APPENDIX
DPR REPORT

Kettleman City Community Exposure Assessment

Evaluation of Pesticides in Air

December 2010

California Environmental Protection Agency
Department of Pesticide Regulation

APPENDIX
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Potential Sources of Environmental Contamination – Use of Pesticides in Agricultural Operations

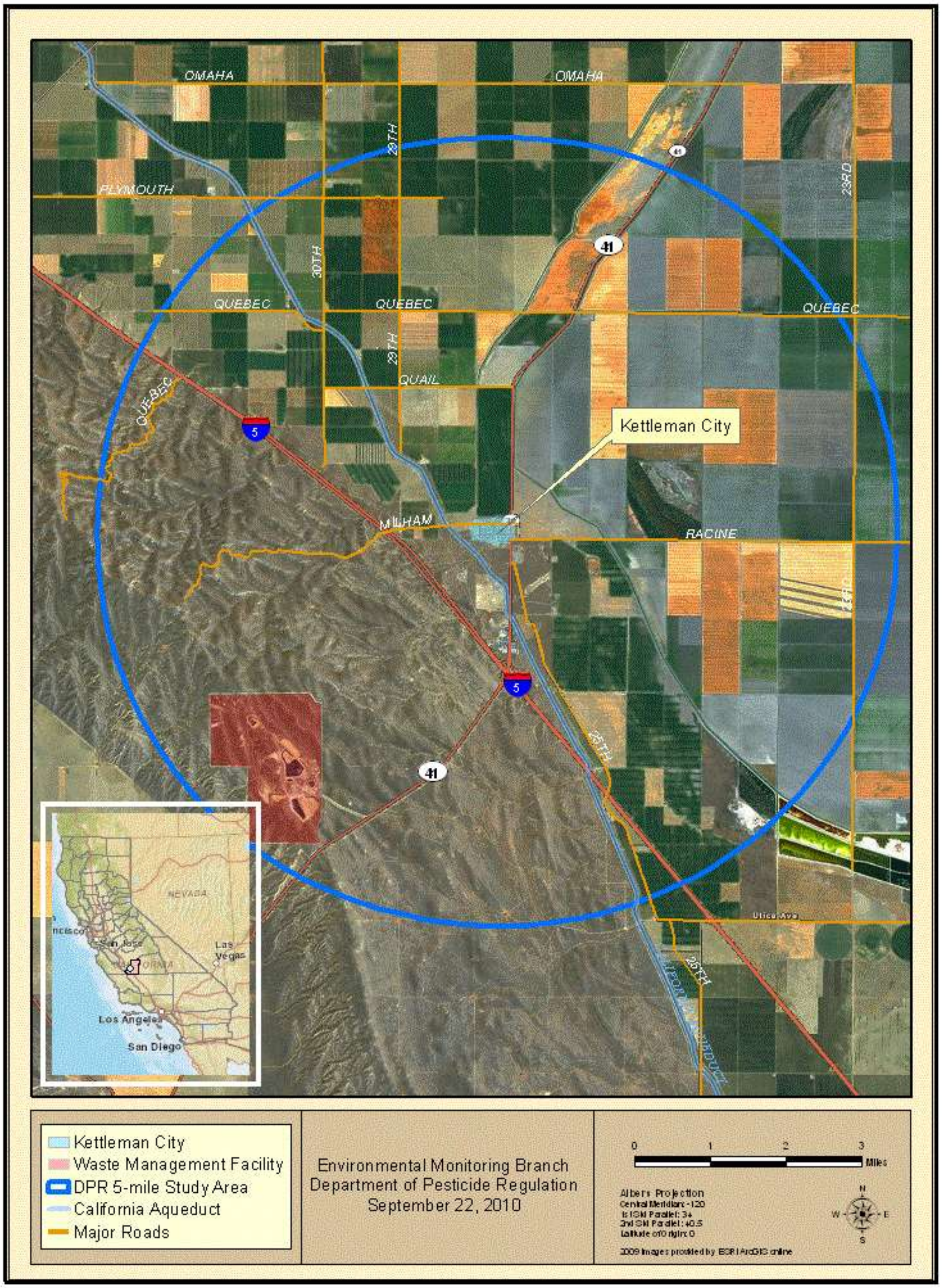
Kettleman City is surrounded by agricultural fields to the west, north and east, with minimal distance separating them from homes. Pesticides commonly associated with agricultural operations may migrate to the community as a result of improper application or winds. Throughout this assessment, DPR considered pesticide applications within five miles of the border of Kettleman City for its evaluation, encompassing 110 square miles or 70,400 acres (Figure 1). This distance was a subjective selection, although previous monitoring for another community monitoring project (Parlier) typically corresponded with applications within five miles. Major crops grown within five miles of Kettleman City include alfalfa, carrots, nuts (almonds, pistachios), onions, tomatoes, and stone fruit (apricots, nectarines, peaches, plums). Of the approximately 1,000 pesticides currently approved for sale in California, approximately 236 pesticides totaling 650,000 pounds were reported to have been used within five miles of Kettleman City each year from 2007 through 2009 (Table 1 shows the top 10 pesticides). Although this is a significant amount of pesticides, many other San Joaquin Valley agricultural communities had higher levels of pesticide use within five miles of those other communities.

NOTE: Two of the highest use pesticides in California and the Kettleman City area are metam-sodium and potassium N-methyldithiocarbamate (metam-potassium). These pesticides rapidly break down to methyl isothiocyanate (MITC). MITC is the actual pesticidal agent and is the primary chemical of toxic concern. In this report, metam-sodium and potassium N-methyldithiocarbamate are referred to as MITC-generating pesticides.

Table 1. Reported total pounds applied for top ten pesticides used within five miles of Kettleman City during 2007-2009. Acres treated and number of applications are also shown.

Pesticide	2007-2009 Pounds	2007-2009 Acres	2007-2009 Applications
Potassium N-methyldithiocarbamate (MITC pesticide)	664,458	7,728	56
Sulfur	405,999	21,032	194
Mineral oil	273,012	10,562	156
Petroleum oil, unclassified	121,296	6,401	70
Metam-sodium (MITC pesticide)	109,631	1,489	15
Kaolin	68,642	2,039	13
1,3-dichloropropene	47,055	353	6
Glyphosate, isopropylamine salt	37,235	17,225	220
Ziram	23,623	4,436	94
Chlorothalonil	12,286	8,838	55

Figure 1. Agricultural area within five miles of Kettleman City included in DPR's pesticide evaluation.



There are a number of potential ways for pesticide exposure to occur. Pesticides applied in nearby fields may enter the community as airborne particles or gases (when pesticides drift into the community or are volatilized after application). Community members may be exposed primarily from inhalation of contaminated air.

Besides air, other potential sources of agricultural pesticide exposure include food, water, soil, dust, and workplaces. Exposure to levels that cause birth defects from agricultural pesticides in food is unlikely for Kettleman City residents. DPR, U.S. Food and Drug Administration, and the U.S. Department of Agriculture routinely monitor for pesticide residues in food. DPR samples individual lots of domestic and imported produce and analyzes them for pesticide residues to enforce the residue limits (tolerances) set by the U.S. Environmental Protection Agency. Samples are collected from throughout the channels of trade, including wholesale and retail outlets, distribution centers, and farmers markets. Samples are tested for more than 200 pesticides and breakdown products. Samples rarely exceed the tolerance levels. Results of DPR's food residue monitoring are available at http://www.cdpr.ca.gov/docs/enforce/residue/rsmonmnu.htm

Exposure to levels that cause birth defects from agricultural pesticides in water is unlikely for Kettleman City residents. Municipal water providers routinely monitor for pesticides that are likely water contaminants. In addition, DPR monitors for pesticides with the potential to contaminate ground or surface waters. DPR monitors in regions vulnerable to ground water contamination. These ground water protection areas have permeable soils and water located at shallow depths. The nearest pesticide ground water protection area is 27 miles north of Kettleman City, making pesticide contamination unlikely. Since 2007, the Kettleman City Community Services District has tested the wells in Kettleman City for 32 pesticides. Only benzene was detected, but it is no longer sold as an active ingredient in pesticide products. Some pesticide products may still contain benzene as an "inert ingredient." Surface water is not used for drinking water in Kettleman City. However, DTSC collected water samples from the aqueduct and a drainage canal near Kettleman City for pesticide analysis.

Exposure to levels that cause birth defects from agricultural pesticides in soil is unlikely for Kettleman City residents. Agricultural pesticides in soil of residential yards are likely due to drift. Direct exposure to drift through the air is likely higher than indirect exposure through soil. DPR's evaluation focused on pesticides in air. In addition, while children may ingest and possibly have high exposures through soil, this source of exposure is low for adults (birth mothers). While exposure should be low, DTSC collected soil samples for pesticide analysis at several Kettleman City locations. Pesticides in soil and airborne dust also can enter homes. Because of this, residents may be exposed by inhaling or ingesting dust from surfaces inside their homes.

Chemicals of Interest – Pesticides That Are Possible Development Toxicants

DPR evaluated the 19 pesticides shown in Table 1 for evaluation as possible causes of birth defects in Kettleman City. OEHHA and DPR developed a candidate list of chemicals to evaluate based on possible birth defects in humans or animals. DPR selected the pesticides shown in Table 2 for evaluation because they may cause birth defects and had reported use within five miles of Kettleman City during 2007 or 2008. *(NOTE: 2009 pesticide use data for Kettleman City was not available when these pesticides were selected. The 2009 data became available later, and was included in DPR's evaluation.)*

Table 2: Pesticides evaluated by DPR for developmental effects.

Pesticide	**Common Trade Names**	**2007-8 Average Yearly Use Within 5 Miles (pounds)**
2,4-D (2,4-dichlorophenoxyacetic acid)	2,4-D	495
Abamectin	Agri-Mek, Zephyr	42
Azoxystrobin	Quadris	336
Boscalid	Pristine	311
Bromoxynil	Buctril	1,156
Carbaryl	Sevin	1,374
Chlorpyrifos	Lorsban	3,243
Clethodim	Arrow	252
Diazinon	Diazinon	110
Diflubenzuron	Dimilin	225
Fenoxaprop-p-ethyl	Puma	60
Flumioxazin	Chateau	149
Maneb	Manex	319
MCPA (methylchlorophenoxyacetic acid)	MCPA	1,750
MITC pesticides	Vapam, Sectagon	234,519
Myclobutanil	Rally, Laredo	291
Oxyfluorfen	Goal, Goaltender	1,702
Propiconazole	Bumper, Orbit	157
Pyraclostrobin	Cabrio, Pristine	396

Chemicals of Interest – Pesticides That May Cause Other Toxic Effects

Because of time constraints, DPR relied on a previously validated method to monitor as many pesticides as possible. The method included 27 pesticides which may be associated with a variety of other possible toxic effects, such as neurotoxicity and cancer. Four (chlorpyrifos, diazinon, MITC, oxyfluorfen) of the 19 pesticides of interest (Table 3) were included in this monitoring. Most of these pesticides, including the four that may cause birth defects, may have had low or no use at the time of monitoring.

