Californians for Pesticide Reform (Sarah Aird)

What is your submittal about?

Please select one:
Pesticide group

Provide the name of the pesticide and, if possible, its Chemical Abstracts Service (CAS) Registry Number.

You may use DPR's CalPEST Public Search to look up the CAS Registry Number.
Acephate 30560-19-1
Bensulide 741-58-2
Chlorpyrifos 2921-88-2
Coumaphos 56-72-4
Dichlorvos (DDVP) 62-73-7
Diazinon 333-41-5
Dimethoate 60-51-5
Ethoprop (Ethoprophos) 13194-48-4
Malathion 121-75-5
Naled 300-76-5
Phorate 298-02-2
Phosmet 732-11-6
Tetrachlorvinphos 22248-79-9

(Short Format) In one to three sentences, please describe your pesticide-related concern.

The description provided will appear in the online summary.
Organophosphate (OP) pesticides are neurotoxic by design, and decades of research link exposure—particularly during pregnancy and early childhood—to adverse neurodevelopmental outcomes, including lower IQ, impaired memory and attention, and behavioral effects. Some of the strongest evidence comes from California's CHAMACOS birth cohort in the Salinas Valley, which measured pesticide exposure during pregnancy and has assessed children's health and development over more than two decades. Organophosphates can also cause acute poisoning, while certain compounds have been associated with Parkinson's disease, reproductive toxicity, and cancer. In California, 13 OP active ingredients still had reported use in 2023, and roughly 94% of total OP pounds came from just five—bensulide, malathion, naled, acephate, and dimethoate. Because OPs share a common neurotoxic mechanism—acetylcholinesterase inhibition—and cumulative exposure to multiple OPs can contribute to the same biological effect, there is a strong scientific rationale for addressing them as a class rather than continuing to regulate them one chemical at a time.

(Long Format) Please describe your pesticide-related concern and why it should be a DPR priority.

What type of information should you include?

- **Who or what is affected** (e.g. worker, community, residential, consumer health, sensitive populations, environmental endpoint, pesticide use, or other human health or environmental concern)
- **Description of the situation of concern**, including use site (e.g., crop or residential), region, type of pesticide use and application method (e.g., ground spraying; soil fumigation; bait applications; etc.)

Organophosphate pesticides affect agricultural workers, nearby communities, consumers, and sensitive populations, particularly pregnant people, fetuses, infants, and children. [1][2][3][4][5][6][7] Workers may be exposed during mixing, loading, application, field reentry, and harvest activities, while nearby residents can be exposed through drift and volatilization.[15] There is long-standing evidence that OPs accumulate in indoor environments, prolonging exposures from drift. Dietary exposure is also relevant because OP residues can occur on treated foods. For instance, children who consumed organic diets—particularly organic fruits, vegetables, and juice—consistently had substantially lower or nondetectable organophosphorus pesticide metabolites in urine samples than when they ate conventional foods.[1][2][3] The principal human-health endpoint of concern is neurotoxicity, especially developmental neurotoxicity.[11][12][13][14]
In California, 13 organophosphate active ingredients still had reported use in 2023. Use occurs across agricultural crops including lettuce, broccoli, tomatoes, cotton, strawberries, alfalfa, citrus, nuts, onions, and other fruits and vegetables, as well as in public-health mosquito control and some structural or non-crop settings. Roughly 94% of reported OP pounds came from just five active ingredients—bensulide, malathion, naled, acephate, and dimethoate. Applications include ground spraying, aerial application, chemigation, soil treatment, and other conventional agricultural methods, depending on the active ingredient and crop.
The scientific concern is supported by decades of toxicological and epidemiological research, including documented effects in California agricultural communities.[15][16] Organophosphates share a common mechanism of toxicity—acetylcholinesterase inhibition—which is the basis for EPA's cumulative risk assessment of the class. In California's CHAMACOS birth cohort in the Salinas Valley, higher prenatal OP exposure was associated with lower IQ, poorer working memory and processing speed, and greater attention problems in children; children in the highest prenatal exposure group averaged about seven IQ points lower at age seven than those in the lowest group.[4][5][6][7] Independent birth cohorts at Columbia University and Mount Sinai reported similar associations with cognitive and neurobehavioral outcomes, and Columbia researchers also identified structural differences in children's brains associated with prenatal chlorpyrifos exposure.[8][9][10] OPs can also cause acute poisoning, and certain compounds have been associated with Parkinson's disease,[17][18] reproductive toxicity, and cancer.

