Department of Pesticide Regulation
Air Monitoring Network Monitoring Plan

by

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INTRODUCTION

The Department of Pesticide Regulation (DPR) is the public agency responsible for protecting California and its residents from adverse health effects caused by the use of pesticides. Since February 2011, as part of DPR's legal requirements for "continuous evaluation" of currently registered pesticides, DPR implemented the Air Monitoring Network (AMN) to measure pesticides in three agricultural communities throughout the year. The AMN results supply data needed to accurately determine chronic exposures to various pesticides. These data gaps exist because past studies by the California Air Resources Board (ARB) and DPR usually consisted of two types of sampling better designed to estimate acute and subchronic exposures: application-site and seasonal ambient monitoring, respectively. For application-site monitoring, air is monitored next to applications of a specific pesticide for several days to estimate acute exposures. For seasonal ambient monitoring, air samples are collected for several weeks in communities near high-use regions and during high-use periods to estimate seasonal exposures to a single pesticide. Since long-term data were not available prior to the AMN, DPR extrapolated the short-term concentrations detected in these studies to estimate concentrations associated with annual and lifetime exposures. The AMN results provide the data necessary for DPR to:

- More accurately estimate chronic pesticide exposures,
- Assist in assessing potential health risks,
- Develop measures to mitigate these risks, and
- Evaluate the effectiveness of regulatory requirements.

Additionally, previous application-site and seasonal ambient air monitoring studies were usually designed to sample for single pesticides while the AMN is designed to sample for 31 pesticides and 5 pesticide breakdown products over a longer period of time.

The Budget Act of 2016 increased DPR's funding to enhance the current AMN in two ways. First, the increased funding allows DPR to increase the number of communities it monitors from three to eight until June 30, 2018. Both DPR and ARB will monitor at eight AMN sites: DPR will operate the monitoring stations in three communities, while ARB will be responsible for monitoring at five communities. Second, since children may be more susceptible to the effects of pesticide exposure, DPR and ARB will give selection preference to school sites, which will enable DPR to estimate potential exposure to children in areas of high pesticide use. In addition, communities with more economic and environmental pollution burdens will be selected over communities with lower burdens when regional use is similar based on their environmental justice rating.

This document describes the monitoring plan, including objectives, pesticides monitored, community selection process, and the eight communities to be included in the AMN. DPR will describe other details, particularly on specific monitoring locations as well as sampling, laboratory, and data analysis methods in a later monitoring protocol.

PROJECT OBJECTIVES

The objectives define the scope of the project and are consistent with AMN's overall goals. The intent in developing the objectives is to make them simple, measurable, realistic, and timely. The AMN has the following scientific objectives:

1) Identify common pesticides in air and determine seasonal, annual, and multiple-year concentrations.
2) Compare concentrations to subchronic and chronic health screening levels.
3) Estimate cumulative exposure to multiple pesticides with common modes of action.
4) Attempt to correlate concentrations with use and weather patterns.

In general, DPR uses AMN data for risk assessment, risk management, and to determine the effectiveness of regulatory requirements it has implemented. The AMN data enable DPR to more accurately estimate long-term exposure and resulting risk, since it's no longer necessary to extrapolate from short-term monitoring data. DPR currently assesses exposure and risk for individual pesticides. With the AMN data, DPR can assess cumulative exposure to multiple pesticides for pesticides that cause toxic effects by a common mode of action (e.g., cholinesterase inhibition).

No state or federal agency has established health standards for pesticides in air. Therefore, DPR developed both health screening levels and regulatory targets for monitored pesticides to place the results in a health-based context. DPR, in consultation with the Office of Environmental Health Hazard Assessment (OEHHA) and others, developed health screening levels; they are based on a preliminary assessment of possible health effects. If a pesticide air concentration exceeds a health screening level, it may trigger DPR to conduct a more detailed evaluation. A measured concentration above the screening level would not necessarily indicate a significant health concern, but would indicate the need for a further, more refined evaluation. A measured air concentration below the screening level for a given pesticide would not be considered a significant health concern and the pesticide would not undergo further evaluation at this time. For some pesticides, DPR has developed legal requirements, e.g., using buffer zones, to ensure air concentrations remain below health-protective regulatory targets. DPR normally establishes a regulatory target after completing a comprehensive risk assessment of a chemical's toxicity and potential exposures. DPR determines a regulatory target based on its risk assessment, as well as risk assessments from other agencies, pesticide use patterns, potential effects on use of alternative pesticides, and other factors. DPR puts measures in place based on the regulatory target concentration to limit exposures so that adverse effects can be avoided. Exceeding a regulatory target concentration does not necessarily mean an adverse health effect has occurred, but it does indicate that the restrictions on the pesticide use may need to be modified. Since a regulatory target is based on a more comprehensive evaluation than a health screening level, it supersedes a health screening level (i.e., a specific pesticide and exposure duration will have either a regulatory target or a health screening level, but not both). Vidrio et al. (2013) summarize more information on DPR-determined screening levels including information on deriving screening levels for each pesticide. DPR's Human Health Branch plans to review and update the current screening levels prior to the evaluation of the results of future monitoring.

