water use was estimated.	Meters were not installed on wells ***And*** Water use was not monitored or measured ***And*** Total water use was estimated. *(Select N/A if no wells are on property)*

10-4 Process Water Management*

Winery

Category 4	Category 3	Category 2	Category 1
Flow meters to measure process water discharge were installed and monitored at least quarterly, and weekly during high-demand periods ***And*** Regular testing of pH, dissolved oxygen or other permit requirements was conducted ***And*** This monitoring information was used to develop and implement a comprehensive process water management program that includes cleaning and sanitation procedures ***And*** Sumps, interceptors, or traps were inspected monthly and cleaned quarterly ***And*** Best Management Practices for process water** were in place, if applicable*** ***And*** Storm water was managed to minimize impact on process water (e.g., crush and press pads were covered to eliminate rainfall runoff to storm drains, labeling of diversion values and storm drains).	Flow meters to measure process water discharge were installed and monitored at least quarterly ***And*** Regular testing of pH, dissolved oxygen or other permit requirements was conducted ***And*** This monitoring information was recorded for tracking water quality and total use ***And*** Sumps, interceptors, or traps were inspected quarterly and cleaned annually ***And*** Best Management Practices for process water** were in place.	Flow meters to measure process water discharge were installed ***And*** Regular testing of pH, dissolved oxygen or other permit requirements was conducted ***And*** Sumps, interceptors, or traps were inspected annually.	Flow meters to measure process water discharge were installed, if required ***And*** Regular testing of pH, dissolved oxygen or other permit requirements was conducted.

*Refer to your winery's Waste Discharge Regulations as applicable to your area or operation that describe the regulatory agency's expectations for monitoring and reporting flows to the treatment ponds. Additionally, most of the California Water Quality Control Boards' Regional Boards are asking that wineries track discharge to treatment facilities.

**The *Comprehensive Guide to Sustainable Management of Winery Water* includes an overview of Best Management Practices for process water system as well as ideas for source control. Available at: https://library.sustainablewinegrowing.org/.

***__The Industrial General Permit__ regulates industrial storm water discharges and authorized non-storm water discharges from industrial facilities in California**.** Check with the State Water Resources Control Board website (http://www.swrcb.ca.gov/water_issues/programs/stormwater/industrial.shtml) for regulations regarding industrial storm water runoff and its applicability for your facility.

- See the Stormwater Multiple Application and Report Tracking System at: https://smarts.waterboards.ca.gov/smarts/faces/SwSmartsLogin.xhtml.

10-5 Process Water Discharge*

Winery

Category 4	Category 3	Category 2	Category 1
Process water was applied to cropped area and/or landscaping, if permissible ***And*** Flow data was used to help select reuse or disposal method(s) ***And*** Water quality results were used to develop and implement a plan to reduce constituents in discharge water ***And/Or*** At least one additional alternative reuse or disposal method was implemented, consistent with local waste discharge regulations** (e.g., fire protection, groundwater recharge, fountains, ponds, wetlands, supplying nearby agricultural or landscape interests).	Some process water was applied to cropped area and/or landscaping, if permissible ***And*** Time was invested into researching and visiting other facilities that have implemented alternative reuse or disposal methods for process water.	Some process water was used for irrigation, if permissible ***And*** Time was invested into researching alternative disposal methods for process water.	No process water was reused ***And*** Some process water was discharged through land applications at all times of the year, consistent with local waste discharge regulations. *Select N/A if there was a septic system)*

*Refer to your winery's Process Water Discharge Permit for monitoring and reporting requirements for flow data and water quality data.
Some disposal methods may require notifying the Regional Water Quality Control Board. See **Box 10-B1 for more on disposal methods.

Water Quality Control Boards:

The **North Coast Regional Water Quality Control Board** and the **Central Coast Regional Water Quality Control Board** have adopted general waste discharge requirements for winery process water systems. It is important to review permit terms annually and/or visit your Regional Board's website for any posted changes to how the agencies plan to regulate winery process water.

More information can be found at:
http://www.swrcb.ca.gov/northcoast/publications_and_forms/available_documents/general_winery_wdr/.

The **State Water Quality Control Board** is developing General WDRs for winery process water treatment systems (Winery Order) that addresses land discharge of process water from wineries, grape juice storage facilities, and wine distillation facilities (hereafter collectively referred to as wineries). The Winery Order will be applicable statewide and is intended to streamline and improve permitting consistency.

As part of the development process, the State Water Board will hold stakeholder outreach meetings to receive feedback. Meetings will be scheduled in wine producing areas of the state. This website will be updated with meeting dates, times, and locations as meetings are scheduled:
https://www.waterboards.ca.gov/water_issues/programs/waste_discharge_requirements/winery_order.html.

BOX 10-B1 WATER REUSE AND DISPOSAL OPTIONS

Finding ways to reuse water or put treated wastewater to some form of use can reduce a winery's overall water footprint and create more sustainable and resilient operations in the face of an uncertain water security future in California. Some reuse and disposal options wineries can look into include:

Water Reuse within the Winery
Hot water used to clean wine barrels can be essentially filtered on the spot and reused several times, drastically reducing the overall water usage for this practice. Learn how this practice has been implemented at Kendall Jackson winery at: https://grapesandwine.cals.cornell.edu/newsletters/appellation-cornell/2010-newsletters/issue-4/recycling-hot-water-barrel-washing-reduces/.

Wastewater to Vineyard Irrigation or Landscaping
If winery wastewater is treated to proper levels and is in compliance with local Waste Discharge Requirements, the treated water can be used to irrigate nearby vineyards or landscaping, providing another cycle of useful life for the winery wastewater. Francis Ford Coppola Winery is an example of a winery reusing treated wastewater in their vineyards: https://winesvinesanalytics.com/news/article/118690/Wineries-Conserve-by-Reusing-Wastewater.

Land Discharge
Another option for treated wastewater meeting the proper treatment levels is to discharge the water back into the land. This can be beneficial to help recharge aquifers but not as beneficial for ultimately reducing water use as directly delivering treated water to vineyards for irrigation.

BOX 10-C UNDERSTANDING FLOW METERS

Flow meters play an essential role in the development of a winery or vineyard water efficiency program. They are designed to measure the flow of a material through a pipe. There are various types of flow meters. It is important to choose an appropriate flow meter based on the material (solid or liquid and its chemical and physical properties) being transported.

Guideline 1 in the *Comprehensive Guide to Sustainable Management of Winery Water* includes an overview of meter types (e.g., ultrasonic – transit time, ultrasonic – Doppler, electromagnetic, and area velocity), how they operate, what they measure, and how to mount (see page 25 of the guide). The guideline will help a winery select the most appropriate meter for the type of flow (constant, intermittent, low, high, etc.) and the location of that flow. Available from the CSWA Resource Library: https://library.sustainablewinegrowing.org/.

Flowmeter Directory: This site is a comprehensive web portal on flow meter technology, manufacturers, and suppliers of flow meters. The site contains commercial and non-commercial information on flow meter types, manufacturers, suppliers, articles, and technology: http://www.flowmeterdirectory.com.

Seametrics Flowmeter Finder: This site is useful in helping to identify flow meters based on specific use: http://www.seametrics.com/products.

Tool Lending Library: Customers of Pacific Gas and Electric Company (PG&E) can borrow flow meters from their Pacific Energy Center tool lending library. https://pge.myturn.com/library/inventory/browse?category_hierarchy=0%2FFlow+-+Liquid%7C4947.

BOX 10-D WINERY PROCESS WATER USE IN CCOF CERTIFIED ORGANIC VINEYARDS

The use of treated winery process water for irrigating vineyards is increasing among growers seeking organic certification. Below is information directly extracted from the California Certified Organic Farmer (CCOF) *International Standard Program Manual:*

> **Section 5.6 Water Used in Crop Production**
> 5.6.1 IRRIGATION WATER. Water used for irrigation of organic crops cannot contain any prohibited materials intentionally added by the producer. Water that contains prohibited materials resulting from unavoidable residual environmental contamination may be used, provided the crops meet residue standards of §5.1.7.

CCOF publishes four manuals that provide information about requirements for CCOF certification. Visit the CCOF website for more information at: http://www.ccof.org or call CCOF headquarters at (831) 423-2263.

Source: CCOF International Standard Program Manual, May 2019 https://www.ccof.org/sites/default/files/CCOF_International_Standard_Program_Manual_May_2019.pdf.

10-6 Septic Systems or Onsite Systems*

Winery

Category 4	Category 3	Category 2	Category 1
The septic system was regularly checked at least once every three years and results recorded ***And*** A grease trap was installed and regularly maintained for restaurant and/or food service activities (if applicable) ***And*** An operations and maintenance plan was in place with an assigned staff person ***And*** Management and staff were trained in the "dos and don'ts" for septic tanks and leach fields ***And*** Educational posters listing items not to be flushed were in bathrooms ***And*** A second leach field was installed with a hand-operated diversion valve ***Or*** Separate septic tanks and leach fields were maintained for processed process water.	The septic system was regularly checked at least once every three years to ensure effective operation ***And*** A grease trap was installed and randomly maintained for restaurant and/or food service activities (if applicable) ***And*** An operations and maintenance plan was in place with an assigned staff person ***And*** Management and staff were trained in the "do's and don'ts" for septic tanks and leach fields ***Or*** A second leach field was installed with a hand-operated diversion valve.	The septic system was randomly checked to ensure effective operation ***And*** A grease trap was installed for restaurant and/or food service activities (if applicable).	The septic system was designed, engineered, and constructed to handle the sanitary waste and/or winery process water volumes. *(Select N/A if winery does not have a septic system)*

*Check with your local Department of Environmental Health for specific regulations regarding septic systems. If your system is comingled (domestic, tasting room and/or process water) you need to check for your local regulatory requirements.

10-7 Crush Operations*			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Crush operations were outside and covered or moved inside to eliminate “baking” of waste material on equipment surfaces ***And*** Pre-cleaning of equipment surfaces was done with appropriate tools (e.g., a stiff brush) to loosen and remove large material before wash-down ***And*** Water for cleaning equipment was applied as needed from a high pressure/low volume nozzle fitted with a shut-off valve. A broom and squeegee were nearby and workers were encouraged to use them to clean up spills ***And*** Written cleaning procedures were implemented and adhered to in crush operations as part of a water conservation plan ***And*** Lees control/source separation practices were in place to ensure lees and other residuals were separated from water waste stream ***And*** Employees were trained in crush operation cleaning procedures.	Crush operations were outside and covered to reduce “baking” of waste material on equipment surfaces ***And*** Pre-cleaning of equipment surfaces was done with appropriate tools (e.g., a stiff brush) to loosen and remove large material before wash-down ***And*** Water for cleaning equipment was applied as needed from a high pressure/low volume nozzle fitted with a shut-off valve. A broom and squeegee were nearby and workers were encouraged to use them to clean up spills ***And*** Written cleaning procedures were implemented and adhered to in crush operations as part of a water conservation plan.	Crush operations were outside and uncovered ***And*** Pre-cleaning of equipment surfaces was done with appropriate tools (e.g., a stiff brush) to loosen and remove large material before wash-down ***And*** Water for cleaning equipment was applied as needed from a high pressure/low volume nozzle fitted with a shut-off valve. A broom and squeegee were nearby and workers were encouraged to use them to clean up spills ***And*** Cleaning procedures were developed for crush operations.	Crush operations were outside and uncovered ***And*** No pre-cleaning of equipment surfaces was done before wash-down occurred ***And*** Water for cleaning equipment was applied as needed.
*Check with your Regional Water Quality Control Board for regulations regarding crush operations.			

10-8 Presses			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Presses were outside and covered, or moved inside to eliminate “baking” of waste material on equipment surface ***And*** Pre-cleaning was done to loosen and remove large material before wash-down ***And*** Water for cleaning equipment was applied as needed from a high pressure/low volume nozzle fitted with a shut-off valve ***And*** Written cleaning procedures were implemented and adhered to in press operations as part of a water conservation plan ***And*** Lees control/source separation practices were in place to ensure lees and other residuals were separated from water waste stream ***And*** Employees were trained in press operation cleaning procedures ***Or*** A water efficient self-cleaning press was installed.	Presses were outside and covered to reduce “baking” of waste material on equipment surfaces ***And*** Pre-cleaning was done to loosen and remove large material before wash-down ***And*** Water for cleaning equipment was applied as needed from a high pressure/low volume nozzle fitted with a shut-off valve ***And*** Written cleaning procedures were implemented and adhered to in press operations as part of a water conservation plan.	Presses were outside and uncovered* ***And*** Pre-cleaning of equipment surfaces was done to loosen and remove large material before wash-down ***And*** Water for cleaning equipment was applied as needed from a high pressure/low volume nozzle fitted with a shut-off valve ***And*** Cleaning procedures were developed for press operations.	Presses were outside and uncovered* ***And*** No pre-cleaning of equipment surfaces was done before wash-down occurred ***And*** Water for cleaning equipment was applied as needed.
*Check with your Regional Water Quality Control Board for regulations regarding outside press operations.			

10-9 Tanks and Transfer Lines

Winery

Category 4	Category 3	Category 2	Category 1
Tanks and transfer lines were cleaned with a measured amount of water ***And*** Water for cleaning tanks was applied in a way that captures and recirculates the water in the tanks ***And*** The amount of water used was measured, monitored and tracked as part of a written water conservation plan, which includes checking transfer lines for appropriate diameter, lay out design, leak detection ***And*** Written cleaning procedures were implemented and adhered to in tank and transfer line cleaning as part of a water conservation plan that includes employee training ***And*** The feasibility of capturing and reusing tank rinse water has been determined and implemented ***And*** A sanitation option that conserves water (e.g., ozone, pigging, recycled water) was implemented.	Tanks and transfer lines were cleaned with a measured amount of water ***And*** Water for cleaning tanks was applied in a way that captures and recirculates the water in the tanks (e.g., a spray ball tank rinser/washer) ***And*** Written cleaning procedures were implemented and adhered to in tank and transfer line cleaning as part of a water conservation plan ***And*** The feasibility of capturing and reusing tank rinse water has been evaluated ***And*** A sanitation option that conserves water (e.g., ozone, pigging, recycled water) was implemented.	Tanks and transfer lines were cleaned with an estimated amount of water ***And*** Water for cleaning tanks was applied with a high pressure/low volume nozzle fitted with a shut-off valve ***And*** The water used was not monitored and tracked ***And*** Tank cleaning was part of a water conservation plan ***And*** All process water goes straight to drain without reuse ***And*** Research into sanitation options that conserve water (e.g., ozone, pigging, recycled water) was conducted.	Tanks and transfer lines were cleaned with an unknown amount of water ***And*** All process water goes straight to drain without reuse.

BOX 10-E CLEANING IN THE WINERY

Appendix D (Cleaning and Sanitation) of the *Comprehensive Guide to Sustainable Management of Winery Water and Associated Energy* includes a detailed description of cleaning and sanitation methods; strategies to improve cleaning; strategies for source reduction of salts and other constituents; and identification of conventional versus more environmentally ‘preferred’ cleaning and sanitation agents. The guide is developed around a stepwise program to help winemakers reduce constituents in process water and increase water use efficiency while maintaining their quality goals. (The guide can be found in the CSWA Resource Library: https://library.sustainablewinegrowing.org/)

Source reduction is pertinent for process water reuse, particularly via land application, as wineries are facing increasing scrutiny from regulatory agencies on salinity and nutrients. Guideline 2 in the Comprehensive Guide provides a broad range of source reduction opportunities, most of which fall into the following categories: Product Substitution, Good Housekeeping, Process Modification, Operating Procedures, Recycling/Reuse, and Improved Water Softener Operations.

As a means to improve both winery equipment sanitation and water use efficiency, some wineries are embracing the use of ozone systems. Properly used and designed ozone sanitation systems are safer than chemical- or heat-based sanitizing systems and can reduce water use. Ozone-based systems are effective for barrel and tank cleaning and sanitation, clean-in-place systems, and general surface sanitation. Drawbacks are that ozone can oxidize certain materials, ozone is a toxic gas regulated by OSHA, and the development of an ozone cleaning system requires an initial high investment in equipment, maintenance, and health and safety programs.

Some wineries are using chlorine dioxide as a sanitizer for winery equipment. Chlorine dioxide is an effective biocide over a wide pH range and low concentrations, resulting in cleaning procedures that use less water and are less polluting.

Paracetic acid (PAA) is being used by more wineries to help eliminate water used in wine tank cleaning. Peroxyacetic acid is a sanitizing agent increasingly used in the wine industry for its ability to efficiently kill microbes and sanitize surfaces “on contact” (Orth 1998). Despite its killing power against microbes, tank rinsing following sanitation is not required as the diluted concentrations (2.5-15%) at which it is used leaves low residual PAA, found harmless to human consumption (Orth 1998), and breaks down to form acetic acid, oxygen, and water. Fetzer Vineyards saw a reduction of over 200,000 gallons of water per year when they began using PAA in 2012.

Source: Adapted with permission from Hanson, B. (2000). “Use of ozone for winery and environmental sanitization”, *Practical Winery and Vineyard Magazine*, January/February.

10-10 Cellars			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
The total water use was measured, monitored and tracked, and used in employee training as part of a water conservation program ***And*** Cellar clean-up time was accurately determined, recorded and tracked to help reduce water use ***And*** Cellar workers were implementing written water conservation practices ***And*** Floors were pressure-washed with high pressure/low volume cleaning equipment fitted with shut-off nozzles ***And*** One alternative cleaning technology was tested or implemented in the cellar ***And*** Water awareness information, including the water performance metric, was posted in the cellar or communicated to cellar workers ***And*** A cellar worker was a member of the water team, if applicable.	The total water use was measured and tracked as part of a water conservation program ***And*** Cellar clean-up time was accurately determined and recorded ***And*** Cellar workers were trained in written water conservation practices ***And*** Floors were pressure-washed with high pressure/low volume cleaning equipment fitted with shut-off nozzles ***And*** Facilities using alternative cleaning technology were visited or educational meetings were attended where this technology was discussed ***And*** Water awareness information was posted in the cellar or communicated to cellar workers.	The total amount of water used was estimated ***And*** Water use and clean-up time for the cellar were estimated and recorded ***And*** Cellar workers were aware of water conservation information ***And*** Floors were pressure-washed with high pressure/low volume cleaning equipment fitted with shut-off nozzles ***And*** Alternative cleaning technologies were researched.	The total amount of water used was unknown ***And*** Water use and clean-up time for the cellar were unknown ***And*** Floors were pressure-washed with as much water as needed.

10-11 Barrel Washing

Winery

Category 4	Category 3	Category 2	Category 1
Water to clean barrels was applied with a high pressure/low volume nozzle and water volume was controlled by timers ***And*** The temperature of the water was monitored, controlled, and adjusted based on the new cleaning alternative(s) selected ***And*** The amount of water used was measured, monitored and tracked as part of a written water conservation plan ***And*** An alternative sanitization (e.g., ozone) or cleaning technology (e.g., automated systems) that conserves water and protects water quality has been investigated, selected, and implemented ***And*** Written cleaning procedures were implemented and adhered to in barrel cleaning as part of a water conservation plan that includes employee training ***And*** Capturing and reusing rinse water has been implemented.	Washing of barrels was done with a high pressure/low volume nozzle using temperature-controlled hot water* ***And*** The temperature of the water was monitored and controlled ***And*** The amount of water used was measured and monitored and as part of a written water conservation plan ***And*** Alternative sanitization and cleaning technologies that conserve water and protect water quality were tested ***And*** Written cleaning procedures were implemented and adhered to in barrel cleaning as part of a water conservation plan ***And*** The feasibility of capturing and reusing rinse water has been evaluated.	Barrels were cleaned by washing with hot water* until the discharge water was clear ***And*** Washing was done with a high pressure/low volume nozzle fitted with a shut-off valve ***And*** The amount of water used was estimated ***And*** Alternative sanitization and cleaning technologies were being investigated.	Barrels were cleaned by washing with as much hot water* as needed ***And*** The water used was not monitored and tracked. *(Select N/A if no barrels were used)*

*Hot water used for sanitation first needs to be heated to 180ºF for 10 minutes.

10-12 Barrel Soaking			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Each barrel was filled with a measured amount of water ***And*** Barrels were rotated on their side to detect leaks and to seal ***And*** Barrel heads were soaked separately in the same measured amount of water to detect leaks and to seal ***And*** Only cold water was used for 15 minutes (or as needed) ***And*** An alternative sanitization technology (e.g., ozone) was implemented ***And*** The amount of water used was measured, monitored and tracked as part of a written water conservation plan ***And*** Employees were trained in barrel soaking procedures.	Each barrel was filled with an estimated amount of water ***And*** Barrels were rotated on their side to detect leaks and to seal ***And*** Barrel heads were soaked separately in the same estimated amount of water to detect leaks and to seal ***And*** Hot or cold water was used ***And*** Alternative sanitization technologies (e.g., ozone) were investigated ***And*** The amount of water used was measured and monitored as part of a written water conservation plan.	Each barrel was filled completely to the top to detect leaks and to seal ***And*** Only hot water was used ***And*** The amount of water used was estimated.	Each barrel was filled completely to the top to detect leaks and to seal. *(Select N/A if there was no barrel soaking)*

10-13 Bottling*

Winery

Category 4	Category 3	Category 2	Category 1
Filler sanitization procedures were developed with set cleaning times (e.g., 20 minutes at 180ºF) for hot and cold water applications ***And*** The pump and filler were pressure-washed with high pressure/low volume cleaning equipment fitted with shut-off nozzles ***And*** Total water use was measured, monitored and tracked as part of a written water conservation plan ***And*** Appropriate employees were trained in bottling sanitization procedures ***And*** The feasibility of capturing and reusing rinse water was determined and implemented.	Filler sanitization with hot and cold water was accurately determined ***And*** The pump and filler were pressure-washed with high pressure/low volume cleaning equipment fitted with shut-off nozzles ***And*** Total water use was measured and monitored as part of a written water conservation plan ***And*** The feasibility of capturing and reusing rinse water was evaluated.	Filler sanitization procedures were developed with set cleaning times for hot and cold water applications ***And*** The pump and filler were pressure-washed with high pressure/low volume cleaning equipment fitted with shut-off nozzles ***And*** Total water use was measured or estimated ***And*** Alternative cleaning and sanitization technology was researched.	Filler was sanitized with hot and cold water for as long as needed ***And*** The pump and filler were pressure-washed with high volume cleaning equipment fitted with shut-off nozzles ***And*** The amount of water used was unknown ***And*** All water was sent down the drain. *(Select N/A if bottling was not done at the winery)*

*If a mobile bottling line is used, get this information from the bottling line contractor.

10-14 Labs			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
The rinse-time for lab equipment was accurately determined and tracked to reduce water consumption ***And*** Lab workers implemented written water conservation practices ***And*** The total water use for the lab was measured and tracked as part of a water conservation plan and was used in employee training ***And*** Sinks and rinse tanks were fitted with water-saving devices (e.g., flow restrictors) ***And*** Water awareness information, including the water performance metric, was available to lab employees ***And*** New lab techniques that reduce water and hazardous waste were implemented.	The rinse-time for lab equipment was accurately determined ***And*** Lab workers were trained in written water conservation practices ***And*** The total water use for the lab was measured and tracked as part of a water conservation plan ***And*** Water-saving devices for sinks and rinse tanks were researched ***And*** Water awareness information was available in the lab ***And*** New lab techniques that reduce water use and hazardous waste generation were investigated.	The rinse-time for lab equipment was estimated ***And*** Lab workers were aware of water conservation information.	The rinse-time for lab equipment was unknown.

BOX 10-E1 HIGH EFFICIENCY FIXTURES AND APPLIANCES

WaterSense, a voluntary partnership program sponsored by the U.S. Environmental Protection Agency (EPA), is both a label for water-efficient products and a resource for helping you save water.

The WaterSense label makes it simple to find water-efficient products and programs that meet EPA's criteria for efficiency and performance. WaterSense-labeled products and services are certified to use at least 20 percent less water, save energy, and perform as well as or better than regular models.

EPA has certified many different fixtures and appliances as being efficient such as toilets, sinks/faucets, urinals, flush valves, irrigation controls and sprinklers.

You can find EPA WaterSense certified products by searching on their website at: https://lookforwatersense.epa.gov/products/.

10-15 Landscaping *Winery*

Category 4	Category 3	Category 2	Category 1
The total amount of water used was measured, monitored and tracked as part of a water conservation plan and the results were used in employee training ***And*** Most of the landscaping utilizes drought-tolerant plants or recycled water was used for landscaping ***And*** Irrigation lines were checked regularly for leaks, defective emitters, and sprinkler heads ***And*** Mulch or compost was applied at least twice a year and soils were tested at appropriate intervals. ***And*** Landscaping used some treated process water* and had automatic irrigation ***And*** Moisture sensors or rain shut-off devices were installed to override automatic sensors.	The total amount of water used was measured and tracked as part of a water conservation plan ***And*** Over half of the landscaping utilizes drought-tolerant plants or recycled water was used for landscaping ***And*** Irrigation lines were checked regularly for leaks, defective emitters, and sprinkler heads ***And*** Mulch or compost was applied twice a year (or as appropriate) ***And*** Landscaping had automatic irrigation ***And*** Moisture sensors or rain shut-off devices were installed to override automatic sensors.	The total amount of water used was estimated ***And*** Some of the landscaping utilizes drought-tolerant plants or recycled water was used for landscaping ***And*** Irrigation lines were checked regularly for leaks, defective emitters, and sprinkler heads ***And*** Mulch or compost was applied once a year (or as appropriate). ***And*** Percentage of drought tolerant plants was known.	The total amount of water used was unknown.

*Check with your local regulatory agency responsible for process water reuse and recycling permits to make sure they allow landscaping irrigation and determine any special conditions.
See **Box 10-F** for information on drought-tolerant plants.

BOX 10-F CHOOSING THE RIGHT PLANTS TO CONSERVE WATER

One strategy to increase water efficiency in landscapes or buffer zones is to choose drought-tolerant plants that are adapted to the climate in your area, and then properly irrigate based on specific plant needs. By supplying only the amount of water needed to maintain landscape health and appearance, unnecessary irrigation is avoided and water is conserved. To do so, however, requires some knowledge of plant species needs.

WUCOLS – A Guide to Estimating Irrigation Water Needs of Landscape Plants in California produced by UC Cooperative Extension (https://cimis.water.ca.gov/Content/PDF/wucols00.pdf) provides irrigation water needs evaluations for over 1,900 species used in California landscapes. Specific water requirements are based on the observations and field experience of 41 of the most knowledgeable landscape horticulturists in California.

Another good source for identifying native drought tolerant plants that are suitable for the specific climatic conditions of your area is the California Native Plant Society. Find out more at http://www.cnps.org/.

"Pigging" is a common sanitation option that can save a lot of water when cleaning transfer lines.

11. MATERIAL HANDLING

Original Chapter Authors: John Garn and Jeff Dlott; Modified by the Sustainable Winegrowing Joint Committee

Many materials used in vineyards and wineries exhibit hazardous characteristics, and, in the interest of safety of the public, emergency responders, and the environment, all businesses are required by law to report hazardous materials and give them special handling. Materials are considered hazardous if they pose a significant potential or present threat to human health and safety or to the environment if released. The "hazardousness" of any material stored depends on its quantity, concentration, and physical or chemical characteristics. Wastes generated during operations are considered hazardous if they meet the formal definitions of toxic, reactive, ignitable or corrosive, or if they are listed or defined as hazardous. It is the waste generator's responsibility to determine the characteristic(s) of their wastes.

Reducing the amounts of hazardous materials in operations wherever possible can decrease or perhaps eliminate some regulatory oversight and inspection, enhance the health and safety of people at the facilities, and minimize the risk of pollution to the environment. Any measures in place to reduce or eliminate the use of hazardous materials and the generation of hazardous waste can also reduce liability exposure. As with all workbook chapters, the assumption is that compliance with federal, state, and local regulations has been maintained, and that operation's staff is aware of the category of regulation that they fall under. Therefore, the focus of this chapter is on pollution prevention – reducing the use of hazardous materials or replacing them with non-hazardous products. A pollution prevention approach to material handling takes a full system view of operations to identify the best areas for the reduction, substitution, or elimination of hazardous materials.

The proper disposal of hazardous waste is important for legal, health and safety, and environmental protection reasons. Many companies specialize in the collection and disposal of hazardous waste. Businesses are still required to obtain an EPA Identification number, and typically pay a small fee to cover costs for their waste disposal. These same generators may also dispose of their used oil in public used oil collection tanks. There are also many organizations and governmental agencies that provide useful information on pollution prevention. This chapter includes references and links to several key information sources.

The purpose of this chapter is to provide you with 8 criteria to self-assess:

- The state of your material handling planning, monitoring, goals, and results
- How hazardous materials handled are monitored and evaluated
- The extent of pollution released by major operations
- The extent of management support for and employee training in pollution prevention efforts
- The opportunities in your operation to identify and prioritize pollution prevention options.

The desired outcome of completing this chapter is to reinforce and improve your understanding of the full cost of hazardous material handling and hazardous waste generation, and the multiple benefits of implementing pollution prevention throughout your operation. Reviewing this chapter will also help you be in a better position to promote existing or develop new pollution prevention targets with action plans to execute pollution prevention measures. Monitoring and evaluating hazardous materials used or waste generated in your operations improves your ability to target specific pollution prevention opportunities to the biggest problem areas, while enhancing the overall efficiency of your operation.

List of Material Handling Criteria

A concrete-padded fueling area along with training employees in fuel handling, spill prevention, control, and clean-up are best practices for aboveground storage tanks.

BOX 11-A HAZARDOUS MATERIAL BUSINESS PLAN PROGRAM PER THE CALIFORNIA HEALTH AND SAFETY CODE SECTION 25501(N)

For businesses to be in compliance and avoid liability exposure, it is important that they understand the regulatory issues affecting hazardous materials.

(n) (1) **"Hazardous material"** means a material listed in paragraph (2) that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment, or a material specified in an ordinance adopted pursuant to paragraph (3).

(2) Hazardous materials include all of the following:
(A) A substance or product for which the manufacturer or producer is required to prepare a material safety data sheet pursuant to the Hazardous Substances Information and Training Act (Chapter 2.5 (commencing with Section 6360) of Part 1 of Division 5 of the Labor Code) or pursuant to any applicable federal law or regulation.
(B) A substance listed as a radioactive material in Appendix B of Part 30 (commencing with Section 30.1) of Title 10 of the Code of Federal Regulations, as maintained and updated by the Nuclear Regulatory Commission.
(C) A substance listed pursuant to Title 49 of the Code of Federal Regulations.
(D) A substance listed in Section 339 of Title 8 of the California Code of Regulations.
(E) A material listed as a hazardous waste, as defined by Sections 25115, 25117, and 25316.

(3) The governing body of a unified program agency may adopt an ordinance that provides that, within the jurisdiction of the unified program agency, a material not listed in paragraph (2) is a hazardous material for purposes of this article if a handler has a reasonable basis for believing that the material would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment, and requests the governing body of the unified program agency to adopt that ordinance, or if the governing body of the unified program agency has a reasonable basis for believing that the material would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment. The handler or the unified program agency shall notify the secretary no later than 30 days after the date an ordinance is adopted pursuant to this paragraph.

To find out more visit http://www.calepa.ca.gov/CUPA/.

11-1 Planning, Monitoring, Goals, and Results*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The total amount of hazardous materials onsite and hazardous waste generated was monitored, tracked, and recorded ***And*** Measures for pollution prevention and hazardous waste reduction have been implemented for at least one year ***And*** Recorded information was used to determine if yearly targets were met and to set future targets for overall hazardous material reduction ***And*** Local, state, and federal regulatory agencies were contacted for pollution prevention information ***And*** All employees were trained in pollution prevention practices.	The total amount of hazardous materials onsite and hazardous waste generated was monitored, tracked, and recorded ***And*** Measures for pollution prevention and hazardous waste reduction had begun to be implemented ***And*** Local, state, and federal regulatory agencies were contacted for pollution prevention information ***And*** All employees had easy access to pollution prevention information.	The total amount of hazardous materials onsite and hazardous waste generated was monitored ***And*** Measures for pollution prevention and hazardous waste reduction were investigated (e.g., reducing or eliminating waste at the source, using non-toxic or less-toxic substances, reusing materials) ***And*** Local, state, and federal regulatory agencies were considered potential resources for pollution prevention information.	The total amount of hazardous materials purchased and hazardous waste generated was known. ***And*** The requirements for management of hazardous materials were known and followed.**

*Check with local regulatory agencies to determine specific county requirements. A useful first step is to go to: http://www.calepa.ca.gov/CUPA/. Additional resources include: https://www.osha.gov/dsg/hazcom/, https://www.calrecycle.ca.gov/swfacilities/uniwaste/, https://dtsc.ca.gov/universalwaste/, https://www.calrecycle.ca.gov/usedoil

**Regulatory requirements for hazardous materials vary depending on an operation's size and amount of hazardous materials used. For more information on which regulations may apply, visit the CSWA Environmental Regulatory Tool https://library.sustainablewinegrowing.org/.

See **Box 11-B** for more information on Pollution Prevention.

Box 11-B Pollution Prevention

Pollution prevention is reducing or eliminating waste at the source by modifying production processes, promoting the use of non-toxic or less-toxic substances, implementing conservation techniques, and re-using materials rather than putting them into the waste stream.

- Generating hazardous waste should be **prevented** or **reduced** at the source whenever feasible.
- Hazardous waste that cannot be prevented may be able to be reused, like solvent.
- Materials may be extended for a longer life, such as motor oil testing in trucks and equipment rather than scheduled oil changes.
- Hazardous waste that cannot be prevented should be recycled or disposed of in an environmentally safe manner.

Remember, pollution is a form of wasted resources.

Sources: US Environmental Protection Agency (US EPA). http://www.epa.gov/p2/.

Box 11-C Environmental Accounting

Environmental accounting is a term for the addition of environmental cost information into existing cost accounting procedures and/or recognizing embedded environmental costs and allocating them to appropriate products or processes. It can refer solely to costs that directly impact a company's bottom line, or it can encompass the costs to individuals, society, and the environment for which a company is not directly accountable.

To fully understand the total cost of hazardous materials and the hazardous waste those materials generate, it is important to include the cost of purchasing the material and the cost of complying with the regulations. This may include the purchasing of safety equipment, time involved in preparing and submitting reports, time involved in onsite inspections, and the time involved in training employees. When these costs are added together it produces a truer "full cost" of the material selected for use.

A successful environmental management system should have a method for accounting for full environmental costs and integrate capital budgeting, cost allocation, process/product design, and other processes into forward-looking decision making. Companies can make progress in environmental accounting incrementally, beginning with a limited scale, scope, and applications. Staff can start with those costs they know the most about and work toward the more difficult-to-estimate costs and revenues.

Source: US Environmental Protection Agency (US EPA). An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms. 1995. (http://www.greenbiz.com/sites/default/files/document/O16F13759.pdf).

BOX 11-D COMMON HAZARDOUS MATERIALS AND WASTE AT WINERIES AND VINEYARDS

Some of the most common hazardous materials used at wineries include sulfur dioxide, anhydrous ammonia, inert gases (e.g., argon, carbon dioxide, nitrogen), cleaning agents (e.g., tri-sodium phosphate, potassium metabisulfite, potassium carbonate, sodium hydroxide, organic acids), sulfurous acid, lab chemicals, gasoline, diesel, and propane.

The types of hazardous waste typically generated by wineries include used oil, laboratory chemicals, solvents, antifreeze, paint, and universal wastes (batteries, electronic wastes, fluorescent lamps, etc.).

For vineyards, the more hazardous classes of pesticides include organophosphates and carbamates (due to human & environmental toxicity and persistence) and fumigants (high toxicity including high potential hazard to handlers/applicators). Other hazardous materials and waste include some types of fertilizers, empty pesticide containers, used oil, absorbents, non-empty aerosol cans, treated wood waste, and solvents.

Source: Andrew Parsons, Assistant Chief, Sonoma County Fire & Emergency Services Department

BOX 11-E GREEN CHEMISTRY

Green chemistry, also known as sustainable chemistry, refers to chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, and use. For more information go to http://www.epa.gov/greenchemistry.

For an overview of what other companies are doing to reduce hazardous material use in their products see: https://www.greenbiz.com/blogs/enterprise/right-chemistry?page=1

11-2 Good Housekeeping – Dumpster Area

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The dumpster area was part of an integrated solid and hazardous waste program that included a formal scheduling system for inspecting dumpsters ***And*** The dumpster area was regularly inspected for leaks, spills, litter, and unintentional disposal of hazardous waste ***And*** Dumpster areas were kept litter free and dumpster lids were kept closed or were managed to eliminate any leakage ***And*** Bilingual signs (if applicable) were posted on or near dumpsters describing what can and cannot be disposed ***And*** Employee training included hazardous waste identification to avoid unintentional hazardous waste disposal ***And*** Dumpsters were on a concrete pad to contain spills ***And*** Dumpsters were located away from high traffic areas.	A formal scheduling system was in place for inspecting dumpsters ***And*** The dumpster area was regularly inspected for leaks, spills, litter, and unintentional disposal of hazardous waste ***And*** Dumpster areas were kept litter free and dumpster lids were kept closed or were managed to eliminate any leakage ***And*** Bilingual signs (if applicable) were posted on or near dumpsters describing what can and cannot be disposed ***And*** Employee training included hazardous waste identification to avoid unintentional hazardous waste disposal ***And*** Dumpsters were on a concrete pad to contain leaks and spills**.**	An informal scheduling system was in place for inspecting dumpsters ***And*** The dumpster area was infrequently inspected for leaks, spills, litter, and unintentional disposal of hazardous waste ***And*** Dumpster areas were kept litter free and dumpster lids were kept closed or were managed to eliminate any leakage ***And*** Signs were posted on or near dumpsters describing what can and cannot be disposed.	No scheduling system was in place for inspecting dumpsters ***And*** Dumpsters were not inspected for unintentional hazardous waste disposal. *(Select N/A if no commercial dumpsters were on-site)*

BOX 11-F UNIVERSAL WASTE

California's Universal Waste Rule allows individuals and businesses to transport, handle, and recycle certain common hazardous wastes, termed "universal wastes," in a manner that differs from the requirements for most hazardous wastes.

Universal Wastes may not be disposed of in the trash!

Examples of universal waste include:

1. **Electronic devices**: Includes any electronic device that is a hazardous waste (with or without a Cathode Ray Tube (CRT)), including televisions, computer monitors, cellphones, VCRs, computer CPUs, and portable DVD players.
2. **Batteries**: Most household-type batteries, including rechargeable nickel-cadmium batteries, silver button batteries, mercury batteries, alkaline batteries, and other batteries that exhibit a characteristic of a hazardous waste.
3. **Lamps**: Fluorescent tubes and bulbs, high intensity discharge lamps, sodium vapor lamps, and electric lamps that contain added mercury, as well as any other lamp that exhibits a characteristic of a hazardous waste (e.g., lead).
4. **Mercury-containing equipment**: Thermostats, mercury switches, mercury thermometers, pressure or vacuum gauges, dilators and weighted tubing, mercury rubber flooring, mercury gas flow regulators, dental amalgams, counterweights, dampers, and mercury added novelties such as jewelry, ornaments, and footwear.
5. **Cathode ray tube (CRTs)**: The glass picture tubes removed from devices such as televisions and computer monitors.
6. **Cathode ray tube (CRT) glass**: A cathode ray tube that has been accidently broken or processed for recycling.
7. **Non-empty aerosol cans**

Note: Solar Panels: The California Department of Toxic Substances Control (DTSC) has proposed regulations that would allow discarded photovoltaic (PV) modules (commonly referred to as solar panels) to be managed as universal waste.

For more information on Universal Waste go to: https://dtsc.ca.gov/universalwaste/

BOX 11-G TIRES

The program for handling waste tires is full of caveats so it is good to be aware of the primary ones and to also go to the state's website for information on handling them appropriately.

