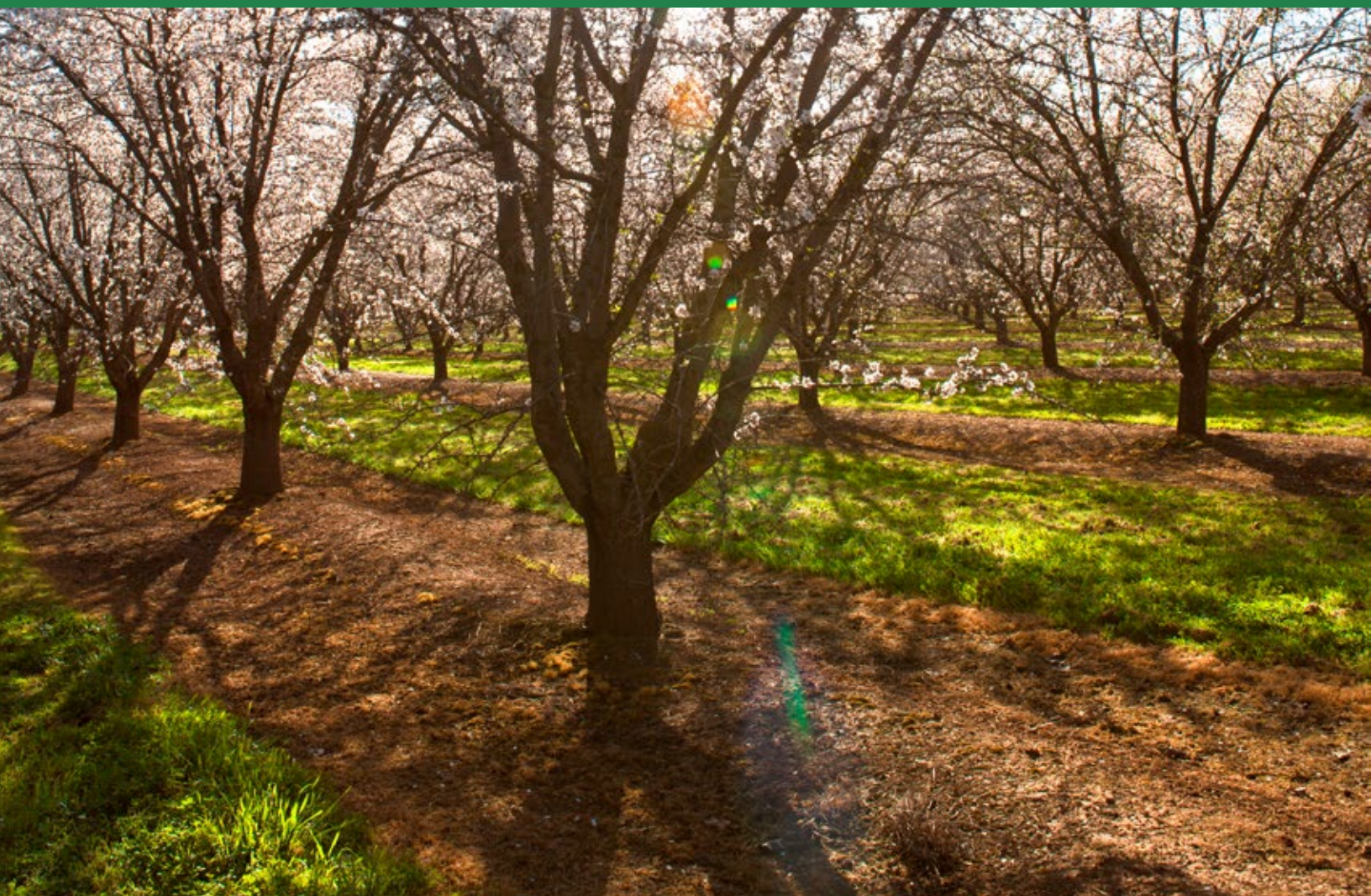
San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

2020 Staff Report and Recommendations on Agricultural Burning



SAN JOAQUIN VALLEY
AIR POLLUTION CONTROL DISTRICT

Final 2020 Staff Report and Recommendations on Agricultural Burning

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1 Executive Summary

Historically, the practice for disposing of agricultural waste materials such as prunings and orchard removals has been through the open burning of the materials in the field. Burning agricultural materials has provided a feasible method for the timely disposal of these materials, helping to prevent the spread of plant diseases, and controlling weeds and pests. The District, California Air Resources Board (CARB), and Valley growers have implemented a number of measures to reduce open burning emissions and minimize the impact on the Valley over the years.

The San Joaquin Valley, in adherence with applicable state laws instituted under SB 705 (2003 Florez), has the toughest restrictions on agricultural burning in the state. District requirements, implemented through District Rule 4103 (Open Burning), no longer allow the burning of all field crops (with the exception of minimal levels of rice for disease control), almost all prunings, and almost all orchard removals. The District also operates a comprehensive Smoke Management System (SMS), which ensures that the open burning of any remaining agricultural materials does not cause or contribute to exceedances of federal air quality standards, cause a public nuisance, or impact nearby smoke-sensitive areas. These requirements are enforced through permits, project inspections, proactive surveillance, and complaint response. While CARB modeling conducted for the San Joaquin Valley's *2018 PM2.5 Plan* found that agricultural managed burning does not significantly impact the Valley's ability to meet federal PM2.5 standards, the District Governing Board's direction has been to identify additional measures for reducing particulate emissions, including development of strategies to continue to reduce localized community impacts from agricultural burning.

Per the requirements in Rule 4103, every five years the District must review and make recommendations on agricultural burning in the Valley. Under state law, open burning for agricultural crop categories are required to be phased-out under a prescribed schedule, unless certain findings are made with respect to the availability of funding and economically feasible alternatives to open burning. In implementing these state requirements, the District has successfully phased-out the open burning of the majority of crop types, and has postponed prohibitions for the remaining categories where feasible alternatives and funding have not been available. In 2015, the District prepared the most recent report, the *2015 Agricultural Burning Review* (2015 Report), which re-evaluated the technological and economic feasibility for the crop categories that had previously had burning prohibitions required by the rule postponed, due to a lack of feasible alternatives for eliminating the agricultural material. Based upon the 2015 Report, CARB provided concurrence through 2020 on the District's recommended postponements.

In accordance with CARB's five-year concurrence and requirements set forth in Rule 4103, the District is again evaluating the economic and technologic feasibility of removing the current postponement of burning prohibitions for certain crop categories. District staff are actively working with agricultural industry stakeholders, CARB, USDA-

NRCS, and other partners to identify and promote alternatives to open burning in the Valley. This *2020 Staff Report and Recommendations on Agricultural Burning* (2020 Report) provides staff recommendations on the feasibility of further potential prohibitions on agricultural burning in the Valley.

1.1 Efforts to Reduce Agricultural Managed Burning in the San Joaquin Valley

The District has significantly reduced emissions from agricultural burning to date by prohibiting the open burning of a variety of field crops, prunings, weeds, orchards, vineyards, surface harvested prunings, and other materials. State law, as codified in California Health and Safety Code (CH&SC) Sections 41855.5 and 41855.6, and incorporated into Rule 4103, outlined a phased-in approach to the prohibitions that is only applicable to the San Joaquin Valley. Through multiple actions, the Governing Board has amended Rule 4103 to include specific requirements as outlined in the first three phases of the CH&SC. The current open burn prohibitions for various crop categories are summarized in the following table.

Table 1-1: Agricultural Materials Prohibited from Open Burning

Date	Crop Category	Agricultural Material Prohibited from Open Burning
2005	**Field Crops**	Alfalfa, asparagus, barley stubble, beans, corn, cotton, flower straw, hay, lemon grass, oat stubble, pea vines, peanuts, safflower, sugar cane, vegetable crops, and wheat stubble
	Field Crops	Rice stubble: No more than 70% of operator's acreage can be burned
	Prunings	Apricot crops, avocado crops, bushberry crops, cherry crops, Christmas trees, citrus crops, date crops, eucalyptus crops, kiwi crops, nectarine crops, nursery prunings, olive crops, pasture or corral trees, peach crops, persimmon crops, pistachio crops, plum crops, pluot crops, pomegranate crops, prune crops, and rose crops
	Weed Abatement	Berms, fence rows, pasture, grass, and Bermuda grass
2007	**Field Crops**	Rice stubble: No more than 50% of the operator's acreage can be burned
	Orchard Removals	Orchard removal matter for all crops with the exception of citrus, apple, pears, quince, and fig crops, and from 20 acres or less at a single location
2010	**Orchard Removal Matter**	Small orchards: Reduced burn allowance to 15 acres or less per location per year (includes fig crops)
	Other Materials	Brooder paper, deceased goats
	Field Crops	Rice stubble: Modified schedule to phase out by June 2015
	Prunings	Fig crops

Table 1-1: Agricultural Materials Prohibited from Open Burning

Date	Crop Category	Agricultural Material Prohibited from Open Burning
	Surface Harvested Prunings	Almond, walnut, and pecan: Prohibit burning for each ag operation whose total nut acreage at all sites is 3,500 acres or more (allows burning of up to 20 acres per year for ag operations whose total nut acreage at all sites is less than 3,500 acres with a case-by-case allowance of additional burn requests based on economic feasibility); grape canes (defined as "vineyard materials) and grape vines
2012	**Orchard Removals**	Citrus orchard removals at agricultural operations whose total citrus acreage at all agricultural operation sites is ≥ 3,500 acres; and citrus orchard removals greater than 15 acres at agricultural operations whose total citrus acreage at all agricultural operation sites is < 3,500 acres and an alternative is feasible through a case-by-case determination

Until 2014, the restrictions imposed by the District resulted in an 80% reduction in the open burning of agricultural waste. The exceptional drought conditions that the Valley experienced from 2012 to 2016 resulted in hundreds of thousands of acres of orchards, vineyards and other agricultural crops being fallowed or removed, and ongoing crop transitions have continued to exacerbate the challenge with respect to the disposal of agricultural materials. Additionally, in recent years, a significant number of existing biomass plants that historically provided an outlet for agricultural materials have shut down due to evolving state energy markets and lower energy prices offered by utilities upon contract renewal. These conditions, further exacerbated by new state mandates such as the Sustainable Groundwater Management Act that will likely generate significant additional fallowing of agricultural acreage, threaten the District's ability to continue to maintain and strengthen its restrictions into the future.

Figure 1-2 and Table 1-2 below summarize the amount of material burned by major crop category since 2000. The Figure also identifies key reductions in biomass capacity as indicated by decreasing megawatt capacity (MW).

Figure 1-2: Historical Agricultural Material Burned under Rule 4103 and Reductions in Biomass Capacity

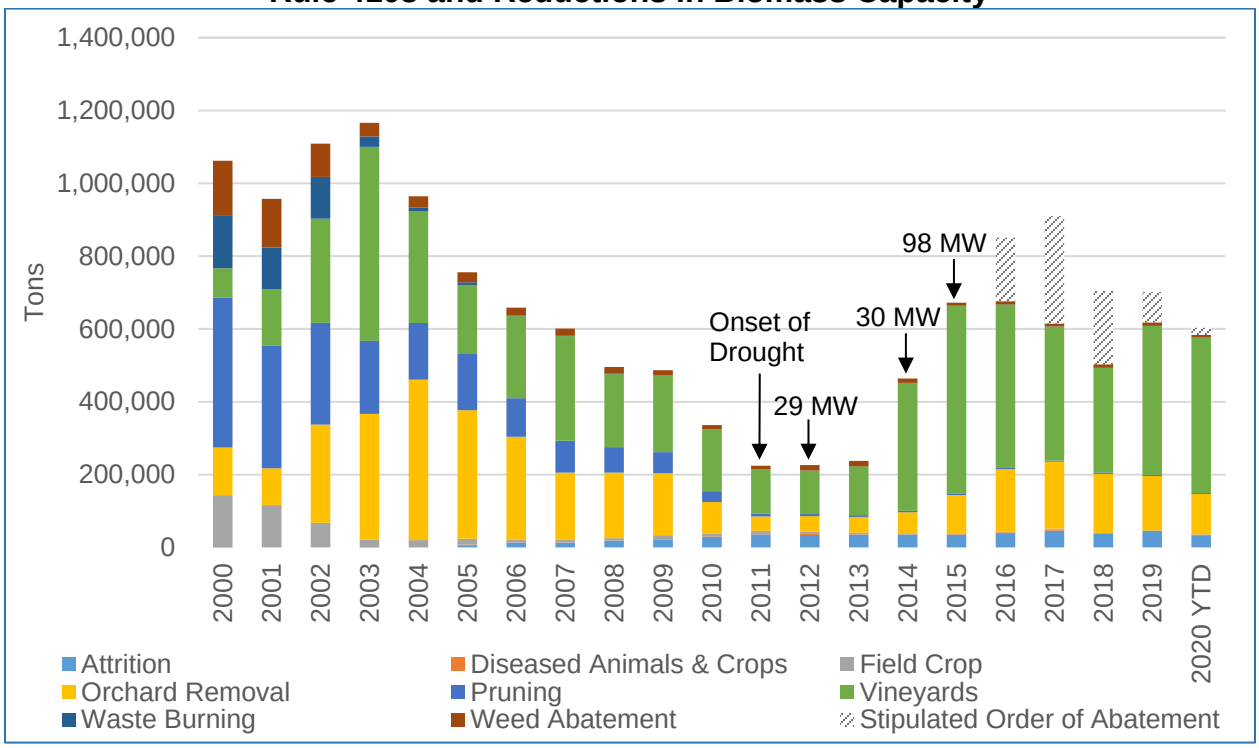


Table 1-2: Historical Agricultural Material Burned under Rule 4103

Crop Category	Pre-SB 705 Average Tons Burned/Yr (2000-2005)	Average Tons Burned/Yr (2006-2019)	Average Reduction (2006-2019)	Average Tons Burned/Yr (2015-2019)		Tons Burned (2020 - YTD)
Field Crops	63,014	5,317	-92%	1,684		731
Prunings	65,386	1,280	-98%	428		361
Weed Abatement	10,234	268	-97%	101		152
Orchard Removals	273,589	130,929	-52%	apples, pears, quince	5,646	1,260
				small removals	93,307	58,650
				citrus	53,592	31,440
Surface Harvested Prunings	222,873	38,892	-83%	2,852		2,128
Raisin Trays	1,357	795	-41%	640		79
Vineyard Removals	224,871	253,255	+13%	393,422		420,526
Other Materials	147	84	-43%	65		50
Stipulated Order (Orchard Removals)	*N/A*	*188,507*	*N/A*	*188,507*		*19,560*

In the face of these challenges, to continue making progress with respect to reducing emissions from managed burning, the District's Governing Board has prioritized measures to identify, develop, and deploy new alternatives to agricultural open burning. In November 2015, the District's Governing Board directed staff to take actions aimed at short-and long-term measures to alleviate the effect on agricultural growers of the biomass capacity shortfall in the Valley and to identify cleaner alternatives to agricultural open burning. As a part of the District's efforts to identify and advance cleaner alternatives to open burning of agricultural waste, in November 2017, the District convened the Central Valley Summit on Alternatives to Open Burning of Agricultural Waste to bring together Valley growers, researchers/experts, representatives from the biomass power industry, representatives from new and developing technology vendors, and Valley stakeholders. Over the course of the two day Summit, the comprehensive agenda explored the history of agricultural burning regulations in the Valley, the current state of agricultural burning and alternatives, air quality impacts associated with open burning, challenges faced in other regions of the state, and the opportunities and challenges of implementing alternatives to open burning of agricultural waste.

Through collaboration with the agricultural sector, CARB, USDA-NRCS, and Valley stakeholders, the District has pursued a number of initiatives to develop new alternatives to managed burning, including legislative energy policy enhancements, development of registration mechanisms for air curtain burners, supporting new bioenergy projects that utilize agricultural woody materials, and development of incentive measures to promote the development and demonstration of new alternatives.

Based on the discussions at the Summit, it was determined that air curtain burn boxes may serve as one potential feasible alternative to significantly reduce emissions from open burning of agricultural and other wood waste materials. Towards that end, in December 2018, the Governing Board adopted amendments to District Rule 2280 (Portable Equipment Registration) to streamline permitting requirements and facilitate the use of air curtain burners in the Valley.

In November 2018, the Governing Board adopted a new District incentive program to assist growers in demonstrating new on-field practices for the disposition of agricultural materials. Recognizing the variety of agricultural operations in the Valley, the well-subscribed program allows growers to select from several on-field uses for chipped agricultural materials from orchard or vineyard removals, such as soil incorporation (whole orchard recycling) and land application of mulch. Since the Governing Board's adoption of program, the District has provided $13.5 million in funding to support the transition of approximately 26,000 acres and 730,000 tons of woody materials to non-burning alternatives, primarily through soil incorporation of orchard removal material.

1.2 2020 Staff Report and Recommendations on Agricultural Burning

As required under Rule 4103 and consistent with CH&SC Sections 41855.5 and 41855.6, this 2020 Report is the District's latest evaluation of agricultural open burning and consideration of any additional prohibitions and postponements since the District's most recent evaluation and CARB concurrence in 2015. After two decades of working to reduce agricultural open burning, the 2020 Report is intended to establish the final framework for the phase-out, as feasible, of agricultural managed burning.

Through the 2020 Report, the District is proposing a comprehensive approach to eliminate agricultural managed burning where feasible, including new prohibitions on open burning reliant on newly emergent alternatives, a call for federal, state and local incentive funding to assist with widespread transition to costly new alternatives, and partnerships with agricultural stakeholders, CARB, and USDA-NRCS to assist with the final stages of development of feasible alternatives. Alternatives that may be feasible in the coming years as identified through this 2020 Report include the use of any remaining biomass plant capacity in the Valley, chipping and grinding of material for soil incorporation, composting, air curtain burners, and new bioenergy production (e.g. pyrolysis and cellulosic ethanol plants). To allow for an expedited transition to cleaner alternatives, this 2020 Report also recommends the continued postponement of managed burn prohibitions of certain crop categories while alternatives continue to be developed and become available on broader scales.

The 2020 Report includes the following staff recommendations:

1. Consistent with Rule 4103, Section 5.2.2, the District recommends additional open burn prohibitions and transitionary postponements as specified in Table 1-4 below. CARB concurrence is requested for the District's recommendations. The District will continue to evaluate these categories on an ongoing basis and as required under Rule 4103. The District will continue to carefully manage all remaining agricultural burning with its Smoke Management System (SMS) to ensure that managed burning does not cause a public nuisance, impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard.

2. To support the District's 2020 Report recommendations and transition of remaining crop categories to newly emergent alternatives, the District requests that sustained state funding support of approximately $15 million per year be provided and made available to Valley growers. This estimate is based on approximately 500,000 tons per year (25,000 acres) of agricultural woody waste requiring cleaner alternatives at a funding level of $600 per acre. This funding is requested for the duration of at least the CARB concurrence period for the District's recommendations, with the expectation that over the course of the District's recommendations, alternatives are more broadly deployed, costs are reduced, and overall are more feasible with a reduced need for incentives over

time.

3. To support the District's 2020 Report recommendations and transition of remaining crop categories to newly emergent alternatives, the District will seek program enhancements and dedicated San Joaquin Valley funding through the California Department of Food and Agriculture (CDFA) Healthy Soils Program for whole orchard recycling and other feasible alternatives. In order for this program to be effective in assisting the transition to emerging alternatives, program changes are needed to make the program more accessible and responsive to the needs of Valley growers, and increase local participation.

4. To support the District's 2020 Report recommendations and transition of remaining crop categories to newly emergent alternatives, the District will advocate for additional federal funding to assist with deployment of feasible alternatives, including working closely with the USDA-NRCS to support funding programs for whole orchard recycling and other alternatives.

5. The District recommends the following with respect to state energy policy to ensure that existing and new bioenergy production is responsive to the need for establishing viable and sustainable options for the disposal of agricultural woody materials:

    a. Given the high development costs associated with developing advanced bioenergy conversion projects, state incentives must be established to help defray the significant up-front costs that present barriers to startup.

    b. The District recommends that a new Clean Biomass Collaborative be established, in partnership with CARB, U.S. Environmental Protection Agency (EPA), and other local, state, and federal agencies, to serve as a forum to identify and overcome issues that are inhibiting the deployment of advanced bioenergy conversion projects.

    c. The District recommends that the state develop a plan for addressing the ongoing challenges faced by existing biomass plants that, while reduced in total capacity, still serve as a key outlet for agricultural materials. This plan should recognize the emission reduction benefits that may be associated with the processing of agricultural materials, conflicting state energy policies that result in significant forest waste being hauled to Valley biomass facilities, and community concerns associated with the emissions from and location of these plants.

Table 1-4: 2020 Report Recommendations

Crop Category	2020 Report Recommendations	Findings
Field Crops	Effective January 1, 2021, prohibit open burning of 75% of rice stubble per year of the total acreage of rice farmed by the operator (Reduces acreage allowed to burn from 70% down to 25%)	• Reinforce decline in open burn acreage for rice stubble • Remaining postponement due to disease issues • Aligns prohibitions with state law for Sacramento Valley
	Effective January 1, 2021, prohibit burning of residual rice stubble (left over stubble after baling)	Phase-out to reinforce transition to non-baling practices
	Effective January 1, 2021, prohibit spot burning of rice stubble (rice stubble compacted due to mobile equipment)	Phase-out to reinforce transition to alternative practices
	Continue postponed prohibition of burning of weeds and vegetative materials on rice field levees and banks	No feasible alternative as mowing and herbicides are not viable alternatives due to slopes and water contamination issues
Prunings	Continue postponed prohibition of burning of apple, pear, and quince crop prunings	No technologically feasible alternative due to fire blight (contagious disease)
Weed Abatement	Continue postponed prohibition of weed abatement burning affecting ponding and levee banks	No feasible alternative as mowing and herbicides are not viable alternatives due to slopes and water contamination issues

Table 1-4: 2020 Report Recommendations

Crop Category	2020 Report Recommendations	Findings
Orchard Removals	Prohibit open burns for citrus orchard removals greater than 15 acres on the following phase-out schedule: • Effective January 1, 2021, prohibit open burns for citrus orchard removals at agricultural operations whose total citrus acreage at all agricultural operation sites is greater than 500 acres; and citrus orchard removals greater than 40 acres at a single location per year; maintain case-by-case determination for removals greater than 15 acres and less than or equal to 40 acres at agricultural operations whose total citrus acreage at all agricultural operation sites is less than or equal to 500 acres • Effective January 1, 2022, prohibit open burns for citrus orchard removals at agricultural operations whose total citrus acreage at all agricultural operation sites is greater than 200 acres; and citrus orchard removals greater than 30 acres at a single location per year; maintain case-by-case determination for removals greater than 15 acres and less than or equal to 30 acres at agricultural operations whose total citrus acreage at all agricultural operation sites is less than or equal to 200 acres • Effective January 1, 2023, prohibit all citrus removal open burns, except for small orchard removals < 15 acres as provided through small orchard removal allowance for all orchards	• No economically feasible alternatives to open burning without incentives and wider availability of contractors • To reinforce transition to cleaner emerging alternatives, District recommends a two-year phase-out as supported and made feasible through existing and new incentive programs (District, USDA-NRCS, CDFA)
	Continue postponed prohibition of burning apple, pear, and quince orchard removals	No technologically feasible alternative due to fire blight (contagious disease)

Table 1-4: 2020 Report Recommendations

Crop Category	2020 Report Recommendations	Findings

Orchard Removals (Continued)	Continue postponed prohibition of burning orchard removals ≤ 15 acres at a single location, per year	• The availability of contractors for small orchard removals remains an issue:
		  ○ Small removals are not a priority for contractors
		  ○ Contractors may decline small acreage removals
		  ○ Wait times for contractors become extended
		• In addition to contractor availability, the cost-per-acre of alternatives is not economically feasible for small orchard removals due to fixed and minimum contractor costs

Vineyard Removals	• Continue postponed prohibition through December 31, 2021, in conjunction with launch of Vineyard Removal Alternatives Partnership with CARB, USDA-NRCS, and agricultural stakeholders to develop alternatives and provide funding for the deployment of feasible alternatives to the open burning of vineyards, including wire removal/soil incorporation, air curtain incinerators, and other alternative practices • Effective January 1, 2022, phase-out of open burning of grape and kiwi vineyard removals greater than 15 acres for removals where feasible alternatives are available through case-by-case evaluation of any managed burn request that takes into account the availability of contractors and incentive funding	• No economically feasible alternatives to open burning without incentives • Soil incorporation of certain vineyards has been demonstrated successful through District Pilot Grant Program ($1.7 million for 46,500 tons of vineyard removal material) • To transition to feasible cleaner emerging alternatives, District recommends phase-out effort supported through demonstration projects and incentive programs (District, USDA-NRCS, CDFA)

Table 1-4: 2020 Report Recommendations

Crop Category	2020 Report Recommendations	Findings
Surface Harvested Prunings	Effective January 1, 2024, prohibit open burning of raisin trays, in conjunction with continued phase-down efforts to develop alternatives for the limited remaining raisin acreage still designed to operate with raisin trays	• District recommendations reinforce ongoing phase-out of use of raisin trays by transitioning to other vineyard types and mechanical harvesting methods, eliminating the need for raisin tray disposal • Raisin trays are now more environmentally friendly, which assists with the final disposition of this material • The District and industry representatives are exploring the feasibility of recycling raisin trays, including exploring the potential development of a pilot project
	Prohibit open burns for surface harvested prunings ≤ 20 acres on the following phase-out schedule: • Effective January 1, 2022, prohibit open burning ≤ 20 acres of total prunings per year for almond, walnut, and pecan crops for agricultural operation whose total nut acreage at all agricultural operation sites > 200 acres • Effective January 1, 2023, prohibit open burning ≤ 20 acres of total prunings per year for almond, walnut, and pecan crops for agricultural operation whose total nut acreage at all agricultural operation sites > 50 acres	• No economically feasible alternatives to open burning without incentives • District recommendations reinforce ongoing transition for limited remaining pruning burning with ongoing allowance for small growers (less than 1% of historical prunings) • District recommendations supported and made feasible through existing and new incentive programs (District, USDA-NRCS, CDFA)
	Effective January 1, 2021, prohibit surface harvested pruning open burns > 20 acres	Phase-out to reinforce transition to alternative practices
Other Materials	Continue postponed prohibition of burning of diseased beehives	No technologically feasible alternative due to disease issues

2 Regulatory Background

2.1 California Health and Safety Code Burning Prohibitions

In 2003, California Senate Bill 705 (Florez), incorporated into CH&SC Sections 41855.5 and 41855.6, requires the District to regulate the burning of diseased crops, establish best management practices (BMP) for the maintenance and control of weeds, and phase-out the open burning for numerous crop categories. SB 705 established a schedule for specific types of agricultural material to no longer be burned in the field, but provided for a postponement of the phase-out where justified by technical and economic impediments. The San Joaquin Valley Air District (District) has implemented SB 705 through Rule 4103 and the District's Smoke Management Program.

Under CH&SC Sections 41855.5 and 41855.6, the District may postpone the open burning restrictions for the remaining crop categories if all of the following conditions are met:

1. There is no economically feasible alternative means of eliminating waste.
2. There is no long-term federal or state funding commitment for continued operation of biomass facilities in the Valley or development of alternatives to burning.
3. Continued issuance of permits for that specific category or crop will not cause, or substantially contribute to, a violation of an applicable federal ambient air quality standard.
4. CARB concurs with the District's determinations.

The following table summarizes the requirements for specific categories of agricultural material and their corresponding prohibition dates under state law.

Table 2-1: Timeline for SB 705-Specific Crop Category Requirements

Effective Date	Category of Agricultural Material
June 1, 2005	Prohibit burning for Field Crops, Prunings, and Weed Abatement
	Establish BMP for Other Weeds and Maintenance
	Regulate burning of diseased crops
June 1, 2007	Prohibit burning for Orchard Removals
June 1, 2010	Prohibit burning for Vineyard Removals, Prunings from Surface Harvested Crops and Other Materials

2.2 District Rule 4103 (Open Burning)

Rule 4103 was first adopted on June 18, 1992 to permit, regulate, and coordinate the use of open burning while minimizing smoke impacts on the public. Rule 4103 has subsequently been amended numerous times to incorporate state law requirements. The provisions of Rule 4103 apply to open burning conducted in the Valley; this rule is not applicable to prescribed and hazard reduction burning, as defined and regulated by

District Rule 4106 (Prescribed Burning and Hazard Reduction Burning).

Rule 4103 provides for the APCO to restrict and allocate burning based on meteorology and the predicted smoke production. Rule 4103 prohibits issuing permits for the burning of field crops, prunings, weed abatements, orchard removals, vineyard removal materials, surface harvest prunings, and other materials described in the rule. Rule 4103 contains requirements for collecting, sorting, drying, and igniting agricultural materials; the timing, monitoring, and maintenance of burns; and specific requirements for field crop burning, ditch bank and levee maintenance, contraband materials, Russian thistle (tumbleweeds), and diseased materials.

In September 2004, the Governing Board amended Rule 4103 to include specific requirements that must be met for the burning of diseased crops. In May 2005, the rule was further amended to include best management practices for the control of other weeds and maintenance, as well as eliminate burning of waste from field crops, some types of orchard prunings, and weed abatement operations. These amendments implemented the burn prohibition for 90% of the crops identified in those categories. The May 2007 amendments to the rule further prohibited open burning of orchard removals, except for citrus crops, pome fruit crops (apple, pear, and quince), fig crops, and any other orchard removal that is less than 20 acres. The most recent amendment in April 2010, further prohibited open burning of brooder paper, deceased goats, grape canes, prunings of grape vines and fig crops, and orchard removals of greater than 15 acres, excluding citrus crops and pome fruit crops.

In 2010, the District prepared the *2010 Final Staff Report and Recommendations on Agricultural Burning* (2010 Report), which evaluated each crop category identified in CH&SC Section 41855.5 and provided recommendations for allowing or prohibiting the open burning of categories as outlined by CH&SC. Based upon the 2010 Report, CARB provided a two-year concurrence on the District's recommended remaining postponements, based on the lack of feasible alternatives to open burning. Additionally, Rule 4103 was amended in 2010 to incorporate the provisions of CH&SC §41855.5 and §41855.6 directly into the rule to more efficiently allow the District to consider the feasibility of non-burning alternatives for specific crops and materials. Rule 4103 requires that, at least every five years, the District prepare a report and recommendations for any Governing Board determinations made pursuant to Section 5.5.2, which is to be presented to the Governing Board for review and approval, and subsequent CARB concurrence as appropriate. The Governing Board-approved report shall be submitted to CARB and EPA for inclusion into the State Implementation Plan.

In 2012, the District prepared the 2012 Recommendations on Agricultural Burning (2012 Report), which re-evaluated the technological and economical impediments for the crop categories that had been postponed. Based upon the 2012 Report, CARB provided an additional three-year concurrence on the District's recommended remaining postponements, based on the continued lack of feasible alternatives to open burning.

In 2015, the District prepared the *2015 Agricultural Burning Review* (2015 Report) which re-evaluated the technological and economic feasibility of the crop categories that had been postponed. Based upon the 2015 Report, CARB provided an additional five-year concurrence until 2020 on the District's recommended remaining postponements, based on worsened technological and economic feasibility of alternatives, severe drought conditions, and the demise of the biomass industry.

Based on the District's ongoing evaluations and CARB concurrence, the table below summarizes the crop categories that are prohibited from open burning under Rule 4103:

Table 2-2 Prohibited Crop Categories as of 2015 Report under Rule 4103

Crop Category	Specific Crop Types Not Allowed to Open Burn
Field Crops	Alfalfa, asparagus, barley stubble, beans, corn, cotton, flower straw, hay, lemon grass, oat stubble, pea vines, peanuts, safflower, sugar cane, vegetable crops, and wheat stubble
Prunings	Apricot crops, avocado crops, bushberry crops, cherry crops, Christmas trees, citrus crops, date crops, eucalyptus crops, kiwi crops, nectarine crops, nursery prunings, olive crops, pasture or corral trees, peach crops, persimmon crops, pistachio crops, plum crops, pluot crops, pomegranate crops, prune crops, rose crops, and fig crops
Weed Abatement	Berms, fence rows, pasture, grass, and bermuda grass
Orchard Removals	Orchard removal matter of more than 15 acres at a single location, per calendar year
	Citrus orchard removals at agricultural operations whose total citrus acreage at all agricultural operation sites is ≥ 3,500 acres; and citrus orchard removals greater than 15 acres at agricultural operations whose total citrus acreage at all agricultural operation sites is < 3,500 acres and alternative is feasible through case-by-case
Surface Harvested Prunings	Grape canes and grape vines
	Prunings of almond, walnut, and pecan crops for each agricultural operation whose total nut acreage at all agricultural operation sites is 3,500 acres or more
Other Materials	Brooder paper and deceased goats

2.3 Summary of Methodology for Determining Recommendations

This report will address several crops and materials that had been postponed during earlier burn prohibition deadlines, as summarized in the table below. The District worked closely with CARB, representatives from the agricultural sector, contractors, growers, and other agencies to address the burn prohibition requirements for various crops. The information used in this report include economic data, costs for soil

incorporation and other alternatives, costs for open burning, descriptions of activities, and other related information.

The availability of economically feasible alternatives to open burning is a key factor in the District's ability to further restrict agricultural burning for the limited categories of crops that are not already prohibited from burning. Through ongoing evaluation of alternatives to agricultural open burning, input from agricultural stakeholders, technology manufacturers and vendors, and work with USDA-NRCS and other partners, District staff have identified several potential alternatives to the open burning of agricultural waste. In recent years, alternatives have continued to progress which may provide opportunities moving forward, but that must also be carefully evaluated with respect to availability, cost, and feasibility. Specific alternatives analyzed as part this 2020 evaluation include:

- ***Soil Incorporation/Land Application:*** Chipped or shredded agricultural biomass materials can be used to produce wood mulch. Wood mulch can be a mixture of shredded wood, bark, and compost. Wood mulch can be used in landscape projects, or for erosion control. The material is primarily used to reduce erosion by protecting bare soil from rainfall impacts, increasing water infiltration, and reducing runoff. A significant portion of pruned orchard material is currently shredded in-row and used as mulch in the orchard. The shredded material can be left on the ground or can be incorporated into the soil when the field is tilled. Recent research studies and demonstration projects have evaluated the costs and feasibility of "whole orchard recycling" or soil incorporation, where agricultural material from orchard and vineyard removals is chipped and then tilled into the soil.

- ***Biomass Plants:*** Biomass power plants have historically provided a significant alternative to the open burning of agricultural waste. Due to current energy policies, biomass facilities are facing a lack of funding and difficulty in sustaining ongoing operation in the face of new energy markets and pricing. The closing of numerous biomass facilities has resulted in a decrease in total megawatt capacity at Valley plants, significantly reducing available alternatives to open burning.

- ***Advanced Bioenergy (Pyrolysis/Gasification/Ethanol):*** Pyrolysis and gasification are possible paths to convert agricultural biomass to higher value products including synthetic gas and biochar. Syngas can also be used to produce methanol and hydrogen, or converted into a liquid fuel. Biochar can be created by pyrolysis or gasification of biomass, and is a high value product that can help increase the feasibility of gasification/pyrolysis projects. Cellulosic ethanol plants that utilize agricultural woody materials can also provide an important outlet for these materials if developed in the San Joaquin Valley.

- ***Composting:*** Composting is the process by which organic material is broken

down aerobically by bacteria and other microorganisms to form a biologically stable organic substance suitable as a soil amendment and plant fertilizer. Organic waste decomposes naturally in the presence of water, warmth, and oxygen. Composting accelerates the process by adding moisture and maintaining an elevated temperature.

- ***Air Curtain Burners:*** Air Curtain Burners were designed to control pollution from open burning, primarily to reduce PM or smoke. These devices are open top combustion devices with vertical, refractory lined walls that operates by forcefully projecting a fan driven pane of high velocity air over the top of the combustion chamber in such a manner as to maintain a curtain of air over the surface and a recirculating motion of air under the curtain.

The District reviewed the technologically feasible alternatives for each of the affected agricultural crops in the San Joaquin Valley. From those alternatives, the District continued to evaluate what appears to be the most viable and likely alternative methods to open burning for many of the affected crops. For the crop types that did not have any technologically feasible alternatives to open burning, the District has recommended postponing the burn prohibition for that specific crop type. The District also recommended that the crop types where viable alternatives are considered widely accepted practices be prohibited from open burning. For the remaining crop types, the District conducted further research and analyses on costs and economic impact based on the alternatives that were determined to be most viable and likely method to open burning. This economic analysis, consistent with prior evaluations and CARB concurrence, was utilized to inform the District's recommendations regarding the economic feasibility of alternatives, as required for crop-specific determinations under Rule 4103. Growers are not bound to the selected alternative for each of the specific crop type in this report and may choose other alternatives.