SAMPLING PLAN

The eight AMN sampling sites will be operated by either DPR (three communities) or ARB (five communities). At each monitoring site, one 24-hour sample will be collected by ARB or DPR personnel each week. The starting day will vary each week with the actual start dates being randomly selected. Sampling start time will most likely vary by week and by location as the site operator will dictate actual sampling start time, but it will normally be between the hours of 9:00 a.m. to 2:00 p.m. Sampling one day each week will provide adequate data to estimate subchronic and chronic exposures, as previously determined by DPR (Tao, 2009).

PESTICIDES INCLUDED IN MONITORING

From 2011- 2016, the AMN monitored a total of 37 chemicals (i.e., 32 pesticides and 5 breakdown products). However, beginning in 2017, DPR will continue monitoring for a total of 36 chemicals (i.e., 31 pesticides and 5

pesticide breakdown products) currently included in the AMN. DPR has decided to no longer monitor for carbon disulfide because no current product registrations exist for carbon sulfide or sodium tetrathiocarbonate (the parent fumigant that breaks down into carbon disulfide as the active ingredient). In addition, carbon disulfide is a natural byproduct of anaerobic decomposition from the breakdown of plant material and has consistently been measured at similar concentrations in ambient air by ARB in the past (ARB, 1997).

DPR gives higher-risk pesticides higher priority for monitoring. Initial pesticide selection including use information and DPR priority rankings are detailed in Neal et al. (2010). Pesticides were selected based on the following criteria:

1) Pounds of use by area/region (indicator of exposure)
2) Volatility (indicator of exposure)
3) DPR risk assessment priority (indicator of toxicity)
4) Feasibility of including in multi-residue monitoring method

The 36 chemicals included in the AMN are listed below (breakdown products are shown with an *):

1. 1,3-Dichloropropene
2. Acephate
3. Bensulide
4. Chloropicrin
5. Chlorothalonil
6. Chlorpyrifos
7. Chlorpyrifos Oxygen Analog*
8. Chlorthal-dimethyl (DCPA)
9. Cypermethrin
10. Diazinon
11. Diazinon Oxygen Analog*
12. Dicofol
13. Dimethoate
14. Dimethoate Oxygen Analog*
15. Diuron
16. Endosulfan
17. Endosulfan Sulfate*
18. EPTC
19. Iprodione
20. Malathion
21. Malathion Oxygen Analog*
22. Methidathion
23. Methyl Bromide
24. Methyl Isothiocyanate (MITC)
25. Metolachlor (S-metolachlor)
26. Naled as Dichlorvos (DDVP)
27. Norflurazon
28. Oryzalin
29. Oxydemeton-methyl
30. Oxyfluorfen
31. Permethrin
32. Phosmet
33. Propargite
34. Simazine
35. SSS-tributylphosphorotrithioate
36. Trifluralin

Some of the pesticides in the AMN can cause a variety of adverse effects when present at concentrations above health-protective levels. These adverse effects can include respiratory illnesses, damage to the nervous system, cancer, and birth defects. Vidrio et al. (2013) summarize the potential health effects of each pesticide. The pesticides included in the AMN were selected in part because: (1) completed risk assessments indicate the potential for high exposure or (2) they are high priority for a risk assessment to be conducted due to toxicity and/or exposure concerns.

COMMUNITY SELECTION CRITERIA

The AMN will monitor eight communities: three will be monitored by DPR and five will be monitored by ARB. DPR evaluated 1,267 communities for selection and ranked them based on objective data, using criteria that can be quantified, validated, and verified. DPR ranked the monitored communities based on the following criteria:

- Two sets of communities were selected (four communities per set):
    - One set was based on 2012-2014 use of 4 fumigants – 1,3-dichloropropene, chloropicrin, methyl bromide and MITC-generators