There is growing evidence that some people may be genetically more sensitive to the effects of OPs, due to variations in the PON1 gene.[18] Current pesticide-protection systems generally do not account for individual genetic differences in PON1-mediated susceptibility to OP insecticides. Neurological effects may be subtle and/or delayed, making identifying and quantifying such vulnerabilities impractical, if not impossible.[17][18][19]

Because multiple OPs can contribute to the same neurotoxic endpoints, the shared mechanism and cumulative exposure potential provide a strong scientific basis for evaluating and regulating organophosphates as a class rather than solely one active ingredient at a time. With respect to perinatal exposures and exposures of young children, the risk assessment that caused chlorpyrifos to lose its registration status in California was not able to identify a no risk level of exposure. There is no body of

evidence that concern does not apply broadly across OPs as a class.

For use of organophosphates in California, see Attachment "California Organophosphate Active Ingredients 2023" in Question 5.

What scientific information or additional information supports your submittal?

DPR will collect pesticide use reports, pesticide illness reports, environmental and human health data for each submission; submitters do not need to provide this information. Description of DPR collected data can be found on slide 52 of August 7th SPARC Meeting Slides.

Attach supporting documents using the “Upload a File” option below.

Please provide a brief rationale for each file you attach. Explain why each attachment is being included and how it supports your submittal.
References. Please note that the reference numbers listed below match the corresponding citations used throughout our responses to Question 4.

Dietary Exposure and Biomonitoring

1. Chensheng Lu, Kathryn Toepel, Rene Irish, Richard A. Fenske, Dana B. Barr, Roberto Bravo; Organic Diets Significantly Lower Children’s Dietary Exposure to Organophosphorus Pesticides. Environ. Health Perspect. 1 February 2006; 114 (2): 260–263. DOI:10.1289/ehp.8418

https://pubs.acs.org/evhpaz/article/114/2/260/5248420/Organic-Diets-Significantly-Lower-Children-s

Description: This is a peer-reviewed 15-day study of 23 elementary-age children that used urinary biomonitoring to compare conventional and mostly organic diets. During five consecutive organic-diet days, metabolites of the organophosphorus pesticides malathion and chlorpyrifos fell immediately to nondetectable levels, returning after conventional foods resumed. Other metabolites also declined. The longitudinal dietary intervention indicated that diet was children’s primary exposure source and that organic food provided immediate protection.

2. Curl CL, Fenske RA, Elgethun K. Organophosphorus pesticide exposure of urban and suburban preschool children with organic and conventional diets. Environ Health Perspect. 2003 Mar;111(3):377-82. DOI: 10.1289/ehp.5754.

https://pmc.ncbi.nlm.nih.gov/articles/PMC1241395/

Description: Peer-review study where researchers assessed dietary organophosphorus pesticide exposure in Seattle preschool children using food diaries and 24-hour urine samples. Children eating conventional diets had median dimethyl pesticide-metabolite levels about six times higher than those eating organic diets. Estimated exposures suggested organic fruits, vegetables, and juice could reduce children’s OP pesticide exposure from above EPA guidelines to negligible-risk levels, offering parents a practical exposure-reduction strategy.

3. Lu C, Barr DB, Pearson MA, Waller LA. Dietary intake and its contribution to longitudinal organophosphorus pesticide exposure in urban/suburban children. Environ Health Perspect. 2008 Apr;116(4):537-42. doi: 10.1289/ehp.10912. PMID: 18414640; PMCID: PMC2290988.

https://pmc.ncbi.nlm.nih.gov/articles/PMC2290988/

Description: The Children's Pesticide Exposure Study followed 23 Seattle-area children ages 3–11 for one year, collecting urine samples twice daily across four seasons. During five-day periods when conventional fruits and vegetables were replaced with organic options, urinary metabolites of malathion and chlorpyrifos fell to nondetectable or near-nondetectable levels. Seasonal variation also tracked fresh-produce consumption, indicating that dietary intake is young children's primary source of organophosphorus pesticide exposure.

California birth-cohort and child neurodevelopment studies

4. Bouchard, M.F., Chevrier, J., Harley, K.G., Kogut, K., Vedar, M., Calderon, N., Trujillo, C., Johnson, C., Bradman, A., Barr, D.B., & Eskenazi, B. (2011). "Prenatal Exposure to Organophosphate Pesticides and IQ in 7-Year-Old Children." Environmental Health Perspectives, 119(8), 1189–1195. DOI: 10.1289/ehp.1003185.

https://pmc.ncbi.nlm.nih.gov/articles/PMC3237357/

Description: CHAMACOS longitudinal birth-cohort study of predominantly Mexican-American families in California's Salinas Valley. Higher maternal urinary OP metabolite concentrations during pregnancy were associated with lower scores across several cognitive domains at age seven. Children in the highest quintile of prenatal exposure averaged approximately 7 points lower in full-scale IQ than children in the lowest quintile.