- Hauling without being/using a registered hauler limits tire loads to "Less than 10."
- Disposing of 10 or more tires requires a registered hauler, proper manifesting, and record retention.
- The Ag exemption for hauling can be used (14CCR, Section 18460.1).
- Multiple trips of less than 10 tires can be done.
- New tires don't apply to this limit/program.
- If more than 499 waste/used tires are onsite, then storage regulations apply.

Link: http://www.calrecycle.ca.gov/Tires/#. If you have specific questions for your area go to http://www.calrecycle.ca.gov/Tires/Enforcement/Contacts.htm.

11-3 Hazardous Materials – Hazardous Material Storage and Replacement*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The total amount of hazardous materials was known and a hazardous materials inventory was kept and reviewed annually ***And*** Hazardous materials were stored away from storm drains, well heads, and waterways, and under cover with secondary containment ***And*** Legal requirements were reviewed regularly ***And*** All hazardous materials were reviewed for less hazardous alternatives as part of an evaluation plan designed to replace them.**	The total amount of hazardous materials was known and a hazardous materials inventory was kept ***And*** Hazardous materials were stored away from storm drains, well heads, and waterways ***And*** Legal requirements were reviewed regularly ***And*** Priority hazardous materials were reviewed for green chemistry alternatives.	The total amount of hazardous materials was known ***And*** Hazardous materials were stored away from storm drains, well heads, and waterways ***And*** Legal requirements were reviewed periodically ***And*** Research was conducted into hazardous material replacement.	The total amount of hazardous materials was known ***And*** The requirements for management of hazardous materials were known and followed.*

*Check with Federal, State, and local regulatory agencies to determine if a Hazardous Material Business Plan is required in your area. Regulatory staff can also answer specific questions on storage and transport, hazardous communications, self-generation, and the need for SDS sheets. For additional information, including updated requirements, on hazardous material business plans, go to: https://www.caloes.ca.gov/cal-oes-divisions/fire-rescue/hazardous-materials/hazmat-business-plan.

**For a useful overview of how to access alternatives to hazardous materials go to: https://dtsc.ca.gov/scp/alternatives-analysis-guide-version-1-0-downloads/.

11-4 Hazardous Materials – Hazardous Waste Disposal*,** *Vineyard & Winery*

Category 4	Category 3	Category 2	Category 1
The total amount of hazardous waste generated was known and a waste log with the last three years of waste hauler manifests or receipts was kept and reviewed for cost of disposal ***And*** A program was in place for hazardous waste disposal to both minimize amounts stored and to separate and store necessary hazardous waste in a designated location(s) away from storm drains, well heads, and waterways ***And*** Recyclable hazardous wastes (e.g., used oils, batteries, anti-freeze) were stored carefully to facilitate recycling (drums closed and covered). ***And*** The hazardous waste disposal storage area had secondary containment and was covered ***And*** Actions were taken to reduce hazardous materials use.	The total amount of hazardous waste* generated was known and a hazardous waste log with the last three years of waste hauler manifests or receipts was kept ***And*** A program was in place for hazardous waste disposal to both minimize amounts stored and to separate and store necessary hazardous waste in a designated location(s) away from storm drains, well heads, and waterways .	The total amount of hazardous waste* generated was known and a hazardous waste log with the last three years of waste hauler manifests or receipts was kept ***And*** Hazardous waste was separated and stored in a designated location(s) away from storm drains, well heads, and waterways.	The total amount of hazardous waste* generated was known and a hazardous waste log with the last three years of waste hauler manifests or receipts was kept.

* Hazardous wastes for vineyards include empty pesticide containers, used oil, absorbents, non-empty aerosol cans, treated wood waste, and solvents. If a management company helps deal with hazardous waste disposal, consider contacting them to help answer this criterion. Hazardous wastes for wineries include used oil, laboratory chemicals, solvents, antifreeze, paint, and universal wastes (batteries, electronic wastes, fluorescent lamps, etc.). See **Box 11-D** for more examples.

**Check with local regulatory agencies to determine specific CUPA requirements. For specific information on hazardous waste disposal such as manifests, waste generator permits, and other requirements, go to: https://dtsc.ca.gov/managing-hazardous-waste/

Box 11-H Waste Lamps And Ballasts

Fluorescent lamps and High Intensity Discharge (HID) lamps, including mercury vapor, high-pressure sodium, and metal halide lamps from businesses, can contain levels of mercury and lead that make them hazardous waste when disposed. Mercury and lead are toxic metals that can accumulate in living tissue and cause adverse health effects.

Fluorescent light ballasts manufactured before 1979 contain polychlorinated byphenyls (PCBs), which are classified as "probable human carcinogens"; while fluorescent light ballasts manufactured between 1979 and 1991 contain diethylhexyl phthalate (DEHP), which is classified as a carcinogen and regulated by the US Environmental Protection Agency under the Superfund Law (CERCLA). Non-PCB ballasts are marked "no PCBs". Electronic or "dry" ballasts (those manufactured after 1991) should be recycled as scrap metal. If in doubt, take ballasts to hazardous waste facility.

For more information about managing universal hazardous waste including lamps and ballasts see: https://dtsc.ca.gov/universalwaste/.

Box 11-I Treated Wood Waste

According to the State of California Department of Toxic Substance Control, the only acceptable method of disposal available for chemically treated wood is at a hazardous waste or a qualified solid waste landfill. Treated Wood Waste (TWW) wood is typically treated with preserving chemicals that protect the wood from insect attack and fungal decay during its use. TWW contains hazardous chemicals that pose a risk to human health and the environment. Arsenic, chromium, copper, creosote, and pentachlorophenol are among the chemicals added to preserve wood. Examples include fence posts, sill plates, landscape timbers, pilings, guardrails, and decking.

The requirements for handling TWW vary depending on if the waste is "incidentally generated" because the operation is not routinely involved in construction, demolition, or other activities that involve treated wood, or if the operation generates, handles, or accumulates more than 1,000 pounds of TWW in 30 days.

Stress to employees that, for their personal safety, treated wood must NOT be disposed in bonfires or used in warming fires in the field or at home.

To learn more about disposing of treated wood waste and how to identify treated wood see the fact sheet at https://dtsc.ca.gov/toxics-in-products/treated-wood-waste-information-and-fact-sheets/

BOX 11-J RE-REFINED OIL FACTS

Turning used oil products into re-refined oil products is an important part of reusing petroleum and reducing dependency on imports. To make sure that your products can be recycled, it is important to keep oils, coolants, lubricants, and solvents separated to avoid contamination.

Re-refined oil products are subject to the same stringent refining, compounding, and performance standards applied to virgin oil products. For performance, American Petroleum Institute (API)-licensed re-refined oils must pass the same cold-start, pumpability, rust-corrosion, engine-wear, and high-temperature viscosity tests. The API and American Automobile Manufacturers Association (AAMA) have developed the Engine Oil Licensing Certification System (EOLCS) to ensure that all engine oils consistently meet performance specifications.

Re-refining is an energy efficient and environmentally beneficial method of managing used oil. In fact, less energy is required to produce a gallon of re-refined base stock than a base stock from crude oil. It also cuts down on the amount of foreign oil that must be imported, making the country less dependent on increasingly unstable oil supplies.

To find out more about re-refined oil and access additional links, go to: https://www.calrecycle.ca.gov/usedoil/rerefined/facts.

BOX 11-K TECHNICAL ANTIFREEZE COMPARISON

Many winery and vineyard operators have questions regarding the difference between ethylene glycol (EG) and propylene glycol (PG) antifreeze. A key consideration for choosing between them is intended use. Both perform similarly but there are differences in additives and toxicity, with EG being more toxic. The low toxicity of PG is the reason for its use as a heat exchange medium in large-scale chillers for wine and other food products.

11-5 Paint and Paint Thinners*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Paints and/or thinners were stored onsite, and stored in a designated location(s) ***And*** Paints with low volatile organic compounds (VOCs) were preferentially used ***And*** Paint containers were allowed to dry out before being disposed with paint waste in solid waste containers** ***And*** Employees were trained in solvent (including paints and thinners) safety, clean-up, storage and disposal, and signs and posters about paint clean-up and disposal were posted ***And*** Materials were used that do not require painting, when feasible.	Paints and/or thinners were stored onsite, and stored in a designated location(s) ***And*** Paints with low volatile organic compounds (VOCs) were preferentially used ***And*** Paint containers were allowed to dry out before being disposed with paint waste in solid waste containers or unused paint was returned to the seller** ***And*** Employees were trained in solvent (including paints and thinners) safety, clean-up, storage and disposal , or signs and posters about paint clean-up and disposal were posted.	Paints and/or thinners were stored onsite and stored in a designated location(s) ***And*** Methods for disposing paints, thinners, paint waste, and wash water were known ***And*** Paint solids in used thinner were allowed to settle to allow reuse of the clear thinner on top ***And*** Used paint containers and thinner were placed in a single container and disposed as hazardous waste.**	Paints and/or thinners were stored onsite. *(Select N/A if no paints or thinners were on-site during the assessment year)*

*An overview of different paints, their performance, and disposal considerations can be found at: http://www.rethinkrecycling.com/government/eppg/-buy-products-services/green-building-products-and-services/paint.

**A business that generates less than 27 gallons of hazardous waste per month, must dispose of paint at a Paint Care Take-Back center (https://www.paintcare.org/drop-off-locations/#/find-a-drop-off-site) or county drop off site (no more than 5 gallons per business per day). The store will require signing a CESQG certification log for each drop-off, confirming that the business generates less than 27 gallons of hazardous waste per month.

Box 11-L Solvent Reuse or Replacement

Solvents can be reused prior to recycling in a variety of ways. For example:

- Used solvent can be used to initially rinse out spray equipment, after which, a small amount of fresh solvent can be used to remove any residues.
- In cases where high-purity solvents are required for cleaning certain parts, these parts can be cleaned with fresh solvent, after which, the used solvent can be used to clean other dirtier parts.
- Recycled paint thinner, although not always suitable for reuse to thin paint, can be used as "wash thinner." Additionally, an alternative "wash thinner" can be obtained by simply allowing the waste thinner to separate out into thinner and sludge. The thinner can then be siphoned-off and used as "wash thinner."

Solvent recycling can be done off- or on-site.

- Off-site recycling can be achieved by contracting with a solvent tank maintenance service. They will visit businesses on a regular basis, remove the solvent and sludge from tanks, and replace with clean solvent.
- Spent solvents can be sent off-site to a commercial recycler, where generally 70-80% of the solvent can be reprocessed and sold back to the generator at a reduced cost.
- Solvent recovery can also take place on-site. Commercial solvent recovery units are available in various sizes – the smallest units can handle 5 gallons of waste solvent per batch. Most recovery systems pay for themselves in less than two years by reducing the quantity of raw material needed to be purchased and the amount of waste that has to be managed. However, there are many factors to consider before deciding to install a solvent distillation unit.

For more details on solvents, go to epa.gov and search "solvent."

11-6 Aerosol Cans*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Refillable dispensers were used (if appropriate) and less-hazardous content was used ***And*** Non-empty aerosol cans containing ignitable, corrosive, toxic, or reactive substances were separated for disposal in hazardous waste containers ***And*** Empty aerosol cans were disposed in recycling containers or appropriate waste containers ***And*** Employees were trained to segregate aerosol cans appropriately for disposal.	Refillable compressed air dispensers or pump dispensers were considered for use, if appropriate ***And*** Non-empty aerosol cans containing ignitable, corrosive, toxic, or reactive substances were separated for disposal in hazardous waste containers ***And*** Empty aerosol cans were disposed in recycling containers or appropriate waste containers.	Non-empty aerosol cans containing ignitable, corrosive, toxic, or reactive substances were separated for disposal in hazardous waste containers ***And*** Empty aerosol cans were disposed in recycling containers or appropriate waste containers.	Aerosol cans were stored in various locations around the facility ***And*** All aerosol cans were disposed in appropriate waste containers. *(Select N/A if no aerosol cans were on-site during the assessment year)*

*To learn more about how to properly handle aerosol cans go to: https://dtsc.ca.gov/aerosol-can-waste-management/.

See **Box 11-M** for information on refillable spray bottles and aerosol cans.

Box 11-M Refillable Spray Bottles and Refillable Aerosol Cans

While there may be some use of refillable spray bottles in the wine industry, the automotive industry has been using them for several years. The following fact sheet was authored for the automotive industry but contains valuable information for any business sector on refillable spray bottles, including perceived problems and solutions: https://dtsc.ca.gov/wp-content/uploads/sites/31/2016/01/RefillableBottles02.pdf.

BOX 11-N CATEGORIES OF FOOD-GRADE LUBRICANTS

The three categories of lubricants for use in food establishments are:

- **H1 (Incidental Contact):** These are food-grade lubricants used in food-processing environments where there is the possibility of incidental food contact. Generally, ingredients complying with the H3 criteria below can be used. For example, certain white mineral oils can be used as a direct food additive or as an ingredient of an H1 lubricant.
- **H2 (Non-food Contact):** These are non-food-grade lubricants used on equipment and machine parts in locations where there is no possibility of food contact. Most substances generally used for this purpose in industry would be acceptable. However, products that contain heavy metals or ingredients classified as carcinogens, mutagens, teratogens, and mineral acids are subject to exclusion.
- **H3 (Soluble Oils):** These are food-grade lubricants, typically edible oils, used to prevent rust. Products may be composed of certain edible oils, mineral oils, and GRAS (Generally Recognized As Safe) substances, as defined by the Code of Federal Regulations.

Source: http://www.machinerylubrication.com/Read/445/food-grade-lubricants.

Clearly marking storm drains helps to keep them clear of hazardous materials and waste.

Box 11-O Underground Storage Tanks (USTs)

California Health and Safety Code 25281:
(y) (1) "Underground storage tank" means any one or combination of tanks, including pipes connected thereto, that is used for the storage of hazardous substances and that is substantially or totally beneath the surface of the ground.

"Underground storage tank" does ***not*** include any of the following:

(A) A tank with a capacity of 1,100 gallons or less that is located on a farm and that stores motor vehicle fuel used primarily for agricultural purposes and not for resale.

(B) A tank that is located on a farm or at the residence of a person, that has a capacity of 1,100 gallons or less, and that stores home heating oil for consumptive use on the premises where stored.

Check with staff at local regulatory agencies for regulations about tank removal and agricultural exemptions. For more information on USTs visit: http://www.swrcb.ca.gov/water_issues/programs/ust/leak_prevention/index.shtml.

Follow the Best Management Practices for aboveground tank fueling areas in **Criterion 11-7**.

11-7 Fuel Storage – Aboveground Storage Tanks (ASTs) or Portable Tanks*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Locations and sizes of all tanks were known and the amount of fuel was recorded and tracked ***And*** Spill clean-up supplies were easily accessible ***And*** The fueling area was concrete-padded and inspected and findings were recorded, if applicable ***And*** A positive shut-off nozzle was installed and the hose and nozzle were inspected for leaks and damage ***And*** Employees were trained in fuel handling and spill prevention, control, and clean-up ***And*** Bilingual signs about fueling safety procedures were posted, if applicable.	Locations and sizes of all tanks were known and the amount of fuel was recorded and tracked ***And*** Spill clean-up supplies were easily accessible ***And*** The fueling area was concrete-padded and inspected and findings were recorded, if applicable ***And*** A positive shut-off nozzle was installed and the hose and nozzle were inspected for leaks and damage ***And*** Employees were trained in fuel handling and spill prevention, control, and clean-up ***And*** Signs about fueling safety procedures were posted.	Locations and sizes of all tanks were known and the amount of fuel was recorded ***And*** Spill clean-up supplies were easily accessible ***And*** The fueling area was inspected regularly ***And*** A positive shut-off nozzle had been installed and the hose and nozzle were inspected for leaks and damage.	Locations of all fuel tanks were known ***And*** Spill clean-up supplies were easily accessible. *(Select N/A if there were no aboveground storage tanks or portable tanks)*

*Wineries with ASTs are required to have Spill Prevention, Control and Countermeasure plans if the total volume of bulk petroleum storage is > 1320 gallons. For vineyards, the threshold is much higher (>20,000 gallons for individual ASTs & > 100,000 gallons aggregate). For more information see the Aboveground Petroleum Storage Act in **Box 11-P**. Check with staff at local agencies for regulations about tank removals and agricultural exemptions. Propane handling and storage regulations for California can be found at https://www.dir.ca.gov/title8/sb1a5.html.

BOX 11-P ABOVE GROUND STORAGE TANK ACT (APSA)

Who is subject to the requirements of the California Aboveground Storage Tank Act (APSA)?
A tank facility is subject to APSA if:

- the "tank facility" is subject to the oil pollution prevention regulations specified in part 112 (commencing with section 112.1) of subchapter D of chapter I of title 40 of the Code of Federal Regulations; or
- the tank facility has a storage capacity of 1,320 gallons or more of petroleum.

Important Note: The California APSA only regulates tank facilities that store petroleum and not other oils, as does the federal SPCC Rule (subject to 40CFR112). The Act's definition of petroleum and tank facility must first be applied before considering the first applicability criteria above.

What tank facilities are exempt from the APSA program?
A tank facility located on a farm, nursery, logging site, or construction site, while still regulated under APSA, is not subject to the requirement to prepare and implement an SPCC Plan if:

- no storage tank at the location exceeds 20,000 gallons; and,
- the cumulative storage capacity of the tank facility does not exceed 100,000 gallons.

The owner or operator of an exempted tank facility located on a farm, nursery, logging site, or construction site, is required to take the following actions:

- Conduct a daily visual inspection of any aboveground tank storing petroleum.
- Allow the Unified Program Agency to conduct a periodic inspection of the tank facility.
- If the Unified Program Agency determines installation of secondary containment is necessary for the protection of the waters of the state, install a secondary means of containment for each tank or group of tanks where the secondary containment will, at a minimum, contain the entire contents of the largest tank protected by the secondary containment plus precipitation.

*VERY IMPORTANT: Please note that while farms, nurseries, logging sites, or construction sites are conditionally exempt from the requirement to prepare an SPCC Plan under APSA, these facilities are not exempt from federal SPCC requirements enforced by US EPA.

Visit https://osfm.fire.ca.gov/divisions/pipeline-safety-and-cupa/certified-unified-program-agency-cupa/aboveground-petroleum-storage-act/ for more information.

BOX 11-Q SAFETY DATA SHEET (SDS) BASICS

An SDS is designed to give detailed information about a material and any hazards associated with the material. OSHA specifies that each SDS includes information such as properties of each chemical; the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical.

SDSs must be immediately available to employees in the workplace. It is the responsibility of the employer to provide SDSs and training to employees on reading, interpreting, and using SDSs. It is the responsibility of the employees to read and understand all SDSs associated with chemicals they use on the job.

SDS information and resources can be found at:
https://www.osha.gov/pls/publications/publication.html and search "Safety Data Sheet" and https://blink.ucsd.edu/safety/resources/SDS/index.html.

A central collection location for hazardous waste, such as batteries, ensures employees can easily separate hazardous waste from the solid waste stream.

11-8 Winery Sanitation Supplies

Winery

Category 4	Category 3	Category 2	Category 1
Sanitation supplies were considered a potential source of hazardous or toxic materials ***And*** Product labels were read before products were purchased or used ***And*** Two or more low-or non-toxic products have been replaced with green chemistry or non-hazardous products from a baseline ***And*** Handling of sanitation supplies was part of employee training and an element of a comprehensive pollution prevention program ***And*** Customer service numbers on product labels, company websites or Safety Data Sheets were used to get information on potentially hazardous ingredients.	Sanitation supplies were considered a potential source of hazardous or toxic materials ***And*** Product labels were read before products were purchased or used ***And*** Priority materials were reviewed for green chemistry alternatives which were considered for use ***And*** Handling of sanitation supplies was part of employee training.	Sanitation supplies were considered a potential source of hazardous or toxic materials ***And*** Product labels were read before products were purchased or used ***And*** Research was conducted into low-or non-toxic products.	Sanitation supplies were considered a potential source of hazardous or toxic materials ***And*** Product labels were read before products were purchased or used.

12. SOLID WASTE REDUCTION AND MANAGEMENT

Original Chapter Authors: John Garn and Jeff Dlott; Modified by the Sustainable Winegrowing Joint Committee

Reducing and recycling solid waste helps conserve natural resources, reduce greenhouse gases, and decrease costs for businesses. Fortunately, California is the leader in the nation, in large part due to AB939 enacted in 1989. While the state saw a 58% diversion rate of the solid waste stream in 2010, the majority of this was achieved through recycling programs in the residential sector. This indicates that there is still a large untapped recycling opportunity in the commercial sector, which comprises two-thirds of California's solid waste generation. In July 2012, the state passed AB341 making commercial recycling mandatory for any business that generates four cubic yards or more of commercial solid waste per week. One metric the state uses to measure solid waste generation is pounds of material thrown away per employee per day. In 2017, California had a per resident disposal rate of 5.2 pounds/resident/day and a "diversion rate equivalent" of 58 percent. The 2017 per employee disposal rate was 11.9 pounds/employee/day, and the per employee "diversion rate equivalent" was at 62 percent, according to CalRecycle data.

The five main materials that make up most of the solid waste stream are paper, food, metal, plastic, and lumber. Organics, such as food, are the largest component of the solid waste stream. The wine industry is in a unique position because much of the solid waste generated at the winery (e.g., pomace, lees, cardboard, paper, glass) can be reused or recycled. Many wineries are composting pomace for use in vineyards, and a few are composting their paper and cardboard as well. As the largest source of organic waste at the winery, composting pomace can divert 50% or more of the waste stream. Several wineries have been recognized in the past by California's Waste Reduction Award's Program (WRAP), with one winery being recognized for twelve consecutive years (the program ended in 2011, although business can still be recognized for waste reduction through the GEELA award: https://calepa.ca.gov/Awards/GEELA/). Many others are realizing that a very cost effective strategy is to work with suppliers to reduce packaging that comes with the materials and supplies they purchase. This direct communication of environmental requirements can spur suppliers to develop systems for reusable containers, recyclable packaging, or reprocessing of waste material.

The purpose of this chapter is to help vintners understand the full cost of solid waste generation and the multiple benefits of implementing reduction measures, and improve existing or develop new solid waste reduction and recycling plans to target the biggest problem areas while optimizing the overall efficiency of winery operations. This chapter includes 18 criteria to self-assess:

- The state of your solid waste reduction planning, monitoring, goals, and results
- The total solid waste generated
- The extent of solid waste generated per major operation
- The extent of management support for and employee training in solid waste reduction efforts
- The opportunities in your operation to identify and prioritize options to reduce solid waste.

List of Solid Waste Reduction and Management Criteria

12-1 Planning, Monitoring, Goals, and Results
12-2 Pomace and Lees
12-3 Diatomaceous Earth
12-4 Plate and Frame Filters
12-5 Cooperage
12-6 Glass
12-7 Cardboard
12-8 Paper
12-9 Plastic
12-10 Packaging (Incoming and Outgoing)
12-11 Metals
12-12 Natural Cork
12-13 Pallets, Wood Packaging, Bins, etc.
12-14 Capsules
12-15 Landscape Residuals
12-16 Food Waste
12-17 Single Stream Recycling
12-18 Vineyard Solid Waste

Talking with vendors can result in waste reduction since some will take back pallets, bins, and other packaging for reuse.

Box 12-A REDUCE, REUSE AND RECYCLE

Nearly everyone has heard of the three "R's" (Reduce, Reuse, Recycle), but they are important to reiterate since they form the backbone of handling the materials and supplies coming to your operations. We should all look to Reduce, Reuse and then Recycle, in that particular order.

- **Reduce:** This is the best strategy for beginning to gain control over the amount of materials and supplies being purchased for your operations. If you can't reduce the amount you are using, begin by looking at the containers and packaging associated with the materials and supplies coming in. Talk with your main suppliers to see if there is some other way to deliver the materials and supplies you need with less packaging, and less waste.
- **Reuse**: Reusing supplies whenever possible is a better use than recycling. During the conversations with your vendors encourage them to begin reusing their packaging. This will allow them to save money and develop a service along with their products. Several companies providing winery supplies already do this, including capsules, cork and label manufacturers.
- **Recycle**: If you can't reduce or reuse, recycling is the next best step to take. Most of the materials used in the wine industry can be recycled but this does require labor and training to ensure employees are using containers at the operations to divert solid waste out of the waste stream and into the recycling stream.

Reusing old wine barrels for trash and recycling bins is a great way to reinforce the concept of reuse and recycling.

12-1 Planning, Monitoring, Goals, and Results *Winery*

Category 4	Category 3	Category 2	Category 1
The winery conducted a solid waste audit within the last 3 years* ***And*** Results from the audit are used to make decisions on procurement, inventory procedures, production, packaging, and employee training ***And*** The total solid waste generation and the percentage of waste recycled was monitored and recorded, and the information is shared with employees ***And*** Yearly goals were set for overall solid waste reduction and solid waste diversion (e.g., zero waste policy) ***And*** Information about reducing, reusing, and recycling solid waste is part of employee training and available in Spanish, if applicable.	The winery conducted a solid waste audit within the last 5 years* ***And*** Results from the audit were used to make decisions on procurement, inventory procedures, production, packaging, and employee training ***And*** The total solid waste generation and the percentage of waste recycled was monitored and recorded ***And*** Yearly goals were set for overall solid waste reduction and solid waste diversion ***And*** Information about reducing, reusing, and recycling solid waste is part of employee training.	The winery conducted a solid waste audit within the last 5 years* ***And*** The total solid waste generation was monitored throughout the year ***And*** Information about reducing, reusing, and recycling solid waste was easily accessible to all employees.	The winery did not track the total solid waste generated per year ***And*** Some waste was diverted from landfills.

*A solid waste audit can be accomplished with complementary approaches such as combining input from operations staff with the expertise of outside personnel, or by conducting a self-audit using the Solid Waste Audit Tool or a similar template (See Box 12-A1 or download the Excel tool: https://library.sustainablewinegrowing.org/). Many disposal companies and solid waste management agencies offer solid waste audit assistance. A solid waste audit can also be carried out by operations staff if they have the knowledge necessary to complete the audit without additional outside expertise.
Check with your local provider for available services in your area, such as single stream recycling.

BOX 12-A1 DIY SOLID WASTE AUDIT TOOL

CSWA's **Solid Waste Audit Tool** provides wineries with easy-to-follow steps for estimating the volume of solid waste generated at their facility by type: pomace and lees, diatomaceous earth, barrels, glass, cardboard, paper, capsules, cork, plastic, wood pallets, packaging, bins, food, landscaping yard waste, and metals. Creating a baseline for solid waste is the first step in creating a solid waste management strategy as outlined in 12-1. The tool covers how to collect available information, how to conduct a solid waste audit, identifying disposal practices, and estimating the costs and revenues for managing each waste stream.

To download the tool go to: https://library.sustainablewinegrowing.org/

To see a video demonstration on how to use the tool, go to: https://vimeo.com/227816745**.**

BOX 12-B RECYCLABLE DOESN'T MEAN IT IS RECYCLED

Many products and supplies have the term "recyclable" on them, giving the impression to the consumer that they are easily recycled. Unfortunately, this is not always the case. Just because a product says "recyclable" doesn't mean it is. It is very important to talk to your local solid waste agency or recycling company to find out just what materials they can recycle, what materials they may pick up but don't recycle, and where the material they do recycle goes.

There are several reasons why materials that say "recyclable" may not be recycled:

- Markets for recycled materials fluctuate
- Materials collected on-site can become contaminated, making them non-recyclable
- Processing facilities for some materials may exist too far away from point of collection to make recycling economically feasible
- There is no national recycling law so the necessary recycling infrastructure does not exist in every state.

To find out more on what can be recycled visit:
http://www.calrecycle.ca.gov/PublicEd/EarthDay/What

American Canyon
Recology American Canyon
https://www.recology.com/

Arcata, CA
Recology Arcata
https://www.recology.com/

Chico, CA
Northern Recycling and Waste Services Recycling Center
http://northernrecycling.biz/

Davis, CA
Recology Davis
https://www.recology.com/recology-davis/

Montague, CA
Yreka Transfer LLC
http://www.yrekatransferllc.com/index.html

Napa
Upper Valley Disposal & Recycling
http://uvds.com/

Napa
Napa Recycling & Waste Services
https://naparecycling.com/

Oxnard
California Recycling Services Corporation
(805) 987-2546

Sacramento
Sims Recycling Solutions
https://www.simsrecycling.com/

San Diego
Universal Waste Disposal Company
http://universalwaste.com/

San Diego
The Green Company
http://sandiegogreencompany.com/

San Jose
Green Team of San Jose
https://www.greenteam.com/

San Jose
Premier Recycle Company, Sorting Facility
https://www.premierrecycle.com/

San Lucas
C&C Recycling
(831) 758-5357

Fresno
Recyco Inc.
https://www.recycofresno.com/

San Luis Obispo
San Luis Garbage Co.
https://www.sanluisgarbage.com/

Sonoma
Recology Sonoma Marin
https://www.recology.com/recology-sonoma-marin/

Stockton
Granda's Recycling
(312) 388-0892

BOX 12-B1 ZERO WASTE WINE COMPANY AND TRUE ZERO WASTE

Location:
Hopland, California

TRUE Zero Waste Certification Level:
Platinum

Percent of Overall Diversion Achieved:
98.34 (as of 2017)

Facility Size:
446,700

Type of Operation:
Winery

Project Overview:
Fetzer Vineyards has been committed to decreasing impacts to the waste stream for decades, reducing annual waste sent to landfill by more than 98 percent since 1990 through recycling, reusing, and composting used materials. These results derive from many years of refining waste programs, policies, and initiatives.

In 2017, Fetzer Vineyards diverted 98.34 percent of waste from landfills and incineration. This diversion includes composting all winery waste – grape skins, stems, and seeds from the winemaking process – and later reintroducing these materials to the vineyards as nutrient-rich compost. It also encompasses a comprehensive recycling program across the winery campus, including the streamlined collection of glass, plastic cardboard, metal, and PET from production processes. These waste reduction milestones have been achieved in partnership with the company's supply chain by working with suppliers to identify materials that can be eliminated from the production stream, repurposed, or recycled. Additionally, employee engagement is a key ingredient in Fetzer Vineyards' success: all break areas contain clearly labeled recycle bins for varied materials, including food waste.

Fetzer Vineyards realizes significant cost savings through reduced landfill tipping fees due to reductions in waste and obtains revenue from recycling certain materials. These financial benefits complement the environmental benefits that arise from a zero waste approach and help us to remain competitive as a business while pursuing our sustainability goals.

About TRUE Zero Waste

The US Green Building Council's TRUE Certification, a zero waste program, certifies businesses that have achieved at least 90% waste diversion from the landfill, incineration (WTE) and the environment through recycling, composting or reusing, and has achieved at least 31 of the 81 points on the TRUE Rating System. The TRUE Rating System can be a very valuable tool for wineries and vineyards that not only want to work towards zero waste certification but may just be looking for a guiding framework to lead their zero waste efforts. The rating system covers all aspects of solid waste management including the following categories. The scorecard covers the following categories with the associated points per category:

Redesign	4	Leadership	6
Reduce	7	Training	8
Reuse	7	Zero Waste Analysis	5
Compost	7	Upstream Management	4
Recycle	3	Hazardous Waste Prevention	5
Zero Waste Reporting	4	Closed Loop System	4
Diversion	5	Innovation	3
Zero Waste Purchasing	9	**Total Points**	**81**

More information on the TRUE, a Zero Waste program, can be found at: https://true.gbci.org/.

Many wineries have achieved TRUE Certification and can be viewed at https://true.gbci.org/projects

BOX 12-C ORGANIC AND INORGANIC MATERIALS

The wine community is fortunate that a majority of waste generated from the winemaking process is organic in nature and can be composted for direct use back in the vineyards, in landscaping, or provided to commercial composting operations for processing and sale. Organic waste streams also include paper, cardboard, DE, filter paper, and food waste, and can also be incorporated into composting operations for use back on the soil.

A smaller percentage of the waste generated is inorganic material, much of which can also be recycled, reducing the percentage of waste going to landfill. This includes glass, plastics, metals, barrels, and wooden containers and pallets. Very little waste is actually left from the winemaking cycle if full use of available reuse and recycling options are implemented.

By addressing both the inorganic and the organic waste streams the wine community can effectively divert almost all of their waste away from landfills and get close to the concept known as "zero waste". A working definition of zero waste, often cited by experts in the field originated from a working group of the Zero Waste International Alliance in 2004, is as follows:

- Zero Waste is a goal that is ethical, economical, efficient, and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use.
- Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them.
- Implementing Zero Waste will eliminate all discharges to land, water, or air that are a threat to planetary, human, animal, or plant health."

12-2 Pomace* and Lees

Winery

Category 4	Category 3	Category 2	Category 1
Pomace and lees were considered "high value" resources ***Or*** A market assessment was conducted to identify priority byproducts in current pomace and lees ***And*** Material was composted on-site for direct application to vineyards and/or landscaping ***And/Or*** At least one byproduct was recovered through implementation of selected technology.	Pomace and lees were considered "medium value" resources ***And*** An off-site composting company removed this material and delivered compost in the spring ***Or*** Material was composted on-site for direct application to vineyards and/or landscaping ***And*** Research and/or a waste assessment was conducted to identify technologies for extracting value-added material from pomace and lees.	Pomace and lees were considered "low value" resources ***And*** This material was applied directly to vineyards and landscape areas and worked directly into the soil ***Or*** Material was hauled off-site for use as animal feed or compost for other agriculture operations.	Pomace and lees were considered "valueless" resources ***And*** This material was stored on-site for later off-site disposal ***Or*** Material was hauled off-site for disposal immediately after crush.

*The pomace, or stems, seeds, and skin left after pressing, comprises about 25% of the harvested grape weight. Proper composting techniques eliminate the potential of vine mealybugs from being present in compost. See this article from UC Davis researchers for more information: http://cenapa.ucanr.edu/files/52580.pdf
For additional composting resources see:
Composting Grape Waste: https://compost-turner.net/composting-technologies/grape-stalks-and-pomace-composting-process.html
Notes on composting grape pomace: https://www.arec.vaes.vt.edu/content/dam/arec_vaes_vt_edu/alson-h-smith/grapes/viticulture/extension/growers/documents/composting-grape-pomace.pdf
Grape Pomace Composting: https://medium.com/@ellazhai/grape-pomace-composting-technology-1937f24d168f

12-3 Diatomaceous Earth (DE)*			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
The amount of DE used yearly by our winery was known and tracked ***And*** DE cakes were incorporated into compost operations ***And*** Alternative DE unloading and conveying technology was researched and implemented ***And*** One alternative filtration technology was implemented ***And*** The DE filtration efficiency was optimized through training employees in DE handling and loading.	The amount of DE used yearly by our winery was known ***And*** DE cakes were incorporated into compost operations ***And*** Research in alternative DE unloading and conveying technologies was undertaken ***And*** Alternative materials and technologies to DE filtration were tested (perlite, cellulose filter, cross flow) ***Or*** A facility using alternative technologies to DE filtration was visited.	The amount of DE used yearly by our winery was estimated ***And*** DE cakes were composted (onsite or offsite) and applied to vineyards and/or landscaping, if allowed ***And*** Alternative materials and technologies to DE filtration were investigated (perlite, cellulose filter, cross flow).	The amount of DE used yearly by our winery was not known ***And*** DE cakes were thrown out in trash as waste. *(Select N/A if winery does not use DE)*

*Material Safety Data Sheet information for DE is available at https://www.ima-europe.eu/content/idpa-safe-handling-guide. Check with local regulatory agencies to determine pertinent regulations for your area.
See **Box 12-D** for more information on Diatomaceous Earth.

BOX 12-D DIATOMACEOUS EARTH

While a low cost filtration medium of wine, Diatomaceous Earth (DE), crystalline silica comprised of sharp particles, is a potential health hazard if inhaled. Its use requires proper safety training in the handling and use of this material inside the winery. In addition, some insurance companies have refused to provide coverage to wineries using DE, global supplies are being exhausted, and prices have increased. These additional aspects must be taken into consideration when calculating the full cost of DE.

Several alternatives for DE exist. Some, like crossflow or reverse osmosis filtration may be too expensive for smaller operations to consider. Other alternatives, such as using perlite instead of DE, or moving to a cellulose filter may prove an attractive alternative to DE. Filtering options beyond DE include:

- Pad filtration

- Membrane filtration
- Crossflow filtration
- Ultra filtration
- Ceramic membrane crossflow

For further information on each filtering method see: http://www.grapeworks.com.au/blog/filtration-methods-in-winemaking/

12-4 Plate and Frame Filters

Winery

Category 4	Category 3	Category 2	Category 1
Alternatives to plate and frame filter media disposal were researched ***And*** One facility implementing alternative plate and frame filter disposal was contacted or visited ***Or*** Plate and frame filters were slit open and applied to landscaping for soil amendment and weed suppression.	Alternatives to plate and frame filter media disposal were researched ***And*** Plate and frame filters were disposed of in a solid waste container* ***Or*** One facility implementing alternative plate and frame filter disposal was contacted.	Alternatives to plate and frame filter media disposal were researched ***And*** Plate and frame filters were disposed of in a solid waste container.*	Plate and frame filter media were disposed of in a solid waste container.* *(Select N/A if plate and frame filters were not used)*

*Check with local regulatory agencies to determine regulations for disposal of plate and frame filters in your area.

12-5 Cooperage *Winery*

Category 4	Category 3	Category 2	Category 1
A formal system for tracking age, date received, current use, and location of barrels was used (e.g., bar-codes) ***And*** The percentage of barrels made from sustainably harvested wood* was determined and recorded ***And*** Unwanted barrels were sold, repurposed or recycled ***And*** Unwanted barrels were donated for reuse (e.g., to schools and community centers for use as planters, rain barrels).	A formal system for tracking the condition of oak barrels was in place ***And*** Barrels were tracked by their history (date received and amount of use) ***And*** The percentage of barrels made from sustainably harvested wood* was determined ***And*** Unwanted barrels were sold, repurposed, recycled, or donated for reuse (e.g., to schools and community centers for use as planters, rain barrels).	An informal system for tracking the history of oak barrels was in place ***And*** Inquiries were made to determine if the oak used for barrels was sustainably harvested* ***And*** Unwanted barrels were sold, repurposed, recycled or donated for reuse (e.g., to schools and community centers for use as planters, rain barrels).	There was no system for tracking the history of oak barrels. *(Select N/A if barrels were not used)*

*Ordering barrels made from certified sustainable oak is another aspect of sustainable cooperage. See **Box 12-E** for more information on sustainably harvested oak. To find out how to screen suppliers for environmental considerations, see **Chapter 13 Sustainable Purchasing**.

Sustainable practices for oak barrels include tracking, sourcing, and recycling.

Box 12-E Cooperage Sustainability

Questions about sustainability are resonating in many industries today, so it is no surprise that personnel at more wineries are wondering how the wood used for their barrels is harvested. Currently there is only one certifying organization for oak barrels – Chain of Custody certification from the Program for the Endorsement of Forest Certification Schemes (PEFC), a worldwide forestry certification program.

Most of the oak originating from Europe is harvested from government-owned and -operated forests, so the rate of oak tree removal is carefully managed to prevent over-harvesting. In the US, most of the oak is harvested east of the Mississippi River. The US sources of oak range from small privately owned wood lots to large corporate-controlled forests. As of 2012, no certified sustainable oak is used in US barrel manufacturing.

In addition, PEFC and the Forest Stewardship Council (FSC) have certified sustainable cork used in wine production. The FSC promotes responsible global forest management by certifying forest products that meet rigorous standards. Consumers purchasing wood products bearing the FSC label can be assured that these products come from a forest that has been responsibly managed to FSC standards. The FSC's web site (http://fscus.org) lists several wood products that have been certified.

A majority of waste generated from the winemaking process is organic in nature, such as pomace and lees, and can be composted for direct use back in the vineyards.