    - One set was based on 2012-2014 use of 11 organophosphates – acephate, bensulide, chlorpyrifos, DDVP, diazinon, dimethoate, malathion, methidation, naled, oxydemeton-methyl, phosmet and S,S,S-tributyl phosphorotrithioate.
- For all communities considered, reported pesticide use was calculated for 3 zones:
    - Use within the community boundary (community zone)
    - Use between the community boundary and 1 mile of community boundary (local zone)
    - Use between 1 mile of community boundary and 5 miles of community boundary (regional zone)
- The use density (lbs/sq mi) was determined by pesticide, year, and zone for each community.
- Using data from the nearest California Irrigation Management Information System (CIMIS) station, DPR used the average wind speed as a weighting factor.
- Each community was ranked from highest to lowest community (1 to 1,267) for each zone and assigned a final ranking based on the average rank of the three zones.
- Highly ranked communities were grouped by geographic region, and one community was selected from the region.

Pesticide Use Data

The average amount of combined fumigants and combined organophosphates applied to each square-mile section per year was calculated from use information obtained from DPR's pesticide use report database for 2012, 2013, and 2014. DPR's PUR database is composed of pesticide use reports collected by County Agricultural Commissioners for each agricultural pesticide application occurring in their county and includes information on the pesticide product used, crop or site use type, location, date, amount applied, and type of application.

Community Data

Geographic boundaries of 1,267 communities were obtained from the US Census Bureau's 2015 TIGER/Line Place shapefile (http://www.census.gov/geo/maps-data/data/tiger-line.html). Geographic information system (GIS) analysis calculated the amount of each pesticide applied to individual sections around the communities. Three zones were evaluated, as shown in Figure 1: within the community boundary (the "community zone"); between the community boundary and 1 mile of the community boundary (the "local zone"); and within 1 to 5 miles of the community boundary (the "regional zone").

To date, the smallest geographic unit for reporting pesticide use to DPR is the square-mile section. Until such time as DPR collects site-specific field-level application data, it is not possible to determine where in a section a particular pesticide application was made. For sections that are only partially included within the zone boundary (see examples 15S18E03 and 15S18E04 in Figure 1) including the entire amount of pesticide applied within those sections may result in considerable over counting. To adjust for this, the proportion of each section within a zone was calculated and the amount of pesticide included was reduced in proportion to the area of the section within the zone. The multiplication (or portion) factor assumes that pesticide use is distributed uniformly across the section in which it is reported. Clearly this assumption is incorrect, but until such time as actual field locations are in place statewide, and use reports correspond to them with an acceptable degree of certainty, DPR considers this assumption as a justifiable way to address this issue.

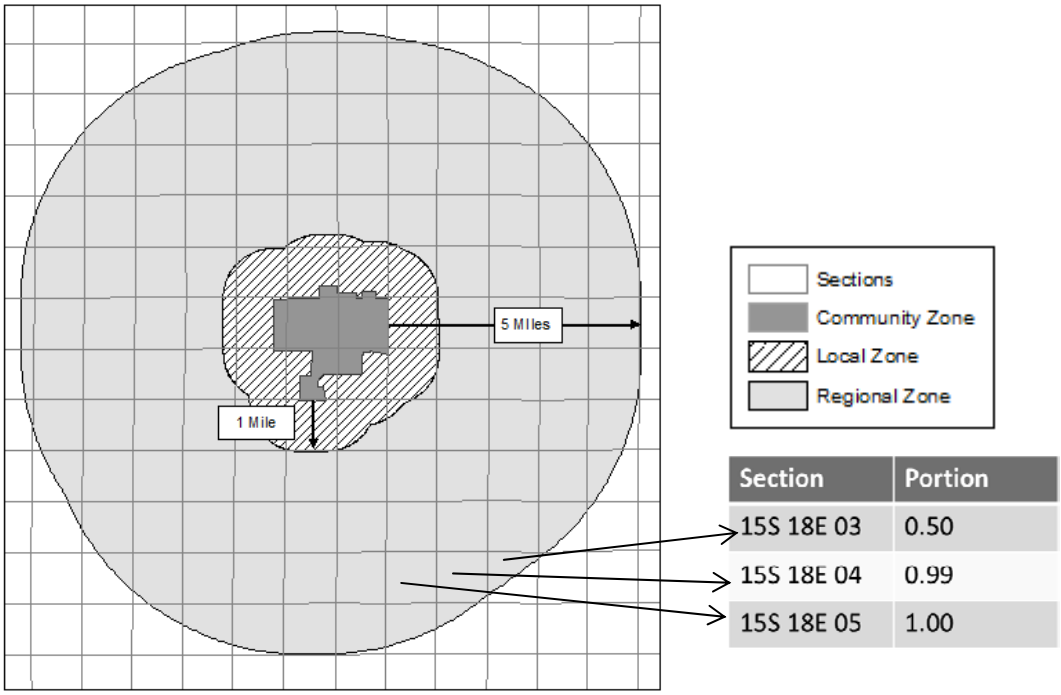

Figure 1. A graphical representation of the community, local and regional zones around a community.

