Attachment to OEHHA Memorandum: "Health-Based Recommendations to Mitigate Cancer Risk of Occupational Bystander Exposure to 1,3-Dichloropropene"

Pursuant to Food and Agricultural Code sections 12980 and 12981, the Office of Environmental Health Hazard Assessment (OEHHA) has developed health-based recommendations for reducing the cancer risk to occupational bystanders[1] from exposure to 1,3-dichloropropene (1,3-D or Telone) while at work. These recommendations are based on estimates of occupational bystanders' exposures to 1,3-D that result from working adjacent to and in the vicinity of treated fields, and the reductions needed to reduce their cancer risk to an acceptable level.

Several options within DPR's purview are available to mitigate occupational bystander risks due to exposure from working in close proximity to a field that has been treated. These include:

1. Changes to application methods, such as changing to a lower-emitting field fumigation method (FFM). This document shows which treatment methods OEHHA estimated would have acceptable risks when applied to an 80-acre field (e.g., FFM 1242: totally impermeable film [TIF] tarps).
2. Restrictions on proximity of occupational bystanders to fields after 1,3-D application, such as instituting buffer zones to reduce the amount of time occupational bystanders spend in close vicinity to a treated field. Size and duration of buffer zone requirements are calculated taking into account application rate (pounds per acre) and fumigation method.
3. Controlling application conditions, for example, restricting application rates, month of application, frequency of application, soil water content, and other factors. For each FFM, the percent reduction in exposure that would reduce working lifetime cancer risk to acceptable levels was calculated.

In these evaluations, a cancer risk level of one per one hundred thousand (10^{-5}) was used by OEHHA as the acceptable risk level, as is done in other OEHHA programs.[2] As detailed below, OEHHA accordingly calculated that occupational bystander exposure to an average air concentration of 0.21 ppb or below over a working lifetime was associated with an acceptable risk.

Occupational bystanders can also be exposed to 1,3-D in ambient air when working in the general vicinity of 1,3-D applications. These kinds of ambient exposures have historically been controlled by maintaining a cap on the use of 1,3-D within each

[1] For the purposes of this memorandum, an occupational bystander is an individual working in the vicinity of fields treated with 1,3-D, but is not directly handling, mixing or applying the pesticide.

[2] In Proposition 65, no significant cancer risk is 10^{-5}. See CA Code of Regs, Title 27, Section 25703(b). OEHHA (2012): "…a 1×10^{-5} level for notification is a common standard for the Air Districts," as in ARB and CAPCOA (2015) Appendix G. OEHHA (2007) used target risk values for occupational exposures of 10^{-3} to 10^{-5}. OEHHA (2015) p. 8-18 referenced 10^{-5} as an acceptable risk level.

specified six-mile by six-mile area, also known as a township. DPR has indicated to OEHHA that the current township cap will remain in place for the next two years until the occupational bystander regulations for 1,3-D become effective. While background exposures to occupational bystanders are expected to sufficiently decrease once DPR's residential bystander regulations are in place, OEHHA recommends that during this period DPR confirm this is the case by tracking how the new methods are being implemented, conducting air monitoring to the extent feasible, and further evaluating through modeling ambient 1,3-D concentrations to which occupational bystanders can be exposed (DPR, 2022b). If resulting ambient concentrations experienced by occupational bystanders working in the general vicinity of treated fields in high 1,3-D use areas fall significantly above work-life average levels of 0.21 ppb, DPR should evaluate additional mitigation options for reducing exposure, such as retaining the township cap or other measures. (See Section C for further discussion.)

OEHHA conducted this preliminary analysis to estimate exposures and risks associated with different 1,3-D treatment methods utilizing modeling conducted by DPR, and considered approaches for risk mitigation. It is recognized that during the regulatory process information may become available that may result in changes in assumptions and corresponding changes and updates by OEHHA to its analyses and recommendations.

A. Assumptions and Methods

Below is an overview of the initial assumptions and methods used to develop the recommendations for mitigation measures to reduce risks to occupational bystanders.

Population of focus in the analysis

OEHHA considered various types of occupational bystanders that might be exposed to 1,3-D, focusing on those most exposed. Fieldworkers directly hired by a grower, and who mainly perform manual work such as harvesting, weeding, and pruning, are likely to be the ones most chronically exposed to 1,3-D through working in fields adjacent to treated fields and/or by working in an area where 1,3-D is routinely applied. These fieldworkers also tend to live in an agricultural area close to where they work. California-specific data from the National Agricultural Worker Survey found that between 2015 – 2020, 92% of farmworkers were settled in an area and did not work far away from home (< 75 miles) (NAWHS, 2022). And in that same period, almost 71% of California fieldworkers were employed directly by a grower, while 29% were employed by farm labor contractors. In this preliminary analysis, individual farmworkers were assumed to work in either Coastal or Inland Regions (as defined in DPR's proposed regulations for residential bystanders) and not to work in both regions over the year.