5. Marks, A.R., Harley, K., Bradman, A., Kogut, K., Barr, D.B., Johnson, C., Calderon, N., & Eskenazi, B. (2010). "Organophosphate Pesticide Exposure and Attention in Young Mexican-American Children: The CHAMACOS Study." Environmental Health Perspectives, 118(12), 1768–1774. DOI: 10.1289/ehp.1002056.

https://pmc.ncbi.nlm.nih.gov/articles/PMC3002198/

Description: CHAMACOS study examining attention at ages 3.5 and 5 years. Higher prenatal urinary OP metabolite concentrations were associated with more attention problems and ADHD-related scores, particularly at age five; associations were generally stronger in boys.

6. Sagiv, S.K., Harris, M.H., Gunier, R.B., Kogut, K.R., Harley, K.G., Deardorff, J., Bradman, A., Holland, N., & Eskenazi, B. (2018). "Prenatal Organophosphate Pesticide Exposure and Traits Related to Autism Spectrum Disorders in a Population Living in Proximity to Agriculture." Environmental Health Perspectives, 126(4), 047012. DOI: 10.1289/EHP2580.

https://pmc.ncbi.nlm.nih.gov/articles/PMC6071837/

Description: CHAMACOS study examining whether prenatal OP exposure was associated with traits related to autism spectrum disorder, rather than clinical autism diagnoses. Maternal urinary OP metabolites and residential proximity to agricultural OP use were evaluated against parent-, teacher-, and child-based measures through age 14. The findings provided some evidence of associations between prenatal OP exposure and ASD-related traits, but results varied by exposure metric, outcome measure, age, and sex and

should not be summarized as showing that OP exposure “causes autism.”

7. Gunier, R.B., Bradman, A., Harley, K.G., Kogut, K., & Eskenazi, B. (2017). “Prenatal Residential Proximity to Agricultural Pesticide Use and IQ in 7-Year-Old Children.” Environmental Health Perspectives, 125(5), 057002. DOI: 10.1289/EHP504.

https://pmc.ncbi.nlm.nih.gov/articles/PMC5644974/

Description: CHAMACOS study using California DPR Pesticide Use Reporting data to estimate agricultural pesticide use near mothers’ residences during pregnancy. Greater nearby use of OPs, toxicity-weighted for acetylcholinesterase inhibition, was associated with lower cognition at age seven. The OP association remained after adjustment for maternal urinary OP metabolites and other neurotoxic pesticide classes, although high correlations among pesticides made it difficult to identify individual chemicals responsible for the associations.

Independent U.S. birth cohorts

8. Rauh, V., Arunajadai, S., Horton, M., Perera, F., Hoepner, L., Barr, D.B., & Whyatt, R. (2011). “Seven-Year Neurodevelopmental Scores and Prenatal Exposure to Chlorpyrifos, a Common Agricultural Pesticide.” Environmental Health Perspectives, 119(8), 1196–1201. DOI: 10.1289/ehp.1003160.

https://pmc.ncbi.nlm.nih.gov/articles/PMC3237355/

Description: Columbia University longitudinal birth cohort in New York City. Prenatal chlorpyrifos exposure was measured in umbilical-cord blood. Each standard-deviation increase in chlorpyrifos was associated with declines of approximately 1.4% in full-scale IQ and 2.8% in working memory at age seven.

9. Rauh, V.A., Perera, F.P., Horton, M.K., Whyatt, R.M., Bansal, R., Hao, X., Liu, J., Barr, D.B., Slotkin, T.A., & Peterson, B.S. (2012). “Brain Anomalies in Children Exposed Prenatally to a Common Organophosphate Pesticide.” Proceedings of the National Academy of Sciences, 109(20), 7871–7876. DOI: 10.1073/pnas.1203396109.

https://pmc.ncbi.nlm.nih.gov/articles/PMC3356641/

Description: MRI study of 40 children from the Columbia cohort comparing 20 with higher and 20 with lower prenatal chlorpyrifos exposure. Higher exposure was associated with measurable differences in cerebral surface morphology and cortical thickness. Because the study was small, it is best presented as supporting neuroimaging evidence, not as a stand-alone definitive demonstration of structural brain injury.