To determine use density (lbs/sq mi), the amount of pesticide applied within each of these three "zones" was divided by the area of each zone (in square miles), and then expressed as amount of pesticide active ingredient per square mile by pesticide and zone for each community. GIS analysis was used to determine the closest CIMIS station to each community, and the use density of each community was then divided by the average annual wind speed from that CIMIS station. Communities were ranked independently for weighted fumigant and organophosphate use within the three zones, and a final ranking was assigned based on the average rank of the three zones. Table 3 lists the top 30 communities for fumigants and organophosphates.

Table 3. Rankings of the top 30 communities for fumigant and organophosphate use during 2012 -2014.

Fumigants				Organophosphates		
Name	**County**	**Rank**		**Name**	**County**	**Rank**
Mettler CDP	Kern	1		Guadalupe city	Santa Barbara	1
El Rio CDP	Ventura	2		Woodlands CDP	San Luis Obispo	2
Edmundson Acres CDP	Kern	3		Chualar CDP	Monterey	3
Pajaro CDP	Monterey	4		Ivanhoe CDP	Tulare	4
Camarillo city	Ventura	5		Richgrove CDP	Tulare	5
Weedpatch CDP	Kern	6		Rodriguez Camp CDP	Tulare	6
Macdoel CDP	Siskiyou	7		Lindsay city	Tulare	7
Pajaro Dunes CDP	Santa Cruz	7		Exeter city	Tulare	8
Mount Hebron CDP	Siskiyou	9		Lindcove CDP	Tulare	8
Santa Maria city	Santa Barbara	9		San Joaquin city	Fresno	10
Interlaken CDP	Santa Cruz	11		Hamilton City CDP	Glenn	11
Cuyama CDP	Santa Barbara	12		Gonzales city	Monterey	12
Guadalupe city	Santa Barbara	13		Seville CDP	Tulare	13
Amesti CDP	Santa Cruz	14		Pajaro CDP	Monterey	14
Las Lomas CDP	Monterey	15		Santa Maria city	Santa Barbara	15
Watsonville city	Santa Cruz	16		Tranquillity CDP	Fresno	15
Woodlands CDP	San Luis Obispo	17		Lost Hills CDP	Kern	17
Arvin	Kern	18		Sultana CDP	Tulare	18
Oxnard city	Ventura	19		Cantua Creek CDP	Fresno	19
Salinas city	Monterey	20		Poplar-Cotton Center CDP	Tulare	20
New Cuyama CDP	Santa Barbara	21		London CDP	Tulare	21
Nipomo CDP	San Luis Obispo	22		Terra Bella CDP	Tulare	21
Callender CDP	San Luis Obispo	23		Seeley CDP	Imperial	23
Rosedale CDP	Kern	24		Delft Colony CDP	Tulare	24
Castroville CDP	Monterey	25		Cutler CDP	Tulare	25
La Selva Beach CDP	Santa Cruz	26		Callender CDP	San Luis Obispo	26
Farmersville city	Tulare	27		Shafter city	Kern	27
Orcutt CDP	Santa Barbara	28		Garey CDP	Santa Barbara	28
Boronda CDP	Monterey	29		Tonyville CDP	Tulare	29
Lamont CDP	Kern	30		Farmersville city	Tulare	30

Environmental Justice Considerations

DPR also considered environmental justice factors when selecting the eight communities to be included in the AMN. OEHHA created the California Communities Environmental Health Screening Tool: CalEnviroScreen Version 2.0 (CES 2.0). CES 2.0 is a screening methodology that helps identify California communities that are disproportionately burdened by multiple sources of pollution. In order to give higher weight in the AMN community selection process to California communities that are disproportionately burdened as ranked by OEHHA's CES 2.0 tool, DPR used the CES 2.0 Population Characteristics (PC) percentile in the AMN community selection process. The CES 2.0 PC percentile for any California census tract is based on the following parameters: percent of children and elderly in the population, percent of low birth-weight births, and the rates of asthma emergency department visits, educational attainment, linguistic isolation, poverty, and unemployment (OEHHA, 2014). The CES 2.0 tool is based on census tracts and not community borders; therefore, a single community, if large enough, can have multiple census tracts with various PC percentiles. For DPR's AMN community selection rankings, an average of all PC percentiles from all census tracts bisecting a community was utilized.