In addition to the analyses above, the District analyzed the emissions and emissions reductions from agricultural burning and the likely alternative, as well as health considerations from those emissions. The District also conducted extensive research on biomass power plants, including the capacity to accept agricultural materials and long-term federal or state funding commitment.

The District cannot forecast increases or decreases to specific crop types in the Valley due to uncertainties with several influencing factors. These influencing factors include market fluctuations, increases in fallowed land for various reasons, including SGMA and California's most recent severe drought. There has been an overall decrease in total harvested agricultural crop acreage over the past ten years. However, it is not appropriate to estimate the future acreage of an individual crop type, as the aforementioned fluctuations and changing crop dynamics occur annually. As such, the District is relying on historic trends for the analyses in this 2020 Report. The five year time period since the 2015 Report, years 2015 - 2019, will be utilized as the baseline period for this 2020 Report.

For the purposes of this Report, the District will not address the following crop categories and crop types, which have been address through prior regulatory actions and evaluations:

- Prohibited crop types from earlier deadlines: In previous years, the District evaluated several alternatives to open burning for the crop categories identified in the CH&SC and has prohibited open burning for most of those crops and materials.

- Diseased crops: The District incorporated the state law requirements for diseased crops into Section 5.9 of Rule 4103 in 2004. The requirements provide for the issuance of a conditional crop burning permit if certain criteria were met and the county agricultural commissioner makes specific determinations for the crop type. This category includes crop types that are identified as diseased per Section 5.9 of Rule 4103.

- Other weeds and maintenance: These materials have already been addressed in 2005 as part of the CH&SC requirements to establish best management practices for the control of other weeds and maintenance. The best management practices were developed in consultation with the University of California Cooperative Extension, stakeholders (growers), producers, and agricultural industry groups. See Rule 4103, to view the Best Management Practices for the control of other weeds and maintenance.

- Attrition of various crops: Attrition includes vegetative materials not associated with pruning or orchard/vineyard removals. Attrition materials include the incidental cuttings of dead or broken branches, tree mortality, water sprouts or suckers, or other damage to tree crops, and are relatively small in tonnage compared to other categories of removals. State law does not include any prohibitions for this category of material.

Table 2-3: Postponed Crop Categories Under Review in 2020

Crop Category	Specific Crop Types Under 2020 Review
Field Crops	Rice stubble up to 70% of the total acreage of rice farmed by the operator per year
	Residual rice stubble (left over stubble after baling)
	Spot burning of rice stubble (rice stubble compacted due to mobile equipment)
	Burning of weeds and vegetative materials on rice field levees and banks
Prunings	Apple, pear, and quince crops
Weed Abatement	Weed abatement activities affecting ponding and levee banks
Orchard Removals	Open burns at agricultural operations whose total citrus acreage at all agricultural operation sites is < 3,500 acres on a case-by-case analysis based on economic feasibility and availability of alternatives
	Apple, pear, and quince crops
	Orchard removal matter from ≤ 15 acre open burns at a single location, per calendar year
Vineyard Removals	Vineyard removal materials from grape and kiwi crops
Surface Harvested Prunings	Raisin trays
	≤ 20 acre open burns of prunings per year for almond, walnut, and pecan crops for agricultural operations whose total nut acreage at all agricultural operation sites is < 3,500 acres
	> 20 acre open burns of prunings per year for almond, walnut, and pecan crops for agricultural operations whose total nut acreage at all agricultural operation sites is < 3,500 acres upon a case-by-case approval based on economic feasibility
Other Materials	Diseased beehives

2.4 District Smoke Management System

In 2004, the District developed the first of its kind Smoke Management System (SMS), a refined method of authorizing or prohibiting individual open burns based on modeling the air quality impacts of smoke. The program is managed by the District's Compliance Department, enforcing strict guidelines to effectively limit burning. The entity requesting a burn permit must first provide the District with the acres and type of burn material, the specific location of the burn, and the date of the burn. This information is entered into the SMS, where acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. A burn request may be

authorized after analysis and review from the compliance staff, and only if sufficient emissions have been allocated to the burn zone. Open burning has only been permitted under the District's comprehensive SMS, which uses real-time meteorological information to analyze the impact of burning on air quality and appropriately limit burn allocations by area. The proper management of burning allocations under the SMS ensures that open burning of agricultural materials does not cause or contribute to exceedances of federal air quality standards, cause a public nuisance, or impact nearby smoke-sensitive areas. These requirements are enforced through permits, project inspections, proactive surveillance, and complaint response.

Each year, windows for growers to open burn have continued to become smaller, particularly with respect to longer summer/fall wildfire seasons in recent years, and increasingly stringent residential wood burning requirements. During the winter season from November through February each year, agricultural open burning is strictly prohibited if there are any residential wood burning episodic curtailments under District Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters). These Rule 4901 curtailments are becoming increasingly frequent, with the majority of winter days now declared as No Burn days for residential wood burning, resulting in fewer agricultural open burn days each winter. The number of agricultural open burn days is reduced and aligned with during those increasing number of Rule 4901 curtailments.

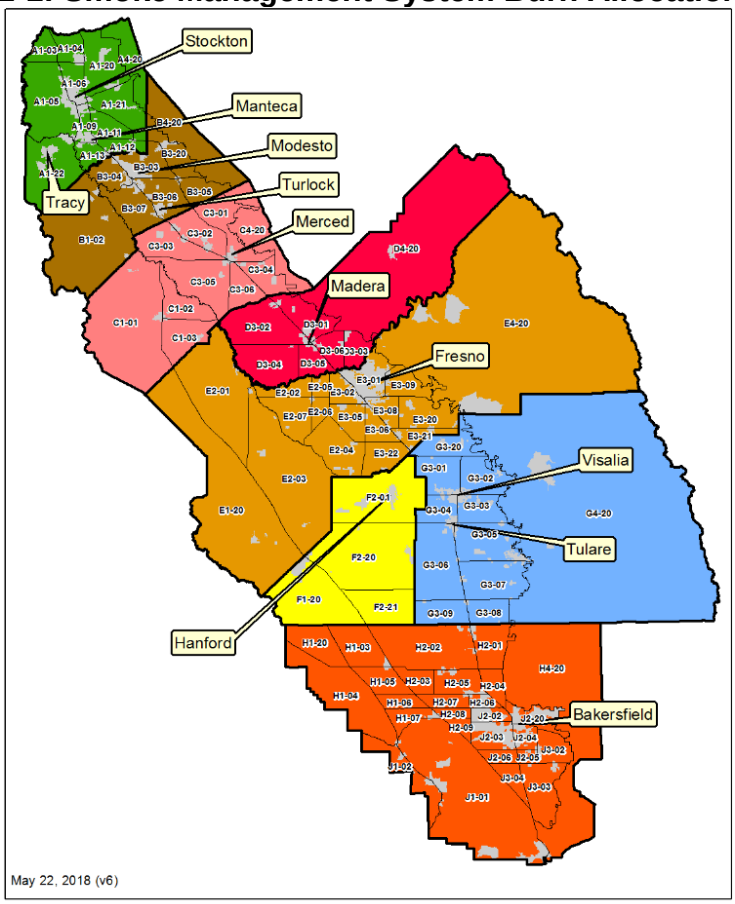
Under the District's SMS program, the Valley is divided into 97 zones. The allocation zones are based on a number of criteria such as crop distribution throughout the Valley, historical burning activities, nearby sensitive receptors, and known geographic boundaries. The amount of burning allowed in a given zone on a specific day is based on factors such as the local meteorology, the air quality conditions, the atmospheric holding capacity, the amount of burning already approved or happening in a given area, and the potential impacts on downwind populations.

Through the SMS, permit holders submit requests to burn. All requests are subject to an on-site inspection by District field staff prior to being granted a daily burn authorization. This is to ensure only material identified on a burn permit are burned, no foreign material or trash is mixed within the material, and drying time requirements have been met. The surrounding location is also surveilled to determine if any sensitive receptors could be impacted by the burn. Additional restrictions to minimize or eliminate smoke impacts can be added to the burn permit if necessary. In addition to the District's robust SMS process, the District responds to complaints reported by Valley stakeholders. Investigation of complaints that are currently taking place takes precedence over all other assigned activities for enforcement staff. After business hours, the District has an automated, bilingual complaint hotline for members of the public to report complaints. These complaints are immediately directed to on-call inspectors who are available 24 hours per day, 7 days a week, to respond to complaints and will address reporting parties' concerns and abate potential non-compliance in an effort to protect public health.

Through the SMS, the District calculates the emissions from burn requests and compares them against the established emissions allocation for that zone. If there is available allocation and all regulatory requirements have been met, the authorization is approved, otherwise burn requests are placed on a waiting list for when emissions are allocated for the applicable burn zone in the future. In order to avoid exceeding or contributing to exceedances of federal air quality standards, the District must reduce and balance the impacts of agricultural burning, wildfires, and prescribed burning. In scenarios when wildfire smoke impacts are severe, no agricultural burning is allowed. The most recent example of this are the wildfires in the summer of 2020, during which there were no agricultural open burns allowed for an extended period of time, and which overlapped with the commencement of residential wood burning requirements and curtailments. In these scenarios, growers in the Valley must wait for limited burn windows to appear under the right dispersion conditions.

Figure 2-1 below shows the burn allocation zones in each of the eight counties in the Valley.

Figure 2-1: Smoke Management System Burn Allocation Zones



The District has been able to manage emissions effectively from agricultural burning through allocation of emissions across the Valley using SMS, and strict enforcement through permitting, inspections, and enforcement actions when necessary. While certain crop categories have experienced challenges in recent years with increased managed burn requests due to the loss of biomass power or difficulty in identifying feasible alternatives, the District has continued to make significant progress with respect to meeting health-based ozone and PM2.5 standards. While CARB modeling has confirmed that agricultural open burning does not significantly contribute to the Valley's attainment of PM2.5 standards due to the management of open burning under the District's comprehensive SMS, the District continues to seek additional opportunities for reducing emissions and improving public health.

2.5 Stipulated Order of Abatement (SOA)

As an intermediate response to the loss of biomass power plants and resulting lack of feasible alternatives to dispose of agricultural woody waste, a Stipulated Order of Abatement was granted by the District's Hearing Board on December 16, 2015, to allow managed burning of orchard removal material in situations where no economically feasible option is available. This action was consistent with the Governing Board's direction to prevent roll-backs of existing prohibitions by providing necessary relief, despite the significant loss of biomass power and related state and federal incentives necessary to support the prohibitions under the CH&SC. In addition to a per acre penalty (currently at $750 per acre), as is the case for all managed agricultural burning in the Valley, all burning conducted pursuant to the Stipulated Order of Abatement has been carefully controlled, monitored, and enforced through the District's SMS to prevent emissions from these burns do not cause or contribute to exceedances of federal air quality standards, cause a public nuisance, or impact nearby smoke-sensitive areas. Penalties collected through this process have been utilized to fund the demonstration of new alternatives, almost exclusively in support of soil incorporation projects at orchards and vineyards. In conjunction with the wider demonstration of new alternatives through the District's Alternative to Agricultural Open Burning Incentive Pilot Program and other related initiatives, the District has seen a steep decrease in requests for managed burning under this process. In 2020, only several requests have been submitted to date, and the District will continually evaluate the per acre penalty to ensure that sufficient incentive is created to pursue any potentially available alternatives.

2.6 Sustainable Groundwater Management Act

In September of 2014, a three-bill legislative package known as the Sustainable Groundwater Management Act (SGMA) was signed into law. SGMA created a framework for sustainable groundwater management, requiring governments and water agencies located in high and medium priority basins to balance groundwater basin levels. High and medium priority basins must reach these balanced level of pumping and recharge by 2042. Similarly, over-drafted basins must reach these levels by 2042. Groundwater Sustainability Agencies (GSAs) must submit and adopt Groundwater

Sustainability Plans (GSPs) outlining how they plan to meet their specified deadline.

Due to being an over-drafted area, hundreds of thousands of acres of land are expected to go fallow in the San Joaquin Valley as SGMA is implemented over the next 20 years. This will greatly affect the farming acreage in the Valley and cause hardships for farmers as they will have to use less water to ensure that the basins reach a balanced level of pumping and recharge. This anticipated increase in fallowed land will cause farmers to seek disposal options for their crops. Due to the challenges of fallowed land, the need for alternatives to open burning will become critical.

3 Central Valley Summit on Alternatives to Open Burning of Agricultural Waste

As a part of the District's efforts to identify and advance cleaner alternatives to open burning of agricultural waste, in February 2017, the District convened the Central Valley Summit on Alternatives to Open Burning of Agricultural Waste to bring together Valley growers, researchers/experts, representatives from the biomass power industry, representatives from new and developing technology vendors, and Valley stakeholders.

Over the course of the two-day Summit, the comprehensive agenda explored the history of agricultural burning regulations in the Valley, the current state of agricultural burning and alternatives, air quality impacts associated with open burning, challenges faced in other regions of the state, and the opportunities and challenges of implementing alternatives to open burning of agricultural waste. In response to the Summit, the District Governing Board approved the following actions to continue addressing the ongoing issues associated with agricultural managed burning:

1. Withhold rolling back the District's current agricultural burning prohibitions until further work on exploring and advancing alternatives to open burning is completed.

2. Continue to implement the District's Smoke Management System safeguards to ensure no adverse air quality impact from authorized agricultural open burning.

3. Explore the feasibility of utilizing air curtain burn boxes subject to the District's Smoke Management System safeguards as an extension of agricultural operations.

4. Continue to support state and federal financial assistance to biomass power industry for the disposal of agricultural waste.

5. Support technology advancement for emerging cleaner alternatives to the open burning of agricultural waste, with priority given to on-the-farm deployable (minimum or no transportation related emissions) and scalable technologies.

6. In assessing the feasibility of alternatives to open burning, consider the full life-cycle emissions and impact on air quality.

The District has continued to utilize lessons learned from the summit and other related efforts to move forward with the Board's direction to seek out additional opportunities to addressing agricultural managed burning and promote cleaner alternatives.

4 Technological and Economic Feasibility Analysis of Affected Crop Categories and Recommendations

For postponed crop categories where a technologically feasible alternative exists, the District must perform an analysis that determines the cost and economic feasibility of implementing alternatives in order to consider postponement of those categories. The District has reviewed the technologically feasible alternatives for each of the affected agricultural crops in the Valley. While there are several other emerging technologies and alternatives, the District has performed an analysis of the economic feasibility of the most viable and likely alternative methods to open burning, which are:

- On-site chipping and soil incorporation of the material,
- Trucking the material to Valley biomass plants for incineration, and
- Trucking the material to Valley facilities for composting

The District estimated the per-acre costs for each alternative method, based on the appropriate technique for that specific crop and practice, and considering economies of scale. The cost estimates used to determine the economic feasibility of the selected alternatives could include capital costs, maintenance costs, and operational costs.

The District worked closely with stakeholders during this research process to ensure the costs of the alternatives were identified and characterized properly in this report. The District consulted agricultural industry representatives, growers in the Valley, contractors providing related services, and other government agencies to gather the information. Many of the growers and contractors the District communicated with participated in the District's open burning permitting program and the District's Ag Burn Alternative grant program.

In accordance with state law, the District has conducted an economic feasibility analysis of the potential impacts of the burning prohibitions, consistent with prior evaluations under Rule 4103 and CARB concurrence. The basis of the analysis is a comparison of costs of the likely non-burning alternatives to net profits (Return on Sales, or ROS) for each crop type. The analysis compares the per-acre costs for each alternative to the per-acre net profit for each crop category, utilizing the 10 percent significant threshold established in prior evaluations and for other District and CARB regulatory efforts. The 10 percent threshold utilized in this analysis represents the economic significance level utilized by the District in the development of District rules, and represents the level that a regulatory action would pose a significant economic impact to affected sources. More specifically, the criteria for determining the level of "significance" of economic impact for District rulemaking projects is a ten percent change in ROS. The ten percent threshold was based on the parameters of accepted methodologies discussed in a 1995 CARB report called "Development of a Methodology to Assess the Economic Impact Required by SB 513/AB 969" (by Peter Berck, PhD, UC Berkeley Department of Agricultural and Resources Economics, Contract No. 93-314, August, 1995). One methodology described in the report relates to determining a level below or above which a rule and its

associated costs is deemed to have significant economic impacts.

If the cost of implementing the alternative exceeds ten percent of the crop category's net profit, the District may recommend a temporary postponement of the burn prohibition for that specific crop/material. While the 10 percent threshold is an important metric in identifying the economic feasibility of potential alternatives, additional information was taken into consideration in the 2020 Report. For the purpose of this evaluation, in addition to reviewing the economic feasibility for each crop type (cost of alternatives as percentage of net profit), the District also took into account increasing adoption rates of new alternatives and potential local, state, and federal incentives that may make the transition towards cleaner alternatives feasible over time.

To support this 2020 Report, the District contracted with a socioeconomic consultant, Eastern Research Group (ERG), to assist the District in conducting the economic feasibility analysis, including developing revenues and net profit for each crop type under review in the economic feasibility analysis. ERG has familiarity with and access to comprehensive production, revenue, and profitability data. The specific methodology and detailed analysis is attached as Appendix C. The District's incremental cost analysis by crop category are shown in the tables in Appendix B.

High-level summaries of the economic feasibility analysis for each crop category and potential alternatives are included in the below tables:

Table 4-1: Soil Incorporation Alternative Economic Feasibility Summary

Open Burn Category	Crop Category	Farm Size (Acres)	Cost/Profit (%)
Vineyard Removal	Grapes - Raisin	< 100	50%
Vineyard Removal	Grapes - Raisin	≥ 100	43%
Vineyard Removal	Grapes - Table	< 100	21%
Vineyard Removal	Grapes - Table	≥ 100	19%
Vineyard Removal	Grapes - Wine	< 100	57%
Vineyard Removal	Grapes - Wine	≥ 100	49%
Vineyard Removal	Kiwi	< 100	10%
Vineyard Removal	Kiwi	≥ 100	10%
Orchard Removal	Citrus	< 100	17%
Orchard Removal	Citrus	≥ 100	15%
Surface Harvested Prunings	Almond, Pecan, Walnut	< 100	18%
Surface Harvested Prunings	Almond, Pecan, Walnut	≥ 100	12%

Table 4-2: Biomass Alternative Economic Feasibility

Open Burn Category	Crop Category	Farm Size (Acres)	Cost/Profit (%)
Orchard Removal	Citrus	< 100	20%
Orchard Removal	Citrus	≥ 100	18%

Table 4-3: Composting Alternative Economic Feasibility

Open Burn Category	Crop Category	Farm Size (Acres)	Cost/Profit (%)
Orchard Removal	Citrus	< 100	31%
Orchard Removal	Citrus	≥ 100	28%

4.1 Field Crops

Per District Rule 4103, field crops includes alfalfa, asparagus, barley stubble, beans, corn, cotton, flower straw, hay, lemon grass, oat stubble, pea vines, peanuts, rice stubble, safflower, sugar cane, vegetable crops, and wheat stubble, and other field crops, as determined by the State Board. The table below identifies the historic open burning tonnage, which has increased since prior to SB 705.

Table 4-4: Field Crops Tonnage Burned Averages

Crop Category	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)
Field Crops	63,014	5,317	1,684

All field crops have previously been prohibited from open burning with the exception of rice. The categories related to rice crops are shown in the table below.

Table 4-5: Field Crops Under 2020 Review

Field Crops Under 2020 Review
Rice stubble up to 70% of the total acreage of rice farmed by the operator per year
Residual rice stubble (left over stubble after baling)
Spot burning of rice stubble (rice stubble compacted due to mobile equipment)
Burning of weeds and vegetative materials on rice field levees and banks

Table 4-6: Estimated Reductions

Crop Category	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)	Estimated Reductions from 2020 Report (tons/yr)
Field Crops	63,014	5,317	1,684	0

Recommendation:
The District has considered the factors currently impacting the alternatives for disposing rice stubble, and recommends the following:

- Effective January 1, 2021, prohibit open burning of 75% of rice stubble total acreage of rice farmed by the operator per year (Reduces acreage allowed to burn from 70% down to 25%)
- Effective January 1, 2021, prohibit burning of residual rice stubble (left over stubble after baling)
- Effective January 1, 2021, prohibit spot burning of rice stubble (rice stubble compacted due to mobile equipment)
- Continue delayed prohibition of burning of weeds and vegetative materials on rice field levees and banks

Discussion:
Most of the rice grown in the San Joaquin Valley is grown in the northern part of the air basin. Rice is planted in the spring and harvested in the fall. Once the rice is harvested, the rice straw remains in the field for disposition. Reducing the amount of post-harvest straw residue in the rice fields is important to the successful production of the next crop. Burning has been the historical cultural practice for removing straw and residues for the California rice industry. Burning rice straw helps prepare the field for the next rice crop as burning destroys any diseases in the rice straw of the current crop. The University of California Agronomy Research & Information Center on Rice explains the many types of diseases that can grow from improper preparation of rice fields, including but not limited to Bakanae, Stem Rot, Rice Blast, and Kernel Smut. As a result, it is imperative that rice growers are able to burn a portion of their field as post-harvest straw residue builds up.

The farming operations for rice growers in the San Joaquin Valley are different from Sacramento Valley growers, where significant acres of rice are also farmed. Rice growers in the Sacramento Valley dispose the majority of their rice straw by incorporating the rice straw into the soil. California Health and Safety Code § 41865 allows up 25% of the rice acreage farmed by the operator per year to be burned in the Sacramento Valley.

In the Valley there are very small specialty markets for two other alternatives for rice straw. One such alternative is utilizing the rice straw as cattle feed. Only certain cattle will eat rice straw, the straw needs to be processed and mixed at a specific moisture contents, as well as being chopped into specific sizes for feed. The other alternative is utilizing the rice straw as erosion control by packing and rolling the straw into long tubular rolls called rice wattles. Wattles then can be laid out to control sediment and prevent soil erosion.

According to the District's burn data for rice stubble, residual rice stubble, and spot burning of rice stubble, the acreage of rice stubble burned has significantly reduced,

with the average acreage burned from 2015 through 2019 at 547 acres (1,580 tons) annually. Due to this decrease in open burning of rice stubble from the baseline, the District is recommending to lower the acreage of each farm allowed to burn from 70% to 25%. This will align the District's burn requirements with the California Health and Safety Code Section 41865, which applies to the Sacramento Valley Air Basin, where approximately 98% of the rice acreage in the state is grown.

Additionally, tons burned of residual rice stubble (stubble left over after baling) and spot burning of rice stubble (rice stubble compacted due to mobile equipment) have been decreasing since 2006 and have been reduced to zero tons per year in the Valley in the last five years. Due to this absence in burning of residual rice stubble and spot burning of rice stubble, the District is recommending to prohibit burning for both categories.

Lastly, the District is recommending continued open burning prohibition postponement for weeds and vegetative materials on rice field levees and banks. Landowners and operators have considered using hand crews for removing weeds but found the alternative to be impractical. Landowners and operators typically mow and spray most of the weeds or use flame desiccation, for direct heating of residual weed foliage and over growth of weeds to assure the destruction of weed seeds. In remote locations, such as rice field levees and banks, fire is the only option for effective control of weed seeds and for safety of workers.

In addition, burning weeds is the most effective option to slope the banks to stabilize them and allow the water to flow easily, with less erosion. Rodents, such as gophers, have also been a concern around levees, including some ground squirrels that have bored through entire levees. Standing weeds make it nearly impossible to check the banks for rodents, which can cause ditch breaks or erosions and lead to flooding of surrounding areas. Prohibition of open burning in these areas could also increase additional use of other chemicals for pest control.

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. Remaining postponement due to disease issues
2. Prohibitions reinforce declining open burn acreage for rice stubble
3. Align rice straw prohibitions with state law for Sacramento Valley
4. District received no open burn requests for residual rice stubble; phase-out reinforces transition to non-baling practices
5. District received no open burn requests for spot burning of rice stubble; phase-out reinforces transition to non-baling practices
6. No feasible alternative as mowing and herbicides are not viable alternatives due to slopes and water contamination issues

4.2 Prunings (not including surface harvested crops)

Prunings are the vegetative material produced from the regularly scheduled removal of any portion of the agricultural crop for the purpose of achieving a desired size, shape, or to promote plant growth for improved cultivation, harvesting, and the maintenance of crop health. The regularly scheduled removal does not include the incidental cuttings of dead or broken branches, water-sprouts or suckers, and other damaged crops. This category includes prunings from apple crops, apricot crops, avocado crops, bushberry crops, cherry crops, Christmas trees, citrus crops, date crops, eucalyptus crops, fig crops, kiwi crops, nectarine crops, nursery prunings, olive crops, pasture or corral trees, peach crops, pear crops, persimmon crops, pistachio crops, plum crops, pluot crops, pomegranate crops, prune crops, quince crops, rose crops, and other prunings, as determined by the State Board. The table below identifies the historic open burning tonnage, which has increased since prior to SB 705.

Table 4-7: Prunings Tonnage Burned Averages

Crop Category	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)
Prunings	65,386	1,280	428

All crop type prunings have been prohibited from open burning with the exception of apple, pear, and quince, which are under 2020 review.

Figure 4-8: Prunings Under 2020 Review

Prunings Under 2020 Review
Apple, pear, and quince crops

Recommendation:
The District has considered the factors currently impacting the alternatives for disposing prunings from apple, pear, and quince crops and recommends the following:

- Continued prohibition postponement for prunings from apple, pear, and quince crops

Discussion:
Pome fruit including apple, pear, and quince crops are susceptible to a disease called fire blight. Fire blight is a destructive bacterial disease that kills blossoms, shoots, limbs, and sometimes the entire tree. Insects, wind, and mechanical devices can spread fire blight. According to agricultural representatives and agricultural commissioners, fire blight can destroy an entire orchard in a single season if left uncontrolled. The bacterium can be easily transmitted to susceptible tissue by contact.

The equipment used to prune the trees are routinely sterilized with antibacterial agents when moving from one tree to the next to mitigate exposure to the disease or potential disease. The unrestricted movement of infected tissue will cause the disease to spread rapidly and under certain environmental conditions (hot and wet). Containment of the infected tissue is an essential element for control. Farmers can utilize pest management strategies to attempt to limit the spread of bacteria, including pruning cankers in the winter and growing season, apply control products, and develop a balanced nutrition program. Pruned cankers must be removed and burned each winter before any normal dormant pruning occurs.[1]

Apple, pear, and quince prunings are burned to combat further spread of fire blight within orchards and to prevent potential infection of nearby orchards. Under the District's SMS, an average of 182 acres (428 tons) of apple, pear, and quince prunings were burned annually from 2015 to 2019 (over 98% reduction from historical practice). Operators and county agricultural commissioners have indicated that there is a lack of effective treatment for fire blight. Chemicals that are used to control the bacterial disease could prove ineffective if the disease becomes resistant over time. According to agricultural commissioners, the options for controlling fire blight that is becoming resistant to chemical means of control with Streptomycin are burning on site or disposal by placing infected plant material in double plastic bags for burial.

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. No technologically feasible alternative due to disease issues, specifically fire blight

4.3 Weed Abatement

Weed abatement refers to the reduction or removal of noxious weeds and grasses. Weed abatement includes, but is not limited to, berms, Bermuda grass, fence rows, grass, pasture, and ponding or levee banks. The District has phased out open burning of berms, Bermuda grass, fence rows, grass and pasture. The table below identifies the historic open burning tonnage, which has increased since prior to SB 705.

[1] https://www.agr.gc.ca/eng/agriculture-and-the-environment/agricultural-practices/agricultural-pest-management/agricultural-pest-management-resources/integrated-management-of-fire-blight-on-apple-and-pear-in-canada/?id=1544193381450

Table 4-9: Weed Abatement Tonnage Burned Averages

Crop Category	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)
Weed Abatement	10,234	268	101

The weed abatement activities under 2020 review are identified below.

Table 4-10: Weed Abatement Materials Under 2020 Review

Weed Abatement Materials Under 2020 Review
Weed abatement activities affecting ponding and levee banks

Recommendation:
The District has considered the factors currently impacting the weed abatement activities affecting surface waterways, including ponding and levee banks and recommends the following:

- Continued prohibition postponement for weed abatement activities affecting surface waterways, including ponding and levee banks

Discussion:
While some weeds and locations lend themselves to Best Management Practices, there remains a need for limited burning of some weeds. As mentioned earlier, this analysis does not include the category for "other weeds and maintenance". The CH&SC required the District to establish best management practices in 2005 for the control of other weeds and maintenance, which includes ditch bank work, canal bank work, dodder weed, star thistle, tumbleweeds, noxious weeds, pesticide sacks, and fertilizer sacks. Since the implementation, landowners and irrigation districts have continued to do their part to reduce burning by seeking alternative ways to manage weeds. The best management practices in the rule were developed in collaboration with affected sources and are alternatives that must be considered prior to any open burning. Landowners and operators have also opted for more mechanical and chemical control of weeds and only burned at times when conditions, such as remote locations or other requirements, prevent other alternative practices.

Since 2005, open burning has no longer been allowed for weed abatement activities from berms, fence rows, pasture, grass and Bermuda grass. However, open burning is currently allowed for weed abatement activities affecting surface waterways, including ponding and levee banks. Under the District's SMS, an average of 46 acres (101 tons) of weeds affecting ponding and levee banks were open burned annually from 2015 to 2019. The following materials are not considered to be part of the burn allowance for weed abatement activities affecting surface waterways, ponding, and levee banks: 1)

weeds that originate from outside and away from the surface waterways, ponding or levee banks and 2) any other debris or materials that are gathered from surface waterways, ponding, or levee banks, such as tree limbs or foreign materials.

There are currently no feasible alternatives to burning all of the weeds along surface waterways, ponding and levee banks. Landowners and operators typically mow and spray most of the weeds or use flame desiccation, for direct heating of residual weed foliage and over growth of weeds to assure the destruction of weed seeds. In many remote locations along surface waterways, ponding, and levee banks, fire is the only option for effective control of weed seeds and for safety of workers.

In addition, burning weeds is the most effective option to slope the banks to stabilize them and allow the water to flow easily, with less erosion. Rodents, such as gophers, have also been a concern around levees, including some ground squirrels that have bored through entire levees. Standing weeds make it nearly impossible to check the banks for rodents, which can cause ditch breaks or erosions and lead to flooding of surrounding areas. Complete prohibition to open burning in these areas could also increase additional use of other chemicals for pest control.

The Federal EPA and the State and Regional Water Boards continue to push to eliminate the use of chemicals near any waterway. Recognizing these issues, many landowners and operators are controlling the use of chemicals along surface waterways, ponding, and levee banks due to concerns over runoff of chemicals from land to waterways. The California Porter-Cologne Water Quality Act regulates the discharge of waste into ambient waters, and authorizes Regional Boards to impose requirements on waste dischargers after consideration of several factors. Along with other responsibilities, the Regional Boards also regulate all pollutant or nuisance discharges that may affect either surface water or groundwater. One of the purposes of the federal Water Pollution Control Act (or Clean Water Act) is to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint pollution sources.

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. No feasible alternative as mowing and herbicides are not viable alternatives due to slopes and water contamination issues

4.4 Orchard Removals

Orchard removals includes, but are not limited to, orchard removal matter, stumps, and untreated sticks. The table below identifies the historic open burning tonnage, which has increased since prior to SB 705.

Table 4-11: Orchard Removals Tonnage Burned Averages

Crop Category	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)
Orchard Removals	273,589	130,929	152,545

The District has prohibited open burning from for all orchard removals except the remaining categories as listed below:

Table 4-12: Orchard Removals Under 2020 Review

Orchard Removals Under 2020 Review
Orchard removals > 15 acres at agricultural operations whose total citrus acreage at all agricultural operation sites is < 3,500 acres on a case-by-case analysis based on economic feasibility and availability of alternatives
Apple, pear, and quince crops
Orchard removal matter from ≤ 15 acre open burns at a single location, per calendar year

The table below is a summary of the orchard removal study results, including economic feasibility.

Table 4-13: Orchard Removal Study Results

Crop Category	Potential Alternative	Farm Size (Acres)*	Incremental Cost Increase ($/Acre)	Cost / Profit (%)
Citrus	Soil Incorporation	< 100	$878	17%
Citrus	Soil Incorporation	≥ 100	$860	15%
Citrus	Biomass Incineration	< 100	$1,015	20%
Citrus	Biomass Incineration	≥ 100	$1,006	18%
Citrus	Composting	< 100	$1,615	31%
Citrus	Composting	≥ 100	$1,606	28%

**Average citrus farm sizes <100 acres is 38.5 acres;*
Average citrus farm sizes ≥ 100 acres is 283.9 acres.

Table 4-14: Estimated Reductions

Crop Category	Remaining Postponement Category	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)	Estimated Reductions from 2020 Report (tons/yr)
Orchard Removal	Apples, pears, and quince	273,589	130,929	152,545	53,592
	Small orchard removals less than 15 acres				
	Citrus orchard removals greater than 15 acres at operations with combined citrus acreage of less than 3,500 acres on a case-by-case basis where alternatives are not feasible				

4.4.1 Citrus

Recommendation:
Currently open burns for any orchard removals at citrus farms whose total citrus acreage in the Valley is ≥ 3,500 acres is prohibited. Citrus removal open burns greater than 15 acres at citrus farms whose total citrus acreage in the Valley is < 3,500 acres are allowed if, on a case-by-case basis, the District concurs that there are no economically feasible or available alternatives to open burning. As shown in the table above, there are no economically feasible alternatives to open burning, with incremental cost increases ranging from $860 to $1,315 ($/acre), and cost to net profit impacts ranging from 15% to 25%.

However, to ensure the continued downward trend of citrus open burning acreage in the Valley and continue the deployment of new alternatives including soil incorporation, as supported and made feasible through existing and new incentive programs (District, USDA-NRCS, CDFA), the District recommends the following phase-out of citrus orchard open burns greater than 15 acres, as follows:

- Effective January 1, 2021, prohibit open burns for citrus orchard removals at agricultural operations whose total citrus acreage at all agricultural operation sites is greater than 500 acres; and citrus orchard removals greater than 40 acres at a single location per year; maintain case-by-case determination for removals greater than 15 acres and less than or equal to 40 acres at agricultural operations whose total citrus acreage at all agricultural operation sites is less than or equal to 500 acres.

- Effective January 1, 2022, prohibit open burns for citrus orchard removals at

agricultural operations whose total citrus acreage at all agricultural operation sites is greater than 200 acres; and citrus orchard removals greater than 30 acres at a single location per year; maintain case-by-case determination for removals greater than 15 acres and less than or equal to 30 acres at agricultural operations whose total citrus acreage at all agricultural operation sites is less than or equal to 200 acres.

- Effective January 1, 2023, prohibit all citrus orchard open burns, except for small orchard removals ≤ 15 acres as provided through small orchard removal allowance for all orchards.

Discussion:
Citrus orchard open burn tonnage has been decreasing over the past five years. While the citrus acreage in the Valley has remained relatively steady, open burns have been decreasing due to several reasons: 1) an increased number of no-burn days per year due to wildfires and carefully managed burn allowances under SMS, 2) growers utilizing the District's grant program to incentivize soil incorporation of the material (approximately $500,000 in executed grants to incorporate 835 acres over the past two years), and 3) growers utilizing other alternatives such as biomass and composting on a more limited basis.

There was an average of 1,786 acres (53,592 tons) of citrus orchard removals >15 acres from 2015 through 2019. These open burns will be completely phased-out on the basis that there are viable alternatives in place such as biomass capacity, available contractors for soil incorporation, and grants to incentivize soil incorporation or other alternatives. The table below identifies the estimated total acres removed annually, including the percent of reductions due to the two-year phase out. As shown in the table below, the District is proposing to reduce open burning from citrus removals > 15 acres by 100%, which represents a 35% reduction from the orchard removal category.

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. No economically feasible alternatives to open burning without incentives and wider availability of contractors

2. To reinforce transition to cleaner emerging alternatives, District recommends a two-year phase-out as supported and made feasible through existing and new incentive programs (District, USDA-NRCS, CDFA)

4.4.2 Apple, Pear, Quince

Recommendation:
The District has considered the factors currently impacting the alternatives for disposing of orchard removals for apple crops, pear crops, and quince crops and has determined that there are currently no feasible alternatives that would substitute open burning of these crops. The open burn alternatives introduce a potential of spreading of a prevalent common bacteriological disease associated with these crops.