12-6 Glass*			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
All glass was separated into recyclable bottles, recyclable broken glass, and non-recyclable glass (e.g., Pyrex, window glass) ***And*** All recyclable glass was placed in recycling containers in a designated location ***And*** Non-recyclable lab glass was disposed of in a solid waste container and taken to landfill ***And*** Bottling operations were evaluated regularly for opportunities to reduce bottle waste ***And*** Bottle breakage rates (on delivery and on bottling line) were recorded and tracked, and the data is used to implement a breakage reduction strategy.	All glass was separated into recyclable broken glass, and non-recyclable glass (e.g., Pyrex, window glass) ***And*** All recyclable glass was placed in recycling containers in a designated location ***And*** Non-recyclable lab glass was disposed of in a solid waste container and taken to landfill ***And*** Bottling operations were evaluated for opportunities to reduce bottle waste ***And*** Bottle breakage rates (on delivery and on bottling line) were recorded and tracked.	All glass was separated into recyclable glass and non-recyclable glass (e.g., Pyrex, window glass) and recyclable glass was recycled ***And*** Non-recyclable lab glass was disposed of in a solid waste container and taken to landfill.	All glass was disposed of in a solid waste container and taken to landfill. *(Select N/A if no glass was used)*
*Check if single stream recycling (when different materials such as glass, paper, metal, etc. are mixed in one recycling container) is available in your area.			

12-7 Cardboard*

Winery

Category 4	Category 3	Category 2	Category 1
Cardboard was recycled in a designated recycling container ***And*** The amount of cardboard recycled was known and tracked ***And*** The major sources of cardboard coming to the winery were known ***And*** One major cardboard supplier agreed to reduce their use of cardboard or take it back for reuse ***And*** Tracked information was used to determine the financial, storage, and volume considerations of alternative recycling programs.	Cardboard was recycled in a designated recycling container ***And*** The amount of cardboard recycled was estimated ***And*** The major sources of cardboard coming to the winery were known ***And*** Major cardboard suppliers were contacted about their cardboard use.	Cardboard was recycled in a designated recycling container ***And*** The amount of cardboard recycled was estimated.	Cardboard was disposed of in a solid waste container ***And*** The amount of cardboard discarded was not known. *(Select N/A if the winery used a single stream recycling program and cardboard is included)*

*Check if single stream recycling is available in your area. See **Criterion 12-17** if winery uses single stream recycling.

12-8 Paper*			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Paper was recycled in a designated recycling container ***And*** The amount of paper recycled was known and tracked ***And*** Paper reduction practices were in place (e.g., scrap paper reused for drafts before being recycled, printers defaulted to two-sided copying, use of electronic documents and publications) ***And*** At least one alternative use for paper was implemented (e.g., shredding for packaging material, vermiculture bedding, sheet mulching) ***Or*** Paper towels and other soiled paper were composted**.**	Paper was recycled in a designated recycling container ***And*** The amount of paper recycled was estimated ***And*** Paper reduction practices were in place (e.g., scrap paper reused for drafts before being recycled, printers defaulted to two-sided copying, use of electronic documents and publications).	Paper was recycled in a designated recycling container ***And*** The amount of paper recycled was estimated.	Paper was disposed of in a solid waste container ***And*** The amount of paper discarded was unknown. *(Select N/A if the winery uses a single stream recycling program and paper is included)*
*Check if single stream recycling is available in your area. See Criterion **12-17** if winery uses single stream recycling.			

12-9 **Plastic***			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Plastic was recycled in designated recycling containers ***And*** The amount of plastic recycled was known and tracked, and used in employee training ***And*** The major sources of plastic coming to the winery were known ***And*** One major plastic supplier agreed to reduce their use of plastic or take it back for reuse ***And*** The winery contracted with at least one vendor specializing in plastic reuse or recycling, if possible ***And*** Action was taken to use less plastic (e.g., resuable bags, less shrink wrap with shipping).	Plastic was recycled in designated recycling containers ***And*** The amount of plastic recycled was known ***And*** The major sources of plastic coming to the winery were known ***And*** Vendors who specialize in plastic recycling were investigated ***And*** An effort was made to use less plastic.	Plastic was recycled in designated recycling containers, if available ***And*** The amount of plastic discarded was estimated ***And*** An effort was made to use less plastic.	Plastic was disposed of in a solid waste container ***And*** The amount of plastic discarded was unknown. *(Select N/A if the winery uses a single stream recycling program and plastic is included)*
*Check if single stream recycling is available in your area. See Criterion **12-17** if winery uses single stream recycling.			

BOX 12-F A GREEN ECONOMY

California has one of the best recycling infrastructures in the nation, diverting far more material from landfills than any other state. California also has a goal to recycle 75% of its solid waste. More than 110,000 jobs could be created as a result of California's solid waste goal. Meeting the 75% recycling goal would create more than 34,000 jobs in materials collection, 26,000 jobs in materials processing, and 56,000 jobs in manufacturing using the recovered materials.

Source: https://www.nrdc.org/experts/darby-hoover/waste-jobs-growing-californias-economy-through-recycling

12-10 Packaging (Incoming packaging from suppliers and outgoing product packaging)

Winery

Category 4	Category 3	Category 2	Category 1
When shipping products recyclable packaging materials were used whenever possible ***And*** Packaging was separated and recycled in designated recycling containers ***Or*** Contract shipper only used fully recyclable packaging material ***And*** The amount of packaging recycled was known ***And*** One major packaging supplier agreed to reduce their use of packaging or take it back for reuse ***And*** The winery contracted with at least one vendor specializing in packaging reuse or recycling.	Testing resulted in the use of alternative packaging materials when shipping products ***And*** Packaging was separated and recycled in designated recycling containers ***Or*** Contract shipper only used recyclable packaging material ***And*** The amount of packaging recycled was known ***And*** The major sources of packaging coming to the winery were known ***And*** Vendors that specialize in packaging recycling were investigated.	Research was begun into alternative packaging materials ***And*** Packaging was disposed of in a solid waste container ***And*** The amount of packaging discarded was estimated ***Or*** Contract shipper accepted used packaging material for their operations.	Packaging was disposed of in a solid waste container ***And*** The amount of packaging discarded was unknown ***Or*** Packaging material used by contract shipper is unknown.

12-11 Metals			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Metals were separated from the waste stream for reuse or recycling ***And*** Recycling containers were placed close to points of material generation and discard for ease of reuse or recycling ***And*** Employee training included information on metal reuse and recycling in Spanish, if appropriate ***And*** No metals were disposed of in solid waste containers.	Metals were separated from the waste stream for reuse or recycling ***And*** Recycling containers were placed close to points of material generation and discard for ease of reuse or recycling ***And*** Employee training included information on metals recycling ***And*** Only small pieces of scrap metal were disposed of in solid waste containers.	Metals were separated from the waste stream for reuse or recycling.	All metals were disposed of in a solid waste container.

12-12 Natural Cork

Winery

Category 4	Category 3	Category 2	Category 1
An alternative to cork disposal (e.g., donate to schools and senior centers for art projects, compost on site, post a notice on a material exchange web site) was selected and implemented ***And*** Cork was separated out of the solid waste stream ***And*** Employee training included information on cork recycling or composting ***And*** Tasting and bottling rooms had signs posted about cork recycling (in English and Spanish, if appropriate) and containers for recycling or composting cork, if applicable ***And*** No cork was disposed of in solid waste containers.	An alternative to cork disposal was selected ***And*** Cork was separated out of the solid waste stream ***And*** Containers were made available in tasting room and bottling rooms to recycle or compost corks, if applicable ***And*** The percentage of corks made from sustainably harvested material* was determined ***And*** A minimal amount of cork was disposed of in solid waste containers.	Alternatives to cork disposal were investigated ***And*** Most cork was separated out of the solid waste stream ***And*** Containers were made available in tasting room and bottling rooms to recycle or compost corks, if applicable ***And*** Very little cork was disposed of in solid waste containers.	All cork was disposed of in a solid waste container. *(Select N/A if natural cork closures were not used)*

*Ordering corks made from certified sustainable cork (e.g. Programme for the Endorsement of Forest Certification (PEFC) and Forest Stewardship Council (FSC) is another aspect of sustainability. To find out how to screen suppliers for environmental considerations, see **Criterion 13-11** in **Chapter 13 Sustainable Purchasing**.

12-13 Pallets, Wood Packaging, Bins, etc.			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Unused pallets and/or bins were stacked and stored under cover for vendor pickup ***And*** All broken pallets were repaired and reused when possible ***And*** One major pallet supplier agreed to take back their pallets for reuse ***And*** Unusable pallets were recycled or sent to a biomass waste-to-energy system ***And*** The major sources of pallets coming to the winery were known ***And*** Employee training included information on pallet reuse and recycling ***And*** Signs were posted in the shipping and receiving areas about pallet reuse and recycling (in English and Spanish, if applicable) ***And*** No pallets were disposed of in solid waste containers.	Unused pallets and/or bins were stacked and stored for vendor pickup ***And*** All broken pallets were repaired and reused when possible ***And*** One major pallet supplier agreed to take back their pallets for reuse ***Or*** Unusable pallets were recycled or sent to a biomass waste-to-energy system ***And*** The major sources of pallets coming to the winery were known ***And*** Employee training included information on pallet reuse and recycling ***And*** No pallets were disposed of in solid waste containers.	Unused pallets and/or bins were stacked and stored for vendor pickup ***And*** Some broken pallets were repaired and reused when-possible ***And*** The major sources of pallets coming to the winery were known ***And*** Remaining broken pallets were disposed of in solid waste containers or recycled locally.	There was no centralized area for storing unused pallets and bins ***And*** All broken pallets and bins were disposed of in solid waste containers.

12-14 Capsules			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
All capsules were separated out of the solid waste stream and all aluminum and tin capsules were recycled ***And*** Employee training included information on capsule recycling ***And*** Tasting and bottling rooms had signs posted about capsule recycling (in English and Spanish, if applicable) and containers for recycling capsules ***And*** At least one capsule vendor was contacted to take back capsules, plastic trays, or shipping material ***And*** No capsule-related materials were disposed of in solid waste containers.	All capsules were separated out of the solid waste stream and all aluminum and tin capsules were recycled ***And*** Employee training included information on capsule recycling ***And*** Containers were made available in tasting room and bottling rooms to recycle capsules ***And*** Vendors that specialize in capsule recycling were investigated ***And*** Very few capsules were disposed of in solid waste containers.	All aluminum and tin capsules were separated out of the solid waste stream and recycled ***And*** All other capsules were disposed of in a solid waste container.	All capsules were disposed of in a solid waste container. *(Select N/A if no capsules were used)*

12-15 Landscape Residuals			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
All landscape residuals were chipped first and then left on the ground or composted ***And*** No landscape residuals were disposed of in solid waste containers.	Some landscape residuals were chipped first and then left on the ground ***And*** Some landscape residuals were composted ***And*** No landscape residuals were disposed of in solid waste containers.	Some landscape residuals were left on the ground ***And*** Some landscape residuals were disposed of in solid waste containers ***And*** Some landscape residuals were picked up for off-site composting or were composted onsite.	All landscape residuals were disposed of in a solid waste container. *(Select N/A if winery did not have landscaping)*

BOX 12-G MULCHING

Mulching is the process of applying organic materials to the soil surface as a permanent or temporary cover. The primary functions of mulching are to reduce erosion by protecting bare soil from rainfall impact, increase soil water-holding capacity, and reduce herbicide use. Common types of mulch are straw, wood or bark chips, and green material.

For more information about mulch, read the guide "Project Planning and Design Guide" available at: https://dot.ca.gov/-/media/dot-media/programs/design/documents/final-ppdgjuly-2017-revnmta4292019borderscr.pdf
.

12-16 Food Waste

Winery

Category 4	Category 3	Category 2	Category 1
All food waste and utensils were separated out of the solid waste stream for composting or recycling ***And*** A designated worker was responsible for ensuring that all solid waste and recyclables are placed in appropriate containers ***And*** Utensils and plates were made of recycled content, or dishwasher safe ***Or*** Reusable, biodegradable or compostable utensils were used ***And*** Food waste and utensils were composted or processed ***And*** Reduce, reuse, and recycle information was easily accessible to all employees, part of employee training, and available in Spanish, if applicable.	All food waste and utensils were separated out of the solid waste stream for composting or recycling ***And*** A designated worker was responsible for ensuring that all solid waste and recyclables were placed in appropriate containers ***And*** Utensils and plates were made of recycled content, or dishwasher safe ***Or*** Reusable, biodegradable or compostable utensils were used ***And*** Reduce, reuse, and recycle information was easily accessible to all employees and part of employee training.	All food waste and utensils were separated out of the solid waste stream for composting or recycling ***And*** A designated worker was responsible for ensuring that all solid waste and recyclables were placed in appropriate containers.	All food waste and utensils were disposed of in a solid waste container ***And*** No centralized recycling containers were on site.

12-17 Single Stream Recycling			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Single stream recyclable materials (paper, plastic, glass and metal - or depending on what is accepted by your recycling vendor) were recycled in a designated recycling container ***And*** The total amount of single stream recycled material was known ***And*** Paper reduction practices were in place (e.g., scrap paper reused for drafts before being recycled, printers defaulted to two-sided copying, use of electronic documents and publications) ***And*** An audit was conducted within the past 3 years** to understand the various percentages of different materials making up your single stream waste. ***And*** Based on the findings of the audit, actions were taken to reduce the materials that made up the larger percentages of the single stream waste.	Single stream recyclable materials (paper, plastic, glass and metal - or depending on what is accepted by your recycling vendor) were recycled in a designated recycling container ***And*** The total amount of single stream recycled material was known ***And*** Paper reduction practices were in place (e.g., scrap paper reused for drafts before being recycled, printers defaulted to two-sided copying, use of electronic documents and publications) ***And*** An audit was conducted within the past 5 years** to understand the various percentages of different materials making up your single stream waste.	Single stream recyclable materials (paper, plastic, glass and metal - or depending on what is accepted by your recycling vendor) were recycled in a designated recycling container ***And*** The total amount of single stream recycled material was estimated ***And*** Paper reduction practices were in place (e.g., scrap paper reused for drafts before being recycled, printers defaulted to two-sided copying, use of electronic documents and publications).	All waste was disposed of in a solid waste container ***And*** The amount of waste discarded was not known *(Select N/A if the winery does not have single stream recycling)*

*A solid waste audit can be accomplished with complementary approaches such as combining input from operations staff with the expertise of outside personnel, or by conducting a self-audit using the Solid Waste Audit Tool or a similar template (See **Box 12-A1** or download the Excel tool: https://library.sustainablewinegrowing.org/.

Watch a video about Solid Waste Management at Trinchero Family Estates at available in the CSWA Resource Library (https://library.sustainablewinegrowing.org/) and learn about how Jackson Family Wines is becoming a Zero Waste winery at: https://www.kj.com/blog/how-were-striving-become-zero-waste-company)

12-18 Vineyard Solid Waste

Vineyard

Category 4	Category 3	Category 2	Category 1
Most solid waste (e.g., metal, paper, cardboard, glass, plastic) was recycled in designated recycling containers ***And*** Most organic matter was composted on or off-site ***And*** Information about reducing, reusing, and recycling solid waste was part of employee training and signs were posted on proper waste disposal (in English and Spanish, if appropriate) ***And*** Yearly goals were set for overall solid waste reduction and solid waste diversion.	Some solid waste (e.g., metal, paper, cardboard, glass, plastic) was recycled in designated recycling containers ***And*** Some organic matter was composted on or off-site ***And*** Information about reducing, reusing, and recycling solid waste was part of employee training.	Some solid waste (e.g., metal, paper, cardboard, glass, plastic) was recycled in designated recycling containers.	All vineyard waste materials* were managed and disposed of according to applicable regulations.

*Vineyard waste materials may include vine trimmings and prunings, pulled vineyards, vineyard stakes and other organic and inorganic waste materials created from the development, management and demolition of vineyards.

13. SUSTAINABLE PURCHASING

Original Chapter Authors: John Garn and Jeff Dlott; Modified by the Sustainable Winegrowing Joint Committee

Recycling and reusing materials whenever possible are simple steps in helping to reduce the burgeoning amounts of solid waste going to landfills every day, but this is only part of the cycle. The key to reducing waste and reusing existing materials is to begin working with suppliers and vendors to eliminate unnecessary packaging and to incorporate or expand features and functionalities that have beneficial environmental attributes. Being aware of the material that is purchased for use in vineyards and wineries helps “close the loop” and increases the market for products made of recycled content. One of the primary ways this can be accomplished is through Sustainable Purchasing.

Sustainable Purchasing is a process for selecting products or services that have a reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. The first step in a Sustainable Purchasing program is to screen products and services for their relative beneficial environmental attributes (such as recycled content and energy efficiency) as well as potential adverse environmental and human health effects. While the review process requires an investment of time, vendors and suppliers should be called upon to assist in the process by providing information on the environmental attributes of their products and services. If they don’t know, or don’t seem very interested in making that information available, consider seeking suppliers who will support the Sustainable Purchasing efforts of the organization.

Internal communication by personnel within vineyard and winery operations is also a critical component of an effective Sustainable Purchasing program. For example, individuals with accounting, receiving, facilities management, production, and other pertinent responsibilities need to talk to each other so that there is a clear understanding of how supplies are delivered, how they are used, how much they cost, and how much waste is generated. Such communication builds awareness and understanding about all of the products used at the vineyard or winery operation. Growers and vintners who collaborate individually and collectively with suppliers to minimize waste and increase use of environmentally preferable products help improve not only their businesses, but the environment and society as a whole.

The purpose of this chapter is to help growers and vintners identify opportunities for implementing and improving vineyard and winery Sustainable Purchasing efforts. It provides 15 criteria to self-assess:

- The state of your Sustainable Purchasing planning, monitoring, goals, and results
- The opportunities to reduce unwanted material coming to your operations from suppliers
- The opportunities to drive positive social and environmental outcomes in your supply chain
- The extent of management support for and employee training in Sustainable Purchasing efforts
- The opportunities in your operation to identify and prioritize Sustainable Purchasing options.

List of Sustainable Purchasing Criteria

13-1 Planning, Monitoring, Goals, and Results
13-2 Service Providers
13-3 Vineyard Supplies
13-4 Vehicles
13-5 Vehicle Maintenance Products
13-6 Office Equipment
13-7 Wine Containers
13-8 Closures
13-9 Capsules
13-10 Boxes
13-11 Winery Equipment
13-12 Paper
13-13 Cleaning Supplies
13-14 Packaging – From Suppliers
13-15 Packaging – To Customers

The environmental attributes of glass bottles, capsules, corks, and other materials used in the winery can be part of a Sustainable Purchasing policy.

BOX 13-A IMPORTANT SUSTAINABLE PURCHASING ATTRIBUTES

The following are examples of key attributes to consider when making Sustainable Purchasing decisions.

- Recycled content
- Recyclability (e.g., Can the material actually be recycled in your area or where your product is consumed?)
- Product disassembly potential
- Durability
- Reusability
- Reconditioned or remanufactured
- Take-back
- Bio-based or biodegradable
- Low toxicity or non-toxic
- Energy efficient
- Water efficient
- Women or minority owned business
- Where the products are sourced and where the business is located (e.g., locally owned business,
- U.S. manufactured products) – Purchasing products and materials locally help to support more small, independent businesses, support and grow the local economy and help reduce environmental impacts such as GHG emissions associated with transportation. Third-party certification of product (e.g., Energy Star, Forest Stewardship Council, Organic, EPEAT etc.)
- Third party certification of business/operations (CCSW, SIP, Lodi Rules, B Corp etc.)
- Other attributes with positive environmental effects

These attributes should be maximized not only for their potential beneficial impacts to the environment, but also for their potential contribution to improving the workplace, enhancing quality of winegrapes and wine, and even increasing the bottom line. It should be noted that the presence of these attributes alone does not automatically make a product or service environmentally preferable. While making purchasing decisions, consider a wide range of environmental, social, and economic impacts associated with products – from a life cycle perspective, when possible.

For a complete list of environmental attributes, including resources to identify greener products and services, go to: http://www.epa.gov/epp/pubs/guidance/finalguidanceappx.htm#AppendixB.

Source: US Environmental Protection Agency (US EPA). Sustainable Marketplace: Greener Products and Services: https://www.epa.gov/greenerproducts.

BOX 13-B GUIDING PRINCIPLES FOR SUSTAINABLE PURCHASING

Guiding Principle 1: Environment + Price + Performance = Sustainable Purchasing
Environmental considerations should become part of normal purchasing practice, consistent with such traditional factors as product safety, price, performance, and availability.

Guiding Principle 2: Pollution Prevention
Consideration of environmental preferability should begin early in the acquisition process and be rooted in the ethic of pollution prevention, which strives to eliminate or reduce up-front, potential risks to human health and the environment.

Guiding Principle 3: Life Cycle Perspective/Multiple Attributes
A product's or service's environmental preferability is a function of multiple attributes from a life cycle perspective. **It is important to understand all impacts associated with a product from its raw material extraction through its end-of-life disposal. More information on life cycle impacts can be found at:** https://www.epa.gov/smm/sustainable-materials-management-basics#needsRCRApermit.

Guiding Principle 4: Comparison of Environmental Impacts
Determining environmental preferability might involve comparing environmental impacts. In comparing environmental impacts, consider the reversibility and geographic scale of the environmental impacts, the degree of difference among competing products or services, and the overriding importance of protecting human health.

Guiding Principle 5: Environmental Performance Information
Comprehensive, accurate, and meaningful information about the environmental performance of products or services is necessary in order to determine environmental preferability.

Source: US Environmental Protection Agency (US EPA). Office of Pollution Prevention, Environmentally Preferable Purchasing Program: http://www.epa.gov/epp/index.htm.

13-1 Planning, Monitoring, Goals, and Results

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Purchasing decisions were based on defined supplier criteria that included environmental attributes ***And*** A written purchasing policy* that includes specific environmental standards was approved by owner/manager ***And*** Environmental considerations were included in most purchasing decisions ***And*** Alternative materials and environmental attributes of products (e.g., amount of recycled or post-consumer content, environmental certification such as Energy Star, Forest Stewardship Council) were considered in relevant purchasing decisions ***And*** Goals were established and reviewed annually to increase the purchase of environmentally preferable products ***And*** Significant suppliers** and outside service providers were evaluated against comprehensive criteria including availability of environmentally preferable products and services.	Purchasing decisions were based on defined supplier criteria that included environmental attributes ***And*** The vineyard and/or winery operation had a written purchasing policy* that included specific environmental standards ***And*** Environmental considerations were included in some purchasing decisions ***And*** Research into alternative materials and products was undertaken ***And*** Goals were established to increase the purchase of environmentally preferable products.	Purchasing decisions were based on defined supplier criteria ***And*** The vineyard and/or winery operation had an informal purchasing policy ***And*** Environmental considerations were included in some purchasing decisions ***And*** Research into alternative materials and products was undertaken.	Purchasing decisions were primarily based on lowest cost ***And*** The vineyard and/or winery operation had an informal purchasing policy.

*Visit the CSWA Online Resources Library and search for "Sustainable Procurement Policy Template" for a template that can be used to start your own policy (https://library.sustainablewinegrowing.org/).
**"Significant supplies/service providers" are typically identified as 80% of a company's spend/cost of goods. Looking at all of a company's cost of goods over 12 months, the suppliers that contribute to the top 80% of those costs would be considered significant.

Box 13-C Resources to Collect Information About Your Suppliers

Many companies are attempting to make their commitment to sustainability and their effects on society and to the environment more transparent by producing a corporate sustainability report or by participating in some other process that provides information about their commitment to environmental, economic, and social principles. Many of the largest corporations follow the Global Reporting Initiative guidelines (see https://www.globalreporting.org/Pages/default.aspx). To determine if one of your suppliers has produced a corporate sustainability report go to http://database.globalreporting.org/search and search for the company.

Another source for information on supplier sustainability practices is the Carbon Disclosure Project (CDP) (see https://www.cdproject.net/research). Companies committed to reducing their greenhouse gas footprint provide information on what they are doing in their operations to save energy and reduce water use, which is closely linked to energy use). Check out which companies have the best CDP scores at: https://www.cdp.net/en/companies/companies-scores.

There are six major supplier sustainability ranking tools/websites that purchasers can use to view the rankings of companies they might be purchasing from. Information on these six sites can be found at: https://www.sustainablepurchasing.org/supplier-ratings-tools/.

Since many of the suppliers to growers and vintners are not publicly traded, finding information may require your own investigation using some of the following techniques:

- Visit your suppliers' company websites for publicly available information.
- Prepare a list of questions to discuss with significant suppliers when they visit your vineyard or winery to discuss products and/or services or email the questions to them and request their response. ("Significant suppliers" are typically identified as 80% of a company's spend/cost of goods.) Examples of questions you may want to ask your significant/primary suppliers include:
    - Tell us about your company's overall approach to sustainability.
    - Does your company have any sustainability-related policies in place (sustainability policy, zero waste policy, diversity and inclusion policy, sustainable procurement policy, etc.)?
    - Does your company track and monitor sustainability-related metrics such as water use, waste, energy use or GHG emissions?
    - Does your company have any social or environmental focused goals or targets you are working towards? If so, what are those goals or targets?
    - How does your company promote a diverse and inclusive workplace?
- Prepare a survey that can be given to all of your suppliers, from the smallest to the largest, and use the information provided to refine your selection of vendors.

13-2 Service Providers*

Winery

Category 4	Category 3	Category 2	Category 1
Primary factors in awarding service contracts were quality, dependability, and lowest bid ***And*** Significant service providers that demonstrated environmental awareness are prioritized ***Or*** Some significant service providers attained voluntary industry acknowledgement, governmental recognition, or third-party certification for their environmental practices ***And*** All service providers were evaluated on their environmental practices and results were used in future contract negotiations ***And*** Requirements for services mandated specific environmental standards and practices.	Primary factors in awarding service contracts were quality, dependability, and lowest bid ***And*** Significant service providers were asked about their environmental practices ***And*** Some significant service providers were evaluated on their environmental practices ***And*** Some requirements for services mandated specific environmental standards and practices (e.g., take back, packaging, recyclability, used of non-toxic substances).	Primary factors in awarding service contracts were quality, dependability, and lowest bid ***And*** Some significant service providers were asked about their environmental practices ***And*** Requirements for services included some environmental considerations.	Primary factors in awarding service contracts were quality, dependability, and lowest bid. *(Select N/A if no service providers were used)*

*Service providers can include contract labor, PCAs, janitorial, landscaping, catering services, printers, etc. See **Box 13-D** for some examples of environmental standards and practices for different service providers. "Significant service providers/suppliers" are typically identified as 80% of a company's spend/cost of goods. Looking at all of a company's cost of goods over 12 months, the suppliers that contribute to the top 80% of those costs would be considered significant.

BOX 13-D EXAMPLE OF STANDARDS AND PRACTICES FOR SERVICE PROVIDERS

Specific standards and practices can be required of service providers to ensure that a high standard of environmental quality is provided to a winery or vineyard. Below are examples of recommended environmental practices for some common services.

Landscaping: Use natural pesticides, hand weed, no leaf blowers, compost all material, and competent in IPM practices. For information on specific landscaping products, visit https://www.epa.gov/greenerproducts/identifying-greener-landscaping-choices.

Graphics and Printing: Use recycled paper, minimum post-consumer content, tree-free paper, and soy-based inks. Printing hint: the key to effective, environmentally sensitive printing jobs is addressing issues in the design stage. To learn more about making printing more environmentally friendly, visit: http://www.rethinkrecycling.com/government/eppg/-buy-products-services/printing/printing-services.

Janitorial: Use non-toxic cleansers and detergents. Janitorial products can contain toxic or hazardous materials that may cause severe health problems. A good source to begin reviewing products is https://www.epa.gov/greenerproducts/greening-your-purchase-cleaning-products-guide-federal-purchasers.

Painting: Use latex paints, paints with low volatile organic compound (VOC) content, and no solvent-based cleaning products. American businesses and households spend about $18 billion a year on approximately 15 million tons of paints and other coatings. For complete information on Sustainable Purchasing of paint and services, visit: http://www.rethinkrecycling.com/government/eppg/-buy-products-services/green-building-products-and-services/paint.

Construction: Use green building supplies and recycled materials, consider indoor air quality issues, and recycle construction debris. (For more information on green building, see **Box 13-D1 Green Building**.) For comprehensive information on recycling construction debris and green building materials, visit https://www.epa.gov/smm/best-practices-reducing-reusing-and-recycling-construction-and-demolition-materials. For relevant information about specific products, visit: https://www.wbdg.org/design-objectives/sustainable.
https://www.epa.gov/smartgrowth/location-and-green-building or
https://www.usgbc.org/resources

Catering: Use biodegradable or reusable plates and utensils, purchase organically grown food and recycled content paper products. For information, visit https://www.epa.gov/greenerproducts/identifying-greener-food-services .

Vehicle Maintenance: Use recycled coolant, re-refined oil, non-toxic cleaners, non-aerosol dispensers, and recycle tires. A good place to get the facts about re-refined oil and managing, reusing, and recycling used oil is https://www.epa.gov/recycle/managing-reusing-and-recycling-used-oil.

Box 13-D1 Green Building

Green building principles and design look at sustainability in the built environment, including the materials used in buildings, integrated HVAC systems, energy efficiency, water efficiency, waste reduction and renewable energy systems.

LEED

The most well-known framework for guiding green building principles and design in new construction and existing buildings is Leadership in Energy and Environmental Design (LEED). Available for virtually all building types, LEED provides a framework for healthy, highly efficient, and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement and leadership established by the U.S. Green Building Council.

The LEED rating system differs based on building type and industry, but generally includes specific practices and initiatives around the following categories:

- Integrative Process
- Location and Transportation
- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation

Living Building Challenge

The Living Building Challenge is another green building certification program created by the International Living Future Institute that goes beyond the sustainable criteria of LEED to strive for net-zero and regenerative achievements such as 100% renewable energy, water neutral, zero waste etc. The two principles of the Living Building Challenge are:

1. Living Building Challenge compliance is based on actual, rather than modeled or anticipated, performance. Therefore, projects must be operational for at least twelve consecutive months prior to audit to verify Imperative compliance.
2. All Living Building Challenge projects must be holistic—addressing aspects of all seven Petals through the Core Imperatives.

Source: https://living-future.org/lbc/

Learn more about LEED at: https://www.usgbc.org/leed
Learn more about the Living Building Challenge at: https://living-future.org/lbc/

Vehicle maintenance can be accomplished using environmental practices such as using recycled coolant, re-refined oil, non-toxic cleaners, non-aerosol dispensers, and recycled tires.

13-3 to 13-6 Vineyard & Winery Products*

Vineyard & Winery

Instructions: Please use the same Category descriptions for Criteria 13-3 to 13-6.

Category 4	Category 3	Category 2	Category 1
Primary factors in purchasing this product were quality, dependability, lowest cost and environmental attributes as part of the vineyard and/or winery operation's Sustainable Purchasing program ***And*** Only significant vendors who demonstrated environmental awareness and a proven record for delivering environmentally friendly products were given priority, if available ***Or*** Significant vendors attained voluntary industry or governmental recognition of certification for their products' environmental attributes (e.g., Energy Star®, Green Seal®), if available ***And*** Environmental attributes of products were evaluated (e.g., recycled content, reusability, recyclable packaging) ***And*** Most orders for supplies specified environmental requirements ***And*** Significant vendors and products were evaluated, and results were used in future contract negotiations.	Primary factors in purchasing this product were quality, dependability, lowest cost, and environmental attributes ***And*** Significant vendors who demonstrated environmental awareness were considered (if available) ***And*** Significant vendors were evaluated on their products' environmental attributes ***And*** Environmental attributes of products were evaluated (e.g., recycled content, reusability, take-back or recyclable packaging, non-toxic) ***And*** Some orders for this product specified environmental requirements.	Primary factors in purchasing this product were quality, dependability, and lowest cost ***And*** Some significant vendors were asked about their products' environmental attributes ***And*** Requirements for this product included some environmental considerations.	Primary factors in purchasing this product were quality, dependability, and lowest cost.
13-3 Vineyard Supplies (e.g., posts, trellis systems, irrigation systems, pruning equipment, etc.)			
13-4 Vehicles (including tractors)			
13-5 Vehicle Maintenance Products			
13-6 Office Equipment			
*See **Box 13-E** for examples of environmental attributes for each product type.			

BOX 13-E EXAMPLES OF ENVIRONMENTAL ATTRIBUTES FOR VINEYARD AND WINERY PRODUCTS

Products that a vineyard or winery operation may purchase can have specific environmental attributes that are useful to look for when making purchasing decisions. Below are some recommended environmental attributes to consider as part of a Sustainable Purchasing strategy.

Vineyard Supplies (e.g., posts, trellis systems, irrigation systems, pruning equipment): Recycled or refurbished materials, non-toxic materials, energy and water efficient, low emissions.

Vehicles: High mileage, low emissions, alternative fuels, used vehicles, electric. For information on alternative fueled vehicles visit: https://www.epa.gov/greenvehicles.

Vehicle Maintenance Products: Recycled material content, re-refined oil, remanufactured parts, take-back or recyclable packaging, recycling services. For information on specific vehicle supplies visit: https://www.epa.gov/recycle/managing-reusing-and-recycling-used-oil.

Office Equipment: Recycled plastic components, Energy Star® certification, reusable parts, repairable, take-back or recyclable packaging. For relevant information on copiers, computers, and other office equipment, go to: https://www.energystar.gov/products?s=mega.

BOX 13-F SUSTAINABLE PURCHASING RESOURCES

For a comprehensive database for purchasing environmentally friendly products visit: https://www.epa.gov/greenerproducts/identify-greener-products-and-services.

For a good overview on why Sustainable Purchasing programs are useful visit: https://www.epa.gov/greenerproducts/why-buy-greener-products.

For tips on tracking environmental purchases visit: https://www.epa.gov/smm/sustainable-materials-management-tools.

EPA guide to identifying green products and services: https://www.epa.gov/greenerproducts/identify-greener-products-and-services

Energy Star qualified products: https://www.energystar.gov/productfinder/

Eco-Logo product list: http://www.ecolabelindex.com/ecolabel/ecologo

"Cradle to Cradle" certified products: https://www.c2ccertified.org/products/registry

For examples of Sustainable Purchasing policies visit: http://www.stopwaste.org/home/index.asp?page=439.

13-7 to 13-13 Winery Products* *Instructions: Please use the same Category descriptions for Criteria 13-7 to 13-13.*			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Primary factors in purchasing this product were quality, dependability, lowest cost, and environmental attributes as part of the winery operation's Sustainable Purchasing program ***And*** Only significant vendors who demonstrated environmental awareness and a proven record for delivering environmentally friendly products were given priority, if available ***Or*** Significant vendors attained voluntary industry or governmental recognition of certification for their products' environmental attributes (e.g., Energy Star®, Green Seal®), if available ***And*** Environmental attributes of products were evaluated (e.g., recycled content, reusability, take-back or recyclable packaging, non-toxic materials) ***And*** Most orders for this product specified environmental requirements ***And*** Significant vendors and products were evaluated, and results are used in future contract negotiations.	Primary factors in purchasing this product were quality, dependability, lowest cost, and environmental attributes ***And*** Significant vendors who demonstrated environmental awareness were considered (if available) ***And*** Significant vendors were evaluated on their products' environmental attributes ***And*** Environmental attributes of products were evaluated (e.g., recycled content, reusability, take-back or recyclable packaging, non-toxic materials) ***And*** Some orders for this product specified environmental requirements.	Primary factors in purchasing this product were quality, dependability, and lowest cost ***And*** Some significant vendors were asked about their products' environmental attributes ***And*** Requirements for this product included some environmental considerations.	Primary factors in purchasing this product were quality, dependability, and lowest cost.
13-7 Wine Containers			
13-8 Closures			
13-9 Capsules			
13-10 Boxes			
13-11 Winery Equipment			
13-12 Paper			
13-13 Janitorial Cleaning Supplies			
*See **Box 13-G** for examples of environmental attributes for each product type.			

Box 13-G Examples of Environmental Attributes For Winery Products

When making purchasing decisions for winery products there are specific environmental attributes that are useful to look for. Below are some environmental attributes to consider as part of any Sustainable Purchasing strategy.

Wine Containers: High recycled content, recyclable material, low GHG emissions, take-back or recyclable packaging

Closures: Sustainable forestry practices, sustainable certification, take-back or recyclable packaging

Capsules: Recycled material content, recyclable material, take-back or recyclable packaging

Boxes: Recyclable material, high post-consumer content, reusability, chlorine free

Winery Equipment: Energy efficiency, water efficiency, take-back or recyclable packaging, low emissions. US EPA offers assistance in finding energy efficient equipment at http://www.energystar.gov/index.cfm?c=products.pr_find_es_products.

Paper: Recycled paper, high post-consumer content, tree-free paper.

Utensils: Biodegradable or reusable plates and utensils, washable glasses and mugs, recycled content paper products. For information on biodegradable utensils visit: https://www.epa.gov/greenerproducts/identifying-greener-food-services .

Cleaning Supplies: Non-toxic cleansers and detergents, biodegradable, no VOCs. Janitorial products can contain toxic or hazardous materials that may cause severe health problems. A good resource to begin reviewing products is https://www.epa.gov/saferchoice/products. See https://www.epa.gov/greenerproducts/identify-greener-products-and-services for additional information on green cleaning products. See **Box 13-H** for more information.

BOX 13- H ENVIRONMENTAL CONSIDERATIONS OF CHEMICALS IN CLEANING PRODUCTS

Many cleaning products can have very negative impacts on indoor air quality and human health. These products contain chemicals associated with cancer, reproductive disorders, respiratory ailments, eye or skin irritation, and other human health issues. They also can include toxic materials that adversely affect plant and animal life, contribute to ozone depletion, and accumulate in the environment with potentially harmful consequences.

Indoor air pollution, some of which is linked to cleaning product exposure, is ranked among the nation's top five environmental risks. According to the US EPA, indoor air pollution can be from twice as high to 100 times higher than outdoor levels of air pollution. This is particularly alarming because most people spend as much as 90% of their time indoors. For more information on indoor air quality visit https://www.epa.gov/indoor-air-quality-iaq.

Many purchasers interested in environmentally preferable cleaning products prohibit products that contain certain potentially hazardous chemicals. The US Environmental Protection Agency worked with Yellowstone National Park and Grand Teton National Park to evaluate and replace the cleaning products used through the parks with safer alternatives. The summary report includes an ingredient guide and glossary that covers chemicals to try to avoid and provides background on how to choose safer cleaning products, which is available at https://www.epa.gov/sites/production/files/2015-05/documents/cleaning.pdf.

In recent years a new practice for developing chemicals has taken hold in industry. Green chemistry, also known as sustainable chemistry, is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, and use (http://www.epa.gov/greenchemistry/).

US EPA’s Design for the Environment has expertise on green chemistry and toxicology to assist businesses and industry in finding safe alternatives to chemicals of concern. They have a label that can be found on certified products (http://www.epa.gov/dfe/product_label_purch.html#purchasers).

Box 13- I The Role of Packaging in a Winery's Carbon Footprint

When comprehensive GHG emissions inventories of wineries are conducted, it is very common to see packaging responsible for one of the largest percentages of GHG emissions. In fact, a Wine Institute study on the GHG emissions associated with the California wine industry show that packaging accounts for 38% of total emissions, much larger than any other single aspect of the business: https://www.sustainablewinegrowing.org/docs/California_Wine_Executive_Summary.pdf.

The emissions associated with packaging typically include the extraction and transportation of the raw materials needed for the packaging, the energy associated with manufacturing of the materials and the transportation for delivering the materials to their final destination.

Steps that can be taken to reduce the GHG emissions associated with your packaging materials include:

- Incorporate more recycled content into your packaging materials such as bottles, labels and boxes
- Look to lightweight your bottles, reducing the amount of glass used and the amount of energy needed to transport the low-weight bottles
- Work with suppliers to eliminate any unnecessary packaging associated with the products they are sending
- Work with suppliers to reuse packaging materials such as boxes and pallets where possible.

CSWA integrates performance metrics into the Sustainable Winegrowing Program to further promote, measure, and communicate continuous improvement around GHG emission reduction, including emissions from packaging, and other important metrics.

The online Performance Metrics Calculator is used by growers and vintners to calculate metrics and access associated educational information. Metrics results are confidentially stored (password protected) in the SWP online system for individual business use.

More information on performance metrics for the California Sustainable Winegrowing Program can be found at: https://metrics.sustainablewinegrowing.org/.