Farmworkers often perform physically demanding work that impacts their breathing rate, thereby modifying their intake and increasing their exposure to pesticides. A breathing rate of 10 cubic meters over the workday was assumed, consistent with moderately

intensive work and assumptions for occupational exposure used in OEHHA guidelines for other programs (OEHHA, 2015).

Key variables on frequency and duration of exposure used to estimate lifetime 1,3-D exposure of occupational bystanders

Key to estimating lifetime exposure of occupational bystanders is a clear understanding of California-specific agricultural practices and fieldworker activity patterns. For example, when crops are harvested, fieldworkers may work more than the average 40 hours per week. It is also important to understand the distances between fieldworkers' working locations and 1,3-D application sites and how frequently fieldworkers may change locations. To gain further insight into fieldworker activity patterns, OEHHA performed an extensive search of available information in reports, databases, and publications, and contacted experts and stakeholders from various organizations.

Despite this effort, OEHHA was not able to identify references that would specifically indicate the frequency at which a farmworker might be present at the edge of a treated field, or within a certain distance of that field, during the time 1,3-D is being released into the air. Instead, OEHHA made assumptions about the frequency mainly based on an analysis of DPR's Pesticide Use Report (PUR) data.

To estimate average working lifetime exposure for occupational bystanders from 1,3-D applications in close proximity to their work, OEHHA assumed they are directly exposed at the edge of the field:

(1) for 8 hours per day during the hours of 8:00 a.m. to 4:00 p.m. DPR used this assumption in their modeling to estimate average 8-hr air concentrations for the 8:00 a.m. to 4:00 p.m. period following treatment of fields with 1,3-D. There is evidence that occupational bystanders may be working an overall 10 hours per day during harvesting season (NAWHS, 2022). However, only one study on activity patterns was available. This study of broccoli fieldworkers observed that these workers on average harvest for 6.6 hours with a maximum workday of 8.8 hours (UCANR, 2017). Assuming an 8-hour workday seemed a reasonable approach for these preliminary risk projections. This assumption may be modified during this regulatory process upon receipt of additional reliable and robust data.
(2) for 3 days per week. From conversations OEHHA had with University of California Cooperative Extension (UCCE) advisors, the most frequently a fieldworker may return to the same fields is during harvesting where, for example, they need to pick strawberries every 2 to 3 days. Therefore, OEHHA assumed 3 days per week a worker may be in the same field.
(3) for a 3-week emission period following an application. The data provided by DPR is an average over the 3 week-period, which includes both high and low levels. DPR has reported that their modeling shows that by 21 days, 1,3-D emissions are not significant (DPR, 2019), and OEHHA has made this assumption.

(4) with a frequency of 4 times per year in the Coastal Region or 2 times per year in the Inland Region. Coastal and Inland Regions are defined in DPR's proposed field fumigation requirements (DPR, 2023d). Using DPR's PUR data for the 2016 – 2019 period, OEHHA calculated:
    a. the number of applications per year from the average application counts per section (1-mile by 1-mile area) in the top 10 townships of each region.
    b. the seasonal distribution of applications per Inland or Coastal Region by using the top 10 townships in each region. A winter season is November – February, a non-winter season is March – October.
(5) over a 40-year working period in a 70-year lifetime. This is the default number of years worked over a lifetime used by both OEHHA, in calculating risk under Proposition 65,[3] and DPR, in its risk characterization documents. This is consistent with experts' testimony and with reports showing that the agricultural working community is aging (NAWS 2022, UC Merced 2023).

At the present time, OEHHA believes it is using an appropriate approach and parameters considering the data gap in estimating how frequently a fieldworker might be present at the edge of a treated field during the time 1,3-D is being released into the air. OEHHA is aware that some of its assumptions may overestimate exposure while others may underestimate it. For example, in the modeling described below, OEHHA obtained from DPR median concentration levels for large regions, which can underestimate concentrations for smaller localities. But OEHHA believes these parameters (i.e., edge of field, hours per day, not accounting for background, frequency of exposure) and other modeling assumptions overall balance each other out. Taken together they provide a realistic and health-protective exposure estimate that reflects occupational bystanders' lifetime exposure from working adjacent to a treated field.

Use of modeling to estimate average air concentrations near treated fields

OEHHA calculated average air concentrations breathed by occupational bystanders from DPR's modeling results. An overview of the approach is provided here.