The District has considered the factors currently impacting the alternatives for disposing of orchard removals from apple, pear, and quince crops and recommends the following:

- Continued prohibition postponement for orchard removal open burns from apple, pear, and quince

Discussion:
As mentioned above for prunings from pome fruits, crops such as apples, pears, and quince are susceptible to fire blight, a bacteriological disease that can spread through insects, wind, and mechanical devices and kills blossoms, shoots, limbs, and sometimes the entire tree. In most cases, the on-set of fire blight is unidentifiable and can be spread by contact or exposure to other healthy orchard material. For orchard removals, the equipment used to cut or remove the tree are also routinely sterilized with antibacterial agents to mitigate exposure to the disease or potential disease.

Similar to pruning, orchard removals from apple, pear, and quince crops need to be burned to combat further spread of fire blight within orchards and to prevent potential infection of nearby orchards. Farmers can utilize pest management strategies to attempt to limit the spread of bacteria, including pruning cankers in the winter and growing season, apply control products, and develop a balanced nutrition program. Pruned cankers must be removed and burned each winter before any normal dormant pruning occurs.[2]

As indicated by some operators and county Ag commissioners, they are not aware of an effective treatment for fire blight. Growers have considered chipping the orchard removals and transporting the materials to biomass facilities. However, the primary concern with each of the alternatives is spreading the disease.

As a result, burning is the preferred and most viable method used in the Valley to dispose of these crops in order to avoid potential spread and exposure of the fire blight disease. Under the District's SMS, an average of 188 acres (5,646 tons) of apple, pear, and quince orchard removals were open burned annually from 2015 to 2019.

[2] https://www.agr.gc.ca/eng/agriculture-and-the-environment/agricultural-practices/agricultural-pest-management/agricultural-pest-management-resources/integrated-management-of-fire-blight-on-apple-and-pear-in-canada/?id=1544193381450

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. No technologically feasible alternative due to disease issues, specifically fire blight.

4.4.3 Less than 15 Acre Orchard Removals

Recommendation:
The District has considered the factors currently impacting the alternatives for disposing of orchard removal materials from orchards 15 acres or less and recommends the following:

- Continued prohibition postponement for orchard removal open burns 15 acres or less at a single location, per calendar year

Discussion:
The availability of contractors for small orchard removals remains an issue. Generally, small acreage growers are not a priority for chipping operators, and in many cases not available. Due to the nature of small orchards, contractors typically require a minimum charge (or move-in fee) that is infeasible for small operations. The move-in fee covers travel time and distance of hauling heavy-duty equipment such as bulldozers, excavators, grinders, and wheel loaders to the job site, and is typically $5,000. Growers are then also responsible for a per-acre charge for the contractor to operate and maintain the equipment. In fact, chipping operators typically refuse certain small jobs, making it difficult for growers to remove small acreages from orchards. As a result of the minimum charge, the per acre cost for such small removals increases as the acreage becomes smaller. The fee could vary among chipping operators and is dependent on the availability of chipping contractors, storage at biomass power plants, the crop type and density, topography, soil type, and location.

Growers have indicated that when chipping operators work on small acreage jobs, they are often forced to wait until the chipping operator plans to be in the area. This can cause significant delays in fumigation, land preparation, irrigation, and planting. Trees must be ordered a year in advance. When the land is not prepared in time for the trees to be planted, these young trees die, at a large cost to the grower.

The biomass industry also struggles to provide consistent service to growers needing timely removal of material to ensure the land is ready for the next planting season. In the past, lack of coordination and available storage for biomass fuels has caused uncertainty over the timing of material removal. The inability to guarantee consistent acceptance of agricultural biomass offers further confirmation that remaining crop categories should be allowed to continue open burning.

Some agricultural operations have been able to utilize soil incorporation as an alternative with the recent development of the District's Alternative to Agricultural Open Burning incentive program; however, the incremental cost is significant and renders the alternative infeasible without incentives to offset the cost, particularly for smaller removals for all of the same reasons mentioned above. For illustrative purposes, as seen in Appendix B, for citrus orchard removals, utilizing soil incorporation as an alternative practice is not economically feasible without the use of incentives, notwithstanding all of the other reasons that continue to render this category difficult to address due to infeasibility.

Due to the infeasibility of alternatives, the District has allowed open burning of small orchard removals through the District's SMS. An average of 3,110 acres (93,307 tons) of orchard removals 15 acres or less were open burned annually from 2015 through 2019. As the issues with available alternatives have not changed and have only been exacerbated with the decline of biomass power options, the District is recommending to continue postponing the prohibition for small orchard removals of 15 acres or less.

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. The availability of contractors for small orchard removals remains an issue
    - Small removals are not a priority for contractors
    - Contractors may decline small acreage removals
    - Wait times for contractors become extended

2. In addition to contractor availability, the cost-per-acre of alternatives is not economically feasible for small orchard removals due to fixed and minimum contractor costs.

4.5 Vineyard Removals

Vineyard removal materials is agricultural waste generated by the removal of vineyards. This includes grape vines, grape canes, trunks, roots, untreated grape stakes, and wires, as well as similar materials from kiwi vineyards. There no existing prohibitions for this category. The table below identifies the historic open burning tonnage, which has increased since prior to SB 705.

Table 4-15: Vineyard Removals Tonnage Burned Averages

Crop Category	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)
Vineyard Removals	224,871	253,255	393,422

Table 4-16: Vineyard Removals Under 2020 Review

Vineyard Removals Under 2020 Review
Vineyard removal materials from grape crops (raisin, table, wine)
Vineyard removal materials from kiwi crops

The table below is a summary of the vineyard removal study results, including technological and economic feasibility.

Table 4-17: Vineyard Removal Study Results

Crop Category	Potential Alternative	Farm Size (Acres)*	Incremental Cost Increase ($/Acre)	Cost / Profit (%)
Grapes - Raisin	Soil Incorporation	< 100	$1,218	50%
Grapes - Raisin	Soil Incorporation	≥ 100	$1,204	43%
Grapes - Table	Soil Incorporation	< 100	$1,218	21%
Grapes - Table	Soil Incorporation	≥ 100	$1,204	19%
Grapes - Wine	Soil Incorporation	< 100	$1,218	57%
Grapes - Wine	Soil Incorporation	≥ 100	$1,204	49%
Kiwi	Soil Incorporation	< 100	$1,217	10%
Kiwi	Soil Incorporation	≥ 100	$1,206	10%

**Average grapes farm size <100 acres is 39.9 acres;*
Average grapes farm size ≥ 100 acres is 477.7 acres;
Average kiwi farm size <100 acres is 43.1 acres;
Average kiwi farm size ≥ 100 acres is 183.1 acres

Table 4-18: Estimated Reductions

Crop Category	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)	Estimated Reductions from 2020 Report (tons/yr)
Vineyard Removals	224,871	253,255	393,422	118,027

Recommendation:
Currently all vineyard removals are eligible for managed burning under SMS. As shown in the table above, there are no economically feasible alternatives to open burning, with incremental costs for soil incorporation is approximately $1,200/acre, with cost to net profit impacts ranging from 10% to 57% depending on crop type and farm size. However, to reduce open burning from vineyard removals, the District is recommending the following phased approach:

- Postponement of prohibition through December 31, 2021, in conjunction with launch of Vineyard Removals Alternatives Partnership with CARB, USDA-NRCS, and agricultural stakeholders to develop alternatives and provide funding for the deployment of feasible alternatives to the open burning of vineyards, including wire removal/soil incorporation, air curtain incinerators, and other alternative practices.

- Effective January 1, 2022, phase-out of open burning of grape and kiwi vineyard removals greater than 15 acres for vineyards that lend themselves to feasible alternatives (wire removal/soil incorporation, air curtain incinerators, etc.), through case-by-case approval that takes into account the availability of contractors and incentive funding (request CARB concurrence through December 31, 2025)

Discussion:
Vineyards include both grape vines and kiwi vines because both crops require support, such as the trellis systems to help keep the fruits off the ground. Grape vines are used to produce table grapes, wine grapes or raisin grapes. The cultural practices and the type of trellis system used at a vineyard are based on the intended use of the grapes (table, wine, or raisins) and other factors. In addition to the vine and trellis wire, a vineyard may contain cross arms, as well as metal or wooden stakes and posts. Treated stakes (sometimes with metal braces) cannot be chipped and must be taken to a landfill. The posts currently used are predominantly made out of steel. Metal stakes are removed before chipping. The end posts can also be made out of redwood which can be burned. Farmers either practice cane pruning or spur pruning depending on the vineyard type and other cultural practices. A likely alternative scenario for certain types of vineyard removals is soil incorporation of the material. Vineyard materials are not accepted at biomass or composting facilities due to the potential presence of wires in the material.

<u>Cane Pruned Vineyards</u>
Grapes only grow on vines that are growing in that same year (less than one year old canes). The canes in these vineyards do not mature into the thicker woody vines in spur-pruned (cordon) vineyards since they are pruned annually, and a result, the training wire does not become embedded into the cane. Growers are able to prune these vineyards in preparation to remove the support system including the training wires. Upon completion of pruning, end posts, stakes and wires can be completely

removed. In this scenario, the entire vineyard is available to the grower to chip and incorporate the material back into the soil. In conversation with agricultural stakeholders, this type of vineyard removal scenario is estimated to represent approximately 30% of the vineyard acreage in the Valley.

A recent practical example of the potential for vineyards to utilize soil incorporation as an alternative is the District's Pilot Alternatives to Ag Burn program. Beginning in 2019, growers in the Valley have been utilizing this pilot program, which provides growers $600/acre for a maximum of 100 acres, to remove vineyards and incorporate the material back into the soil. The program has funded $1.9 million dollars for growers to incorporate 3,336 acres (50,040 tons) of vineyard removal material back into the ground. The growers participating in this program managed cane pruned type vineyards. The participation from grape growers in this pilot grant program make up 13% of the total $13.5 million dollars awarded under this program.

Figure 4-1: Drawing of a Cane Pruned Vine[3] and Photo of Cane Pruned Vine[4]

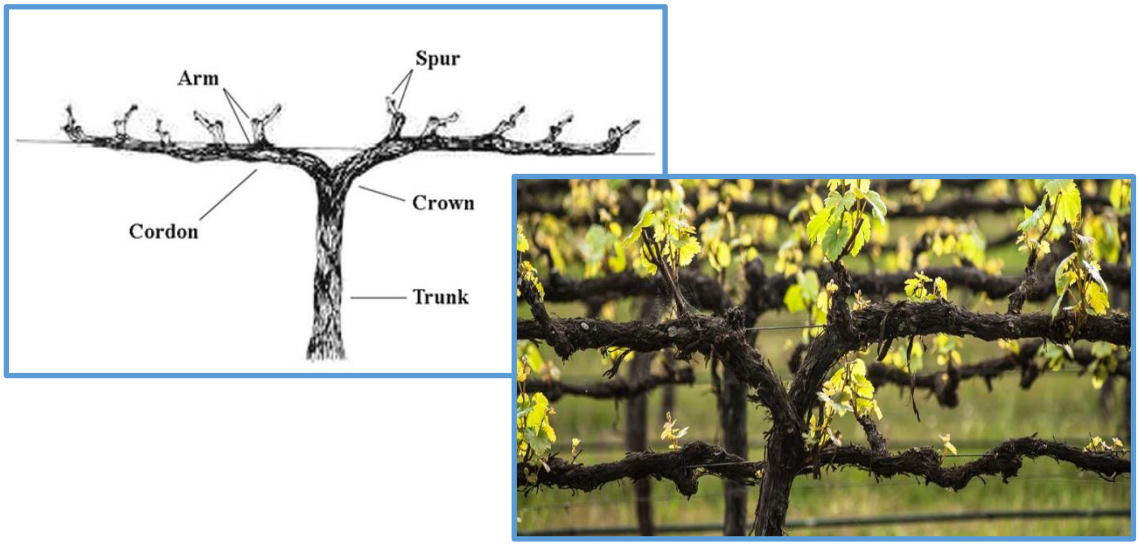
Spur Pruned (Cordon) Vineyards

Spur pruned (cordon)-type vineyards result in the trellis/training wire becoming embedded in the mature cordon woody vines. Due to the fact that the wire is embedded in the woody vine, separating the wire from the wood is completely infeasible at this time. There are no feasible open burn alternatives for spur pruned (cordon)-type vineyards for numerous reasons: 1) manually clipping out the exposed wire would result in some of those wire clippings to fall to the ground resulting in a dangerous hazard for workers walking around in the field, 2) the labor involved with clipping and gathering all exposed cordon wire and wire-embedded cordon material would be extremely high, 3) woody cordon vines will still have embedded wire in them, which makes chipping the

[3] https://www.wineshopathome.com/grapevine-pruning/
[4] https://www.virtualviticultureacademy.com/grower-guides/cane-pruning-with-renewal-spur/

wood and soil incorporation technologically infeasible since the wire will damage the chippers/grinders, 4) hauling wire-embedded cordon vines to biomass plants or other types of facilities is infeasible since the cordon would not be able to be chipped first, 5) biomass plants and other types of facilities will not take in wire-embedded vines since the wire will damage chippers/grinders, and 6) there has been no demonstration of a successful alternative to open burning for this type of vineyard.

Figure 4-2: Drawing of a Spur Pruned Vine[5] and Photo of Spur Pruned Vine[6] with Embedded Wire



Although cane pruned vineyards may lend themselves to removing the wire to implement alternatives, in some cases it is prohibitively expensive for farmers to remove their trellis systems. In the case that the farmer is implementing an alternative and has to remove their costly trellis system, there would be additional costs per acre as the farmer would have to invest again to rebuild the system. Due to this issue, the District is recommending that open burning phase-outs only apply to vineyards that lend themselves to feasible alternatives through a case-by-case approval.

The District recommends postponement of a burn prohibition for vineyard removals through December 31, 2021, in order to develop an Alternative to Vineyard Open Burning Partnership Program with CARB, USDA-NRCS, and agricultural stakeholders. The focus of this effort will be twofold: 1) develop feasible open burn alternatives and provide funding for the deployment of these alternatives, and 2) provide the framework for evaluating case-by-case feasibility determinations upon open burn requests. The program will explore all feasible alternatives to the open burning of vineyards, including wire removal/soil incorporation, air curtain incinerators, and other alternative practices.

This phase-out is also dependent on the availability of contractors for soil incorporation,

[5] https://www.wineshopathome.com/grapevine-pruning/
[6] https://www.groworganic.com/blogs/articles/tips-on-spur-and-cane-pruning-your-grape-vines

grants to incentivize soil incorporation or other alternatives, and available offsite alternatives such as biomass and composting availability. In conversation with agricultural stakeholders, this type of vineyard removal scenario is estimated to represent approximately 30% of the vineyard acreage in the Valley.

The average annual vineyard removal acreage burned from 2015-2019 was 26,228 acres (393,422 tons). Estimating a 30% reduction in vineyard removal open burns results in a reduction of 7,868 acres per year (118,027 tons per year).

In conjunction with the proposed phase-out strategy, outreach to vineyard owners and operators will be critical. In support of the District's recommendations, staff will conduct outreach to educate vineyard owners and operators regarding potentially available alternatives and the District's incentive program and process. Given the up-front planning necessary to consider potentially available alternatives, it will be important that growers are aware of these alternatives and any available incentives prior to removing vineyards, which may limit or eliminate the feasibility of alternatives such as wire removal and soil incorporation.

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. No economically feasible alternatives to open burning without incentives.

2. Soil incorporation of certain vineyards has been demonstrated successful through District Pilot Grant Program ($1.9 million for 50,040 tons of vineyard removal material).

3. To transition to feasible cleaner emerging alternatives, District recommends phase-out effort supported through demonstration projects and incentive programs (District, USDA-NRCS, CDFA).

4.6 Surface Harvested Prunings

Surface harvested prunings are the vegetative material produced from the regularly scheduled removal of any portion of the agricultural crop for the purpose of achieving a desired size, shape, or to promote plant growth for improved cultivation, harvesting, and the maintenance of crop health. The regularly scheduled removal does not include the incidental cuttings of dead or broken branches, water-sprouts or suckers, and other damaged crops. Surface harvested prunings includes, but is not limited to, almond prunings, walnut prunings, pecan prunings, grape vines, and vineyard materials. The table below identifies the historic open burning tonnage, which has increased since prior to SB 705.

Table 4-19: Surface Harvested Prunings Tonnage Burned Averages

Crop Category	Crop Type	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)
Surface Harvested Prunings	Prunings	222,873	38,892	2,852
	Raisin Trays	1,357	795	640

For this report, the District will be reviewing the following remaining crops and materials:

Table 4-20: Surface Harvested Prunings Under 2020 Review

Surface Harvested Prunings Under 2020 Review
Raisin trays
≤ 20 acre open burns of prunings per year for almond, walnut, and pecan crops for agricultural operations whose total nut acreage at all agricultural operation sites is < 3,500 acres
> 20 acre open burns of prunings per year for almond, walnut, and pecan crops for agricultural operations whose total nut acreage at all agricultural operation sites is < 3,500 acres upon a case-by-case approval based on economic feasibility

Table 4-21: Surface Harvested Prunings Study Results

Crop Category	Potential Alternative	Farm Size (Acres)*	Incremental Cost Increase ($/Acre)**	Cost / Profit (%)	Technologically & Economically Feasible Alternative?
≤ 20 Acre Tree Nut Prunings	Soil Incorporation	< 100	$887	18%	No
> 20 Acre Tree Nut Prunings	Soil Incorporation	≥ 100	$714	12%	No

**Average tree nut farm size <100 acres is 41.9 acres;*
Average tree nut farm size ≥ 100 acres is 439 acres;
***Per-acre cost is based on 10 years of pruning*

The total estimated reductions including the recommendations outlined in this section are estimated below:

Table 4-22: Estimated Reductions

Crop Category	Crop Type	Pre-SB 705 Average Tons Burned/yr (2000-2005)	Average Tons Burned/yr (2006-2019)	Average Tons Burned/yr (2015-2019)	Estimated Reductions from 2020 Report (tons/yr)
Surface Harvested Prunings	Prunings	222,873	38,892	2,852	970
	Raisin Trays	1,357	795	640	640

4.6.1 Raisin Trays

Recommendation:
The District has considered the factors currently impacting the alternatives for open burning of raisin trays and recommends the following:

- *Postponement of prohibition through December 31, 2023, in conjunction with partnership effort to develop alternatives to raisin tray burning, including recycling options for raisin trays, and transition to cultural practices that do not utilize raisin trays*
- Effective January 1, 2024, open burning of raisin trays will be prohibited

Discussion:
Raisin trays are used in producing raisins. There are several types of drying trays used for sun-dried raisins. Wooden trays were used in the past, but were replaced by paper raisin trays or continuous rolls containing up to 5% of polymer or poly-coated paper. The polymer serves as a moisture barrier between the soil and the grapes and raisins to allow for proper drying of the raisins. Due to the polymer in the paper, these trays cannot be incorporated into the soil and are not accepted at biomass and composting facilities, and therefore have historically been open burned. Under the District's SMS, an average of 21,345 acres (640 tons) of raisin trays were open burned annually from 2015 to 2019.

Once the raisins have cured adequately and the moisture in the rolls is acceptable, normally in late September, they are ready to be collected. Raisins must be at 16 percent or less moisture content to meet the industry's incoming inspection requirements. There are several methods used for collecting the raisins and preparing them for the next step in their processing. After the raisins are collected, they are separated from the raisin trays for further processing and delivery to a raisin handler. Once the raisins are removed from the raisin trays, the raisin trays are ready for some other use or disposal.

Previously, the raisin trays contained polymer (5%) that historically made many identified alternatives infeasible. However, the percentage of polymer in trays has since decreased to less than 1%. Due to the decrease in polymer, the raisin trays are now

more environmentally friendly, which assists with the final disposition of this material. There are several alternatives that have been identified including soil incorporation, air curtain incineration, landfill, and recycling (pilot).

Growers have continued to pursue alternatives to burning raisin trays for over 50 years. Based on information received from agricultural representatives, the historical use of paper raisin trays has been significantly reduced due to the industry shift to continuous rolls that are shredded and to mechanical harvesting vineyards (no paper). Raisin tray acreage has reduced from 200,000 acres decades ago to less than 25,000 acres today. In consultation with agricultural representatives, the goal is to completely phase out the use of raisin trays, eliminating the need for disposal.

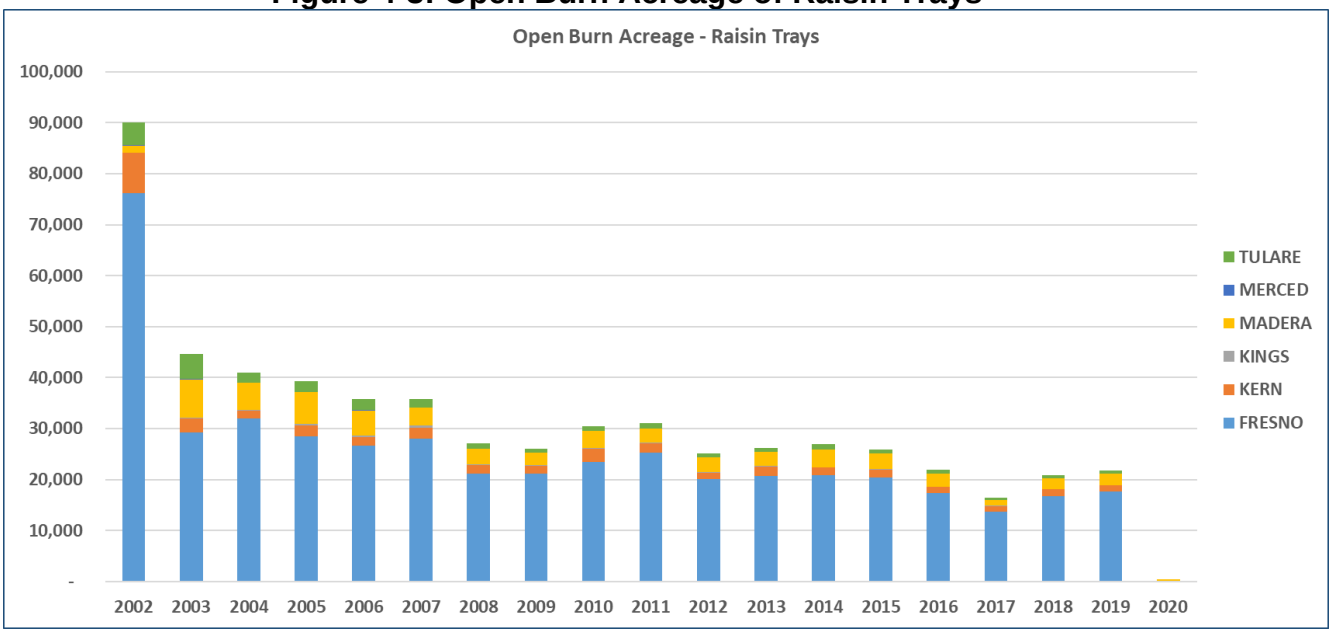
Soil Incorporation

The District evaluated soil incorporation as a potential alternative, which grinds up and reincorporates the shredded material back into the soil. Agriculture industry representatives stated the materials in the 1% polymer raisin trays must be incorporated deep into the soil to ensure the chipped material is not carried by wind onto other properties.

Recycling and Landfilling

The District and industry representatives are exploring the feasibility of recycling raisin trays, including exploring the potential development of a pilot project. The pilot research will be evaluating the current market for raisin trays to be sold to recyclers and potential feasibility issues with raisin residue remaining on the trays. The recycling market has faced a downturn in the last few years, due to increased stringency on the quality of materials received. In addition, the current market for cardboard-type material is not prevalent, therefore charges to pick up raisin tray material may not be feasible for growers. Through this pilot research, local disposal and pick up services will provide samples of trays to perform research options such as blending and selling material. As shown in the chart below, most raisin trays are open burned in Fresno County. In communication with a local Fresno County area recycler, there may be an issue with recycling due to raisin residue remaining on the trays. Another option available for these raisin trays is disposal at a landfill, however this is currently not in practice and is cost-prohibitive at this time.

Figure 4-3: Open Burn Acreage of Raisin Trays



Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. District recommendations reinforce ongoing phase-out of use of raisin trays by transitioning to other vineyard types and mechanical harvesting methods, eliminating the need for raisin tray disposal.

2. Raisin trays are now more environmentally friendly, which assists with the final disposition of this material.

3. The District and industry representatives are exploring the feasibility of recycling raisin trays, including exploring the potential development of a pilot project.

4.6.2 Surface harvested prunings of almond, walnut, and pecan crops

Recommendation:
As shown in Tables 4-1, 4-2, and 4-3, there are no economically feasible alternatives to open burning for almond, walnut, and pecan prunings, with incremental costs for soil incorporation ranging from $714 to $887 ($/acre over 10 years), and cost to net profit impacts ranging from 12% to 18%.

However, to ensure the continued downward trend of open burning acreage in the Valley and continue the deployment of new alternatives including soil incorporation, as supported and made feasible through existing and new incentive programs (District, USDA-NRCS, and CDFA), the District recommends the following three-year phase-out

of surface harvested prunings:

- Effective January 1, 2021, prohibit all open burning of total surface harvested prunings > 20 acres

- Effective January 1, 2022, prohibit open burning of total surface harvested prunings ≤ 20 acres at agricultural operations with a total nut acreage at all agricultural operations > 200 acres

- Effective January 1, 2023, prohibit open burning of total surface harvested prunings ≤ 20 acres at agricultural operations with a total nut acreage at all agricultural operations > 50 acres

Discussion:
Nut trees are usually pruned after harvesting, either late or early in the year. In the past, growers generally open burned nut prunings to dispose of the material. However, many growers have found alternative ways to convert prunings into something useful, such as soil amendment. Many nuts growers are currently shredding the prunings and leaving the materials on the orchard floor. The ability to shred the materials varies among growers of different size farms and regions, with commercial shredders potentially being infeasible due to either excessive cost or unavailability. Additionally, there are also concerns for this practice, including preventing the pruning material from interfering with the harvesting of the crop and potential build-up of chipped material on the ground. This situation can then cause the chipped material to be picked up during harvest. Although tilling could be done to bury the chipped material to promote faster decomposition, growers try to minimize the number of tractor passes in their orchards.

Leaving chipped material on the ground has caused issues during harvesting; therefore, many growers have mostly relied on removing the pruning material from the field and open burning the pruning material. Due to harvesting and pruning practices, there is a short window of opportunity to have these types of prunings chipped. Some growers usually find it more conducive to their operations to gather the prunings and burn them.

Further, the availability of contractors to chip, incorporate, or remove surface harvested prunings at small orchards remains an issue. Generally, small acreage growers are not a priority for chipping operators, and in many cases not available. Due to the nature of small orchards, contractors typically require a minimum charge (or move-in fee) that is infeasible for small operations. The move-in fee covers travel time and distance of hauling heavy-duty equipment to the job site and is typically $5,000. Growers are then also responsible for a per-acre charge for the contractor to operate and maintain the equipment. In fact, chipping operators typically refuse certain small jobs, making it difficult for growers to remove small acreages from orchards. As a result of the minimum charge, the per acre cost for such small removals increases as the acreage becomes smaller. The fee could vary among chipping operators and is dependent on the availability of chipping contractors, storage at biomass power plants, the crop type

and density, topography, soil type, and location.

Under the District's SMS, an average of 2,689 acres (2,852 tons) of almond, walnut, and pecan prunings were open burned annually from 2015 to 2019. The District concluded that operations above 50 acres are generally able to get contractors to chip their prunings, and the removals are large enough that the contractors will transport the chips to a biomass or composting facility so that the chips do not impose problems during harvest. Phasing out surface harvested pruning open burns for operations greater than 50 acres account for 34% of the acres and associated tonnage of material (902 acres and 970 tons of material).

Due to alternative practices and absence of burn requests for > 20 acres of almond, walnut, and pecan prunings over the last 3 years, the District is recommending to prohibit burning pruning > 20 acres beginning December 31, 2020.

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. No economically feasible alternatives to open burning without incentives

2. District recommendations reinforce ongoing transition for limited remaining pruning burning with ongoing allowance for small growers (less than 1% of historical prunings)

3. District recommendations supported and made feasible through existing and new incentive programs (District, USDA-NRCS, CDFA)

4.7 Other Materials

Other materials includes, but is not limited to brooder paper, deceased goats, and diseased beehives. The District has prohibited open burning from brooder paper and diseased goats, and therefore will only be evaluating diseased beehives in this report.

Table 4-23: Other Materials Under 2020 Review

Other Materials Under 2020 Review
Diseased beehives

Recommendation:
Several key considerations for diseased beehives are that the diseases could be dormant in the frames and used equipment, as well as develop resistance to chemicals used in the sterilization process. The CH&SC specifically identify this crop type as "diseased" bee hives. The District believes that there are currently no technologically feasible alternatives to open burning of diseased beehives at this time. The District

recommends that diseased beehives be allowed to continue to be burned.

Discussion:
Bees are a key component in the growing of crops. The U.S. Food and Drug Administration article[7] noted the importance of bees, estimating that "bee pollination accounts for about $15 billion in added crop value" in 2018. They went on to explain that "about one-third of the food eaten by Americans comes from crops pollinated by honey bees, including apples, melons, cranberries, pumpkins, squash, broccoli, and almonds". In light of this, it is vitally important to growers that the supply and availability of bees are protected to the highest degree possible.

Artificial beehives serve two purposes: production of honey and pollination of crops. The hives are commonly transported so the bees can pollinate crops in selected areas. Modern beehives are usually constructed of wood and consist of several parts, which include the following:

- Bottom board - this has an entrance for the bees to get into the hive.
- Brood box - is the most bottom box of the hive and is where the queen bee lays her eggs.
- Honey Super - same as brood box, but is the upper-most box where honey is stored.
- Frames and Foundation - wooden frame and plastic sheet with honeycomb impression where bees build wax honey combs.
- Inner and Outer Cover - As the name implies.

Beekeepers have experienced several problems in the past few years. A recent development is the problem of colony collapse disorder (CCD), a phenomenon where bees mysteriously abandon their hives. The U.S Department of Agriculture's website contains an article[8] dated May 13, 2015 about the loss of bee's due to CCD, written by Kim Kaplan. The article reports that "Annual colonies losses were 34.2 percent for 2013-14, 45 percent for 2012-2013, 28.9 percent for 2011-2012, and 36.4 percent for 2010-2011."

Section 29207-29208 of California Code of Regulations Title 3, Food and Agricultural Code, Division 13, Bee Management and Honey Production, requires that "If American foulbrood is found in an apiary, the abatement shall be by killing the bees in the infested colonies and disposing of the hives and their contents, together with any other infested comb, hives, and associated appliances which are found in the apiary, in one of the following ways: If abatement is by burning, the person abating shall act in accordance with applicable air pollution control district or air quality maintenance district regulations and state and local fire control laws. If the regulations or laws prohibit burning immediately, the diseased colonies shall be sealed and placed in an enclosed structure

[7] https://www.fda.gov/animal-veterinary/animal-health-literacy/helping-agricultures-helpful-honey-bees
[8] https://www.ars.usda.gov/news-events/news/research-news/2015/bee-survey-lower-winter-losses-higher-summer-losses-increased-total-annual-losses/

and thereafter burned on the first date allowed by the regulation or law. All the activities shall be reported to the inspector prior to burning, who may require that burning occur only under his or her supervision."

Due to the lack of alternatives, the District has allowed open burning of diseased beehives under the SMS, in which an average of 30 acres (65 tons) of diseased beehives were open burned annually from 2015 to 2019. As burning remains the only feasible option for disposal of these diseased beehives, the District is recommending the continued postponement of prohibiting open burning for this material.

Findings:
The District reaches the following findings for this category in support of the 2020 Report and recommendations under Rule 4103:

1. No technologically feasible alternative due to disease issues

5 Technological Feasibility of Alternatives to Burning

This chapter discusses the technologic feasibility of alternatives to open burning, including potential alternatives that are in development. The District has conducted detailed research and identified several potentially feasible alternatives to open burning of agricultural materials. Some of the alternatives were identified in previous District reviews.

5.1 Biomass Power Plants

Biomass power plants in the San Joaquin Valley will generally accept agricultural, forestry, construction, and urban residues. The power plants burn the material in combustors to produce steam. The steam is then used to spin turbines to generate electricity. Biomass plants have historically served as the primary alternative to open agricultural burning in the Valley. They offer a cleaner solution to open burning, turning materials into steam to generate electricity. In addition, biomass facilities provide payment to contractors or farmers that drop off agricultural material, ranging from $10 - $27 per dry ton.

Biomass power plants do not universally accept all agricultural material due to concerns that some materials may harm power plant machinery. For example, citrus chips can contain debris and excess moisture, and vineyard materials can contain wires. Material must meet fuel quality standards including size requirements, moisture content requirements, no dirt, and no foreign matter.

In recent years, a significant number of existing biomass plants that historically provided an outlet for agricultural materials have shut down due to evolving energy markets and lower energy prices offered by utilities upon contract renewal. This issue is discussed further in Chapter 8.

5.2 Land Application / Soil Incorporation

Applying agricultural materials to the soil is a common method of disposal method in agriculture. The pruning material from many tree crops and vineyards is usually gathered into windrows and shredded in place using grinders suitable for brush. The shredded material can either be left on the ground or be incorporated into the soil when the field is tilled. Over time, the material decomposes into the soil, which adds valuable organic material to the soil and can lead to better water infiltration and soil quality. This practice is evolving as more growers and equipment manufacturers innovate and collaborate to make the process work for everyone.

Studies have found that whole orchard recycling, through chipping the trees and then incorporating the chips into the soil, has the potential to benefit second-generation tree growth and crop yields of almond and stone fruit orchards. Soil incorporation of woody agricultural material has been found to increase soil organic matter content, increasing

microbial communities in the soil, storing carbon, increasing water retention, and potentially increasing yields in second-generation trees. Ongoing research studies are investigating potential risks of spreading disease through this practice, and additional peer-reviewed research is needed to inform the feasibility of implementing this practice for other crop types. For example, this practice is not established for all crops, especially for pome (apple, pears, and quince) fruits with concerns over the spread of diseases. Research has also highlighted the high costs, the need to further understand feasibility of this practice with different crop and soil types, and the need to assess and understand the net emissions impact associated with implementing this practice effectively.

While questions remain regarding the wide-spread feasibility of soil incorporation as an alternative to open burning, the District conducted a robust lifecycle emissions analysis to estimate the emissions from this practice as compared to the open burning of agricultural materials. This comprehensive analysis included emissions from the operation of additional heavy-duty equipment and vehicles necessary to complete the soil incorporation process, which includes tree removal, chipping, spreading, soil ripping, and soil tilling. This analysis shows that on-field soil incorporation of woody biomass has the potential to result in significant emission reductions when compared to open burning of woody agricultural material.

The costs associated with on-field alternatives, such as soil incorporation of woody agricultural material, may be prohibitively high when compared with the costs of open burning or the disposal at a biomass facility, in the limited areas where biomass disposal remains an option. To encourage the implementation of this emerging practice, in November 2018, the District adopted a new pilot incentive program to assist growers in demonstrating the feasibility of utilizing woody agricultural material for soil incorporation or as a surface application in lieu of burning. This program is explained in further detail in Chapter 9.

5.3 Composting

Composting is the process by which organic material is broken down aerobically by bacteria and other microorganisms to form a biologically stable organic substance suitable as a soil amendment and plant fertilizer. Organic waste decomposes naturally in the presence of water, warmth, and oxygen. Composting accelerates the process by adding moisture and maintaining an elevated temperature. Biomass is one of the sources of organic material for composting operations, but woody biomass must be well mixed with high nitrogen concentration materials to be an effective compost component.

Agricultural material is one of the sources of organic material for composting operations. Other sources could include, but are not limited to, urban waste, biosolids, and manure. The District distinguishes the blend of organic material into two categories, composting and co-composting. Along with vegetative material, co-composting includes biosolids, manure, and/or poultry litter. The vegetative materials are a good source of nitrogen,

whereas, chipped wood provides carbon to the mixture. As a result, compost and co-compost facilities sometimes accept agricultural materials either as feedstock or as amendment for the operation. Some compost and co-compost facilities also accept and store the material for other use such as fuel for biomass power plants or animal feed.