Table 3. The common trade name, use (action), and chemical class for each pesticide monitored.

Pesticide	Common Trade Names	Type of Use
Azinphos-methyl	Guthion	Insecticide
Chlorothalonil	Bravo, Daconil	Fungicide
Chlorpyrifos	Dursban, Lorsban	Insecticide
Cypermethrin	Demon	Insecticide
Diazinon	Various brands	Insecticide
Dichlorvos	Vapona, DDVP	Insecticide
Dicofol	Kelthane	Insecticide
Dimethoate	Cygon	Insecticide
Diuron	Karmex	Herbicide
Endosulfan	Thiodan	Insecticide
EPTC	Eptam	Herbicide
Malathion	Various brands	Insecticide
MITC	Vapam, K-pam	Fumigant
Metolachlor	Dual	Herbicide
Molinate	Ordram	Herbicide
Naled (dichlorvos)	Dibrom	Insecticide
Norflurazon	Solicam	Herbicide
Oryzalin	Surflan	Herbicide
Oxyfluorfen	Goal	Herbicide
Permethrin	Ambush, Pounce	Insecticide
Phosmet	Imidan	Insecticide
Propanil	Duet, Wham	Herbicide
Propargite	Omite, Comite	Insecticide
Simazine	Princep	Herbicide
SSS-tributylphosphorotrithioate	DEF, Folex, Tribufos	Defoliant
Thiobencarb	Bolero, Abolish	Herbicide
Trifluralin	Treflan	Herbicide

Methods to Evaluate Pesticides in Air

DPR's methods to evaluate and monitor pesticide exposure for Kettleman City are summarized in this section. A complete description of the methods is given in Appendices DPR-A and DPR-B. DPR normally uses a combination of monitoring and computer modeling to estimate air concentrations. DPR and ARB routinely conduct two types of air monitoring studies for pesticides: sampling near a specific application (application-site monitoring), and sampling for a region of use in a community (ambient monitoring). Monitoring is typically conducted for individual pesticides in a region and period of high use. Monitoring provides a snapshot of air concentrations at a specific location and specific time. DPR supplements the air monitoring with computer modeling to estimate concentrations for other locations, time periods, and circumstances.

DPR relied primarily on computer modeling instead of air monitoring to estimate pesticide air concentrations in Kettleman City. Pesticide use in the Kettleman City area changed considerably between 2007 and 2010. As a result, air monitoring for pesticides in 2010 would provide little information about airborne concentrations that may have reached the community during 2007 to 2009. DPR has conducted evaluations of risk from multiple pesticides for two other communities previously: Lompoc in Santa Barbara County and Parlier in Fresno County. Many of the methods used to evaluate Kettleman City are modifications of the methods used for Lompoc and Parlier.

DPR conducted a two-step evaluation for the 19 pesticides of interest. For the first step, DPR determined “health screening levels” based on the available toxicology data. Health-protective screening levels are necessary because there are no federal or state standards for pesticides in air, that is, no enforceable health-based limits on pesticide emissions allowed in air. The screening levels are designed to point out potential concerns for health effects. Although they are not regulatory standards, these screening levels are useful for preliminary evaluations of air monitoring data. Detections below the screening level for a given pesticide would not be considered to represent a significant health concern and generally would not undergo further evaluation. Detections above the screening level would not necessarily signal a significant health concern but would point out the need for a more refined evaluation.

To the extent possible, health screening levels are based on identified critical toxicology values or exposure levels taken from existing documents that have already been subject to peer review and/or public comment. The primary sources are risk assessments in the form of risk characterization documents conducted by DPR; re-registration eligibility documents completed by U.S. EPA; risk assessments completed by USEPA, and reference exposure levels established by OEHHA. For some pesticides, DPR determined two screening levels. The highest or maximum screening level was the concentration that would trigger further evaluation for birth defects. The lowest or minimum screening level was the concentration that would trigger further evaluation for any adverse health effect.

After determining the health screening levels, DPR used information from pesticide use reports to estimate the worst-case air concentrations in Kettleman City between September 2006 and December 2009, the relevant exposure time period identified by CDPH for these occurrences of birth defects. DPR estimated air concentrations with an air dispersion computer model (Industrial Source Complex-Short Term model; ISCST). USEPA developed this model and has validated its performance. The model is used by many government agencies and others to estimate air concentrations of toxic chemicals. As part of the validation, USEPA and others agencies compared air concentrations measured in the field to air concentrations predicted by the model. In addition, two scientific panels have reviewed DPR’s modeling procedures and found them acceptable.

DPR used a tiered approach to the air dispersion computer modeling. The first tier (Tier 1) modeled simple, hypothetical worst-case situations for each pesticide. This hypothetical situation assumed 100 percent emission of the pesticide off of the field or orchard, which is unlikely to occur. However, this is strictly used as a screening tool to determine if further evaluation is warranted. If the first tier modeled air concentrations exceeded health screening levels, a second tier of modeling was conducted. The second tier (Tier 2) used information from pesticide use reports for specific applications during September 2006 through December 2009, and local weather data for this period to provide a more refined estimate of historical air concentrations in Kettleman City. DPR estimated air concentrations for individual pesticides as well as air concentrations for multiple pesticides combined to estimate cumulative exposure.

Both the first tier and second tier of air dispersion computer modeling relied on the following key information to estimate air concentrations:

- Agricultural field information – number, dimensions, locations
- Pesticide applications – product, dates, and amount applied
- Amount of applied pesticide released to the air (emission rate or flux)
- Weather – wind speed, wind direction, atmospheric stability
- Location of Kettleman City boundary relative to application locations

NOTE: Both the pesticide air concentrations and screening levels are expressed as the mass or weight of pesticide in a volume of air. The pesticide air concentration units used for this report are nanograms (one-billionth of a gram, ng) of pesticide per cubic meter (m^3) of air, ng/m^3.

To evaluate cumulative exposure to multiple pesticides, DPR determined hazard quotients for individual pesticides, and a hazard index for multiple pesticides. The ratio of measured air concentration of a pesticide to a reference concentration or screening level for that pesticide is called the hazard quotient (HQ). In this case,

$$Hazard\ Quotient = \frac{Air\ Concentration\ (ng/m^3)}{Screening\ Level\ (ng/m^3)}$$

If the HQ is greater than 1, then the air concentration exceeds the screening level. The risk from multiple pesticides (cumulative risk) was evaluated using the hazard index (HI) approach, by adding the HQs for the pesticides that can be appropriately grouped according to mechanism or site of toxicity.

$$HI = HQ_1\ (pesticide\ 1) + HQ_2\ (pesticide\ 2) + HQ_3\ (pesticide\ 3) + \ldots \text{ (and so forth)}$$

As with the HQ, an HI greater than 1 indicates the need for further evaluation. If an HQ for one pesticide is greater than 1, the HI for the same period will be greater than 1, since the HQs are added together. The HI is most useful when individual HQs are less than 1. However, if the HI is greater than 1, this indicates that the cumulative toxicity of the multiple pesticides should be further evaluated and that potential health impacts may have been missed by only considering the pesticides individually.

Methods for Monitoring Pesticides in Air

There are two primary reasons why DPR estimated air concentrations using historical data and air dispersion computer modeling:

- Air monitoring conducted in 2010 may not show the potential exposures to pesticides applied in earlier years, when reported birth defects occurred. Monitoring can only provide a snapshot of air concentrations of pesticides at a specific location and specific time. This is particularly true for the Kettleman City area where pesticide use patterns have changed in recent years as orchards and other crops have replaced cotton fields. Different pesticides are used now than those used just a few years ago. DPR can model air concentrations for earlier years using information from pesticide use reports and data from nearby weather stations.

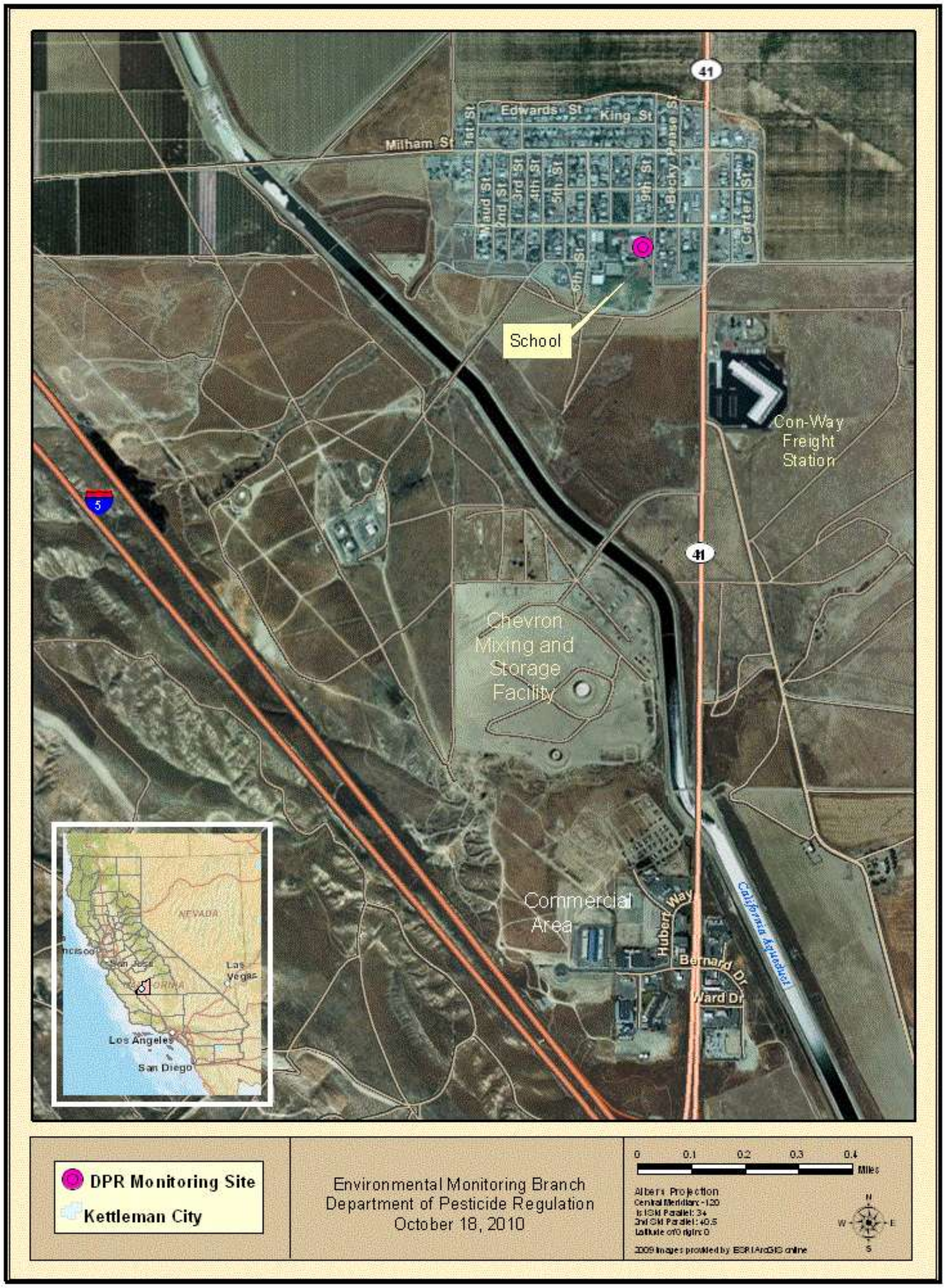
- Comprehensive air monitoring would take several months or possibly more than one year for many of the pesticides assessed. Some of those pesticides have not been monitored in air previously, and no methods exist to analyze air for these pesticides. Developing analytical methods for a single pesticide normally takes several months.