DPR modeled average air concentrations based on maximum allowed acreage and application rate (i.e., 80-acre treatments and 332 lbs per acre) for groups of FFMs and regions (Inland and Coastal) for the 2016 – 2019 period. DPR provided OEHHA with 1,3-D concentrations at the edge of the field, at distances of 25, 60, and 100 ft, and at durations of 48 hrs, 120 hrs (5 days), 168 hrs (7 days), and 500 hrs (21 days) after 1,3-D was applied. Further, DPR reported averaged 1,3-D air concentrations specific to workday hours of 8:00 a.m. to 4:00 p.m., since emissions and air concentrations also depend on the time of day. The DPR estimates of average exposure at the field edge, as well as at 100 ft from the field edge, are provided in Appendix A1.

[3] California Code of Regulations, Title 27, Section 25721(d)(3)

To estimate lifetime exposure of occupational bystanders who routinely work near fields treated with 1,3-D, OEHHA adjusted the DPR modeling results for each FFM from the maximum possible application rate to the average application rate currently available from the PUR. This is because application rates for annually or semi-annually planted crops such as strawberries are approximately 3-fold lower than the maximum rate. For example, in 2018, despite the maximum allowable application rate of 332 pounds per acre for FFM 1259, the maximum application rate used was 130 pounds per acre and the average usage was 79 pounds per acre. In contrast, the maximum application rate in the same year for FFM 1210, which is mostly used once as a pretreatment for tree and grape planting, was 360 pounds per acre and the average was 324 pounds per acre.

DPR provided OEHHA with modeling data for 80 acres, which is the current maximum application block size of field for 1,3-D application. While fieldworkers working for a single grower in a high use area (e.g., Salinas) are more likely working in small size farms with smaller field sizes (CDFA, 2020), Pest Control Operators tend to group applications from adjacent small fields. On the other hand, contract workers, who represent a third of fieldworkers in the state, are usually employed for the season and are mainly hired to do specific tasks such as harvesting, and maybe pruning and weeding. They travel from farm to farm and may be exposed to large field sizes (NAHWS, 2022, UC Merced, 2023), and with greater frequency than those workers employed on a farm. Therefore, OEHHA used the 80 acres as a basis for the proposed mitigations.

Fumigation methods were grouped according to DPR's proposed residential regulations.[4] The FFM groupings considered are given in the Table below, with the treatment method used as representative for the group given in bold:

Group of FFMs	FFM Codes
1: Standard nontarped and non-TIF tarp shallow (12 inch) methods	**1201**, 1202
2: Standard nontarped and non-TIF tarp deep (18 inch) methods	**1206**, 1207, 1210, 1211
3: Chemigation (drip)/non-TIF tarp method	**1209**
4: 24-inch injection methods	**1224**, 1225, 1226
5: TIF methods – broadcast and drip	**1242**, 1247, 1249
6: TIF methods – bed and strip	**1243**, 1245, 1259
7: 40% TIF with 18-inch injection depth method	**1250**
8: 40% TIF with 24-inch injection depth method	**1264**

[4] https://www.cdpr.ca.gov/docs/legbills/rulepkgs/22-005/dpr_22-005_oal_text_13-d.pdf

Application rates from the PUR were available for FFM groups 1201, 1206, 1209, 1242, and 1243. In the proposed residential regulations, FFM groups 1201, 1206, and 1209 won't be allowed for tree and grape applications. Therefore, OEHHA excluded tree and grape data to calculate the average rates for these FFMs. No average rates are available in the PUR for the new methods introduced in the residential regulations (FFM 1224, 1250, and 1264). FFM 1206 is used in over 95% of the fumigations done for trees and grapes, and on a poundage basis, trees and grapes represent 69% of 1,3-D usage. It is anticipated that the new methods will be used to replace FFM 1206 for tree and grape applications. OEHHA thus used the average application rate for FFM 1206 as a surrogate rate for FFM 1224, 1250, and 1264.

In the proposed residential regulations, FFM groups 1201, 1206, and 1209 will only be used for shallow crops. In coastal areas, these include Brussels sprout, broccoli, cabbage, carrot, cauliflower, pepper, potato, and squash and represent less than 3% of 1,3-D use in the state.

Average application rates used to adjust the DPR modeling results are given in Table 1.

