Drought & Water Management Manual

Sonoma & Mendocino County Agriculture Practices



Information compiled from the following Sustainability and Climate Friendly Farming Programs:
Fish Friendly Farming, California Code of Sustainable Winegrowing, Sustainability in Practice, University of California Agriculture & Natural Resources Range Management

FOREWORD.

The January and February rainfall in 2021 in coastal counties pointed to a potential drought that has now been declared by the Department of Water Resources. Unlike the interior valley of California, the coastal counties rely on rainfall rather than snowpack at high elevation, a reservoir network, and redirected streams for their water availability. This requires more specific and quantitative actions related to water management in vineyards than is used in other parts of the State.

The annual water budget of a productive field is largely made up of the difference between the annual rainfall and the annual evapotranspiration from the crop leaves and the annual evaporation from the soil on the site. Water deficits are usually made up by groundwater removed from aquifers below the surface and by external water (rainfall or re-used) applications to the soil surface. The annual water budget of the soil is made up of gains permeating from the surface by rainfall and applications and depletions from the root zone by the crops. The annual water balance of an aquifer used for irrigation will depend on the annual withdrawal for irrigation, the downward permeation from the soil above it, direct recharge into it, and lateral flows entering and leaving the aquifer zone.

In order to manage the water balance and avoid substantial loss of productive agriculture in Sonoma County, information about the crops type and phenological status are needed, as well as the daily weather conditions, soil status, and sources of water that are available for application when needed.

In practice, water applications for irrigation can be based on visual observations, manual measurements of plant water status, threshold values of soil moisture content, some time-based method based on calendar dates, or computation of daily loss of water from weather and crop type.

While evident within the first two months each year, the onset of drought requires a greater efficiency of water management if dramatic economic outcomes due to crop loss and damage are to be avoided.

For the long term, Informed and efficient water application will require investments in actions and practices if the water balance is to be managed on individual farm sites and across groundwater basins at the regional scale. While such efforts have not been essential for past success or required by regulation, the influence of climate change on rainfall variability now requires documented actions that demonstrate the efficient use of water.

Foreword provided by: Jackson Family Wines Environmental Compliance Department

SECTION 1: BUSINESS STRATEGY

CHAPTER 1. BUSINESS STRATEGY	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY ACHIEVED
1.1 Integrating Drought	Vineyards and/or winery operations have	Vineyards and/or winery operations have	
Program into Business and	formally integrated a drought strategy into	formally integrated a drought strategy into	Category 1
Sustainability Strategies	the business strategy (e.g., company	the business strategy (e.g., company	
	sustainability documents) AND These were	sustainability documents) AND the strategy	Category 2
	shared with employees and external	was implemented in drought years.	
	shareholder AND the strategy was		
	implemented in drought years, as necessary.		

(i)

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/.

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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.

SECTION 2. VINEYARDS

CHAPTER 2. VITICULTURE	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY ACHIEVED
2.1 Vineyard Replacement for Drought Prone Regions	As vineyards are replanted vines that are drought resistant <i>AND</i> vineyard design (spacing trellising, and training) and pruning, crop load adjustments, irrigation and cover cropping were implemented to accommodate drought conditions <i>AND</i> Vine phenology was recorded.	As vineyards are replanted vines that are drought resistant AND vineyard design (spacing trellising, and training) irrigation and cover cropping were implemented to accommodate a reduction in water use.	Category 1
2.2 Shoot Density Management	Shoots were thinned to the appropriate level for achieving appropriate number of shoots per foot to accommodate a reduction in water use <i>AND</i> if nonfruiting shoots, shoots with late-ripening clusters, and shoots sprouting from the head of the vine existed, they were removed.	Shoots were thinned to the appropriate level for achieving appropriate number of shoots per foot to accommodate a reduction in water use.	Category 1
2.3 Leaf Removal	Leaves around the clusters were removed shortly after bloom to expose the clusters to the appropriate amount of indirect light to accommodate a reduction in water use.	Leaf removal was sometimes done, or very lightly done, to accommodate a reduction in water use.	Category 2
2.4 Crop Pruning	Crop-to-pruning weight ratio was monitored and recorded, and adjustments were made to maintain the ratio in the regionally appropriate range to accommodate a reduction in water use. (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 and to accommodate a reduction in water use.	Category 1
2.5 Monitoring Canopy and Vigor	The canopy density and shoot-tip vigor were monitored by an objective method, including visual assessment and point quadrat and recorded at various times throughout the growing season with corrective actions taken to accommodate a reduction in water use.	The canopy density and shoot-tip vigor were monitored by an objective visual assessment at various times throughout the growing season with corrective action taken to accommodate a reduction in water use.	Category 1