Despite these limitations, DPR conducted air monitoring for several pesticides during June-July 2010. The monitoring included pesticides with a variety of possible toxic effects, such as neurotoxicity and cancer, but only included 4 of the 19 pesticides selected for evaluation of possible birth defects (chlorpyrifos, diazinon, MITC, and oxyfluorfen). Additionally, all four may have had low or no use at the time of monitoring. This monitoring provided an additional source of measured data to compare with the air dispersion computer modeling estimates. However, the monitoring has limited value because comparing the computer modeling to concentrations measured at a single location provided a minimal evaluation of the modeled air concentration estimates.

The specific objective of the monitoring was to estimate the daily and monthly (seasonal) average air concentrations in Kettleman City for certain pesticides during June-July.

DPR collected pesticide air samples at the same location as ARB, Kettleman City Elementary School (Figure 2). Ambient air monitoring began on June 8, 2010 and ended on July 29, 2010. Individual air samples were 24 hours in duration, collected twice weekly for 8 weeks, for a total of 16 discrete sampling periods. Two air samples were collected for each sampling period, one for MITC and one for 26 other pesticides (Table 3). (ARB's monitoring will detect several other chemicals with pesticidal uses including 1,3-dichloropropene and methyl bromide.) MITC samples were collected using personal sample pumps equipped with coconut charcoal tubes. The other pesticides were monitored with air sampling pumps equipped with a sampling tube containing XAD-4 adsorbent.

Figure 2. Location of DPR air monitoring site in Kettleman City.



Collected samples were immediately placed on dry ice and kept frozen until they were delivered to the California Department of Food and Agriculture's (CDFA's) Center for Analytical Chemistry in Sacramento. Under contract to DPR, the CDFA laboratory analyzed the samples using validated methods and standard quality control procedures, including the use of certified analytical standards to calibrate the instruments, analysis of samples within prescribed holding times, analysis of blank samples (samples with no pesticides) to check for contamination, and analysis of spiked samples (samples with known amounts of pesticides) to measure precision and accuracy. DPR used these sampling and laboratory methods for an earlier project in Parlier. Detection limits for all pesticides included in the monitoring were less than the health screening levels.

Methods for Compiling Pesticide Use Data

Pesticide use reports served as a key source of information for two purposes: (1) to conduct air dispersion computer modeling to estimate concentrations of pesticides in air; and (2) to identify unusual use patterns from 2007 to 2009. Under California law, all agricultural pesticide use must be reported. DPR maintains a database of all reported agricultural pesticide applications in California. The pesticide use report database contains information on all agricultural pesticide use and some nonagricultural use in California. The database includes information on the pesticide product used, the application date, the application amount, crop/site treated, and application location to a square-mile section.

To aid in providing representative air dispersion computer modeling for Kettleman City, the Kings County Agricultural Commissioner's office provided data showing the locations of agricultural fields identified in pesticide use reports, enabling DPR to model air concentrations associated with specific pesticide applications.

DPR also evaluated pesticide use reports of the 19 pesticides of interest to determine if the applications in the Kettleman City area during 2007-2009 were unusual. DPR compared Kettleman City to other communities in the San Joaquin Valley and evaluated trends over time for the 19 pesticides of interest.

Methods for Compiling Weather Data

The meteorological station selected for modeling was operated by the Department of Water Resources, as part of the California Irrigation Management System (CIMIS). CIMIS consists of a network of weather stations in agricultural areas that records a variety of weather data. DPR used the data from station #15 Stratford. This station is roughly 12 miles northeast of Kettleman City. The elevation is 193 feet. The surrounding terrain is flat. This station was chosen because it reflected meteorology in the agricultural area of the San Joaquin Valley. Also, it provided needed elements for computer simulation modeling: wind speed, wind direction, temperature, standard deviation of horizontal wind direction, and amount of sunlight (net radiation). The

Kettleman CIMIS station (#21) is roughly 10 miles to the south southeast. Although it is closer to Kettleman City, it is located in the hills and may not reflect the meteorology in the agricultural areas because of local topographic influence. In addition, using weather data from a station closer to the sources of pesticides (fields to the north and upwind from Kettleman City) was preferred for modeling purposes. The Kettleman Hills Waste Facility records meteorological information. However, this information may not be reflective of the relatively flat agricultural areas in the San Joaquin Valley. DPR considered using data from other weather stations, such as the one at Lemoore, but the other stations were further from Kettleman City and the agricultural fields north of the city.

Modeling Results of Pesticides in Air

Because pesticide use in the Kettleman City area changed considerably between 2007 and 2010, air monitoring for pesticides in 2010 would provide little information about airborne concentrations of pesticides that may have reached the community in 2007 to 2009. Instead, DPR used air dispersion computer modeling and data from pesticide use reports to estimate air concentrations for the 19 pesticides of interest that were used within five miles of Kettleman City during 2007 to 2009. Modeled air concentrations represent the application(s) that resulted in the highest concentrations at the border of Kettleman City. Tier 1 modeling is the hypothetical worst-case air concentration. However, this was strictly used as a screening tool to determine if further evaluation was warranted. If the first tier modeled air concentrations exceeded health screening levels, a second tier of modeling was conducted. For each pesticide, Tier 1 modeling was conducted with the following key model inputs:

- Application size was the largest that occurred during September 2006 – December 2009 (relevant exposure time period for these occurrences of birth defects)
- 100 percent of the pesticide amount applied was released to the air in 24 hours (this is a hypothetical scenario – not a real occurrence)
- Kettleman City was 25 feet downwind from the application
- Reasonable worst-case weather conditions, including wind blowing directly toward Kettleman City at approximately 3 miles per hour

Appendix DPR-A shows that the Tier 1 modeling assumptions resulted in higher air concentrations than the maximum air concentration measured during monitoring studies, for all pesticides monitored, indicating that the Tier 1 computer modeling procedures likely overestimated air concentrations.

Of the 19 pesticides evaluated, four (carbaryl, chlorpyrifos, diazinon, and MITC) exceeded the lowest health screening level using Tier 1 modeling assumptions (Table DPR-4), indicating additional evaluation using Tier 2 modeling procedures was needed. The lowest or minimum screening level is the concentration that triggers further evaluation for any adverse health effect, not just birth defects.

Table 4. Summary of air dispersion computer modeling results. Air concentrations are the highest estimated 24-hour average concentration at the border of Kettleman City.

Pesticide and Modeling Method	**Max Air Concentration (ng/m^3)**	**Min Screening Level* (ng/m^3)**
2,4-D Tier 1 modeling	32,550	118,000
Abamectin Tier 1 modeling	880	1,900
Azoxystrobin Tier 1 modeling	11,910	1,180,000
Boscalid Tier 1 modeling	112,910	1,025,000
Bromoxynil Tier 1 modeling	16,330	18,800
Carbaryl Tier 1 modeling Carbaryl Tier 2 modeling	82,930 1,510	51,700 51,700
Chlorpyrifos Tier 1 modeling **Chlorpyrifos Tier 2 modeling**	81,420 **19,700**	334 **334**
Clethodim Tier 1 modeling	9,310	4,700,000
Diazinon Tier 1 modeling **Diazinon Tier 2 modeling**	65,340 **7,680**	376 **376**
Diflubenzuron Tier 1 modeling	10,410	1,230,000
Fenoxaprop-p-ethyl Tier 1 modeling	3,380	470,000
Flumioxazin Tier 1 modeling	16,730	141,000
Maneb Tier 1 modeling	59,200	94,000
MCPA Tier 1 modeling	106,280	188,000
MITC pesticides Tier 1 modeling **MITC pesticides Tier 2 modeling**	11,077,000 **176,500**	66,000 **66,000**
Myclobutanil Tier 1 modeling	7,010	470,000
Oxyfluorfen Tier 1 modeling	82,000	1,410,000
Propiconazole Tier 1 modeling	11,200	1,410,000
Pyraclostrobin Tier 1 modeling	8,090	235,000
Cumulative exposure to multiple pesticides Modeling for multiple applications on 4/17/08 Azoxystrobin (Tier 1) Chlorpyrifos (Tier 2) Combined	 12,120 19,700 	Hazard Quotient/Index 0.01 60.43 60.44

* Concentration that triggers further evaluation for any adverse health effect.

For the four pesticides that exceeded the lowest screening levels using Tier 1 modeling, Tier 2 modeling was conducted with the following key model inputs:

- Exact application sizes as recorded in pesticide use reports during September 2006 – December 2009
- Amount of pesticide released to the air was based on worst-case data
- Exact location of the applications as recorded in pesticide use reports
- Weather conditions as recorded by a local weather station

Using Tier 2 modeling for the days with the highest applications, at least one day exceeded the screening levels for three pesticides (chlorpyrifos, diazinon, and MITC;

Table 4). DPR staff then conducted a more-detailed modeling and health evaluation for these three pesticides by conducting additional Tier 2 modeling for all applications (not just the highest applications) of chlorpyrifos, diazinon, and MITC from September 2006 through December 2009. The greatest uncertainty in the modeled air concentrations was the estimate of the "flux." The flux is the amount of pesticide released to the air, either due to drift or volatilization following application, and expressed as the percentage of the amount of pesticides applied. For chlorpyrifos and diazinon, DPR estimated that the amount released to the air due to drift is 10-60 percent of the amount applied. DPR also estimated that the amount of chlorpyrifos and diazinon released to the air due to volatilization is 2 percent of the amount that reaches the target. Therefore, DPR estimated that the flux of chlorpyrifos and diazinon ranges from 12-61 percent of the amount applied. This flux range is reflected in the minimum and maximum air concentrations shown in Table 5. The flux for MITC was 77 percent of the amount applied, based on a single field study of the application method used (sprinkler application, with one post-application water treatment). The variability in the flux for this application method is unknown, so the minimum and maximum MITC air concentrations are the same. More details on the estimation of the flux for each pesticide are given in their specific sections in Appendix DPR-A.