Sources usually pay a tipping fee to compost operators to dispose of the material at the composting site. With competing materials from subsidized urban waste, disposal costs for agricultural materials could be higher and the accepted amount of agricultural materials could vary. This fee would be additional to other operational costs, such as chipping and transporting the material to the compost facility. These operational costs for the grower would be similar to the cost of chipping and transporting the material to the biomass power plants, which does not charge a fee for disposal.

5.4 Cellulosic Ethanol Production

Cellulosic ethanol is an advanced next-generation biofuel that can be made from agricultural wastes, wood chips, switch grass, corn stover, forest wastes, fast-growing trees, and other plant material. Currently, ethanol produced in the United States is most commonly produced from corn kernels. In the United States, corn ethanol is primarily used as an alternative or additive to gasoline. Advanced biofuels are those that do not rely on the starch in corn kernels. Production of large quantities of ethanol from woody biomass will likely require the use of chemical treatment or enzymes to speed the breakdown of the cellulose in the biomass.

Currently, the production of cellulosic ethanol is still predominately in the demonstration phase of development and no permitted facilities are operation in the District. A proposed facility is currently in the permitting process with the District, which will use a combined gasification system to produce about 12.5 million gallons per year of renewable cellulosic ethanol. Approximately 500 to 600 tons/day of locally sourced agricultural waste will be used as a feedstock, including almond, walnut, and pistachio shells.

5.5 Pyrolysis/Gasification

A new biofuel derived from wood chips through a pyrolysis process has been developed. The process involves heating wood chips and small pellets in the absence of oxygen and high temperature (pyrolysis). About a third of the dry wood becomes charcoal and the rest becomes a gas. The gas then undergoes a chemical process where it is converted into liquid bio-oil.

Pyrolysis can be used to create many high value products. Syngas can be used in power production and offers certain advantages over traditional biomass power plants, such as it can provide higher thermal efficiency and can be cleaned relatively easily for a cleaner power production. It can also be used to produce renewable natural gas, methanol, and hydrogen. Another byproduct of pyrolysis, biochar, is a high value

product that can be used as a soil amendment to increase soil fertility and agricultural productivity by improving retention of water and nutrients. Biochar can also be processed into activated carbon that can be used in emission control for the removal of specific compounds from gaseous and liquid process streams. Several innovative technologies are in development phase to produce bio-fuels from pyrolysis, although none are currently in commercial operation in the District. Bio-oil, also known as bio-crude or pyrolysis oil, is a mixture of organic compounds that is distilled from the products of fast pyrolysis at approximately 500°C. Bio-oil can be used as fuel in boilers and power generation equipment. In addition, bio-oil can be upgraded to renewable transportation fuels. Bio-oil with high cellulosic materials such as orchard debris is not currently commercially viable.

To date no commercial pyrolysis facilities are operational within the District, which reflects many inherent challenges faced by this alternate technology. Although several innovative variations of this technology are currently in design and conceptual phase, none has proven to be commercially viable due to the wide variety of biomass feedstock and insufficient design data from the pilot test studies. This further makes it difficult to secure all funding resources and obtain required approvals. The low calorific value of syngas, compared to digester or natural gas, also reduces the power production thermal efficiency. Tar formation during gasification is also a serious concern if feedstock contains plastics and other waste products. Additionally, each facility may have unique set of challenges.

5.6 Air Curtain Burners

Air Curtain Burners were designed to control pollution from open burning, primarily to reduce PM or smoke. These devices are open top combustion devices with vertical, refractory lined walls that operate by forcefully projecting a fan driven pane of high velocity air over the top of the combustion chamber in such a manner as to maintain a curtain of air over the surface and a recirculating motion of air under the curtain.

The District saw potential for these units being utilized by contractors that provide services to growers. As such, the District amended District Rule 2280 (Portable Equipment Registration) in December 2018 to allow the District to issue portable registrations for air curtain burn boxes. However, to date this type of portable contractor service is not readily available.

Only agricultural materials listed on the APCO prepared list of “Air Curtain Burn Box Approved Agricultural Materials,”[9] forest management materials or hazard reduction materials may be burned in an air curtain burn box. The APCO approved materials list includes orchard removals, vineyard removals, orchard attrition, grape attrition, untreated grape stakes, paper raisin trays, diseased materials, tumbleweeds, and diseased beehives.

[9] http://www.valleyair.org/busind/pto/ptoforms/Air-Curtain-Burn-Box-Approved-Materials-List-rev.pdf

Rule 2280 limits the amount of emissions that can be produced from a project in a single day. NOx and VOC emissions are limited to 100 lb/day and PM10 is limited to 150 lb/day. The emission factors for air curtain burners are such that NOx is the limiting pollutant, and a project would be able to process 100 tons of material per day without exceeding the rule limits. This is roughly equivalent to processing a little more than three acres per day for almond orchard material, and therefore a large removal could take over two months to complete if operating five days a week. Processing rates vary depending on the unit manufacturer and the type of material burned.

Unit costs range from $53,000 for a smaller unit, to $170,000 for a larger unit. Based on the cost of the units and potential project restrictions, the District will continue working with the agricultural sector and potential operators of air curtain burners to determine the potential feasibility of this option.

5.7 Fiberboard

Biomass can be treated and processed to produce fiberboard that can be used in the manufacture of various products. Fiberboard is a type of engineered wood product that is made out of wood fibers that are bonded together with resin. Types of fiberboard (in order of increasing density) include particle board or low-density fiberboard (LDF), medium-density fiberboard (MDF), and hardboard (high-density fiberboard, HDF). Plywood is not a type of fiberboard, as it is made of thin sheets of wood, not wood fibers or particles. Fiberboard, particularly medium-density fiberboard, is frequently used in many industries, such as furniture production, and is generally made with waste material from wood processing facilities. Although fiberboard could be an excellent alternative technology, no fiberboard industry is current present in the Valley.

5.8 Hand Crews for Removal of Materials

Some operators have considered using hand crews to remove materials, such as weeds, as a potential alternative for open burning. The labor-intensive removal of individual weeds is often characterized with unreasonable costs and safety issues. Additionally, hand removal of weeds is technically infeasible due to the magnitude of weed abatement. Technological development is needed to reduce the burning of weed abatement material.

5.9 Water Decomposition for Rice Stubble (Straw)

Rice farmers flail mow the rice stubble into about 4-inch sections and stubble disk it, to ensure it has contacted with the soil four to five inches deep. It is then flooded as soon as possible to keep the clods covered. Flooding the fields during the winter helps with blast and speeds decomposition, as well as providing some fertilizer benefits.

Historically, water decomposition has been a common alternative to open burning for rice stubble. However, with the recent drought and new water restrictions, this is no

longer a feasible alternative.

5.10 Baling Rice Stubble (Straw)

In previous reviews, the District identified baling rice stubble as a potential alternative to open burning. This alternative was a highly anticipated option, however baling rice straw is utilized even less due to a diminished market need and cost of production.

6 Emissions from Agricultural Burning and Alternatives to Burning and Health Considerations

This chapter discusses emissions from agricultural burning and includes an emission reduction analysis for the recommendations contained in this report.

6.1 Distribution of Agricultural Open Burning Emissions

Figure 6-1: Map Illustrating PM2.5 Emissions in the Valley from Open Burning

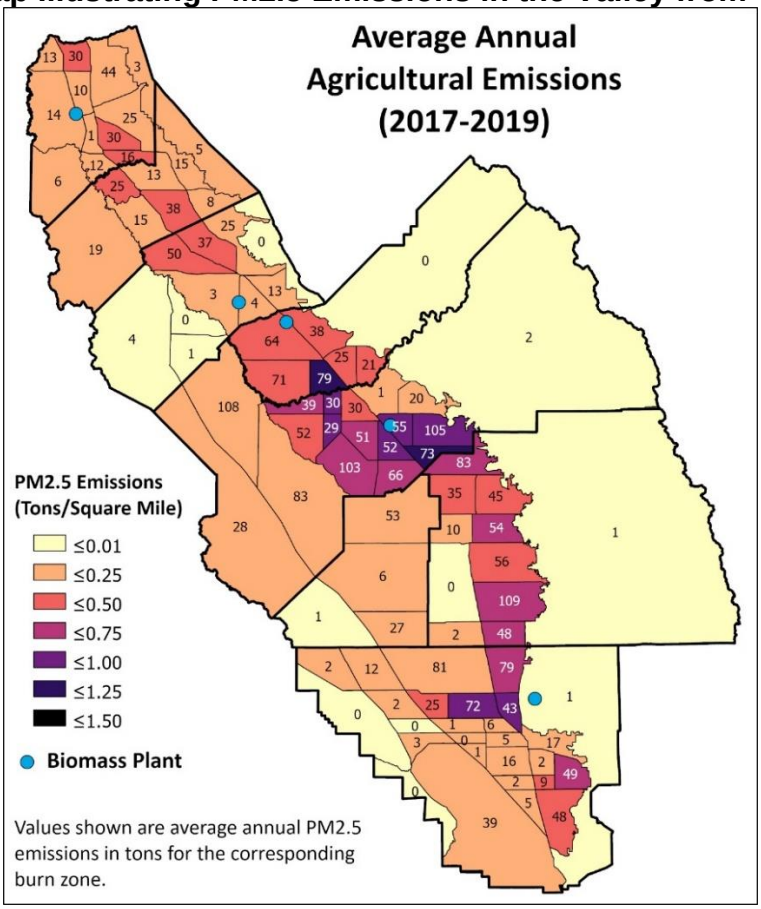


Figure 6-1 illustrates the tons of PM2.5 emissions per square mile and existing and proposed biomass plants in the SJVAB. The sectional divisions of the map are the burn allocation zones as developed by the District for use in the smoke management system (SMS). Each zone on the map is marked to illustrate the three-year average annual tons of PM 2.5 emissions per square mile generated from agricultural burning of all types for that zone between the years of 2017 and 2019. Most of the burn allocation zones with the highest emissions from agricultural burning have biomass facilities in or near them.

6.2 Current Emissions Inventory from Agricultural Burning

For purposes of this report, the criteria pollutants analyzed include volatile organic compounds (VOC), oxides of nitrogen (NOx), and fine particulate matter (PM2.5). As shown in Figure 6-2, agricultural burning is concentrated in winter months when PM2.5 is elevated and ozone values are relatively low.

Figure 6-2: Average Monthly Tons of Agricultural Burning (2017-2019)

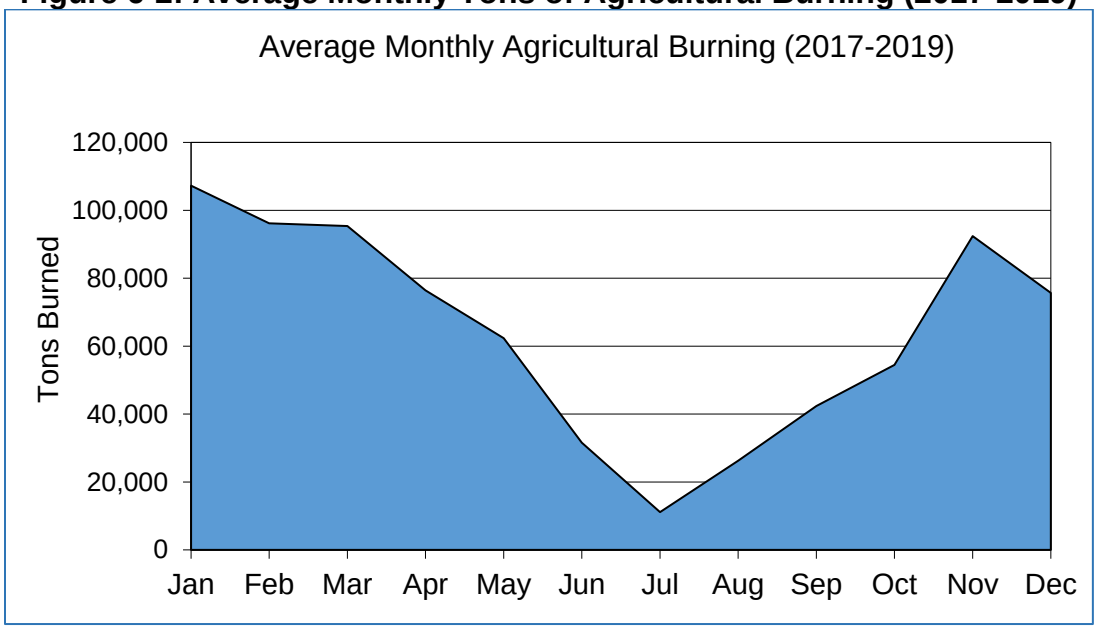


Table 6-1 below presents the burn tons, burn acres, and tons of associated criteria pollutant emissions associated with agricultural burning averaged over a five year period for specific crop types and activities. The specific crop types and activities are the crops to be analyzed for the 2020 review. Because several crops are not a part of this analysis and do not pertain to this report, the data from those crops has been omitted from the table below. The data for this table is the best available information, and came from the District SMS emission database.

Table 6-1: Average Annual Tons, Acres, and Emissions from Open Burning of the Remaining CH&SC Crop Types (2015-2019)

Crop Name	Tons Burned	Acres Burned	Emissions (Tons)			
			NOx	PM25	VOC	PM10
Almond Pruning	1,943	1,943	5.76	6.53	5.07	6.82
Apple Pruning	318	138	0.83	0.59	0.37	0.62
Pear Pruning	101	39	0.26	0.42	0.26	0.45
Pecan Pruning	48	28	0.12	0.17	0.15	0.19
Quince Pruning	8	5	0.02	0.03	0.02	0.03
Walnut Pruning	862	718	1.94	1.72	2.07	1.81
<15 Acre Orchard Removal (All Crops)	93,307	3,110	242.32	340.18	293.58	363.48
Apple Orchard Removal	4,734	158	12.31	8.76	5.44	9.23
Citrus Orchard Removal	53,592	1,786	139.34	150.06	182.21	158.10
Pear Orchard Removal	864	29	2.25	3.59	2.20	3.80
Quince Orchard Removal	48	2	0.12	0.18	0.15	0.19
Diseased Beehives	65	30	0.15	0.49	0.35	0.52
Ponding/Levee Banks	101	46	0.23	0.77	0.54	0.80
Rice *	1,684	594	4.34	5.45	4.27	5.80
Raisin Trays	640	21345	1.38	0.22	1.42	0.23
Vineyard Removal	393,422	26,228	1,023.42	1,436.75	1,239.94	1,535.13
Total	**551,736**	**56,200**	**1,435**	**1,956**	**1,738**	**2,087**

** Rice category includes residual rice straw, rice straw, rice stubble, and rice field levees.*

Table 6-1 includes the previously postponed materials that were issued open burning permits. The District calculated the burn acres and associated emissions from a list of the remaining crops and materials that were issued open burning permits, averaged from 2015-2019.

6.3 Emission Reduction Analysis

6.3.1 Introduction

The recommendations described in this report will result in greater curtailment of agricultural open burning currently allowed under District Rule 4103. Estimated reductions for each crop category are based on the proposed phase-outs and limited postponements that may be in place during the period of requested concurrence from CARB. Any remaining SB 705 managed burning phase-outs will be imposed in full after

the approved CARB concurrence period, unless further postponements are necessary and approved in the future under additional CARB concurrence actions.

The estimated emission reductions to be achieved by the new prohibitions are presented in Table 6-2. Details of the emission reduction analysis are discussed in the next section (Methodology and Calculations).

Table 6-2: Total Annual Emission Reductions from 2020 Recommendations

Category	Crop	NOx (ton/year)	PM2.5 (ton/year)	VOC (ton/year)
Orchard Removals	Citrus	104.3	189.3	141.3
Surface Harvested Prunings	Almond, Walnut, and Pecan	0.4	3.2	2.8
	Raisin Trays	1.4	0.2	1.4
Vineyard Removals	Grape and Kiwi	163.7	427.2	367.4
Total		**269.8**	**619.9**	**512.9**

6.3.2 Methodology and Calculations

Step 1: Determine the reduction in acreage which will be burned as a result of the new prohibitions

The District analyzed information collected during 2015-2019 from the District's Smoke Management System (SMS) in order to estimate the reduction in acreage of burning resulting from the new prohibitions. The SMS manages agricultural open burning in the San Joaquin Valley Air Basin (SJVAB) and collects and maintains information pertinent to the amount and type of material burned in the SJVAB. For each permitted open burning operation during the time period, the SMS identifies the specific item burned and the associated acreage.

In order to estimate the reductions in acreage of orchard burning resulting from each of the new orchard prohibitions listed, it was assumed that average annual acreage of permitted burns in the SMS for the period 2015-2019 is representative of the expected burning reduction for each category. Extraction and analysis of data from the SMS yielded the following annual reductions in acres burned:

Table 6-3: Estimated Reductions in Open Burn Acreage

Category	New Prohibition	Average Annual Reduction in Acreage Burned	Tons of Material
Orchard Removals	Citrus	1,786	53,592
Surface Harvested Prunings	Almond, Walnut, and Pecan	902	970
	Raisin Trays	21,345	640
Vineyard Removals	Grape and Kiwi	7,868	118,027
Total		**31,901**	**173,229**

Step 2: Establish Applicable Emission Factors on a Per Acre Basis

To calculate the tons of emissions reduced per acre, the District calculated the emissions from the average acreage of burn size for each crop category and then divided by the number of acres to get the tons of emissions reduced on a per acre basis.

Emissions reductions for orchard removals (assuming 30 tons dry biomass per acre) were first calculated by calculating the emission reductions for each alternative:

Emissions Reductions (tons/acre) = Burning Emission Factor (tons/acre) - Soil Incorporation Emission Factor (tons/acre)

Emissions Reductions (tons/acre) = Burning Emission Factor (tons/acre) - Biomass Emission Factor (tons/acre)

Emissions Reductions (tons/acre) = Burning Emission Factor (tons/acre) - Composting Emission Factor (tons/acre)

In calculating the averages from all three alternatives, the emissions reductions (tons/acre) for orchard removals are:

NO_x 0.0584 tons per acre
$PM_{2.5}$ 0.1060 tons per acre
VOC 0.0791 tons per acre

Emissions reductions for surface harvested prunings from almond, walnut, and pecan crops (assuming 1 ton of dry prunings per acre) are based on soil incorporation of prunings in lieu of burning:

Emissions Reductions (tons/acre)	=	Burning Emission Factor (tons/acre)	-	Soil Incorporation Emission Factor (tons/acre)

The emissions reductions (tons/acre) for surface harvested prunings from almond, walnut, and pecan crops are:

NO_x 0.0004 tons per acre
$PM_{2.5}$ 0.0036 tons per acre
VOC 0.0031 tons per acre

Emissions reductions for raisin trays (assuming 0.03 tons of dry raisin trays per acre) are based on completely phasing out the use of raisin trays as a practice at raisin vineyards.

Emissions Reductions (tons/acre)	=	Burning Emission Factor (tons/acre)

The emissions reductions (ton/acre) for raisin trays are:

NO_x 0.00006 tons per acre
$PM_{2.5}$ 0.000009 tons per acre
VOC 0.00006 tons per acre

Emissions reductions for vineyard removals (assuming 15 tons of dry biomass per acre) are based on soil incorporation in lieu of burning:

Emissions Reductions (tons/acre)	=	Burning Emission Factor (tons/acre)	-	Soil Incorporation Emission Factor (tons/acre)

The emissions reductions (ton/acre) for vineyard removals are:

NO_x 0.0208 tons per acre
$PM_{2.5}$ 0.0543 tons per acre
VOC 0.0467 tons per acre

Step 3: Apply Applicable Emission Factor to Acreage Data Extracted from the SMS

Table 6-4 presents the results for field crops, orchard removals, surface harvested prunings, and vineyard removals.

Table 6-4: Emissions Reductions from New Prohibitions

Prohibition			Acres Reduced per SMS	NOx		PM2.5		VOC	
Crop	Current Permitted Open Burning	New Prohibition		Emissions Reductions (tons/acre)	Annual Emission Reduction (tons)	Emissions Reductions (tons/acre)	Annual Emission Reduction (tons)	Emissions Reductions (tons/acre)	Annual Emission Reduction (tons)
Orchard Removals									
Citrus	Permitted at sites < 3,500 acres	Burns > 15 acres prohibited at all acreages	1,786	0.0584	104.3	0.1060	189.3	0.0791	141.3
Surface Harvested Prunings									
Almond, Walnut, and Pecan	Permitted < 20 acres at farms with total nut acreage < 3,500 acres	Burns < 20 acres prohibited at farms with total nut acreage > 50 acres	902	0.0004	0.4	0.0036	3.2	0.0031	2.8
Raisin Trays	Permitted at all acreages	Prohibited at all acreages	21,345	0.00006	1.4	0.000009	0.2	0.00006	1.4
Vineyard Removals									
Grape and Kiwi	Permitted at all acreages	Case by case	7,868	0.0208	163.7	0.0543	427.2	0.0467	367.4

6.4 Health Benefits of Reduced Open Burning

The potential health impacts of particle pollution are linked to the size of the particles, with the smaller particles having larger impacts. Numerous studies link PM2.5 to a variety of health problems, including aggravated asthma, increased respiratory symptoms (irritation of the airways, coughing, difficulty breathing), decreased lung function in children, development of chronic bronchitis, irregular heartbeat, non-fatal heart attacks, increased respiratory and cardiovascular hospitalizations, lung cancer, and premature death. Children, older adults, and individuals with heart or lung diseases are the most likely to be affected by PM2.5. Many studies have quantified and documented the health benefits of attaining the U.S. Environmental Protection Agency (EPA) air quality standards for PM.

Any particles 10 microns or less are considered respirable, meaning they can be inhaled into the body through the mouth or nose. PM10 can generally pass through the nose and throat and enter the lungs. PM2.5 can be inhaled more deeply into the gas exchange tissues of the lungs, where it can be absorbed into the bloodstream and carried to other parts of the body.

In addition to affecting human health, air pollution also affects the health of the natural environment. PM2.5 can be transported from sources hundreds of miles away to contribute to visibility problems at remote locations, such as the Sierra Nevada mountain range and associated national parks. As fine particulate matter settles out of the air, it can make lakes and streams acidic, change an ecosystem's nutrient balance, and affect ecosystem diversity. PM2.5 can affect vegetation by damaging foliage, disrupting the chemical processes within plants, reducing light adsorption, and disrupting photosynthesis.

Wood smoke contains PM2.5, carbon monoxide, formaldehyde, sulfur dioxide, irritant gases, and known and suspected carcinogens, such as polycyclic aromatic hydrocarbons (PAH). The toxic air pollutants in wood smoke can cause human health impacts such as coughs, headaches, and eye and throat irritation. Studies show that prolonged inhalation of wood smoke contributes to chronic interstitial lung disease, pulmonary arterial hypertension, and other cardiopulmonary diseases, which can eventually lead to heart failure in adults. Wood smoke has also been linked to detrimental mutagenic and systemic effects such as oxidative stress and coagulation, which can ultimately result in cell damage and possibly lead to cancer. Children with the highest exposure to wood smoke show a significant decrease in lung function. Studies also found that wood smoke is twelve times more carcinogenic than an equal concentration of cigarette smoke.

Through efforts to address PM2.5 standards, the Governing Board's Health Risk Reduction Strategy, and other air quality improvement efforts, the District has long worked to reduce harmful wood smoke emissions, including with respect to residential wood burning, agricultural open burning, and wildfires. District Rule 4901 (Wood

Burning Fireplaces and Wood Burning Heaters) has particular significance under the District Governing Board adopted Health-Risk Reduction Strategy, under which the District prioritizes control strategies that expedite attainment of federal air quality standards and provide the greatest public health benefits to Valley residents. Rule 4901 and the District's corresponding Check Before You Burn program are both key components to the District's Health-Risk Reduction Strategy, reducing the District's multifaceted residential wood burning emission reduction strategy reduced harmful species of PM2.5 where and when those reductions are most needed - in impacted areas when the local weather is forecast to hamper PM dispersion. By decreasing emissions from residential wood burning, Rule 4901 decreases directly emitted PM2.5 and significantly reduces the health effects associated with wood smoke.

While agricultural open burning is heavily regulated through the District's Smoke Management System and is generally rural in nature, efforts to reduce wood smoke through ongoing evaluation and reduction of open burning targets some of the most harmful species of PM2.5 and provide public health benefits. Estimating accurate population exposure reductions resulting from current or estimated reductions on agricultural burning is very difficult and not attempted in this evaluation. However, to assist in this evaluation, in addition to recognizing the emission reduction benefits discussed in Section 6.3 of this Report, the following section includes health risk evaluation for soil incorporation (also known as whole orchard recycling), the most broadly deployed alternative in recent years.

6.5 Health Risk Assessment of Alternative to Open Burning (Soil Incorporation)

6.5.1 Introduction

The District routinely employs several health risk assessment (HRA) models in order to estimate health risks posed by exposure to air pollutants from existing or hypothetical sources. These HRA models are based on the following elements:

(1) Knowledge from prior scientific studies about the relative toxicity of pollutants.
(2) Similar knowledge about the relative effects of increased concentrations of a given pollutant.
(3) The hourly rate of emissions by mass or parts per volume, i.e. emission factor, from a given source and the duration of those emissions.
(4) Specification of meteorological conditions.
(5) How the pollutants are dispersed and/or transformed in the atmosphere.
(6) A gradient or exposure surface that specifies various concentration levels at a given distance from a source and time.
(7) The spatial distribution and characteristics of the exposed population (as applicable).
(8) Whether and how different sub-populations may be differentially affected such as children to a given level and duration of exposure (as applicable).

To evaluate the short-term (acute) and long-term (chronic and cancer) health impacts of alternative disposal methods of agricultural material, the following scenarios were analyzed:

Scenario 1: Land incorporation of material from a 15-acre orchard removal. Emission sources included diesel exhaust from equipment used to shred and incorporate prunings into the soil, fugitive dust from the grinding of the orchard material, and on-road truck travel and idling exhaust from vehicles used to deliver and remove equipment from the field.

Scenario 2: Land incorporation of material from a 15-acre vineyard removal. Emission sources included diesel exhaust from equipment used to shred and incorporate prunings into the soil, fugitive dust from the grinding of the vineyard material, and on-road truck travel and idling exhaust from vehicles used to deliver and remove equipment from the field.

6.5.2 Methodology and Calculations

Emissions for each scenario evaluated were calculated using the parameters listed below:

Table 6-5: Assumptions Used to Estimate Emissions

Operation	Orchard Removal	Vineyard Removal
Ag Material (acres)	15	15
Material Incorporated (tons/acre)	30	15
Field Equipment Exhaust Emissions (lbs DPM/acre)		
Dozer #1: remove ag material	0.12	0.12
Wheel Loader: transport ag material to grinder	0.05	0.05
Excavator: load ag material to grinder	0.06	0.06
Grinder exhaust	0.20	0.20
Tractor: spread chipped ag material	0.03	0.03
Dozer #2: rip soil	0.52	0.52
Tractor: incorporate/disc chips	0.03	0.03
Grinder dust emissions (lb-PM_{10}/acre)	0.21	0.11
On-Road Truck Travel Exhaust Emissions (lb-DPM)	0.15	0.15
On-Road Truck Idling Exhaust Emissions (lb-DPM)	0.0004	0.0004

Off-road diesel equipment was used to process crop material in the field. With the exception of the grinder, off road equipment activity was modeled as an area source over the entire surface of the orchard or vineyard. The grinder was modeled as a point source in the center of the work area. All particulate matter from off-road diesel equipment exhaust was modeled as diesel particulate matter (DPM). Fugitive dust from the grinder was modeled as a small area source centered on the location of the grinder. This fugitive dust was speciated into toxics using District Profile 246 (Compost Dust Green Waste Emissions). All particulate matter from on-road diesel truck exhaust was

modeled as DPM. On-road truck travel was modeled as a half-mile long line volume source. On-road truck idling points for equipment loading and unloading were modeled as point sources on the north and west boundaries of the project.

To calculate pollutant dispersion and the resulting exposure gradient, the AERMOD model was used. Meteorological data for 2013-2017 from Hanford was employed to determine the dispersion factors (i.e., the predicted concentration or X divided by the normalized source strength or Q) for a receptor (human population) grid. These dispersion factors were input into the Hot Spots Analysis and Reporting Program (HARP2) risk assessment module to calculate the chronic and acute hazard indices as well as the carcinogenic risk for two scenarios outlined above.

6.5.3 Health Risk Assessment Results

Worst-case health impacts for the soil incorporation of agricultural material are presented in Table 6-8 and compared to the District's levels of significance. The model results show that the long-term impacts (cancer risk and chronic hazard index) are less than the District's levels of significance. Due to the brief duration of this type of project (< 6 months), acute health impacts are the primary concern. The acute hazard index in this case pertains to risk of an acute respiratory response over the short-term (1-hour) exposure to the dust generated by the grinder. Based on the District's analysis, the District has found that the potential health risk associated with typical soil incorporation projects are not significant, and will continue to decline as diesel off-road equipment continues to transition to later tier equipment through compliance with state off-road regulations and fleet turnover.

Table 6-6: Health Impacts from Chipping/Shredding and Land Incorporation

Health Risk	Emissions Source		Significant Impact?
	Orchard Removal	Vineyard Removal	
Maximum Individual Cancer Risk[1] (x 10^{-6})	1.53	1.53	No
Acute Hazard Index	0.126	0.063	No
Chronic Hazard Index	0.003	0.003	No

[1] Six-month exposure period used

Figure 6-7: Acute Hazard Index Isopleths for Soil Incorporation of Orchard Removal Material

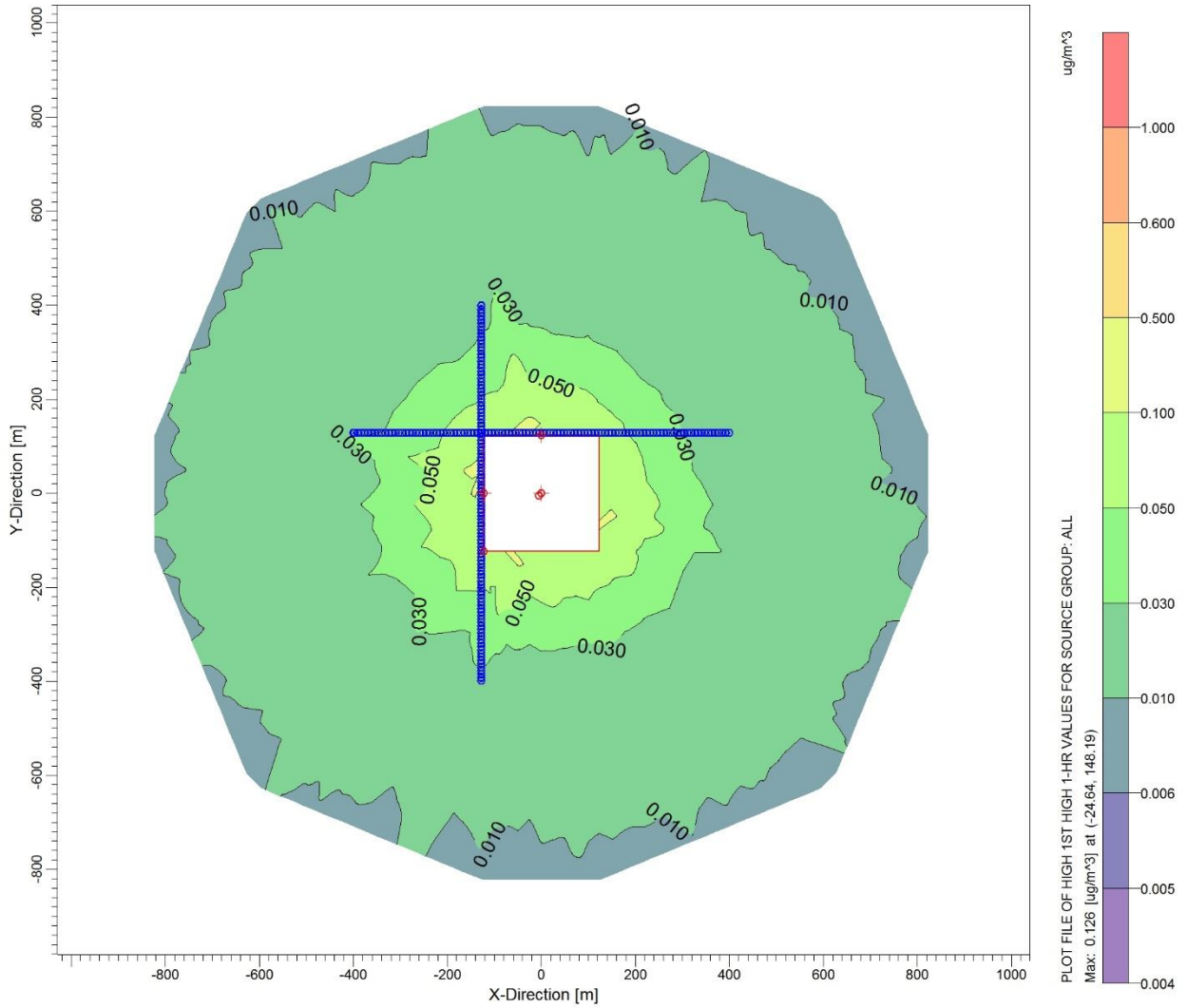
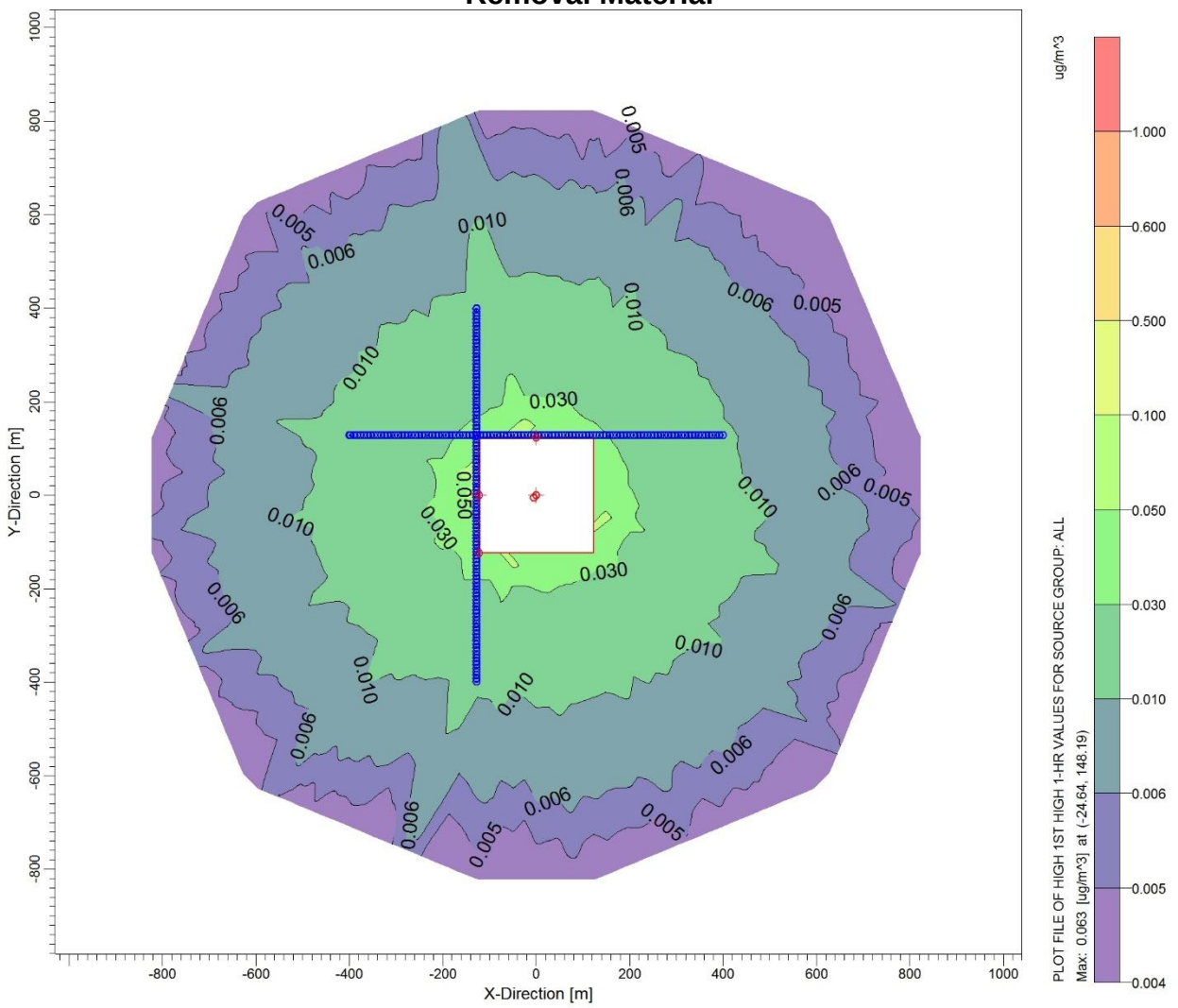


Figure 6-8: Acute Hazard Index Isopleths for Soil Incorporation of Vineyard Removal Material



7 Cost Impacts of Alternatives to Burning

This chapter summarizes the cost information analyzed for the available alternatives to open burning, including soil incorporation, biomass, and composting. In comparing costs differences between open burning and the alternatives, the District calculated the incremental cost increase for each option. The costs shown in this analysis are borne by growers. Growers typically pay the contractor to burn, chip, or shred the materials. The biomass facilities also pay chipping operators for the chipped material. The District is estimating incremental costs of non-burning alternatives by subtracting the cost of open burning from the total cost of the alternative.