2.6 Climate Change Due Diligence 2.7 Soil Profile and	Due diligence considering regional climate change models was carried out before block replanting or purchasing the land (or after deciding to convert to a vineyard) and farmable acreage <i>AND</i> Appropriate public and private entities were contacted. Prior to a new plant, backhoe pits were dug in	Due diligence considering regional climate change models 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 vineyards. Prior to a new plant, backhoe pits were dug in	Category 1
Modification	enough locations to cover the variability of the site and identify the water holding capacity of the soils <i>AND</i> the soil profile was inspected for plowpan, hardpan, claypan, or other restricting layer <i>AND</i> If appropriate, plowpan or hardpan was ripped, claypan was slip plowed, or subsurface drainage was installed.	enough locations to cover the variability of the site and identify the water holding capacity of the soils AND the soil profile was inspected for plowpan, hardpan, claypan, or other restricting layers.	Category 2
2.8 Soil Amendments Pre- planting	In making the decision to plant a new vineyard, soil was tested for pH, organic matter, cation exchange capacity (CEC), SAR, base saturation, and water holding capacity, and for deficiencies or toxicities (i.e., boron, sodium, chlorides, zinc, and phosphorus) <i>AND</i> 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.	In making the decision to plant a new vineyard, soil structure was determined (e.g., rock content and percent sand, silt, and clay) AND Soil was tested for pH, organic matter, CEC, SAR, base saturation, and water-holding capacity, and for deficiencies or toxicities (i.e., boron, sodium, chlorides, zinc, and phosphorus).	Category 1
2.9 Rootstock Selection	Rootstocks were chosen to resist drought and pests presents in the vineyards or region <i>AND</i> Rootstocks were chosen to deal with chemical and physical soil variability, rainfall patterns, and separate irrigation blocks <i>AND</i> rootstocks were chosen to provide adequate vigor when matched with the soil and scion <i>AND</i> Advice was sought from a UC Farm Advisor and/or consultant.	Rootstocks were chosen to resist drought and pests present in the vineyard or region <i>AND</i> Rootstocks were chosen to provide adequate vigor when matched with the soil and scion.	Category 1

2.10 Vineyard Layout	Vineyard layout was designed according to patterns of soil types and operational efficiencies <i>AND</i> 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) <i>AND</i> Vineyard rows were oriented to minimize water flow down the rows, thus minimizing erosion potential <i>AND</i> Buffer zones were created around riparian	Patterns of soil types and operational efficiencies were considered when vineyard layout was designed <i>AND</i> Vineyard rows were oriented with consideration made to prevailing wind (if severe), sunlight angle (for thermal-balance and heat avoidance), sideslope minimization (for safety and erosion prevention).	Category 1
2.11 Scion and Cultivar	habitat, native vegetation, or sensitive areas. The scion is appropriate for climate conditions, soil, and rootstock AND The scion was chosen after consultation with the winery and/or UC Farm Advisor and/or nursery and has claims of being certified virus free AND The scion was chosen with the best available information (e.g., consultation with the winery, UC Farm Extension and/or Nursery).	The scion is appropriate for climate, conditions, soil, and rootstock and both visual consideration and growth characteristics have been considered AND The scion is either certified virus free or has been tested for viruses.	Category 1
2.12 Conservation of Habitat for Pest Predators and Soil Health	During initial vineyard establishment and/or development, habitat was assessed and enhanced for water holding capacity, <i>AND</i> Hedgerows, shrubs, drought resistant grasses with native and, if appropriate, nonnative flowering plants were maintained throughout the property <i>AND</i> 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 fish life cycles.	During initial vineyard establishment and/or development, habitat was assessed and enhanced for water holding capacity, <i>AND</i> Hedgerows, shrubs, drought resistant grasses with native and, if appropriate, nonnative flowering plants were maintained throughout the property	Category 1