DPR also conducted a more in-depth health evaluation. Most if not all chemicals have the potential to cause a variety of adverse health effects, with different health effects occurring at different exposure levels. DPR's evaluation included a consideration of the variety of possible health effects, and the air concentrations at which different health effects might occur. For chlorpyrifos, diazinon, and MITC, the air concentrations that might cause birth defects are higher than the other health effects, such as neurological effects. In addition, DPR considered a variety of uncertainty factors to account for the differences between test animals and humans (interspecies variability), variation within the human population (intraspecies variability), and possible increased sensitivity of children for certain health effects (Food Quality Protection Act, FQPA safety factor). For chlorpyrifos, the lowest screening level is based on the lack of effects at the highest dose of a rat subchronic inhalation study (see Appendix DPR-A for a detailed description of the screening levels), with the application of the conventional uncertainty factor of 100X (10X for interspecies variability, 10X for intraspecies variability) and the FQPA safety factor of 10X, for a total factor of 1,000X. The highest chlorpyrifos screening level is based on decreased pup survival and growth in a rat developmental neurotoxicity study with the application of conventional uncertainty factor of 100X. For diazinon, the lowest screening level is based on cholinesterase inhibition in a subchronic rat inhalation study with the application of the conventional uncertainty factor of 100X and uncertainty factor of 3X for extrapolating a NOEL from a LOEL, for a total factor of 300X. The highest diazinon screening level is based on maternal toxicity and minor fetal structural changes and variations in a rat developmental toxicity study with the application of the conventional uncertainty factor of 100X. For MITC, the highest screening level is based on decreased fetal body weight and decreased maternal body weight gain in a rabbit developmental toxicity study with the application of the conventional uncertainty factor of 100X. The lowest MITC screening level is based on eye irritation in a study of human volunteers and the application of an uncertainty factor of 10X (intraspecies variability). The lowest and highest screening levels for chlorpyrifos, diazinon, and MITC are shown in Table 5.

The in-depth evaluation summarized in Table 5 indicated that MITC air concentrations exceeded the screening level for developmental effects on one day, and exceeded the screening level for lung irritation on two days. Chlorpyrifos air concentrations did not exceed the screening level for developmental effects, but exceeded the screening level for cholinesterase inhibition on three to nine days. Similarly, diazinon air concentrations did not exceed the screening level for developmental effects, but exceeded the screening level for cholinesterase inhibition on three to six days.

Figures 3, 4, and 5 show the locations of the applications and pesticide air concentrations in the Kettleman City area on the days that the highest concentrations occurred for each pesticide. The data shows that the days with higher concentrations were due to several factors. 1) Relatively large amounts of pesticides were applied on a single day, in some cases due to multiple fields treated on the same day. 2) Wind direction was a greater factor than distance. In some cases, relatively high concentrations occurred in Kettleman City because it was directly downwind from a large application several miles away. 3) Wind speeds were low. Air concentrations are higher when wind speeds are lower. Higher air concentrations occurred when wind speeds were less than five miles per hour for much of the day.

Table 5. In-depth evaluation of chlorpyrifos, diazinon, and MITC air concentrations that may have exceeded the health screening levels. Air concentrations are the highest and lowest estimated 24-hour average concentrations at the border of Kettleman City using Tier 2 modeling procedures. The range of values for the air concentrations is based on the uncertainty in the percentage of the applied pesticides that is released to the air. The range of values for the screening levels is based on different adverse health effects, and uncertainties in the toxicological data.

Pesticide and Application Date	Estimated Air Concentrations (ng/m^3)		Health Screening Levels (ng/m^3)	
	Minimum	Maximum	Minimum[a]	Maximum[b]
Chlorpyrifos				
09/06/06	200	1,010	334	47,000
03/12/07	75	380		
05/04/07	160	800		
05/07/07	430	2,190		
04/17/08	3,820	19,400		
07/22/08	96	490		
08/15/08	83	420		
09/06/08	1,890	9,600		
10/28/08	240	1,200		
Diazinon				
03/05/07	1,510	7,680	376	940,000
03/28/07	380	1,920		
05/10/07	150	780		
04/05/08	400	2,050		
04/21/08	120	620		
05/14/09	160	830		
MITC[c]				
11/13/08	110,300	110,300	66,000	141,000
12/03/08	176,500	176,500		

[a] Screening level for most sensitive adverse health effect and highest uncertainty factors.
[b] Screening level for developmental effect and lowest uncertainty factors. See Appendix DPR-A for descriptions of the data used to determine the screening levels.
[c] The flux for MITC is based on a single field study, so the variability is unknown, and the minimum and maximum air concentrations are the same.

Figure 3. Highest estimated chlorpyrifos air concentrations using air dispersion computer modeling, April 17, 2008. The modeled area south of the aqua-colored line exceeds the lowest screening level of 334 ng/m^3.

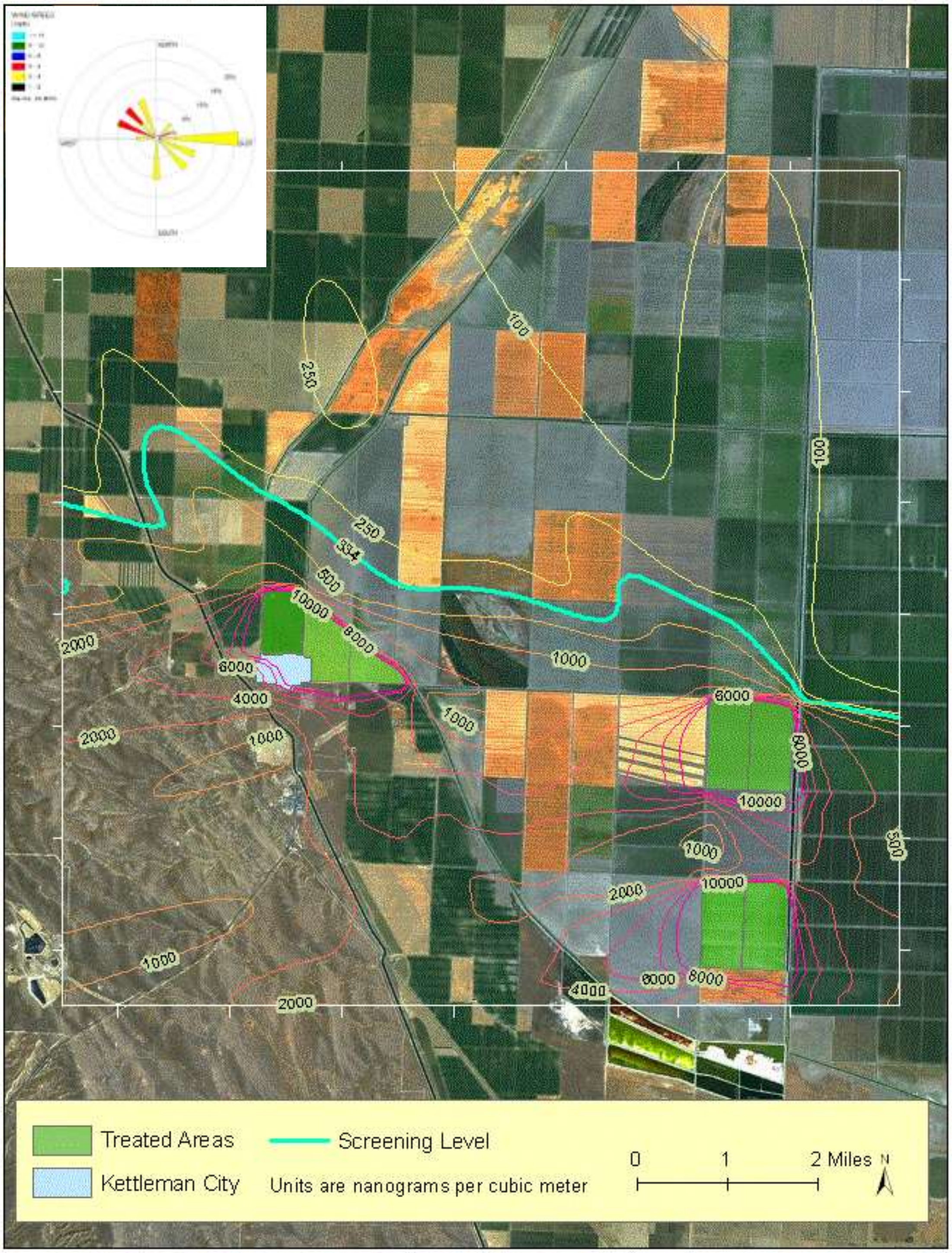


Figure 4. Highest estimated diazinon air concentrations using air dispersion computer modeling, March 5, 2007. The modeled area inside the aqua-colored lines exceeds the lowest screening level of 376 ng/m^3.