Please note, the economies of scale can significantly impact smaller farms when it comes to cost of alternatives. Due to the nature of small orchards and vineyards, contractors typically require a minimum charge (or move-in fee) that is infeasible for small operations. The move-in fee covers travel time and distance of hauling heavy-duty equipment such as bulldozers, excavators, grinders, and wheel loaders to the job site. Growers are then also responsible for a per-acre charge for the contractor to operate and maintain the equipment. In fact, chipping operators typically refuse certain small jobs, making it difficult for growers to remove small acreages from orchards and vineyards. As a result of the minimum charge, the per acre cost for such small removals increases as the acreage becomes smaller. The incremental costs are then used in further analysis.

To establish the costs of open burning and alternatives for the purposes of this report, the District used the information available through various sources. Each of the sources below provided information that was evaluated and utilized in the District's cost model to develop an estimated average range of the costs associated with each practice:

- Agricultural crop removal contractors providing services such as chipping, grinding, and hauling agricultural materials,
- Growers utilizing the District's burn permitting program,
- Growers utilizing the District's soil incorporation pilot grant program that includes 539 applications with project cost estimates, and over 200 claims with post-project invoices of the actual project costs,
- Agricultural industry representatives, and
- Facilities with tipping fees, as applicable

All contractors requested confidentiality with respect to their pricing. The actual costs of implementing alternatives vary widely farm to farm based on specific site configurations, crop-specific factors, cultural practices, logistics, and a myriad of potential issues. The costs for alternatives can increase dramatically based on these site specifics, up to $2,500/acre for soil incorporation solely for the chipping/grinding and soil incorporation steps in the whole orchard recycling process, with a minimum $9,000 charge. Minimum contractor charges render chipping services economically infeasible for smaller farms. Growers may face additional short-term and long-term issues and associated costs,

including:

- Costs associated with delayed chipping/grinding/burning:
  - Delayed field preparation activities (fumigation, ripping, leveling),
  - Not being able to plant costly pre-ordered bare root stock on time,
  - Bare root stock planted late stunts tree growth and proper development, which can result in a year or more of lost development,
- Negative impacts on farm's nitrogen management plan that carefully balances the soil's nitrogen to carbon ratio (expense to implement a nitrogen plan rebalance, including on-field activities),
- Negative impacts from chips in soil not breaking down (can take several years),
- Field may require additional leveling due to necessary additional deep ripping passes,
- Removed root materials with nematodes that cannot be incorporated back into the soil,
- Roots with embedded rocks that damage grinding/shredding equipment,
- Vineyards and orchards with leftover wires and rope that damage grinding/shredding equipment,
- Additional soil fumigation costs to combat nematodes introduced into the soil due to the whole orchard recycling process

The tables below summarize the District's cost findings that represent an average range of the costs associated with each practice, and does not include the potential additional costs listed above that may growers may be faced with.

Table 7-1: Summary of Estimated Average Costs

Activity	Orchard Removals ($/acre)	Vineyard Removal ($/acre)	Surface Harvested Prunings ($/acre)	Minimum Charge per Orchard/Vineyard Removal
Open Burning	$281 - $433	$447 - $637	$63 - $123	$5,000 - $9,000
Soil Incorporation	$1,146 - $1,450	$1,656 - $1,960	$173 - $354	$5,000 - $9,000
Biomass Plant	$1,308 - $1,518	N/A	N/A	$5,000 - $9,000
Composting Facility	$1,890 - $2,118	N/A	N/A	$5,000 - $9,000

**Costs based on the following removal size acreages: Vineyard/Orchard Removal: 5-100 acres, Prunings: 5-20 acres.*

Table 7-2: Incremental Cost Increases of Alternatives over Open Burning

Activity	Orchard Removals ($/acre)	Vineyard Removal ($/acre)	Surface Harvested Prunings ($/acre)
Soil Incorporation	$865 - $1,017	$1,209 - $1,323	$110 - $231
Biomass Plant	$1,027 - $1,085	N/A	N/A
Composting Facility	$1,609 - $1,685	N/A	N/A

**Incremental costs increases based on the following typical removal size acreages: Vineyard/Orchard Removal: 5-100 acres, Prunings: 5-20 acres.*

7.1 Costs for Open Burning of Orchards and Vineyards

Since the entire orchard or vineyard removal process may be affected by the method utilized for disposal of the material, the District examined current costs for the complete removal/burning process including tree or vine extraction, piling and burning. For orchard removals, the trees are typically either pushed over with a dozer or removed from the ground with an excavator. Large trees may require some breaking up for handling. After drying in the field, the downed trees are then moved to burn piles either by dozer or wheel-loader. The burning of the piles involves labor to burn and oversee the piles. Vineyards are typically bull dozed into piles for burning with vineyard wire in place (the wire is removed and disposed after burning is complete) and plastic irrigation tubing along with chemically treated wood stakes are removed prior to piling.

Costs for open burning includes the following:

- Removal of treated stakes (vineyard only)
- Fixed move-in costs of heavy-duty equipment to push and pile trees or vines
- Labor, fuel and maintenance to operate machinery (bulldozer / front end loader)
- Burn pile
- Pick up and haul wires and metal stakes (vineyard only)

It is important to note that contractors typically require a minimum charge (or move-in fee) of $5,000 - $9,000, which is a fixed cost. The resulting per acre charge to small farms less than 20 acres is much higher than larger farms. The move-in fee covers travel time and distance of hauling heavy-duty equipment such as bulldozers and wheel loaders to the job site. Growers are then also responsible for a per-acre charge for the contractor to operate, fuel, and maintain the equipment.

Table 7-3: Summary of Costs for a Typical 15 Acre Vineyard Open Burn

Activity / Equipment	Fixed Costs ($)	Operating Costs ($/acre)	Total Cost for 15 Acres ($)
Stake Removal	N/A	$173/acre	$2,595
Bull Dozer - push vineyard	$400	$115/acre	$2,125
Wheel Loader - pile vineyard	$400	$115/acre	$2,125
Burn Pile Management	N/A	$43/acre	$645
Pick up and Haul Metal	$200	N/A	$200
Metal Recycling Savings	N/A	-$9/acre	-$135
Project Subtotal	$1,000 ($67/acre)	$437/acre	$7,555
Per Acre Cost Total	**$504 / acre**		

The costs of open burn orchard removals are similar to vineyard removals except that there are no costs associated with removing treated stakes. The table below summarizes the costs of a typical 15 acre orchard removal with soil incorporation.

Table 7-4: Summary of Costs for a Typical 15 Acre Orchard Open Burn

Activity / Equipment	Fixed Costs ($)	Operating Costs ($/acre)	Total Cost for 15 Acres ($)
Bull Dozer - push orchard	$400	$115/acre	$2,125
Wheel Loader - pile orchard	$400	$115/acre	$2,125
Burn Pile Management	N/A	$43/acre	$645
Project Subtotal	$800 ($53/acre)	$273/acre	$4,895*
Project Total Minimum Charge	**$5,000**		
Per Acre Cost Total	**$333 / acre**		

*Since this project is below the minimum charge typical of contracted services, the minimum charge of $5,000 would be required.

7.2 Cost of Open Burning of Surface Harvested Prunings

Disposal of orchard prunings by open burning requires that the prunings be pushed to the end of each row and then piled for burning. Weights for almond, walnut, and pecan prunings are between 1 to 1.7 dry tons per acre. To burn the prunings, costs must be incurred to push the prunings to the end of each row and then pile them for burning, obtain a burning permit, and then supervise the burn. While orchard and vineyard removals occur infrequently, pruning orchards and vineyards take place annually. For economic feasibility purposes, pruning costs are applied each year for 10 years.

Table 7-5: Summary of Costs for a Typical 5 Acre Prunings Open Burn

Activity / Equipment	Fixed Costs ($)	Operating Costs ($/acre)	Total Cost for 5 Acres ($)
Wheel Loader – pile prunings	$400	$38/acre	$590
Burn Pile Management	N/A	$5/acre	$25
Project Subtotal	$400 ($80/acre)	$43/acre	$615
Per Acre Cost Total	**$123 / acre / year**		

7.3 Costs for Soil Incorporation of Orchard and Vineyard Removals

The costs associated with on-field alternatives, such as soil incorporation of woody agricultural material, may be high when compared with the costs of open burning. To encourage the implementation of this emerging practice, in November 2018, the District adopted a new pilot incentive program to assist growers in demonstrating the feasibility of utilizing woody agricultural material for soil incorporation or as a surface application in lieu of burning.

Equipment utilized in recycling/soil incorporation activities are very similar to equipment used in traditional open burning. Recycling/soil incorporation projects require additional pieces of diesel-powered equipment, such as an excavator to load the chipped material into the grinder, a grinder to chip the material, and a tractor for ripping the soil and discing the chipped material into the soil.

Orchard and Vineyard Removals

In order to incorporate vineyard material, the trellis system, which includes end posts, stakes, and wires, needs to be removed from the vineyard. As described in Section 4.5, only certain types of vineyards may utilize the soil incorporation alternative. For vineyards where the wires can be separated from the vineyard material, the vines are then extracted or pushed over, pushed into piles, ground or chipped, spread onto the field, and then reincorporated into the soil. Due to the relatively large amount of material being incorporated into the soil for whole orchard recycling, i.e. 30 tons of woody material per acre for orchards and 15 tons of material for vineyards, the fields require deep ripping of the soil and extra passes. Growers need to ensure the woody material is worked in to the soil as deep as possible prior to planting the next crop.

Although cane pruned vineyards may lend themselves to removing the wire to implement alternatives, in some cases it is prohibitively expensive for farmers to remove their trellis systems. In the case that the farmer is implementing an alternative and has to remove their costly trellis system, there would be additional costs per acre as the farmer would have to invest again to rebuild the system. Due to this issue, the District is recommending that open burning phase-outs only apply to vineyards that lend themselves to feasible alternatives through a case-by-case approval.

For orchards and certain vineyards, the costs for soil incorporation include the following:

- Pruning, stake and end post removal, pulling out wires, collecting stakes and wires (vineyard)
- Heavy duty equipment move-in/move-out, fuel, maintenance, and skilled labor costs to:
    - push over the trunks (bulldozer / front end loader)
    - pile the material (front end loader)
    - grind the material (grinder and excavator / front end loader)
    - spread the material (tractor)
    - rip soil (bulldozer / tractor)
    - disc soil (tractor)

It is important to note that contractors typically require a minimum charge (or move-in fee) of $5,000 - $9,000, which is a fixed cost. Typical move-in/move-out heavy duty equipment costs range from $1,600 - $3,200, depending on the number of pieces of heavy-duty equipment. The move-in fee covers travel time and distance of hauling heavy-duty equipment such as bulldozers and wheel loaders to the job site. As a conservative estimate, cost model assumes that growers have at least one tractor with necessary attachments to perform the soil incorporation activities. Also conservatively, the model assumes that for larger removal acreages, e.g. greater than 100 acres, additional pieces of heavy duty equipment are not necessary as operators of larger farms may have their own equipment.

Growers are then also responsible for a per-acre charge for the contractor to operate, fuel, and maintain the equipment. For operation of heavy-duty equipment, skilled labor is necessary. Contractors typically pay their skilled operators an hourly pay rate of $25/hr - $30/hr. Contractors also need to maintain their equipment. For example, chippers / grinders require the teeth be replaced approximately every month, depending on the amount of material ground. Replacement of these teeth can cost $4,000 per month. Additional maintenance on grinders can cost $3,000 per month, totaling $7,000 per month in maintenance. Another primary cost of operating heavy duty equipment is diesel fuel. Orchard removal grinders typically range from 500 - 1,000 bhp and consume 25 - 45 gallons of diesel fuel per hour. At $2.50/gallon, the cost of diesel fuel can total $450 per day for one grinder.

The table below summarizes the costs of a typical 15 acre vineyard removal with soil incorporation.

Table 7-6: Summary of Costs for a Typical 15 Acre Vineyard Removal

Activity / Equipment	Fixed Costs ($)	Operating Costs ($/acre)	Total Cost for 15 Acres ($)
Pruning, Wire / Stake Removal and Collection	N/A	$510/acre	$7,650
Bull Dozer - push vineyard	$400	$115/acre	$2,125
Wheel Loader - pile vineyard	$400	$115/acre	$2,125
Grinder - grind material	$400	$400/acre	$6,400
Tractor - Spreading	$400	$100/acre	$1,900
Tractor - Rip Soil	N/A	$200/acre	$3,000
Tractor - Discing	N/A	$200/acre	$3,000
Project Subtotal	$1,600 (107/acre)	$1,640/acre	$26,200
Per Acre Cost Total	**$1,747 / acre**		

The costs of orchard removals are similar to vineyard removals except that there are no costs associated with pruning vines and removing trellis wires and stakes. The table below summarizes the costs of a typical 15 orchard removal with soil incorporation.

Table 7-7: Summary of Costs for a Typical 15 Acre Orchard Removal

Activity / Equipment	Fixed Costs ($)	Operating Costs ($/acre)	Total Cost for 15 Acres ($)
Bull Dozer - push orchard	$400	$115/acre	$2,125
Wheel Loader - pile orchard	$400	$115/acre	$2,125
Grinder - grind material	$400	$400/acre	$6,400
Tractor - Spreading	$400	$100/acre	$1,900
Tractor - Rip Soil	N/A	$200/acre	$3,000
Tractor - Discing	N/A	$200/acre	$3,000
Project Subtotal	$1,600 ($107/acre)	$1,130/acre	$18,550
Per Acre Cost Total	**$1,237 / acre**		

7.4 Costs for Biomass Plant Alternative

The District has identified the grinding (or chipping) of orchard removal material followed by utilization of the material as fuel for power generation as a feasible alternative to open burning. In this approach for orchard removal, the trees are typically extracted or pushed over and then allowed to dry in the field for approximately four weeks prior to grinding (except for citrus for which a drying time of approximately eight weeks is required to ensure that grinding will produce a usable biomass fuel). After drying, the downed trees are typically loaded on a wheel-loader, which transports them to the grinder. The grinder may be either a tub grinder or a horizontal hammer mill, depending upon the contractor and/or the specifics of the job. After grinding, the biomass is normally loaded into heavy haul trucks and transported to the biomass facility. Costs for the biomass alternative include the following:

- Heavy duty equipment move-in/move-out, fuel, maintenance, and skilled labor

costs to:
  - push over the trunks (bulldozer / front end loader)
  - pile the material (front end loader)
  - grind the material (grinder and excavator / front end loader)
- Haul material to biomass power plant

Contractors are typically paid to deliver materials by biomass plant operators by the dry ton. To ensure that the quoted costs would be comparable to those quoted for open burning, the scope included tree removal, grinding and transport to the biomass facility.

Costs for hauling material is based on the number of heavy duty truck round trips necessary. The average heavy duty truck can haul up to 25 tons of chipped orchard material per trip. Contractors noted that one acre of orchard material equates to approximately 50 tons of wet material; therefore, two truck trips are required per acre. The average cost of these two truck trips is $648. Therefore the cost utilized in the cost analyses is $648 per acre.

Vineyard removal materials are not accepted at biomass facilities due to the potential of embedded wire in the material. Metal material and debris can cause problems for biomass facility equipment. Therefore, the District did not include costs for disposal of vineyard removal materials at biomass plants.

Table 7-8: Summary of Biomass Costs for a Typical 15 Acre Orchard Removal

Activity / Equipment	Fixed Costs ($)	Operating Costs ($/acre)	Total Cost for 15 Acres ($)
Bull Dozer - push orchard	$400	$115/acre	$2,125
Wheel Loader - pile orchard	$400	$115/acre	$2,125
Grinder - grind material	$400	$400/acre	$6,400
Haul Material to Biomass	N/A	$648/acre	$9,720
Project Subtotal	$1,200 ($80/acre)	$1,278/acre	$20,370
Per Acre Cost Total	**$1,358 / acre**		

7.5 Costs for Composting Orchard and Vineyard Removals

The District has identified the grinding (or chipping) of orchard removal material followed by composting as a feasible alternative to open burning. In this approach for orchard removal, the trees are typically extracted or pushed over and then allowed to dry in the field for approximately four weeks prior to grinding (except for citrus for which a drying time of approximately eight weeks is required to ensure that grinding will produce a usable biomass fuel). After drying, the downed trees are typically loaded on a wheel-loader, which transports them to the grinder. The grinder may be either a tub grinder or a horizontal hammer mill, depending upon the contractor and/or the specifics of the job. After grinding, the material is normally loaded into heavy haul trucks and transported to the composting facility. Costs for the composting alternative include the following:

- Heavy duty equipment move-in/move-out, fuel, maintenance, and skilled labor costs to:
  - push over the trunks (bulldozer / front end loader)
  - pile the material (front end loader)
  - grind the material (grinder and excavator / front end loader)
- Haul material to composting facility
- Tipping fees

Costs for hauling material is based on the number of heavy duty truck round trips necessary. The average heavy duty truck can haul up to 25 tons of chipped orchard material per trip. Contractors noted that one acre of orchard material equates to approximately 50 tons of wet material; therefore, two truck trips are required per acre. The average cost of these two truck trips is $648. Therefore the cost utilized in the cost analyses is $648 per acre.

Unlike biomass plants, compost facilities charge a tipping fee that the grower must pay, typically $20 per ton, which equates to $600/acre for orchards. Vineyard removal materials are not accepted at composting facilities due to the potential of embedded wire in the material. Therefore, the District did not include costs for disposal of vineyard removal materials at composting facilities.

Table 7-9: Summary of Composting Costs for a Typical 15 Acre Orchard Removal

Activity / Equipment	Fixed Costs ($)	Operating Costs ($/acre)	Total Cost for 15 Acres ($)
Bull Dozer - push orchard	$400	$115/acre	$2,125
Wheel Loader - pile orchard	$400	$115/acre	$2,125
Grinder - grind material	$400	$400/acre	$6,400
Haul Material to Biomass	N/A	$648/acre	$9,720
Compost Facility Tipping Fees	N/A	$600/acre	$9,000
Project Subtotal	$1,200 ($80/acre)	$1,878/acre	$29,370
Per Acre Cost Total	**$1,958/acre**		

7.6 Costs for Soil Incorporation of Surface Harvested Prunings

Soil incorporation of surface harvested prunings requires that the prunings be pushed into windrows to prepare for chipping. Weights for almond, walnut, and pecan prunings are between 1 to 1.7 dry tons per acre. To soil incorporate the prunings, costs must be incurred to push the prunings into windrows, chip the prunings in place, and then disc the chipped material back into the soil. Per industry representatives, local contractors charge approximately $300/hr ($38/acre) with a two hour minimum for chipping activities. Equipment can process approximately eight acres per hour. There are also additional costs for windrowing prunings in preparation to be chipped. While orchard and vineyard removals occur infrequently, pruning orchards and vineyards take place annually. For economic feasibility purposes, pruning costs are applied each year for 10

years.

Table 7-10: Summary of Soil Incorporation Costs for a Typical 5 Acre Pruning Removal

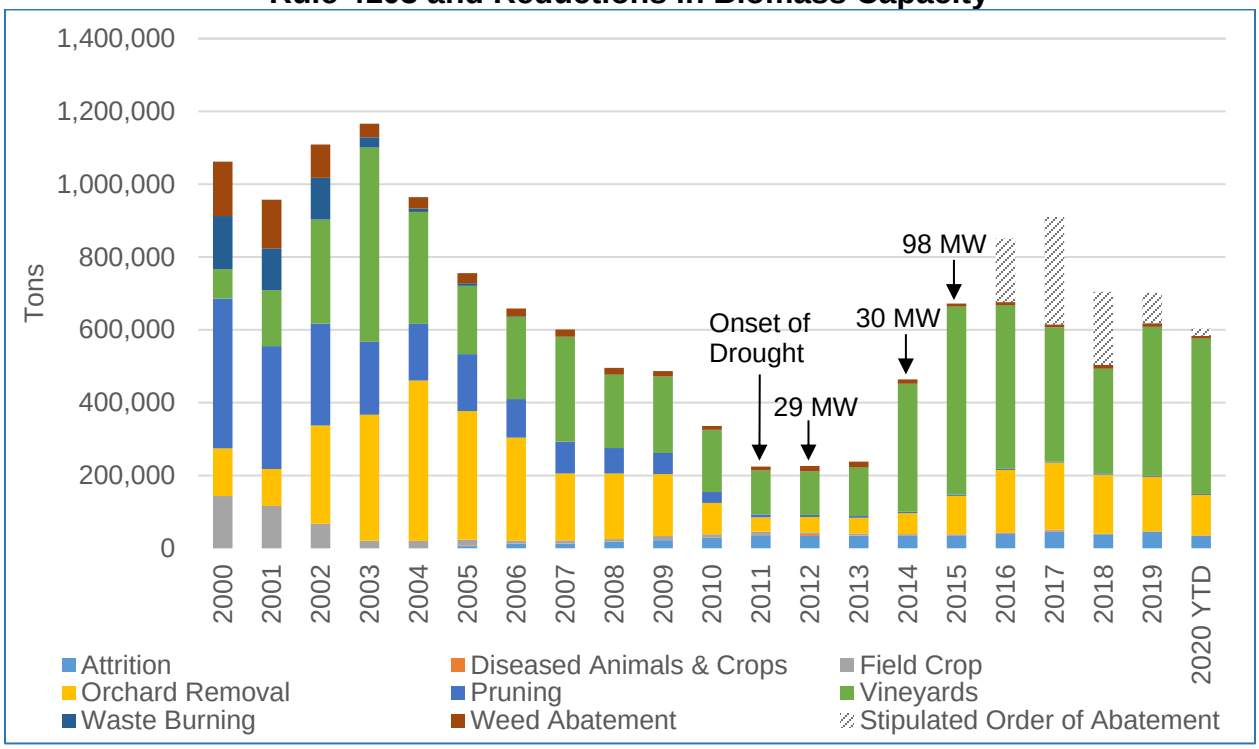
Activity / Equipment	Fixed Costs ($)	Operating Costs ($/acre)	Total Cost for 5 Acres ($)
Windrow Prunings	$400	$38/acre	$590
Grinder – chip material	$400	$38/acre	$590
Tractor – disc material	$400	$38/acre	$590
Project Subtotal	$1,200 ($240/acre)	$114/acre	$1,770
Per Acre Cost Total	**$354 / acre / year**		

8 Biomass Power

A key consideration in the evaluation of an alternative to open burning is whether the operators, facilities and other resources that would be impacted by the alternative have the capability and capacity to receive large amounts of the agricultural material if the material cannot be soil incorporated. If additional agricultural material is prohibited from being open burned, the District expects that such prohibition would generate a substantial amount of agricultural material. The alternatives to open burning would need to be able to accept and handle the additional diverted agricultural material.

Growers normally prefer to clear away the agricultural material from their farms as soon as possible in order to carry on with their farming operations; therefore, growers depend on operators such as chippers to provide timely service. The ability to provide such timely service could be impacted if chipping operators are not equipped to handle the additional agricultural material. Similarly, if biomass power plants are not prepared to handle the additional agricultural material, the plants may be forced to turn away agricultural material. Other affected operators could face similar issues in regards to their capability to handle additional agricultural material. The District has evaluated the potential ability of the affected operators to handle, store and process the additional agricultural material.

Figure 8-1: Historical Annual Tons of Agricultural Material Burned under Rule 4103 and Reductions in Biomass Capacity



8.1 Traditional Biomass

SB 705 (Florez) included, as a consideration when phasing out agricultural burning, whether there are long-term federal or state funding commitments for the continued operation of biomass facilities in the Valley. The traditional biomass power industry is primarily the product of the Public Utility Regulatory Policy Act (PURPA), which was enacted in 1978 at the height of the energy crisis to promote the use of alternative nonutility power generation. Much has changed in the energy markets since PURPA was implemented. Natural gas has replaced oil for electricity generation, and supplies of natural gas have increased, driving down the wholesale cost of electricity. California has adopted a Renewable Portfolio Standard (RPS) that requires a significant percentage of the power that is purchased by utilities be renewable. This has driven competition to fill the renewable energy needs of the state. Under the RPS, Investor Owned Utilities (IOUs) have tended to favor subsidized lower-cost intermittent sources of renewable power, such as solar and wind. This has left the biomass industry in a position where the power that they produce is not ideal, since most traditional biomass plants provide baseload power instead of intermittent power, and the current rate being paid for power does not allow them to remain viable. Today, many of the original biomass plants have closed and most of the remaining facilities are fully depreciated and nearing the ends of their long-term contracts to sell their power to the utilities. The Valley has lost six biomass plants since 2012, and there are currently only five operating.

Table 8-1: Status of Biomass Plants in San Joaquin Valley

Facility Name	City	Capacity (MW)	Contract Expiration
Ampersand Chowchilla Biomass, LLC	Chowchilla	12.5	Feb. 2031
DTE Stockton, LLC	Stockton	54	Feb. 2039
Merced Power, LLC	El Nido	13	Feb. 2031
Mt. Poso Cogeneration Company, LLC	Bakersfield	49.5	Feb. 2027
Rio Bravo Fresno	Fresno	28.5	May 2022

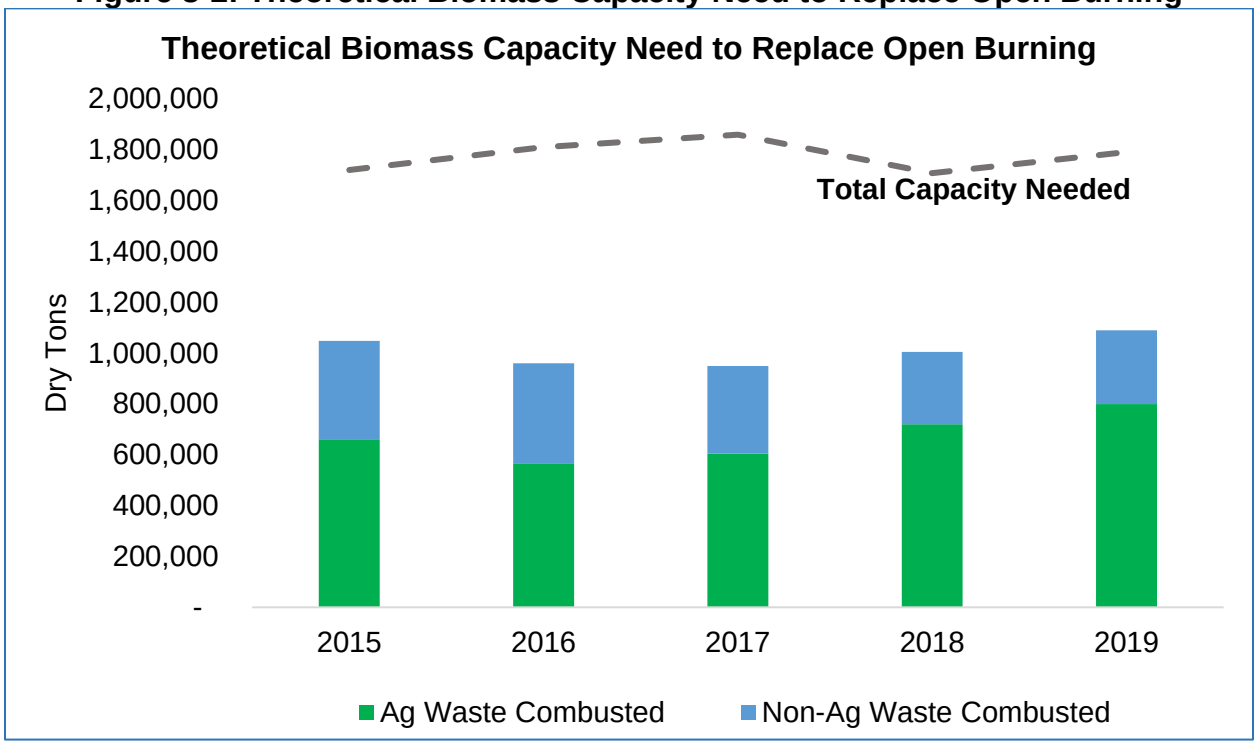
There is little federal or state support of the traditional biomass power industry. One program that does offer contracts for traditional biomass plants at rates that allow them to remain viable is the Biofuel Renewable Auction Mechanism (BioRAM) program. In response to the State of California tree mortality crisis, Governor Brown issued an emergency proclamation on October 30, 2015 that, among other things, required the California Public Utilities Commission (CPUC) to expedite contracts for bioenergy facilities that receive feedstock from high hazard tree mortality zones. The CPUC adopted resolution E-4770 on March 17, 2016 that required that the Investor Owned Utilities procure 50 MW of power from facilities that committed to accept specified amounts (40% in 2016, 50% in 2017, 60% in 2018, and 80% for subsequent years) of fuel from high hazard tree mortality zones. One facility in the San Joaquin Valley, Rio Bravo in Fresno has a BioRAM contract that expires in 2021. While the BioRAM program does not directly encourage that biomass plants accept agricultural waste, the BioRAM program has allowed facilities to remain on-line and they continue to accept

agricultural waste material. The amount of agricultural waste material that traditional biomass plants accept has continued to be insufficient to handle the agricultural waste material needs in the Valley, and without changes to state energy policy it appears that this trend will continue.

8.2 Agricultural Material Capacity of Remaining Active Biomass Plants

The District analyzed the historical fuel usage of the annual bone dry tons (BDT) combusted at the five remaining biomass facilities in the Valley. Figure 8-3 below represents the theoretical total capacity needed to send all agricultural woody material to biomass plants as an alternative to burning. In 2014, a snapshot of fuel burned in remaining biomass plants (9 remaining at time) indicated that they were processing 1.2 million tons of agricultural material at the time, and if they were operating at full capacity, had the potential to process 1.6 million tons of agricultural material. The plants are currently handling approximately 800,000 tons/year, representing half of the capacity just several years ago, and significantly less than the capacity in 2003 when SB 705 was enacted. The biomass capacity needed estimates below are based on summing the total of the current total agricultural biomass throughputs from the remaining five plants and the total annual agricultural open burning tonnage in the Valley, and are consistent with the 2014 estimated biomass capacity.

Figure 8-2: Theoretical Biomass Capacity Need to Replace Open Burning



8.3 Next Generation Biomass

There are a number of small scale advanced bioenergy conversion technologies that have the potential to utilize agricultural waste material. In most cases, these projects convert woody material to gas through non-combustion thermal conversion of biomass material to methane gas. The gas generated by the project can then be utilized to generate electricity or directly as a gaseous fuel. The primary energy program in the State of California that is designed to encourage the development of these projects is the Bioenergy Market Adjusting Tariff (BioMAT) program, which is a feed-in tariff program for small bioenergy renewable generators less than 5 MW in size.

The BioMAT program offers up to 250 MW of capacity to eligible projects through a fixed-price standard contract to export electricity to California's three large investor owned utilities (IOUs). Electricity generated as part of the BioMAT program counts towards the utilities' RPS targets. The BioMAT program is divided into three categories of projects from which utilities must accept specified amounts of energy. Projects that utilize agricultural waste materials are part of Category 2: Dairy and other agricultural bioenergy projects. This category is capped at 90 MW of power, and that cap has yet to be reached.

Additionally, AB 3163 (Salas) was recently signed by the Governor expanding the definition of "biomethane" to include methane that is produced from the non-combustion thermal conversion of eligible biomass feedstock. This legislation opens up the option of directly injecting biomethane into natural gas distribution pipelines for sale to downstream users. The biomethane produced by these projects is attractive to the market, and can be sold at a premium since it has a low carbon intensity score that helps to decarbonize natural gas fuels.

In speaking with proponents of advanced bioenergy conversion projects, the general consensus is that both of these programs provide attractive outlets for the biomethane produced by these projects. However, to date, a limited number of these projects have come to fruition. In most cases, successful projects have been at locations with a single owner and significant amounts of available biomass fuel on-site for bioenergy conversion (i.e. almond huller, rice straw, forest materials). This eliminates questions of who will own and operate the project, uncertainty about the price and availability of biomass fuel for the projects, and costs and logistics associated with processing, transporting and storing biomass off-site material. The logistics and uncertainty associated with projects that are not a single owner with significant on-site biomass fuel available is often enough to discourage project proponents from moving forward with projects that would accept agricultural waste from a variety of outside sources.

In addition to the cost and logistics challenges associated with accepting materials from a variety of outside sources, project proponents have also identified the high upfront costs associated with project development as a major barrier to bringing new projects online. Initial work that needs to be completed before a project moves forward include

preliminary engineering assessments, preparation of environmental documents, interconnect agreements with utilities, and identifying adequate biomass suppliers for the project. These costs can exceed a half a million dollars, and often times are enough to stop a project before it gets started.

The following table includes a summary of new biomass energy/fuel projects currently in the permitting and development phase (not operating) that may provide outlets for agricultural biomass in the future:

Facility Name	Technology Type	Location	Capacity (tons/year)
Aemetis Advanced Products Riverbank Inc	Cellulosic Ethanol	Riverbank	182,500 - 219,000
California Biochar LLC	Pyrolysis/Biochar	Lockeford	402
Corigin Solutions LLC	Pyrolysis/Biochar	Merced	4,818
Wonderful Renewable Energy, LLC	Pyrolysis/Biochar	Lost Hills	54,000

9 Incentive Programs

The costs associated with on-field alternatives are much more costly than traditional practices, including open burning and disposal at biomass power plants. These alternatives not only provide criteria emission reduction benefits, but are increasingly recognized for providing carbon sequestration benefits. Recognizing these environmental benefits and also the high cost of new emerging agricultural practices, local, state, and federal programs have increasingly been made available, including the state Healthy Soils Program.

The upcoming major transition to these emerging practices will not be feasible without significant and sustained funding being provided to offset the incremental cost and encourage transition to new practices. This chapter summarizes some of the key available incentive programs at the local, state, and federal level, and highlights the critical need to develop increased and sustained funding at the state and local levels to ensure the feasibility of alternatives as the region transitions to non-open burn alternatives.

In order to ensure that these programs are effective at assisting Valley growers, the Valley needs to advocate for sufficient funding for these programs. Additionally, the Valley needs to seek policy changes on how the funding is allocated to make the programs more responsive to growers needs.

9.1 District Alternative to Agricultural Burning Incentive Pilot Program

The District has taken action to pursue a number of alternatives to open burning, including adoption of a new incentive program in November 2018, to assist growers in demonstrating new on-field practices for the disposition of agricultural materials. This well-subscribed program provides incentives for growers to chip, shred, or mulch woody agricultural material as an alternative to the open burning of these materials. Recognizing the variety of agricultural operations in the Valley, the program allows growers to select from several on-field uses for chipped agricultural materials from orchard or vineyard removals, such as soil incorporation (whole orchard recycling) and land application of mulch. The District has executed $13.5 million in grants under this program since it was launched, which has funded soil incorporation and land application projects to assist with the disposal of approximately 26,000 acres and 730,000 tons of agricultural material. Data received through the implementation of this incentive program has provided the District with valuable data as to the cost and feasibility of soil incorporation for various crop types, which will assist in the preparation of the District's recommendations for agricultural burning.