CHAPTER 3. SOIL MANAGEMENT	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY ACHIEVED
3.1 Soil Moisture Analysis	Soil moisture assessments were conducted using soil moisture probes AND Soil variations were considered when selecting sites for moisture probes AND Data from the probes is used to manage vineyard water schedules AND	Soil moisture assessment was conducted prior to onset of irrigation season <i>AND</i> Assessment informed vineyard water schedules <i>AND</i> Records of water use were kept.	Category 1
3.2 Nutrient Management	Records of water use were kept. Vine vigor, fruit quality, leaf symptoms, vineyard history and wine quality informed soil moisture content <i>AND</i> water quality test results were factored into decisions made for nutrient applications <i>And</i> When Appropriate minerals and amendments such as gypsum and manure are added to enhance moisture capacity and porosity.	Vine vigor, fruit quality, leaf symptoms, vineyard history and wine quality informed soil moisture content.	Category 1
3.3 Nitrogen Management	A 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 applying before rainfall 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.	Soil or plant tissue analysis was done within the last 6 years <i>And</i> Nitrogen was applied only if justified by plant tissue analysis, inadequate vine vigor and/or balanced with nutrients removed by the crop <i>And</i> Nitrogen was only applied when vines can best utilize it.	Category 1
3.4 Amendments for Water Penetration	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	If water penetration was poor (water puddles and runs off when subsurface soil was dry), appropriate amendments were added, or a cover crop was grown for at least one year	Category 1

	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 <i>AND</i> Water pH was tested and adjusted if necessary.	AND Water pH was tested and adjusted if necessary.	Category 2
3.5 Increasing Soil Organic Matter	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 and soil porosity (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.	Soil analysis was done for organic matter*, and inputs and outputs were monitored AND Practices were implemented to increase nutrient cycling and soil porosity (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.	Category 1
3.6 Soil Compaction	Equipment was chosen or modified to minimize soil compaction (e.g., operated lightest equipment possible, used tracklayers, 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 never entered the vineyard during saturated soil conditions AND A permanent, non-tilled cover crop or resident vegetation was maintained.	Equipment was chosen or modified to minimize soil compaction* (e.g., operated lightest equipment possible, used tracklayers, 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 A permanent cover crop, annual cover crop, or resident vegetation crop existed (mowed or not) during the springtime spray season.	Category 1
3.7 Erosion and Water Management on Site	There was no evidence of rills or gullies AND Erosion was controlled to support water percolation and prevent water quality degradation by sediment delivery sites (e.g.,	There was no evidence of rills or gullies AND Erosion was controlled to support water percolation and prevent water quality degradation by sediment delivery sites (e.g.,	Category 1

	cover crops, buffer/filter strips, setbacks from stream areas where appropriate, etc.) <i>AND</i> An engineered drainage system was present if needed and maintained if the erosion potential for the vineyard was high <i>AND</i> Maintenance and repair materials were available for emergency repair.	cover crops, buffer/filter strips, setbacks from stream areas where appropriate, etc.)	
3.8 Sink, Spread and Infiltration Buffers	Buffers are established in non-crop and hard to farm areas to allow for sinking, spreading and infiltrating of water for benefits to erosion control and recharge of groundwater AND If needed amendments/organic matter was added to the buffers to enhance soil porosity. NRCS/AG and Open Space Program	Buffers are established in non-crop and hard to farm areas to allow for sinking, spreading and infiltrating of water for benefits to erosion control and recharge of groundwater.	Category 1 Category 2
CHAPTER 4 WATER MANAGEMENT	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY ACHIEVED
4.1 Water Management Strategy	A 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 <i>AND</i> Tools were in place to accomplish these goals (soil monitoring devices, weather stations, etc.) <i>AND</i> 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).	A documented water management plan was based on grapegrowing goals set before the growing season and accounted for soil types, slopes, irrigation water availability and quality, and energy efficiency <i>AND</i> Tools were in place to accomplish these goals (soil monitoring devices, weather stations, etc.) <i>AND</i> 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).	Category 1
4.2 Monitoring and Amending Quality of Irrigation Water	Irrigation water was tested annually and simultaneously for pH, salinity or total dissolved solids (electrical conductivity),	Irrigation water was tested at least once every three years or annually if the water quality changed frequently and simultaneously for	Category 1