13-14 Packaging – From Suppliers

Winery

Category 4	Category 3	Category 2	Category 1
The amount of packaging used by all suppliers was a primary consideration in purchasing decisions ***And*** Most significant suppliers were required to demonstrate that their packaging materials are environmentally responsible ***And*** Requirements for packaging coming from all suppliers mandated specific environmental attributes ***And*** Requirements for supplier packaging specified all environmental attributes to be met as part of a company-wide Sustainable Purchasing program.	The amount of packaging used by significant suppliers was a primary consideration in purchasing decisions ***And*** Most significant suppliers were required to demonstrate that their packaging materials are environmentally responsible ***And*** Requirements for packaging coming from significant suppliers mandated specific environmental attributes (e.g., recycled content, post-consumer content, reusable material, biodegradable material, take-back or recyclable packaging).	The amount of packaging used by significant suppliers was considered in purchasing decisions ***And*** Some significant suppliers were asked about their use of packaging materials ***And*** Requirements for packaging coming from significant suppliers included some environmental requirements.	The amount of packaging used by suppliers was not taken into consideration in purchasing decisions.

13-15 Packaging – To Customers *Winery*

Category 4	Category 3	Category 2	Category 1
Primary factors in purchasing packaging material were quality, dependability, and lowest bid ***And*** Only suppliers of packaging material who demonstrated environmental awareness and had a proven record for delivering environmentally friendly products were considered ***And*** Significant suppliers were evaluated on their products' environmental attributes and results were used in future contract negotiations ***And*** Requirements for packaging material mandated specific environmental attributes ***And*** Packaging material from suppliers was reused when possible at the winery ***And*** Orders for packaging material specified most environmental attributes to be met as part of a company-wide Sustainable Purchasing program.	Primary factors in purchasing packaging material were quality, dependability, and lowest bid ***And*** Suppliers of packaging material who demonstrated environmental awareness were given preferential treatment ***And*** Significant packaging material suppliers were evaluated on their products' environmental attributes ***And*** Requirements for packaging material mandated specific environmental attributes (e.g., recycled content, post- consumer content, ease of reuse or recycling, biodegradability) ***And*** Packaging material from suppliers was reused when possible at the winery ***And*** Orders for packaging material specified some environmental attributes to be met.	Primary factors in purchasing packaging material were quality, dependability, and lowest bid ***And*** Some significant suppliers of packaging material were asked about their products' environmental attributes ***And*** Requirements for packaging material included some environmental considerations ***And*** Packaging material from suppliers was sometimes reused at the winery.	Primary factors in purchasing packaging material were quality, dependability, and lowest bid. *(Select N/A if there was no direct shipping)*

14. HUMAN RESOURCES

Original Chapter Author: Liz Thach; Modified by the Sustainable Winegrowing Joint Committee

The effective management of human resources (HR) is a key component to the sustainability of any organization. Attracting and retaining an excellent workforce in vineyard and/or winery operations can improve productivity, profitability and therefore, sustainability. Job creation and employee professional development strengthen and enhance the quality of life in local communities. Training focused on the conservation of natural resources such as programs targeting water conservation, energy efficiency, and recycling are critical to operations achieving tangible environmental results. This chapter addresses the three major HR components – workforce staffing and recruiting, training and development, and employee relations – and the promotion of sustainability concepts and practices in the workplace.

California has a strong regulatory framework for human resources and worker health and safety. This chapter provides self-assessment and resources to promote effective management within your organization and the industry as a whole. Many vineyard and winery operations are already implementing HR best practices, resulting in higher levels of workforce productivity and satisfaction.[1] These practices are also positively impacting the bottom-line profits and long-term competitiveness of these companies, in terms of enhanced sustainability. Most vineyard and winery operations in California have a combination of full-time, part-time, and seasonal workers. For most companies and farming operations, it is important to create a workforce plan and recruiting process that helps ensure that sufficiently trained and motivated employees are available when needed, even during labor shortages. By appropriately hiring, developing, managing, and rewarding employees, the California wine community can create a sustainable competitive advantage that will help improve productivity, efficiency, and innovation.

The purpose of this chapter is to help growers and vintners identify and implement best practices in human resources management that can increase the effectiveness of their employees. It provides 11 criteria to self-assess:

- The state of your HR planning and goals
- The status of recruitment needs and procedures
- The extent of employee training and skills to accomplish work effectively
- The status of integrating sustainability in the workplace.

As a reminder, regulatory compliance for all practices is assumed. Category 1 is intended to meet or exceed legal requirements where they exist; while Categories 2, 3 and 4 move growers and vintners beyond compliance towards increasingly sustainable practices. However, it is important to note that not all practices will make sense for all operations.

If you have no employees you may select N/A where appropriate throughout the chapter.

[1]Thach, L. & Kidwell, R., (2009) HR Practices in United States and Australian Family Wineries: Cultural Contrasts and Performance Impact. *International Entrepreneurship and Management Journal*, Vol. 5, Issue 2, p. 219-240

List of Human Resources Criteria

14-1 HR Planning and Goals
14-2 Staffing and Recruiting Strategy
14-3 Interviewing Process
14-4 Employee Orientation
14-5 Safety Training
14-6 Continuing Education, Training and Development
14-7 Industry Knowledge and Participation
14-8 Promoting Sustainability in the Workplace
14-9 Employee Performance
14-10 Compensation Benchmarking
14-11 Diversity, Equity and Inclusion

BOX 14-A IMPORTANT NOTE ON LANGUAGE FOR HUMAN RESOURCE ISSUES

If there are employees who do not speak or comprehend English well, it is highly recommended that HR interactions, such as interviewing, training, and other HR communications, be conducted in the primary language of those employees, or that a translator is present. It is also recommended that, if possible, any written HR materials be translated into the primary language. By ensuring that job descriptions, applications, training, and other HR materials are translated into applicable languages, there is less chance that employees will misunderstand some of the important messages and procedures being communicated. This is especially critical with safety training.

Spanish Language Sustainability Resources
CSWA is working to provide many sections of this self-assessment workbook, along with additional educational sustainability resources, in Spanish. You can find the most up-to-date list of Spanish-language materials on the CSWA website at: http://www.sustainablewinegrowing.org/espanol.php.

14-1 HR Planning and Goals*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation had an established process to monitor and review human resources legal and regulatory requirements that pertain to the operation and, to the best of our relevant staff's knowledge, is in compliance** ***And*** The vineyard and/or winery operation developed and implemented an HR plan that addressed business needs and included staffing and recruitment, training and development, employee relations, compensation and benefits, and record-keeping ***And*** The plan included HR goals (e.g., percent employees retained, training completed, etc.) ***And*** HR goals were monitored and results were used to refine HR policies and practices.	The vineyard and/or winery operation had an established process to monitor and review human resources legal and regulatory requirements that pertain to the operation and, to the best of our relevant staff's knowledge, is in compliance** ***And*** The vineyard and/or winery operation developed and implemented an HR plan that addressed business needs and included staffing and recruitment, training and development, employee relations, compensation and benefits, and record-keeping.	The vineyard and/or winery operation had an established process to monitor and review human resources legal and regulatory requirements that pertain to the operation and, to the best of our relevant staff's knowledge, is in compliance** ***And*** The vineyard and/or winery operation had an HR strategy that addressed business needs and included staffing and recruitment, training and development, employee relations, compensation and benefits, and record-keeping.	The vineyard and/or winery operation had an established process to monitor and review human resources legal and regulatory requirements that pertain to the operation and, to the best of our relevant staff's knowledge, is in compliance.** *(Select N/A if you had no employees* and did not use contractors)*

*If you have no employees you may select N/A where appropriate throughout the chapter.
**When completing a self-assessment, a vineyard or winery that is actively responding to a regulatory non-compliance issue may still score themselves as "in compliance." E.g., if there is an active Notice of Violation at the vineyard and/or winery, the issue has been identified, corrective actions are in place and the issue is being resolved with the oversight agency.

BOX 14-B STAFFING AND RECRUITING

Retaining good employees is important to a sustainable business strategy. By establishing a strategic staffing, recruiting, and retention plan and process, vineyard and winery operations ensure that they have the correct number of employees and appropriate skills to effectively implement their business strategy. The replacement cost of an employee can be more costly than their annual salary when considering the costs associated with recruiting a new employee, downtime, potential overtime or temporary employees, management time to interview candidates, orienting and training a new employee, and potential unemployment. By staffing your organization with talented employees, selecting the most effective recruiting strategies, and implementing retention practices to keep employees satisfied, you will helps enhance your business strategy effectively even during labor shortages.

Establishing a good recruiting and retention process helps ensure that sufficiently trained and motivated employees are available when needed.

14-2 Staffing and Recruiting Strategy

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation had a long-term staffing strategy that analyzed future staffing needs (which could include succession planning, long term growth, etc.) ***And*** If the vineyard contracted for labor, state license requirements were checked* ***And*** We analyzed recruiting methods** to ensure they were effective and equitable ***And*** We had a written job description*** for each position, that was reviewed for updates every 1-2 years or whenever an opening occurred ***And*** We began to leverage the reputation of our organization in the recruitment process, that included sustainability ***And*** We tracked results of each recruiting method to calculate the cost/benefit.	The vineyard and/or winery operation had a long-term staffing strategy that analyzed future staffing needs (which could include succession planning, long term growth, etc.) ***And*** If the vineyard contracted for labor, state license requirements were checked* ***And*** We analyzed recruiting methods** to ensure they were effective and equitable ***And*** We had a written job description*** for some positions.	The vineyard and/or winery operation had a staffing strategy that analyzed future staffing needs ***And*** If the vineyard contracted for labor, state license requirements were checked* ***And*** We analyzed recruiting methods** to ensure they were effective.	The vineyard and/or winery operation had an informal method for staffing ***And*** If the vineyard contracted for labor, state license requirements were checked.* *(Select N/A if you had no employees and do not use contractors)*

*To check the license of a contractor/vineyard manager to ensure they meet license requirements please visit the Farm Labor Contractors License Database on the California Department of Industrial Relations website at: http://www.dir.ca.gov/databases/dlselr/FarmLic.html. (See **Box 14-C** for more information on how to select a reputable contractor.)
See **Box 14-D for examples of recruiting methods and **Box 14-E** for more information on recruiting. For tools and resources on responsible recruitment, visit: responsiblerecruitmenttoolkit.org.
***Free sample job descriptions are available at: https://hiring.monster.com/employer-resources/job-description-templates/sample-job-descriptions/.

BOX 14-C SELECTING CONTRACTORS

Taking the time to select a good Farm Labor Contractor (FLC) or Vineyard Management Company (VMC) is important. There are several good practices to undertake to ensure you are hiring a reputable contractor.

Why is it important to hire a reputable farm labor contractor?
There is a growing trend in litigation and enforcement actions where plaintiffs' attorneys and government agencies are trying to impose joint employer liability on growers and FLCs. One common example, if the grower pays the FLC for their services and the FLC subsequently fails to pay their workers, the grower will be responsible for unpaid wage claims. Well-drafted written contracts between the FLC/VMC and the grower are the first line of protection against a finding of joint employer liability.

What should the grower examine before hiring a FLC?
Before hiring a FLC, growers should verify, investigate, and receive copies of the following:

- State and federal certificates of FLC registration;
- Registration with the IRS, California Employment Development Department, California Franchise Tax Board, and County Agricultural Commission;
- Workers' Compensation Insurance and Certificate of Insurance;
- Workers' Compensation Experience Modification rating;
- Licensing, inspection, and registration requirements for vehicles and drivers used by the FLC for transportation;
- Compliance with OSHA standards including lighting standards, heat illness prevention, injury and illness prevention, safety training and inspection records, first aid and CPR training certificates, field sanitation procedures, and COVID-19 prevention;
- Acknowledgment of compliance with the requirements of the California Labor Code
- Pesticide training documentation and pesticide safety information forms and notices; and
- Proof of compliance with I-9 verification process.

What should a FLC/VMC-Grower contract include?
The best defense a grower has against joint employer liability claims is a sound written contract, which is a prudent first step in any business relationship. Although written contracts between a grower and FLC/VMC are not required, it's advisable to use a contract to ensure, at a minimum, compliance with California Labor Code section 2810 and to include:

- The contact information for the grower and FLC;
- A description of the labor or services to be provided and completion date;
- FLC identification number for state tax purposes;
- FLC Workers' Compensation insurance policy number and carrier;
- Vehicle identification number, insurance policy, and insurance carrier for any vehicle used by the FLC for transportation;
- Physical address of any property used to house workers;
- Total workers employed under the contract, total amount of wages to be paid, and the date when wages are to be paid;
- A provision indemnifying the grower from any liabilities stemming from the work, labor and services performed by the FLC;
- The amount of commission paid for the FLC services; and
  Any independent contractors that will be utilized along with their respective license numbers.

Check license databases to verify that the contractor you select is properly licensed:
California: http://www.dir.ca.gov/databases/dlselr/farmlic.html.
Federal: http://www.dol.gov/whd/regs/statutes/FLCList.htm.
Sources: Michael Saqui of the Saqui Law Group, Granite Bay, CA, www.laborcounselors.com, and Collin Cook and Brandon Kahoush at Fischer and Phillips LLP.

BOX 14-D POTENTIAL RECRUITING METHODS

There are many methods for recruiting vineyard or winery employees. These can include referrals, online job ads, newspapers, job fairs, wine journals/publications, college recruiting, community outreach, and internal postings. Some methods may be better for certain circumstances. If unsure which method(s) is best for your situation, consider discussing options with experienced growers/vintners/organizations prior to recruiting. In addition, review and ensure all relevant legal requirements will be followed before recruiting and hiring (see **Box 14-E**).

BOX 14-E IMPORTANT STAFFING AND RECRUITING LAWS TO CONSIDER

Record-Keeping

- KEEP ALL EMPLOYMENT AND RECRUITMENT RECORDS!
- You should maintain a file for each employee that includes their original job application, resume, interview notes, and any other correspondence regarding their job application. This file should be kept the length of employment plus three (3) years. You should keep applications, interview notes, and resumes of job candidates not hired for a solicited position for a minimum of two (2) years (see https://www.eeoc.gov/employers/recordkeeping-requirements).
- Title VII of the Civil Rights Act of 1974 and the Americans with Disabilities Act (ADA), federal laws, apply to all employers with 15 or more employees. Under Title VII, companies are required to preserve all employment records for one (1) year, and unsolicited applications for six (6) months. Records include application forms and all other data related to the hiring process (resumes, job postings, interview notes, etc.).

Equal Employment Opportunity (EEO)

- The Equal Employment Opportunity Commission (EEOC) was created in 1964 to enforce Title VII of the Civil Rights Act, which protects employees from discrimination. Protected groups under Title VII include race, color, national origin, religion, age, sex (gender), sexual orientation, and physical or mental disability. Employees who believe they are being discriminated against have the right to file a complaint with their local EEOC office. This includes discrimination in interviewing and hiring practices.
- The EEOC created a document titled the *Uniform Guidelines for Employee Selection Procedures* (see http://www.uniformguidelines.com) to help employers interpret the federal statutes on discrimination. This document also provides information on illegal interview questions. Unless the employer has a "business necessity" (bona fide occupational qualification) to hire someone of a certain religion, sex or national origin, etc., they cannot ask questions related to these protected categories.
- An employer's hiring practices become illegal when the company operates to the disadvantage of one or more protected classes of individuals – termed "adverse impact." See **Figure 14-a** below on Protected Classes.

Affirmative Action (Executive Order 11246) Requirements

- If a company has been found to be in violation of Title VII statutes by the EEOC or courts, they may be required to implement an Affirmative Action Program. Also, if a company has a federal contract for products or services of more than $50,000 and 50 or more employees, they are required to establish an Affirmative Action Program.

- An Affirmative Action Program includes specific goals and timetables for hiring protected groups who are under-represented. It also must include a plan, procedures, and an EEO policy.

Cal/OSHA – Recording Work-Related Injuries and Illnesses

- Cal/OSHA requires employers to prepare and maintain records of work-related injuries and illnesses. The Log of Work-Related Injuries and Illnesses (Form 300) is used to classify work-related injuries and illnesses and to note the extent and severity of each case. When an incident occurs, use the Log to record specific details about what happened. The Summary—a separate form (Form 300A)—shows the totals for the year in each category. At the end of the year, post the Summary in a visible location so that your employees are aware of the injuries and illnesses occurring in their workplace. https://www.dir.ca.gov/dosh/dosh_publications/reckeepoverview.pdf

Immigration and Employment of Foreign Nationals

- For information on the Immigration and Nationality Act (INA) visit: https://www.uscis.gov/laws-and-policy/legislation/immigration-and-nationality-act.
- For information on the Migrant and Seasonal Agricultural Worker Protection Act (MSPA) visit: https://www.dol.gov/agencies/whd/agriculture/mspa.

For additional information on interviewing questions and hiring practices, see **Criterion 14-3**, **Box 14-F,** and **Box 14-G.** If you have questions about illegal interview questions or hiring practices, please consult your legal counsel.

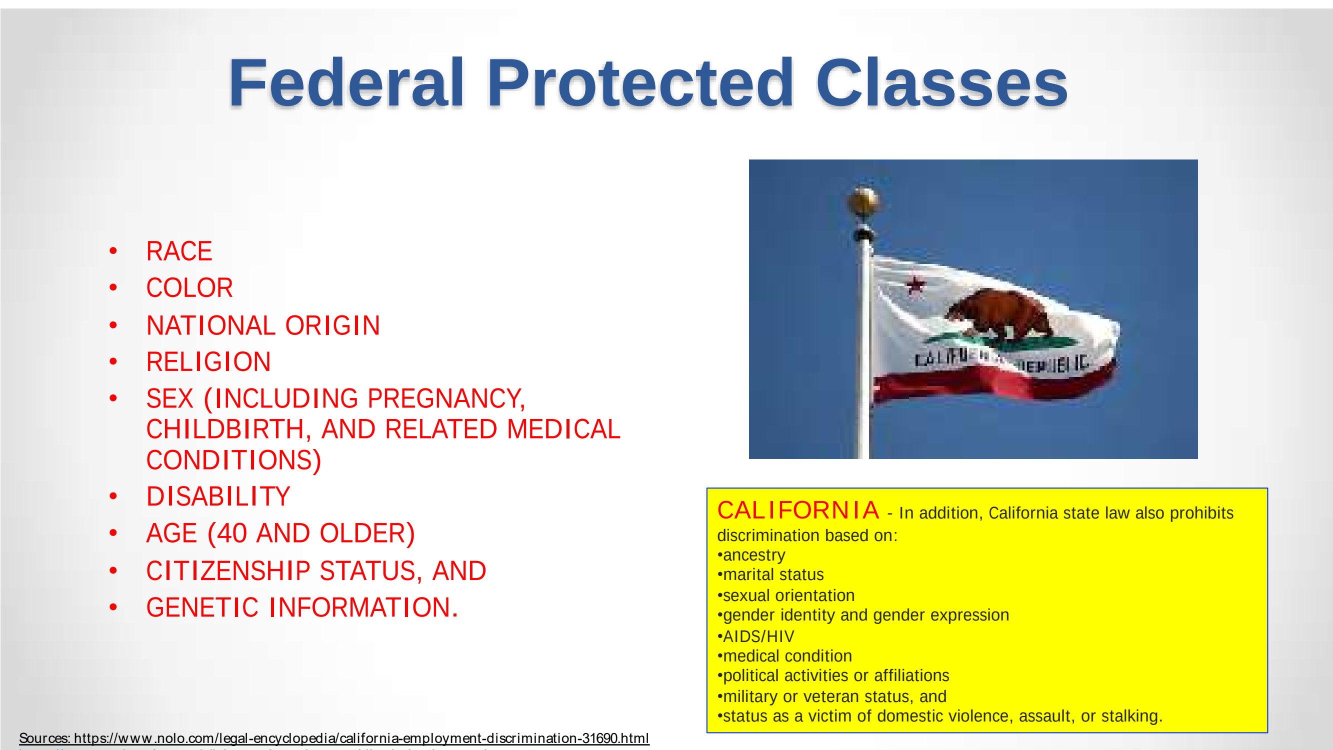


Figure 14-a Description of federal protected classes and discrimination prohibited by California state law.

14-3 Interviewing Process*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation's interviewing process included submission of a job application or a resume ***And*** Interviews involved a set of specific questions, including competency-based questions, designed to ensure qualifications were met for each position ***And*** Information was provided about the company, performance expectation, and essential aspects of the job ***And*** Interviews included information and questions designed to assess candidate's fit for company culture, including sustainability values ***And*** The interview format included a formal scoring system to evaluate knowledge and skills objectively.	The vineyard and/or winery operation's interviewing process included submission of a job application or a resume ***And*** Interviews involved a set of specific questions designed to ensure qualifications were met for each position ***And*** Information was provided about the company, performance expectations, and essential aspects of the job.	The vineyard and/or winery operation's interviewing process included submission of a job application or a resume ***And*** Interviews involved a set of specific questions designed to ensure qualifications were met for each position.	The vineyard and/or winery operation had an informal interviewing process in place. *(Select N/A if you had no employees)*

*Forms on structured interviews, resume and application tracking, and applications for employment are available at https://www.shrm.org/resourcesandtools/tools-and-samples/hr-forms/pages/default.aspx.
See **Box 14-F** for examples of interviewing best practices.

BOX 14-F EXAMPLES OF INTERVIEWING BEST PRACTICES

- Involve at least two or more employees on the interviewing team who are trained in the organization's interview process.
- Ensure the selection process is based on job description and candidate's experience.
- Interviewer should be knowledgeable about best practices on appropriate interview questions.
- Keep company Inclusion Policy on hiring diverse employees in mind when selecting and interviewing candidates
- Manage reputation of company through interview questions and procedures.
- Follow up with candidates who applied and were interviewed but were not selected, and when feasible, acknowledge all applications.

For more information on appropriate interview questions, see https://hiring.monster.com/employer-resources/recruiting-strategies/interviewing-candidates/legal-job-interview-questions/.

The California Department of Fair Employment and Housing provides a fact sheet on what employers can ask applicants, available at: https://equity.ucla.edu/wp-content/uploads/2016/06/Questions-to-Avoid-dfeh-161.pdf.

Box 14-G Hiring Process for New Employees

After completing the interview process and identifying a top candidate, it is highly recommended that you undertake the hiring process detailed below to protect your company and employees.

Offer Letter: Write an offer of employment letter to the candidate that includes the agreed salary and benefits. Make the offer ***contingent*** upon the candidate accomplishing the following:

- Passing a reference check that includes possible credential
- Passing a drug/alcohol screening test (if appropriate)
- Passing a physical (if appropriate)
- Passing any other required employment tests (math exam, etc.)
- Passing a background check (if appropriate)

Important: *Employment tests must be validated by a professional, and you must be able to provide proof that the test is a reliable indicator of a good hire.*

At Will Language: It is important to include an "at will" clause in both your offer letter and Employee Handbook (if you have one). The following is an example of an "at will" clause:

> *It is understood that your employment is not bound or governed by any written or orally implied contract. Your employment with ________________ is considered to be an at-will arrangement. This means that you are free to terminate your employment relationship at any time and for any reason. Conversely, ________________ retains the right to do the same at anytime, so long as there is no violation of federal or state law.*

New Employee Orientation: You should have some type of process to welcome and orient employees to the company (see **Criterion 14-4** and **Boxes 14-J** and **14-K**). An effective employee orientation process will assist them in quickly becoming productive.

Box 14- H Workplace Postings

In California, all employers must meet workplace posting obligations. Workplace postings are usually available at no cost from the requiring agency. The Department of Industrial Relations requires employers to post information related to wages, hours, and working conditions in an area frequented by employees where it may be easily read during the workday (visit http://www.dir.ca.gov/wpnodb.html for the posters). Additional posting requirements apply to some workplaces. For a list of available safety and health postings, visit the Cal/OSHA publications web page at http://www.dir.ca.gov/dosh/puborder.asp.

BOX 14-I POST-HIRE PROCESS

Once the employee has been successfully hired, you will want to complete the Post-Hire Process by ensuring the new hire package includes all the requirements needed.

AB 469 requires employers to give new hires, at the time of hire, a notice containing certain information listed in the law. The statute also requires the California Division of Labor Standards Enforcement to issue a model notice, which can be found at http://www.dir.ca.gov/dlse/LC_2810.5_Notice.pdf.

The United State Department of Labor has a Migrant and Seasonal Agricultural Worker Protection Act website (http://www.dol.gov/whd/mspa/) which includes general guidance, fact sheets, and resources such as required posters and forms.

For a more information on requirements for employers, please see Farm Employers Labor Service Personnel & Labor Audit Checklist: http://www.fels.net/Data/Checklists/Audit-Checklist.pdf.

Source: Provided with permission from Farm Employers Labor Service (FELS), Copyright 2012, 2300 River Plaza Drive, Sacramento, CA 95833, http://www.fels.net.

14-4 Employee Orientation *Vineyard & Winery*

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation provided an orientation program* for new employees that included written documentation of company policies, job expectations, and terms of employment contained in an employee handbook** ***And*** Employees signed off verifying receipt of orientation documents ***And*** The orientation program included an overview and/or tour of our company's purpose, operations, culture, and sustainability policies and practices ***And*** The employee handbook included information on the company's sustainability policies and/or practices ***And*** The orientation program included one or more best practices*** for employee orientation.	The vineyard and/or winery operation provided an orientation program* for new employees that included written documentation of company policies, job expectations, and terms of employment contained in an employee handbook** ***And*** Employees signed off verifying receipt of orientation documents ***And*** The orientation program included an overview and/or tour of our company's purpose, operations, culture, and sustainability policies and practices.	The vineyard and/or winery operation provided an orientation program* for new employees that included written documentation of company policies, job expectations, and terms of employment.	The vineyard and/or winery operation orientation process consisted of verbal communication of job expectations and company policies at the time of hire. *(Select N/A if you had no employees)*

*See **Box 14-J** for examples on content for a formal employee orientation program.
See **Box 14-L, Box 14-M, and **Box 14-N** for information on employee handbooks.
***See **Box 14-K** for examples of orientation program best practices to consider.

Box 14-J Sample Elements of an Employee Orientation Process

It is common for employee orientation programs to include some or all of the content listed below.

- Review of company mission, vision, and values
- Overview of company strategy, products, and goals
- Review of company work standards and discipline issues (e.g., tardiness, dress, timekeeping procedures)
- Overview of company benefits
- Review of specific company policies (e.g., policies for inclusion/diverse workforce, harassment, health and safety, drug and alcohol use, violence, employment at will)
- Review of performance management process, including performance assessment and appraisal
- Policies on social media practices and remote work, if employee is working from home or other location away from the company office.
- Information about workers' rights with respect to freedom of association
- Harassment free workplace
- Compensation
- Overview of company organizational structure
- Review of company philosophy on sustainability
- Operations tour and introduction to other employees
- Signing required documents (e.g. employment at will, policy review, handbook receipt, etc.)

Note: Employee orientation should occur ideally on the first day of work or at least within the first week of employment.

Box 14-K Examples of Orientation Best Practices

Orientation programs may include the practices listed below. Some of the practices are more appropriate for certain companies/farming operations and job positions.

- **Mentoring or Buddy System:** Match a new winery or vineyard employee with an experienced employee or foreman to help provide necessary training and assistance for the new employee, on the job, until he or she is able to acclimate to the new surroundings and is able to understand and adequately perform the job requirements and his/her responsibilities (e.g., safety, hygiene, etc.). The Mentoring/Buddy System should be considered when new or experienced employees are placed in a new department or given a new work assignment. Assigning the appropriate, knowledgeable employee for each new job or process as a mentor/buddy will increase the success rate for the new trainee and can help provide a valuable, confident cross-trained employee.
- **Peer Meetings:** Peer meetings may be set up where new winery employees meet on a monthly basis for 1 to 2 hours (could be over lunch) with appropriate staff or managers who can provide updates on the business and policies and listen to issues or questions they have. These meetings also help new employees form positive working relationships and increase cross-departmental communication.
- **Affinity Group or Employee Resource Groups (ERG):** If your company is large enough, consider setting up this type of group that brings together employees with similar interests and/or ethnic backgrounds. These types of groups/networks can help you attract more diverse candidates, reduce turnover and increase morale. For more information see: https://www.shrm.org/resourcesandtools/legal-and-compliance/employment-law/pages/affinity-groups-risks-rewards.aspx.
- **Rotational Work Assignments:** For winery management or other relevant positions, placing new employees in several different departments during the first few weeks or months on the job allows them to gain a broader perspective on the company and how it works.
- **New Hire Feedback:** Incorporate the opportunity for vineyard or winery new hires to provide feedback on the orientation process.

BOX 14-L FORMAT OF EMPLOYEE HANDBOOKS

The format of an employee handbook will vary according to the size and needs of a company. For a small owner-operated vineyard, the handbook may be limited to a few pages stapled together. For larger organizations, it may be a binder/book or in an online format on the company Intranet.

BOX 14-M COMMON EMPLOYEE HANDBOOK CONTENTS

- Welcome and Purpose
- At-Will Employment
- Company Strategy and Values
- Sustainability Philosophy and Practices
- Employment Guidelines
- Communication and Grievance Policies
- Harassment and Discrimination Policies
- Inclusion/Diversity Policy
- The Way We Work
- Work Schedules and Compensation
- Time-Off Policies
- Transportation and Travel
- Performance Management and Discipline
- Transfer and Separation
- Environmental Health and Safety
- Employee Acknowledgements

Important legal considerations regarding Employee Handbooks:

- **Implement Handbook Policies**: Handbooks are very useful to companies and employees in that they provide specific information on company policies and procedures. However, if the company does not implement the policies and procedures as outlined in the handbook, they can be held legally liable. Therefore, it is important to update handbooks to reflect the actual practices used by the companies.

- **Obtain Written Employee Handbook Acknowledgement**: If you use an employee handbook, it is important to review the handbook with employees as part of your orientation process. It is important to have them sign a document verifying they have received and reviewed the handbook. It is also important to have them acknowledge, in writing, any revisions or updates to the handbook. A copy of the written acknowledgement should be given to the employee, and another copy should be placed in their personnel file. Also, it is always useful to reference, where applicable, another language version of the handbook and to include a statement that if there is an inconsistency between the English and another language version, then the policies and procedures in the English version rule.

- Below is a sample acknowledgement:
  This is to acknowledge that I have received, read, and fully understand the company handbook and the policies and guidelines included within it. Any rules or regulations that I did not understand were explained to me.

  I understand that I will abide by all the rules and regulations listed in the handbook and that my failure to do so could make me subject to immediate termination. I also understand that I am employed at will and that the information provided in the handbook is subject to change, and without notice.

  *Employee Signature*______________________________ *Date*____________________

BOX 14-N RESOURCES FOR WRITING AN EMPLOYEE HANDBOOK

The following websites provide information for designing an employee handbook.

- Farm Employers Labor Service: https://www.fels.net/1/ (view the catalog for a current listing of products and services)
- Online Employee Handbook Samples: http://www.hr-guide.com/
- Small Business Association: California Employee Handbooks: https://www.calchamber.com/california-labor-law/employee-handbook
- Guidelines for Employee Handbooks: https://www.shrm.org/resourcesandtools/tools-and-samples/pages/employee-handbooks.aspx

14-5 Safety Training

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation conducted or had external professionals conduct frequent (at least quarterly) employee safety training meetings as the year progressed and safety issues changed ***And*** We conducted safety audits and investigations as needed ***And/Or*** Farm labor contractors' safety program was reviewed or audited annually, if applicable ***And*** We or external professionals conducted tailgate trainings as needed and tasks assessments when conditions changed ***And*** We documented safety training session dates, attendance, and solicited and incorporate employee feedback when appropriate ***And*** We established and tracked safety statistics (e.g., lost-time accidents, cost/benefit analysis).	The vineyard and/or winery operation conducted or had external professionals conduct frequent (at least quarterly) employee safety training meetings as the year progressed and safety issues changed ***And*** We conducted safety audits and investigations as needed ***And/Or*** Farm labor contractors' safety program was reviewed or audited annually, if applicable ***And*** We or external professionals conducted tailgate trainings as needed and task assessments when conditions changed ***And*** We documented safety training session dates, attendance, and solicited and incorporated employee feedback when appropriate.	The vineyard and/or winery operation conducted or had contracted professionals conduct employee safety training meetings annually (unless required more often by law) ***And*** We conducted safety audits and investigations as needed ***And/Or*** Farm labor contractors' safety program was reviewed or audited every two years, if applicable.	The vineyard and/or winery operation regularly ensured safety training complied with local, state, and federal requirements for employee safety training.* *(Select N/A if you had no employees or did not use contractors)*

*California requires that all employers establish, implement, and maintain a written Injury and Illness Prevention Program (IIPP). A copy of the program must be maintained at each workplace or at a central worksite. Cal/OSHA's Model IIPP Program can be reviewed at http://www.dir.ca.gov/dosh/dosh_publications/iipp.html.

See **Box 14-O**, **Box 14-P**, **Box 14-Q,** and **Box 14-R** for more information related to safety training.

BOX 14-O JSHA AND RESOURCES FOR TRAINING SUPERVISORS

What is a JSHA?

JSHA is an acronym for Job Safety Hazard Analysis. It is a safety management tool to identify the hazards associated with any job. Once identified, ways to eliminate or control the hazards are implemented. Steps to control the hazard are documented and posted to guide workers in safe performance on the job. JSHA is an ongoing process, and changes may be made to the document if conditions require it. *(NOTE: JSHA is known by different names. In some companies it is called job hazard analysis (JHA), risk assessment (RA), or activity hazard analysis (AHA).*

See **Figure 14-a** for an example of a Job Hazard Analysis form.

Examples of Job Activities in the Wine Industry Requiring a JSHA

Worker in wine cellar – moving wine barrels in a safe manner

Worker in the vineyard spraying pesticides or other products

TRAINING COURES FOR SUPERVISORS ON SAFETY

- Ag Safe
- Worker's Compensation Training
- FELS Safety Training Programs

ONLINE RESOURCES FOR SUPERVISORS

Short YouTube Videos on JSHA:
http://www.youtube.com/watch?v=MQqfclDA55A&feature=results_main&playnext=1&list=PL3521B20DDAD75869

OSHA Pamphlet on JSHA: http://www.osha.gov/Publications/osha3071.pdf

Sample Form to Conduct a JSHA: http://www.ccohs.ca/oshanswers/hsprograms/job-haz.html#_1_9

JOB HAZARD ANALYSIS FORM Page 1 of 1

Job Task: Hooking up irrigation pipe that has come apart in preparation for irrigation.		DATE: July 28, 2006
TITLE OF PERSON WHO DOES JOB: Farm Assistant	SUPERVISOR: Name	ANALYSIS BY: Name
DEPARTMENT:	SECTION:	REVIEWED BY:
REQUIRED AND/OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT Safety Glasses, Gloves and Rubber Boots		APPROVED BY:

SEQUENCE OF BASIC JOB STEPS Beware of being too detailed; record only the information needed to describe each job action. Rule of thumb: no more than 10 steps/job to be evaluated	POTENTIAL ACCIDENTS OR HAZARDS (Hazard Classification Categories: Struck By/Against, Caught In/Between, Slip, Trip, or Fall, Overexertion, Ergonomic (Awkward Postures, Excessive Force, Vibration, Repetitive Motion))	RECOMMENDED SAFE JOB PROCEDURE (Hazard Controls, Corrections: Engineer Out/New Way to Do, Change Physical Conditions or Work Procedures, Adjust/Modify/Replace Work Station Components, Tools, Decrease Performance Frequency, Personal Protective Equipment (PPE), Training, Improve Housekeeping)
Shut off line of pipe at the valve or turn off the pump.	Excessive pressure on the pipe.	Training or change work procedures.
Allow the line to drain until it is empty.	Overexertion and awkward postures.	Relax, change posture and exercise patience.
Locate the pipe that has come apart. Elevate the pipe to drain the water out. Check the female end of the pipe to make sure the gasket is still in place.	Trip, slip or fall in standing water or muddy areas. Overexertion, awkward postures. Repetitive motion, slip, trip or fall in the wet environment while walking back to the end of the line to get a new gasket.	PPE – safety glasses, rubber boots, rubber gloves. Training and change work procedures. Have the recommended equipment nearby i.e. gaskets.
Hook pipe up to the line by pushing gently against the line of pipe.	Excessive force or overexertion.	Training.
When pipe is hooked then pull gently from the middle or bottom of the sprinkler standpipe. Repeat steps 4, 6, and 7, until all pipe are hooked together and ready to irrigate.	Excessive force, overexertion or struck by/against rainbird. Repetitive motion, overexertion, struck by/against rainbird. Trip, slip or fall in wet environment.	Training. Training.

Figure 14-a Example of a Job Hazard Analysis Form
(**Source:** https://www.uidaho.edu/dfa/administrative-operations/ehs/safety-programs/occupational-safety/job-hazard-analysis.)

BOX 14-P SAFETY AREAS TO CONSIDER EMPHASIZING DURING TRAINING MEETINGS

- Safe use and handling of pesticides (and other chemicals) and pesticide notification procedures
- Procedure for reporting workplace injuries
- Hazardous materials handling
- Availability and interpretation of Safety Data Sheets (SDSs)
- Prevention of heat stress (see **Box 14-Q**)
- Preventing machinery related accidents
- Equipment operational safety
- Personal Protective Equipment (e.g., hearing, eyes, hands)
- Importance of personal hygiene and daily changes of clean clothing
- Solid waste handling
- Avoiding field sanitation hazards
- First aid
- Avoiding dangerous snakes, spiders, and related hazards in the vineyard
- Office safety
- Lock out/tag out of equipment (See http://www.osha.gov/OshDoc/data_General_Facts/factsheet-lockout-tagout.pdf)
- Confined spaces
- Hazard communication
- Emergency Action Plan
- Fall protection
- Injury Illness and Prevention Program
- Bloodborne pathogens
- Staying Healthy, e.g. COVID19 Prevention

Note: Generally your worker's compensation insurance provider will provide free or low-cost safety training and safety audits. Contact them to determine if they can assist in this area.

For more information on safety issues, see Farm Employers Labor Service Safety Audit Checklist: http://www.fels.net/Data/Checklists/Safety-Checklist.pdf. (Provided with permission from Farm Employers Labor Service (FELS), Copyright 2012, 2300 River Plaza Drive, Sacramento, CA 95833, http://www.fels.net/).

BOX 14-Q PROTECTING WORKERS FROM HEAT STRESS*

California's Heat Illness Prevention Standard (GISO 3395) requires that employers follow specific requirements for preventing heat illness. **Visit Cal OSHA's Heat Illness Prevention Tool for requirements and resources:** http://www.dir.ca.gov/dosh/etools/08-006/index.htm.

Symptoms of heat stress are: loss of concentration; increased heart rate, body temperature, and irritability; fatigue; headache; little desire to drink; fainting; and possible death if not removed from the situation causing heat stress.

Examples of ways to reduce the risk of heat stress include encouraging workers to drink often (1-2 quarts per hour), provide rest breaks, stay alert for workers' early symptoms of excessive exposure to heat, and training supervisors and first aid workers to recognize heat stress disorders and awareness of conditions that put workers at greater risk for heat stress.

For a free heat stress prevention training kit in English or Spanish visit: http://99calor.org/.

Source: Adapted from the *Agricultural Safety and Health Inspection Project (ASHIP)*, California Department of Industrial Relations, Division of Occupational Safety and Health, Sacramento.

*For additional information, see the California Code of Regulations Heat Illness Prevention Standard (http://www.dir.ca.gov/Title8/3395.html), Cal/OSHA Heat Illness Prevention Training (https://www.dir.ca.gov/dosh/heatillnessinfo.html), the US Department of Labor OSHA FactSheet (http://www.osha.gov/OshDoc/data_Hurricane_Facts/heat_stress.pdf), and the National Institute for Occupational Safety and Health (NIOSH) info sheet *Protecting Workers from Heat Illness* (http://www.cdc.gov/niosh/docs/2011-174/pdfs/2011-174.pdf). Free heat stress prevention pocket cards in English and Spanish are available at: https://www.sustainablewinegrowing.org/docs/CAWG%20Bilingual%20heat_stress.pdf (produced by California agricultural trade associations and the UC Berkeley College of Natural Resources with funding from the US Department of Agriculture through the Western Center for Risk Management Education).