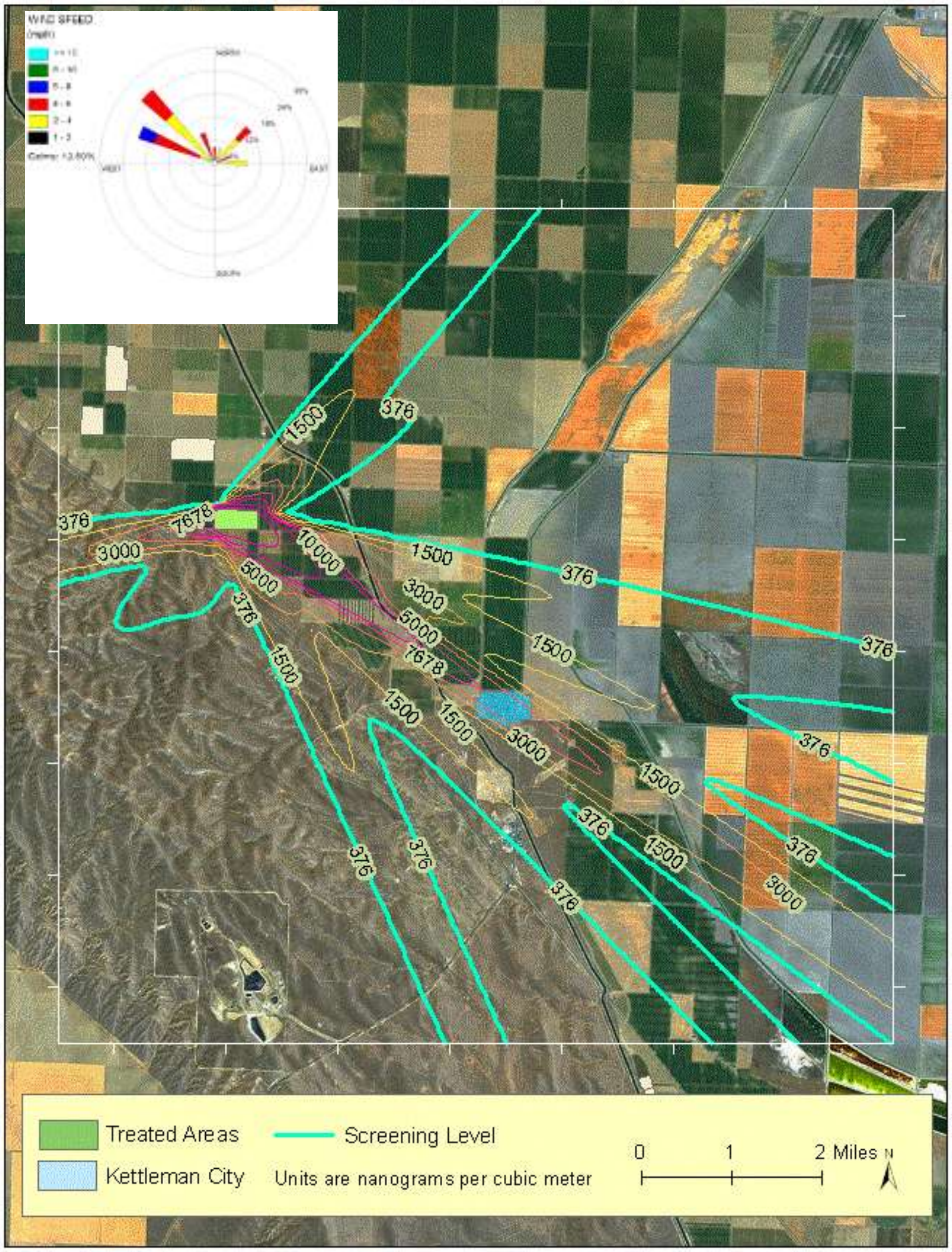
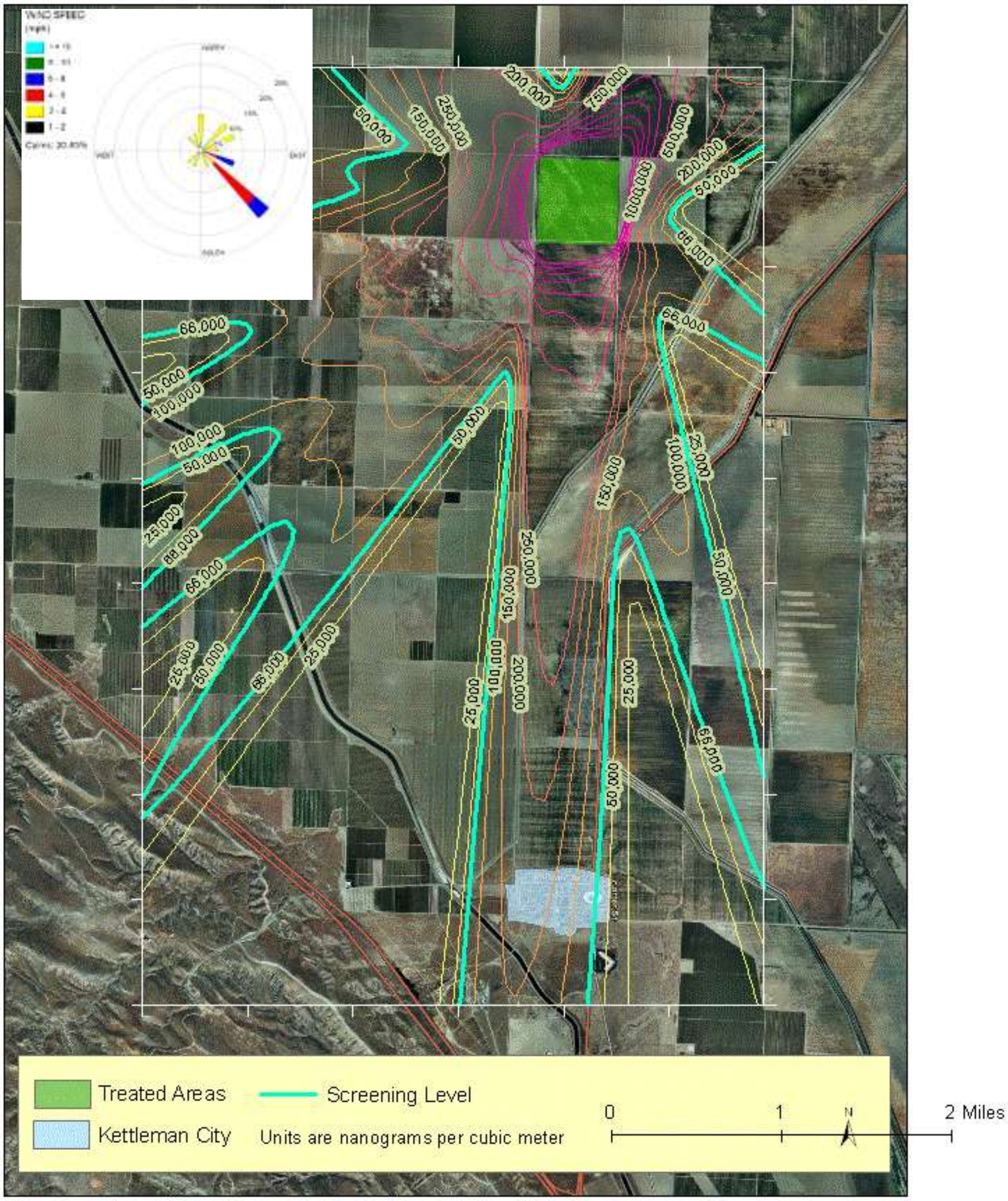


Figure 5. Highest estimated MITC air concentrations using air dispersion computer modeling, December 3, 2008. The modeled area inside the aqua-colored lines exceeds the lowest screening level of 66,000 ng/m^3.



DPR evaluated cumulative exposure to multiple pesticides by examining the five days with the highest air concentrations for chlorpyrifos, diazinon and MITC: 04/17/08 and 09/06/08 for chlorpyrifos, 03/05/07 for diazinon, and 11/14/08 and 12/03/08 for MITC. April 17, 2008, was the only day when another pesticide of interest was applied. A single application of azoxystrobin occurred on this day, along with several chlorpyrifos applications. Because azoxystrobin and chlorpyrifos have different toxic effects, it is not appropriate to evaluate their cumulative exposure. However, assuming they have the same toxic effect, combining the Tier 1 modeling results for azoxystrobin with the maximum Tier 2 modeling results for chlorpyrifos shows that the azoxystrobin would have negligible contribution to the combined toxic effect (Table 4).

Detailed descriptions of the inputs for the air dispersion computer modeling, results, and health evaluation are given in Appendix DPR-A.

Monitoring Results of Pesticides in Air

DPR conducted air monitoring at the Kettleman City Elementary School for 27 pesticides, four of which may possibly cause birth defects. DPR collected two 24-hour samples each week, for eight weeks, beginning on June 8, 2010 and ending on July 29, 2010. Sample analysis also included four oxygen analog breakdown products. ARB's monitoring included two additional pesticides: 1,3-dichloropropene and methyl bromide. DPR collected 16 sets of samples, as planned. All samples were valid (23.2-24.2 hours in duration, starting and ending air flow rates within seven percent), and quality control results were within the expected values (Appendix DPR-B).

Table 6 shows that DPR detected four pesticides (chlorpyrifos, endosulfan, MITC, trifluralin) and one breakdown product (chlorpyrifos oxygen analog). Additionally, ARB detected methyl bromide (bromomethane) in its monitoring. Four pesticides were detected at quantifiable concentrations (chlorpyrifos oxygen analog, endosulfan, methyl bromide, MITC); the other two were detected at trace levels. None of the detected concentrations exceeded the lowest screening levels. All concentrations were less than those detected in other monitoring studies. Chlorpyrifos oxygen analog had the highest risk with a measured concentration of 15 nanograms per cubic meter (ng/m^3), five percent or 1/20th of the 325 ng/m^3 minimum screening level.

Table 6. Highest 24-hour pesticide air concentrations detected in Kettleman City during monitoring in June-July 2010, and comparison to historical monitoring and the lowest screening levels. Samples were analyzed for 27 pesticides, 4 of which possibly cause birth defects. Sample analysis also included four oxygen analog breakdown products. ARB's monitoring included two additional pesticides.

Pesticide	Max Concentration (ng/m^3)	Detection Limit (ng/m^3)	Max Concentration in Other Studies (ng/m^3)	Min Screening Level (ng/m^3)
1,3-dichloropropene (ARB)	None Detected	450.0	135,000	160,000
Azinphos-methyl	None Detected	7.6	None Detected	101,000
Chlorothalonil	None Detected	13.7	14	34,000
Chlorpyrifos (possible birth defects)	Trace (<23.1)	5.1	1,340	326
Chlorpyrifos oxygen analog	15	2.9	230	326
Cypermethrin	None Detected	4.7	None Detected	40,000
Diazinon (possible birth defects)	None Detected	1.2	290	376
Diazinon oxygen analog	None Detected	2.1	71	376
Dichlorvos	None Detected	3.2	65	11,000
Dicofol	None Detected	2.1	None Detected	68,000
Dimethoate	None Detected	2.3	None Detected	34,000
Dimethoate oxygen analog	None Detected	1.9	None Detected	34,000
Diuron	None Detected	5.1	None Detected	170,000
Endosulfan	27	3.2	166	4,000
EPTC	None Detected	1.7	240	230,000
Malathion	None Detected	2.2	90	40,000
Malathion oxygen analog	None Detected	1.3	28	40,000
Methyl bromide (ARB)	160	130.0	142,000	820,000
Metolachlor	None Detected	2.7	None Detected	85,000
MITC (possible birth defects)	387	5.6	18,000	66,000
Molinate	None Detected	1.8	1.2	200,000
Naled (dichlorvos)	None Detected	3.2	None Detected	920
Norflurazon	None Detected	3.8	None Detected	170,000
Oryzalin	None Detected	1.4	None Detected	420,000
Oxyfluorfen (possible birth defects)	None Detected	6.4	None Detected	1,410,000
Permethrin	None Detected	7.2	Trace	168,000
Phosmet	None Detected	7.8	None Detected	77,000
Propanil	None Detected	2.3	149	51,000
Propargite	None Detected	3.8	1,300	14,000
Simazine	None Detected	1.2	18	110,000
SSS-tributylphosphorotrithioate	None Detected	1.8	330	8,800
Thiobencarb	None Detected	5.6	None Detected	425,000
Trifluralin	Trace (1.7-23)	1.7	Trace	1,200,000

Table 7 shows the frequency of detection and pesticide use during June-July. Chlorpyrifos oxygen analog and endosulfan were detected most frequently, both in 44 percent of the samples. Use of two of the pesticides of interest (chlorpyrifos and MITC pesticides) was higher during the 2010 monitoring than in 2007-2009, but June-July was not the peak use period (Table DPR-8). The other two pesticides of interest (diazinon and oxyfluorfen) had similar use levels in 2010 and 2007-2009, but June-July was also not the peak use season.

DPR normally conducts air monitoring during the peak use season for each pesticide, but due to the time constraints air samples were only collected during June-July 2010. As shown in Tables 7 and 8, it's likely that the air monitoring captured the peak use only for chlorothalonil, endosulfan and permethrin. Of these three pesticides, only endosulfan was detected.

Table 7. Percent of samples with detectable concentrations and reported use within five miles of Kettleman City.