Table 1. FFM Average Application Rates (pounds per acre) by Region and Season

FFM code	FFM	Inland		Coast		PUR Data 2016-2019
		Mar-Oct	Nov-Feb	Mar-Oct	Nov-Feb	
1201	Nontarp/shallow/broadcast or bed	120	100	100	100	Average for commodities other than trees and grapes
1206	Nontarp/18 inches deep/broadcast or bed	150	130	110	150	
1209	Chemigation (drip system)/tarp	100	90	110	110	
1242	Totally Impermeable Film (TIF) tarp/shallow/broadcast	120	180	120	100	Average for all commodities in
1243	TIF tarp/shallow/bed	90	90	80	80	
1224	Nontarp/24 inches deep/broadcast	280	250	130	190	Average application rate of FFM 1206 for all commodities
1250* with trees & grapes	40% TIF tarp/18 inches deep/broadcast	280	250	130	190	
1264* with trees & grapes	40% TIF tarp/24 inches deep/broadcast	280	250	130	190	
1250* No trees & grapes	40% TIF tarp/18 inches deep/broadcast	150	130	110	150	Average application rate of FFM 1206 for commodities other than trees and grapes
1264* No trees & grapes	40% TIF tarp/24 inches deep/broadcast	150	130	110	150	

Estimation of an acceptable air concentration for occupational bystanders

OEHHA developed the recommendations above to reduce the risk of developing cancer to occupational bystanders to 1 in 100,000 (target risk value). Multiple factors inform the risk of developing cancer. These include the potency of the chemical and the extent of the exposure, including both the duration of the exposure and the concentration of the chemical to which the individual is exposed (exposure concentration). OEHHA assumed a potency value of 0.057 ppm^{-1}, equivalent to an inhalation cancer slope factor of 0.19 $(mg/kg\text{-}day)^{-1}$.[5] Using this assumption, OEHHA estimated that an occupational bystander exposed five days a week, eight hours per day, for forty years to 0.21 ppb has a risk of cancer of 1 in 100,000. Exposures to higher concentrations with less frequency also can result in an average concentration of 0.21 ppb over the work life, and a risk of 1 in 100,000. The calculation employed to attain this value is explained below.

The average air concentration experienced by occupational bystanders over their working lifetime that is associated with a given level of cancer risk can be calculated using the following equation:

$$\bar{C}_{lifetime-occ\ bystander} = CR \times \frac{BW}{BR \times CSF} \times \left(\frac{365 \frac{days}{yr} \times 70\ yr}{5 \frac{days}{wk} \times 50 \frac{wks}{yr} \times 40\ yr} \right) \times \frac{1}{4.53\ \times 0.001}$$

The meaning of the variables and values assumed for them by OEHHA are as follows:

CR = acceptable cancer risk: 10^{-5};

BW = adult body weight: 70 kg;

BR = breathing rate for 8 hours moderately intensive work per day: 10m^3/day;[6]

CSF = Inhalation Cancer Slope Factor[7] for Humans: 0.19 $(mg/kg - day)^{-1}$.

The equation also includes unit conversion values: 4.53 for ppb to $\mu g/m^3$, and 0.001 for $\mu g/m^3$ to mg/m^3.

The cancer potency assumed, 0.19 $(mg/kg\text{-}day)^{-1}$, is equivalent to 0.057 ppm^{-1}.

[5] OEHHA (2021). Initial Statement of Reasons. Proposed amendment to Section 25705(b). Specific regulatory levels posing no significant risk. 1,3-Dichloropropene (oral and inhalation routes).

[6] OEHHA Air Toxic Hot Spots Guidance Manual, 2015; California Code of Regulations, Title 27, Section 25721(d)(3).

[7] The cancer potency assumed, 0.19 $(mg/kg\text{-}day)^{-1}$, is equivalent to the inhalation unit risk value of 0.057 ppm^{-1}. Cancer potency from OEHHA (2021). Initial Statement of Reasons. Proposed amendment to Section 25705(b). Specific regulatory levels posing no significant risk. 1,3-Dichloropropene (oral and inhalation routes).

Using the above equation, an occupational bystander exposed during the workday to an average concentration of 0.21 ppb is estimated to experience a risk of 10^{-5}.

Estimation of relative reduction of air concentrations

To protect occupational bystanders from the adverse effects of long-term exposure to 1,3-D, OEHHA calculated the relative reduction of air concentrations needed to reduce risks to acceptable levels using, for each FFM and region, the average application rates extracted from PUR data as described above. These mitigations would ensure that lifetime cancer risk would be reduced to an acceptable cancer risk level of 10^{-5}, as discussed above.

B. Results and Recommendations

1. Occupation bystander exposure for FFMs

Occupational bystander exposure, in terms of an average concentration during work, was calculated for each of the FFMs and is shown in Table 2. This was done by adjusting modeled results received from DPR for air concentration at the edge of the field to the lifetime working period, average application rate for the FFM, frequency of exposure to the treated field and season.