	nitrate, bicarbonate, suspended solids, chlorides, boron, manganese, and magnesium (as appropriate for the site and region) <i>AND</i> If problems with quality of irrigation water existed, water was amended and/or managed (e.g., via sulfuric acid, gypsum, polymers, root-zone lacking.	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).	Category 2
4.3 Off-site Water Movement	Irrigation practices and/or property Location or design caused no rills or gullies due to	Irrigation practices and/or property location or design caused no rills or	
	concentrated flows from rainfall or applied water AND Preventive techniques (e.g., cover	gullies to form due to concentrated flows from rainfall or applied water AND Preventive	Category 1
	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.,	techniques (e.g., cover crops, vegetated, rocked, or solid surfaced ditches) were in place* to reduce rainfall runoff, minimizing off-site movement of water, silt, pesticides,	Category 2
	proper and adequate ditch relief culverts) were in place to minimize off-site movement of water, silt, pesticides, and/or fertilizers.	and/or fertilizers.	
4.4 Irrigation System	An engineered* microirrigation system (including drip irrigation or micro sprinklers)	A low flow engineered sprinkler irrigation system was installed in the vineyard.	Category 1
4.5 Distribution Uniformity	was installed in the vineyard.		Category 2
4.5 Distribution Uniformity	The distribution uniformity of the irrigation	The distribution uniformity of the irrigation	
Irrigation System	system was tested in years of predicted drought, and recorded by monitoring both	system was tested in years of predicted drought and recorded by monitoring both	Category 1
	emitter outflows and pressure differences	emitter outflows and pressure differences	Category 1
	across the block (or furrow distribution was	across the block (or furrow distribution was	Category 2
	checked visually if applicable). NRCS/RCD	checked visually if applicable). NRSC/RCD	
	Program Program	Program Program	
4.6 Filters and Lines	The irrigation system was equipped with a	Water filters in the irrigation system were	
	properly operating flushing system for	inspected and cleaned when pressure	
	filters and lines and were monitored to	differences were found,	Category 1
	maintain optimum operation multiple times	and irrigation lines were flushed multiple	
	per year AND An inspection of the irrigation	times per year to maintain proper irrigation	Category 2
	system was part of a regular maintenance	system efficiency, if needed.	
	program (i.e., conditions of screens and/or media checked at least twice per year).		
	media checked at least twice per year j.		

4.7 Water Budget	The amount of water used by the vineyard	The amount of water used by the vineyard	
	between each irrigation (cumulative crop ET	between each irrigation (cumulative crop ET	
	[ETc] or similar method) was known and only	[ETc] or similar	Category 1
	water that was used by the vineyard (or less if	method) was determined, and only water that	
	deficit irrigating) was replaced. Amounts used	is used by the vineyard (or less if deficit	Category 2
	were verified by assessing soil moisture status	irrigating) was replaced. Amounts used and	
	and vine response following applications AND	application volumes were verified by	
	Plant moisture status was used to modify the	assessing soil moisture status and vine	
	irrigation applications as necessary AND If soil	response following irrigation applications.	
	salinity was believed to be an issue, it was		
	confirmed annually (by analysis) and managed		
	appropriately.		



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.



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.

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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.

(i) 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. nupestris): 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.



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.

TABLE 4-b COMPOST A	TABLE 4-b COMPOST AND MANURE PROS AND CONS			
(characteristics may va-	ry 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	High nitrogen (slow release) and low carbon.			
compost				
Steer manure	High nitrogen (slow release) and low carbon. May contain high levels of			
compost	salts.			
Grape pomace	High potassium and nitrogen (slow release). Recycles winery waste			
compost	products.			
Chicken manure	High nitrogen (slow release) and very high phosphorus.			
compost				
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 Mat	tthiasson, 2000.			