Pesticide	Number of Samples Collected	Percent of Samples With Detections	Jun-Jul 2010 Use (pounds)	Jun-Jul 2007-9 Use (avg pounds)
1,3-dichloropropene (ARB)	20	0	0	0
Azinphos-methyl	16	0	0	0
Chlorothalonil	16	0	2,352	1,936
Chlorpyrifos Chlorpyrifos OA	16 16	19 44	1,729	166
Cypermethrin	16	0	15	0
Diazinon Diazinon OA	16 16	0 0	0	6
Dichlorvos	16	0	0	0
Dicofol	16	0	0	
Dimethoate Dimethoate OA	16 16	0 0	206	147
Diuron	16	0	0	0
Endosulfan	16	44	209	56
EPTC	16	0	0	0
Malathion Malathion OA	16 16	0 0	0	0 0
Methyl bromide (ARB)	20	10	0	0
Metolachlor	16	0	0	0
MITC	16	5	15,663	0
Molinate	16	0	0	0
Naled (dichlorvos)	16	0	0	0
Norflurazon	16	0	0	0
Oryzalin	16	0	0	0
Oxyfluorfen	16	0	20	39
Permethrin	16	0	81	114
Phosmet	16	0	0	1,127
Propanil	16	0	0	0
Propargite	16	0	0	204
Simazine	16	0	0	0
SSS-tributylphosphorotrithioate	16	0	0	0
Thiobencarb	16	0	0	0
Trifluralin	16	38	0	279

Table DPR-8. Reported use of the pesticides included in the air monitoring by month during 2007-2009. Highest month for each pesticide is shown in bold.

	Reported Use During 2007-2009 (pounds)												
Pesticide	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1,3-dichloropropene	**17,736**	8,555	0	0	0	0	0	11,814	5,513	3,436	0	0	47,055
Azinphos-methyl	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorothalonil	0	0	338	1,230	1,555	1,799	**4,008**	3,066	290	0	0	0	12,286
Chlorpyrifos	30	97	**2,084**	796	1,479	6	491	511	889	224	0	28	6,635
Cypermethrin	0	0	15	0	**17**	0	0	0	0	0	0	0	32
Diazinon	**160**	0	11	6	26	19	0	0	0	0	0	0	222
Dicofol	0	0	0	0	0	0	0	0	0	0	0	0	0
Dimethoate	0	64	0	**1,419**	901	260	180	0	0	0	0	0	2,824
Diuron	**238**	0	0	0	0	0	0	0	81	82	0	236	637
Endosulfan		20	20	0	0	0	**167**	132	0	0	0	0	339
EPTC	0	0	0	0	0	0	0		0	0	0	0	0
Malathion	0	0	0	0	0	0	0	0	0	0	0	0	0
Methyl bromide	0	0	0	0	0	0	0	0	0	0	0	0	0
Metolachlor	0	0	0	0	0	0	0	0	0	0	0	0	0
MITC Pesticides	12,887	165,726	39,823	0	1,375	0	0	42,599	20,945	133,211	**255,532**	101,991	774,088
Molinate	0	0	0	0	0	0	0	0	0	0	0	0	0
Naled (dichlorvos)	0	0	0	0	0	0	0	0	0	0	0	0	0
Norflurazon	0	0	0	**6,010**	821	0	0	0	0	0	0	0	6,832
Oryzalin	0	**525**	0	0	0	0	0	0	0	0	0	0	525
Oxyfluorfen	**1,979**	612	145	23	129	87	31	0	224	39	646	1,048	4,964
Permethrin		4	6	6	228	**238**	104	73	0	39	0	0	698
Phosmet	0	0	0	0	0	**3,381**		0	0	0	0	0	3,381
Propanil	0	0	0	0	0	0	0	0	0	0	0	0	
Propargite	0	0	0	0	0	157	**455**	0	0	0	0	0	612
Simazine	0	0	0	0	0	0	0	0	0	0	0	0	122
SSS-tributylphosphorotrithioate	0	0	0	0	0	0	0	0	0	0	0	0	0
Thiobencarb	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifluralin	0	142	**1,428**	876	1,173	694	144	0	0	0	0	401	4,857
Total	33,031	175,868	43,869	10,366	7,703	6,642	5,580	58,196	27,942	137,031	256,177	103,705	866,110

Some pesticide detections were consistent with the reported use within five miles of Kettleman City, such as endosulfan (Figure 6b). Other pesticide detections were inconsistent with the reported use, such as MITC (Figure 6c). Additionally, methyl bromide and trifluralin were detected in several samples, but there were no reported applications within five miles of Kettleman City during the monitoring period. The methyl bromide results are similar to previous monitoring in Parlier where this pesticide was also detected, but there were no reported applications within five miles. Since pesticide detections did not always coincide with reported applications, and since so few detections were quantifiable, comparison of the measured concentrations to predicted concentrations by computer modeling was not feasible.

Several factors could account for the instances of inconsistency between reported pesticide applications and detected concentrations. 1) Applications made further than five miles from Kettleman City may have influenced the concentrations detected. 2) Volatilization of pesticides may have occurred several days after application. 3) Some pesticide applications may not have been reported, or reported inaccurately. All agricultural pesticide applications must be reported, but the compliance with this requirement is unknown. DPR receives some reports of non-agricultural applications, but most non-agricultural applications are not required to be reported. Reporting errors, particularly in the date or location of application could have occurred.

Figure DPR-6a. Measured air concentrations of chlorpyrifos and/or its oxygen analog in Kettleman City and use of chlorpyrifos within five miles.

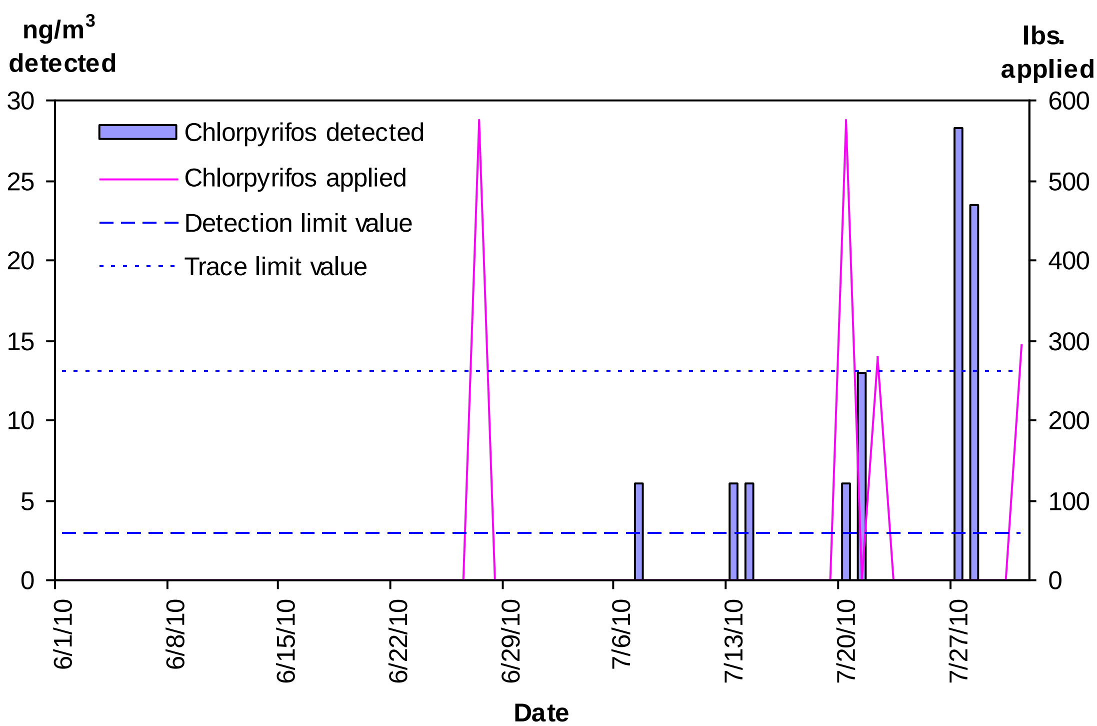


Figure DPR-6b. Measured air concentrations of endosulfan in Kettleman City and use within five miles.