Table 2. Average Concentrations (ppb) Experienced by Occupational Bystanders Working at the Edge of Field Following Application of 1,3-D*

FFMs	Average Concentrations (ppb)	
	Inland	Coastal
1201, 1202	0.28	0.46
1206, 1207, 1210, 1211	0.23	0.43
1209	0.42	0.84
1224, 1225, 1226	0.25	0.31
1242, 1247, 1249	0.13	0.15
1243, 1245, 1259	0.10	0.15
1250* with trees & grapes	0.32	0.40
1264* with trees & grapes	0.19	0.24
1250* No trees & grapes	0.17	0.31
1264 No trees & grapes	0.10	0.19

* For an 80-acre field using average applicaon r ate esm ated by OEHHA from PUR data (Table 1).

Several fumigation methods are associated with occupational bystander exposures at or below the acceptable concentration level of 0.21 ppb. These are shown in Table 2 (see shaded cells) and, among others, include FFMs 1242 and 1243. Any mitigation measures that result in similar near-field average annual concentration levels are assumed to result in bystander exposures at acceptable levels and are consistent with OEHHA recommendations.

2. Restrictions on proximity of occupational bystanders to fields after 1,3-D application

OEHHA considered the average application rates for the different treatment methods and the frequency of exposure for the Inland and Coastal Regions where 1,3-D is used. OEHHA developed several examples of buffer zone distances and durations that would mitigate risks to acceptable levels for occupational bystanders working in close proximity to where 1,3-D is being applied. For example, consistent with the findings shown in Table 2, for FFM groups 1242 and 1243, no buffer zone (BZ) is needed. For several other FFM groups, buffer zones of 100 feet for 48 hours post application were calculated to result in mitigation to acceptable risk levels (e.g., for FFM groups 1201, 1206, and 1209 in the Inland Region). Per OEHHA's calculations, other examples of buffer zones and durations post-application would mitigate risks to the acceptable risk level of 10^{-5} and are shown in Table 3.

Table 3. Example: Buffer Zones and Duration Periods for Different FFMs Estimated to Mitigate Risks to Occupational Bystanders *

Group of FFMs	FFMs in the group	Inland	Coastal
1: Standard nontarped and non-TIF tarp shallow (12 inch) methods	**1201**, 1202	100 feet for 48 hrs	100 feet for 7 days
2: Standard nontarped and non-TIF tarp deep (18 inch) methods	**1206**, 1207, 1210, 1211	100 feet for 48 hrs	100 feet for 7 days
3: Chemigation (drip)/non-TIF tarp method	**1209**	100 feet for 48 hrs	
4: 24-inch injection methods	**1224**, 1225, 1226	100 feet for 7 days	100 feet for 7 days
5: TIF methods – broadcast and drip	**1242**, 1247, 1249	None needed	None needed
6: TIF methods – bed and strip	**1243**, 1245, 1259	None needed	None needed
7: 40% TIF with 18-inch injection depth method	**1250**	Trees/Grapes: 100 ft for 5 days Other: None needed	Trees/Grapes: 100 ft for 5 days Other: 100 ft for 5 days
8: 40% TIF with 24-inch injection depth method	**1264**	Trees/Grapes: none needed Other: None needed	Trees/Grapes: 100 ft for 5 days Other: None needed

* The bolded FFM is the representative method. These were based on an 80-acre field using average application rate estimated by OEHHA (Table 1).

This analysis and the proposed mitigations are based on 2016 – 2019 PUR data (i.e., number of applications per year and average application rates). Under the proposed residential regulations, usage might change. It is anticipated that overall exposures would be lower under the new regulations, but this would need to be confirmed as discussed in the OEHHA recommendation below.

3. Controlled application conditions

Restricting application rates (e.g., pounds per acre), month of application, frequency of application, soil water content, and other factors can also mitigate risk. The degree of reduction in concentration to achieve acceptable levels for the different FFMs is provided in the table below.

Table 4. Reduction in concentration experienced by occupational bystander to reduce risk to acceptable levels*

FFMs	Percent Reduction in Concentration (%)	
	Inland	Coastal
1201, 1202	26.9	54.6
1206, 1207, 1210, 1211	9.8	51.9
1209	50.3	75.3
1224, 1225, 1226	17.1	33.8
1242, 1247, 1249	None	None
1243, 1245, 1259	None	None
1250 with trees & grapes	35.0	47.6
1264 with trees & grapes	None	13.4
1250 No trees & grapes	None	33.9
1264 No trees & grapes	None	None

*These were based on an 80-acre field using average application rate estimated by OEHHA (Table 1).

Limiting the daily exposure of occupational bystanders while working in close proximity to a recent application of 1,3-D to an average air concentration of 0.21 ppb or below will mitigate occupational bystanders' cancer risk to an acceptable level. This can be accomplished by achieving the percent reductions in nearby concentrations provided in the table above.