Table 4 lists the communities with the highest adjusted 2012-2014 use rankings for four fumigants and 11 organophosphates. The listed communities are grouped by county and region and include the CES 2.0 PC percentile for each community. Some of the potential communities that were considered are shown in Figures 2 and 3.

Table 4. Communities with the highest adjusted use rankings for four fumigants and 11 organophosphates (2012-2014 data) grouped by region (use ranking was adjusted for wind speed and use density factors). In parentheses, average CalEnviroscreen 2.0 Population Characteristics percentiles are also given for each community.

Communities (CES 2.0 PC Percentile)	County	Adjusted Use Ranking
Fumigants		
El Rio (42.6), Camarillo (26.3), Oxnard* (68.7)	Ventura	2,5,19
Watsonville Area (10 communities, including Watsonville* (62.8))	Monterey, Santa Cruz	4 - 29
Santa Maria* (54.1), Guadalupe (73.3), Woodlands (30.0), Nipomo (37.7), Callander (30.0), Orcutt (22.4)	Santa Barbara, San Luis Obispo	9, 13, 17, 22, 23, 28
Mettler (37.1), Edmundson Acres (83.0), Weedpatch (92.1), Arvin (82.6), Rosedale (6.0), Lamont (83.1)	Kern	1, 3, 6, 18, 24, 30
Macdoel (54.7), Mount Hebron (54.7)	Siskiyou	7, 9
Cuyama (51.7), New Cuyama (51.7)	Santa Barbara	12, 21
Organophosphates		
Guadalupe (73.3), Woodlands (30.0), Santa Maria* (54.1), Callendar (30.0), Garey (23.4)	Santa Barbara, San Luis Obispo	1, 2, 15, 26, 28
Chualar (69.7), Gonzalez (67.7)	Monterey	3, 12
Tulare–Kingsburg area (20 communities)	Tulare	4-30
San Joaquin (82.4), Tranquility (82.4), Cantua Creek (82.4)	Fresno	10,15,19
Hamilton City (73.4)	Glenn	11
Lost Hills (78.2), Shafter* (69.8)	Kern	17, 27
Seeley (83.4)	Imperial	23

*Denotes a community in which ARB or DPR has a current ambient air monitoring site.