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.



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-versison 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 versison. 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% ETc. 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.

SECTION 3: WINERY WATER CONSERVATION

CHAPTER 1 WATER MANAGEMENT	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY ACHIEVED
Practice 3.1 Winery Water Conservation Planning,	Total water use was monitored, recorded and tracked throughout the year And A Error!	Total water use was monitored and recorded throughout the year And A Error! Reference	Category 1
Monitoring, Goals, and	Reference source not found. was conducted	source not found. was conducted in the last 5	o ,
Results	in the last 5 years <i>And</i> Water use data and assessment results were used to make decisions on maintenance, capital improvements, employee training, and reducing water use <i>And</i> Yearly goals were revised for the continuous improvement of overall water use <i>And</i> A comprehensive water conservation program, including water <i>Error!</i> Reference source not found., person(s) responsible for water conservation, and implementation of cleaning and sanitizing	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.	Category 2
Practice 3.3 Winery Water	procedures was implemented. Error! Reference source not found. are	Meters are installed on wells and water use	Category 1
Supply	installed on wells and water use was	was monitored monthly throughout the year	
	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).	and at least weekly during high-demand periods <i>And</i> This monitoring information was recorded for tracking total water use <i>And</i> 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 <i>And</i> Water use information was provided in employee training and made publicly available as appropriate (e.g., through websites, newsletters, and/or annual reports).	Category 2
Practice 3.5 Winery Process	Process water was applied to cropped area	Some process water was applied to cropped	Category 1
Water Discharge	and/or landscaping, if permissible	area and/or landscaping, if permissible	
	And Flow data was used to help select reuse or disposal method(s)	And Time was invested into researching and visiting other facilities that have implemented	Category 2

	And Water quality results were used to	Alternative Reuse or Disposal Methods for	
	develop and implement a plan to reduce	process water.	
	constituents in discharge water	process 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).		
Practices 3.7 Crush	Crush operations were outside and covered or	Crush operations were outside and covered or	Category 1
Operations	moved inside to eliminate "baking" of waste	moved inside to eliminate "baking" of waste	
	material on equipment surfaces And Pre-	material on equipment surfaces And Pre-	Category 2
	cleaning of equipment surfaces was done	cleaning of equipment surfaces was done	
	with appropriate tools (e.g., a stiff brush) to	with appropriate tools (e.g., a stiff brush) to	
	loosen and remove large material before	loosen and remove large material before	
	wash-down And Water for cleaning	wash-down And Water for cleaning	
	equipment was applied as needed from a high	equipment was applied as needed from a high	
	pressure/low volume nozzle fitted with a	pressure/low volume nozzle fitted with a	
	shut-off valve. A broom and squeegee were	shut-off valve. A broom and squeegee were	
	nearby and workers were encouraged to use	nearby and workers were encouraged to use	
	them to clean up spills And Written cleaning	them to clean up spills And Written cleaning	
	procedures were implemented and adhered	procedures were implemented and adhered	
	to in crush operations as part of a water	to in crush operations as part of a water	
	conservation plan And Lees control/source	conservation plan And Lees control/source	
	separation practices were in place to ensure	separation practices were in place to ensure	
	lees and other residuals were separated from	lees and other residuals were separated from	
	water waste stream And Employees were	water waste stream And Employees were	
	trained in crush operation cleaning	trained in crush operation cleaning	
	procedures.	procedures.	
Practices 3.8	Presses were outside and covered, or moved	Presses were outside and covered to reduce	Category 1
Presses	inside to eliminate "baking" of waste material	"baking" of waste material on equipment	
	on equipment surface And Pre-cleaning was	surfaces And Pre-cleaning was done to loosen	Category 2
	done to loosen and remove large material	and remove large material before wash-down	
	before wash-down And Water for cleaning	And Water for cleaning equipment was	
	equipment was applied as needed from a high	applied as needed from a high pressure/low	