BOX 14-R SAFETY INCENTIVE BEST PRACTICES TO CONSIDER

Providing positive recognition, incentives, and bonuses for safe job performance are useful best practices to promote a safe and healthy work environment. Your winery or vineyard may want to consider the following:

- Provide regular verbal and written recognition regarding safety
- Document and post "safe days" or "accident free" information in public locations for all employees to see
- Have an incentives program in place that recognizes and appreciates individuals for safe job performance. This could include a safety certificates, bonuses, or annual recognition ceremony for employees who have excellent safety records and/or have prevented safety mishaps.

Note: Research has confirmed that the positive recognition of employees for demonstrating safe practices and for contributing to safety policies and safety awareness programs is much more effective than merely implementing a safety bonus program.

For a fact sheet on the OSHA Voluntary Protection Programs Star Award, see https://www.osha.gov/enforcement/directives/csp-03-01-003.

For a complete perspective on program benefits and what to expect from a visit by OSHA personnel, see www.osha.gov/oshprogs/vpp/index.html.

Shading outdoor work spaces such as sorting tables keeps workers cooler during hot days, and the shade is good for the grapes, too.

14-6 Continuing Education, Training and Development *Vineyard & Winery*

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation evaluated training needs and was aware of outside training opportunities or develop in-house training to meet those needs ***And*** Employees were encouraged to attend training, seminars, or other educational events that could enhance their understanding and skills in the workplace, including training that covers sustainable practices ***And*** The vineyard and/or winery operation approved paid time to attend and covered training costs for some employees, if applicable ***And*** The vineyard and/or winery operation had training plans and goals that incorporated sustainability policies and practices.	The vineyard and/or winery operation evaluated training needs and was aware of outside training opportunities or developed in-house training to meet those needs ***And*** Employees were encouraged to attend training, seminars, or other educational events that could enhance their understanding and skills in the workplace ***And*** The vineyard and/or winery operation approved paid time to attend and covered training costs for some employees, if applicable.	The vineyard and/or winery operation was aware of available training opportunities ***And*** Employees were given the opportunity to attend appropriate training, seminars, or other educational events on their own initiative and the company may have approved paid time to attend.	If employees attended training, seminars, or other educational events outside the workplace, they did it on their own initiative outside of company time. *(Select N/A if you had no employees)*

Box 14-S1 MANDATORY SEXUAL HARASSMENT TRAINING IN CALIFORNIA

In California, employers with 5 or more employees must provide sexual harassment training and education by January 1, 2021, and thereafter once every 2 years. New, nonsupervisory employees should be provided with sexual harassment training within 6 months of hire. New supervisory employees should be provided with sexual harassment training within 6 months of the assumption of a supervisory position. Below are some important metrics for all employers to be aware of when creating sexual harassment training policies:

- Training may be completed by employees individually or as part of a group presentation, and may be completed in shorter segments, as long as the applicable hourly total requirement is met.
- The training and education required must include information and practical guidance regarding the federal and state statutory provisions concerning the prohibition against and the prevention and correction of sexual harassment and the remedies available to victims of sexual harassment in employment.
- The training and education must include practical examples aimed at instructing supervisors in the prevention of harassment, discrimination, and retaliation, and must be presented by trainers or educators with knowledge and expertise in the prevention of harassment, discrimination and retaliation.
- Training must include harassment based on gender identity, gender expression, and sexual orientation.
- These laws set a minimum threshold for training. Employers can choose to provide longer, more frequent or elaborate training and education.

Free online training is available here: https://www.dfeh.ca.gov/shpt/

Source: https://www.dfeh.ca.gov/wp-content/uploads/sites/32/2018/12/SB_1343_EmployerFAQ.pdf

Box 14-S2 RESPONSIBLE SERVICE TRAINING

Through responsible service training, those who serve alcoholic beverages are educated on the dangers of serving alcohol to minors and over-serving alcohol to patrons with the intention of reducing harm to communities.

Assembly Bill 1221, passed in 2017, created the Responsible Beverage Service Training Act which requires the Alcoholic Beverage Control to create the Responsible Beverage Service Training Program (RBSTP) and mandates training for on-premise alcohol servers, their managers and licensees. Although the original Bill specified that the training requirement would begin in 2021, Assembly Bill 82 extended the date to 2022 due to COVID-19.

Beginning July 1, 2022, any alcohol server and their manager must have a valid RBS certification from an ABC accredited RBS training provider and pass an online ABC administered RBS exam within 60 calendar days from the first date of employment.

For more information, visit https://www.abc.ca.gov/education/rbs/.

Box 14-S Training Resources

Examples of Statewide Wine Industry Organizations and Conferences:

- AgSafe Conference: www.AgSafe.org
- American Society for Enology and Viticulture (ASEV): www.asev.org
- California Sustainable Winegrowing Alliance: http://www.sustainablewinegrowing.org/workshopcalendar.php
- Direct to Consumer Wine Symposium: https://dtcwinesymposium.com/
- Farm Employers Labor Service (FELS): www.fels.net
- Unified Wine and Grape Symposium: www.unifiedsymposium.org
- Wine Industry Financial Symposium: http://wbmevents.com/
- Wine Industry Technology Symposium: http://wineindustrytechnologysymposium.com/
- Wine Tourism Conference: http://winetourismconference.org/
- Wine Market Council Industry Updates: http://www.winemarketcouncil.com/

Other Training Opportunities:

- Regional grower and vintner association events (e.g., IPM Days, tailgates, workshops)
- UC Cooperative Extension or other university/college events
- Workers compensation training through insurance provider
- Responsible Recruitment Toolkit: responsiblerecruitmenttoolkit.org

Tailgates and workshops are a great way for employees to continue their education and learn more about best practices relevant to their work.

14-7 Industry Knowledge and Participation			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Appropriate manager/employee(s) in the vineyard and/or winery operation stayed informed on key industry issues (via trade journals, newspaper, association newsletters, attended meetings, etc.) ***And*** We took a leadership role by actively participating in grower and/or vintner associations (e.g., participated on committees or boards) to stay informed of and influence industry issues and trends ***And*** We encouraged our employees to gain more industry knowledge as part of their career advancement process.	Appropriate manager/employee(s) in the vineyard and/or winery operation stayed informed on key industry issues (via trade journals, newspaper, association newsletters, attended meetings, etc.) ***And*** We actively participated in grower and/or vintner associations or other industry-related organizations to stay informed of industry issues and trends.	Appropriate manager/employee(s) in the vineyard and/or winery operation stayed informed on key industry issues (via trade journals, newspaper, association newsletters, attended meetings, etc.) ***And*** We occasionally participated in grower and/or vintner associations or other industry-related organizations to stay informed of industry issues and trends.	Appropriate manager/employee(s) in the vineyard and/or winery operation occasionally read industry publications to stay informed on key issues (via trade journals, newspaper, etc.).

BOX 14-T CAREER AND SUCCESSION PLANNING BEST PRACTICES TO CONSIDER

Examples of Career and Succession Planning Best Practices

- Put together a succession plan for company principals
- Document actions that employees may take to achieve career aspirations, and, if possible, link actions to annual performance appraisals
- Have individual discussions with employees regarding their career goals and how to achieve them at the company (e.g., rotate through different company positions, take training classes, obtain college degrees, etc.)

Example of How to Link Career Planning to Performance Management

A simple method to link career development to performance management is to add a section to the performance appraisal form in which the employee is able to document their career goals. In addition, a development section can be added that documents some steps the employee should take to prepare for the career goal (e.g., rotate to different work departments, take on more responsibility, get a degree or certificate, attend training, etc.).

Cost/Benefit of Training and Development (Average Training Hours Per Employee = 46)

By establishing an effective training and development system, companies will not only ensure that employees have the skills needed to accomplish their work but will also increase employee satisfaction, which has been proven to enhance customer service. The American Society of Training and Development (ASTD) completed a 3-year study verifying that those companies investing in training report higher profit margins and higher incomes per employee.

- "The 2018 Training Industry Report estimates that U.S. organizations spent approximately $87.6 billion on employee learning in 2018, with an average of **46.7** hours of training per employee each year. Also, 25.6% of training was delivered online."

Sources: https://trainingmag.com/trgmag-article/2018-training-industry-report/
https://www.td.org/videos/atds-2019-state-of-the-industry

14-8 Promoting Sustainability in the Workplace			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Employees and any contractors relevant to the successful adoption and implementation of sustainability concepts and practices were knowledgeable about the vineyard and/or winery operations sustainability efforts (e.g., group meetings, internal postings) ***And*** We sought and implemented appropriate suggestions and ideas from employees and any contractors to improve our efficiency and sustainability ***And*** We had a dedicated group focused on implementing efficiency and sustainable practices ***Or*** We had an incentive, bonus, or recognition program for outstanding contributions to increased sustainability.	Employees and any contractors relevant to the successful adoption and implementation of sustainability concepts and practices were knowledgeable about the vineyard and/or winery operations sustainability efforts (e.g., group meetings, internal postings) ***And*** We sought suggestions and ideas from employees and any contractors to improve our efficiency and sustainability.	Employees and any contractors relevant to the successful adoption and implementation of sustainability concepts and practices were informed about the vineyard and/or winery operations sustainability efforts (e.g., group meetings, internal postings).	Employees and any contractors relevant to the successful adoption and implementation of sustainability concepts and practices were not informed about the vineyard and/or winery operations sustainability efforts (e.g., group meetings, internal postings). *(Select N/A if you had no employees and did not use contractors)*
See **Box 14-U** for examples of ways to promote sustainability in the workplace.			

BOX 14-U EXAMPLES OF WAYS TO PROMOTE SUSTAINABILITY IN THE WORKPLACE

The following list of ideas and activities not only helps improve efficiency and sustainability in the workplace, but also helps promote positive relations among employees and enhances their buy-in to achieve the company's objectives for adopting sustainable practices.

- Feature information about the vineyard and/or winery's sustainability efforts and achievements (e.g., performance metrics) in emails, newsletters, postings, tailgates, etc.
- Provide sustainability-focused meetings or tours where employees are informed of the latest company sustainability efforts and achievements.
- Host group events such as a picnic or barbecue to share sustainability goals and objectives or celebrate accomplishments achieved.
- Create a team where several employees meet to discuss sustainability goals and objectives and work to integrate sustainability into the broader work environment.
- Create a "Best Sustainability Idea of the Year Award," and encourage employees to submit ideas to improve sustainability in the company. Then celebrate award winners at annual company meeting, picnic, or barbecue.

BOX 14-V ORGANIZATIONAL DEVELOPMENT AND COMMUNICATIONS

HR activities that can help further improve organizational effectiveness, employee well-being and job satisfaction, training, and development include:

- **Employee Communications**: Communicating often and in as many forms as possible helps create the desired workplace culture, especially by emphasizing the company's values and encouraging managers and employees to demonstrate them in their daily activities.
- **360 Feedback**: An activity where leaders receive feedback, usually in written questionnaire format, from direct reports, peers, customers, and their boss. The feedback provides valuable information on strengths and areas for improvement regarding their leadership skills.
- **Executive Coaching**: An activity whereby external consultants are hired to "coach" leaders on improving their leadership skills. Can be combined with 360 Feedback.
- **Career Development**: Processes whereby employees receive guidance on how to advance to the next career level within the company.
- **Succession Planning**: A system that assesses, identifies, and develops leaders as potential candidates to move into top management within a company. Usually only done at the top executive team level.
- **Change Management**: Systematic processes that allow companies to implement large changes, such as mergers, acquisitions, new product lines, major expansion, layoffs, etc., according to principles and steps that help induce change.
- **Diversity/Cross-Cultural Awareness**: Training sessions involving group discussions that educate all employees on diversity and cross-cultural issues within their workforce, supplier, and consumer base.
- **Inclusion/Diversity Policies and Initiatives:** Develop policies and programs to educate, promote, and celebrate diversity within the workforce.
- **Culture of Innovation:** Programs, such as rewards and recognition, which encourage creative and innovative ideas from employees to provide better products/services for customers. Also creates a more positive and fun working environment for employees.

14-9 Employee Performance

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation had an established process for assessing competency and performance for employees, that includes a minimum of two best practices from the list in **Box 14-W** ***And*** Employees were encouraged to communicate to management and supervisory staff ideas and suggestions on improving operations and efficiency ***And*** Performance reviews incorporate a section on career development goals and progress. ***And*** Performance reviews included contributions towards sustainability goals.	The vineyard and/or winery operation had an established process for assessing competency and performance for employees ***And*** Employees were encouraged to communicate to management and supervisory staff ideas and suggestions on improving operations and efficiency.	The vineyard and/or winery operation had an established process for assessing competency and performance for employees.	The vineyard and/or winery operation had an informal process for assessing competency and performance for employees. *(Select N/A if you had no employees)*

BOX 14-W PERFORMANCE MANAGEMENT SYSTEM BEST PRACTICES TO CONSIDER

Best Practices in Performance Management include:

- A consistent performance review process across the organization
- Clear linkage to the employee's job duties and responsibilities
- A section on career development plans and goals for the future
- Contains "no surprises" (e.g., includes a process that ensures employees and managers meet face to face to discuss performance at least once a quarter)
- A section and system to address and resolve poor performance
- A performance evaluation form on which employees are able to offer their comments
- Linkage of the performance management system to pay and promotions
- A sustainability component (e.g., contribution towards sustainability goals)
- Training for managers on how to give an effective performance review
- A 360 assessment component if applicable – especially at the managerial and executive level

Source: https://www.insala.com/

Note: Sample performance appraisal forms and information on establishing performance management systems can be found at: https://www.shrm.org/resourcesandtools/tools-and-samples/hr-forms/pages/cms_002017.aspx.

BOX 14-X OTHER BEST PRACTICES TO CONSIDER IN PERFORMANCE MANAGEMENT

- **Satisfaction Assessment:** Administer an Employee Satisfaction Survey at least every 1 to 2 years to all employees and share the results with employees. Develop and implement action plans to address the most pressing employee issues, ensuring that the implementation of each action is communicated so all employees know it actually occurred.

  Note: One method to objectively determine how employees perceive the HR staff is to conduct an annual HR Satisfaction Survey. This element can be included as a section in a regular company Employee Satisfaction Survey, or it can be a separate survey distributed via company mail, email, fax, etc.

  Examples of Employee Satisfactory Survey questions:
  https://www.talentlyft.com/en/resources/employee-satisfaction-survey-questions or:
  https://www.shrm.org/resourcesandtools/tools-and-samples/hr-forms/pages/cms_002078.aspx

- **Employee Recognition:** Implement two or more employee recognition programs and hold at least one formal meeting or ceremony in which an employee is recognized publicly, e.g., an awards luncheon or dinner. Employee recognition may or may not include a monetary bonus. The purpose of employee recognition systems is to recognize employees for contributing to the overall company business strategy through good work ethics (e.g., no absenteeism, not tardy, not sick), good safety performance, positive sustainability practices, customer service, length of service, teamwork, community service, etc. Consider implementing a "Best Sustainability Practice of the Year Award" and announce it at an annual employee meeting. Examples could be for employees who identified new ways to promote sustainability, ways to save money through recycling, encouraging others to implement sustainable practices, etc.

- **Letting Employees Go:** Make sure you have documented the situation and prepare all your materials in advance. If the termination is performance related, you should have had one or more documented coaching conversations to attempt to resolve the problem. Plan what you are going to say in advance and invite another person, (HR rep if possible) to witness the conversation. Schedule the meeting and deliver the message in a short but humane manner. Describe next steps, such as collecting belongings and saying good-bye to other employees. Ask employee to complete an Exit Survey or Interview with another person. Communicate with remaining employees about the situation. Answer questions and describe future steps. Maintain all documentation for a period of 2 years.

Sample Exit Interview Survey: https://www.shrm.org/resourcesandtools/tools-and-samples/hr-forms/pages/termination_exitinterviewquestionnaire.aspx

14-10 Compensation Benchmarking *Vineyard & Winery*

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation benchmarked compensation levels within the industry and/or by location using data from salary surveys in addition to word-of-mouth or other informal methods ***And*** We reviewed our compensation package to ensure it properly attracted and retained employees ***And*** We participated in salary surveys ***And/Or*** We tracked retention.	The vineyard and/or winery operation benchmarked compensation levels within the industry and/or by location using word-of-mouth or other informal methods ***And*** We reviewed our compensation package to ensure it properly attracted and retained employees.	The vineyard and/or winery operation benchmarked compensation levels within the industry and/or by location using word-of-mouth or other informal methods.	The vineyard and/or winery operation had not yet benchmarked compensation levels. *(Select N/A if you had no employees)*

Box 14-Y Rationale for Participating in Wine Community Salary Surveys

If all companies participate in wine community salary surveys, the entire industry benefits from better understandings of salary structures. These understandings enable the establishment of salary ranges for employees which drive employee productivity, quality, loyalty, and retention – helping companies achieve sustainability goals. Each year Wine Business Monthly magazine sponsors a salary survey for the industry and publishes the results online. The most recent survey can be accessed in this issue: https://www.winebusiness.com/wbm/?go=getDigitalIssue&issueId=11330.

Box 14-Z Bonuses in the Wine Community

The wine community has many employee bonus systems. Bonuses can be used as a tool to incentivize employee retention (e.g., staying through the end of harvest) and employee performance (e.g., achieving tasting room sales quotas or producing award-winning wines).

Bonuses can also be used to reward employees for ideas and practices that help the vineyard or winery meet sustainability goals (e.g., energy or water saving techniques). These same ideas and practices can reduce inputs, save money, and increase revenue for the vineyard or winery, which in turn can be applied to the bonus pool.

14-11 Diversity, Equity and Inclusion*

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
The vineyard and/or winery operation has assessed and evaluated practices related to diversity, equity and inclusion ***And*** Employees were trained on diversity, equity and inclusion*** and participated in discussions on topics related to diversity, equity and inclusion ***And*** A diversity, equity and inclusion strategy or policy was implemented.****	The vineyard and/or winery operation has assessed and evaluated practices related to diversity, equity and inclusion ***And*** Employees were trained on diversity, equity and inclusion*** and participated in discussions on topics related to diversity, equity and inclusion ***And*** A diversity, equity and inclusion strategy or policy was under development.****	The vineyard and/or winery operation began to assess and evaluate practices related to diversity, equity and inclusion ***And*** Employees participated in informal, yet facilitated, discussions about topics related to diversity, equity and inclusion (e.g., during team meetings, events).	The vineyard and/or winery operation has written anti-harassment and anti-discrimination policies, and provides required training, if applicable** ***And*** Topics related to diversity, equity and inclusion were not directly addressed.

*See **Box 14-AA** for a brief description of diversity, equity and inclusion.
**See California Government Code 12950.1.
***There are many training opportunities available on diversity, equity and inclusion. See **Box 14-AA** for examples of training resources.
****A diversity, equity and inclusion strategy or policy can include: a written commitment to diversity, equity and inclusion; a recruitment strategy for diverse hiring; a commitment to diversity in marketing materials (imagery and stories); mentorship for new employees from underrepresented groups (e.g., racial or ethnic minority, LGBT, veteran); measurable diversity improvement goals; description of zero-tolerance for harassment, etc. See **Box 14-BB** for more details on what could be included in a strategy or policy.

BOX 14- AA DIVERSITY, EQUITY AND INCLUSION

The benefits of a diverse and inclusive workplace have become increasingly clear. Research has shown that companies that have greater workplace diversity outperform their competitors and achieve higher profits. A diversity of perspectives, skills and experiences leads to increased creativity and innovation, faster problem-solving and better decision-making. And when a workplace is more inclusive, employees feel accepted and valued, which leads to more employee engagement and higher retention.

Source: McKinsey & Company, “Delivering through Diversity”, https://www.mckinsey.com/business-functions/organization/our-insights/delivering-through-diversity#.

For further reading: https://www.talentlyft.com/en/blog/article/244/top-10-benefits-of-diversity-in-the-workplace-infographic-included

What is Diversity, Equity and Inclusion?

Diversity in the workplace means that a company's workforce includes people of varying gender, age, race, ethnicity, cultural background, sexual orientation, religion, languages, education, abilities, etc.

Equity seeks to ensure fair treatment, equality of opportunity and fairness in access to information and resources for all.

Inclusion builds a culture of belonging by actively inviting the contribution and participation of all.

"Diversity is being invited to the party, inclusion is being asked to dance."

Source: Ford Foundation, https://www.fordfoundation.org/about/people/diversity-equity-and-inclusion/
For further reading: https://ideal.com/diversity-and-inclusion/

Unconscious/Implicit Bias
Implicit or unconscious bias refers to the attitudes or stereotypes that affect our understanding, actions, and decisions in an unconscious manner. These biases, which encompass both favorable and unfavorable assessments, are activated involuntarily and without an individual's awareness or intentional control. Residing deep in the subconscious, these biases are different from known biases that individuals may choose to conceal for the purposes of social and/or political correctness. Rather, implicit biases are not accessible through introspection, but can be gradually unlearned through a variety of debiasing techniques.

Source: Kirwan Institute for the Study of Race and Ethnicity, The Ohio State University, http://kirwaninstitute.osu.edu/research/understanding-implicit-bias/

Microagression Prevention
Microagressions are everyday insults, demeaning messages and indignities perpetrated by an often well-intentioned person in a dominant group against a person in a minority group. Microagressions are not intended to cause harm or be hurtful, but the underlying meaning reveals bias and is offensive. Many people do not realize they hold unconscious biases, but with training on unconscious bias and reducing microagression they can begin to recognize that comments they make may be offensive and they can begin to change that behavior.

For further reading: https://rightasrain.uwmedicine.org/life/relationships/microaggressions

Non-Racist vs. Anti-Racist
The term "antiracist" refers to people who are actively seeking not only to raise their consciousness about race and racism, but also to take action when they see racial power inequities in everyday life. When we choose to be antiracist, we become actively conscious about race and racism *and* take actions to end racial inequities in our daily lives. Being antiracist is believing that racism is everyone's problem, and we all have a role to play in stopping it.

Sources: National Museum of African American History & Culture, https://nmaahc.si.edu/sites/default/files/downloads/resources/racialhealinghandbook_p87to94.pdf and https://nmaahc.si.edu/learn/talking-about-race/topics/being-antiracist

Resources for Diversity, Equity and Inclusion Training:

- A free Implicit Association Test is available online from Harvard University at: https://implicit.harvard.edu/implicit/takeatest.html
- A free online course on diversity and inclusion in the workplace: https://www.coursera.org/learn/diversity-inclusion-workplace
- A free online course by Purdue University on Understanding Diversity and Inclusion: https://www.futurelearn.com/courses/diversity-inclusion-awareness
- Cornell Online Diversity and Inclusion certificate: https://www.ecornell.com/certificates/leadership-and-strategic-management/diversity-and-inclusion/?utm_source=Cornell+Online&utm_medium=referral&utm_campaign=Cornell+Online+-+Diversity+and+Inclusion
- There are many consultants who offer training programs on diversity, equity and inclusion, with some programs offered online.

BOX 14-BB DIVERSITY, EQUITY AND INCLUSION STRATEGY OR POLICY

A diversity, equity and inclusion strategy or policy can cover many different areas. Below are examples of practices and topics that could be included in a strategy or policy:

- A written commitment to diversity, equity and inclusion
- A recruitment strategy for diverse hiring
- A commitment to diversity in marketing materials (imagery and stories)
- A diversity and inclusion review and audit of current practices, policies and procedures
- Measurable diversity improvement goals and objectives
- Action plans and timelines for carrying out diversity and inclusion goals
- A description of the process to monitor and report on progress
- A process for reviewing and updating the strategy to ensure it remains relevant
- Mentorship for new employees from underrepresented groups (e.g., racial or ethnic minority, LGBT, veteran)
- A description of zero-tolerance for harassment

A purchasing policy to give preferences to suppliers with ownership from underrepresented populations

Box 14-CC Diversity, Equity and Inclusion Communications

Organizations communicate about their Diversity, Equity and Inclusion, often through their website or social media.

Website Examples:

Constellation Brands
https://www.cbrands.com/responsibility/diversity

> Diversity and Inclusion at Constellation Brands:
>
> Diversity, inclusion and equal opportunity have been at the heart of who we are as a company for more than 70 years.
>
> At Constellation Brands, we're committed to championing a sense of belonging, celebrating individuality, and empowering our diverse and talented employees to bring their true selves to work every day and reach their highest potential personally, enabling us to do the same collectively.
>
> Our visionary employee base reflects the diverse communities and consumers that we serve, positively impacting our business performance and creating stronger connections with our consumers.
>
> Together – and only together – we become stronger, and are able to continually build on our success.
>
> Together, we shine.
>
> Mission:
> At Constellation, we aim to foster an inclusive culture characterized by diversity in background and thought, that reflects our consumers and the communities where we live and work, where everyone feels that they belong.
>
> We are committed to continuously enhancing a culture that enables our employees to shine, and that allows our business to meaningfully connect with our stakeholders, leading to continued mutual success.

E. & J. Gallo Winery
http://www.gallo.com/responsibility

> OUR COMMITMENT TO DIVERSITY & INCLUSION
>
> We value the diverse skills, backgrounds, experiences and cultural differences every individual brings to the workplace. We believe that seeking diversity in all its dimensions encourages innovation and creativity, leading to a stronger company with better results. Our initiatives will focus on ensuring equity and opportunity for all. We are committed to Diversity and Inclusion and fully acknowledge it is a journey.

McBride Sisters
https://www.mcbridesisters.com/Our-Story/SHE-CAN

> #SHECANTHRIVE2020
>
> Let's help black-female-owned small businesses not only survive, but thrive in 2020.

We created “The McBride Sisters SHE CAN Professional Development Fund” in 2019 to promote the professional advancement of women in the wine industry. In the first year we awarded scholarships of nearly $40k to empower women to strive for change and to create opportunities for themselves where there hadn’t been before…

In 2020, #shecanthrive2020 will award grants to black-female-owned small businesses who need access to funds to help bring their ideas to life, to help them reopen after the pandemic closures and to make necessary adjustments to not just survive but to thrive in a post-quarantine world. To qualify, women will need to own a small business and present an idea of what they are needing to do to thrive after the effects of the closures and how funds could be put to use.

Winners will be awarded funds and will also be partnered with a mentor to help them build their business strategies.

Social Media Examples:

Barefoot Wine
https://www.facebook.com/BarefootWine

We stand with the black community in coming together to demand justice and support the goal of racial equality.

We acknowledge that the events culminating in the death of George Floyd and many other black men, women and children are unacceptable. We stand together against racism, injustice and violence.

We choose not to be silent or complicit in the status quo moving forward and are committed to becoming a stronger ally.

We accept our responsibility as leaders in the wine industry to use our platform to be active participants in the path to progress and to support black communities and individuals.

We are committed to making a difference. We’re open to ideas, opportunities and constructive criticism to help strengthen our allyship. We’re listening.

In solidarity.

Delicato Family Wines
https://www.instagram.com/delicatofamilywines/

We stand against racism.
We can do better.
We are committed to change.

J. Lohr Vineyards & Wines
https://www.facebook.com/JLohrWines

At the heart of who we are as a family business is the commitment to nurturing sustainable communities.

Let’s all hold a vision for unity that transcends limitations and engenders respect.

15. NEIGHBORS AND COMMUNITY

Original Chapter Authors: Jeff Dlott, John Garn, and Carla M. DeLuca; Modified by the Sustainable Winegrowing Joint Committee

Vintners and growers around the state are committed to being good stewards of the land and good neighbors. In 2020, California's 3,900 wineries produced over 90% of U.S. wine, and California's 5,900 winegrape growers farmed more than 637,000 acres of winegrapes in 49 of 58 counties (though vineyards cover less than one percent of the state's terrain). Many owners and employees live at or near their vineyards and wineries and strive to maintain a healthy and beautiful environment and vibrant communities for their families, neighbors, and wine country visitors. Many of the practices they use also provide ecosystems services that benefit the environment (e.g., carbon sequestration, groundwater recharge), protect wildlife habitat, and improve quality of life for the broader community. In addition, as a signature product, California wine adds to the economic vitality of diverse wine regions throughout the state, as well as to the California and U.S. economies, through jobs, tourism, and taxes. Growers and vintners are also active in their local communities, contributing time, money, and wine to help neighbors and a wide variety of organizations and institutions thrive.

At the same time, California's population growth and shifts from urban to rural areas increase the potential for conflicts over land use, natural resources, public services, and other neighbor and community issues. From a sustainability perspective, it is important to understand how these pressures and broader neighbor and community issues may affect your business, and conversely how your business may affect your neighbors and community (see **Figure 15-a**). Many of these issues are covered in depth in other Chapters of the workbook.

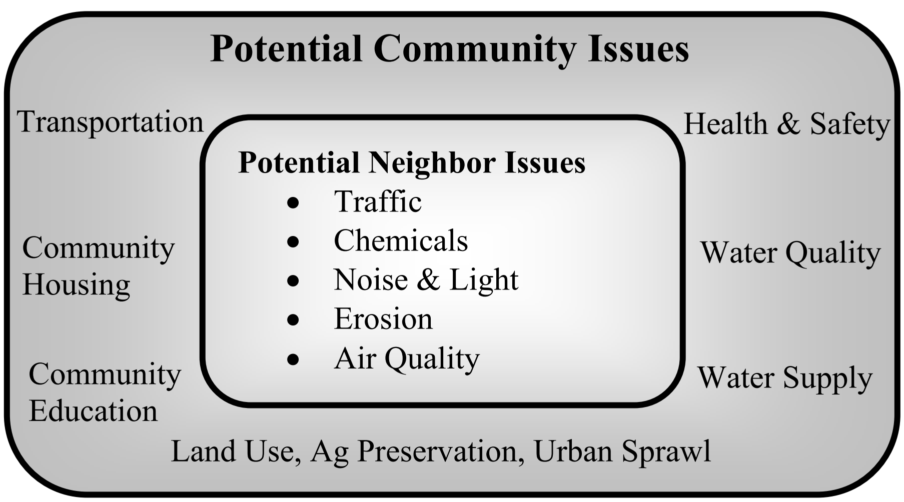


Figure 15-a   Potentially important neighbor and community issues.

This chapter has drawn from the proactive and innovative work of regional associations – including the Sonoma County Winegrape Commission, Napa Valley Vintners, and the Vineyard Team – as well as CAWG's *The Winegrape Guidebook for Establishing Good Neighbor and Community Relations* (2001).

The purpose of this chapter is to help growers and vintners understand the broad range of potential community issues that may affect vineyards and wineries, and the potential community issues that vineyards and wineries may affect, and to demonstrate the many positive contributions of the California wine industry. It includes 9 criteria to self-assess:

- The state of your neighbor and community outreach and feedback
- The current level of awareness of potential neighbor issues
- The current level of awareness of community issues that could affect a winery
- The state of contributions to neighbors and community.

List of Neighbors and Community Criteria

15-1 Neighbors and Community Relations
15-2 Awareness of Potential Neighbor and Community Issues
15-3 Mitigation of Winery Light, Noise, and Traffic Impacts
15-4 Awareness of Community Issues that Could Affect a Winery

Contributions to the Community
15-5 Arts and Culture (non-profit organizations, concerts, galleries or art exhibits, tastings at events, other cultural events, etc.)
15-6 Community (police and fire departments, schools, other community organizations, etc.)
15-7 Environment (habitat restoration, environmental organizations, etc.)
15-8 Wine Industry Research (American Vineyard Foundation, National Grape Research Alliance, universities, etc.)
15-9 Other Philanthropic Causes

Fostering two-way communication between your vineyard or winery operation and neighbors is important for good neighbor relations.

15-1 Neighbors and Community Relations			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Neighbors who may be affected by our operations had appropriate contact information for the vineyard and/or winery (name, telephone number, email, emergency contact, etc.) ***And*** The vineyard and/or winery had a process for receiving, considering, and acting upon neighbor/community comments, questions, and concerns ***And*** Proactive efforts* were made to foster good relations with neighbors and community, and to promote a better understanding of our operation and the industry ***And*** We communicated to neighbors and the community about our practices and sustainability commitment (through our website, signage, tours, newsletters, brochures, etc.).	Neighbors who may be affected by our operations had appropriate contact information for the vineyard and/or winery (name, telephone number, email, emergency contact, etc.) ***And*** The vineyard and/or winery had a process for receiving, considering, and acting upon neighbor/community comments, questions, and concerns ***And*** Proactive efforts* were made to foster good relations with neighbors and community, and to promote a better understanding of our operation and the industry.	Neighbors who may be affected by our operations had appropriate contact information for the vineyard and/or winery (name, telephone number, email, emergency contact, etc.) ***And*** The vineyard and/or winery had a process for receiving, considering, and acting upon neighbor/community comments, questions, and concerns.	Contact information for the vineyard and/or winery was not available to neighbors or members of the community.
*Proactive efforts could include a wine tasting, tour of the vineyard, informal conversation, participation in a local association, etc. See **Box 15-A** for additional examples.			

BOX 15-A COMMUNICATING WITH NEIGHBORS AND THE COMMUNITY

Communication with neighbors and the local community is important to foster understanding of your vineyard and/or winery operation and the California wine industry. There are many ways to inform your neighbors and/or local community about changes in your operation that may impact them. Keeping your neighbors informed is a great way to ensure that they are familiar with your operation and will be supportive. This will also help to minimize neighbor or community opposition to any new activities or developments. In addition, participation in a local association that conducts relevant community outreach and education can further promote understanding and awareness about your vineyard and/or winery operation and the wine community.

Examples of Potential Communication Tools:

- Informal conversation with neighbors about noticeable changes in the operation that may impact the neighborhood or community
- Postcards sent to neighbors alerting them to expected activities such as harvest noise
- Tours of your vineyard or winery and/or wine tasting for neighbors to share information about your operation and practices including those affecting stewardship of natural and human resources
- Newsletters, signage, brochures, and/or website content about your practices and commitment to sustainability
- Participation in a meeting or local event to share information about your vineyard or winery with the external community

For more ideas on how to effectively communicate with the community and information on how to develop your message to reach your desired audience, see *The Winegrape Guidebook for Establishing Good Neighbor and Community Relations*, a publication by the California Association of Winegrape Growers available from the CSWA Resource Library at: https://library.sustainablewinegrowing.org/.

Washington State's WineryWise Community Outreach Checklist is another good resource to consult for information on how to develop an outreach plan: http://www.winerywise.org/files/Winerywise%208%20Community%20Outreach.pdf.

In some cases, you may need a full environmental report if you are proposing a significant project for your vineyard and/or winery operation. For more information on assessing the need for an environmental report and how to create one visit: http://www.greenbiz.com/toolbox/howto_third.cfm?LinkAdvID=4205 or http://www.dfg.ca.gov/habcon/ceqa/intrnlproced/eir.html.

15-2 Awareness of Potential Neighbor and Community Issues* *Vineyard & Winery*

Category 4	Category 3	Category 2	Category 1
Attitudes and perceptions of neighbors about key issues* that involved the vineyard and/or winery were known ***And*** It was understood how vineyard and/or winery operations may have affected neighbors and community stakeholders ***And*** Meetings or other direct communication with neighbors or community stakeholders to address relevant issues occurred ***and/or*** there was involvement in an association that addressed neighbor/community issues ***And*** Potentially significant neighbor or community issues were addressed through proactive efforts.	Attitudes and perceptions of neighbors about key issues* that involved the vineyard and/or winery were known ***And*** It was understood how vineyard and/or winery operations may have affected neighbors and community stakeholders ***And*** The need to meet or communicate with neighbors or community stakeholders to discuss relevant issues has been considered.	Attitudes and perceptions of neighbors about key issues* that involved the vineyard and/or winery were known ***And*** It was understood how vineyard and/or winery operations may have affected neighbors and community stakeholders.	Attitudes and perceptions of neighbors about vineyard and/or winery operations were unknown.

*See **Box 15-B** for examples of potential neighbor or community issues.

Box 15-B Potential Neighbor or Community Issues

Below are examples of potential neighbor or community issues that vineyard and/or winery operations may impact. Issues may vary by region, size and scale of operations, and other local conditions. It is important to understand which issues are most relevant to your vineyard and/or winery operation. Increased understanding and tactful dialogue about concerns can enhance relationships with your neighbors and local community and minimize potential conflicts before they arise.

- **Local traffic:** Traffic associated with the vineyard and/or winery operation can cause concerns about dust, speed, infrastructure, equipment, noise, etc. See **Chapter 4 Soil Management** and **Chapter 16 Air Quality and Climate Protection** for best management practices that address issues related to traffic.

- **Agricultural and winery chemicals**: The use or application of chemicals in a manner that may cause neighbors to perceive them as causing a risk to the environment or to human health. See **Chapter 6 Pest Management** and **Chapter 16 Air Quality and Climate Protection** for best management practices that address issues related to agricultural and winery chemicals.

- **Soil erosion control**: Soil loss from vineyards, unpaved roads, or land adjacent to the vineyard or winery onto roadways or into ditches, streams, or rivers can adversely affect neighbor and community perceptions. See **Chapter 4 Soil Management** and **Chapter 5 Vineyard Water Management** for best management practices that address issues related to erosion control and prevention.

- **Air quality**: Emissions from vehicles or pumps, dust, burning, and other winery or vineyard operations can influence neighbor and community perceptions. See the **Chapter 9 Energy Efficiency** and **Chapter 16 Air Quality and Climate Protection** for best management practices that address issues related to air quality.

15-3 Mitigation of Winery Light, Noise, and Traffic Impacts *Winery*

Category 4	Category 3	Category 2	Category 1
The winery operation's potential effect on light, noise, and/or traffic impacts to neighbors was known ***And*** Neighbors who may be affected by light, noise, and/or traffic had appropriate contact information for the winery (name, telephone number, email, emergency contact, etc.) ***And*** Two or more mitigation options* to reduce light, noise, and/or traffic impacts (shields for lighting, soundproofing, timing of operations or events, speed limit signs, employee training, etc.) were implemented to adequately address the issue(s), and were evaluated regularly ***And*** Meetings or other direct communication with neighbors or community stakeholders to discuss potential light, noise, and/or traffic issues have occurred ***Or*** these issues were adequately addressed.	The winery operation's potential effect on light, noise, and/or traffic impacts to neighbors was known ***And*** Neighbors who may be affected by light, noise, and/or traffic had appropriate contact information for the winery (name, telephone number, email, emergency contact, etc.) ***And*** At least one mitigation option* to reduce light, noise, and/or traffic impacts (shields for lighting, soundproofing, timing of operations or events, speed limit signs, employee training, etc.) were implemented ***And*** The need to meet or communicate with our neighbors or community stakeholders to discuss potential light, noise, and/or traffic issues has been considered.	The winery operation's potential effect on light, noise, and/or traffic impacts to neighbors was known ***And*** Neighbors who may be affected by light, noise, and/or traffic had appropriate contact information for the winery (name, telephone number, email, emergency contact, etc.) ***And*** Mitigation options* to reduce light, noise, and/or traffic impacts (shields for lighting, soundproofing, timing of operations or events, speed limit signs, etc.) were researched.	The winery operation's potential effect on light, noise, and/or traffic impacts to neighbors was unknown. *(Select N/A if none of these are an issue in your area)*

*See **Box 15-C** for examples of potential mitigation options for light, noise, and traffic issues.

BOX 15-C EXAMPLES OF MITIGATION OPTIONS FOR LIGHT, NOISE AND TRAFFIC ISSUES IN AND AROUND A WINERY

Light Mitigation Options:
- Shields for lighting
- Lighting faces down and kept at low levels to avoid light pollution
- Minimize unnecessary night lighting
- Employee training

Noise Mitigation Options:
- Sound proofing
- Timing of specific operations
- Staging trucks to reduce idling time
- Employee training

Traffic Mitigation Options:
- Speed restricted with speed limit signs and/or speed bumps
- Parking attendants for events
- Post directional signs toward winery parking
- Employee training

Communication with neighbors and the local community during vineyard tours or winery tastings can help to foster understanding of your vineyard and/or winery operation.