C. Other Considerations: Occupational Bystanders Working in the Vicinity of Treated Fields

The risk mitigation measures recommended above by OEHHA aim to protect bystanders at the edge of the field, but they do not account for other potential exposures contributing to the occupational bystander's aggregate exposure to 1,3-D during their workday. To limit ambient air concentration in high use areas, DPR historically instated a cap on the use of 1,3-D within each specified six-mile by six-mile area, also known as townships, to protect both occupational and residential bystanders. Currently, DPR has an annual limit of 136,000 adjusted total pounds of 1,3-D usage within each township. In its proposed residential regulations, DPR plans to phase out the capping of use as a means to control cumulative exposures (DPR, 2022b). Effective January 1, 2024, DPR's regulations for residential bystanders that aimed at mitigating risks from ambient exposures will be in place.

DPR's decision to remove the township cap was based on modeling results of annual air concentrations with new mitigations put in place in the residential bystander regulations and warrants confirmation with air monitoring data to demonstrate efficacy. DPR has indicated to OEHHA that the current township cap will remain in place for the next two years until the occupational bystander regulations for 1,3-D become effective. While background exposures to occupational bystanders are expected to sufficiently decrease once the proposed residential bystander regulations are in place, OEHHA recommends that during this period DPR confirm this is the case by monitoring how the new methods are being implemented, conducting air monitoring to the extent feasible, and further evaluating through modeling ambient 1,3-D concentrations to which occupational bystanders are exposed. If resulting ambient concentrations experienced by occupational bystanders working in the general vicinity of treated fields in high 1,3-D use areas fall significantly above work-life average levels of 0.21 ppb, DPR should evaluate additional mitigation options for reducing exposure, such as retaining the township cap in areas of high 1,3-D use and emissions or other measures.

OEHHA also recommends ongoing assessment of 1,3-D concentrations through the evaluation of use, measurement and modeling of concentrations to ensure occupational bystanders remain protected, once the joint and mutual regulations have been adopted. Effective January 1, 2024, DPR will be required to provide on a regular basis in publicly released reports, data and analyses on the impacts of the residential bystander regulation. The data collection and analysis for this exercise can be leveraged in the evaluations of occupational bystander exposures that OEHHA is recommending. Through the joint and mutual process, OEHHA may develop additional recommendations for modeling and monitoring pursuant to this recommendation.

There are historical observations (prior to implementation of the residential bystander regulations) that support the recommendation for continued tracking of use and monitoring 1,3-D concentrations in high use areas. For example, during the 2013 – 2016 period when DPR granted waivers for the township cap, 1,3-D use was higher than the following period when waivers were generally not given.[8] Also, in the last six years, annual average concentrations at monitoring stations in Shafter, Parlier, and Delhi have significantly exceeded the concentration of 0.21 ppb, as shown in Table 5. These sites can reflect the possible exposure an occupational bystander might currently experience while working in the vicinity of pesticide-treated areas in a high-use inland township, before the adoption of the residential bystander regulations. However, based on expected use and modeling, under the DPR residential bystander regulations that will become effective January 2024, 1,3-D concentrations in ambient air for both residential and occupational bystanders are expected to be considerably lower than the levels for the Inland Region shown in Table 5 (DPR, 2022b). DPR's highest annual modeled level in any township in one year was 0.35 ppb (Santa Maria, S11N35W), and

[8] DPR (2022), Ini al Statement of Reasons and Public Report, Pertaining to health risk mig aon and volal e organic compound emission reduc on for 1,3-dichloropropene. Available at: h ps://www.cdpr.ca.gov/docs/legbills/rulepkgs/22-005/dpr_22-005_oal_isor_1,3-d.pdf

the 5-year period highest value was 0.25 ppb (Parlier, M15S22E), near the occupational bystander acceptable concentration level. These are modeled results during historically high use periods when banking was allowed. Monitoring of use and ambient concentrations will indicate whether additional mitigation is needed, as noted in the 2022 DPR memorandum by Segawa and Luo (DPR, 2022b).

Table 5. Annual average concentration of 1,3-D in the six high-use communities monitored by DPR between 2017 and 2022*.

Region	**Community**	**Annual Average for 2017-2022 (ppb)**
Inland	Delhi	0.315
	Parlier	1.112
	Shafter	0.630
Coastal	Santa Maria	0.068
	Watsonville	0.068
	Oxnard	0.057

*The limit of detection varied between 0.01 and 0.1 ppb.

Appendix A

DPR conducted modeling for an 80-acre treatment with 2013 – 2017 weather data. For each of 8 FFM groups, results were summarized as 120-hr time weighted average (TWA) concentrations (or averages of 8-hr TWA concentrations over 15 working days of 3 weeks) at the edge of the application (Table A1) and at 100 ft buffer zone for 48 hours (Table A2), 5 days (Table A3) and 7 days (Table A4). The estimated concentrations provided to OEHHA are the median concentrations for each of two seasons, winter (November – February) and non-winter (March – October), over the 5-year weather data period. DPR used the maximum application rate of 332 lbs/acre in the modeling.