	pressure/low volume nozzle fitted with a shut-off valve <i>And</i> Written cleaning procedures were implemented and adhered to in press operations as part of a water conservation plan <i>And</i> Lees control/source separation practices were in place to ensure lees and other residuals were separated from water waste stream <i>And</i> Employees were trained in press operation cleaning procedures Or A water efficient self-cleaning press was installed.	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.	
Practice 2.9 Tanks and Transfer Lines	Tanks and transfer lines were cleaned with a measured amount of water <i>And</i> Water for cleaning tanks was applied in a way that captures and recirculates the water in the tanks <i>And</i> 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 <i>And</i> 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 <i>And</i> The feasibility of capturing and reusing tank rinse water has been determined and implemented <i>And</i> 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 <i>And</i> 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) <i>And</i> Written cleaning procedures were implemented and adhered to in tank and transfer line cleaning as part of a water conservation plan <i>And</i> The feasibility of capturing and reusing tank rinse water has been evaluated <i>And</i> A sanitation option that conserves water (e.g., ozone, pigging, recycled water) was implemented.	Category 2
Practice 3.10 Cellars	The total water use is measured, monitored and tracked, and used in employee training as part of a water conservation program <i>And</i> Cellar clean-up time is known, recorded and tracked to help reduce water use <i>And</i> Cellar workers implement written water conservation practices	The total water use is measured, monitored and tracked, and used in employee training as part of a water conservation program <i>And</i> Cellar clean-up time is known, recorded and tracked to help reduce water use <i>And</i> Cellar workers implement written water conservation practices	Category 2

Practice 3.11 Barrel Washing	And Floors are pressure-washed with high pressure/low volume cleaning equipment fitted with shut-off nozzles And Water awareness information, including the water performance metric, is and communicated to cellar workers Barrel washing is done with a high pressure/low volume nozzle and water volume is 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 has been implemented	And Floors are pressure-washed with high pressure/low volume cleaning equipment fitted with shut-off nozzles And Water awareness information, including the water performance metric, is and communicated to cellar workers Barrel washing is done with a high pressure/low volume nozzle 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 Written cleaning procedures were implemented and adhered to in barrel cleaning as part of a water conservation plan	Category 1
Practice 3.12 Barrel Soaking	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. 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	Each barrel was filled with an estimated amount of water And Barrels were rotated on their side to detect leaks and to seal And	Category 1
	same <i>measured</i> amount of water to detect leaks and to seal <i>And</i> An alternative		

			<u> </u>
	sanitization technology (e.g., ozone) was	Barrel heads were soaked separately in the	
	implemented And	same estimated amount of water to detect	
	The amount of water used was measured,	leaks and to seal And	
	monitored and tracked as part of a written	The amount of water used was measured and	
	water conservation plan <i>And</i> Employees were	monitored as part of a written water	
	trained in barrel soaking procedures.	conservation plan.	
Practice 3.13 Bottling	Filler sanitization procedures were developed	The pump and filler were pressure-washed	Category 1
	with set cleaning times (e.g., 20 minutes at	with high pressure/low volume cleaning	
	180°F) for hot and cold water applications	equipment fitted with shut-off nozzles	Category 2
	And The pump and filler were pressure-	And	
	washed with high pressure/low volume	Total water use was measured and monitored	
	cleaning equipment fitted with shut-off	as part of a written water conservation plan	
	nozzles And Total water use was measured,		
	monitored and tracked as part of a written		
	water conservation plan <i>And</i> Appropriate		
	employees were trained in bottling		
	sanitization procedures And The feasibility of		
	capturing and reusing rinse water was		
	determined and implemented.		
Practice 3.14 Labs	The rinse-time for lab equipment was	The rinse-time for lab equipment was	Category 1
	accurately determined and tracked to reduce	accurately determined And Lab workers were	
	water consumption And	trained in written water conservation	Category 2
	Lab workers implemented written water	practices And	
	conservation practices And The total water	The total water use for the lab was measured	
	use for the lab was measured and tracked as	and tracked as part of a water conservation	
	part of a water conservation plan and was	plan And	
	used in employee training And	Water-saving devices for sinks and rinse tanks	
	Sinks and rinse tanks were fitted with water-	were researched And	
	saving devices (e.g., flow restrictors) And	Water awareness information was available in	
	Water awareness information, including the	the lab And New lab techniques that reduce	
	water performance metric, was available to	water use and hazardous waste generation	
	lab employees And	were investigated.	
	New lab techniques that reduce water and		
	hazardous waste were implemented.		
		1	l.