15-4 Awareness of Community Issues that Could Affect a Winery*			*Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Community issues* that could affect the winery were understood ***And*** Appropriate community meeting(s) were attended ***And/Or*** the winery belongs to an association that addressed community issues ***And*** Efforts were made to resolve community issues (volunteered, assigned company liaison, made philanthropic contribution, etc.).	Community issues* that could affect the winery were understood ***And*** Appropriate community meeting(s) were attended ***And/Or*** the winery belongs to an association that addressed community issues.	Community issues* that could affect the winery were understood.	Community issues* that could affect the winery were not well understood.
* See **Box 15-D** for examples of potential community issues.			

BOX 15-D POTENTIAL COMMUNITY ISSUES

Below are examples of potential community issues that may impact your business. Issues may vary by local conditions. It is important to understand which issues are most relevant in your area and to your operation. By understanding and, when appropriate, being involved in dialogue about these issues, wineries can enhance their long-term viability by can helping with resolutions.

- **Regional Transportation:** Can impact the ability of employees and winery visitors to access the winery, and winery's ability to transport winery supplies and wine (infrastructure, transportation options, quality of roads, etc.).
- C**ommunity Housing:** Can impact accessibility to housing for employees and the broader community (availability, cost, etc.) See **Box 15-E** for more information on housing.
- **Community Education**: Can impact accessibility to educational opportunities for employees, their families, and the broader community (community colleges, public schools, ESL programs, etc.).
- **Community Health & Safety**: Can impact accessibility to health care and safety services for employees and the broader community (hospitals, clinics, fire department, police, etc.).
- **Regional Water Quality and Supply:** Can impact ability to meet winery water needs as well as broader community needs (e.g., quantity and quality).
- **Land Use, Ag Preservation and/or Urban Sprawl:** Can have various impacts. It is important to understand development and preservation patterns and plans. See **Box 15-F** for more information on ag preservation and urban sprawl.

BOX 15-E COMMUNITY HOUSING ISSUES

There are several community housing issues that may be of interest to vineyards and wineries. The primary concern for vineyards and wineries is often availability of housing for their workforce. Other concerns could include affordable housing, low income housing, senior housing, and/or homelessness.

All issues related to housing are connected to the development and expansion of urban boundaries into agricultural areas. It is important that issues pertinent to development and urban growth are tracked so that pressures and conflicts resulting from the agriculture/urban interaction are mitigated as early as possible.

TYPES OF HOUSING AND POSSIBLE INVOLVEMENT
In each county and municipality, elected officials create planning documents that dictate development. These documents define the types of development and housing planned for your area. Knowing the housing categories (e.g., residential, rural residential, low income) will help you understand the probable interactions and challenges you will experience with future neighbors. For relevant information about planning, visit: http://opr.ca.gov/planning/general-plan/guidelines.html and http://opr.ca.gov/docs/OPR_C3_final.pdf.

15-5 to 15-9 Contributions to the Community

Vineyard & Winery

Instructions: *Please use the same Category descriptions for Criteria 15-5 to 15-9. Vineyards and wineries are not expected to be active in all areas. CSWA would like to track and report California vineyards and wineries' involvement in their communities.*

Category 4	Category 3	Category 2	Category 1
We volunteered, contributed staff time, or donated financial resources, wine, or made other contributions to enhance this area in our community.			We were not active in this particular area.
15-5 Arts and Culture (non-profit organizations, concerts, galleries or art exhibits, tastings at events or in tasting rooms to support art/cultural activities, other cultural events, etc.)			
15-6 Community (police and fire departments, schools, other community organizations, etc.)			
15-7 Environment (habitat restoration, environmental organizations, etc.)			
15-8 Wine Industry Research (American Vineyard Foundation, National Grape Research Alliance, universities, etc.)			
15-9 Other Philanthropic Causes			

BOX 15-F AG PRESERVATION AND REGIONAL URBAN SPRAWL ISSUES

Many different tools have been developed to protect agricultural land and the economic viability of agriculture from the impacts of urban sprawl. Right-to-Farm Ordinances and Conservation Easement Programs are just two of the many ways agricultural land is preserved. Monitoring urban development patterns and plans also is important for understanding how urban boundaries relate to your agricultural operations. To access relevant information and tools visit: https://www.farmlandinfo.org/directory.

RIGHT-TO-FARM ORDINANCE

As the population in California increases, there is increasing pressure to convert agricultural land to housing. As agricultural areas become more urbanized, misunderstandings and confrontations about agricultural operations unfortunately can occur between homeowners and farmers. Consequently, in California and across the nation, states and communities have enacted "Right-to-Farm" legislation to protect agricultural activities. The California Agricultural Protection Act includes right-to-farm language (https://docs.vcrma.org/images/pdf/planning/ordinances/Right-to-Farm-CALIFORNIA-CIVIL-CODE-3482-5.pdf). Check with staff at the Farm Bureau or Agricultural Commissioner's office to determine whether your county has a Right-to-Farm Ordinance.

LAND TRUSTS AND CONSERVATION EASEMENTS

Land trusts and conservation easements are other important tools for preserving agricultural land. **Chapter 8 Ecosystem Management** includes more information about conservation easements. Visit educational **Box 8-N** and **Box 8-O** to learn more and to determine if they are an appropriate tool for your property.

VIEWSHEDS

In addition to experiencing fine wines, visitors to wineries relish the associated scenic landscapes (viewsheds). Ambience is part of the experience of wine tasting, yet urban development can threaten the natural beauty and distinctive communities in many wine areas. Wineries and vineyards can support various strategies protect these unique areas. Many of these strategies are part of a comprehensive approach to development. For more information on viewsheds, scenic area protection, and effective protection strategies, visit http://www.scenic.org/issues/scenic-easements-a-view-protection.

16. AIR QUALITY AND CLIMATE PROTECTION

Original Chapter Authors: Joe Browde, John Garn, and Jeff Dlott; Modified by the Sustainable Winegrowing Joint Committee

Because it is ubiquitously distributed and generally invisible, air is a critical natural resource that is often taken for granted. Various activities and an expanding human population in California and elsewhere are increasing emissions to the atmosphere, taxing the air quality of California, and placing a disproportionate burden on certain air basins such as the San Joaquin Valley and the South Coast. To address the increasing importance and scope of concerns about air quality and climate change, it is important that everyone takes steps to reduce emissions.

The winegrowing community is an important contributor to California's vibrant economy. Because agriculture constitutes only one source of the state's air emissions and the wine industry is only a fraction of the agricultural component, emissions associated with each vineyard or winery may seem minimal. However, a collective commitment by the winegrowing community to limit emissions acknowledges that all efforts make a difference and moves the dialogue beyond the narrow and reactive focus on individual sources, impacts, and regulations. Through voluntary assessment and proactive efforts to decrease emissions, cost-effective practices and technologies can be identified and implemented, improving air quality and mitigating climate change while maintaining the economic viability of this important business sector.

Certain emissions are categorized and regulated as criteria (or common) air pollutants – specific gases and small particles escaping to the atmosphere during various activities which can include crop production or processing. Through air movement, pollutants can travel great distances, potentially impacting humans, other organisms, crops, and the environment far from the source. Growers and vintners are encouraged to identify sources of criteria air pollutants as a means for developing and implementing plans for effective mitigation. Although not criteria pollutants, carbon dioxide (CO_2), nitrous oxide (N_2O), and other greenhouse gases emitted during the combustion of fossil fuels, applications of nitrogen fertilizer, tillage, refrigerant use, and other activities have been linked with global climate change. Understanding how and which operations produce greenhouse gases help managers develop a strategy for reducing and offsetting them (e.g., carbon sequestration). This chapter provides criteria to assess winegrowing practices for protecting air quality and addressing climate change by focusing on activities to limit emissions of criteria air pollutants and limit and offset greenhouse gases.

Concerns about air quality and climate change have intensified. It is important, therefore, that the winegrowing community leads and highlights its efforts to decrease and offset emissions. Many growers and vintners are proactively implementing preventive measures. Vehicular traffic and speed have been reduced on unpaved roads. Integrated approaches to vineyard management that include cover cropping, low/no tillage, and integrated pest management (IPM) are practiced. Older diesel engines have been replaced with low-emission technology. Moreover, it is crucial to note that agriculture provides key biological filters for some emissions. For example, vines, cover crops, and other plants associated with the vineyard or winery extract CO_2 from the air and sequester the carbon in their tissues. The conservation and augmentation of flora is important for enhancing this capacity.

The purpose of this chapter is to help growers and vintners identify and improve management practices that help protect air quality and mitigate climate change. Included are 10 criteria to self-assess:

- The status of air quality protection and climate change mitigation planning, monitoring, goals, and results for the vineyard or winery
- The greenhouse gas metrics of pounds of CO_2 equivalents emitted per acre and ton of grapes or gallon and case of wine
- The awareness of emission sources by major operation and of conservation practices to reduce and offset emissions
- Management support and employee training to improve air quality and mitigate climate change
- Options in the vineyard or winery operation to prioritize for decreasing and offsetting emissions.

Combustion and vineyard applications of nitrogen are important contributors of criteria air pollutants and greenhouse gases. However, single criteria that document recommended practices for reducing emissions from combustion and from nitrogen use are excluded because pertinent practices are addressed across the criteria and educational boxes in this chapter, and in **Chapter 4 Soil Management** (nitrogen use) and **Chapter 9 Energy Efficiency** (combustion and alternatives).

List of Air Quality and Climate Protection Criteria

16-1 Planning, Monitoring, Goals, and Results
16-2 Vineyard Floors
16-3 Unpaved Surfaces – Roadways and Traffic and Equipment Staging Areas
16-4 Vineyard Water Use
16-5 Pest Management Strategy
16-6 Pesticide Stewardship
16-7 Agricultural and Winery Chemicals and Materials
16-8 Transportation
16-9 Agricultural Burning
16-10 Winery Refrigerants

Performance Metrics – Greenhouse Gas Emissions

Why are Performance Metrics important?
Knowing and understanding the actual use of resources is an important aspect for controlling costs and increasing the profitability for any business. Including the relationship between practices and measurable outcomes allows your business to accurately benchmark its performance and set achievable targets for improvement using actual, not perceived, outcomes. Whereas the practice-based self-assessment helps determine what winery or vineyard practices affect energy or fuel use, for example, performance metrics calculations provide the rationale for setting targets based on real measurements. As the adage goes, "You can't manage what you don't measure."

The Greenhouse Gas Metric is used to track the carbon dioxide equivalents from fuel and electricity use. For wineries, the metric also includes refrigerant loss and the corresponding Global Warming Potential of the specific refrigerant(s) used. Vineyards also have the option of using a simplified tool called the DeNitrification DeComposition (DNDC) tool within the Online Metrics Center to evaluate the greenhouse gas emissions and soil carbon sequestration potential of their vineyard.

How to Calculate Greenhouse Gas Metrics?
Greenhouse gas emissions for vineyards and wineries can be calculated as carbon dioxide equivalents generated per unit of production (see below for calculation examples).

Using Performance Metrics

1. Collect
Identify and gather data needed to calculate the metric

2. Measure
Calculate metrics and determine your baseline

3. Track
Track your metrics calculations from year to year

4. Manage
Set targets for improvement and identify action plans

Metric Area	Metric Calculation	Data Elements	Data Sources
Greenhouse Gas (GHG) Emissions* (Vineyard)	**GHG Intensity** = $\frac{\text{Pounds of Carbon Dioxide Equivalents}}{\text{Acre}}$ $\frac{\text{Pounds of Carbon Dioxide Equivalents}}{\text{Ton of Grapes}}$	• Fuel usage • Electricity usage • Acreage • Yield (total tons) * additional data elements will be added as GHG calculation models evolve	Utility records; Fuel receipts; Meter & equipment readings
Greenhouse Gas (GHG) Emissions* (Winery) *from energy use and refrigerant loss	**GHG Intensity** = $\frac{\text{Pounds of Carbon Dioxide Equivalents}}{\text{Gallon of Wine}}$ $\frac{\text{Pounds of Carbon Dioxide Equivalents}}{\text{Case of Wine}}$	• Fuel usage • Electricity usage • Refrigerant usage • Gallons and cases produced	Utility records; Fuel receipts; Meter & equipment readings, refrigerant purchase receipts

How do I start tracking my Performance Metrics?
To get started tracking and recording greenhouse gas emissions, as well as other performance metrics (e.g., water, applied nitrogen, and energy use) visit http://www.sustainablewinegrowing.org/metrics.php or click on the "Metrics" tab within the SWP Online System.

16-1 Planning, Monitoring, Goals, and Results

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
Sources of air emissions associated with the vineyard and/or winery were known ***And*** The difference between and sources of PM_{10} and $PM_{2.5}$ particulate matter were known ***And*** Resources for air quality information (e.g., Air Quality Index, regional web sites) were used regularly ***And*** A documented air and climate protection plan** was developed ***And*** Annual greenhouse gas emissions were calculated* ***And*** Goals and reduction targets for limiting emissions were met ***And*** Employees were trained in air and climate protection and training includes written material.	Sources of air emissions associated with the vineyard and/or winery were known ***And*** The difference between and sources of PM_{10} and $PM_{2.5}$ particulate matter were known ***And*** There was awareness of resources for air quality information ***And*** Annual greenhouse gas emissions were calculated* ***And*** Information about air and climate protection was available to employees.	There was awareness of some sources of air emissions associated with the vineyard and/or winery ***And*** There was a general idea of the difference between and sources of PM_{10} and $PM_{2.5}$ particulate matter ***And*** Sources and impacts of emissions from the vineyard and/or winery were being assessed.	There was a general idea about some sources of air emissions (criteria pollutants and greenhouse gases) associated with the vineyard and/or winery ***And*** The difference between PM_{10} and $PM_{2.5}$ particulate matter was not known.

*Calculations for wineries should include fuel usage, electricity usage and refrigerant usage. Calculations for vineyards should include emissions from fuel usage and electricity usage, and from soil processes. Available tools for doing the vineyard calculations include the DNDC (DeNitrification-DeComposition) model in the CSWA Metrics Center, COMET-Planner, and COMET-Farm. See **Criterion 4-14** and **Box 4-M** in **Chapter 4 Soil Management** for more information.

A documented air and climate protection plan could include elements such as vineyard floors and unpaved surfaces, combustion and alternative technology or fuels, pesticides, and refrigerants. To see an **air and climate protection plan template for vineyards visit the CSWA Resource Library at: https://library.sustainablewinegrowing.org/. The template is available in English and Spanish.

Box 16-A Air Quality Index (AQI)

The Air Quality Index (AQI) is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you. The AQI focuses on health effects that you may experience within a few hours or days after breathing polluted air. The US Environmental Protection Agency (US EPA) calculates the AQI for five of the criteria air pollutants regulated by the Clean Air Act: ground-level ozone, nitrogen dioxide, particulate matter, sulfur dioxide, and carbon monoxide. For each of these pollutants, US EPA has established national air quality standards to protect public health.

How Does the AQI Work? Think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality. An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level that US EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy – at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101-150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151-200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201-300	Health alert: everyone may experience more serious health effects.
Hazardous	> 300	Health warnings of emergency conditions. The entire population is more likely to be affected.

US EPA has assigned a specific color to each AQI category to make it easier for people to understand quickly whether air pollution is reaching unhealthy levels in their communities. For example, the color orange means that conditions are “unhealthy for sensitive groups”, while red means that conditions may be “unhealthy for everyone”, and so on.

Adapted from US EPA at https://www.airnow.gov/aqi/aqi-basics/. Go to this webpage to determine the real-time AQI for your area. Links to local air districts can be found at http://www.arb.ca.gov/capcoa/roster.htm.

BOX 16-B WHAT ARE AIR PARTICLES? WHERE DO THEY COME FROM?

Particles in the air are a mixture of solids and liquid droplets that vary in size and often are referred to as “particulate matter”. Small particles or respirable particulate matter – particles less than or equal to 10 microns in diameter (PM_{10}) – pose a greater health concern than larger particles because they can pass through the nose and throat and penetrate the lungs. Ten microns is about one-seventh the diameter of a human hair. Particles exceeding 10 microns usually do not reach the lungs, but can irritate the eyes, nose, and throat.

PM_{10} include “coarse” and “fine” particles. Coarse particles, with diameters ranging between 2.5 and 10 microns, typically are released during crushing or grinding operations and, importantly, as fugitive dust (from non-point sources) disturbed by wind, vehicles, or equipment.

Fine particles ($PM_{2.5}$) have diameters less than or equal to 2.5 microns and pose the greatest health concerns. $PM_{2.5}$ is directly emitted when fuels such as coal, oil, diesel, gasoline, or wood are burned. Fine particles can be emitted during combustion associated with power plants, wood stoves, and motor vehicles (e.g., cars, trucks, buses, marine engines). These particles also are produced during fuel use by construction equipment, agricultural burning, forest fires, and residential fireplaces. Moreover, a large fraction of $PM_{2.5}$ is secondarily formed through the atmospheric reaction of oxides of nitrogen (NOx) or sulfur dioxide with ammonia to form ammonium nitrates and ammonium sulfates, respectively. NOx and sulfur dioxide are combustion by-products.

For more information on air particles and health impacts go to
http://www.airnow.gov/index.cfm?action=particle_health.index.

Controlling speeds on dirt roads helps to reduce airborne particulate matter.

Box 16-C Characterization and Regulation of Criteria Air Pollutants

The Federal Clean Air Act required US EPA to set nationwide standards for air quality based on human health concerns. Federal standards have been established for the six criteria or common air pollutants: ground-level ozone, nitrogen dioxide, particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide, carbon monoxide, and lead. Moreover, the California Air Resources Board (CARB) generally has adopted more restrictive state standards for these pollutants pursuant to the California Clean Air Act. Standards are reviewed periodically and may be revised. Geographic areas in which the level of a criteria air pollutant exceeds federal and/or state standards are classified as non-attainment areas. There are 15 air basins within California that are designated as being in attainment or non-attainment status. Regional or county air districts associated with non-attainment areas for one or more pollutants must prepare management plans that detail means for ensuring future compliance with federal and/or state standards. Regional or county plans are incorporated into the State Implementation Plan submitted to US EPA describing how California will attain and maintain the national standards.

Criteria Air Pollutant	**Relevant Sources**
Ozone (ground level)	Formed by photochemical reaction involving volatile organic compounds (VOCs) and nitrogen oxides (NOx)
Volatile organic compounds (VOCs)*	Released from handling and combustion of fossil fuels (e.g., diesel, gasoline, oil, coal, natural gas); livestock; solvents, paints, glues, pesticides, and other petroleum-derived products; alcoholic fermentation and storage; and respiration by plants and decomposition of organic matter
Nitrogen dioxide	Combustion of fossil fuels (especially diesel)
Particulate matter (PM_{10} and $PM_{2.5}$)	Combustion of wood and fossil fuels (especially diesel), dust from industrial and agricultural operations and unpaved roadways, some applications of pesticides, and atmospheric conversion of gaseous pollutants
Sulfur dioxide	Combustion of coal and oil
Carbon monoxide	Combustion of fossil fuels, especially during cold temperatures
Lead	Leaded aviation gasoline, paint, smelters, and manufacture of lead storage batteries

Detailed information about the Clean Air Act and criteria air pollutants is at https://www.epa.gov/clean-air-act-overview/plain-english-guide-clean-air-act. For more information and an orientation course on criteria pollutants, and greenhouse gases and climate change, visit https://www.apti-learn.net/LMS/register/EPALearning.aspx?t=0

A glossary of air pollution terms is at http://www.arb.ca.gov/html/gloss.htm.

*Although not criteria pollutants, volatile organic compounds are included because they are important ozone precursors. See **Box 16-E** for more information on VOCs.

BOX 16-D HOW IS OZONE BOTH GOOD AND BAD?

Ozone occurs in two layers of the atmosphere. The stratosphere, which contains the "good" ozone layer, extends from about 6 to 30 miles above earth and protects life from the sun's harmful ultraviolet rays. Ozone is produced naturally in the stratosphere. This "good" ozone has been gradually depleted by man-made chemicals referred to as ozone-depleting substances, including chlorofluorocarbons, hydrochlorofluorocarbons, halons, methyl bromide, carbon tetrachloride, and methyl chloroform. The loss of stratospheric ozone allows additional ultraviolet radiation to reach earth's surface, endangering human health and damaging crops.

The layer closest to earth's surface is the troposphere, extending about six miles up. Here, ground-level or "bad" ozone is an air pollutant causing human health and other concerns. Ground-level ozone is the main component of urban smog and is formed when nitrogen oxides (NOx) react with volatile organic compounds (VOCs) in the presence of sunlight. Highest ozone concentrations occur during the spring and summer, when meteorological conditions (i.e., hot sunny days) are optimum for ozone formation. Such conditions can result in ozone peaks lasting from a few days to a week. Emissions associated with industrial facilities, electricity utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some major NOx and VOC sources.

Ground-level ozone damages vegetation and ecosystems. It can reduce the growth and yield of crops, especially for sensitive species and varieties. Moreover, ozone can increase crop susceptibility to pests and other stresses such as harsh weather. US EPA estimates that annual crop damage caused by ozone amounts to $2 billion to $3 billion nationwide.

Ozone is used as a sanitizer in winery operations and can greatly reduce the salinity of winery wastewater. Because ozone has such a short half-life, it cannot be stored but must be generated on-site and used immediately. Most wineries use ozone dissolved in water and some off-gassing can occur. To protect workers, managers need to thoroughly train staff in standard operating procedures for ozone usage and safety; use only properly designed, correctly sized, and carefully maintained ozone generating equipment; and appropriately test and monitor ozone concentrations.

For more general information, visit http://www.airnow.gov/index.cfm?.action=aqibasics.ozone. For information about impacts on crop productivity, go to https://www.ars.usda.gov/southeast-area/raleigh-nc/plant-science-research/docs/climate-changeair-quality-laboratory/ozone-effects-on-plants/.

BOX 16-E UNDERSTANDING AND REGULATION OF VOLATILE ORGANIC COMPOUNDS (VOCS)

Ground-level ozone, a criteria air pollutant, is produced by chemical reactions involving VOCs, nitrogen oxides (NOx), and sunlight. Although not criteria air pollutants, VOCs are important ozone precursors and considered a key target for reduction in order to achieve federal and state ozone standards. Definitive understanding of the capacity for each VOC to produce ozone is evolving. Nevertheless, State Implementation Plans must address means to reduce VOC emissions in air basins exceeding ozone standards. Plans are continually updated to reflect changes in standards resulting from improved understandings of ozone precursor capacities and health risks (e.g., more stringent federal 8-hr ozone standard established in 2015).

The reality is that VOC emissions associated with agriculture continue to be scrutinized. It is important for the California winegrowing community to remain alert to issues and take proactive steps to minimize emissions where feasible and collaborate with regulators about possible additional regulations. Scrutinized sources of VOCs associated with the wine industry include pesticides (see **Box 16-M** for more detail and proactive mitigative measures) and fermentation/storage processes affecting ethanol releases. Winery personnel should keep abreast of their Air District's regulations regarding VOC emissions from fermentation and storage. The wine industry must invest its vast knowledge and experience in actively participating in dialogue and research towards improved understandings of impacts to air quality and reasonable solutions.

Updated information and links pertaining to State Implementation Plans for VOCs and the criteria air pollutants are at http://www.arb.ca.gov/planning/sip/sip.htm.

BOX 16-F CALIFORNIA AIR RESOURCES BOARD AGRICULTURAL ACTIVITIES

Agricultural activities are becoming increasingly subject to air pollution permits and other regulations. One purpose of the Air Resources Board website is to keep the California agricultural community informed about air quality related activities that may impact their operations. It includes board meetings (past and future), actions, programs, news clips, and other details. To explore this site, go to http://www.arb.ca.gov/ag/ag.htm.

To obtain electronic notices about significant regulatory activities and developments, register at http://www.arb.ca.gov/listserv/listserv_grp.php?listtype=A0.

BOX 16-G GREENHOUSE GASES, CLIMATE CHANGE, AND CARBON SEQUESTRATION

Human activities have been linked to four key greenhouse gases – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and the halocarbons (includes refrigerants). Unlike criteria air pollutants, greenhouse gases are of concern primarily because of their impacts on climate change and ramifications such as glacial melting, rising sea levels, and more intense and frequent weather events (e.g., heat waves, droughts, floods, hurricanes). These gases warm the Earth's surface and lower atmosphere by absorbing thermal radiation emitted by the land and ocean and reradiating it back to Earth. CO_2 is the most prevalent greenhouse gas but the CO_2 equivalents of CH_4 and N_2O are 25 and 298 times higher, respectively. While various factors affect climate, most scientists agree that greenhouse gases associated with human activities, predominantly the burning of fossil fuels and clearing of forests, are responsible for the warming observed over the past 50 years. Climate change could impact California agriculture by decreasing the reliability of water supplies, changing the dynamics of pest populations, causing variations in crop yield and quality, and creating more extreme weather events.

The major greenhouse gases associated with grape and wine production are CO_2 and N_2O. In the vineyard, CO_2 can be emitted or stored (sequestered) by plants and soils as a result of plant and microbial activities and management practices. The combustion of fuels by electrical utilities, irrigation pumping plants, or by tractors or other vehicles is a key source of CO_2. N_2O is mostly attributed to excessive use of fertilizers. The precise impacts of a number of management practices (e.g., tillage, irrigation) on the timing and quantity of CO_2 and N_2O emissions from soil microbiological activities are being refined by research and modeling. Combustion-related CO_2 emissions and evaporative losses of refrigerants are important sources of greenhouse gas emissions for wineries.

Carbon sequestration can be defined as the long-term storage of carbon in vegetative structures and soils. Plants are considered a "sink" for CO_2 because they uptake this gas during photosynthesis. Carbon sequestration offsets atmospheric concentration of CO_2 and can be increased by maximizing and diversifying vegetation in and around the vineyard, such as utilizing cover crops (especially permanent covers), maintaining or planting hedgerows, and planting trees and shrubs. Sequestration and emission reductions generally are maximized by combining beneficial practices, e.g., cover crops with no or minimal tillage and additions of compost. According to some models, perennial crops like vineyards may sequester more carbon than annual crops. The net balance of greenhouse gas emissions and carbon sequestration for a vineyard is termed its "carbon footprint." The DeNitrification-DeComposition (DNDC) model has been modified to help quantify soil-related greenhouse gas emissions and carbon sequestration in California vineyards. Key inputs impacting results are vineyard location (climate and soils), row spacing, tillage practices, use and type of cover crop, and amounts of compost and applied nitrogen fertilizer. For more information and how to use the model, see https://www.sustainablewinegrowing.org/docs/Vineyards_GHGs_Handout_7.3.13_rev13.lorez.pdf. For general information about climate change, see https://www.ipcc.ch/reports/ . Updated information for California is at https://www.climatechange.ca.gov/.

To review current understandings about vineyard management practices and carbon footprints, visit the CSWA Resource Library and search for **Vineyard Management Practices and Carbon Footprints** (https://library.sustainablewinegrowing.org/).
To learn more about winery carbon footprints, search for **California Wine's Carbon Footprint** in the CSWA Resource Library.

16-2 Vineyard Floors *Vineyard*

Category 4	Category 3	Category 2	Category 1
Soil management practices for mitigating airborne dust and PM_{10} were known ***And*** A written soil conservation plan* was implemented that included a permanent or no-till cover crop, no or minimally disruptive under-the-vine tillage, and other practices (e.g., wind barriers such as trees and hedgerows, nighttime farming, under-the-vine mulches/compost, vegetated non-farmed areas, combined operations enabling reduced tractor passes).	Soil management practices for mitigating airborne dust and PM_{10} were known ***And*** A soil conservation strategy was implemented that included cover cropping, reduced tillage, and one or more other practices.	There was awareness of soil management practices for mitigating airborne dust and PM_{10} ***And*** A soil conservation strategy was implemented that included reduced tillage.	Soil management practices were not implemented to mitigate airborne dust and PM_{10} unless required by regional regulations (see **Box 16-H**).

In addition to benefiting air quality, the minimization of dust also prevents outbreaks of mite pests.
*A soil conservation plan can be a component of a larger air and climate protection plan. To see an air and climate protection plan template for vineyards visit the CSWA Resource Library at: https://library.sustainablewinegrowing.org/ The template is available in English and Spanish.

BOX 16-H CONSERVATION MANAGEMENT PRACTICES TO REDUCE PM_{10}

The San Joaquin Valley Unified Air Pollution Control District requires that growers with 100 or more acres of continuous, or adjacent, farmland prepare, update, and implement Conservation Management Practices (CMPs) that minimize PM_{10} emissions for each crop farmed. Affected growers must implement at least five CMPs per crop, generally one from each of five categories: land preparation and cultivation, harvest activities, unpaved roads, unpaved equipment yards, and other cultural practices. Detailed information, including the characterization of various CMPs, is available from *Agricultural Air Quality, Conservation Management Practices for San Joaquin Valley Farms* (2004) found at http://www.valleyair.org/farmpermits/updates/cmp_handbook.pdf.

16-3 Unpaved Surfaces – Roadways and Traffic and Equipment Staging Areas			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
Practices for mitigating airborne dust and PM_{10} from unpaved surfaces were known ***And*** A conservation strategy was implemented that included effectively timed applications of water or regulatory compliant anti-dust materials* and/or layering gravel, chipping, mulching, sanding, paving, or seeding ***And*** Speeds and travel were restricted on and around the operation ***And*** Employees were trained to reduce fugitive dust from unpaved areas.	Practices for mitigating airborne dust and PM_{10} from unpaved surfaces were known ***And*** A conservation strategy was implemented that included effectively timed applications of water or regulatory compliant anti-dust materials* and/or layering gravel, chipping, mulching, sanding, paving, or seeding ***And*** Speeds and travel were restricted on and around the operation.	There was awareness of practices for mitigating airborne dust and PM_{10} from unpaved surfaces ***And*** A conservation strategy was implemented that included effectively timed applications of water or regulatory compliant anti-dust materials* and/or layering gravel, chipping, mulching, sanding, paving, or seeding ***Or*** Speeds and travel were restricted during high use periods on and around the operation.	Practices were not specifically implemented to mitigate airborne dust and PM_{10} from unpaved surfaces unless required by regional regulations (see **Box 16-H**). *(Select N/A if all roadways and staging areas are paved)*

*Check with local regulatory officials about regulatory compliant and environmentally sustainable anti-dust materials for your area. See **Box 16-I** for more information on anti-dust materials.
In addition to benefiting air quality, the minimization of dust also prevents outbreaks of mite pests.
To evaluate the economic costs and returns of various management practices for unpaved roads, see the **CSWA Dust Mitigation Comparison Tool** available from the CSWA Resources Library at: https://library.sustainablewinegrowing.org/.

BOX 16-I ANTI-DUST MATERIALS AVAILABLE FOR CONTROLLING PM_{10}

Chips/Mulches, Organic Materials, Polymers, "Road Oil", and Sand: Using regional or county air district approved materials to suppress dust on roads that meet the vehicle trips per day threshold.

Paving: Paving the roads greatly reduces the amount of dust released. Be advised that paving can increase runoff in certain circumstances.

Gravel: Adding gravel to a sufficient depth will reduce dust. If the road has greater than 75 trips per day, the applied gravel must be washed.

Seeding: Seeding to establish ground cover where feasible can greatly reduce roadway dust.

Detailed information and specific products recommended for the San Joaquin Valley are available from *Agricultural Air Quality, Conservation Management Practices for San Joaquin Valley Farms* (2004) found at http://www.valleyair.org/farmpermits/updates/cmp_handbook.pdf. Additional information regarding regulations for controlling PM_{10} from unpaved roadways and traffic areas for the San Joaquin Valley is at http://www.valleyair.org/busind/comply/PM10/compliance_PM10.htm.

For products and practices appropriate for other regions, check with your regional or county air district. The list of air districts is at http://www.arb.ca.gov/capcoa/roster.htm.

Cover crops provide many air quality benefits for vineyards, including dust abatement and reduced soil erosion, improved soil structure and often reduces the number of tractor passes between rows.

16-4 Vineyard Water Use*

Vineyard

Category 4	Category 3	Category 2	Category 1
There was knowledge about how irrigation design and practices affect air quality and climate change ***And*** A cost-effective strategy for reducing emissions was implemented that included a monitored and maintained irrigation system ***And*** The irrigation strategy (including frost protection) delivered minimal amounts of water to achieve yield and quality goals ***And*** Irrigation occurred before mid-morning or at night (decreases ozone formation and conserves energy) ***And*** If applicable, older diesel-powered irrigation units were replaced/retrofitted with cleaner-burning technology (e.g., low-emission diesel engines), converted to electric motors, or use alternative fuels (e.g., biodiesel, propane, natural gas, methane).	There was knowledge about how irrigation design and practices affect air quality and climate change ***And*** A cost-effective strategy for reducing emissions was implemented that included a monitored and maintained irrigation system ***And*** The irrigation strategy (including frost protection) delivered minimal amounts of water to achieve yield and quality goals.	There was awareness of how irrigation design and practices affect air quality and climate change ***And*** The irrigation strategy (including frost protection) delivered minimal amounts of water to achieve yield and quality goals.	The relationship between irrigation operations and air quality and climate change was not known. *(Select N/A if no water was applied during the assessment year)*

*Air emissions associated with pumping water include nitrogen oxides (NOx), fine particulate matter ($PM_{2.5}$), volatile organic compounds (VOCs), and greenhouse gases (e.g., CO_2). Different irrigation systems and practices can variously affect emissions of greenhouse gases from soils (visit the CSWA Resource Library and search for Vineyard Management Practices and Carbon Footprints available at: https://library.sustainablewinegrowing.org/).

BOX 16-J AGRICULTURAL PUMPING EFFICIENCY PROGRAM

The Advanced Pumping Efficiency Program (APEP) is an educational and incentive rebate program funded by PG&E through December 31, 2021 using the Public Purpose Programs Fund under the auspices of the California Public Utilities Commission. The goal of the program is to improve overall pumping plant efficiency and encourage energy conservation. Eligible participants often receive rebates for costs associated with on-site efficiency tests and necessary equipment upgrades. Increases in pumping efficiency lead to less energy consumption, decreased cost, and fewer air emissions.

Who is eligible?
All owners or users of a non-residential, PG&E electric or natural gas account that is primarily used for pumping water for production agriculture, landscape or turf irrigation, or specified municipal purposes. Customers must pay the Public Purpose Programs Charge on their utility bill. An electric or natural gas utility account that is used for production agriculture or large turf irrigation (non-residential accounts of five or more horsepower for turf irrigation) who are paying the Public Goods Charge are eligible (normally customers of PG&E, SCE, SCG, or SDG&E – SDG&E customers should contact APEP to ensure their eligibility).

For additional eligibility requirements, details, and contact information, visit http://www.pumpefficiency.org.

BOX 16-K AIR QUALITY AND DIESEL ENGINES

In 1998, the California Air Resources Board (CARB) designated diesel exhaust as a toxic air contaminant after an exhaustive, 10-year scientific assessment process. Using the newly developed cancer risk assessment for diesel, CARB estimated that diesel particulate matter or soot was responsible for 70% of the state's risk of cancer from airborne toxics for the year 2000. In September 2000, CARB adopted the Diesel Risk Reduction Plan (Diesel RRP or Plan), which recommended control measures to reduce risks by achieving a 75% reduction in diesel particulate matter by 2010 and 85% by 2020, compared to the year 2000.

Agricultural engines are not being singled out. To meet goals, all uses and categories (on road, off road, and stationary) of diesel-fueled engines are being examined and controls implemented where determined to be technically and economically feasible. Based on the statewide diesel particulate matter emissions inventory for the year 2000, emissions from agricultural operations (excluding logging) represented 14% of the total and were comparable to that from on-road heavy-duty trucks (16% of total). Diesel engines also are an important source of the nitrogen oxides (NOx) and volatile organic compounds (VOCs).

Since implementation of the Diesel RRP, emission standards for diesel engines have gradually become more and more stringent. By January 1, 2023 most diesel engines will have to have been retrofitted or replaced to meet the 2010 Model Year Emissions Equivalent Engine standard.

CARB has also instituted Airborne Toxic Control Measures (ATCM's) to further restrict the amount of diesel particulate matter released into the air. These ATCM's are codified in the California Code of Regulations. (https://ww2.arb.ca.gov/resources/documents/airborne-toxic-control-measures)

The new emission standards have been successful, achieving a 68% reduction in diesel particulate matter in 2012, as compared to 1990. (The most recent data available, which can be found here: https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health).

For detailed information about agricultural diesel engines and air quality, see http://www.arb.ca.gov/diesel/ag/agengine.htm.

The CARB Diesel Risk Reduction Plan is at http://www.arb.ca.gov/diesel/documents/rrpapp.htm**.**

BOX 16-L COST-SHARE PROGRAMS TO IMPROVE AIR QUALITY AND/OR MITIGATE CLIMATE CHANGE

Detailed below are select programs by the US Department of Agriculture Natural Resources Conservation Service (NRCS) and others which provide the winegrowing community with cost-share incentives for improving technology or practices to reduce air emissions of criteria pollutants and/or greenhouse gases. For a complete list, visit the CSWA website at: add URL.

NRCS Environmental Quality Incentives Program (EQIP) – National Air Quality Initiative

- A program administered by NRCS that provides cost-share incentives and technical assistance for qualified growers in non-attainment areas for $PM_{2.5}$, PM_{10}, and/or ozone
- Diesel Engine Replacement – to reduce pollutants and greenhouse gases from diesel irrigation engines by replacing older engines with certified cleaner-burning diesel engines, electric motors, or natural gas or propane fueled engines
- Unpaved Roads and Equipment Areas – to reduce $PM_{2.5}$ and PM_{10} pollutants by implementing dust control technologies
- Chipping Removed Vineyards – to reduce pollutants and greenhouse gases by chipping instead of burning removed vines
- Planting Cover Crops – to reduce $PM_{2.5}$ and PM_{10} pollutants by dust mitigation
- Use of Integrated Pest Management – to reduce pollutants and greenhouse gases by mitigation of dust and combustion
- Implementation of Nutrient Management Plans – to reduce pollutants and greenhouse gases by reduced combustion and efficient nitrogen use
- Disposing Chemically Treated Stakes and End-Posts – to prevent toxic dust emissions by disposal at appropriate landfills instead of burning
- Developing Conservation Activity Plans (CAPs) for Comprehensive Air Quality Management or Energy Management
- Updated information about these and other practices and technologies eligible for cost-share incentives and application procedures are at https://www.nrcs.usda.gov/wps/portal/nrcs/main/ca/programs/

Carl Moyer Program

- A statewide grants program administered by local air districts to retrofit or replace diesel engines for heavy-duty vehicles and equipment (e.g., off-road heavy-duty vehicles, irrigation pumps) with lower-emission technology
- More information is at https://ww2.arb.ca.gov/our-work/programs/carl-moyer-memorial-air-quality-standards-attainment-program.

16-5 Pest Management Strategy *Vineyard*

Category 4	Category 3	Category 2	Category 1
There was knowledge about how pest management practices affect air quality and climate change ***And*** A cost-effective strategy was implemented that reduced emissions from soil disturbance, fuel use, and pesticides while maintaining pests at tolerable levels ***And*** The strategy first relied on biological and cultural tactics that minimize equipment passes and pesticide inputs ***And*** Decisions for pesticide applications were based on economic thresholds and/or weather model decision tools ***And*** Weed and floor management practices mitigated dust and PM_{10}.	There was knowledge about how pest management practices affect air quality and climate change ***And*** A cost-effective strategy was implemented that reduced emissions from soil disturbance, fuel use, and pesticides while maintaining pests at tolerable levels ***And*** The strategy first relied on biological and cultural tactics that minimize equipment passes and pesticide inputs.	There was awareness of how pest management practices affect air quality and climate change ***And*** A strategy was being developed to reduce emissions from pest management operations while maintaining pests at tolerable levels.	The relationship between pest management practices and air quality and climate change was not known.