Table A1. DPR modeled 1,3-D concentrations for the 21-day emission period at field edge. Average 8-hr air concentrations (08:00-16:00), Mon-Fri, 80-acre application, 332 pounds per acre, receptor height of one meter.

Field Fumigation Method	FFM Code	Avg Air Conc at Field Edge (ppb)			
		Inland	Inland	Coastal	Coastal
		Winter	Non-Winter	Winter	Non-Winter
Nontarp/shallow/broadcast or bed	1201	15.3	10.8	14.8	10.3
Nontarp/18 inches deep/broadcast or bed	1206	9.8	6.8	9.6	6.6
Chemigation (drip system)/tarp	1209	25.0	18.6	23.5	17.3
Nontarp/24 inches deep/broadcast	1224	5.6	3.9	5.5	3.8
Totally Impermeable Film (TIF) tarp/shallow/broadcast	1242	4.9	3.5	4.7	3.3
TIF tarp/shallow/bed	1243	6.2	4.3	6.1	4.2
40% TIF tarp/18 inches deep FFM 1250 w/ trees & grapes	1250	7.3	4.9	7.0	4.8
40% TIF tarp/24 inches deep FFM 1264 w/ trees & grapes	1264	4.2	2.9	4.3	2.9
40% TIF tarp/18 inches deep FFM 1250 no trees & grapes	1250	7.3	4.9	7.0	4.8
40% TIF tarp/24 inches deep FFM 1264 no trees & grapes	1264	4.2	2.9	4.3	2.9

Table A2. DPR modeled 1,3-D air concentrations at 48 hours and 100 ft from the edge of field. Average 8-hr air concentrations (08:00-16:00), Mon-Fri, 80-acre application, 332 pounds per acre, receptor height of one meter.

Field Fumigation Method	FFM Code	Avg Air Conc at 100 ft buffer zone (ppb)			
		Inland	Inland	Coastal	Coastal
		Winter	Non-Winter	Winter	Non-Winter
Nontarp/shallow/broadcast or bed	1201	11.1	7.7	10.7	7.6
Nontarp/18 inches deep/broadcast or bed	1206	8.9	6.1	8.8	6.0
Chemigation (drip system)/tarp	1209	12.8	9.1	12.2	9.1
Nontarp/24 inches deep/broadcast	1224	5.5	3.8	5.5	3.8
Totally Impermeable Film (TIF) tarp/shallow/broadcast	1242	4.5	3.2	4.4	3.1
TIF tarp/shallow/bed	1243	5.5	3.8	5.4	3.7
40% TIF tarp/18 inches deep FFM 1250 w/ trees & grapes	1250	6.5	4.5	6.5	4.4
40% TIF tarp/24 inches deep FFM 1264 w/ trees & grapes	1264	4.2	2.9	4.3	2.9
40% TIF tarp/18 inches deep FFM 1250 no trees & grapes	1250	6.5	4.5	6.5	4.4
40% TIF tarp/24 inches deep FFM 1264 no trees & grapes	1264	4.2	2.9	4.3	2.9

Table A3. DPR modeled 1,3-D air concentrations at 5 days and 100 ft from the edge of field. Average 8-hr air concentrations (08:00-16:00), Mon-Fri, 80-acre application, 332 pounds per acre, receptor height of one meter.

Field Fumigation Method	FFM Code	Avg Air Conc at 100 ft buffer zone (ppb)			
		Inland	Inland	Coastal	Coastal
		Winter	Non-Winter	Winter	Non-Winter
Nontarp/shallow/broadcast or bed	1201	7.4	5.3	7.3	5.2
Nontarp/18 inches deep/broadcast or bed	1206	5.9	4.1	5.9	4.1
Chemigation (drip system)/tarp	1209	10.8	8.0	10.4	7.8
Nontarp/24 inches deep/broadcast	1224	4.4	3.0	4.3	3.0
Totally Impermeable Film (TIF) tarp/shallow/broadcast	1242	3.2	2.3	3.2	2.3
TIF tarp/shallow/bed	1243	3.5	2.4	3.5	2.5
40% TIF tarp/18 inches deep FFM 1250 w/ trees & grapes	1250	4.5	3.1	4.5	3.2
40% TIF tarp/24 inches deep FFM 1264 w/ trees & grapes	1264	3.4	2.3	3.5	2.4
40% TIF tarp/18 inches deep FFM 1250 no trees & grapes	1250	4.5	3.1	4.5	3.2
40% TIF tarp/24 inches deep FFM 1264 no trees & grapes	1264	3.4	2.3	3.5	2.4

Table A4. DPR modeled 1,3-D air concentrations at 7 days and 100 ft from edge of field. Average 8-hr air concentrations (08:00-16:00), Mon-Fri, 80-acre application, 332 pounds per acre, receptor height of one meter.