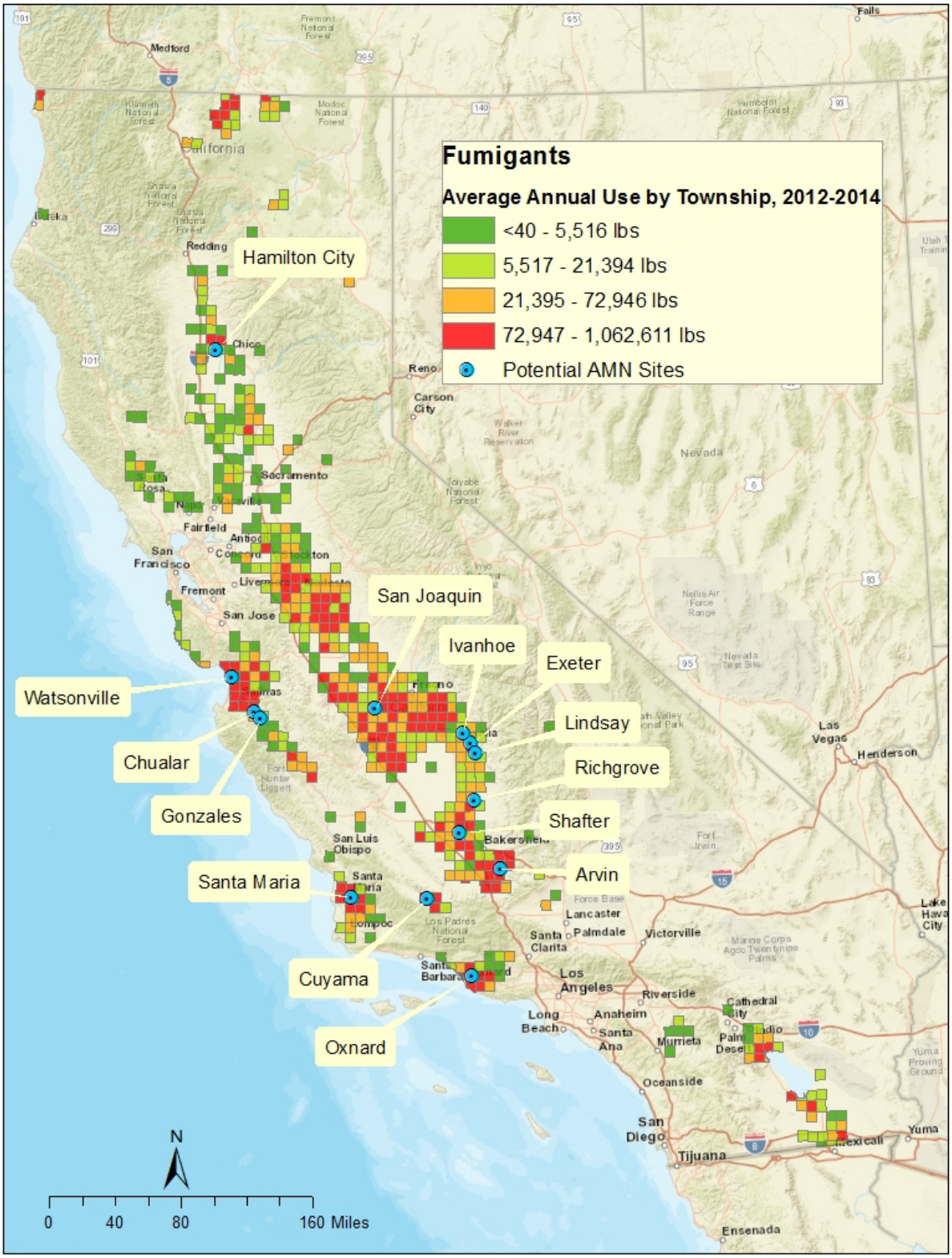

Figure 2. Map displaying reported fumigant use by township (6x6 miles) from 2012-2014. High ranking communities in terms of reported use that were considered for inclusion in the Air Monitoring Network are also displayed.