16-6 Pesticide Stewardship *Vineyard*

Category 4	Category 3	Category 2	Category 1
Recommended practices were followed to minimize PM_{10} and drift* from dust (e.g., sulfur) and liquid applications ***And*** Pesticides associated with higher VOC emissions were known or determined and avoided for use (see **Box 16-M**) ***And*** Applicators were trained about pesticide issues relevant to air quality.	Recommended practices were followed to minimize PM_{10} and drift* from dust (e.g., sulfur) and liquid applications ***And*** There was some understanding of pesticide products associated with higher VOC emissions (see **Box 16-M**).	Recommended practices were followed to minimize PM_{10} and drift* from dust (e.g., sulfur) and liquid applications.	Pesticides were chosen and applied without considering impacts to air quality other than following legal requirements.

*Recommended practices to avoid pesticide drift and PM_{10} are detailed in **Criteria 6-28** and **6-29** and associated educational boxes in **Chapter 6 Pest Management**. Additional sources of information about pesticide drift, spray particle size, and mitigative practices are at https://www.curesworks.org/best-management-practices/.

The use of electrostatic sprayers can allow for less use of products and better on-target deposition – both potentially leading to less offsite movement (drift, etc.). To evaluate the economic costs and returns of electrostatic sprayers vs. air blast sprayers, see the **CSWA Sprayer Decision Tool – Air Blast vs. Electrostatic Sprayers** available from the CSWA Resources Library at: https://library.sustainablewinegrowing.org/.

BOX 16-M VOLATILE ORGANIC COMPOUNDS (VOCS) AND PESTICIDES

Many pesticide active and inert ingredients are sources of VOCs, which can react with nitrogen oxides (NOx) and sunlight to form ground-level ozone. Emissions data from the San Joaquin Valley in 2006 list agricultural pesticides as the sixth highest contributor to VOCs (5%), following passenger vehicles (14%), other (13%; waste disposal/composting), livestock waste (9%), oil and gas production (6%), and consumer products (5%). Because ozone concentrations exceed federal and state standards in some air basins, State Implementation Plans include elements to reduce VOC emissions from pesticides in non-attainment areas. In addition, the California Department of Pesticide Regulation (DPR) began adopting regulations in 2008 restricting uses and enforcing new reporting requirements for fumigants (highest in VOCs) in VOC non-attainment areas. Regulations include limiting fumigant applications occurring May 1 to October 1 in the San Joaquin Valley to specific methods (https://www.cdpr.ca.gov/docs/emon/vocs/vocproj/newreg.htm). Regulations imposing sales and use restrictions for high-VOC, non-fumigant pesticides began in 2013. These include the requirement that grape and other growers must obtain written recommendation from a licensed pest control adviser for use of high-VOC products containing abamectin, chlorpyrifos, gibberellins, or oxyfluorfen between May 1 and October 31 in the San Joaquin Valley (https://www.cdpr.ca.gov/docs/emon/vocs/vocproj/reduce_nonfumigant.htm).

In cooperation with the California Air Resources Board, DPR determines and maintains pesticide VOC emission inventories using estimates of product-specific emission potentials (EPs) and pesticide use report data. The EP is that fraction of the product assumed to potentially contribute to atmospheric VOCs.

Potential VOC emission (pounds) = pounds pesticide product applied x EP

Understanding the relationship of estimated laboratory EPs to field emission rates and subsequent ozone formation is evolving. However, growers should keep abreast of current understandings and limit use of pesticides with higher estimated EPs, especially fumigants (also directly toxic) and emulsifiable concentrates. Additional information and pesticide VOC calculators are at https://apps.cdpr.ca.gov/voc-calculator/.

16-7 Agricultural and Winery Chemicals and Materials (excluding pesticides)			*Vineyard & Winery*
Category 4	**Category 3**	**Category 2**	**Category 1**
There was knowledge about how chemicals and materials used in the vineyard and/or winery affect air quality ***And*** A strategy was implemented for chemical acquisition and use that included considerations of VOC potential, air toxicity, potential for ozone depletion* ***And*** The strategy included the purchase and use of only materials with both low potential to emit VOCs and low toxicity ***And*** Proven or suspected ozone depleting materials were not used ***And*** Employees were trained about relevant air quality issues, and safe storage, use, and cleanup procedures.	There was knowledge about how chemicals and materials used in the vineyard and/or winery affect air quality ***And*** A strategy was implemented for chemical acquisition and use that included considerations of VOC potential, air toxicity, potential for ozone depletion* ***And*** The strategy included the preferential purchase and use of materials with both low potential to emit VOCs and low toxicity ***And*** Proven or suspected ozone depleting materials were being eliminated from use.	There was awareness of how chemicals and materials used in the vineyard and/or winery affect air quality ***And*** A strategy was being developed for chemical acquisition and use that included VOC potential, air toxicity, potential for ozone depletion*	The relationship between chemicals and materials used in the vineyard and/or winery and air quality was not known.
*See **Chapter 11 Material Handling** for more details.			

16-8 Transportation

Vineyard & Winery

Category 4	Category 3	Category 2	Category 1
There was knowledge about links between miles traveled, air quality, and climate change ***And*** The miles traveled, fuel use, or greenhouse gas emissions by the vineyard and/or winery operations' trucks each year were tracked ***And*** A strategy was implemented for over one year to minimize the miles traveled to and from the facility (e.g., consolidating deliveries, video conferencing/virtual meetings, carpooling) and to reduce engine idling time each year ***And*** Employees were trained to reduce emissions from travel ***And*** Employees utilize commute alternatives or credits were purchased to offset emissions.	There was knowledge about links between miles traveled, air quality, and climate change ***And*** The miles traveled, fuel use, or greenhouse gas emissions by the vineyard and/or winery operations' trucks each year were known ***And*** A strategy was developed to minimize the miles traveled to and from the facility (e.g., consolidating deliveries, video conferencing/virtual meetings, carpooling) and to reduce engine idling time each year ***And*** Employee training to reduce emissions from travel was provided.	There was awareness about links between miles traveled, air quality, and climate change ***And*** There was a general idea of the miles traveled by the vineyard and/or winery operations' trucks each year ***And*** A strategy was being developed to minimize the miles traveled to and from the facility each year.	The relationship between miles traveled, air quality, and climate change was not known ***And*** The miles traveled by the vineyard and/or winery operations' trucks each year was not known.

16-9 Agricultural Burning

Vineyard

Category 4	Category 3	Category 2	Category 1
No burning was done in the vineyard ***And*** Vineyard prunings and diseased vines were managed to minimize air quality issues (such as by being chipped, ground, and either composted and utilized in the vineyard or sent for biomass processing or use elsewhere).	Vineyard prunings (but not diseased vines) were managed to minimize air quality issues (such as by being chipped, ground, and either composted and utilized in the vineyard or sent for biomass processing or use elsewhere) ***And*** Only diseased vines were burned ***And*** All burning was done under the supervision of a trained vineyard manager.	Only vineyard prunings, diseased vines, and/or weeds were burned ***And*** All burning was done under the supervision of a trained vineyard manager ***And*** Alternatives to burning were being investigated and tested.	Various flammable materials were burned following legal requirements* ***And*** Field workers were allowed to supervise the burning.

*Legal requirements for open-field burning include the need to obtain a burn permit and burn authorization from the regional or county air district. Never burn chemically treated wood (see **Box 16-N**). The California Health and Safety Code requires the San Joaquin Valley Unified Air Pollution Control District to prohibit the burning of many categories of agricultural waste, including vineyard prunings (http://www.valleyair.org/burnprograms/Ag_Burning.htm). Check with your air district and Agricultural Commissioner's office for additional and specific requirements and restrictions.

Box 16-N Removal and Destruction of Chemically Treated Wood

Because of the significant public health risk determined by the California Department of Toxic Substances Control, stakes and end-posts treated with the preservative chromated copper arsenate cannot be burned or chipped. Chromated copper arsenate is regulated as a toxic substance and burning or chipping releases toxic dust. Chemically treated wood must be extracted prior to waste piling and hauled to and disposed of at certified Class II or specified Class III composite-lined landfills. After inspection by regional or county air district personnel, remaining vineyard waste may be piled and burned according to legal requirements, chipped and utilized in the vineyard, or processed as an energy source.

A compliance assistance bulletin for vineyard removal for the San Joaquin Valley is at http://www.valleyair.org/BurnPrograms/Ag_burning.htm.

16-10 Winery Refrigerants

Winery

Category 4	Category 3	Category 2	Category 1
The type, amount, and global warming potential (GWP)* of the current refrigerant(s) were known ***And*** The amount of refrigerant(s) was monitored and tracked ***And*** Results of the refrigeration audit were used to make efficiency improvements were made to the refrigeration system ***And*** Information on refrigerants and impacts on human health and the environment was used in employee training ***And*** Refrigerant leak inspections were performed weekly, or there was an automatic leak detection system.	The type, amount, and global warming potential (GWP)* of the current refrigerant(s) were known ***And*** The amount of refrigerant(s) was monitored ***And*** Results of the refrigeration audit were considered ***And*** Information on refrigerants, leaks, and impacts on human health and the environment was available to employees ***And*** Refrigerant leak inspections were performed monthly.	The type, amount, and the global warming potential (GWP)* of the current refrigerant(s) were known ***And*** An audit of the refrigeration system was completed.	The type, amount, and global warming potential (GWP)* of the current refrigerant(s) were unknown ***And*** The refrigeration system was operated and maintained much as it has been since installation. ***And*** If applicable, regulatory requirements for the refrigeration system were met.**

*Determine details about refrigerants from the refrigeration service company, or visit the Air Resources Board website for a list of refrigerant's global warming potential at: https://ww2.arb.ca.gov/resources/documents/high-gwp-refrigerants

**Any facility with a refrigeration system with over 50 pounds of high-GWP (global warming potential) refrigerant has to register and participate in the California Air Resources Board's Refrigeration Management Program (RMP). To learn more about requirements based on size of the refrigeration system visit: https://ww2.arb.ca.gov/our-work/programs/refrigerant-management-program/rmp-businesses-refrigeration-systems

Box 16-O Tips for Improving Air Quality

You Can Help Keep the Air Cleaner!

Every day tips:

- Conserve electricity. Consider setting your thermostat a little higher in the summer and lower in winter. Participate in local energy conservation programs. Look for the ENERGY STAR label when buying home or office equipment.
- Keep car, boat, and other engines properly tuned, and avoid engines that smoke.
- Carpool, use public transportation, bike, or walk when possible.
- Combine errands to reduce “cold starts” of your car and avoid extended idling.
- Consider using gas logs instead of wood. If you use a wood-burning stove or fireplace insert, make sure it meets EPA design specifications. Burn only dry, seasoned wood.
- Mulch or compost leaves and yard waste.

Tips for days when particle pollution is expected to be high:

- Reduce the number of trips you take in your car.
- Reduce or eliminate fireplace and wood stove use.
- Avoid using gas-powered lawn and garden equipment.
- Avoid burning leaves and other materials.

For your local forecast visit EPA's Website at: https://airnow.gov/

Source: Office of Air and Radiation (6301A), EPA 452/F-03-002 ().

Efficiency improvements to the refrigeration system can include insulating glycol lines.

START OF VINEYARD EVALUATION SHEETS

2. SUSTAINABLE BUSINESS STRATEGY	V/W	4	3	2	1	N/A
2-1 Integrating Sustainability Into Your Business Strategy	**V&W**					
2-2 Environmental Compliance Planning	**V&W**					

SUMMARY EVALUATION SHEETS – VINEYARD

3. VITICULTURE	V/W	4	3	2	1	N/A
3-1 Balanced Vines	V					
3-2 Shoot Density	V					
3-3 Leaf Removal	V					
3-4 Crop-to-Pruning Weight Ratio	V					
3-5 Vineyard Design and Trellis	V					
3-6 Vineyard Vigor Uniformity	V					
3-7 Monitoring Canopy Density and Vigor	V					
3-8 Environmental Due Diligence for a New Vineyard Site or a Replanting	V					
3-9 Soil Profile Inspection and Modification for Pre-Planting	V					
3-10 Soil Tested for Physical and Chemical Properties and Amended Pre-Planting	V					
3-11 Soil Sampled for Biological Problems Pre-Planting	V					
3-12 Addressing Biological Problems	V					
3-13 Rootstocks	V					
3-14 Vineyard Layout	V					
3-15 Row and Vine Spacing	V					
3-16 Scion/Cultivar	V					
3-17 Trellis Selection and Design	V					
3-18 Conservation Habitat for Wildlife and Pest Predators	V					
3-19 Creation of Habitat for Wildlife and Pest Predators	V					

Summary Evaluation Sheets – Vineyard

4. Soil Management	V/W	4	3	2	1	N/A
4-1 Plant Tissue Analysis	V					
4-2 Soil Nutrient Analysis	V					
4-3 Nutrient Management	V					
4-4 Nitrogen Management	V					
4-5 Fertigation	V					
4-6 Amendments for Water Penetration	V					
4-7 Soil pH Adjustments in an Existing Vineyard	V					
4-8 Preserving or Increasing Organic Matter	V					
4-9 Soil Compaction	V					
4-10 Surface Water Diversions for Erodible Sites	V					
4-11 Management of Erosion from Roads, Ditches, and Culverts	V					
4-12 Non-Point Source Pollution (NPS) Prevention Within the Vineyard Block	V					
4-13 Cover Crops	V					
4-14 Soil Carbon Sequestration	V					

SUMMARY EVALUATION SHEETS – VINEYARD

5. VINEYARD WATER MANAGEMENT		V/W	4	3	2	1	N/A
5-1	Water Management Strategy	V					
5-2	Monitoring and Amending Quality of Irrigation Water	V					
5-3	Off-Site Water Movement	V					
5-4	Irrigation System	V					
5-5	Distribution Uniformity for Irrigation Systems	V					
5-6	Filters and Lines	V					
5-7	Water Budget	V					
5-8	Measuring Water Use	V					
5-9	Soil Water-Infiltration Rates and Water-Holding Capacity	V					
5-10	Soil Moisture and Plant Water Status Monitoring Methods	V					
5-11	Planned Deficit Irrigation through Reduced Deficit Irrigation	V					

SUMMARY EVALUATION SHEETS – VINEYARD

6. PEST MANAGEMENT		V/W	4	3	2	1	N/A
6-1	Vineyard Monitoring for Insect and Mite Pests	V					
6-2	Training for Pest and Disease Monitoring	V					
6-3	Economic Thresholds and Pest-Natural Enemy Ratios for Leafhoppers, Mites, and Thrips	V					
6-4	Minimizing Risks from Insecticides and Miticides	V					
6-5	Cultural Practices for Insect and Mite Management	V					
6-6	Dust Abatement in and around Vineyards for Mite Management	V					
6-7	Use of Weather Data and Degree-Days for Managing Moth Pests	V					
6-8	Portion of Vineyard Treated for Mites or Leafhoppers	V					
6-9	Mealybug Management	V					
6-10	Soil-Borne Pest Management after Planting	V					
6-11	Vineyard Monitoring for Disease	V					
6-12	Powdery Mildew Management	V					
6-13	Minimizing Risks from Fungicides for Powdery Mildew and Botrytis Control	V					
6-14	Pruning for Canker Management	V					
6-15	Bunch Rot Management	V					
6-16	Pierce’s Disease Management where Blue-Green Sharpshooter is Primary Vector	V					
6-17	Vineyard Monitoring for Weeds	V					
6-18	Weed Knowledge	V					
6-19	Weed Management	V					
6-20	Herbicide Leaching Potential	V					

SUMMARY EVALUATION SHEETS – VINEYARD

6. PEST MANAGEMENT – *CONT.*	V/W	4	3	2	1	N/A
6-21 Area Treated with Herbicides	V					
6-22 Vineyard Monitoring for Vertebrate Pests	V					
6-23 Vertebrate Pest Management	V					
6-24 Predation by Vertebrates	V					
6-25 Low-Volume Vine Canopy Sprayers	V					
6-26 Sprayer Calibration and Maintenance	V					
6-27 Spray Coverage	V					
6-28 Spray Buffer Zone	V					
6-29 Spray Drift	V					
6-30 Pesticide Storage	V					
6-31 Pesticide Mixing and Loading	V					
6-32 Pesticide Emergency Response Plan	V					
6-34 Using Lower Risk Crop Protection Materials	V					
6-35 Virus Management	V					

SUMMARY EVALUATION SHEETS – VINEYARD

7. WINE QUALITY		V/W	4	3	2	1	N/A
7-1	Field Fruit Maturity	V					
7-2	Taste Grapes with Winery Representative	V					
7-3	Juice Chemistry	V					
7-4	Taste Wine Made from the Grapes	V					
7-5	Knowledge of Wine Quality	V					
7-6	Knowledge of Wine Industry Marketing and Trends	V&W					
7-7	Viticultural Improvement	V					

8. ECOSYSTEM MANAGEMENT		V/W	4	3	2	1	N/A
8-1	Ecosystem Processes – Resource Base Ecosystem Biodiversity	V&W					
8-2	Watershed Management – Watershed Awareness	V&W					
8-3	Ecosystem Management – Native Woodlands	V&W					
8-4	Ecosystem Management – Riparian Habitat	V&W					
8-5	Ecosystem Management – Aquatic Habitats: Streams, Rivers, and Wetlands	V&W					
8-6	Habitat Enhancement for Wildlife	V&W					
8-7	Conservation Easements	V&W					
8-8	Sensitive Species	V&W					
8-9	Sensitive Species and Collaboration with Partners	V&W					

SUMMARY EVALUATION SHEETS – VINEYARD

9. ENERGY EFFICIENCY	V/W	4	3	2	1	N/A
9-1 Planning, Monitoring, Goals, and Results	V&W					
9-2 Vineyard Pump Efficiency	V					
9-3 Vineyard Vehicles	V					
9-8 Lighting – Offices and Labs	V&W					
9-9 Lighting – Shops and Facilities	V&W					
9-10 Lighting – Outdoor and Security	V&W					
9-11 Office Equipment	V&W					
9-12 Renewable Sources of Power	V&W					

11. MATERIAL HANDLING	V/W	4	3	2	1	N/A
11-1 Planning, Monitoring, Goals, and Results	V&W					
11-2 Good Housekeeping – Dumpster Area	V&W					
11-3 Hazardous Materials – Hazardous Material Storage and Replacement	V&W					
11-4 Hazardous Materials – Hazardous Waste Disposal	V&W					
11-5 Paint and Paint Thinners	V&W					
11-6 Aerosol Cans	V&W					
11-7 Fuel Storage – Aboveground Storage Tanks (ASTs) or Portable Tanks	V&W					

12. SOLID WASTE MANAGEMENT	V/W	4	3	2	1	N/A
12-18 Vineyard Solid Waste	V					

SUMMARY EVALUATION SHEETS – VINEYARD

13. SUSTAINABLE PURCHASING	V/W	4	3	2	1	N/A
13-1 Planning, Monitoring, Goals, and Results	V&W					
13-3 Vineyard Supplies	V					
13-4 Vehicles	V&W					
13-5 Vehicle Maintenance Products	V&W					
13-6 Office Equipment	V&W					

14. HUMAN RESOURCES	V/W	4	3	2	1	N/A
14-1 HR Planning and Goals	V&W					
14-2 Staffing and Recruiting Strategy	V&W					
14-3 Interviewing Process	V&W					
14-4 Employee Orientation	V&W					
14-5 Safety Training	V&W					
14-6 Continuing Education, Training and Development	V&W					
14-7 Industry Knowledge and Participation	V&W					
14-8 Promoting Sustainability in the Workplace	V&W					
14-9 Employee Performance	V&W					
14-10 Compensation Benchmarking	V&W					
14-11 Diversity, Equity and Inclusion	V&W					

SUMMARY EVALUATION SHEETS – VINEYARD

15. NEIGHBORS AND COMMUNITY		V/W	4	3	2	1	N/A
15-1	Neighbors and Community Relations	V&W					
15-2	Awareness of Potential Neighbor and Community Issues	V&W					
15-5	Arts and Culture (non-profit organizations, concerts, galleries or art exhibits, tastings, other cultural events, etc.)	V&W					
15-6	Community (e.g. police and fire departments, schools, other community organizations, etc.)	V&W					
15-7	Environment (e.g. habitat restoration, environmental organizations, etc.)	V&W					
15-8	Wine Industry Research (e.g. American Vineyard Foundation, National Grape Research Alliance, universities, etc.)	V&W					
15-9	Other Philanthropic Causes	V&W					

16. AIR QUALITY AND CLIMATE PROTECTION		V/W	4	3	2	1	N/A
16-1	Planning, Monitoring, Goals, and Results	V&W					
16-2	Vineyard Floors	V					
16-3	Unpaved Surfaces – Roadways and Traffic and Equipment Staging Areas	V&W					
16-4	Vineyard Water Use	V					
16-5	Pest Management Strategy	V					
16-6	Pesticide Stewardship	V					
16-7	Agricultural and Winery Chemicals and Materials	V&W					
16-8	Transportation	V&W					
16-9	Agricultural Burning	V					

START OF WINERY EVALUATION SHEETS

2. SUSTAINABLE BUSINESS STRATEGY	V/W	4	3	2	1	N/A
2-1 Integrating Sustainability Into Your Business Strategy	V&W					
2-2 Environmental Compliance Planning	V&W					
2-3 Integrating Sustainability Into Communications Strategy	W					

6. PEST MANAGEMENT	V/W	4	3	2	1	N/A
6-33 Winery Pest Management	W					

7. WINE QUALITY	V/W	4	3	2	1	N/A
7-6 Knowledge of Wine Industry Marketing and Trends	V&W					
7-8 Planning, Monitoring, Goals, and Results for Food Safety	W					
7-9 Planning, Monitoring, Goals, and Results for Security	W					

SUMMARY EVALUATION SHEETS – WINERY

8. ECOSYSTEM MANAGEMENT		V/W	4	3	2	1	N/A
8-1	Ecosystem Processes – Resource Base Ecosystem Biodiversity	V&W					
8-2	Watershed Management – Watershed Awareness	V&W					
8-3	Ecosystem Management – Native Woodlands	V&W					
8-4	Ecosystem Management – Riparian Habitat	V&W					
8-5	Ecosystem Management – Aquatic Habitats: Streams, Rivers, and Wetlands	V&W					
8-6	Habitat Enhancement for Wildlife	V&W					
8-7	Conservation Easements	V&W					
8-8	Sensitive Species	V&W					
8-9	Sensitive Species and Collaboration with Partners	V&W					

9. ENERGY EFFICIENCY		V/W	4	3	2	1	N/A
9-1	Planning, Monitoring, Goals, and Results	V&W					
9-4	Winery Motors, Drives, and Pumps	W					
9-5	Refrigeration System	W					
9-6	Tanks and Lines	W					
9-7	Heating Ventilation and Air Conditioning (HVAC)	W					
9-8	Lighting – Offices and Labs	V&W					
9-9	Lighting – Shops and Facilities	V&W					
9-10	Lighting – Outdoor and Security	V&W					
9-11	Office Equipment	V&W					
9-12	Renewable Sources of Power	V&W					

SUMMARY EVALUATION SHEETS – WINERY

10. WINERY WATER CONSERVATION AND WATER QUALITY	V/W	4	3	2	1	N/A
10-1 Water Conservation Planning, Monitoring, Goals, and Results	W					
10-2 Source Water Quality Planning, Monitoring, Goals, and Results	W					
10-3 Water Supply	W					
10-4 Process Water Management	W					
10-5 Process Water Discharge	W					
10-6 Septic Systems or Onsite Systems	W					
10-7 Crush Operations	W					
10-8 Presses	W					
10-9 Tanks and Transfer Lines	W					
10-10 Cellars	W					
10-11 Barrel Washing	W					
10-12 Barrel Soaking	W					
10-13 Bottling	W					
10-14 Labs	W					
10-15 Landscaping	W					

SUMMARY EVALUATION SHEETS – WINERY

11. MATERIAL HANDLING		V/W	4	3	2	1	N/A
11-1	Planning, Monitoring, Goals, and Results	V&W					
11-2	Good Housekeeping – Dumpster Area	V&W					
11-3	Hazardous Materials – Hazardous Material Storage and Replacement	V&W					
11-4	Hazardous Materials – Hazardous Waste Disposal	V&W					
11-5	Paint and Paint Thinners	V&W					
11-6	Aerosol Cans	V&W					
11-7	Fuel Storage – Aboveground Storage Tanks (ASTs) or Portable Tanks	V&W					
11-8	Winery Sanitation Supplies	W					

SUMMARY EVALUATION SHEETS – WINERY

12. SOLID WASTE REDUCTION AND MANAGEMENT	V/W	4	3	2	1	N/A
12-1 Planning, Monitoring, Goals, and Results	W					
12-2 Pomace and Lees	W					
12-3 Diatomaceous Earth	W					
12-4 Plate and Frame Filters	W					
12-5 Cooperage	W					
12-6 Glass	W					
12-7 Cardboard	W					
12-8 Paper	W					
12-9 Plastic	W					
12-10 Packaging (Incoming packaging from suppliers and Outgoing product packaging)	W					
12-11 Metals	W					
12-12 Natural Cork	W					
12-13 Pallets, Wood Packaging, Bins, etc.	W					
12-14 Capsules	W					
12-15 Landscape Residuals	W					
12-16 Food Waste	W					
12-17 Single Stream Recycling	W					

13. SUSTAINABLE PURCHASING		V/W	4	3	2	1	N/A
13-1	Planning, Monitoring, Goals, and Results	V&W					
13-2	Service Providers	W					
13-4	Vehicles	V&W					
13-5	Vehicle Maintenance Products	V&W					
13-6	Office Equipment	V&W					
13-7	Wine Containers	W					
13-8	Closures	W					
13-9	Capsules	W					
13-10	Boxes	W					
13-11	Winery Equipment	W					
13-12	Paper	W					
13-13	Janitorial Cleaning Supplies	W					
13-14	Packaging – From Suppliers	W					
13-15	Packaging – To Customers	W					

SUMMARY EVALUATION SHEETS – WINERY

14. HUMAN RESOURCES	V/W	4	3	2	1	N/A
14-1 HR Planning and Goals	V&W					
14-2 Staffing and Recruiting Strategy	V&W					
14-3 Interviewing Process	V&W					
14-4 Employee Orientation	V&W					
14-5 Safety Training	V&W					
14-6 Continuing Education, Training and Development	V&W					
14-7 Industry Knowledge and Participation	V&W					
14-8 Promoting Sustainability in the Workplace	V&W					
14-9 Employee Performance	V&W					
14-10 Compensation Benchmarking	V&W					
14-11 Diversity, Equity and Inclusion	V&W					

SUMMARY EVALUATION SHEETS – WINERY

15. NEIGHBORS AND COMMUNITY	V/W	4	3	2	1	N/A
15-1 Neighbors and Community Relations	V&W					
15-2 Awareness of Potential Neighbor and Community Issues	V&W					
15-3 Mitigation of Winery Light, Noise and Traffic Impacts	W					
15-4 Awareness of Community Issues that Could Affect a Winery	W					
15-5 Arts and Culture (non-profit organizations, concerts, galleries or art exhibits, tastings, other cultural events, etc.)	V&W					
15-6 Community (e.g. police and fire departments, schools, other community organizations, etc.)	V&W					
15-7 Environment (e.g. habitat restoration, environmental organizations, etc.)	V&W					
15-8 Wine Industry Research (e.g. American Vineyard Foundation, National Grape Research Alliance, universities, etc.)	V&W					
15-9 Other Philanthropic Causes	V&W					

16. AIR QUALITY AND CLIMATE PROTECTION	V/W	4	3	2	1	N/A
16-1 Planning, Monitoring, Goals, and Results	V&W					
16-3 Unpaved Surfaces – Roadways and Traffic and Equipment Staging Areas	V&W					
16-7 Agricultural and Winery Chemicals and Materials	V&W					
16-8 Transportation	V&W					
16-10 Winery Refrigerants	W					

ACTION PLANS

Now that you have completed the self-assessment(s), your evaluation sheets will show which areas of your vineyard and/or winery operations may need changes to maximize performance or prevent environmental problems. Devote special attention to criteria that have a one or a two rating to determine if these are areas of potential concern.

The next step is to develop an action plan to take care of these potential concerns. You will have to analyze the situation and then decide what to do and when it can be done. You can decide what actions to take over the next year, three years, five years, etc. depending on your circumstances and what actions you plan to take. Remember, this is *your* action plan – it must suit you and your operation.

Special Note: Not all action plans need to relate directly to a specific criterion in the workbook. Targets for improvements may also be more general in nature, such as setting a target to reduce energy use by 10% (although specific actions you might take may relate to multiple criteria in the energy chapter). As another example, you could test or implement new technologies or best practices that are not yet included in the workbook.

Steps – Developing Your Action Plan

1. Determine whether the potential concerns can be addressed. Although some aspects such as soil type cannot be changed, for example, you may be able to improve your soil management practices.

2. If the potential concerns *can* be addressed, decide *which* concerns are most important to you, *what* actions you can take to improve the situation, and *when* you can act.

3. Consider how each concern affects the environment, the safety of your family, workers, or community, and the viability of your vineyard and/or winery operation. For each of the potential concerns identified in the worksheets, answer the questions listed below.

    - Will this situation cause any danger to your family or employees' health or safety? Will it affect the health or safety of other people in the community?
    - Will any surface water or ground water be affected?
    - Will fish or wildlife be harmed?
    - Can the situation be improved easily or with difficulty?
    - How much will it cost to make the improvement?
    - How long will it take to make the improvement?
    - How will the improvement affect yield and wine quality?
    - How will other farm operations be affected if the current situation is changed?

4. Develop action plans for those criteria or practices where improvements can be accomplished within your vineyard and/or winery budget and work schedule. The following example is a guide for filling out action plan forms provided in the workbook, or you can create your own action plan forms using Excel or Word or another computer program. (Login to the SWP Online System to download electronic versions of action plan forms at www.sustainablewinegrowing.org.)

Example Action Plan

The example below illustrates what an action plan for two criteria might look like. The first column lists the workbook chapter most closely related to the area of concern. The second column lists the criterion number from the workbook, if the action is directly related to a specific criterion. It may be useful to list the page number on which this criterion appears in case you want to refer back to that page. The third column includes the criterion and corresponding category for which the concern is based, or simply the area of concern if it is not linked to a specific criterion. The fourth column details the specific plan of action you have decided to take in addressing the concern listed in the third column. The fifth column specifies the timetable you plan to use in carrying out the action, and the last column assigns responsibility for carrying out the action.

1. Decide what issues you can address.

5. Decide who is responsible for the action.

ACTION PLAN

Workbook Chapter	Criteria Number (if applicable)	Criteria and/or Area of Concern	Plan of Action	Timetable for Action	Person Responsible
Chapter 6 Pest Management	Criteria 6-1 Page 12	<u>Vineyard Monitoring for Insect and Mite Pests</u> <u>Category 1</u>: The vineyard was never or rarely monitored for insect and mite pests.	Monitor every two weeks.	Next growing season	Vineyard Manager
Chapter 6 Pest Management	Criteria 6-32 Page 70	<u>Pesticide Emergency Response Plan</u> <u>Category 1</u>: Legal requirements were maintained for a pesticide emergency response plan.	Contact Ag Commissioner's office for information on what a typical emergency response plan looks like; figure out how to make it work on my ranch; train both tractor drivers; post plan by the sprayer fill-up.	Immediately	Vineyard Manager

2. Specify the issue and your area of concern.

3. Determine an appropriate plan of action.

4. Create a realistic timetable for carrying out the action.

ACTION PLAN					
Workbook Chapter	**Criteria Number (if applicable)**	**Criteria and/or Area of Concern**	**Plan of Action**	**Timetable for Action**	**Person Responsible**

ACTION PLAN					
Workbook Chapter	**Criteria Number (if applicable)**	**Criteria and/or Area of Concern**	**Plan of Action**	**Timetable for Action**	**Person Responsible**

CERTIFIED CALIFORNIA SUSTAINABLE WINEGROWING

Introduced in January 2010, Certified California Sustainable Winegrowing (CCSW) is a voluntary, third-party certification program for California vineyards and wineries that is based on the *California Code of Sustainable Winegrowing Workbook*. With technical guidance and oversight by the Sustainable Winegrowing Joint Committee, CSWA developed the third-party certification program to increase the sustainability of the California wine industry by promoting the adoption of sustainable practices, ensuring continual improvement, and creating a verification process for vineyards and wineries. The goals of CCSW are to enhance transparency, encourage statewide participation, enhance credibility in the market and public policy arena, and advance the entire California wine industry toward best practices in environmental stewardship, conservation of natural resources and socially equitable business practices.

All CCSW vineyards and wineries must meet the following requirements, which are verified during annual third-party audits:

- **Annual Self-Assessment:** Completion of an annual self-assessment of 144 vineyard & 105 winery best practices using the comprehensive California Code of Sustainable Winegrowing. Auditors verify that all self-assessment scores accurately reflect on-the-ground practices during the annual audit.
- **Minimum Score Threshold:** 85% of the total scores must be Category 2 or higher by Year Two of certification. Practices included in Category 2 and above are considered sustainable practices in the industry.
- **Prerequisite Practices:** There are 60 required prerequisite practices for vineyards, and 41 required prerequisite practices for wineries. (While prerequisites specify minimal scores, certified vineyards and wineries often score above these minimum practices.) For the complete list of prerequisite practices see page 3 below.
- **Comply with Restrictions on Crop Protection Materials:** Crop protection materials on the CSWA Red List may not be used by Year Two of certification. If materials on the CSWA Yellow List are used, alternatives must first be tried or considered, and justification and mitigation of risk documented via a competed Use Form (see the Certification Resources page for additional details).
- **Sustainability Performance Metrics for Water, Energy, Nitrogen and GHGs:** Vineyards must measure, and record water use and nitrogen applied annually by Year Two of certification. Wineries must measure and record water use, energy use, and greenhouse gas emissions (GHGs) annually by Year Two of certification.
- **Continuous Improvement:** All certified vineyards and wineries must also demonstrate continuous improvement in the adoption of sustainable practices on an annual basis. Written action plans are created and audited to document the implementation of additional sustainable practices every year.

- **Annual 3rd Party Audit:** Participants must undergo an annual audit and submit an audit report each year that is reviewed by the Certification Review Panel, before the annual certification is awarded.
- **Chain of Custody Audits:** Wine bearing the CCSW logo or claims must be made in a certified winery, using at least 85% or higher grapes from certified vineyards and 100% California grapes. A winery that uses a certification claim or logo on a wine label is required to complete a Chain of Custody audit.

For more information about CCSW visit:
https://www.sustainablewinegrowing.org/certified-sustainable-winegrowing.php.

For the detailed Certification Guidebook visit:
www.sustainablewinegrowing.org/certificationguidelines.php.

Certification is a voluntary option; vintners and growers can still participate in the educational SWP and use the *California Code of Sustainable Winegrowing Workbook* to evaluate and improve their practices even if they do not choose to pursue certification.

Certification Pre-Requisites:
4th Edition California Code of Sustainable Winegrowing Workbook

Criteria Number	Criteria Title	Vineyard and/or Winery	Pre-Requisite Level
2-1	Integrating Sustainability into Business Strategy	Vineyard & Winery	Action plan required if Category 1 or 2; Category 3 or higher for subsequent years
2-2	Environmental Compliance Planning	Vineyard & Winery	Action Plan required if Category 1; Category 2 or higher for subsequent years
3-12	Addressing Biological Problems	Vineyard	Action plan required if Category 1; Category 2 or higher in next year with planting
3-16	Scion/Cultivar	Vineyard	Category 2 in next planting year
3-18	Conservation of Habitat for Wildlife and Pest Predators	Vineyard	Action plan required if Category 1; Category 2 or higher in next year with planting
4-3	Nutrient Management	Vineyard	Category 2 or higher in first year; Category 3 or higher in subsequent years
4-4	Nitrogen Management	Vineyard	Action Plan required if Category 1; Category 2 or higher for subsequent years
4-5	Fertigation	Vineyard	Action plan required if Category 1 or Category 2; Category 3 or higher in subsequent years
4-10	Surface Water Diversions for Erodible Sites	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
4-11	Management of Erosion from Roads, Ditches, and Culverts	Vineyard	Must be Category 2 or higher
4-14	Soil Carbon Sequestration	Vineyard	Action Plan required if Category 1; Category 2 or higher for subsequent years
5-1	Water Management Strategy	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
5-2	Monitoring and Amending Quality of Irrigation Water	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
5-3	Off-Site Water Movement	Vineyard	Action plan required if Category 1 or Category 2; Category 3 or higher in subsequent years
5-5	Distribution Uniformity for Irrigation Systems	Vineyard	Action Plan required if Category 1; Category 2 or higher for subsequent years
5-6	Filters and Lines	Vineyard	Must be Category 2 or higher
5-7	Water Budget	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
5-8	Measuring Water Use	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
5-9	Soil Water-Infiltration Rates and Water-Holding Capacity	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
5-10	Soil Moisture and Plant Water Status Monitoring Methods	Vineyard	Action plan required if Category 1 or 2; Category 3 or higher for subsequent years
6-1	Vineyard Monitoring for Insect and Mite Pests	Vineyard	Must be Category 2 or higher in first year; Cat 3 or higher in subsequent years
6-2	Training for Pest and Disease Monitoring	Vineyard	Action Plan required if Category 1; Category 2 or higher for subsequent years
6-3	Economic Thresholds and Pest-Natural Enemy Ratios for Leafhoppers, Mites, and Thrips	Vineyard	Must be Category 2 or higher

Criteria Number	Criteria Title	Vineyard and/or Winery	Pre-Requisite Level
6-4	Minimizing Risks from Insecticides and Miticides	Vineyard	Category 2 or higher in first year; Category 3 or higher in subsequent years
6-5	Cultural Practices for Insect and Mite Management	Vineyard	Action Plan required if Category 1; Category 2 or higher for subsequent years
6-7	Use of Weather Data and Degree-Days for Managing Moth Pests	Vineyard	Must be Category 2 or higher
6-8	Portion of Vineyard Treated for Mites or Leafhoppers	Vineyard	Must be Category 2 or higher
6-9	Mealybug Management (vine, grape, obscure, and long-tailed)	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
6-11	Vineyard Monitoring for Disease	Vineyard	Must be Category 2 or higher in first year; Category 3 or higher in subsequent years
6-13	Minimizing Risks from Fungicides for Powdery Mildew and Botrytis Control	Vineyard	Category 2 or higher in first year; Category 3 or higher in subsequent years
6-15	Bunch Rot Management	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
6-16	Pierce's Disease (PD) Management where Blue-Green Sharpshooter is the Primary Vector	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
6-17	Vineyard Monitoring for Weeds	Vineyard	Must be Category 2 or higher in first year; Cat 3 or higher in subsequent years
6-20	Herbicide Leaching Potential	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
6-22	Vineyard Monitoring for Vertebrate Pests	Vineyard	Must be Category 2 or higher in first year; Cat 3 or higher in subsequent years
6-23	Vertebrate Pest Management	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
6-26	Sprayer Calibration and Maintenance	Vineyard	Category 2 or higher in first year; Category 3 or higher in subsequent years
6-27	Spray Coverage	Vineyard	Action plan required if Category 1; Category 2 or higher in subsequent years
6-28	Spray Buffer Zone	Vineyard	Category 2 or higher in first year; Category 3 or higher in subsequent years
6-34	Using Lower Risk Crop Protection Materials	Vineyard	Category 2 or higher in first year; Category 3 or higher in subsequent years
7-3	Juice Chemistry	Vineyard	Action Plan required if Category 1; Category 2 or higher for subsequent years
7-8	Planning, Monitoring, Goals, and Results for Food Safety	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
7-9	Planning, Monitoring, Goals, and Results for Security	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
8-1	Ecosystem Processes – Resource Base Ecosystem Biodiversity	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
8-2	Watershed Management – Watershed Awareness	Vineyard & Winery	Category 2 or higher in first year; Category 3 or higher in subsequent years
8-4	Ecosystem Management – Riparian Habitat	Vineyard & Winery	Action plan required if Category 1; No timeline to move to Category 2 or higher
8-5	Ecosystem Management – Aquatic Habitats: Streams, Rivers, and Wetlands	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
8-8	Sensitive Species	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years

Criteria Number	Criteria Title	Vineyard and/or Winery	Pre-Requisite Level
8-9	Sensitive Species and Collaboration with Partners	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
9-1	Planning, Monitoring, Goals, and Results	Vineyard & Winery	Vineyards: Action Plan required if Category 1; Category 2 or higher for subsequent years Wineries: Action plan required if Category 1; Category 2 or higher in subsequent years
9-2	Vineyard Pump Efficiency	Vineyard	Action Plan required if Category 1; Category 2 or higher for subsequent years
9-4	Winery Motors, Drives, and Pumps	Winery	Action Plan required if Category 1; Category 2 or higher for subsequent years
9-5	Refrigeration System	Winery	Action Plan required if Category 1; Category 2 or higher for subsequent years
9-12	Renewable Sources of Power	Vineyard & Winery	Action Plan required if Category 1; Category 2 or higher for subsequent years
10-1	Water Conservation Planning, Monitoring, Goals, and Results	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
10-2	Source Water Quality Planning, Monitoring, Goals, and Results	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
10-3	Water Supply	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
10-7	Crush Operations	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
10-8	Presses	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
10-11	Barrel Washing	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
10-15	Landscaping	Winery	Action plan required if Category 1; No timeline to move to Category 2 or higher
11-1	Planning, Monitoring, Goals, and Results	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
11-3	Hazardous Material Storage and Replacement	Vineyard & Winery	Action Plan required if Category 1; Category 2 or higher for subsequent year
12-1	Planning, Monitoring, Goals, and Results	Winery	Action Plan required if Category 1; Category 2 or higher in subsequent years
12-7	Cardboard	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years*
12-8	Paper	Winery	Action plan required if Category 1 or 2; Category 3 or higher for subsequent years
12-11	Metals	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years*
12-14	Capsules	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years*
12-15	Landscape Residuals	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
12-17	Single Stream Recycling	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
13-1	Planning, Monitoring, Goals, and Results	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
13-15	Packaging - To Customers	Winery	Action Plan required if Category 1; Category 2 or higher for subsequent years

Criteria Number	Criteria Title	Vineyard and/or Winery	Pre-Requisite Level
14-1	HR Planning and Goals	Vineyard & Winery	Action plan required if Category 1; No timeline to move to Category 2 or higher
14-5	Safety Training	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
14-8	Promoting Sustainability in the Workplace	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
15-1	Neighbors and Community Relations	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
15-2	Awareness of Potential Neighbor and Community Issues	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
15-3	Mitigation of Light, Noise and Traffic Impacts	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
16-1	Planning, Monitoring, Goals, and Results	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
16-3	Unpaved Surfaces – Roadways and Traffic and Equipment Staging Areas	Vineyard & Winery	Action plan required if Category 1; Category 2 or higher in subsequent years
16-10	Winery Refrigerants	Winery	Action plan required if Category 1; Category 2 or higher in subsequent years

*If recycling is not available in your area, the pre-requisite allows for “no timeline” to move to a Category 2 or higher.