During traditional orchard pile burning, a significant number of heavy-duty, diesel-powered machines are required to push, pile and prep the orchard for a burn, and then to remove and dispose of the remaining byproduct. This Alternative to Agricultural Open Burning Incentive Pilot Program replaces the practice of orchard and vineyard

burning with a cleaner practice of recycling the biomass back into the soil, eliminating the practice of open burning, restoring beneficial nutrients to the soil and even stimulating the local economy by creating jobs and work for Valley contractors and agricultural operators with the equipment necessary to complete orchard or vineyard recycling projects. In this program, emissions reductions are quantified for each project. The quantified emissions reductions are calculated by taking the difference in emissions from the baseline operations (i.e. open burning) and woody agricultural material recycling/soil incorporation. Despite the use of additional diesel-powered equipment for woody agricultural material recycling/incorporation, the mass emissions of PM2.5, NOx, and VOC are significantly less than open burning emissions.

Applications are received and processed by the District on a first come, first served basis. During the application review process, the District verifies project information to ensure that only eligible projects are considered for funding. Emission reductions for each project are calculated based on the acreage, biomass quantity per acre, and estimated equipment usage to conduct the chipping and soil incorporation activities. Once the project location has been inspected by the District and the project is deemed eligible, the applicant is sent a voucher allowing them to commence work on their project. Upon completion of the project, applicants return a completed Claim for Payment form to the District, which includes a complete breakdown of services performed by category, their associated invoices and costs, as well as proof of payment. A reimbursement of $600/acre for whole orchard recycling and reincorporation or $300/acre for orchard recycling and surface application is then provided to the applicant. Table 9-1 below shows a regional breakdown of the soil incorporation grant projects executed to date.

Table 9-1: Executed Grant Projects by County

Region/County	Executed Projects	Acres	Grant Amount
North	**208**	**9,092**	**$4,742,028**
Merced	90	3,973	$2,085,672
San Joaquin	44	1,518	$896,262
Stanislaus	74	3,601	$1,760,094
Central	**184**	**8,961**	**$4,710,339**
Fresno	143	6,424	$3,452,319
Kings	9	495	$284,400
Madera	32	2,043	$973,620
South	**147**	**7,881**	**$4,095,885**
Kern	60	4,604	$2,233,911
Tulare	87	3,277	$1,861,974
Grand Total	**539**	**25,934**	**$13,548,252**

Since the launch of the Alternatives to Open Burning of Agricultural Materials Incentive Program, the District has seen a wide range of participation from a variety of growers as shown in the table below.

Table 9-2: Executed Grant Projects by Crop Type

Crop Type	Executed Projects	Acres	Tons of Material	Tons of Material (% of Valley Total)
Almonds	276	16,346	490,380	67%
Grapes	85	3,336	50,040	7%
Walnuts	30	1,026	30,780	4%
Plums	29	1,019	30,570	4%
Peaches	31	929	27,870	4%
Citrus	25	924	27,720	4%
Cherry	23	657	19,710	3%
Apricots	10	536	16,080	2%
Nectarines	8	316	9,480	1%
Olives	9	248	7,440	1%
Other	13	597	17,910	2%
Valley Total	**539**	**25,934**	**727,980**	**100%**

The availability of contractors for small orchard removals remains an issue as small removals are not a priority for contractors seeking cost-effective, larger chipping and grinding opportunities. In addition to contractor availability, the cost-per-acre of alternatives is not economically feasible for small orchard removals due to fixed and minimum contractor costs, which can be up to a $9,000 minimum charge. Due to these issues faced by small farms, and to implement the 2020 Report recommendations on agricultural burning, the District will be allocating funding to smaller farm entities for small orchard removals. If there is insufficient participation in this grant program from smaller farmer entities, the funds will be used toward other eligible projects to ensure continued funding of whole orchard recycling projects and reduced agricultural burning in the Valley.

In addition, the District has allocated funding for the Assembly Bill (AB) 617 communities of Shafter and South Central Fresno. In support of community input that prioritized the reduction of open burning through the use of District's soil incorporation program, the District has developed a plan to provide funding for growers within Shafter and the agricultural areas surrounding South Central Fresno.

ANALYSIS OF EMISSION REDUCTIONS FROM RECYCLING/SOIL INCORPORATION:

Even during traditional orchard pile burning, a significant number of heavy-duty, diesel-powered machines are required to push, pile and prep the orchard for a burn, and then to remove and dispose of the remaining byproduct. The pilot grant program replaces the practice of orchard and vineyard burning with a cleaner practice of recycling the biomass back into the soil, eliminating the practice of open burning, restoring beneficial nutrients to the soil and even stimulating the local economy by creating jobs and work for Valley contractors and agricultural operators with the equipment necessary to complete orchard or vineyard recycling projects.

In this program, emissions reductions are quantified for each project. The quantified emissions reductions are calculated by taking the difference in emissions from the baseline operations (i.e. open burning) and woody agricultural material recycling/soil incorporation. Despite the use of additional diesel-powered equipment for woody agricultural material recycling/incorporation, the mass emissions of PM2.5, NOx, and VOC are significantly less than open burning emissions. Although a number of heavy-duty engines are utilized in both open burning and recycling of vineyards or orchards, the vast majority of emissions come from the burning of the woody agricultural material itself.

Opening Burning Equipment and Activities:

- Bulldozer: used for the removal of the orchard (300 bhp diesel)
- Wheel loader: used to pile ag waste to prepare to burn (250 bhp diesel)
- Manage Burning of Orchard Material Pile
- On-road diesel truck: (1995, 33,000+ lbs. GVWR) for the transport of the off-road equipment identified above

Soil Incorporation Equipment and Activities:

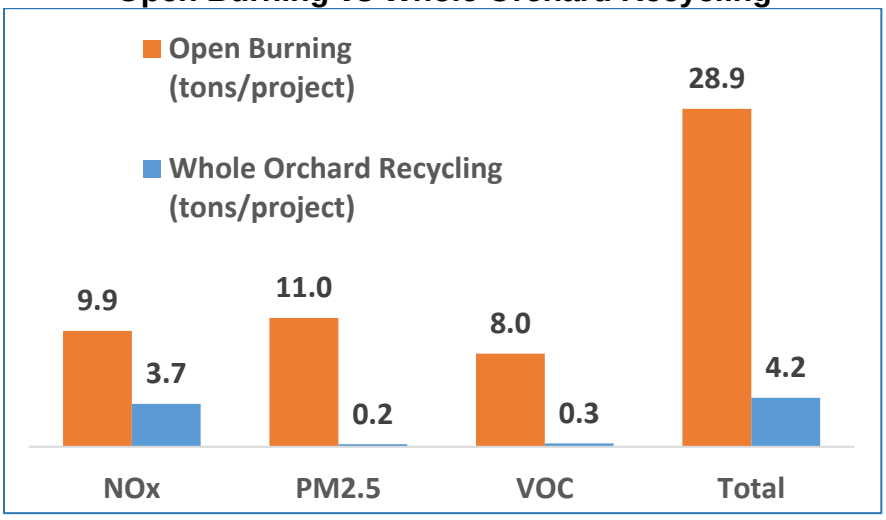
Equipment utilized in recycling/soil incorporation activities are very similar to equipment used in traditional open burning. Recycling/soil incorporation projects require additional pieces of diesel-powered equipment, such as an excavator to load the chipped material into the grinder, a grinder to chip the material, and a bulldozer or tractor for ripping the soil, and a tractor for spreading material and discing the chipped material into the soil. The following is a representative list of equipment typically used in the recycling/soil incorporation process:

- Bulldozer: used for the removal of the orchard (300 bhp diesel)
- Wheel loader: used to pile woody agricultural material to prepare to burn (250 bhp diesel)
- Excavator: used to load chipped material into grinder (240 bhp diesel)
- Grinder: used to grind/chip material (1,000 bhp diesel)

- Bulldozer: used to rip soil (600 bhp diesel)
- Tractor: used to spread material and disc soil (115 bhp diesel)
- On-road diesel truck: (1995, 33,000+ lbs. GVWR) for the transport of the off-road equipment identified above

Example Emission Reduction Analysis for a Typical 100 Acre Project:
A traditional 100 acre open agricultural burn project emits 9.9 tons of NOx, 11.0 tons of PM2.5 and 8.0 tons of VOCs for a total of 28.9 total tons emitted. These emissions are the result of the activities and equipment described above. In comparison, the same 100 acre farm utilizing recycling/soil incorporation instead of open burning emits only 3.7 tons of NOx, 0.2 tons of PM2.5 and 0.3 tons of VOCs for a total of 4.2 total tons of emissions. This represents a 63% reduction in NOx, 98% reduction in PM2.5 and 96% reduction in VOCs. This is illustrated in Figure 9-1 below.

Figure 9-1: Emissions from 100 Acres:
Open Burning vs Whole Orchard Recycling



9.2 Healthy Soils Program

The California Department of Food and Agriculture provides incentive funding through the Healthy Soils Program, which stems from the California Healthy Soils Initiative. The program has two components, including incentives and demonstration projects. The incentives program provides financial assistance for the implementation of conservation management practices that improve soil health and reduce emissions of carbon and greenhouse gas. The demonstration projects display the implementation of conservation practices by California farmers and ranchers. Both components aim to promote the development of healthy soils throughout California through a variety of soil management practices. These include practices such as cover cropping, no-till, reduced-till, mulching including whole orchard recycling, compost application, and conservation plantings. Applications deemed complete are reviewed and ranked by a technical review committee based on project logistics, project design, project work plan,

project budget and greenhouse gas (GHG) emission reduction, and conservation plan if applicable. Funding priority is given to socially disadvantaged farmers and ranchers, and benefits to priority populations.

Of particular interest in regards to open agricultural burning, the program offers $861.42 per acre for whole orchard recycling for orchards with trees at least 10 years of age. Once the orchard is chipped, the chips must be reincorporated in the same place as which they were grown, without exporting chips off-site or to new fields. The chips are to be evenly distributed throughout the orchard. Finally, this practice must not be implemented in soils with Soil Organic Matter greater than 20%. Following woodchip incorporation, the land must be fallowed or replanted with trees within three years. The total grant amount for all implemented practices cannot exceed the maximum grant amount of $100,000 per project. No funding priority is given to whole orchard recycling projects.

The Healthy Soils Program is funded by cap and trade proceeds known as California Climate Investments (CCI), receiving $40.5 million between 2016 - 2019. Additional funds in the amount of $10 million have been received from the California Drought, Water, Parks, Climate, Coastal Protection and Outdoor Access for all Act of 2018. The Healthy Soils Program Incentive Program has awarded a total of $22 million to 316 projects in 2020, and has closed their solicitation for new applications for the remainder of the year. Of those projects funded in 2020, only four Valley farms were awarded incentives for whole orchard recycling. For the 2020-21 fiscal year, the Healthy Soils Program has not received any funding due to uncertainty surrounding the Cap and Trade auctions during the COVID-19 pandemic and resulting economic downturn.

To support the District's 2020 Report recommendations and transition of remaining crop categories to newly emergent alternatives, the District will seek program enhancements and dedicated San Joaquin Valley funding through the California Department of Food and Agriculture (CDFA) Healthy Soils Program for whole orchard recycling and other feasible alternatives. In order for this program to be effective in assisting the transition to emerging alternatives, program changes are needed to make the program more accessible and responsive to the needs of Valley growers, and increase local participation.

9.3 Environmental Quality Incentives Program

The Natural Resources Conservation Service (NRCS-USDA) through the United States Department of Agriculture (USDA) provides incentive funding through the Environmental Quality Incentives Program (EQIP) to agricultural producers to address concerns in relation to natural resources. Practices funded by the program aim to improve a variety of environmental concerns including water and air quality, wildlife habitat, ground and surface water, soil health, soil erosion and sedimentation, and weather volatility. Farmers, ranchers, and forest landowners who own or rent their agricultural land are eligible for the program. The EQIP is authorized under the federal Farm Bill, which is

generally re-authorized for a five year period. In recent years, California has received approximately $20 million in EQIP funding per year, and $24 million this past fiscal year. Those funds are channeled into three air fund pools consisting of: 1) replacing mobile farm equipment, 2) replacing irrigation pump engines, and 3) farm conservation management practices. The vast majority of those funds, approximately $22 million last year, was utilized for replacing mobile farm equipment, such as tractors.

The farm conservation management practices portion of the program, typically allocated approximately $1 million in funds, covers a variety of practices, including chipping/grinding of tree orchards, whole orchard recycling/incorporating ground tree orchard material into the soil, low dust nut harvester equipment, air curtain burners, conservation tillage, treating unpaved roads, precision pest management (e.g. smart sprayers), disposal of treated stakes, and manure injection. The program funding schedules are as follows, including rates for historically underserved (HU) growers:

- Chipping tree orchard material: $767/acre and $920/acre (HU)
- Whole Orchard Recycling (incorporation of chipping material): $242/acre and $290/acre (HU)
- The incentive limit per project is $450,000
- Growers with an adjusted gross income greater than $900,000 are excluded from the program.

From fiscal years 2009 through 2019, the NRCS-USDA contracted with 162 farmers to provide a total of $2,480,000 to chip orchard removal debris on 8,285 acres. These incentives have resulted in a reduction of 907 tons of PM2.5 and 646 tons of NOx in the Valley. NRCS-USDA also offers $113.96 per acre ($136.76 per acre for HU farmers), or $104.91 per acre for larger operations equal to or over 60 acres ($125.89 per acre for HU farmers), to incentivize the use of air curtain burners. However, Valley farmers have yet to take advantage of this incentive.

9.4 State and Federal Funding

9.4.1 Funding Needs

The costs associated with on-field alternatives are significantly higher than the costs of open burning or the disposal at a biomass facility, in the limited areas where biomass disposal remains an option. Ongoing funding of incentive programs will play a crucial role in prohibiting open burning of the remaining crop categories, as these farmers will face costly alternatives. To support the transition of orchard removals and other crops to alternatives, as well as the remaining more difficult categories such as small orchard removals and vineyards, the District needs sustained funding support of approximately $15 million per year until alternatives are more broadly deployed, costs are reduced, and more feasible without the need for incentives. This estimate is based on approximately 500,000 tons per year (25,000 acres) of agricultural woody waste requiring cleaner alternatives at a funding level of $600 per acre.

9.4.2 Funding Advocacy

It is encouraging that the Healthy Soils Program and the Environmental Quality Incentive Program (EQIP) provide funding for whole orchard recycling. In order for these programs to be effective at encouraging growers to adopted new practices, both of these programs need substantially more funding and policy changes to make the programs more responsive to the needs of Valley growers.

At the state level, the Healthy Soils Program receives funding from Cap and Trade revenues in the Greenhouse Gas Reduction Fund (GGRF). Since the inception of the GGRF, the Healthy Soils Program has received $41 million. However, for the 2020-21 fiscal year, the Healthy Soils Program has not received any funding due to uncertainty surrounding the Cap and Trade auctions during the COVID-19 pandemic and resulting economic downturn. Going forward, the Healthy Soils Program needs sufficient and reliable funding that allows growers to depend upon it. Additionally, funding is allocated through a competitive request for proposal (RFP) solicitation process with awards annually (when funding is available). While this type of model is effective at identifying new cost-effective practices, it does not provide enough certainty for growers that want to implement measures, such as whole orchard recycling, that have already proven to be effective. Funding for whole orchard recycling should be carved out and provided through a first come, first served model that is more responsive to growers needs.

At the federal level, EQIP has provided funding in the past for chipping trees during orchard removal and as of this year, will provide funding for re-incorporating the material into the orchard. The EQIP is authorized under the federal Farm Bill, which is general re-authorized for a five year period. In recent years, California has received approximately $20 million in EQIP funding per year. While it is encouraging that the program will now fund whole orchard recycling, these projects share funding with other needed projects including low-dust harvesting equipment and new clean burning tractors. In order to meet the needs of Valley growers, the size of the total EQIP pot needs to be increased. Additionally, like the Healthy Soils Program, EQIP funding is allocated through an annual competitive solicitation process that does not provide the funding certainty that growers need. Funding for whole orchard recycling projects should be carved out and provided on a first come first served model that is more responsive to growers needs. The EQIP also has funding caps for each grower. For the five years covered by the 2018 Farm Bill, the funding cap per grower is $450,000. Additionally, growers with an adjusted gross income greater than $900,000 are excluded from the program. The funding and income caps may exclude some growers from participating in the program.

In order to ensure that these programs are effective at assisting Valley growers, the Valley needs to advocate for sufficient funding for these programs. Additionally, the Valley needs to seek policy changes on how the funding is allocated to make the programs more responsive to growers needs.

10 Air Quality Impacts of Continued Open Burning and Alternatives

To achieve the District's mission of improving air quality and public health for all Valley residents, the District has developed and implemented several air quality plans to reduce emissions from stationary sources. The control strategies outlined in existing District attainment plans include the adoption of nearly 650 of the most stringent rules in the nation, and strong voluntary incentive programs that have invested more than $3 billion of combined funds in clean-air projects. Similarly, the California Air Resources Board (CARB) has adopted regulations for mobile sources. Together, these efforts represent the nation's toughest air pollution emissions controls. Over the past several decades, these air quality improvement efforts have reduced nitrogen oxide (NOx) emissions (primary precursor for both ozone and PM2.5) from mobile and stationary sources by over 75%, including a greater than 90% reduction from stationary sources under the District's jurisdiction, resulting in significant air quality progress towards meeting the health-based federal ozone and PM2.5 standards.

10.1 2016 Ozone Plan

The *2016 Plan for the 2008 8-Hour Ozone Standard* (*2016 Ozone Plan*) was adopted by the District's Governing Board on June 16, 2016. As with all air quality attainment plans for the Valley, the District was detailed in evaluating and identifying further opportunities to advance attainment of the ever-tightening ambient air quality standards during the development of the *2016 Ozone Plan*. This plan demonstrates that regulatory efforts of all sources of VOC and NOx emissions satisfy and even go beyond federal Reasonably Available Control Technology (RACT) requirements. As part of our ongoing efforts to identify additional emission reduction opportunities, the District included regulatory commitments for evaluating the potential of including additional emission control requirements in District Rules 4311 (Flares) and 4694 (Wine Fermentation and Storage Tanks). Working closely with affected sources and through public development processes, the rules will be amended to incorporate more stringent requirements as appropriate.

Through the comprehensive stationary and mobile source control strategy that has been adopted from prior regulatory actions and included in the Plan, the San Joaquin Valley will reduce NOx emissions by over 60% between 2012 and 2031. The ambient ozone concentrations will decrease dramatically in all areas of the Valley with Valley residents experiencing cleaner air over time. CARB used a modeled attainment test consistent with EPA's guidelines to predict future 8-hour ozone concentrations at each monitoring site in the Valley to demonstrate attainment. Modeling shows that the Valley will attain the 2008 8-hour ozone standard by 2031 based on implementation of these ongoing control measures.

In Appendix C of the *2016 Ozone* Plan, the District evaluated Rule 4103 (Open Burning) and found no breakthroughs in technologically achievable and economically feasible alternatives to open burning and traditional biomass power plants. While every effort

should be taken to save this existing resource, the District believes that there is an urgent need to investigate other alternatives for the disposal of agricultural waste material. As the District continues to develop future attainment plans to address increasingly stringent federal air quality standards, this source category will be re-evaluated for additional potential opportunities to reduce emissions

10.2 2018 PM2.5 Plan

The *2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards* (*2018 PM2.5 Plan*) was adopted by the District's Governing Board on November 15, 2018. The development of the Plan utilized extensive science and research, state of the art air quality modeling, and the best available information in developing a strategy for bringing the Valley into attainment with the federal health-based 1997, 2006, and 2012 PM2.5 standards as expeditiously as practicable by the respective federal deadlines of 2020, 2024, and 2025. The attainment strategy includes a combination of innovative regulatory and non-regulatory measures for both stationary and mobile sources that built upon stringent air quality measures already in place from earlier District attainment plans and measures adopted by the District's Governing Board. The *2018 PM2.5 Plan* was developed through an extensive public process, and unanimously supported by the District's Citizens Advisory Committee made up of members representing environmental, business, and city interests. To achieve the significant emissions reductions necessary for expeditious attainment, the *2018 PM2.5 Plan* includes a comprehensive suite of regulatory and incentive-based measures for both stationary and mobile sources. District and CARB staff have been actively implementing the control strategies detailed in the *2018 PM2.5 Plan*, and recent positive air quality trends for PM2.5 reflect emission reductions already being achieved as a result of these effective measures.

Appendix C of the *2018 PM2.5 Plan* listed the Stationary Source Control Measures that are needed to achieve attainment of the standards. Open burning is not included in any of these control measures. Rule 4103 was originally adopted on June 18, 1992, to regulate and coordinate the use of open burning while minimizing smoke impacts on the public. Rule 4103 has since been amended seven times and become progressively more stringent. In 2003, California Senate Bill (SB) 705 (incorporated as CH&SC Sections §41855.5 and §41855.6) established a schedule to phase out the open burning of agricultural material but provided for a postponement of the phase-out where justified by technical and economic impediments. The phase out requirements of SB 705 have been incorporated into Rule 4103 and were implemented beginning June 1, 2005. The District also operates a comprehensive Smoke Management System (SMS) to manage open burning and only allow the limited amount of burning that is still permissible to take place on days with favorable meteorology and in amounts that will not cause a significant impact on air quality or smoke-sensitive areas. While CARB modeling has confirmed that agricultural open burning does not significantly contribute to the Valley's attainment of PM2.5 standards due to the management of open burning under the District's comprehensive SMS, the District continues to seek additional opportunities for reducing emissions and improving public health.

11 Determinations Required by State Law

11.1 Economic Feasibility

The District has determined that there were no economically feasible alternatives to managed burning without incentives.

11.2 Federal and State Commitments for Biomass Facilities

The District has determined that there were no long-term federal or state funding commitments for the operation of biomass facilities or development of alternatives to burning. The District supports legislation that will encourage, promote, and facilitate alternative uses for agricultural material. The District also supports policies and initiatives that encourage renewable energy and energy efficiency, including supporting legislation that provides additional biomass capacity utilizing agricultural materials.

11.3 Air Quality Impacts

The District determined that the continued issuance of burn permits would not cause or substantially contribute to a violation of an applicable federal ambient air quality standard. The District's Smoke Management System (SMS) manages burning of agricultural waste materials. The SMS uses a combination of real-time meteorological information and computer modeling to determine the allowable amount and location of agricultural burning. District's use of the SMS would limit combustion emissions to levels below the violation threshold of any applicable federal ambient air quality standard.

11.4 California Air Resources Board Concurrence

CARB has concurred with all previous District determinations. Prior to the District's Governing Board's consideration of approval of the revised proposed recommendations, the District has worked with CARB toward a concurrence with the determinations, as required by the CH&SC Section 41855.6. Upon District Governing Board approval, the District will forward this 2020 Report with the District's recommendations to CARB for review.

12 Public Process

Throughout the development of the 2020 Report, the District provided updates at regularly scheduled Citizens Advisory Committee (CAC) meetings to solicit feedback. Additionally, the District engaged directly with all interested stakeholders throughout the process.

The progress of the 2020 Report has been publicly available on a webpage specifically developed by the District for the 2020 Report, located at: https://www.valleyair.org/BurnPrograms/open-burn-report-progress/2020.htm

The District held a public discussion on the 2020 Report at the September 17, 2020 Governing Board meeting. Several public comments were provided supporting the District's efforts to seek new alternatives, highlighting the feasibility challenges with remaining crop categories, and urging the District to take strong action to phase-out remaining burning.

The District conducted a public workshop on September 30, 2020, to present, discuss, and receive public comment on the District's analysis of feasible alternatives to agricultural burning in preparation of the 2020 Report. There were no significant comments received as part of this workshop.

The District provided an update on upcoming proposed regulatory actions to the CAC on December 1, 2020, in which the CAC gave their overall support of the 2020 Report and recommendations on agricultural burning.

The District published the draft report on November 24, 2020, followed by a two-week public comment period ending at 5:00 pm on December 8, 2020. The District has incorporated comments as appropriate into the recommended 2020 Report. A summary of significant comments received and District responses is available in Appendix D of the final 2020 Report. The District continued to invite public comment through and during the December 17, 2020, Governing Board Hearing.

13 California Environmental Quality Act

Based on the District's investigation, the District concludes that the proposed 2020 Report will not cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment, and as such is not a "project" as that term is defined under the California Environmental Quality Act (CEQA) Guidelines §15378.

According to Section 15061 (b)(3) of the CEQA Guidelines, a project is exempt from CEQA if, "(t)he activity is covered by the general rule that CEQA applies only to projects which have the potential for causing a significant effect on the environment. Where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA." As such, substantial evidence supports the District's assessment that assuming the 2020 Report is a "project" under CEQA, it will not have any significant adverse effects on the environment.

Furthermore, the proposed 2020 Report is an action taken by a regulatory agency, the San Joaquin Valley Air Pollution Control District, as authorized by state law to assure the maintenance, restoration, enhancement, or protection of air quality in the San Joaquin Valley where the regulatory process involves procedures for protection of air quality. CEQA Guidelines §15308 (Actions by Regulatory Agencies for Protection of the Environment), provides a categorical exemption for "actions taken by regulatory agencies, as authorized by state or local ordinance, to assure the maintenance, restoration, enhancement, or protection of the environment where the regulatory process involves procedures for protection of the environment. Construction activities and relaxation of standards allowing environmental degradation are not included in this exemption." No construction activities or relaxation of standards are included in this project.

Therefore, for all of the above reasons, the proposed 2020 Report is not subject to CEQA. Pursuant to Section 15062 of the CEQA Guidelines, staff will file a Notice of Exemption upon Governing Board approval of the Project.

Appendix A – Summarized Information from CH&SC Section 41855.5

Appendix A: SUMMARIZED INFORMATION FROM CH&SC SECTION 41855.5

Category Definitions List

CHSC Section 41855.5 defines Agricultural Material Categories as follows:

"Field crops" means any of the following crops:

(A) Alfalfa	(B) Asparagus	(C) Barley stubble
(D) Beans	(E) Corn	(F) Cotton
(G) Flower straw	(H) Hay	(I) Lemon grass
(J) Oat stubble	(K) Other field crops, as determined by the state board	
(L) Pea vines	(M) Peanuts	(N) Rice stubble
(O) Safflower	(P) Sugar cane	(Q) Vegetable crops
(R) Wheat stubble		

"Orchard removals" includes, but is not limited to, any of the following:

(A) Orchard removal matter	(B) Stumps	(C) Untreated sticks

"Other materials" includes, but is not limited to, any of the following:

(A) Brooder paper	(B) Deceased goats	(C) Diseased bee hives

"Other weeds and maintenance" includes, but is not limited to, any of the following:

(A) Ditch bank work	(B) Canal bank work	(C) Dodder weed
(D) Star thistle	(E) Tumbleweed	(F) Noxious weeds
(G) Pesticide sacks	(H) Fertilizer sacks	

"Prunings" means prunings from any of the following:

(A) Apple crops	(B) Apricot crops	(C) Avocado crops
(D) Bushberry crops	(E) Cherry crops	(F) Christmas trees
(G) Citrus crops	(H) Date crops	(I) Eucalyptus crops
(J) Fig crops	(K) Kiwi crops	(L) Nectarine crops
(M) Nursery prunings	(N) Olive crops	(O) Other prunings, as determined by the state board
(P) Pasture or corral trees	(Q) Peach crops	(R) Pear crops
(S) Persimmon crops	(T) Pistachio crops	(U) Plum crops
(V) Pluot crops	(W) Pomegranate crops	(X) Prune crops
(Y) Quince crops	(Z) Rose prunings	

"Surface harvested prunings" includes, but is not limited to, any of the following:

(A) Almond prunings	(B) Walnut prunings	(C) Pecan prunings
(D) Grape vines	(E) Vineyard removal materials	

"Vineyard materials" includes, but is not limited to, any of the following:
(A) Grape canes (B) Raisin trays

"Weed abatement" includes, but is not limited to, any of the following:
(A) Berms (B) Bermuda grass (C) Fence rows
(D) Grass (E) Pasture (F) Ponding or levee banks

OPEN BURN PROHIBITION SCHEDULE

State law requires burning to be prohibited for the following crops on the dates listed unless demonstrated to be economically unfeasible:

6/1/05				
	Field Crops			
	Alfalfa	Asparagus	Barley Stubble	Beans
	Corn	Cotton	Flower Straw	Hay
	Lemon Grass	Oat Stubble	Other Field Crops as determined by state board.	Pea Vines
	Peanuts	Rice Stubble	Safflower	Sugar Cane
	Vegetable Crops	Wheat Stubble		
	Prunings			
	Apple Crops	Apricot Crops	Avocado Crops	Bushberry Crops
	Cherry Crops	Christmas Trees	Citrus Crops	Date Crops
	Eucalyptus Crops	Fig Crops	Kiwi Crops	Nectarine Crops
	Nursery Prunings	Olive Crops	Other Prunings as determined by state board.	Pasture or Corral Trees
	Peach Crops	Pear Crops	Persimmon Crops	Pistachio Crops
	Plum Crops	Pluot Crops	Pomegranate Crops	Prune Crops
	Quince Crops	Rose Prunings		
	Weed Abatement			
	Berms	Bermuda Grass	Fence Rows	Grass
	Pasture	Ponding or Levee Banks		

Establish best management practices for control of weeds/maintenance effective 6/1/06:

Other Weeds and Maintenance			
Ditch Bank Work	Canal Bank Work	Dodder Weed	Star Thistle
Tumbleweed	Noxious Weeds	Pesticide Sacks	Fertilizer Sacks

6/1/07			
	Orchard Removals		
	Stumps	Orchard Removal Matter	Untreated Sticks

6/1/10				
	Other Materials			
	Brooder Paper	Deceased Goats	Diseased Bee Hives	
	Surface Harvested Prunings			
	Almond Prunings	Walnut Prunings	Pecan Prunings	Grape Vines
	Vineyard Removal Materials			
	Vineyard Removals			
	Vineyard Materials			
	Grape Canes	Raisin Trays		

Appendix B – District Economic Analysis

Appendix B: DISTRICT ECONOMIC ANALYSIS

Table B-1: Incremental Cost Increase – Soil Incorporation

Crop	Average Profit Rate (2014-2018)	Incremental Cost Increase								
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres	< 100 Acres	≥ 100 Acres
Citrus										
Oranges (Navel)	5.2%	$16,994	$45,268	$126,064	$358,171	$506,483	$757,611	$1,145,656	$36,186	$250,986
Oranges (Valencia)	5.2%	$17,251	$40,127	$132,662	$292,112	$472,725	$661,650	$1,512,195	$29,674	$209,002
Oranges (Unspecified)	5.2%	$16,994	$45,268	$126,064	$358,171	$506,483	$757,611	$1,145,656	$36,186	$250,986
Mandarins & Tangerines	5.2%	$16,736	$42,955	$131,548	$321,672	$535,872	-	-	$33,101	$239,762
Grapefruit	5.2%	$19,221	$37,985	$161,878	$346,519	-	-	$1,154,310	$27,961	$285,686
Lemons	5.2%	$17,079	$40,813	$125,636	$274,291	$514,109	$691,124	$913,121	$31,988	$225,282
Citrus (Unspecified)	5.2%	$16,994	$45,268	$126,064	$358,171	$506,483	$757,611	$1,145,656	$36,186	$250,986
Vineyards										
Grapes (Raisins)	6.0%	$23,092	$61,701	$182,700	$417,162	$736,498	$1,025,044	$2,873,950	$48,591	$574,966
Grapes (Table - Hand Picked)	3.2%	$23,092	$61,701	$182,700	$417,162	$736,498	$1,025,044	$2,873,950	$48,591	$574,966
Grapes (Wine)	6.0%	$23,092	$61,701	$182,700	$417,162	$736,498	$1,025,044	$2,873,950	$48,591	$574,966
Kiwi (Hand Picked)	6.0%	$21,649	$61,220	$189,797	$406,457	-	-	-	$52,440	$220,828
Tree Nuts										
Almonds (Prunings)	9.7%	$21,015	$44,749	$118,246	$249,512	$431,655	$595,494	$1,947,891	$37,510	$332,893
Pecans (Prunings)	9.7%	$21,920	$46,350	$129,452	$268,652	$442,652	$616,652	$877,652	$38,694	$225,987
Walnuts (Prunings)	9.7%	$20,946	$42,870	$116,994	$251,670	$412,098	$608,787	$1,288,362	$36,049	$227,170
Combined Categories										
Citrus	5.2%	$17,079	$43,469	$127,778	$342,492	$517,964	$734,392	$1,129,291	$33,787	$244,046
Tree Nuts (Prunings)	9.7%	$21,015	$44,331	$118,177	$250,069	$428,454	$597,094	$1,878,709	$37,162	$313,544

Table B-2: Percent Return on Sales (Net Profit) – Soil Incorporation

Crop	Average Profit Rate (2014-2018)	Percent Return on Sales (Net Profit)								
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres	< 100 Acres	≥ 100 Acres
Citrus										
Oranges (Navel)	5.2%	23%	21%	20%	19%	19%	18%	17%	21%	19%
Oranges (Valencia)	5.2%	18%	17%	16%	16%	15%	15%	14%	18%	16%
Oranges (Unspecified)	5.2%	28%	26%	25%	24%	23%	22%	22%	27%	24%
Mandarins & Tangerines	5.2%	13%	12%	12%	11%	11%	-	-	13%	11%
Grapefruit	5.2%	19%	18%	17%	16%	-	-	15%	18%	16%
Lemons	5.2%	13%	12%	12%	11%	11%	10%	10%	12%	11%
Citrus (Unspecified)	5.2%	39%	36%	35%	33%	32%	31%	30%	37%	33%
Vineyards										
Grapes (Raisins)	6.0%	52%	49%	47%	45%	44%	42%	41%	50%	43%
Grapes (Table - Hand Picked)	3.2%	23%	21%	20%	20%	19%	18%	18%	21%	19%
Grapes (Wine)	6.0%	60%	57%	54%	52%	50%	49%	47%	57%	49%
Kiwi (Hand Picked)	6.0%	11%	10%	10%	9%	-	-	-	10%	10%
Tree Nuts										
Almonds (Prunings)	9.7%	22%	16%	14%	13%	12%	12%	11%	17%	12%
Pecans (Prunings)	9.7%	31%	23%	20%	18%	17%	17%	16%	24%	18%
Walnuts (Prunings)	9.7%	29%	21%	18%	16%	16%	15%	14%	22%	16%
Combined Categories										
Citrus	5.2%	18%	17%	16%	15%	15%	14%	14%	17%	15%
Tree Nuts (Prunings)	9.7%	23%	17%	14%	13%	12%	12%	11%	18%	12%

Table B-3: Incremental Cost Increase – Biomass

Crop	Average Profit Rate (2014-2018)	Incremental Cost Increase								
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres	< 100 Acres	≥ 100 Acres
Citrus										
Oranges (Navel)	5.2%	$19,391	$52,549	$147,302	$419,502	$593,433	$887,940	$1,343,032	$41,898	$293,802
Oranges (Valencia)	5.2%	$19,692	$46,520	$155,039	$342,032	$553,844	$775,402	$1,772,910	$34,262	$244,566
Oranges (Unspecified)	5.2%	$19,391	$52,549	$147,302	$419,502	$593,433	$887,940	$1,343,032	$41,898	$293,802
Mandarins & Tangerines	5.2%	$19,089	$49,836	$153,732	$376,698	$627,898	-	-	$38,281	$280,639
Grapefruit	5.2%	$22,003	$44,008	$189,302	$405,837	-	-	$1,353,137	$32,252	$334,496
Lemons	5.2%	$19,491	$47,324	$146,799	$321,132	$602,376	$809,967	$1,070,347	$36,975	$263,658
Citrus (Unspecified)	5.2%	$19,391	$52,549	$147,302	$419,502	$593,433	$887,940	$1,343,032	$41,898	$293,802
Combined Categories										
Citrus	5.2%	$19,491	$50,439	$149,311	$401,114	$606,897	$860,710	$1,323,822	$39,085	$285,663

Table B-4: Percent Return on Sales (Net Profit) – Biomass

Crop	Average Profit Rate (2014-2018)	Percent Return on Sales (Net Profit)								
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres	< 100 Acres	≥ 100 Acres
Citrus										
Oranges (Navel)	5.2%	26%	25%	23%	23%	22%	21%	20%	25%	22%
Oranges (Valencia)	5.2%	21%	20%	19%	18%	18%	17%	17%	20%	18%
Oranges (Unspecified)	5.2%	32%	31%	29%	28%	27%	26%	25%	31%	28%
Mandarins & Tangerines	5.2%	15%	14%	14%	13%	13%	-	-	14%	13%
Grapefruit	5.2%	22%	21%	20%	19%	-	-	17%	21%	19%
Lemons	5.2%	15%	14%	14%	13%	13%	12%	12%	14%	13%
Citrus (Unspecified)	5.2%	45%	42%	40%	39%	37%	36%	35%	43%	38%
Combined Categories										
Citrus	5.2%	21%	20%	19%	18%	17%	17%	16%	20%	18%

Table B-5: Incremental Cost Increase – Composting

Crop	Average Profit Rate (2014-2018)	Percent Return on Sales (Net Profit)								
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres	< 100 Acres	≥ 100 Acres
Citrus										
Oranges (Navel)	5.2%	$30,731	$83,689	$235,022	$669,762	$947,553	$1,417,920	$2,144,734	$66,678	$469,002
Oranges (Valencia)	5.2%	$31,212	$74,060	$247,379	$546,032	$884,324	$1,238,182	$2,831,267	$54,482	$390,366
Oranges (Unspecified)	5.2%	$30,731	$83,689	$235,022	$669,762	$947,553	$1,417,920	$2,144,734	$66,678	$469,002
Mandarins & Tangerines	5.2%	$30,249	$79,356	$245,292	$601,398	$1,002,598	-	-	$60,901	$447,979
Grapefruit	5.2%	$34,903	$70,048	$302,102	$647,937	-	-	$2,160,942	$51,272	$533,996
Lemons	5.2%	$30,891	$75,344	$234,219	$512,652	$961,836	$1,293,387	$1,709,191	$58,815	$420,858
Citrus (Unspecified)	5.2%	$30,731	$83,689	$235,022	$669,762	$947,553	$1,417,920	$2,144,734	$66,678	$469,002
Combined Categories										
Citrus	5.2%	$30,891	$80,319	$238,231	$640,394	$969,057	$1,374,430	$2,114,082	$62,185	$456,003

Table B-6: Percent Return on Sales (Net Profit) – Composting

Crop	Average Profit Rate (2014-2018)	Percent Return on Sales (Net Profit)								
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres	< 100 Acres	≥ 100 Acres
Citrus										
Oranges (Navel)	5.2%	41%	39%	37%	36%	35%	34%	32%	39%	35%
Oranges (Valencia)	5.2%	33%	32%	30%	29%	28%	27%	26%	32%	29%
Oranges (Unspecified)	5.2%	51%	49%	47%	45%	43%	42%	40%	49%	44%
Mandarins & Tangerines	5.2%	24%	23%	22%	21%	20%	-	-	23%	21%
Grapefruit	5.2%	35%	33%	32%	31%	-	-	28%	34%	30%
Lemons	5.2%	24%	23%	22%	21%	20%	19%	19%	23%	20%
Citrus (Unspecified)	5.2%	71%	67%	64%	62%	60%	58%	56%	68%	61%
Combined Categories										
Citrus	5.2%	33%	31%	30%	29%	28%	27%	26%	31%	28%

Appendix C – Eastern Research Group Economic Report

2020 AGRICULTURAL BURNING REPORT: ECONOMIC DATA AND ANALYSIS

Final

December 7, 2020

Submitted to:

San Joaquin Valley Air Pollution Control District
1900 East Gettysburg Avenue
Fresno, CA 93726-0244

Submitted by:

Eastern Research Group, Inc. (ERG)
8950 Cal Center Drive, Suite 230
Sacramento, CA 95826

District Agreement No. CONT-00656

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LIST OF TABLES

1. EXECUTIVE SUMMARY

Under District Agreement No. CONT-00656, ERG developed models to estimate farm net returns for specified crops that the District will then use to assess the economic feasibility of alternatives it considered to open burning. At the request of the District, ERG used the same method to estimate baseline costs, gross returns, and net returns for farms growing crops potentially affected by the rule that was used in the District's 2010 report: *Final Staff Report and Recommendations on Agricultural Burning* (SJV APCD, 2010).