Field Fumigation Method	FFM Code	Avg Air Conc at 100 ft buffer zone (ppb)			
		Inland	Inland	Coastal	Coastal
		Winter	Non-Winter	Winter	Non-Winter
Nontarp/shallow/broadcast or bed	1201	6.7	4.8	6.7	4.7
Nontarp/18 inches deep/broadcast or bed	1206	5.0	3.4	5.0	3.5
Chemigation (drip system)/tarp	1209	10.2	7.6	9.7	7.3
Nontarp/24 inches deep/broadcast	1224	3.6	2.4	3.6	2.5
Totally Impermeable Film (TIF) tarp/shallow/broadcast	1242	2.8	2.0	2.8	2.0
TIF tarp/shallow/bed	1243	3.0	2.1	3.0	2.1
40% TIF tarp/18 inches deep FFM 1250 w/ trees & grapes	1250	3.8	2.7	3.9	2.7
40% TIF tarp/24 inches deep FFM 1264 w/ trees & grapes	1264	2.9	2.0	2.9	2.0
40% TIF tarp/18 inches deep FFM 1250 no trees & grapes	1250	3.8	2.7	3.9	2.7
40% TIF tarp/24 inches deep FFM 1264 no trees & grapes	1264	2.9	2.0	2.9	2.0

References

Air Resources Board and the California Air Pollution Control Officers Association (ARB and CAPCOA), 2015. Risk Management Guidance for Stationary Sources of Air Toxics. July 2015.

DPR, 2015. 1,3-Dichloropropene Risk Characterization Document for Inhalation Exposure to Workers, Occupational and Residential Bystanders and the General Public. December 2015

DPR, 2019. HYDRUS-simulated flux estimates of 1,3-dichloropropene maximum period-averaged flux and emission ratio for approved application methods. October 2019

DPR, 2022a. Monitoring of 1,3-Dichloropropene in Fresno and Merced Counties: Results for 2021. August 2022

DPR, 2022b. Analysis of the sufficiency of the acute measures to mitigate cancer risk to non- occupational bystanders from 1,3-Dichloropropene. November 2022

DPR, 2023a. Air Monitoring Network Results For 2021. July 2023

DPR, 2023b. Air Monitoring Network Results For 2022. July 2023

DPR, 2023c. Monitoring of 1,3-Dichloropropene in Fresno and Merced Counties: Results for 2022. August 2023

DPR, 2023d. 1,3-Dichloropropene Field Fumigation Requirements, Est. January 1, 2024

UC Merced, 2023. Farmworker Health Study. February 2023

OEHHA, 2007. Occupational Health Hazard Risk Assessment Project for California: Identification of chemicals of concern, possible risk assessment methods, and examples of health protective occupational air concentrations". December 2007

OEHHA, 2015. Guidance Manual for Preparation of Health Risk Assessments. Risk Assessment Guidelines. Air Toxics Hot Spots Program. February 2015

OEHHA, 2022. OEHHA's comments on DPR's final draft of documents for proposed measures to protect non-occupational bystanders from short-term (acute) and long-term (cancer) inhalation risk to 1,3-Dichloropropene (1,3-D). November 2022

Other Resources

USDA, 2017. 2017 Census of Agriculture, state profile-California –National Agricultural Statistics Service

Macaulay L. & Butsic V., 2017. Ownership characteristics and crop selection in California cropland. California Agriculture, 71(4), 221-230.

UCANR, 2017. Ag Worker Time and Activity Study Report 2017

UC Davis, 2017a. Broccoli Current Cost and Return Study – Central Coast (Monterey/San Benito/Santa Cruz) – Fresh Market- UC Davis Agricultural and Resource Economics

UC Davis, 2017b. Lettuce Current Cost and Return Study - Central Coast (Monterey/San Benito/Santa Cruz) – Iceberg (Head Lettuce), 80-inch beds- UC Davis Agricultural and Resource Economics

CDFA, 2020. California Agriculture Statistics Review 2019-2020

Monterey County, 2021. Monterey County Crop Report - 2021

Imperial County, 2021 Imperial County Crop Report – 2021

UC Davis, 2021. Strawberries Current Cost and Return Study – Central Coast (Monterey, Santa Cruz) – Fresh Market - UC Davis Agricultural and Resource Economics

CIRS, 2021. COVID-19 Farmworker Study 2021 – California Institute for Rural Studies

NAWHS, 2022. National Agricultural Worker Survey Database – California-specific data extracted.

USDA. CroplandCROS National Agricultural Statistics Service Mapping Database