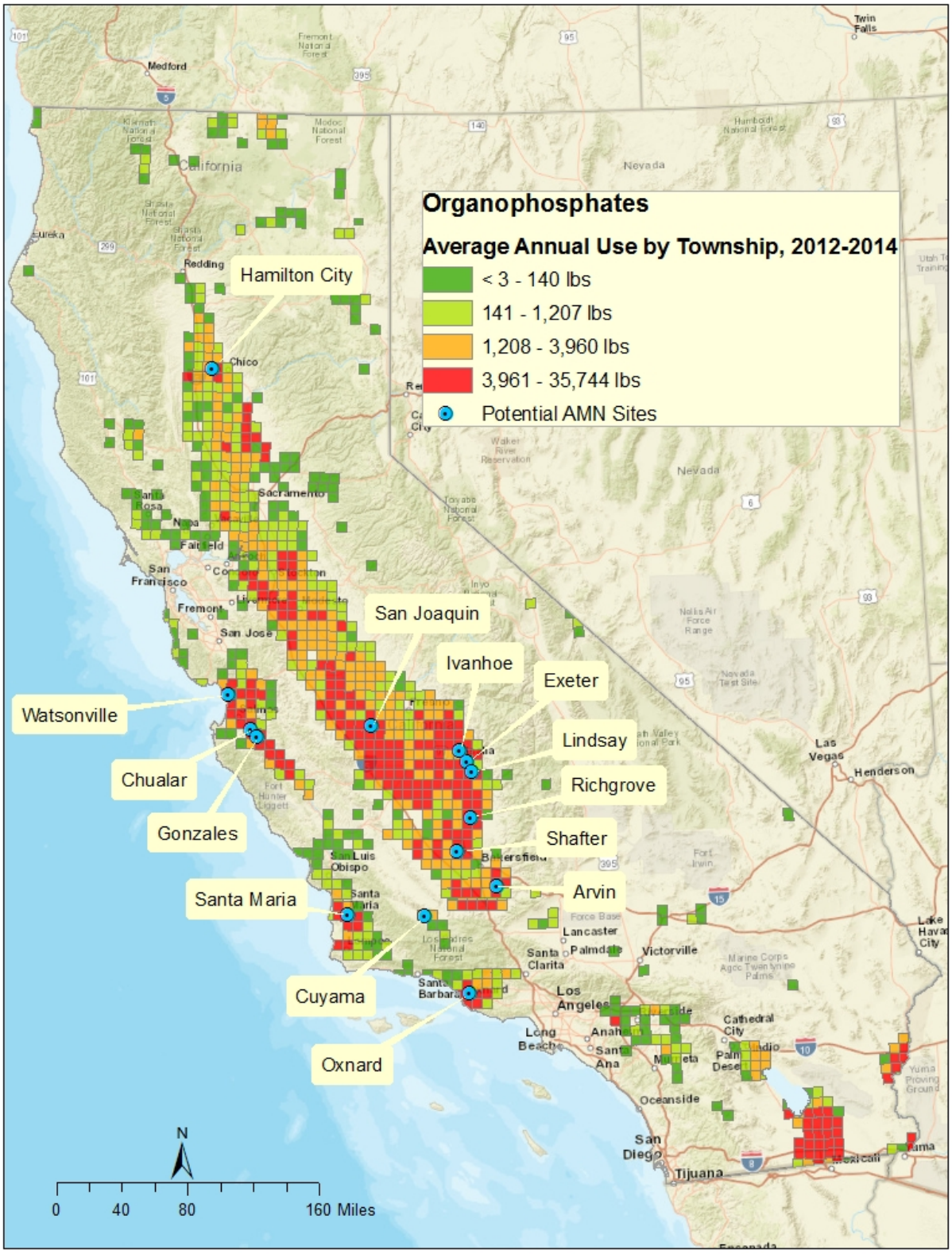

Figure 3. Map displaying reported organophosphate use by township (6x6 miles) from 2012-2014. High ranking communities in terms of reported use that were considered for inclusion in the Air Monitoring Network are also displayed.

SELECTED COMMUNITIES

Pesticide use, wind speed, and environmental justice factors were analyzed for all 1,267 communities. Communities with the highest average ratings for fumigants and organophosphates are shown in Table 4. Based on the information in Table 4, DPR selected the following eight communities to monitor as part of the Air Monitoring Network (Figure 4):

Communities selected based on statewide organophosphate use ranking for selected geographic regions:

1. Chualar (Monterey County)
2. Lindsay (Tulare County)
3. San Joaquin (Fresno County)
4. Shafter (Kern County)

Communities selected based on statewide fumigant use rankings for selected geographic regions:

1. Santa Maria (Santa Barbara County)
2. Cuyama (Santa Barbara County)
3. Watsonville Area (Monterey County)
4. El Rio/Oxnard (Ventura County)

DPR selected these eight communities based primarily on (1) pesticide use ratings (Table 3), which included adjustments for wind speed and use density factors, then (2) used the average CES 2.0 PC percentiles to select between closely ranked communities. The communities selected to include in the AMN were ranked among the top for each geographic group in overall pesticide use ratings for either fumigants or organophosphates (Table 4), with the following exceptions:

- In Santa Barbara and San Luis Obispo Counties, Santa Maria was preferred over Guadalupe and Woodlands due to the available existing air monitoring station in Santa Maria where ARB has collected air samples as part of DPR's Toxic Air Contaminant Program since 2010. Additionally, ambient air monitoring in Santa Maria has shown that chloropicrin levels are near DPR's subchronic health screening level threshold.
- In Kern County, Shafter was selected over the communities of Lost Hills, Mettler, Edmundson Acres, Weedpatch, Arvin, Rosedale, and Lamont due to the presence of a current air monitoring station in Shafter operated by DPR. The Shafter monitoring station is one of the original AMN sampling sites for this study; it also had the highest measured 1,3-dichloropropene concentrations, a pesticide of concern for DPR.
- Although several communities in Siskiyou and Imperial Counties ranked high in the pesticide use rankings, weekly monitoring in these counties, due to their distant locations from the other sampling locations, would make sampling in these communities a logistical problem for both DPR and ARB. However, since use rankings show that either high fumigant (Siskiyou) or organophosphate (Imperial) use is localized in these two counties, ARB, at DPR's request, plans to perform seasonal ambient air monitoring in these counties during the high use season for their respective active ingredients.

Monitoring in the selected communities is contingent on finding suitable monitoring locations that meet U.S. Environmental Protection Agency (U.S. EPA) siting criteria, are secure from tampering, provide electricity to operate sampling equipment, and grant access permission. Unfortunately, these requirements eliminated some high-use ranking communities (e.g., Mettler, Edmunson Acres, Lamont, and Gonzales among others) due to a lack of a suitable public building sampling location or due to DPR's inability to gain sampling permission from the appropriate authorities.