Using the 2010 strategy, ERG estimated revenues by crop for each "average farm" in a range of farm size classes based on acres, yield, productivity, and price for that crop. Those revenues were used to estimate after-tax profit, which is then compared to the expected costs of compliance with the alternatives to burning selected for examination by the District.

This report explains in detail the data and method used in each step to calculate the specified results, and presents tables summarizing those results. Section 3.1 describes how ERG estimated average acres for growing each specified crop by farm size class. In Section 3.2, ERG calculated the average tons of crop per acre (yield) over the last five years for each crop type, adjusting for farm productivity. Section 3.3 then demonstrated how the results of Sections 3.1 and 3.2 were combined to estimate the tons of crop expected for each "average" farm.

Section 3.4 presents the method ERG used to estimate the price per ton of crop, and the use of the National Agricultural Statistics Service "Price Received" index to calculate the 2018 constant dollar price for each crop. Multiply average price per ton by the tons of crop per farm results in the estimated one year's average revenue from the crop for the farm; multiplying this value by 10 represents 10 years of average revenue for that farm size. Finally, Section 3.5 explains the derivation of the ratio of the post-tax profit to revenue by crop, which is then used to estimate ten years' average profit for each farm size by crop.

Finally, ERG gratefully acknowledges the assistance of agricultural stakeholders, economists at Cal Poly San Luis Obispo and U.C. Davis, and staff members at the San Joaquin Valley Air Pollution Control District and the California Air Resources Board (ARB). We thank them for their generosity in sharing their time and expertise in assisting us with the preparation of this report.

2. INTRODUCTION AND BACKGROUND

This report provides economic data and analysis in support of the San Joaquin Valley Air Pollution Control District (i.e., the District) assessment of the economic feasibility of various alternatives to agricultural burning. This work was performed by ERG under District Agreement No. CONT-00656.

2.1. DISTRICT RULE 4103 (OPEN BURNING)

Rule 4103 (last amended April 15, 2010) permits, regulates, and coordinates the use of open burning while minimizing smoke impacts on the public. Under this rule, burning of agricultural residues is prohibited unless the District postpones the prohibition if certain criteria are met:

- No economically feasible alternative to burning the waste exists.
- No long-term federal or state funding commitment for continued operation of biomass facilities in the San Joaquin Valley or development of alternatives to burning.
- Continued issuance of permits for a specific category or crop will not cause, or substantially contribute to, a violation of an applicable federal ambient air quality standard.
- The California Air Resources Board (CARB) concurs with the Board's postponement of the prohibition.

This rule conforms to the requirements under 2018 California Health and Safety Code (HSC) Division 26, Chapter 3, Article 3, Section 41855.6 "Agricultural Burning" (2003).

2.2. DISTRICT AGRICULTURAL BURNING REPORTS

In 2010, the District evaluated alternatives to agricultural burning and provided recommendations, by crop category, for prohibiting or permitting open burning of the agricultural wastes covered by the State regulation and District rule. An updated review was published in 2015. This current document provides economic data to be used in the feasibility of alternatives to burning determinations being examined by the District and to be published in a report later in 2020.

2.3. PROFILE OF AGRICULTURE IN THE SAN JOAQUIN VALLEY

The San Joaquin Valley is a highly productive agricultural region. The eight counties within the Valley contain almost 22,500 farm operations covering almost 4.7 million acres of cropland. While only part of Kern County falls into the District's boundaries, all of Kern County is included in the data presented in this section, as the data were only available at the county level. In 2017, the Valley produced more than $15 billion in crop sales according to the USDA NASS Census of Agriculture. Included in those sales were over ninety percent of California's almonds, raisin and table grapes, nectarines and navel oranges. Many of these crops, which make up the significant of the District's crop sales, are currently allowed burn permits and could be significantly impacted by a rule change to open burning.

A breakdown of farm by size by farm primary product from 2017 is presented in Table 1 (NASS, 2017; NASS, 2019b). Farm size by primary product was not available at the county level. To create Table

1, we assumed the statewide distribution of farm size for each farm classification (NASS, 2019b) and applied to it to the county totals of each classification. The majority of farms in the APCD primarily produce fruit and tree nuts. Most of these operations are small. One third of fruit and tree nut farms are smaller than 10 acres, and two thirds of all fruit and tree nut farms are smaller than 50 acres.

Table 1. Number of Farms by Acreage and Primary Commodity [a]

Farm Size	Fruit and Tree Nut	All other Crops	Animal Production	Total
1.0 to 9.9 acres	4,664	599	1,704	**6,967**
10.0 to 49.9 acres	4,676	803	1,459	**6,938**
50.0 to 69.9 acres	684	142	212	**1,038**
70.0 to 99.9 acres	746	139	209	**1,094**
100 to 139 acres	570	151	216	**937**
140 to 179 acres	480	123	186	**790**
180 to 219 acres	293	69	155	**517**
220 to 259 acres	199	65	99	**362**
260 to 499 acres	638	261	414	**1,313**
500 to 999 acres	404	253	395	**1,051**
1,000 to 1,999 acres	227	190	286	**704**
2,000 or more acres	170	176	374	**719**
Total of each NAICS	**13,750**	**2,970**	**5,709**	**22,429**

Source: NASS, 2017; NASS, 2019a.

Notes: [a] Includes all of Kern county

Table 2 shows total sales by farm (NASS, 2017). Just under half of operations bring in less than $50,000 a year in sales and might be significantly impacted by a change to burn permits. Less than a quarter of operations exceed $500,000 in sales, even though average sales per operation of farms located within the District are over $700,000 (see Table 3). This indicates that fairly small percentage of farms contribute to the bulk of crop sales in the region.

Table 2. Farms by Total Sales

Total Sales	Farms
Less than $50,000	10,495
$50,000 to $99,999	2,146
$100,000 to $499,999	4,659
$500,000 or more	5,129

Source: NASS, 2017

The average sales per farm in each county are presented in Table 3 (NASS, 2017). Average sales in each county appear to be disproportionately affected by the prevalence of large-scale farms (defined as 1,000 acres or more). San Joaquin and Stanislaus Counties have significantly smaller average sales, most likely due to their higher number of smaller farms compared to other counties. Kern County's higher than average sales is likely due to their higher proportion of large farms and their production of high value crops, namely almonds and grapes.

Table 3. Average Sales per Farm for Farms within the District [a]

County	Average Sales per Farm (All Commodities)	Average Crop Sales per Farm	Total Farms
San Joaquin	$634,404	$474,432	2,337
Stanislaus	$697,690	$369,917	4,187
Merced	$1,257,337	$552,065	3,621
Madera	$1,076,903	$833,569	3,430
Fresno	$1,202,926	$855,413	1,386
Kings	$1,712640	$857,348	963
Kern	$2,355,161	$1,984,899	1,731
Tulare	$1,068,739	$531,039	4,774
District	**$1,118,059**	**$712,513**	**22,429**

Source: NASS, 2017.
Note: [a] Includes all of Kern County.

Each county brings in a significant amount of revenue from crops and agricultural commodities. Many of the crops produced in the District contribute a significant amount to the total state production for the respective crops. Therefore, a change to open burning Rule 4103 could potentially have significant economic impacts throughout the District and state.

2.4. IMPACT OF COVID-19 ON AGRICULTURE IN THE SAN JOAQUIN VALLEY

The COVID-19 pandemic has resulted in large-scale negative impacts across the entire U.S. agricultural sector. The pandemic has caused multiple disruptions to the established agricultural supply chain. Widespread shutdowns of in-person business operations, especially of processing plants, restaurants, and schools, has resulted in multiple challenges to agriculture. The closure of processing plants, either as a preventative measure or due to workers testing positive for COVID-19, has slowed the production process (Penson, 2020). This results in a mismatch of supply to meet demand for food, while farmers bear lost profitability because their produce is not being processed, losing valuable time before perishing.

The near total closure of restaurants, bars, and wineries resulted in a significant disruption to how and where people buy their food from. Visits to sit-down restaurants nosedived right after the federal government declared a state of emergency on March 13, 2020. Visits to these restaurants have started to recover slightly, but are nowhere near 2019 levels (Penson, 2020). Smaller wineries, often dependent on cellar-door sales and niche markets, have been severely impacted, while large wineries with high volume sales to retail outlets may have experienced a small increase in sales (ERA Economics, 2020). As a result, it is expected that the price of wine grapes will remain low with wineries shifting impacts onto producers. Stops at supermarkets spiked in mid-March, but have since fallen below 2019 levels as well, likely a result of both the general public's reduced spending capacity and the concern of contracting COVID-19 in heavily trafficked places. Both of these factors also play a role in the shift in consumer preference to more shelf-stable food items as opposed to produce (ERA Economics, 2020). California's table grape market has also seen depressed prices throughout the summer as a result of this shift in consumer demand. School closures also resulted in a reconfiguring of where children get at least some of their meals, since schools provide large amounts of food to children across the United States (Ledbetter, 2020).

This shift in consumer demand has also resulted in logistical complications for the agricultural sector. Shipping and production costs have increased, cutting deeper into the margins for agricultural business (Penson, 2020). The closure of production plants has stalled produce from reaching supermarkets and dining room tables. Even when production plants are not closed, the process is slowed due to required spacing between workers, mandatory sanitation efforts, and increased breaks for personal hygiene (ERA Economics, 2020). Port closures have also stalled the distribution process, making international trade of food products, especially those that are perishable, a much less profitable endeavor. As an example, California's rice producers are heavily dependent on exporting. The export value for rice, according a summer study, was nearly 17 percent lower in March 2020 than it was a year prior (ERA Economics, 2020). Walnut producers in California will also likely face increased international competition, as global stocks of walnuts are expected to be plentiful given the complications associated with exporting. The lack of labor for farm work, transportation, and processing present ongoing challenges. While immigrants are presently permitted entry into the United States for seasonal work in the agricultural sector, the risk of infection is a deterrent to their traveling.

While it is expected that supply chain disruptions are resolved in the near term, the impacts to the agricultural sector caused by a contraction of consumer income will likely take longer to recover from (Westhoff et al, 2020). Farm households will face losses not only from the reduced spending capacity of potential consumers, but also due to reduce off-farm income (USDA ERS, 2020). These households typically use their off-farm income to balance the losses from on-farm operations. With both reduced off-farm income and income from their agricultural products, farm households may not be able to fund some of the necessities of their on-farm operations, including production expenses and debt, as well as their own personal living expenses for day-to-day life.

At the same time, the expectation is that the agricultural sector will not face as large of economic impacts as other sectors (i.e. tourism, restaurants, air transportation). These industries faced wide-ranging shutdowns in an effort to reduce public exposure to COVID-19. The agricultural sector still feels some of the secondary effects of these industries being closed though.

In California, a study from June of this year estimated that the pandemic will have a direct economic impact between $5.9 billion and $8.6 billion in 2020, with an estimated $2 billion in impacts already recognized as of June this year (ERA Economics, 2020). Rural counties throughout the state are expected to see the greatest impacts of these losses. Farm employment across the entirety of California was down 23.2 percent year-over-year (YOY) in April. San Joaquin County experienced the most significant YOY job loss of any county in California, down 89.0 percent compared to April 2019. Tulare County and Kern County also experienced large changes in farm employment, down 28.0 and 27.3 percent, respectively.

3. METHOD

ERG used the same overall strategy to estimate baseline costs, gross returns, and net returns for farms growing crops potentially affected by the rule that was used in the District's 2010 report: *Final Staff Report and Recommendations on Agricultural Burning* (SJV APCD, 2010).

The 2010 strategy estimated revenues by crop for each "average farm" representing a series of farm size classes based on acres, yield, productivity, and price for that crop. Those revenues are used to estimate after-tax profit, which is then compared to the expected costs of compliance with the alternatives to burning selected for examination by the District. For this 2020 report, ERG implemented the 2010 strategy using the following steps:

- Estimate average acres for growing each specified crop by farm size class.
- Calculate the average tons of crop per acre (yield) over the last five years for each crop type, adjusting for farm productivity.
- Multiply the productivity adjusted average yield by the average acres per farm in each farm size class to estimate tons of crop for each "average" farm.
- Multiply the tons of crop per farm by the average price per ton of the crops resulting in an estimate of one year's average revenue from the crop for the farm.
- Multiply the average crop revenue for each farm size by 10 to represent 10 years of average revenue for that farm size.
- Multiply 10 years' average revenue by the ratio of post-tax profits to revenue to estimate ten years' average profit for the farm from that crop.

Each of these steps is described in more detail below.

The estimates presented in this report using this strategy were prepared for the sole purpose of assisting the District in assessing the economic feasibility of various alternatives to agricultural burning it examined in 2020. These estimates should not be used for other purposes. The outlook for agriculture in California at this moment is subject to significant uncertainty due to, among other factors, the impact of COVID-19, the implementation of minimum wage and overtime pay laws affecting agricultural labor, the Sustainable Groundwater Management Act (SGMA), as well as other forces such as climate change. Therefore, extrapolation of these estimates for other purposes is inappropriate.

3.1. ESTIMATE AVERAGE FARM SIZE BY CROP

ERG relied on data from the 2017 Census of Agriculture to estimate average acres per farm by crop type and farm size class. The Census of Agriculture tabulates the number of farms and acres by the specified fruits and nuts comprising the farms' primary crop for the California (NASS, 2019b, Table 37). In addition, farms are further distinguished by farm size for each specified crop:

- Less than 15 acres
- 15 to 24.9 acres
- 25 to 99.9 acres

- 100 to 249.9 acres
- 250 to 499.9 acres
- 500 to 749.9 acres
- 750 to 999 acres
- Over 1,000 acres

In addition, ERG aggregated farm size categories into two groups for further analysis:

- Farms less than 100 acres
- Farms of 100 acres or larger

Census also tabulates farms and acreage by crop type at the county level, but does not further distinguish by farm size (NASS, 2019c, Table 31). Therefore, ERG used the state level data to determine the percentage of farms and acreage allotted to the primary crop within each farm size class listed above. After summing the number of farms and acreage by crop type in each county composing the District, ERG assumed the same percentage of farms and acreage in the District would fall into each size class as occurs at the state level. Dividing acreage by the number of farms in each size class resulted in the average farm acreage for each size class and crop.

When necessary, ERG imputed acre per farm values to fill data gaps (e.g., when Census did not publish values to avoid disclosing potentially identifiable farming data). ERG started by calculating the midpoint of the interval for the size class as its initial estimate of acreage per farm; that is, the initial estimate of average acreage per farm in the 100 to 249.9 acre farm size class would be 175 acres. ERG then calculated the total acreage of all farms growing that crop based on its estimated acreage per farm, multiplying average acres per farm by the number of farms in each size class and summing to get total acreage. If estimated total acreage exceeded the Census total, the imputed values were trimmed until the totals matched; conversely imputed values were increased if the Census total exceeded the estimated total.

ERG followed an identical process for farms growing rice. However, in the Census of Agriculture, data for farms growing rice is tabulated with field crops. Hence rice farm data are taken from Chapter 1, Table 35 at the state level (NASS, 2019b), and Chapter 2, Table 25 at the county level (NASS, 2019c). Finally, Census did not have farm size data for: orange (unspecified), citrus (unspecified), and quince crops. ERG assumed that acreage allotted to those crops on farms that grew them would be similar in size to navel orange farms and apple farms, respectively.

Table 4 presents ERG's estimated acreage per farm by crop and farm size class.

Table 4. Average Farm Size by Farm Size Category (Acres)

Crop	Average Acres by Acreage of Crop						
	15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres
Rice							
Rice	9.31	75.52	170.61	354.21	590.48	0.00	0.00
Citrus							
Oranges (Navel)	18.87	51.87	146.21	417.12	590.21	883.25	1,336.22
Oranges (Valencia)	19.20	45.85	153.91	340.00	550.82	771.33	1,764.04
Oranges (Unspecified)	18.87	51.87	146.21	417.12	590.21	883.25	1,336.22
Mandarins & Tangerines	18.61	49.21	152.58	374.50	624.50	0.00	0.00
Grapefruit	21.50	43.35	188.02	403.51	0.00	0.00	1,346.28
Lemons	18.96	46.73	145.73	319.15	599.13	805.67	1,064.84
Citrus (Unspecified)	18.87	51.87	146.21	417.12	590.21	883.25	1,336.22
Apple, Pear, Quince							
Apples	19.54	46.75	155.44	336.15	560.54	0.00	0.00
Pears	17.94	49.46	135.71	322.13	643.20	0.00	0.00
Quince	19.54	46.75	155.44	336.15	560.54	0.00	0.00
Vineyards							
Grapes (Raisins)	18.69	50.82	151.39	346.46	612.04	851.95	2,389.13
Grapes (Table - Hand Picked)	18.69	50.82	151.39	346.46	612.04	851.95	2,389.13
Grapes (Wine)	18.69	50.82	151.39	346.46	612.04	851.95	2,389.13
Kiwi (Hand Picked)	17.50	50.43	157.31	337.62	0.00	0.00	0.00
Tree Nuts							
Almonds	18.70	52.81	158.45	347.02	608.74	844.14	2,787.23
Pecans	19.95	55.09	174.50	374.50	624.50	874.50	1,249.50
Walnuts	18.62	50.14	156.57	350.09	580.56	863.19	1,839.58
Stone Fruit							
Peaches	18.66	52.65	146.91	310.55	638.20	860.86	2,295.64
Nectarines	18.50	49.42	176.34	378.45	631.09	883.73	1,262.69
Plums	19.44	51.52	138.60	393.89	656.84	0.00	0.00
Apricots	18.65	50.12	249.00	0.00	0.00	0.00	0.00
Cherries	18.65	46.24	153.63	335.15	749.00	0.00	0.00
Olives	18.67	47.67	210.39	343.13	783.67	0.00	0.00
Plumcot	19.00	43.82	174.50	0.00	0.00	0.00	0.00
Combined Categories							
Citrus	19.04	49.75	148.21	398.76	603.61	856.20	1,317.06
Apple, Pear, Quince	18.99	48.09	147.99	329.64	630.31	0.00	0.00
Tree Nuts	18.70	52.24	158.29	347.79	604.07	846.44	2,687.81
Stone Fruit	18.75	48.65	158.09	346.47	668.83	876.38	1,869.20

Source: ERG estimates based on NASS, 2019b; NASS, 2019c.

3.2. FARM YIELD BY CROP

ERG estimated farm yield by crop for 2014 through 2018 based on County Crop Reports (NASS CA, 2020). For each year, ERG totaled acres and tons harvested by crop type across the eight counties that comprise the District, then divided tons by acres to calculate yield. ERG calculated yield for each crop and each year, then calculated the 5-year average yield for each crop. Table 5 summarizes acreage, tonnage, and estimated yield by crop and year used in this analysis.

Table 5. Profile of Agricultural Acreage, Yield, and Price in the District by Crop, 2014–2018

Year	Total Acreage	Total Production (Tons)	Yield (Tons/Acre)	Price/Ton	
				Current $	2018 $
Rice					
Rice					
2014	4,303	20,380	4.74	$400.00	$407.88
2015	3,957	16,950	4.28	$402.12	$410.04
2016	4,410	15,400	3.49	$276.10	$281.54
2017	3,060	14,100	4.61	$349.36	$356.24
2018	3,620	17,400	4.81	$365.00	$372.19
Average	**3,870**	**16,846**	**4.39**	**$358.52**	**$365.57**
Citrus					
Oranges (Navel)					
2014	134,400	1,702,000	12.66	$705.20	$682.79
2015	127,900	1,908,000	14.92	$567.97	$549.93
2016	135,100	2,074,000	15.35	$558.17	$540.44
2017	136,300	1,854,000	13.60	$623.39	$603.58
2018	131,000	1,787,000	13.64	$710.11	$687.56
Average	**132,940**	**1,865,000**	**14.04**	**$632.97**	**$612.86**
Oranges (Valencia)					
2014	24,600	398,700	16.21	$650.05	$629.40
2015	22,180	430,500	19.41	$596.54	$577.59
2016	22,330	420,700	18.84	$537.42	$520.35
2017	22,870	388,700	17.00	$655.60	$634.77
2018	22,030	351,500	15.96	$683.11	$661.41
Average	**22,802**	**398,020**	**17.48**	**$624.55**	**$604.71**
Oranges (Unspecified)					
2014	2,900	37,900	13.07	$456.40	$441.90
2015	2,900	44,300	15.28	$468.84	$453.95
2016	3,000	45,800	15.27	$474.81	$459.73
2017	3,000	46,100	15.37	$460.11	$445.49
2018	2,800	43,400	15.50	$533.34	$516.40
Average	**2,920**	**43,500**	**14.90**	**$478.70**	**$463.49**

Table 5. Profile of Agricultural Acreage, Yield, and Price in the District by Crop, 2014–2018

Year	Total Acreage	Total Production (Tons)	Yield (Tons/Acre)	Price/Ton	
				Current $	2018 $
Mandarins & Tangerines					
2014	59,200	516,000	8.72	$1,564.46	$1,514.76
2015	63,900	676,000	10.58	$1,392.58	$1,348.34
2016	62,200	710,000	11.41	$1,238.69	$1,199.34
2017	72,900	763,000	10.47	$1,683.99	$1,630.50
2018	78,500	762,000	9.71	$1,590.37	$1,539.84
Average	**67,340**	**685,400**	**10.18**	**$1,494.02**	**$1,446.56**
Grapefruit					
2014	3,104	37,700	12.15	$670.34	$649.05
2015	3,227	53,400	16.55	$731.50	$708.26
2016	2,593	31,100	11.99	$856.75	$829.53
2017	3,050	44,600	14.62	$771.21	$746.71
2018	3,250	43,100	13.26	$762.83	$738.59
Average	**3,045**	**41,980**	**13.71**	**$758.53**	**$734.43**
Lemons					
2014	13,060	149,900	11.48	$1,180.24	$1,142.75
2015	13,730	176,400	12.85	$1,083.04	$1,048.63
2016	13,770	186,700	13.56	$1,234.50	$1,195.29
2017	15,680	208,300	13.28	$1,301.35	$1,260.01
2018	16,360	230,200	14.07	$1,079.33	$1,045.04
Average	**14,520**	**190,300**	**13.05**	**$1,175.69**	**$1,138.35**
Citrus (Unspecified)					
2014	1,856	16,800	9.05	$427.98	$414.38
2015	2,012	21,300	10.59	$419.01	$405.70
2016	1,817	14,000	7.71	$618.00	$598.37
2017	2,284	22,900	10.03	$564.72	$546.78
2018	2,621	27,800	10.61	$657.99	$637.09
Average	**2,118**	**20,560**	**9.60**	**$537.54**	**$520.46**
Apple, Pear, Quince					
Apples					
2014	3,621	85,240	23.54	$603.75	$584.57
2015	2,910	58,900	20.24	$610.00	$590.62
2016	4,024	48,080	11.95	$514.52	$498.17
2017	2,760	39,940	14.47	$736.20	$712.81
2018	2,675	35,660	13.33	$523.11	$506.49
Average	**3,198**	**53,564**	**16.71**	**$597.51**	**$578.53**
Pears					
2014	333	5,220	15.68	$1,009.39	$977.32
2015	479	3,830	8.00	$655.35	$634.53
2016	391	6,860	17.54	$1,034.11	$1,001.26
2017	345	4,300	12.46	$784.88	$759.95
2018	165	1,484	8.99	$614.55	$595.03
Average	**343**	**4,339**	**12.53**	**$819.66**	**$793.62**

Table 5. Profile of Agricultural Acreage, Yield, and Price in the District by Crop, 2014–2018

Year	Total Acreage	Total Production (Tons)	Yield (Tons/Acre)	Price/Ton	
				Current $	2018 $
Quince					
2014	86	572	6.65	$2,000.00	$1,936.47
2015	98	712	7.27	$2,089.89	$2,023.50
2016	110	900	8.18	$2,150.00	$2,081.70
2017	117	680	5.81	$1,770.59	$1,714.34
2018	97	688	7.09	$2,000.00	$1,936.47
Average	**102**	**710**	**7.00**	**$2,002.10**	**$1,938.50**
Vineyards					
Grapes (Raisins)					
2014	194,850	1,909,800	9.80	$441.25	$427.23
2015	176,600	1,946,000	11.02	$438.09	$424.17
2016	132,100	1,434,600	10.86	$301.93	$292.34
2017	131,940	1,350,600	10.24	$437.98	$424.06
2018	132,280	1,580,900	11.95	$494.54	$478.83
Average	**153,554**	**1,644,380**	**10.77**	**$422.76**	**$409.33**
Grapes (Table - Hand Picked)					
2014	111,948	1,405,700	12.56	$1,648.21	$1,595.85
2015	107,065	1,230,800	11.50	$1,758.54	$1,702.67
2016	124,024	1,293,100	10.43	$1,773.03	$1,716.70
2017	133,066	1,528,900	11.49	$1,813.21	$1,755.61
2018	129,112	1,673,800	12.96	$1,460.85	$1,414.44
Average	**121,043**	**1, 1,426,460**	**11.79**	**$1,690.77**	**$1,637.06**
Grapes (Wine)					
2014	257,700	2,488,400	9.66	$427.44	$413.86
2015	252,990	2,395,600	9.47	$380.76	$368.66
2016	267,770	2,477,800	9.25	$426.37	$412.82
2017	253,450	2,491,300	9.83	$402.96	$390.16
2018	246,180	2,518,300	10.23	$412.72	$399.61
Average	**255,618**	**2, 2,474,280**	**9.69**	**$410.05**	**$397.02**
Kiwi (Hand Picked)					
2014	2,864	66,150	23.10	$1,633.14	$1,581.26
2015	2,536	34,200	13.49	$1,876.05	$1,816.46
2016	2,437	26,740	10.97	$1,760.28	$1,704.37
2017	3,480	31,520	9.06	$1,168.97	$1,131.84
2018	1,840	26,100	14.18	$1,460.00	$1,413.62
Average	**2,631**	**36,942**	**14.16**	**$1,579.69**	**$1,529.51**
Tree Nuts					
Almonds					
2014	864,900	894,600	1.03	$7,478.00	$7,240.45
2015	923,100	877,700	0.95	$6,951.20	$6,730.38
2016	998,100	1,109,900	1.11	$4,741.50	$4,590.87
2017	1,043,100	1,180,600	1.13	$4,705.14	$4,555.67
2018	1,097,500	1,168,600	1.06	$4,724.61	$4,574.52
Average	**985,340**	**1,046,280**	**1.06**	**$5,720.09**	**$5,538.38**

Table 5. Profile of Agricultural Acreage, Yield, and Price in the District by Crop, 2014–2018

Year	Total Acreage	Total Production (Tons)	Yield (Tons/Acre)	Price/Ton	
				Current $	2018 $
Pecans					
2014	1,060	424	0.40	$3,910.38	$3,786.16
2015	997	867	0.87	$4,169.55	$4,037.10
2016	894	1,340	1.50	$5,000.00	$4,841.16
2017	899	638	0.71	$5,200.63	$5,035.42
2018	877	903	1.03	$4,789.59	$4,637.44
Average	**945**	**834**	**0.90**	**$4,614.03**	**$4,467.46**
Walnuts					
2014	169,974	350,450	2.06	$3,546.73	$3,434.06
2015	168,190	335,380	1.99	$2,397.09	$2,320.94
2016	178,200	345,580	1.94	$1,940.14	$1,878.51
2017	181,200	318,950	1.76	$2,379.33	$2,303.75
2018	190,470	389,470	2.04	$1,625.85	$1,574.20
Average	**177,607**	**347,966**	**1.96**	**$2,377.83**	**$2,302.29**
Stone Fruit					
Peaches [a]					
2014	42,907	565,970	14.62	$818.40	$792.40
2015	41,568	563,060	14.89	$859.34	$832.04
2016	40,318	552,460	16.00	$777.24	$752.55
2017	42,027	540,180	14.34	$985.21	$953.91
2018	41,960	598,850	14.81	$917.56	$888.42
Average	**41,756**	**564,104**	**14.93**	**$871.55**	**$843.86**
Nectarines					
2014	22,075	206,480	9.35	$1,435.63	$1,390.02
2015	21,120	183,900	8.71	$1,517.99	$1,469.77
2016	20,410	195,300	9.57	$1,332.78	$1,290.44
2017	20,680	169,900	8.22	$1,589.73	$1,539.23
2018	19,911	187,210	9.40	$1,504.58	$1,456.78
Average	**20,839**	**188,558**	**9.05**	**$1,476.14**	**$1,429.25**
Plums					
2014	22,147	195,730	8.84	$1,227.15	$1,188.17
2015	20,710	152,910	7.38	$1,372.49	$1,328.89
2016	20,020	183,900	9.19	$1,403.69	$1,359.10
2017	20,180	143,800	7.13	$1,740.13	$1,684.86
2018	21,380	175,800	8.22	$1,479.89	$1,432.88
Average	**20,887**	**170,428**	**8.15**	**$1,444.67**	**$1,398.78**
Apricots					
2014	8,324	80,720	9.70	$803.50	$777.98
2015	7,834	53,320	6.81	$1,277.06	$1,236.49
2016	7,281	74,740	10.27	$949.78	$919.61
2017	7,162	55,140	7.70	$1,036.89	$1,003.95
2018	6,981	37,953	5.44	$1,263.43	$1,223.30
Average	**7,516**	**60,375**	**7.98**	**$1,066.13**	**$1,032.27**

Table 5. Profile of Agricultural Acreage, Yield, and Price in the District by Crop, 2014–2018

Year	Total Acreage	Total Production (Tons)	Yield (Tons/Acre)	Price/Ton	
				Current $	2018 $
Cherries					
2014	36,620	37,342	1.02	$4,201.33	$4,067.86
2015	31,300	78,050	2.49	$6,131.17	$5,936.40
2016	30,660	48,980	1.60	$4,444.61	$4,303.42
2017	31,730	93,620	2.95	$3,285.86	$3,181.47
2018	32,150	44,934	1.40	$5,134.08	$4,970.99
Average	**32,492**	**60,585**	**1.89**	**$4,639.41**	**$4,492.03**
Olives					
2014	16,140	33,709	2.09	$871.43	$843.75
2015	13,260	66,010	4.98	$869.61	$841.98
2016	14,860	57,770	3.89	$960.83	$930.30
2017	14,920	80,960	5.43	$1,004.68	$972.77
2018	15,578	57,170	3.67	$1,290.24	$1,249.25
Average	**14,952**	**59,124**	**4.01**	**$999.36**	**$967.61**
Plumcot					
2014	1,060	5,350	5.05	$1,182.99	$1,145.41
2015	1,040	7,060	6.79	$1,440.93	$1,395.16
2016	1,200	9,970	8.31	$1,970.01	$1,907.43
2017	1,260	11,000	8.73	$1,836.00	$1,777.68
2018	1,410	5,850	4.15	$1,215.04	$1,176.44
Average	**1,194**	**7,846**	**6.60**	**$1,528.99**	**$1,480.42**
Combined Categories					
Citrus					
2014	243,423	2,879,380	12.0	$872.11	$844.40
2015	239,806	3,326,850	14.0	$767.91	$743.51
2016	245,220	3,497,700	14.5	$732.49	$709.22
2017	259,144	3,341,700	13.0	$912.09	$883.12
2018	260,181	3,262,400	12.6	$937.97	$908.18
Average	**249,555**	**3,261,606**	**13.22**	**$844.51**	**$817.69**
Apple, Pear, Quince					
2014	4,040	91,032	22.53	$635.78	$615.58
2015	3,487	63,442	18.19	$629.35	$609.35
2016	4,525	55,840	12.34	$604.71	$585.50
2017	3,222	44,920	13.94	$756.52	$732.49
2018	2,937	37,832	12.88	$553.55	$535.97
Average	**3,642**	**58,613**	**15.98**	**$635.98**	**$615.78**
Tree Nuts					
2014	1,035,934	1,245,474	1.20	$6,370.61	$6,168.24
2015	1,092,287	1,213,947	1.11	$5,691.04	$5,510.25
2016	1,177,194	1,456,820	1.24	$4,077.21	$3,947.69
2017	1,225,199	1,500,188	1.22	$4,210.87	$4,077.10
2018	1,288,847	1,558,973	1.21	$3,950.50	$3,825.00
Average	**1,163,892**	**1,395,080**	**1.20**	**$4,860.05**	**$4,705.66**

Table 5. Profile of Agricultural Acreage, Yield, and Price in the District by Crop, 2014–2018

Year	Total Acreage	Total Production (Tons)	Yield (Tons/Acre)	Price/Ton	
				Current $	2018 $
Stone Fruit					
2014	156,743	1,137,681	7.26	$1,163.29	$1,126.34
2015	143,752	1,117,980	7.78	$1,494.36	$1,446.88
2016	141,298	1,157,160	8.19	$1,204.94	$1,166.67
2017	144,456	1,111,970	7.70	$1,464.90	$1,418.36
2018	145,910	1,126,257	7.72	$1,411.45	$1,366.61
Average	**146,432**	**1,130,210**	**7.73**	**$1,347.79**	**$1,304.97**

Sources: ERG estimates based on NASS, 2019a; NASS CA, 2020.
Note: [a] Total acreage and production of peaches represents the sum of freestone and clingstone peaches. However, yield represents the yields for freestone and clingstone peaches calculated separately then averaged. The yield values presented in this table are the values used in the model.