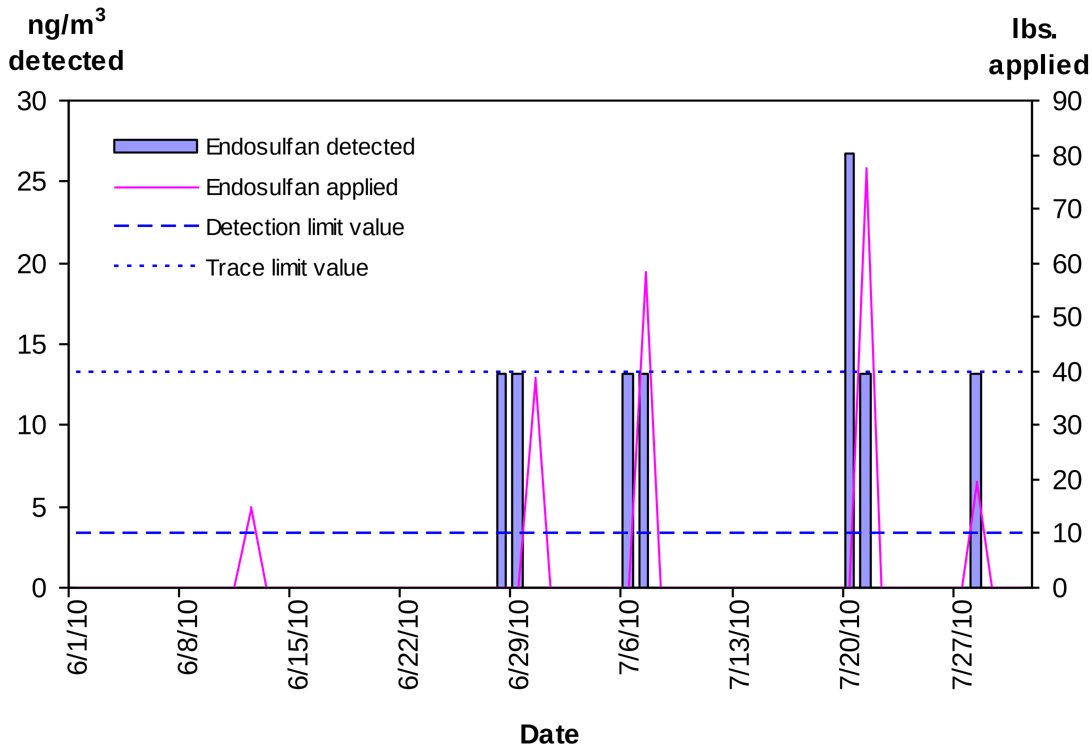
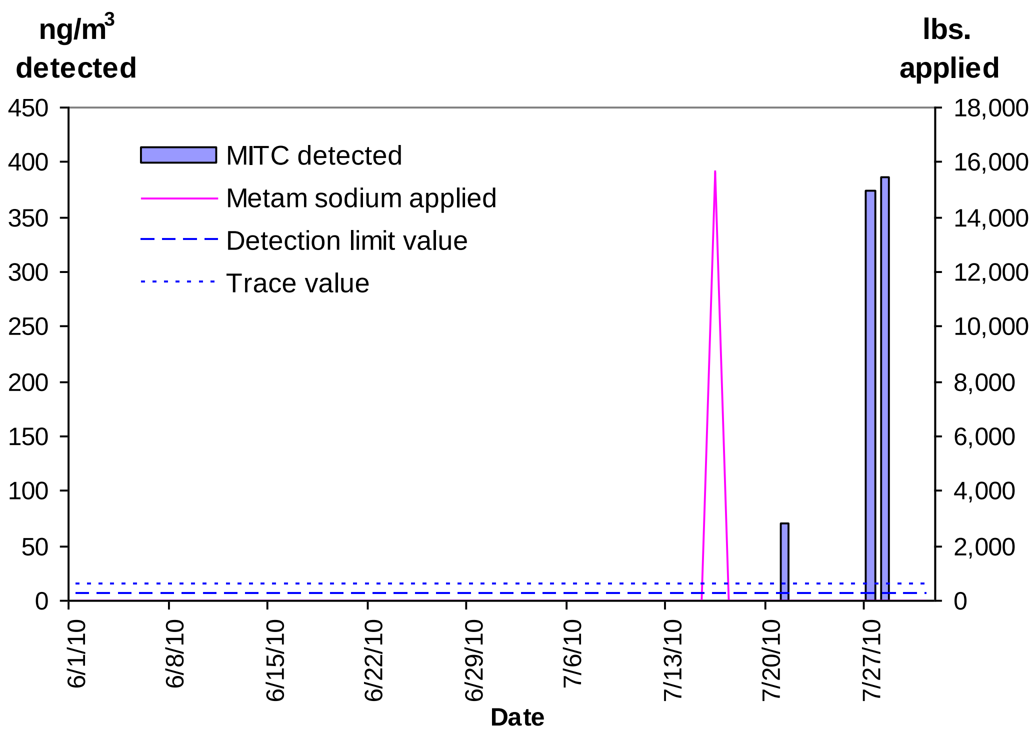
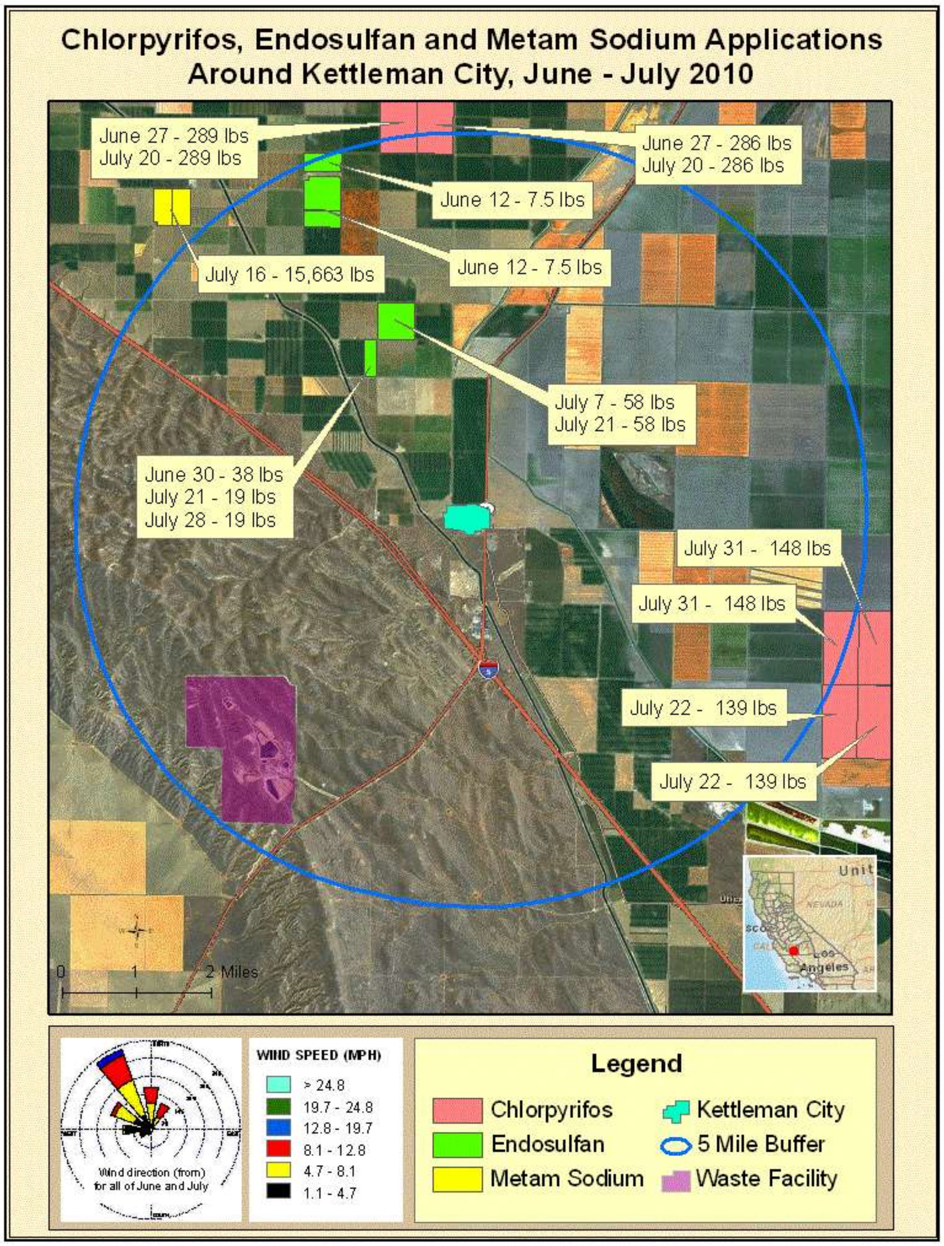


Figure DPR-6c. Measured air concentrations of MITC in Kettleman City and use within five miles. The only MITC pesticide applied during this period was metam-sodium.



Pesticide air concentrations in Kettleman City depend primarily on location of the application(s), amount applied, and weather conditions. Figure 7 shows that the closest applications were more than two miles from Kettleman City during June-July 2010. Individual applications ranged in size from 7 to more than 15,000 pounds. The windrose in Figure 7 indicates that the wind was generally from the north-northwest at 5 to 13 miles per hour. Several applications were downwind from the town.

Figure 7. Locations of chlorpyrifos, endosulfan, and MITC applications and weather conditions during the June-July 2010 monitoring period.



Information from Pesticide Use Reports

DPR compiled pesticide use information for the 19 pesticides of interest, focusing on 2007-2009, the relevant exposure time period identified by CDPH for these occurrences of birth defects. DPR compiled information for pesticide applications within five miles of Kettleman City, as well as within five miles of the other 160 communities within the San Joaquin Valley for 2007-2008. *(NOTE: Statewide use information was only available through 2008.)*

Table 9 shows that the MITC pesticides account for more than 95 percent of the pounds applied in the Kettleman City area, but less than 10 percent of the acreage treated and number of applications. This is consistent with other areas that have crops treated with MITC pesticides or other fumigants, and is due to the higher application rates for fumigants, compared to other pesticides.

Table 9. Reported total pounds applied, acres treated, and number of applications for the 19 pesticides of interest within five miles of Kettleman City during 2007-2009.

Pesticide	2007-2009 Pounds	2007-2009 Acres	2007-2009 Applications
2,4-D	635	952	22
Abamectin	109	9,586	81
Azoxystrobin	779	4,553	27
Boscalid	869	4,507	47
Bromoxynil	1,156	1,842	14
Carbaryl	4,903	6,505	47
Chlorpyrifos	6,635	9,531	53
Clethodim	1,214	9,760	45
Diazinon	222	151	11
Diflubenzuron	559	3,720	66
Fenoxaprop-p-ethyl	110	1,326	5
Flumioxazin	409	4,455	50
Maneb	1,544	3,282	26
MCPA	4,459	12,688	58
MITC pesticides	774,088	9,217	71
Myclobutanil	735	5,305	36
Oxyfluorfen	4,964	10,017	145
Propiconazole	587	6,644	141
Pyraclostrobin	1,230	9,132	72
Total	805,208	113,172	1,031

Table 10 shows the crops that used most of the 19 pesticides of interest in the Kettleman City area during 2007-2009. Additional record checks by the Kings County Agricultural Commissioner's office indicated that the reported "soil application, preplant-outdoor" sites were MITC pesticide applications eventually planted with tomatoes or onions. MITC pesticides account for most of use for tomatoes, onions, and carrots. Other crops primarily use non-MITC pesticides.

Table 10. Reported total pounds applied, acres treated, and number of applications for the 19 pesticides of interest within five miles of Kettleman City during 2007-2009, by crop/site.

Crop/Site	**2007-2009 Pounds**	**2007-2009 Acres**	**2007-2009 Applications**
Soil application, preplant-outdoor	271,490	958	11
Tomatoes, for processing/canning	257,218	24,042	140
Onion	165,358	8,937	67
Tomato	46,353	1,360	12
Carrots, general	37,668	923	10
Alfalfa	4,793	13,337	54
Almond	4,504	14,334	129
Wheat, general	4,448	14,087	61
Peppers	3,074	204	2
Watermelons	1,460	652	24
Pistachio	1,247	1,302	27
Peach	1,197	5,287	93
Cotton, general	1,046	10,126	68
Apricot	955	3,639	74
Barley, general	859	2,464	21
Garlic	784	3,870	22
Plum	653	2,608	77
Nectarine	647	2,480	73
Asparagus	264	431	8
Uncultivated agricultural areas	257	483	6
All other crops	932	3,490	52
Total	805,208	115,014	1,031

Table 11 shows use of the 19 pesticides of interest for a three year period prior to the birth defects being investigated by CDPH (2003-2005) and use during the three years CDPH is investigating as the relevant exposure time period for birth defects in this investigation (2007-2009). Because only a portion of the year 2006 may have been relevant as an exposure period, it was excluded from the analysis. The majority of the pesticides (13 of 19) had greater use during 2007-2009 compared to 2003-2005, although chlorpyrifos and diazinon decreased in use. Use of MITC pesticides increased approximately 6x between 2003-2005 and 2007-2009 due to greater use on fields prior to planting onions and tomatoes.

Table 11. Reported total use of the 19 pesticides of interest within five miles of Kettleman City during during 2003-2005 and 2007-2009.

Pesticide	2003-2005 (pounds)	2007-2009 (pounds)	Percent Change
2,4-D	548	635	16
Abamectin	56	109	95
Azoxystrobin	1,089	779	-28
Boscalid	128	869	579
Bromoxynil	1,352	1,156	-14
Carbaryl	1,804	4,903	172
Chlorpyrifos	11,251	6,635	-41
Clethodim	325	1,214	274
Diazinon	3,002	222	-93
Diflubenzuron	0	559	
Fenoxaprop-p-ethyl	236	110	-53
Flumioxazin	0	409	
Maneb	1,270	1,544	22
MCPA	9,246	4,459	-52
MITC pesticides	124,766	774,088	520
Myclobutanil	43	735	1,609
Oxyfluorfen	3,570	4,964	39
Propiconazole	379	587	55
Pyraclostrobin	358	1,230	244
Total	159,423	805,208	405

Table 12 compares the largest single applications in the Kettleman City area to the largest applications statewide for the 19 pesticides of interest during 2007-2008. Table 12 also shows the rank of the Kettleman City area among the 161 communities in the San Joaquin Valley for total use of each pesticide of interest during 2007-2008, with rank 1 assigned to the community with highest use and rank 161 assigned to the community with lowest use. (Statewide data is not yet available for 2009, so that year could not be included.) In general, Kettleman City has lower pesticide use compared to the other San Joaquin Valley communities. The largest individual applications in the Kettleman City area for 12 of the 19 pesticides of interest used one-half or less than the largest individual applications statewide. Among the 161 San Joaquin Valley communities, Kettleman City ranked among the top quarter of the communities for 7 of the 19 pesticides of interest. For chlorpyrifos, diazinon, and MITC (the three pesticides with higher risk as discussed below), Kettleman City ranked 120, 101, and 8 of the 161 communities, respectively.