Practice 3.15 Landscaping	The total amount of water used was	The total amount of water used was
	measured, monitored and tracked as part of a	measured and tracked as part of a water
	water conservation plan and the results were	conservation plan
	used in employee training	And
	And	Over half of the landscaping utilizes drought-
	Most of the landscaping utilizes drought-	tolerant plants or recycled water was used for
	tolerant plants or recycled water was used for	landscaping
	landscaping	And
	And	Irrigation lines were checked regularly for
	Irrigation lines were checked regularly for	leaks, defective emitters, and sprinkler heads
	leaks, defective emitters, and sprinkler heads	And
	And	Mulch or compost was applied twice a year
	Mulch or compost was applied at least twice a	(or as appropriate)
	year and soils were tested at appropriate	And
	intervals.	Landscaping had automatic irrigation
	And	And
	Landscaping used some treated process	Moisture sensors or rain shut-off devices
	water* and had automatic irrigation	were installed to override automatic sensors.
	And	
	Moisture sensors or rain shut-off devices	
	were installed to override automatic sensors	

Performance Metrics - Winery Water



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	Total Water Use =	Water usage	Utility records;
(Winery)	Gallons of Water Used	 Gallons and cases produced 	Flow meter readings
	Gallon of wine		
	or		
	Gallons of Water Used		
	Case of Wine		

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.

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



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 (http://www.wineinstitute.org/winerywaterguide) 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 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:

- 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. http://www.wineinstitute.org/winerywaterguide.
- Sustainable Water Management Handbook for Small Wineries: The handbook helps small
 wineries conduct a self-assessment of their water use. Available in the CSWA Resource
 Library at https://library.sustainablewinegrowing.org/.



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-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/.

SECTION 4: DAIRIES

CHAPTER 1	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY
WATER MANAGEMENT	Deivice and in plants and a	Delining and the common of the control	ACHIEVED
4.1 Drought Management	Dairies create and implement a	Dairies create a summer/drought	
Plan	summer/drought management plan that	management plan that includes building up	
	includes building up feed before it gets dry,	feed before it gets dry, summer crops, feed	
	summer crops, feed assessment, destocking	assessment, destocking plan, and cow	
	plan, and cow condition assessment.	condition assessment.	
4.2 Monitor the Situation	Farmers regularly monitor both the farm and	Farmers regularly monitor both the farm and	
	the overall drought situation by checking farm	the overall drought situation by checking farm	
	and agriculture and weather reports weekly	and agriculture and weather reports weekly.	
	and do weekly farm walks to monitor		
	conditions.		
4.3 Manage Body Condition	Consideration of Body Condition Scores are	Consideration of Body Condition Scores are	
Score	made, and some management options are	made, and some management options are	
	implemented. Management options include	implemented.	
	getting all known culls off the farm as soon as		
	possible; drying matured animals off based on		
	BCS and somatic cell count; milking low BCS		
	cows once a day in Spring.		
4.4 Use Supplements Wisely	Consideration that feeding supplements can	Consideration that feeding supplements can	
	keep animals in production longer than would	keep animals in production longer than would	
	otherwise be possible in a dry summer was	otherwise be possible in a dry summer was	
	made. Feeding supplements can keep animals	made.	
	in production longer than would otherwise be		
	possible in a dry summer. Only purchase and		
	feed out supplements if you have enough		
	water to cope with increased demand and can		
	offer pasture silage to stock first.		
4.5 Milking Schedules	Consideration of once-a-day milking is made.	Consideration of once-a-day milking is made.	
4.6 Irrigated Pastures	Plans to monitor soil health and moisture are	Plans to monitor soil health and moisture are	
	made and are implemented. Have a	made.	
	contingency plan for when water restrictions		
	are applied.		