Yield tends to vary with farm size due to economies of scale. That is, larger farms tend to be more productive than smaller farms in the sense that a given set of inputs on a larger farm will result in a larger crop than those same inputs will achieve on a smaller farm. These "economies of scale" are largely attributable to the fixed costs associated with farming operations. That is, a minimum, irreducible cost is associated with almost any given farm operation (e.g. preparing equipment to mow between rows of trees in an orchard). This same cost is incurred whether the operation involves 10 acres or 100 acres. However, once that initial cost is incurred, the incremental cost of performing the operation over additional acres is much less than the initial cost; that is, operating over 100 acres will not be ten times the cost of operating over ten acres. Thus, farms smaller than 250 acres will get a lower yield per unit of input than larger farms.

ERG accounted for economies of scale associated with farm size by adjusting crop yield using the productivity factors from the District's 2010 report: *Final Staff Report and Recommendations on Agricultural Burning* (Table 6).

Table 6. Farm Productivity Adjustment Factor by Crop Acreage.

Crop Acreage	Productivity Adjustment Factor
15 to 24.9	0.892
25 to 99.9	0.929
100 to 249.9	0.965
250 to 499.9	1.002
500 to 749.9	1.038
750 to 999	1.075
over 1,000	1.111

Source: SJV APCD (2010) Final Agricultural Burning Report.

Combining average yield per crop with the farm productivity adjustment factors results in the estimated yield by crop and farm size presented in Table 7.

Table 7. Average Yield by Farm Size Category, 2014 –2018 (Tons per Acre)

Crop	Average Yield, All Farms (2014-2018)	Size-Adjusted Average Yield (Tons per Acre)						
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres
Productivity Adjustment								
Productivity Adjustment	—	0.892	0.929	0.965	1.002	1.038	1.075	1.111
Average Yield by Crop								
Rice								
Rice	4.39	3.91	4.07	4.23	4.39	4.55	4.71	4.87
Citrus								
Oranges (Navel)	14.04	12.52	13.04	13.54	14.06	14.57	15.09	15.59
Oranges (Valencia)	17.48	15.59	16.24	16.87	17.52	18.15	18.79	19.42
Oranges (Unspecified)	14.90	13.29	13.84	14.37	14.93	15.46	16.01	16.55
Mandarins & Tangerines	10.18	9.08	9.45	9.82	10.20	10.56	10.94	11.31
Grapefruit	13.71	12.23	12.74	13.23	13.74	14.24	14.74	15.24
Lemons	13.05	11.64	12.12	12.59	13.07	13.54	14.03	14.50
Citrus (Unspecified)	9.60	8.56	8.91	9.26	9.61	9.96	10.31	10.66
Apple, Pear, Quince								
Apples	16.71	14.90	15.52	16.12	16.74	17.34	17.96	18.56
Pears	12.53	11.18	11.64	12.10	12.56	13.01	13.47	13.93
Quince	7.00	6.24	6.50	6.76	7.01	7.27	7.53	7.78
Vineyards								
Grapes (Raisins)	10.77	9.61	10.01	10.40	10.80	11.18	11.58	11.97
Grapes (Table - Hand Picked)	11.79	10.51	10.95	11.37	11.81	12.23	12.67	13.09
Grapes (Wine)	9.69	8.64	9.00	9.35	9.71	10.06	10.41	10.76
Kiwi (Hand Picked)	14.16	12.63	13.15	13.66	14.19	14.70	15.22	15.73
Tree Nuts								
Almonds	1.06	0.94	0.98	1.02	1.06	1.10	1.14	1.18
Pecans	0.90	0.80	0.84	0.87	0.90	0.94	0.97	1.00
Walnuts	1.96	1.75	1.82	1.89	1.96	2.03	2.11	2.18
Stone Fruit								
Peaches	14.93	13.32	13.87	14.41	14.96	15.50	16.05	16.59
Nectarines	9.05	8.07	8.41	8.73	9.07	9.39	9.73	10.05
Plums	8.15	7.27	7.57	7.87	8.17	8.46	8.76	9.06
Apricots	7.98	7.12	7.41	7.70	8.00	8.28	8.58	8.87
Cherries	1.89	1.69	1.76	1.83	1.90	1.96	2.03	2.10
Olives	4.01	3.58	3.73	3.87	4.02	4.16	4.31	4.46
Plumcot	6.60	5.89	6.14	6.37	6.62	6.86	7.10	7.34
Combined Categories								
Citrus	13.22	11.79	12.28	12.76	13.25	13.72	14.21	14.69
Apple, Pear, Quince	15.98	14.25	14.84	15.42	16.01	16.59	17.18	17.75
Tree Nuts	1.20	1.07	1.11	1.16	1.20	1.24	1.29	1.33
Stone Fruit	7.73	6.89	7.18	7.46	7.74	8.02	8.31	8.59

Sources: ERG estimates based on NASS CA, 2020; SJV APCD, 2010.

Note: Values shown reflect the average for 2014 to 2018 for all counties in the District.

3.3. AVERAGE CROP PRODUCTION BY CROP AND FARM SIZE

Multiplying average acres allotted to each crop by farm size (Table 4) by expected yield per acre adjusted for farm size productivity (Table 7) results in ERG's estimated tons of crop per farm by crop type and farm size (Table 8).

Table 8. Tons of Crop per Average Farm by Farm Size Category

Crop	Tons of Crop per Average Farm						
	15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres
Rice							
Rice	36	308	722	1,556	2,688	0	0
Citrus							
Oranges (Navel)	236	676	1,980	5,866	8,599	13,326	20,836
Oranges (Valencia)	299	745	2,596	5,956	9,995	14,495	34,261
Oranges (Unspecified)	251	718	2,102	6,226	9,126	14,143	22,113
Mandarins & Tangerines	169	465	1,498	3,819	6,597	0	0
Grapefruit	263	552	2,488	5,545	0	0	20,513
Lemons	221	566	1,835	4,173	8,114	11,301	15,436
Citrus (Unspecified)	161	462	1,354	4,010	5,878	9,111	14,244
Apple, Pear, Quince							
Apples	291	726	2,506	5,627	9,720	0	0
Pears	201	576	1,642	4,046	8,369	0	0
Quince	122	304	1,050	2,358	4,073	0	0
Vineyards							
Grapes (Raisins)	180	509	1,574	3,740	6,844	9,867	28,597
Grapes (Table - Hand Picked)	196	556	1,722	4,092	7,488	10,795	31,285
Grapes (Wine)	161	457	1,415	3,363	6,154	8,872	25,714
Kiwi (Hand Picked)	221	663	2,150	4,790	0	0	0
Tree Nuts							
Almonds	18	52	162	368	669	961	3,279
Pecans	16	46	152	338	584	848	1,252
Walnuts	33	91	296	688	1,181	1,819	4,006
Stone Fruit							
Peaches	249	730	2,117	4,646	9,892	13,818	38,083
Nectarines	149	415	1,540	3,432	5,928	8,597	12,695
Plums	141	390	1,090	3,217	5,557	0	0
Apricots	133	372	1,918	0	0	0	0
Cherries	31	81	280	635	1,471	0	0
Olives	67	178	814	1,379	3,262	0	0
Plumcot	112	269	1,112	0	0	0	0
Combined Categories							
Citrus	224	611	1,891	5,282	8,282	12,167	19,342
Apple, Pear, Quince	271	714	2,282	5,277	10,454	0	0
Tree Nuts	20	58	183	417	751	1,089	3,575
Stone Fruit	129	349	1,179	2,683	5,365	7,281	16,049

Sources: ERG estimates based on NASS CA, 2020; SJV APCD, 2010.

Note: Values shown reflect the average for 2014 to 2018 for all counties in the District.

3.4. GROSS RETURNS BY CROP AND FARM SIZE

To estimate one year's gross returns by farm size and crop, ERG multiplied expected tons of crop per farm by the average price per ton of that crop. ERG calculated average price per ton as it did average yield per acre based on County Crop Reports data. For each year, ERG totaled tons harvested and total revenue by crop type across the eight counties that comprise the District, then divided total revenue by tons to calculate the average price per ton for that crop and that year in the eight counties comprising the District. ERG calculated average price for each crop and each year, then calculated the 5-year average price for each crop. ERG found the most recent data available dated from 2018 because 2019 County Crop Reports had not yet been published by all counties in the District.

ERG estimated gross in nominal dollars for each year from 2014 to 2018. Due to inflation, a direct comparison of average price and returns over five years does not accurately reflect the difference in returns between years. Therefore, ERG used a "price received" index to adjust all estimated average prices by crop to a 2018 constant dollar value to better reflect how real crop prices have changed in the absence of inflation. This also better represents the relative magnitude of average gross returns (and thus average net returns, which are calculated directly from gross returns) to the estimated cost of alternatives to open burning. The index used to calculate constant crop prices is constructed by the National Agricultural Statistics Service (NASS), which conducts a survey to estimate prices received by farmers for commodities sold. Indices derived from prices received are published at relatively high levels of aggregation at a national level. Therefore, with the exception of rice crops, ERG used the national process received index for Fruit and Tree Nuts to adjust each years' net returns to equivalent 2018 values; the NASS Food Grains index was used to adjust the price of rice.[1]

Table 5 summarizes the estimated average price by crop and year and the 2018 constant dollar average price by crop and year used in this analysis. The 2018 constant dollar price was calculated by taking the current dollar price for each year and dividing by the percent of 2018 dollar price found in Table 9.

[1] Downloaded from https://quickstats.nass.usda.gov/ on 9/8/2020 using the following options:
Commodity: Survey/Crops/Fruit & Tree Nuts/ Fruit & Tree Nut Totals/Index for Price Received, 2011/ Fruit & Tree Nut Totals – Index for Price Received, 2011/
Location: National/
Time: 2010 – 2020/Annual/
Downloaded from https://quickstats.nass.usda.gov/ on 10/20/2020 using the following options:
Commodity: Survey/Crops/Field Crops/ Food Grains/Index for Price Received, 2011/ Food Grains – Index for Price Received, 2011/
Location: National/
Time: 2010 – 2020/Annual/

Table 9. Price Index Values Used by Cost Category

Year	Price Received Fruit & Tree Nuts		Price Received Food Grains	
	Index	As a Percent of 2018 Price	Index	As a Percent of 2018 Price
2014	136.30	104.8%	90.40	121.8%
2015	138.60	106.5%	75.50	101.8%
2016	137.80	105.9%	59.30	79.9%
2017	129.60	99.6%	71.10	95.8%
2018	130.10	100%	74.20	100%

Source: NASS, 2019a

Table 10 presents the estimated average one-year gross returns per farm by crop type and farm size. This table is the result of taking the average tons of crop per farm (Table 8) and multiplying by the constant 2018 dollar price per ton (Table 5) of that crop. Finally, to calculate the estimated average revenue per farm by crop type and farm size, the estimated one year average gross returns (Table 10) is multiplied by ten (Table 11).

Table 10. Average Price per Ton and Annual Revenue per Average Farm

Crop	Average Price per Ton (2014-2018)	Annual Revenue per Average Farm						
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres
Rice								
Rice	$366	$13,317	$112,475	$263,933	$568,992	$982,600	$0	$0
Citrus								
Oranges (Navel)	$613	$144,752	$414,481	$1,213,602	$3,595,134	$5,269,776	$8,167,275	$12,769,578
Oranges (Valencia)	$605	$181,048	$450,303	$1,570,108	$3,601,425	$6,044,167	$8,765,465	$20,718,138
Oranges (Unspecified)	$463	$116,183	$332,677	$974,079	$2,885,577	$4,229,702	$6,555,334	$10,249,300
Mandarins & Tangerines	$1,447	$244,364	$673,033	$2,167,587	$5,524,102	$9,542,715	$0	$0
Grapefruit	$734	$193,122	$405,643	$1,827,453	$4,072,331	$0	$0	$15,065,165
Lemons	$1,138	$251,209	$644,857	$2,088,759	$4,749,849	$9,236,949	$12,864,046	$17,571,570
Citrus (Unspecified)	$520	$84,040	$240,639	$704,591	$2,087,256	$3,059,517	$4,741,741	$7,413,738
Apple, Pear, Quince								
Apples	$579	$168,464	$419,805	$1,449,763	$3,255,385	$5,623,576	$0	$0
Pears	$794	$159,230	$457,072	$1,302,813	$3,210,861	$6,641,600	$0	$0
Quince	$1,938	$236,539	$589,443	$2,035,591	$4,570,838	$7,895,981	$0	$0
Vineyards								
Grapes (Raisins)	$409	$73,504	$208,184	$644,256	$1,530,933	$2,801,630	$4,038,834	$11,705,439
Grapes (Table - Hand Picked)	$1,637	$321,607	$910,881	$2,818,851	$6,698,380	$12,258,139	$17,671,350	$51,215,499
Grapes (Wine)	$397	$64,108	$181,571	$561,896	$1,335,224	$2,443,480	$3,522,524	$10,209,058
Kiwi (Hand Picked)	$1,530	$338,067	$1,014,594	$3,287,718	$7,326,413	$0	$0	$0
Tree Nuts								
Almonds	$5,538	$97,816	$287,654	$896,588	$2,038,940	$3,705,164	$5,321,110	$18,157,863
Pecans	$4,467	$71,674	$206,147	$678,233	$1,511,387	$2,610,875	$3,786,383	$5,591,220
Walnuts	$2,302	$74,939	$210,185	$681,811	$1,582,945	$2,719,344	$4,187,328	$9,222,622
Stone Fruit								
Peaches	$844	$209,703	$616,310	$1,786,391	$3,920,922	$8,347,243	$11,660,891	$32,137,053
Nectarines	$1,429	$213,438	$593,849	$2,200,987	$4,904,722	$8,472,755	$12,287,488	$18,144,506
Plums	$1,399	$197,709	$545,693	$1,524,952	$4,500,011	$7,773,630	$0	$0
Apricots	$1,032	$137,016	$383,561	$1,979,551	$0	$0	$0	$0
Cherries	$4,492	$141,365	$365,071	$1,259,884	$2,853,841	$6,606,890	$0	$0
Olives	$968	$64,628	$171,820	$787,769	$1,334,093	$3,156,364	$0	$0
Plumcot	$1,480	$165,711	$398,003	$1,646,477	$0	$0	$0	$0

Table 10. Average Price per Ton and Annual Revenue per Average Farm

Crop	Average Price per Ton (2014-2018)	Annual Revenue per Average Farm						
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres
Combined Categories								
Citrus	$818	$183,566	$499,580	$1,545,925	$4,318,671	$6,772,155	$9,948,519	$15,815,958
Apple, Pear, Quince	$616	$166,661	$439,587	$1,405,140	$3,249,758	$6,437,204	$0	$0
Tree Nuts	$4,706	$93,964	$273,365	$860,444	$1,962,952	$3,531,978	$5,125,480	$16,820,657
Stone Fruit	$1,305	$168,669	$455,840	$1,538,587	$3,501,170	$7,001,658	$9,501,325	$20,943,776

Sources: ERG estimates based on NASS, 2019a; NASS, 2019b; NASS, 2019c; NASS CA, 2020; SJV APCD, 2010.

Note: Values shown reflect the average for 2014 to 2018 for all counties in the District in constant 2018$.

Table 11. Ten-Year Revenue per Average Farm

Crop	Ten-Year Revenue per Average Farm						
	15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres
Rice							
Rice	$133,169	$1,124,755	$2,639,325	$5,689,918	$9,826,002	$0	$0
Citrus							
Oranges (Navel)	$1,447,516	$4,144,813	$12,136,024	$35,951,338	$52,697,760	$81,672,753	$127,695,782
Oranges (Valencia)	$1,810,480	$4,503,029	$15,701,076	$36,014,248	$60,441,670	$87,654,646	$207,181,377
Oranges (Unspecified)	$1,161,826	$3,326,769	$9,740,788	$28,855,773	$42,297,024	$65,553,345	$102,493,002
Mandarins & Tangerines	$2,443,635	$6,730,331	$21,675,871	$55,241,021	$95,427,149	$0	$0
Grapefruit	$1,931,218	$4,056,434	$18,274,535	$40,723,315	$0	$0	$150,651,652
Lemons	$2,512,088	$6,448,569	$20,887,586	$47,498,489	$92,369,487	$128,640,463	$175,715,700
Citrus (Unspecified)	$840,396	$2,406,388	$7,045,910	$20,872,561	$30,595,167	$47,417,414	$74,137,379
Apple, Pear, Quince							
Apples	$1,684,645	$4,198,055	$14,497,631	$32,553,847	$56,235,761	$0	$0
Pears	$1,592,297	$4,570,719	$13,028,134	$32,108,608	$66,416,000	$0	$0
Quince	$2,365,385	$5,894,427	$20,355,911	$45,708,381	$78,959,809	$0	$0
Vineyards							
Grapes (Raisins)	$735,042	$2,081,843	$6,442,558	$15,309,326	$28,016,302	$40,388,341	$117,054,385
Grapes (Table - Hand Picked)	$3,216,074	$9,108,810	$28,188,506	$66,983,801	$122,581,390	$176,713,504	$512,154,994
Grapes (Wine)	$641,077	$1,815,708	$5,618,965	$13,352,238	$24,434,801	$35,225,243	$102,090,581
Kiwi (Hand Picked)	$3,380,672	$10,145,945	$32,877,184	$73,264,132	$0	$0	$0
Tree Nuts							
Almonds	$978,160	$2,876,540	$8,965,883	$20,389,402	$37,051,636	$53,211,099	$181,578,629
Pecans	$716,744	$2,061,470	$6,782,331	$15,113,874	$26,108,748	$37,863,829	$55,912,199
Walnuts	$749,388	$2,101,849	$6,818,109	$15,829,448	$27,193,437	$41,873,283	$92,226,218
Stone Fruit							
Peaches	$2,097,032	$6,163,099	$17,863,912	$39,209,215	$83,472,429	$116,608,907	$321,370,532
Nectarines	$2,134,381	$5,938,490	$22,009,875	$49,047,217	$84,727,545	$122,874,880	$181,445,060
Plums	$1,977,092	$5,456,934	$15,249,521	$45,000,112	$77,736,297	$0	$0
Apricots	$1,370,159	$3,835,610	$19,795,506	$0	$0	$0	$0
Cherries	$1,413,648	$3,650,713	$12,598,842	$28,538,412	$66,068,895	$0	$0
Olives	$646,280	$1,718,197	$7,877,694	$13,340,928	$31,563,641	$0	$0
Plumcot	$1,657,110	$3,980,030	$16,464,770	$0	$0	$0	$0

Table 11. Ten-Year Revenue per Average Farm

Crop	Ten-Year Revenue per Average Farm						
	15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres
Combined Categories							
Citrus	$1,835,660	$4,995,804	$15,459,254	$43,186,711	$67,721,546	$99,485,194	$158,159,578
Apple, Pear, Quince	$1,666,608	$4,395,866	$14,051,399	$32,497,585	$64,372,042	$0	$0
Tree Nuts	$939,638	$2,733,652	$8,604,438	$19,629,518	$35,319,783	$51,254,798	$168,206,569
Stone Fruit	$1,686,686	$4,558,400	$15,385,872	$35,011,701	$70,016,581	$95,013,248	$209,437,763

Sources: ERG estimates based on NASS, 2019a; NASS, 2019b; NASS, 2019c; NASS CA, 2020; SJV APCD, 2010.

Note: Values shown reflect the average for 2014 to 2018 for all counties in the District in constant 2018$.

3.5. NET PROFIT BY CROP AND FARM SIZE

To calculate the average ten-year net (post-tax) profit per farm by crop type and farm size, ERG multiplied gross returns (Table 11) by the estimated ratio of post-tax profit to revenues. The ratio of pre-tax profit to net revenues was obtained from RMA (Risk Management Association) Annual Statement Studies, which are prepared standardized income statements from data submitted by individual enterprise to assess risk and evaluate financial performance relative to other enterprises in the same industry.

ERG downloaded RMA Annual Statement Studies from the fiscal years ending in March of 2015 through 2019 for the following NAICS codes:

- 1111: Oilseed and Grain Farming[2]
- 111310: Orange Groves
- 111331: Apple Orchards
- 111332: Grape Vineyards
- 111335: Tree Nut Farming
- 111339: Other Noncitrus Fruit Farming

For Oilseed and Grain, Apple Orchards, Grape Vineyards, and Tree Nut Farming, ERG selected annual statements from the West Region.[3] With one exception,[4] these Annual Statement studies were based on a minimum of 20, and generally more than 30 observations; studies for Grape Vineyards, and Tree Nut Farming, comprised more than 70 observations for each year. Because Orange Groves and Other Noncitrus Fruit Farming had fewer than 20 observations from the West Region each year, National level studies were used instead.

To convert RMA pre-tax profit rates to post-tax profit, ERG used a 5-year average of the ratio of pre-tax profit to revenues for each NAICS code, then adjusted this value to account for taxes. To adjust for federal taxes, ERG used the estimated effective income tax rates for family farm households following the 2017 tax cuts by commodity specialization published by the USDA Economic Research Service (Williamson and Bawa, 2016). For state income taxes, ERG used the tax rate (9.3 percent) from the $115,648 to $590,746 tax bracket for married filing jointly as the representative effective rate (https://www.tax-brackets.org/californiataxtable). Table 12 presents the data and results for the calculation of net profit rates used in the analysis, along with the crop types to which each rate was applied.

[2] At the 4-digit NAICS level, RMA distinguishes Cost of Sales (COS) and Non-Cost of Sales reports. Cost of sales include labor, materials, and overhead directly tied to the enterprise's primary product, but excludes cost of secondary products (e.g., a hair salon's sales of styling products). ERG selected the COS report for Oilseed and Grain Farming as more relevant to this analysis.

[3] Comprised of Alaska, Arizona, California, Colorado, Guam, Hawaii, Idaho, western Kansas, Montana, western Nebraska, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

[4] The Apple Orchards study only included 11 observations for 2018.

Table 12. Estimation of Net Profit as Percent of Revenues by NAICS Code

NAICS	Crop Type	Average Pre-tax Profit as % of Revenue	Federal Tax Rate	State Tax Rate	Average Post-Tax Profit as % of Revenue
1111: Oilseed and Grain Farming	Rice	6.00%	14.20%	9.30%	4.59%
111310: Orange Groves	Citrus	7.34%	20.20%	9.30%	5.17%
111331: Apple Orchards	Apples, Pears & Quince	5.38%	20.20%	9.30%	3.79%
111332: Grape Vineyards	Vineyard*	8.50%	20.20%	9.30%	5.99%
111335: Tree Nut Farming	Tree Nuts	13.80%	20.20%	9.30%	9.73%
111339: Other Noncitrus Fruit Farming	Stone Fruit	6.00%	20.20%	9.30%	4.23%

Sources: ERG estimates based on RMA, 2020, Williamson and Bawa, 2016, and CA state income tax rates.

* Except for hand-picked table grapes.

After reviewing estimated net profits based on the gross profits and profit rates presented in this analysis, ERG determined that the approach to estimating net profits for hand-picked table grapes required adjustment. Harvest costs for table grapes are significantly higher than raisin and wine grapes. For example, UC Davis Cost & Returns studies estimated harvesting raisin and wine grapes generally costs less than $500 per acre while harvest costs for hand-picked table grapes exceeds $5,000 per acre (UC Davis, various reports). To justify such high harvest costs, growers must receive a significantly higher price per ton of table grapes; Table 5 shows that the price per ton of table grapes has been roughly four times the price of raisin and wine grapes over the last five years.

UC Davis published Cost & Return studies for four varieties of table grapes in 2018 (Flame Seedless, Sheegene-21, Scarlet Royal, and Autumn King). Calculating the ratio of total costs per acre (including capital recovery costs) to gross revenues, ERG found that the rates of return for three of the four varieties were substantially below the RMA rate of return for Grape Vineyards (Table 12). However, the rate of return for the Scarlet Royal variety was significantly higher than both the other three varieties, and for Vineyard Grapes.

With no data available on market share, ERG calculated a pre-tax rate of return for hand-picked table grapes by calculating two different averages: (1) all four varieties of table grapes, and (2) three varieties excluding Scarlet Royal grapes. ERG then took the midpoint of the interval between these two averages to represent the rate of return for table grapes. After adjusting for taxes, the result of this was used to estimate average profits for table grapes. Table 12 summarizes these calculations.

Table 13. Calculation of Post-tax Profit Rate for Table Grapes

	Total Costs (including Capital Recover) as % of Revenues	
	Average 1	Average 2
Flame Seedless	2.0%	2.0%
Sheegene-21	1.3%	1.3%
Autumn King	5.4%	5.4%
Scarlet Royal	15.8%	
Average Pre-Tax Profit Rate	*6.1%*	*2.9%*
Midpoint of interval	4.5%	
Federal + State Tax Rates	29.5%	
Post-Tax Profit Rate	*3.2%*	

Source: Various UC Davis Cost & Returns studies, 2018

Finally, ERG applied the estimated post-tax profit rates by crop type as shown in Table 12 and Table 13 to the estimated 10-year average revenue by crop and farm size to calculate estimated 10-year profits by crop and farm size. These results are presented in Table 14. These estimated profits will be used by the District to determine the economic feasibility of the alternatives to open burning under consideration for this rulemaking.

Table 14. Ten-Year Net Profit per Average Farm

Crop	Average Profit Rate (2014-2018)	Ten-Year Net Profit per Average Farm								
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres	< 100 Acres	≥ 100 Acres
Rice										
Rice	4.6%	$6,112	$51,626	$121,145	$261,167	$451,013	$0	$0	$17,491	$284,058
Citrus										
Oranges (Navel)	5.2%	$74,905	$214,482	$628,003	$1,860,374	$2,726,951	$4,226,320	$6,607,874	$169,798	$1,324,578
Oranges (Valencia)	5.2%	$93,687	$233,018	$812,484	$1,863,629	$3,127,675	$4,535,865	$10,721,015	$169,251	$1,335,806
Oranges (Unspecified)	5.2%	$60,121	$172,150	$504,057	$1,493,200	$2,188,744	$3,392,189	$5,303,705	$136,286	$1,063,151
Mandarins & Tangerines	5.2%	$126,451	$348,274	$1,121,661	$2,858,557	$4,938,069	$0	$0	$264,536	$2,128,346
Grapefruit	5.2%	$99,935	$209,908	$945,652	$2,107,309	$0	$0	$7,795,771	$151,441	$1,779,601
Lemons	5.2%	$129,993	$333,694	$1,080,870	$2,457,904	$4,779,844	$6,656,758	$9,092,760	$258,140	$2,057,324
Citrus (Unspecified)	5.2%	$43,488	$124,523	$364,605	$1,080,092	$1,583,208	$2,453,709	$3,836,387	$98,581	$769,021
Apple, Pear, Quince										
Apples	3.8%	$63,897	$159,228	$549,881	$1,234,735	$2,132,966	$0	$0	$120,036	$784,093
Pears	3.8%	$60,394	$173,363	$494,144	$1,217,847	$2,519,092	$0	$0	$142,553	$1,083,565
Quince	3.8%	$89,717	$223,570	$772,079	$1,733,673	$2,994,867	$0	$0	$168,541	$1,100,933
Vineyards										
Grapes (Raisins)	6.0%	$44,047	$124,754	$386,070	$917,411	$1,678,877	$2,420,271	$7,014,484	$97,420	$1,334,577
Grapes (Table - Hand Picked)	3.2%	$102,330	$289,826	$896,908	$2,131,305	$3,900,321	$5,622,708	$16,295,857	$226,324	$3,100,453
Grapes (Wine)	6.0%	$38,417	$108,806	$336,716	$800,133	$1,464,255	$2,110,873	$6,117,778	$84,966	$1,163,970
Kiwi (Hand Picked)	6.0%	$202,587	$607,996	$1,970,165	$4,390,353	$0	$0	$0	$517,905	$2,315,906
Tree Nuts										
Almonds	9.7%	$95,165	$279,859	$872,291	$1,983,685	$3,604,754	$5,176,908	$17,665,785	$223,403	$2,803,041
Pecans	9.7%	$69,732	$200,560	$659,853	$1,470,429	$2,540,120	$3,683,772	$5,439,698	$159,726	$1,246,533
Walnuts	9.7%	$72,908	$204,489	$663,334	$1,540,047	$2,645,649	$4,073,852	$8,972,689	$163,419	$1,415,592
Stone Fruit										
Peaches	4.2%	$88,704	$260,699	$755,643	$1,658,550	$3,530,884	$4,932,557	$13,593,974	$203,011	$1,300,807
Nectarines	4.2%	$90,284	$251,198	$931,018	$2,074,697	$3,583,975	$5,197,607	$7,675,126	$191,389	$1,960,592
Plums	4.2%	$83,631	$230,828	$645,055	$1,903,505	$3,288,245	$0	$0	$159,141	$1,083,358
Apricots	4.2%	$57,958	$162,246	$837,350	$0	$0	$0	$0	$118,558	$837,350
Cherries	4.2%	$59,797	$154,425	$532,931	$1,207,175	$2,794,714	$0	$0	$124,208	$911,039
Olives	4.2%	$27,338	$72,680	$333,226	$564,321	$1,335,142	$0	$0	$53,295	$478,780
Plumcot	4.2%	$70,096	$168,355	$696,460	$0	$0	$0	$0	$137,091	$696,460

Table 14. Ten-Year Net Profit per Average Farm

Crop	Average Profit Rate (2014-2018)	Ten-Year Net Profit per Average Farm								
		15 to 24.9 Acres	25 to 99.9 Acres	100 to 249.9 Acres	250 to 499.9 Acres	500 to 749.9 Acres	750 to 999 Acres	Over 1,000 Acres	< 100 Acres	≥ 100 Acres
Combined Categories										
Citrus	5.2%	$94,990	$258,518	$799,970	$2,234,783	$3,504,387	$5,148,060	$8,184,284	$198,667	$1,612,572
Apple, Pear, Quince	3.8%	$63,213	$166,731	$532,956	$1,232,601	$2,441,567	$0	$0	$130,513	$920,747
Tree Nuts	9.7%	$91,417	$265,957	$837,126	$1,909,756	$3,436,262	$4,986,579	$16,364,817	$212,333	$2,523,336
Stone Fruit	4.2%	$71,347	$192,820	$650,822	$1,480,995	$2,961,701	$4,019,060	$8,859,217	$147,568	$1,075,388

Sources: ERG estimates based on NASS, 2019a; NASS, 2019b; NASS, 2019c; NASS CA, 2020; SJV APCD, 2010; RMA, 2020.

Note: Values shown reflect the average for 2014 to 2018 for all counties in the District in constant 2018$.

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Appendix D – Public Comments and District Responses

US EPA REGION IX COMMENTS

No comments were received.

CALIFORNIA AIR RESOURCES BOARD COMMENTS

No comments were received.

STAKEHOLDER COMMENTS

The District received one comment letter submitted by the following group: Central California Environmental Justice Network, Central Valley Air Quality Coalition, Center on Race Poverty & the Environment, Fresno Building Healthy Communities, Leadership Counsel for Justice & Accountability, and National Parks Conservation Association.

The group's comments have been summarized, as follows:

COMMENT: The commenters expressed general disagreement with the 2020 Report and recommended prohibitions and postponements.

RESPONSE: The District appreciates the concerns and continues to seek feedback and opportunities for reducing any remaining agricultural open burning. SB 705, incorporated into state law under California Health & Safety Code (CH&SC) 41855.5 and 41855.6, established a schedule for specific types of agricultural material to no longer be burned in the field; however, provided for a postponement of the phase-out where justified by technical and economic impediments. Per the CH&SC, the District may postpone the open burning restrictions for the remaining crop categories if all of the following conditions are met:

1. There is no economically feasible alternative means of eliminating waste.
2. There is no long-term federal or state funding commitment for continued operation of biomass facilities in the Valley or development of alternatives to burning.
3. Continued issuance of permits for that specific category or crop will not cause, or substantially contribute to, a violation of an applicable federal ambient air quality standard.
4. CARB concurs with the District's determinations.

All District determinations and CARB concurrences conform to CH&SC and Rule 4103 requirements. After two decades of working to reduce agricultural open burning, the 2020 Report is intended to establish the final framework for the

phase-out, as feasible, of agricultural managed burning a comprehensive approach to eliminate agricultural managed burning where feasible. This includes new prohibitions on open burning reliant on newly emergent alternatives, a call for funding assistance (supported by continued local funding allocations) to costly new alternatives, and technology demonstration partnerships to assist with the final stages of development of feasible alternatives. Alternatives that may be feasible in the coming years as identified through this 2020 Report include bioenergy facilities, chipping and grinding of material for soil incorporation, composting, and air curtain burners.

COMMENT: The commenter's expressed concern with the public process in development of the 2020 Report recommendations.

RESPONSE: The development of the 2020 Report was conducted through a public process. This has included a number of meetings and workshops to discuss the evaluation and solicit feedback and comment. The District continues to invite any public input, including technical information or other relevant information.

COMMENT: The commenter's recognize progress made in developing alternatives through the District's Alternatives to Agricultural Burning Pilot Incentive Program. The commenter's believe that feasible alternatives are available for all crop categories and situations and that the District and CARB should immediately ban all agricultural burning.

RESPONSE: The District's 2020 Report includes a detailed evaluation and recognition of available alternatives, and the District appreciates the commenter's recognition of the District's efforts to develop and promote new alternatives through its pilot program that has allocated over $13 million to date for primarily soil incorporation projects. The District agrees that new alternatives have recently emerged, and that reduced agricultural burning for the remaining crop categories that has not already been phased out is possible, as detailed in the 2020 Report. After already implementing numerous prohibitions across multiple crop categories, the 2020 Report includes specific and expedited phase-out actions that leverage potentially available alternatives and partnerships with CARB, USDA-NRCS, agricultural operators, and other interested stakeholders to phase-out open burning of remaining crop categories, where feasible. Additionally, the 2020 Report includes an economic impact analysis, as called for under SB 705, that demonstrates there are no economically feasible alternatives to open burning without the assistance of grants and incentives, and reduced costs in the future as alternatives are more fully developed and proven. To continue the deployment of new alternatives including soil incorporation, as supported and made feasible through existing and new incentive programs (District, USDA-NRCS, CDFA), the District is requesting that sustained state funding support be provided and made available to Valley growers.

COMMENT: The District charges unreasonably cheap agricultural burn permit fees that disincentivize pursuing cleaner alternatives.

RESPONSE: The District is prohibited by state law through Proposition 26 from assessing fees which exceed the regulatory costs to the District for administering the program. Additionally, for any remaining crop categories addressed by the 2020 Report, the District's Smoke Management System establishes stringent requirements for agricultural operators based on air quality conditions, proximity to smoke-sensitive receptors, wood-burning curtailments, and other requirements, which significantly limits the opportunity for growers to dispose of their materials through burning, thereby incentivizing the use of other alternatives, including those supported by the District's and other available incentive programs.

COMMENT: The District should consider recent mega-wildfires.

RESPONSE: In scenarios when wildfire smoke impacts are significant, no agricultural burning is allowed, as enforced by the District's Smoke Management System (SMS). The most recent example of this were the wildfires in the summer of 2020, during which there were no agricultural open burns allowed for an extended period of time, and which overlapped with the commencement of residential wood burning requirements and curtailments. In these scenarios, growers in the Valley must wait for limited burn windows to appear under the right dispersion conditions, and subject to all other requirements.

COMMENT: The District should consider the public health impacts associated with the COVID-19 pandemic and air quality exposure.

RESPONSE: The District agrees that all feasible measures should be taken to protect public health in response to the COVID-19 pandemic.

COMMENT: Reductions from agricultural open burning activities are necessary to meet federal standards for PM2.5.

RESPONSE: Agricultural burning under District Rule 4103 (Open Burning) was evaluated under the most recent CARB approved PM2.5 and ozone attainment plans. Under these plans, reducing emissions from this source category is not required to meet attainment of the national ambient air quality standards (NAAQS). In addition, the proper management of burning allocations under the SMS ensures that open burning of agricultural materials does not cause or contribute to exceedances of federal air quality standards, cause a public nuisance, or impact nearby smoke-sensitive areas. Given the significant challenges facing the District and CARB, the District agrees that all emissions reductions are important, and is committed to identifying additional emission

reduction opportunities to improve air quality and public health, including through additional reductions in agricultural burning.