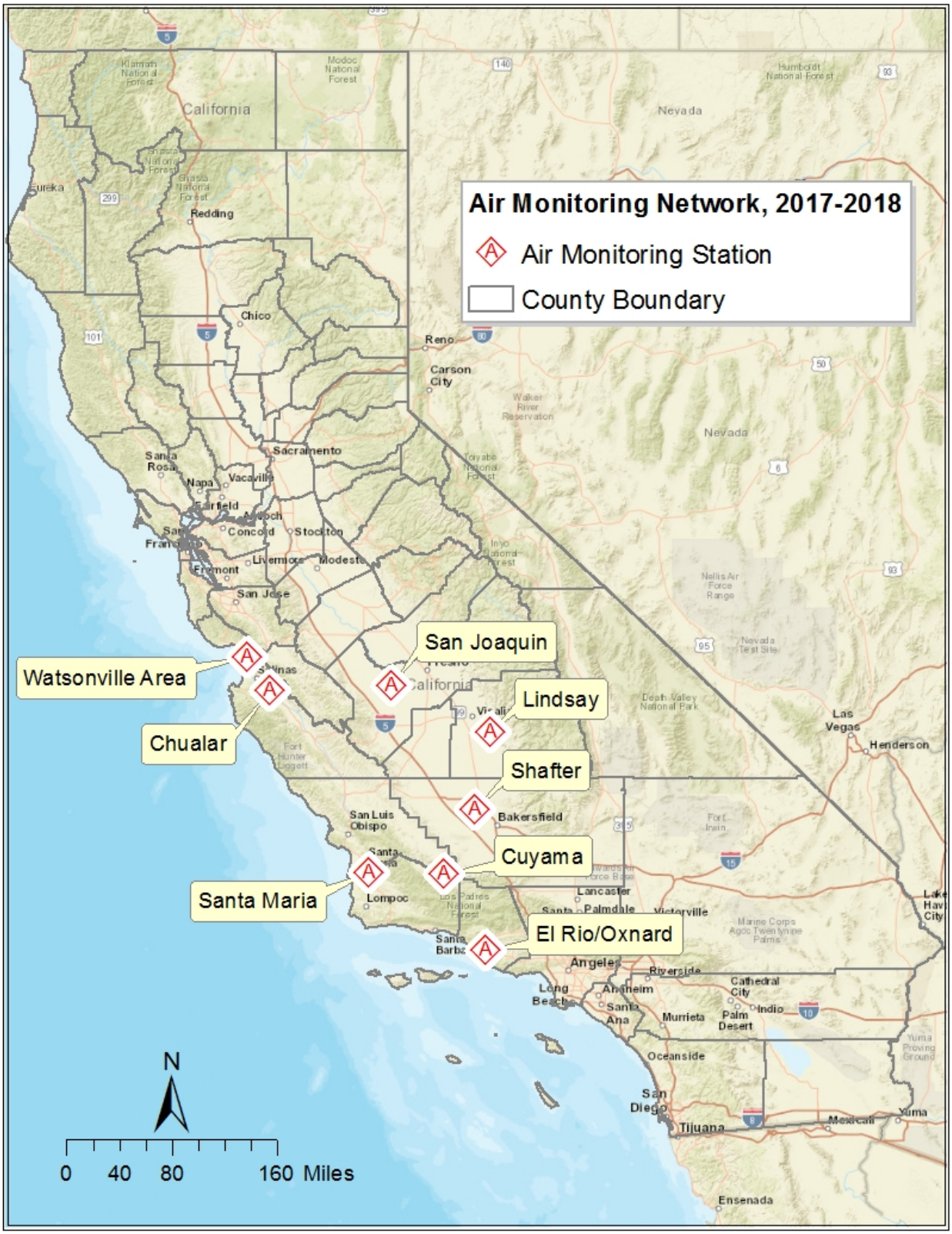

Figure 4. Map showing the location of the eight selected Air Monitoring Network sampling communities. Five stations will be operated by the Air Resources Board while three stations will be operated by the Department of Pesticide Regulation.

Site Location

Monitoring sites within the communities must meet the following minimum criteria:

- Sample collection site meets all U.S. EPA ambient air siting criteria
    - 2 to 15 meters above ground
    - At least 1 meter horizontal and vertical distance from supporting structure
    - Should be at least 20 meters from trees
    - Distance from obstacles should be at least twice the obstacle height
    - Unobstructed air flow for 270°
- Accessible to sampling personnel during time of sampling
- Accessible to electrical outlets
- Secure from equipment loss or tampering
- Permission of site operator/owner

Preferred monitoring sites also meet the following criteria:

- School, day care center, or other "sensitive site"
- Located on the edge of the community and/or adjacent to agricultural fields
- Located in the predominant downwind direction from agricultural fields

ANNUAL REPORTS

Annual reports (January to December) of the sampling results from all eight monitoring locations will be made available by the fall following the sampling year. Annual results reports will be posted on DPR's Air Program website along with any presentations, raw data, and any other AMN-related reports as they are completed by DPR.

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