SECTION 5. ROW & SPECIALITY CROPS

CHAPTER 1 WATER MANAGEMENT	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY ACHIEVED
5.1 Irrigation Mechanisms	Move from overhead to micro sprinklers and drip systems. Maintain and monitor systems to avoid leaks and blowouts. Implement use of timers and controllers, optimal irrigation equipment, soil moisture probes, ET tracking,	Move from overhead to micro sprinklers and drip systems.	
5.2 Water collection and retention	and flow meters. Collect and retain water with rainwater catchment with tanks, maintain water onside with swales and ditches, avoid runoff when irrigating.	Develop plans for water collection and retention.	
5.3 Increase water infiltration	Increase organic matter in the soil with compost, mulch, cover crops, and bio char. Improve tillage and mow cover crops earlier in the season. Water in times of least evaporation, early morning, late in the day, or at night. Develop swales and berms. Keep soil covered and minimize compaction.		
5.4 Minimize unnecessary water loss	Install manual shut off valves for all hoses and outlets. Routinely evaluate and replace gaskets as needed. Address leaks as needed.		
5.5 Distribution Uniformity	Develop a plant to conduct a Distribution Uniformity analysis internally or through a water resource program and adjust irrigation mechanisms to achieve Irrigation Efficiency of at least 80%.		
5.6 Irrigation Tools	Timers and Controllers are installed and are regularly monitored to ensure appropriate irrigation sets.		

SECTION 6: LANDSCAPING

CHAPTER 1 WATER MANAGEMENT	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY ACHIEVED
6.1 Water Consumption in Winery	Winery operations conducts water use analysis and identifies primary sources of water usage.		
6.2 Plant Selection	Drought-tolerant and drought-resistant plants are chosen for landscape design. Drought-resistant plants are not irrigated for long periods of time during drought years. New plantings are selected to replace non-drought plants. New landscaping is put on hold during drought years. Native plants are preferred in landscape designs.		
6.3 Invasive Species Reduction	Invasive species are removed and destroyed quickly.		
6.4 Water Usage	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 <i>And</i> Most of the landscaping utilizes drought-tolerant plants or recycled water was used for landscaping <i>And</i> Irrigation lines were checked regularly for leaks, defective emitters, and sprinkler heads <i>And</i> Mulch or compost was applied at least twice a year and soils were tested at appropriate intervals. <i>And</i> Landscaping used some treated process water* and had automatic irrigation <i>And</i> 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.	
6.5 Irrigation Mechanisms	Drip irrigation is preferred. Sprinkler systems are replaced with drip irrigation systems. If		
	sprinkler systems are still in place, sets are not		

	conducted in windy conditions or during daytime hours.	
6.6 Row and Specialty Crop	All parts of Section 3 are incorporated into	
Discussion	Landscaping criteria.	

SECTION 7. LONG-TERM SOLUTIONS

CHAPTER 1	PRACTICE CATEGORY 2	PRACTICE CATEGORY 1	CATEGORY
LONG-TERM SOLUTIONS			ACHIEVED
7.1 Water Storage Solutions	During drought years, water storage systems		
	are improved. Liners are added to reservoirs		
	when possible. Groundwater wells are		
	installed where possible. Water storage tanks		
	are installed. Resources for programs and		
	monies available are to be listed in an		
	attached document.		
7.4 Irrigation System Tools	Best practice irrigation management tools are		
	utilized in all years, drought, or non-drought.		
	Soil moisture probes are installed, and data is		
	collected for short- and long-term use.		
	Weather stations are installed, and data is		
	collected for short- and long-term use.		
7.5 Trainings	On-going education is included in farming		
	practices. Company participates in yearly		
	sustainability trainings.		
CHAPTER 2 LONG-TERM			
SOLUTIONS FOR VINEYARDS			
7.2 Crop Adjustments	Drought-resistant and drought-tolerant crops	Drought-resistant and drought-tolerant crops	
	are integrated entirely into crop production	are integrated entirely into crop production	
	program, not dependent upon the conditions	program, only in drought years.	
	of the current year. Resources for seed		
	supplies and monies allocated are to be listed		
	in an attached document.		
7.3 Wind Machines	Where possible, wind machines are installed	Frost water protection systems are only in	
	to replace frost water protection systems.	specific areas that are most effected by frost	

	damage. Wind machines are in place where	
	possible.	