Table 12. Comparison of the applications in the Kettleman City area to applications near other communities for the 19 pesticides of interest during 2007-2008. Statewide data for 2009 is not yet available. *Max Application* is the greatest amount of pesticide applied for any single application, comparing the largest application within five miles of Kettleman City to the largest application statewide. *KC Use Rank* is the rank of Kettleman City among the 161 communities in the San Joaquin Valley, of use within five miles of the communities for the 19 pesticides of interest.

Pesticide	**2007-8 KC Max Application (pounds)**	**2007-8 Statewide Max Application (pounds)**	**2007-8 KC Use Rank Among 161 SJV Communities**
2,4-D	73	1,097	80
Abamectin	6	13	81
Azoxystrobin	78	172	36
Boscalid	44	183	103
Bromoxynil	113	139	21
Carbaryl	320	1,592	30
Chlorpyrifos	652	1,306	120
Clethodim	36	90	15
Diazinon	160	1,778	101
Diflubenzuron	71	534	59
Fenoxaprop-p-ethyl	25	50	15
Flumioxazin	38	239	104
Maneb	203	3,177	91
MCPA	181	625	39
MITC pesticides	22,308	51,849	8
Myclobutanil	63	126	60
Oxyfluorfen	260	1,313	103
Propiconazole	95	144	48
Pyraclostrobin	62	88	65

More detailed information on use of the individual pesticides is given in Appendix DPR-A.

Risk Evaluation of Inhalation Exposure to Pesticides

DPR evaluated the risk of pesticides by comparing the modeled and measured air concentrations to health screening levels. The screening levels are based on the available toxicology data. The screening levels are designed to point out potential concerns for health effects. Although they are not regulatory standards, these screening levels are useful for preliminary evaluations of air monitoring data. Detections below the screening level for a given pesticide would not be considered to represent a significant health concern and generally would not undergo further evaluation. Detections above the screening level would not necessarily signal a significant health concern but would point out the need for a more refined evaluation.

DPR's air monitoring and evaluation of pesticide air concentrations using computer modeling indicated most levels of pesticides in Kettleman City during the September 2006 – December 2009 period, as well as in 2010, were below levels of health concern. Pesticide air concentrations estimated by modeling on one day – December 3, 2008 – exceeded the screening level for birth defects during the 40-month period evaluated, indicating a low probability of developmental effects from pesticides. The day with the highest estimated cumulative risk from multiple pesticides was negligibly higher than for a single pesticide. Additionally, other communities in the San Joaquin Valley have higher use and likely higher risk for the 19 pesticides that were evaluated. Kettleman City ranks among the top quarter of the San Joaquin Valley communities for 7 of the 19 evaluated for pesticide use.

The risk in Kettleman City for other heath effects, such as lung irritation and cholinesterase inhibition, is uncertain. However, the computer modeling indicated that the screening levels for other acute toxic effects were likely exceeded on three to nine days for chlorpyrifos, on three to six days for diazinon, and two days for MITC. The uncertainty in the risk is due to the uncertainty in the amount of pesticides emitted to the air.

While the risk of other toxic effects is uncertain, the risk in Kettleman City is expected to be lower than other communities. All of the detected air concentrations in Kettleman City were lower than previously measured in other communities, although the Kettleman City monitoring captured the peak use for only a few pesticides. Other communities have higher use for most if not all of the 27 pesticides monitored. DPR did not estimate long-term pesticide air concentrations or chronic risk for Kettleman City because it was beyond the scope of this assessment. In addition, the methods to model long-term pesticide exposure are uncertain and the high number of samples with no detectable amount makes the estimates using monitoring data uncertain.

Findings and Conclusions for Pesticides Used in Agricultural Operations

The risk of developmental effects from pesticides is very low, both during the September 2006 – December 2009 period, and currently. Computer modeling and monitoring to evaluate 19 pesticides showed only a single day when the estimated air concentration of one pesticide, MITC, exceeded the screening level for birth defects. Pesticide exposures from other pathways, such as groundwater are likely lower than air. For all 19 pesticides of interest, use was higher in three years prior to the relevant exposure time period of September 2006 – December 2009 in Kettleman City. Similarly, use was higher in other communities compared to Kettleman City during this time. The three pesticides with higher risk of developmental effects (chlorpyrifos, diazinon, MITC) have been among the top pesticides used in California for several decades. If chlorpyrifos, diazinon, or MITC caused developmental effects, occurrence of birth defects would likely be higher in other communities, and would have occurred prior to 2006.

The risk of other toxic effects from pesticides is uncertain, but likely lower than other communities. Air concentrations estimated using computer modeling exceeded the lowest acute screening levels for chlorpyrifos, diazinon, and MITC on several days. However, air monitoring in Kettleman City detected chlorpyrifos, endosulfan, methyl bromide, MITC, and trifluralin at concentrations below the lowest acute screening levels. Historical air monitoring in other communities has shown higher concentrations than detected in Kettleman City. This is consistent with the higher use of most pesticides near other communities. Moreover, the Kettleman City area does not have any unusual crops, and the use of pesticides is typical for the crops grown. DPR has conducted evaluations of risk from multiple pesticides for two other communities previously: Lompoc in Santa Barbara County and Parlier in Fresno County. Monitoring in these communities also showed few or no instances of pesticide air concentrations exceeding screening levels, but that chlorpyrifos, diazinon, and MITC had higher risk than most other pesticides. Information about the Lompoc and Parlier projects is available at:
http://www.cdpr.ca.gov/docs/specproj/lompoc/lompoc.htm
http://www.cdpr.ca.gov/docs/envjust/pilot_proj/index.htm

DPR is addressing the higher risk of chlorpyrifos, diazinon, and MITC. In addition to the monitoring in Lompoc and Parlier, air monitoring for these three pesticides in the high use areas of California and/or at application sites indicated concentrations of possible concern. Moreover, misapplications or unusual applications of MITC pesticides have caused several neighborhood evacuations. This information led DPR to start comprehensive risk assessments for all three pesticides. DPR's comprehensive risk assessments include the evaluation of all exposures, including acute and chronic exposure, possible birth defects, and cancer risk. These risk assessments are in progress for chlorpyrifos and diazinon. The risk assessment for MITC is complete and it prompted DPR to develop measures to reduce exposures. DPR will implement the MITC exposure mitigation measures beginning in 2011 that include application method restrictions and buffer zones. In addition, U.S. EPA is phasing in mitigation measures nationwide for MITC pesticides beginning in December 2010. Information on previous monitoring for pesticides is available at:
http://www.cdpr.ca.gov/docs/emon/pubs/tac/tacstdys.htm. Information on DPR's measures to reduce MITC exposure is available at:
http://www.cdpr.ca.gov/docs/emon/methbrom/fum_regs.htm. Information on U.S. EPA's measures to reduce MITC exposure is available at:
http://www.epa.gov/oppsrrd1/reregistration/soil_fumigants/.

Additional monitoring or data evaluation would reduce the uncertainties, but the conclusions about the risks from pesticides would likely remain unchanged. The greatest uncertainty for the Kettleman City assessment is the estimate of the drift and volatilization of certain pesticides. Additional monitoring of specific applications would provide a more accurate estimate, but it would be within the range evaluated by DPR for Kettleman City. There are also uncertainties in the exposure from other pathways, such as household dust. Not including the exposure from these other pathways may underestimate the risks. However, the exposure from the other pathways would need to be greater than the air exposure, and the combined exposure would need to be more than double DPR's current worst-case estimates to change the conclusions about the risks. Pesticide exposure this high from other pathways is very unlikely. Moreover, it's likely that these other exposures are related to use, with higher exposures associated with higher use of pesticides. Since other communities have higher pesticide use, it is likely other communities have higher pesticide exposure from dust or other pathways. The interviews by CDPH did not reveal any unusual pesticide exposures from work or home activities. There are no apparent sources of unusual pesticide applications in or near Kettleman City. The nearest food processing plants are several miles from Kettleman City, and they use minimal amounts of pesticides.

DPR's current programs for assessing and mitigating pesticide air exposures are adequate. Based on State law, DPR has programs to address air and all other human exposures to pesticides. Using the existing data from these programs, DPR would have reached the same conclusions without air monitoring in Kettleman City. Existing monitoring programs provide the data needed to evaluate and mitigate worst-case pesticide air exposures for all communities, including Kettleman City. ARB conducts air monitoring for individual pesticides in regions and periods of highest use. Beginning in 2011, DPR will conduct year-round air monitoring in three high-use communities for at least 27 pesticides simultaneously, including chlorpyrifos, diazinon, and MITC. This air monitoring network will provide data on long-term air concentrations of pesticides, and should indicate the worst-case cumulative exposures that may occur in a community, including Kettleman City. DPR's programs also address pesticides in food and water, as well as occupational exposures, including exposures to agricultural workers.

CDPH's interviews identified odors from pesticide applications as an issue of concern. Odors are related, but a different issue from the potential toxic exposures that were the focus of this assessment. DPR's risk assessments and mitigation are meant to ensure that adverse health effects do not occur; but odors may still be present. However, DPR's efforts to reduce toxic exposures and volatile organic compound (VOC) emissions from pesticides should also reduce odors. Two pesticides that cause odor complaints and have relatively high use in the Kettleman City area are MITC and chlorpyrifos. As described above, DPR is implementing measures to reduce emissions and exposure to MITC. The odor from chlorpyrifos applications is primarily due to the VOC "inert ingredients" rather than the "active ingredient" in the pesticide products. Besides causing odors, VOCs also contribute to smog in the San Joaquin Valley. A new chlorpyrifos product has less VOCs and less odor than other products. DPR is considering requiring pesticide manufacturers to reformulate other chlorpyrifos products as part of its program to reduce VOC emissions from pesticides and improve air quality.

Under guidance from DPR, county agricultural commissioners are the local agents for enforcing pesticide laws and regulations. County agricultural commissioners investigate all complaints of pesticides, including incidents of pesticide odors, drift, and illnesses. DPR has published a "Community Guide to Recognizing & Reporting Pesticide Problems" to assist the public when a pesticide problem is suspected. English and Spanish versions of DPR's community guide are available at http://www.cdpr.ca.gov/docs/dept/comguide/index.htm