GLOSSARY

aggregates: the term given to the clumps of elemental soil particles. The degree to which soil is clumped, or aggregated, has a great deal to do with soil quality, the higher the aggregation the better. The presence of organic matter and its breakdown by soil microbes greatly enhances soil aggregation. The air spaces between the aggregates provide aeration and water-holding capacity.

annual cover crop: a cover crop, usually planted, that is grown for only a portion of the year, usually winter, and then is mowed and/or disked into the soil.

anthocyanins: the red pigment in the grape; their production is stimulated by light hitting the clusters.

anticoagulant bait: bait that interferes with the clotting ability of an animal's blood. If enough is consumed it results in the animal's death. This type of bait needs to be protected as it is very toxic to non-target organisms.

berm sweeping: cleaning the berms under the vine of debris, such as grape mummies, leaves, prunings, and weeds. This material can harbor vineyard pests, such as bunch rot spores, OLR, twig borer, and leafhopper adults.

bicarbonate: an impurity found in water which can raise the pH of the soil, and can cause plugging problems with drip systems.

biofix: when using a pheromone trap, it is the date when the first significant catch of moths is made; a significant catch being three or more moths.

bucket auger: a useful implement used to sample soil consisting of opposed cutting tines attached to a hollow tube several inches in diameter which is attached to a handle with a 'T' at the end opposite the 'bucket'. The auger is worked into the soil with the handle and when it is worked back out of the soil, a sample of the soil is retained in the 'bucket'.

brix: a unit of measure of the soluble solids in plant sap and fruit juice made using a refractometer.

buffer strips: a piece of land that exists between two habitats that insulates one habitat from the other (e.g., a strip of land between a waterway and a vineyard that contains grasses, shrubs, and/or trees that help insulate the waterway from the vineyard).

calibration (of a sprayer): adjusting the configuration and operation of a sprayer so that the desired volume of spray is applied per acre and the droplet size and spray pattern provides for the best spray coverage.

Category I: a category of pesticides that is the most toxic of all pesticides. The oral LD_{50} is 0-50 mg/kg and they are highly toxic. The signal words on the pesticide label are DANGER, POISON, and the skull and crossbones.

claypan: a subsurface layer of soil that has a noticeable increase in clay content that can inhibit water penetration and penetration of plant roots. Ripping does not improve a claypan – the clay must be mixed with the surrounding soil by, for example, a slip-plow.

clonal selections (clone): a strain of a grape variety that has been derived by asexual reproduction and presumably has a desirable characteristic(s). Known as a "bud-sport" in other crops.

compost: the organic matter products resulting from the biological decomposition of raw organic matter, such as plant or animal material. Well-made compost is more concentrated than manure, and is weed- and disease-free.

cultural controls: controlling a pest using physical means (e.g., clearing grape mummies off of berms to reduce bunch rot inoculum and kill overwintering OLR larvae or pupae or pulling to reduce leafhopper and mite numbers and increase air circulation in the grape canopy to reduce the incidence of bunch rot).

degree days: a measure of physiological time; it is a function of the temperature between upper and lower thresholds for growth (of a plant or insect) and the number of days that the temperature occurs between these thresholds.

distribution uniformity: the evenness of water application to plants throughout a field. It is defined as the average of the lowest 25% of water applied to plants in a field divided by the average water applied to plants for the whole field. The highest possible value is 100%.

diversity, equity and inclusion (DEI): Diversity in the workplace means that a company's workforce includes people of varying gender, age, race, ethnicity, cultural background, sexual orientation, religion, languages, education, abilities, etc. Equity seeks to ensure fair treatment, equality of opportunity and fairness in access to information and resources for all. Inclusion builds a culture of belonging by actively inviting the contribution and participation of all.

ecological: pertaining to the ecology of an organism. Ecology is generally defined as the study of organisms and their relationship with their environment.

economic threshold: the level of a pest population above which, if a control action is not taken, the value of crop damage will exceed the cost of treatment.

energy dissipaters: devices located in water ways that alter water flow in a way that reduces its erosion potential.

ethyl carbamate: a carcinogenic compound formed during fermentation from high levels of urea in the must.

evapotranspiration: the amount of water given off from a given area of ground, both from transpiration through the plant and evaporation from the soil surface.

farmscaping: term used to describe enhancing the habitat value and visual beauty of the farming landscape through planting of trees, shrubs, flowers, etc.

fertigation: applying fertilizer through the irrigation water. This is normally done in drip irrigation systems but some growers that use furrow irrigation place fertilizer at the head of the furrow and distribute the fertilizer in the water.

gypsum block: a porous material (gypsum) block with imbedded electrodes used to measure the tension water is held in the soil (water potential). The electrical conductivity of the block is affected by the soil water potential.

hardpan: a very dense, unfractured, rocklike soil layer that can occur at various depths below the soil surface and is impervious to water and plant roots. Ripping can permanently destroy a hardpan.

hotspots: areas of the vineyard that traditionally have higher than normal pest numbers.

insectary plants: plants that provide food for beneficial insects, such as pollen or nectar from flowers or nectar from extra-floral nectaries. Many insect natural enemies require these food sources to complete their life cycle or remain active in their pursuit of prey.

malate: the salt form of malic acid, which is one of the most widespread acids in plants. The ratio of malate to tartrate is a winegrape quality indicator.

malic acid: is one of the most widespread acids in plants. It is found in large quantities in the green grape and diminishes between veraison and harvest, slowly in cool weather, and rapidly in warm weather. The amount of malic acid in a ripe grape varies according to the variety and year. When a wine undergoes malolactic fermentation, the malic acid is transformed to lactic acid, reducing the acidity.

mating disruption or pheromone confusion: the use of pheromones to prevent the females and males of a pest from finding each other and mating. Pheromone dispensers are placed out in the vineyard in such numbers that males are confused and cannot find the females. One formulation for OLR control comes in a sprayable form.

mode of action: term used to describe the particular physiological mechanism by which a pesticide kills its target pest.

native plants: plants living within the region in which they evolved.

natural enemies: organisms that prey on other organisms and classified into two general categories: predators, which chase and kill they prey; and parasites or parasitoids, which live off their host without necessarily killing it. A parasite does not usually kill its host while a parasitoid does kill its host.

neutron probe: a device that measures the water content of the soil. It consists of a tube sunk into the ground; a radioactive source is lowered in the tube and the behavior of the neutrons is directly related to the water content of the soil.

nitrate: is a negatively charged ion with the chemical form of NO_3^-, it is one of two forms of nitrogen that is taken up by plants.

organic matter: material that was produced by plants but is now dead.

organic matter turnover: the process in which organic matter decays and turns into CO_2, H_2O, and humus.

pathogen: an organism that causes a disease in another organism.

perennial grasses: species of grasses that live for more than one year.

perennial weeds: species of weeds that live for more than one year.

permanent cover crop: a cover crop that is left untilled for more than one year.

pH: a measure of the amount of hydrogen ions in the soil; it is a measure of acidity. Soils with pH's below 7 are acidic and above 7 are basic.

phenolics: members of the phenol chemical group. These include tannins which can taste bitter or astringent, as well as anthocyanins or color pigments. Phenolics make up the structure of wine.

pheromone: a chemical (sex attractant) released by an insect, usually by the female, to attract the opposite sex of the same species for mating.

pheromone trap: an IPM tool that uses an insect pheromone to lure males of the species (such as omnivorous leafroller) into the trap, enabling one to monitor the development of that species.

photosynthesis: the process by which plants take energy from light to combine carbon dioxide and water molecules to make simple sugars and then starches.

plowpan: a compacted layer of soil at plowing depth created by plowing repeatedly at the same depth or when the soil is too wet or dry.

powdery mildew disease index: a number that is calculated by the powdery mildew model that indicates the severity of the weather conditions for reproduction and spread of powdery mildew. The index ranges from 0 to 100 and when it is greater than 60, it is considered severe.

pressure bomb: a very sensitive tool that evaluates the water status of a plant. A pressure chamber is used to test the tension holding water in the leaf. A higher level of pressure needed to equalize the leaf's pull on the water indicates a higher level of water stress.

raptors: carnivorous birds that attack and kill other animals.

reduced-risk: a reduced-risk pesticide is one that may be reasonably expected to accomplish one or more of the following: (1) reduce risk to human health; (2) reduce risk to non-target organisms;

(3) reduce the potential for contamination of valued environmental resources; and/or (4) broaden adoption or effectiveness of Integrated Pest Management.

resident vegetation: plants that grow naturally in the vineyard without planting them.

restricted-use: a highly hazardous pesticide that can only be possessed or used by certified commercial or private pesticide applicators.

riparian area: those portions of the watershed that border the bank of a river, stream, or creek. Typically, channel banks and floodplain areas are also included in the riparian zone.

ripping: using a specially designed implement (ripper) pulled by a tractor to shatter the impermeable layers of the soil, such as hardpans and claypans. No soil mixing occurs.

salts: charged ions such as chloride, ammonium, calcium, sodium, magnesium, aluminum, iron, and manganese.

saturated soil: soil which contains water in excess of field capacity (the maximum that it can hold without leaching occurring). At this state the soil is extremely vulnerable to degradation such as compaction from vehicle traffic.

shoot positioning: vine training that results in the shoots being in the correct position and spacing to fully utilize the trellis system and optimize winegrape production and quality.

six-inch air gap: the distance maintained between the fill pipe and the water level in the spray tank.

slip plowing: using an implement (slip plow) pulled by a tractor to shatter the impermeable layers of the soil, such as hardpans and claypans, and, at the same time, mix the soil so that the impermeable layers do not reform.

soil carbon sequestration: Soil carbon sequestration is the long-term storage of stable forms of carbon in the soil. Carbon farming is a term used to describe practices that promote long-term carbon sequestration by capturing carbon in the soil and plant material.

sour rot: a type of bunch rot that is caused by a complex of bacteria and fungi.

sterile shoot-thinning: removing shoots that do not have any fruit clusters.

suspended solids: materials that are suspended in water in their unaltered form, in other words, not dissolved.

tartaric acid: The principal acid in grape berries. Tartaric acid is an extremely important component of wine, because it is both the most prevalent and most stable acid. Achieving optimum levels of tartaric acid is difficult in warm growing regions.

tensiometer: a device for measuring the tension (soil water potential) that water is held in the soil. It consists of a cup made of porous material connected by a tube to a vacuum gauge.

titratable acidity: the sum of the total acidity of the grape juice. Titration is a method of measuring the acidity of a liquid. It is commonly expressed in grams of tartaric acid.

veraison: the stage of grape development when fruit ripening starts that usually coincides with soluble solids and is characterized by berry softening and the beginning of pigmentation in red varieties (usually at 7 to 10 ºBrix).

vernal pool: a seasonally flooded depression found on ancient soils with an impermeable layer such as a hardpan, claypan, or volcanic basalt. This impermeable layer allows the pool to retain water much longer than surrounding area. The ecosystem associated with vernal pools consists of specialized plants and animals.

vine capacity: the number of shoots and leaves, balanced with the appropriate amount of fruit, that a single vine is capable of producing given the soil and climate of the site. Ideally, the capacity determines the vine spacing and trellis design.

water sensitive paper: thickened paper that is sensitive to water and is used to assess the spray pattern of a sprayer. The location where the droplet of water hits the paper turns blue.

REFERENCES

Alcoze, T. (1996). *Restoring Synergistic Human-Wildlife Systems: Managing Ecosystem Complexity for the 21st Century.* In W. Covington and P.K. Wagner (Tech. Coords.) Adaptive Ecosystem Restoration and Management: Restoration of Cordilleran Conifer Landscapes of North America. General Technical Report RM-GTR-278. Rocky Mountain Forest and Range Experiment Station, USDA.

Allen-Diaz, B. (2000). Biodiversity is Critical to Future Health of California's Ecology and Economy. *California Agriculture* 54(2): 26-34.

Altieri, M. A., & Schmidt, L.L. (1985). Cover Crop Manipulation in Northern California Apple Orchards and Vineyards: Effects on Arthropod Communities. *Biological Agriculture and Horticulture 3*(1): 1-24.

Altieri, M. A., Letourneau, D. K., & Davis, J.R. (1983). Developing Sustainable Agroecosystems. *BioScience 33*(1): 45-49.

American Society for Training & Development (ASTD). 2011. State of the Industry Report.

Anderson, J.H., & Anderson, J.L. (1996). Establishing Permanent Grassland Habitat with California Native Perennial Grasses. *Ducks Unlimited Special Publication 14*: 1-12. Western Regional Office of Ducks Unlimited, Rancho Cordova, CA.

Basin: Resolution of the SCB approved by the membership, 8 June 1997. August 1997 Vol. 4(3):7.

Baumgartner, K., & Rizzo, D.M. (2000). Oak Root Fungus on Grapevines. *Practical Winery & Vineyard Mar/Apr:* 13-16.

Baumgartner, K., & Rizzo, D.M. (2001a). Distribution of Armillaria Species in California. *Mycologia 93*(5): 821-830.

Baumgartner, K., & Rizzo, D.M. (2001b). Ecology of Armillaria spp. in Mixed-Hardwood Forest of California. *Plant Disease Sep*: 947-951.

Baumgartner, K., & Rizzo, D.M. (2002). Spread of Armillaria Root Disease in a California Vineyard. *American Journal of Enology and Viticulture 53*(3): 197-203. University of California ANR Publication #78394. http://ajevonline.org/content/53/3/197.short

Bay Area Green Business Program. (1998). *Wine Industry Environmental Compliance and Pollution Prevention/Resource Conservation Self-Assessment Checklists*.

Bettiga, L.J. (2013). *Grape Pest Management*. (3rd ed.). University of California ANR Publication 3343.

Boulton, R.B., Singleton, V.L., Bisson, L.F. & Kunkee, R.E. (1998). *Principles and Practices of Winemaking*. Aspen Publishers, Inc.

Boyce, M.S. & Haney, A. (Eds.). (1997). *Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources*. Yale University Press.

Broome, J.C., English, J.T., Marois, J.J., Latorre, B.A. & Aviles, J.C. (1995). Development of an Infection Model for Botrytis Bunch Rot of Grapes Based on Wetness Duration and Temperature. *Phytopathology 85*: 97-102.

Browde, J.A. (2003). California Winegrape Pest Management Alliance Project Final Report.

Burt, C.M., & Styles, S.W. (1999). *Drip and Micro Irrigation for Trees, Vines, and Row Crops*. Irrigation Training and Research Center (IRTC) Cal Poly.

Business for Social Responsibility Education Fund. (1998). *Winery Eco-Efficiency Assessment Guide*. Business for Social Responsibility Education Fund.

Butzke, C.E. & Bisson, L.F. (1997). *Ethyl Carbamate Preventative Action Manual*. University of California, Davis. https://www.fda.gov/media/75139/download

California Association of Winegrape Growers. (2001a). *Best Management Practices for Sulfur in Winegrapes*.

California Association of Winegrape Growers. (2001b). *Winegrape Guidebook for Establishing Good Neighbor and Community Relations*.

California Certified Organic Farmer (CCOF). (2020). CCOF International Standard Program Manual. https://www.ccof.org/sites/default/files/CCOF_International_Standard_Program_Manual_0.pdf

California Department of Industrial Relations, Division of Occupational Safety and Health. (2000). *Agricultural Safety and Health Inspection Project* (ASHIP). http://www.ncfh.org/?plugin=ecomm&content=item&sku=6564

California Grape Advisory Team. (2002). *Crop/Pest Profile for Wine Grapes in California*. FQPA Grape Partnership.

California Winegrape Work Group. (2009). *A Pest Management Strategic Plan for Winegrape Production in California*. Western Integrated Pest Management Center and the California Association of Winegrape Growers.

Central Coast Vineyard Team. (1996). *Positive Points System*. Report published by the Central Coast Vineyard Team.

Central Coast Vineyard Team. (1998). Central Coast Vineyard Team Positive Points System. *Practical Winery and Vineyard 29*(1).

Christensen, L.P. (2000). *Raisin Production Manual*. University of California ANR Publication 3393.

Christensen, P.L, Kasimatis, A.N., & Jensen, F.L. (1978). *Grapevine and nutrition fertilization in the San Joaquin Valley*. University of California ANR Publication 4087.

Clark, J. & Rollins, G. (1996). *Farming for Wildlife: Voluntary Practices for Attracting Wildlife to Your Farm*. California Department of Fish and Game.

Coalition for Urban/Rural Environmental Stewardship (CURES). *Sulfur Best Application Practices: Managing Sulfur Applications Near Sensitive Areas*. Produced with support from the California Sulfur Task Force. https://www.curesworks.org/pdfs/pubs/sulfur.pdf

Committee on Pest and Pathogen Control through Management of Biological Control Agents and Enhanced Cycles and Natural Processes, Board on Agriculture and National Research Council. (1996). *Ecologically Based Pest Management: New Solutions for a New Century*. National Academy Press.

Covington, W. & DeBano, L.F. (Tech. Coords.). (1994). *Sustainable Ecological Systems: Implementing an Ecological Approach to Land Management*. General Technical Report RM-247. Rocky Mountain Forest and Range Experiment Station, USDA.

Dahlgren, R.A., Tate, K.W., Lewis, D.J., Atwill, E.R., Harper, J.M., & Allen-Diaz, B.H. (2001). Watershed Research Examines Rangeland Management Effects on Water Quality. *California Agriculture 55*(6): 64-71.

DiTomaso, J.M. & Healy, E.A. (2007). *Weeds of California and Other Western States*. University of California ANR Publication 3488.

Dlott, J.W. (2000). California Winegrape Pest Management Alliance Evaluation. California Association of Winegrape Growers. http://www.cawg.org

Dlott, J.W. & Curtis, J. (2000). *Eccountability and Eco-Labels: What Eco-Benefits Did I Buy Today*. Real Toolbox White Paper presented at the Read the Label: Understanding the Challenges & Opportunities for Eco-labels and Eco-brands Conference, October 19, 2000, Portland, OR.

Dlott, J.W & Lynch, S. (2000). *Agricultural Issues and the Restoration of South Florida Everglades and Keys*. World Wildlife Fund Report.

Dlott, J.W., with Nelson, T., Bugg, R., Eck, R., Redmond, J., Klien, J., Spezia, M., & Lewis, L. (1995). A Case Study on the Biologically Integrated Orchard Systems (BIOS) Program in California. *New Partnerships for Sustainable Agriculture.* Community Alliance with Family Farmers Foundation and World Resources Institute.

Dlott, J.W., Altieri, M.A., & Masumoto, M. (1994). Exploring the Theory and Practice of Participatory Research in US Sustainable Agriculture: A Case Study in Insect Pest Management. *Agriculture and Human Values 11* (2&3): 126-139.

Dry, P. & Coombe, B. (Eds.). (2004). Revised Version of "Grapevine growth stages – The modified E-L system. *Viticulture: Volume 1* - Resources. (2nd ed.). Winetitles Media. https://www.awri.com.au/wp-content/uploads/grapegrowth.pdf

Dry, P., Loveys, B., Botting, D., & During, H. (1995). *Effects of Partial Root-Zone Drying on Grapevine Vigor, Yield, Composition of Fruit, and Use of Water.* Proc. 9th Australia Wine Industry Technology Conference 1995: 128-131.

Earnshaw, S. (2004). *Hedgerows for California Agriculture*. Community Alliance with Family Farmers.

Elmore, C., Agamalian,H.S., Donaldson, D., & Fisher, B.B. (1996). *UC IPM Pest Management Guidelines: Grape*. University of California ANR UC IPM Guideline Series #18.

Eviner, V.T., & Chapin, F.S. III. (2001). Plant Species Provide Vital Ecosystem Functions for Sustainable Agriculture, Rangeland Management, and Restoration. *California Agriculture* 55(6): 54-59.

Farm Employers Labor Service (FELS). Farm Employers Labor Service Personnel & Labor Audit Checklist. (2018). https://www.fels.net/1/images/Audit-Checklist-May-2018-with-FELS-letterhead2.pdf

Fischer, B.B. (Ed.). (1998). *Grower's Weed Identification Handbook*. University of California ANR Publication 4030.

Flaherty, D.L., Christensen, L.P., Lanini, W.T., Marois, J.J., Phillips, P.A., & Wilson, L.T.(Eds.). (1992). *Grape Pest Management*. (2nd ed.). University of California ANR Publication 3343.

Flint, M.L. & Van den Bosch, R. (1981). *Introduction to Integrated Pest Management*. Plenum Press.

Ford Foundation. (2021). *Diversity, Equity, and Inclusion.* https://www.fordfoundation.org/about/people/diversity-equity-and-inclusion/

Gadoury, D.M., Stensvand, A., Seem, R.C., & Heidenreich, C. (2007). Ontogenic resistance of leaves, leaf folding and the distribution of mildew colonies in strawberry powdery mildew (Podosphaera macularis). *Phytopathology 97*: S38.

Godfrey, K.E., Daane, K.M., Bentley, W.J., Gill, R.J., & Malakar-Kuenen, R. (2002). *Mealybugs in California Vineyards*. University of California ANR Publication 21612.

Golino, D. A. & Wolpert, J. (2003). Vine Selection and Clones. *Wine Grape Varieties in California: 8-11*. University of California Agricultural and Natural Resources Publication 3419.

Grant, S. (2000). Promoting Fruit Quality and Vine Health. *Practical Winery & Vineyard 51*(1): 46-52, 75.

Grumbine, R.E. (1994). What is Ecosystem Management? *Conservation Biology 8*: 27-38.

Grumbine, R.E. (1997). Reflections on 'What is ecosystem management?' *Conservation Biology 11*: 41-47.

Gu, S., Graves, S., Zoldoski, D., & Jorgensen, G. (2000). Partial Rootzone Drying: Doing more with Less. *Grape Grower 22*(7): 30-32.

Gubler, D., Stapleton, J., Leavitt, G., Purcell, A., Varela, L., Smith, R.J., Bentley, W.J., Zalon, F., Granett, J., Westerdahl, B., Elmore, C., & Donaldson, D. (2002). *UC IPM Pest Management Guidelines: Grapes.* University of California ANR Publication 3343.

Hall, L.S., Krausman, P.R., & Morrison, M.L. (1997). The Habitat Concept and a Plea for Standard Terminology. *Wildlife Society Bulletin 25*(1): 173-182.

Hampson, B.C. (2000). Use of Ozone for Winery and Environmental Sanitation. *Practical Winery & Vineyard Jan/Feb*: 27-30.

Haviland D.R., Bettiga, L.J., Varela, L.G., Baldwin, R.A., Roncoroni, J.A., Smith, R.J., Westerdahl, B.B., Bentley, W.J., Daane, K.M., Ferris, H., Gubler, W.D., Hembree, K.J., Ingels, C.A., Zalom, F.G., & Zasada, I. Revised continuously. *UC IPM Pest Management Guidelines Grape.* UC ANR Publication 3448. http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html

Haviland, D.R., Bentley, W.J., & Danne, K.M. (2005). Hot Water Treatments to Control Planococcus ficus (Hemiptera: Pseudococcidae) in Grape Nursery Stock. *Journal of Economic Entomology 98*:1109-15.

Hardie, W.I., & Considine, I.A. (1976). Response of Grapes to Water-Deficit Stress in Particular Stages of Development. *American Journal of Enology and Viticulture 27*: 55-61.

Hawken, P. (1993). *The Ecology of Commerce: A Declaration of Sustainability*. Harper Collins.

Heard, L.P., Allen, A.W., Best, L.B., Brady, S.J., Burger, W., Esser, A.J., Hackett, E., Johnson, D.H., Pedersen, R.L., Reynolds, R.E., Rewa, C., Ryan, M.R., Molleur, R.T., & Buck, P. (2000). *A Comprehensive Review of Farm Bill Contributions to Wildlife Conservation, 1985-2000*.

Hofstrand, D. (2009). Creating a Mission Statement, Setting Goals and Developing Strategies.

Hohman, W.L., & Halloum, D.J. (Eds.). *Wildlife Habitat Management Institute Technical Report*. USDA Natural Resources Conservation Service USDA/NRCS/WHMI-2000.

Imhoff, D., & Carra, R. (2003). *Farming with the Wild: Enhancing Biodiversity on Farms and Ranches*. Sierra Club Books.

Ingels, C.A., Bugg, R.L., McGourty, G.T., & Christensen, L.P. (1998). *Cover Cropping in Vineyards: A Growers Handbook*. University of California ANR Publication 3338.

Kempen, H.M. (1993). *Growers Weed Management Guide.* (2nd ed.). Thomson Publications.

Kessler, W.B., & Eastland, W.G. (1995). Strategies to Sustain Human and Wildlife Communities. In J.A. Bissonette & P.R. Krausman (Eds.) *Integrating People and wildlife for a Sustainable Future*. The Wildlife Society.

Keystone Center. (1996). *The Keystone National Policy Dialogue on Ecosystem Management: Final Report*. Keystone Center.

Kirwan Institute for the Study of Race and Ethnicity. (2020). *Understanding Implicit Bias.* The Ohio State University. http://kirwaninstitute.osu.edu/research/understanding-implicit-bias/

Knight, R.L., & Meffe, G.K. (1997). Ecosystem Management: Agency Liberation from Command and Control*. Wildlife Society Bulletin 25*(3): 676-678.

Kress, S. (2006). *The Audubon Society Guide to Attracting Birds*. (2nd ed.). Cornell University Press.

Locke, J.P. (2002). *Vineyards in the Watershed: Sustainable Winegrowing in Napa County*. Napa Sustainable Winegrowing Group.

Long, R. (2001). *Quantifying Pest and Beneficial Insects in Insectary Hedgerows*. University of California Cooperative Extension Final Report.

Marcus, L., et al. (1999). *Fish Friendly Farming*. Sotoyome Resource Conservation District, Santa Rosa, CA.

Margalit, Y. (1996). *Winery Technology and Operations: A Handbook for Small Wineries, Revised Edition*. The Wine Appreciation Guild.

Maser, C. (1996). *Resolving Environmental Conflict: Towards Sustainable Community Development*. St. Lucie Press.

Mayer, K.E., & Laudenslayer, W.F., Jr. (Eds.). (1988). *A Guide to Wildlife Habitats of California*. California Department of Forestry.

McKinsey & Company. (2018). *Delivering through Diversity.* https://www.mckinsey.com/business-functions/organization/our-insights/delivering-through-diversity#

Merenlender, A.M. (2000). Mapping Vineyard Expansion Provides Information on Agriculture and the Environment. *California Agriculture 54*(3): 7-12.

Merenlender, A.M. & Crawford, J. (1998). *Vineyards in an Oak Landscape: Exploring the Physical, Biological, and Social Benefits of Maintaining and Restoring Native Vegetation in and Around the Vineyard*. University of California ANR Publication 21577.

Murphy, B., Rosenheim, J.A., & Granett, J. (1996). Habitat Diversification for Improving Biological Control: Abundance of Anagrus epos in Grape Vineyards. *Environmental Entomology 25*: 495-504.

Napa County Conservation Information Group. *Stream and Hillside Natural Resources Protection Guide: Understanding and Complying with Environmental Regulations in Napa County*. Prepared by the Napa County Conservation Information Group in cooperation with USDA Natural Resources Conservation Service.

National Coalition on Integrated Pest Management (NCIPM). (1994). *Toward a Goal of 75 Percent Cropland Under IPM by 2000*. Lewis Publishers.

Nature Conservancy, The. (2001). *Conservation by Design: A Framework for Mission Success*. The Nature Conservancy.

Noss, R.F., & Cooperrider, A.Y. (1994). *Saving Nature's Legacy: Protecting and Restoring Biodiversity*. Island Press.

O'Connor-Marer, P.J. (2000). *The Safe and Effective Use of Pesticides*. (2nd ed.). University of California ANR Publication 3324.

O'Connor-Marer, P.J. (2006). *Pesticide Safety: A Reference Manual for Private Applicators.* (2nd ed.). University of California ANR publication 3383.

O'Connor-Marer, P.J. (2007). *Pesticide Safety: A Reference Manual for Private Applicators.* (2nd ed.). (Spanish version). University of California ANR publication 3383.

Ohmart, C.P., & Matthiasson, S.K. (2000). *Lodi Winegrower's Workbook: A Self-Assessment of Integrated Farming Practices*. Lodi-Woodbridge Winegrape Commission.

Ohmart, C.P., Storm, C.P., & Matthiasson, S.K. (2008). *Lodi Winegrower's Workbook.* (2nd ed.) Lodi Winegrape Commission.

Paine, R.T. (1969). A Note on Trophic Complexity and Community Stability. *American Naturalist 103*: 91-93.

Peacock, B., Danne, K., Beede, B., Haines, D., & Kretsch, J. (2000). *Vine Mealybug: A Serious New Pest in the San Joaquin Valley*. University of California ANR Publication IPM6-00.

Pierce's Disease/Riparian Habitat Workgroup. (2000). *Riparian Vegetation Management for Pierce's Disease in North Coast California Vineyards*. https://nature.berkeley.edu/almeidalab/wp-content/uploads/2016/07/PD_Riparian_Vegetation_Manual.pdf

Pimentel, D., Westra, L., & Noss, R.F. (Eds.). (2000). *Ecological Integrity: Integrating Environment, Conservation, and Health*. Island Press.

Poiani, K.A., Richter, B.D., Anderson, M.G., & Richter, H.E. (2000). Biodiversity Conservation and Multiple Scales: Functional Sites, Landscapes, and Networks. *BioScience 50*:133-146.

Prichard, T. (2010). *Winegrape Irrigation Scheduling Using Deficit Irrigation Techniques.* University of California, University of California Cooperative Extension. Department of Land, Air and Water Resources.

Prichard, T., Hanson, B., Schwankl, L., Verdegaal, P., & Smith, R. (2004). *Deficit Irrigation for Quality Winegrapes Using Micro-Irrigation Techniques.* University of California, University of California Cooperative Extension. Department of Land, Air and Water Resources, Davis, California. http://cesanluisobispo.ucanr.edu/files/89518.pdf

Prichard, T., Verdegaal, P.S., & Rous, C. (1995). Modification of Wine Characteristics Through Irrigation Management. *Grape Grower May*: pp. 8-13.

Reeves, K.A., & Smith, J.R. (2004). *Survey of Falcons, Kites, Hawks, and Owls in the Lower Mokelumne River Watershed, Sacramento and San Joaquin Counties, California*. Joint Settlement Agreement Report. East Bay Municipal Utility District, Lodi, CA.

Robbins, S.P. (2001). *Organizational Behavior*. Prentice Hall, Inc.

Robinson, A.Y. (1990). *Sustainable Agriculture: A Brighter Outlook for Fish and Wildlife*. Izaak Walton League of America.

San Joaquin Valley Unified Air Pollution Control District. (2004). *Agricultural Air Quality, Conservation Management Practices for San Joaquin Valley Farms*. http://www.valleyair.org/farmpermits/updates/cmp_handbook.pdf

Savory, A., & Butterfield, J. (1999). *Holistic Management: A New Framework for Decision Making*. (2nd ed.). Island Press.

Sawyer, J.O., & Keeler-Wolf, T. (1995). *A Manual of California Vegetation*. California Native Plant Society.

Schwankl, L., & Prichard, T. (2001). *Chemigation in Tree and Vine Microirrigation Systems*. University of California ANR Publication 21599.

Singh, A. A. (2019). *The Racial Healing Handbook.* New Harbinger Publications.

Skinkis, P.A., Dreves, A.J., Walton, V.M., & Martin, R.R. (2009). *Field Monitoring for Grapevine Leafroll Virus and Mealybug in Pacific Northwest Vineyards.* Oregon State University Extension Service EM 8985. Oregon, USA.

Smart, R., & Robinson, M. (1991). *Sunlight into Wine: A Handbook for Winegrape Canopy Management*. Winetitles Media.

Smith, R. J. (Ed.). (2001). *Vineyard Site Assessment Guide*. University of California Cooperative Extension.

Society for Conservation Biology. (1997). *An Ecosystem Management Strategy for Federal Lands in the Interior Columbia.* Society for Conservation Biology Newsletter.

Stapleton, J.J., & Grant, R.S. (1992). Leaf Removal for Nonchemical Control of the Summer Bunch Rot Complex of Wine Grapes in the San Joaquin Valley. *Plant Disease 76*(2): 205-208.

State of California Employment Development Department, Labor Market Information Division. (2010). *California's Green Economy: Summary of Survey Results*. https://www.labormarketinfo.edd.ca.gov/contentpub/GreenDigest/CA-Green-Economy-SummarySurveyResults.pdf

Stern, V.M., Van den Bosch, R., & Hagen, K.S. (1959). The Integrated Control Concept. *Hilgardia 29*: 81-101.

Storm, D.R. (2001). *Winery Utilities: Planning, Design and Operation*. Aspen Publishers, Inc.

Swolgaard, C.A. (2004). *Nesting Density and Habitat Use of Swainson's Hawk in a Vineyard Landscape in Northern San Joaquin County, California*. M.S. Thesis, California State University.

Thach, L. (2002). Social Sustainability in the Wine Community: Managing for Employee Productivity and Satisfaction. *Wine Business Monthly July.* Wine Communications Group.

Thach, L. (2002). Supervisory and Management Training the Wine Industry. *Wine Business Monthly November*. Wine Communications Group.

Thrupp, L.A. (1998). *Cultivating Diversity: Agrobiodiversity and Food Security*. World Resources Institute.

Thrupp, L.A. (2002). *Fruits of Progress: Growing Sustainable Farming and Food Systems*. World Resources Institute.

Thrupp, L.A., Costello, M.J., & McGourty, G. (2008). *Biodiversity Conservation Practices in California Vineyards: Learning from Experiences.* California Sustainable Winegrowing Alliance. http://www.sustainablewinegrowing.org/docs/2008-Biodiversity_in_Vineyards.pdf

Tsai, C.W., Rowhani, A., Golino, D.A., Daane, K.M., & Almeida, R.P. (2010). Mealybug Transmission of Grapevine Leafroll Viruses: An Analysis of Virus–vector Specificity. *Phytopathology 100*(8): 830–834.

University of California, Division of Agriculture and Natural Resources. (2002). Agricultural Easements: New Tool for Farmland. *California Agriculture 56*(1). http://calag.ucanr.edu/Archive/?article=ca.v056n01p2

University of California, Division of Agriculture and Natural Resources. *UC IPM Pest Management Guidelines*. http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html

University of California, University of California Cooperative Extension, Sonoma. (2009). Interactive Irrigation Scheduling Worksheet using Current and Historical Evapotranspiration. http://cesonoma.ucdavis.edu/viticulture717/Vineyard_Irrigation/Interactive_Irrigation_Scheduling_Worksheet_using_Current_and_Hi/

United States Environmental Protection Agency (US EPA). (1995). An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms. http://www.greenbiz.com/sites/default/files/document/O16F13759.pdf

United States Environmental Protection Agency (US EPA). *Sustainable Marketplace: Greener Products and Services*. http://www.epa.gov/greenerproducts

United States Environmental Protection Agency (US EPA). (2010). *2010-2014 Pollution Prevention (P2) Program Strategic Plan.* US EPA. https://www.epa.gov/p2

United States Fish and Wildlife Service (USFWS). *Our Endangered Species Program and How It Works with Landowners.* USFWS. https://www.fws.gov/endangered/

Varela, L.G., Bentley, W.J., Clark, J.K., & Strand, L.L. (2011). *Vineyard Pest Identification and Monitoring Cards*. University of California ANR publication 3532.

Varela, L.G., Smith, R.J., & Phillips, P.A. (2001). *Pierce's Disease*. University of California ANR Publication 21600.

Weaver, W.E., Weppner, E. & Hagans, D.K. (2014). *Handbook for Forest and Ranch Roads*. Pacific Watershed Associates. https://mcrcd.org/wp-content/uploads/2017/01/Handbook-for-Forest-Ranch-and-Rural-Roads-Web.pdf

Whiston, T. D. et al. (2000). *Weeds of the West*. University of Wyoming Cooperative Extension. Available as University of California ANR Publication 3350.

Whithaus, S. & Blecker, L. (2016). *The Safe and Effective Use of Pesticide (Pesticide Application Compendium)*. Third Edition. University of California ANR Publication 3324.

Williams, Larry E. (2001). Irrigation of Winegrapes in California. *Practical Winery & Vineyard Nov/Dec:* 42-55.

Winkler, A.J., Cook, J.A., Kliewer, W.M., & Lider, L.A. (1974). *General Viticulture*. University of California Press.

Winter, M. (2001). Power Woes for California Wineries: But Advice and Financial Aid Plentiful. *Wine Business Monthly July*. Wine Communications Group.

Wondolleck, J.M., & Yaffee, S.L. (2000). *Making Collaboration Work: Lessons from Innovation in Natural Resource Management*. Island Press.

Wine Institute, and the American Vineyard Foundation. (2008). *Comprehensive Guide to Sustainable Management of Winery Water and Associated Energy*. https://library.sustainablewinegrowing.org/item/167/sustainable-management-of-winery-water-and-associated-energy

Yolo County Resource Conservation District. (2001). *Bring Farm Edges Back to Life: Landowner Conservation Handbook*. Yolo County Resource Conservation District.

California Code of Sustainable Winegrowing Workbook – 4th Edition

Comments, Corrections, and/or Suggestions

Please email comments, corrections, and/or suggestions to: info@sustainablewinegrowing.org

Or you can complete and return this form to:
California Sustainable Winegrowing Alliance
425 Market Street, Suite 1000
San Francisco, CA 94105