10. Engel, S.M., Wetmur, J., Chen, J., Zhu, C., Barr, D.B., Canfield, R.L., & Wolff, M.S. (2011). “Prenatal Exposure to Organophosphates, Paraoxonase 1, and Cognitive Development in Childhood.” Environmental Health Perspectives, 119(8), 1182–1188. DOI: 10.1289/ehp.1003183.

https://pmc.ncbi.nlm.nih.gov/articles/PMC3237356/

Description: Mount Sinai birth cohort. Higher prenatal total OP metabolite concentrations were associated with poorer mental development at 12 months among Black and Hispanic children. In children ages 6–9, higher prenatal OP metabolites were associated with poorer perceptual reasoning among children whose mothers had a PON1 genotype associated with slower detoxification of chlorpyrifos oxon. The study therefore provides evidence both of neurodevelopmental effects and of differences in susceptibility related to OP metabolism.

Systematic reviews and major evidence syntheses

11. González-Alzaga, B., et al. (2019). “Effects of Prenatal and Postnatal Exposure to Organophosphate Pesticides on Child Neurodevelopment in Different Age Groups: A Systematic Review.” Environmental Research, 176, 108546.

https://pubmed.ncbi.nlm.nih.gov/31041704/

Description: Systematic review of 50 studies; 45 reported an association between OP exposure and at least one neurodevelopmental outcome. The authors concluded that the available evidence more strongly supports prenatal than postnatal exposure as a sensitive window, while also noting heterogeneity and methodological limitations across studies.

12. Muñoz-Quezada, M.T., et al. (2013). “Neurodevelopmental Effects in Children Associated with Exposure to Organophosphate Pesticides: A Systematic Review.” NeuroToxicology, 39, 158–168. DOI: 10.1016/j.neuro.2013.09.003.

https://pmc.ncbi.nlm.nih.gov/articles/PMC3899350/

Description: Systematic review of 27 studies. Twenty-six reported some adverse neurobehavioral association, with outcomes involving cognition, attention/behavior, motor function, and other neurodevelopmental domains. The review found substantial consistency across the longitudinal prenatal-exposure studies while also recognizing differences in exposure assessment and study design.

13. National Academies of Sciences, Engineering, and Medicine. (2018). Gulf War and Health, Volume 11: Generational Health Effects of Serving in the Gulf War. National Academies Press. DOI: 10.17226/25162.

https://www.nationalacademies.org/read/25162/chapter/7

Description: Independent review of the epidemiologic literature, including CHAMACOS, Columbia, Mount Sinai, HOME, and international studies. The committee concluded that there was “sufficient evidence of an association between prenatal exposure to OPs and neurodevelopmental effects.” It found the evidence inadequate or insufficient for other prenatal developmental outcomes.

14. Alqudaimi, M., et al. (2026). “The Impact of Prenatal Organophosphate Exposure on Children’s Neurodevelopment: A Quantitative Analysis with Regional Comparison.” International Journal of Environmental Health Research. DOI: 10.1080/09603123.2026.2676785.

https://pubmed.ncbi.nlm.nih.gov/42163786/

Description: Meta-analysis of 46 publications involving 25,975 participants examining prenatal OP exposure and child neurodevelopment. The study found statistically significant associations between prenatal OP exposure and adverse neurodevelopmental outcomes, including poorer cognitive outcomes, while also examining geographic differences in results.

California exposure and environmental-justice evidence

15. Rotkin-Ellman, M., Carpenter, C., Richardson, M.J., English, P.B., Gunier, R.B., & Harley, K.G. (2025). “Temporal Trends of Agricultural Organophosphate Pesticide Use in California and Proximity to Pregnant

People in 2021." BMC Public Health, 25, 3121. DOI: 10.1186/s12889-025-23939-y.

https://pmc.ncbi.nlm.nih.gov/articles/PMC12481947/

Description: California-wide study linking 2021 birth-certificate residential addresses with DPR pesticide-use data. 29,386 pregnant people—7.5% of California births—lived within 1 km of agricultural OP use during pregnancy. The number of different OPs applied within 1 km ranged from one to six. Exposure prevalence was particularly high in the Central Coast and among Hispanic/Latine and younger pregnant people.

16. Suarez-Lopez, J.R., Gould, C.F., Vashishtha, D., et al. (2026). "Acetylcholinesterase Activity from Childhood to Young Adulthood." Journal of Exposure Science & Environmental Epidemiology, 36, 818–826. DOI: 10.1038/s41370-026-00866-7.

https://doi.org/10.1038/s41370-026-00866-7

Description: Longitudinal study of 746 participants ages 4–26 in an agricultural region of Ecuador, based on 3,119 AChE measurements over 16 years. Its primary purpose was to establish age- and sex-specific reference values for AChE activity. Greater floriculture acreage within 300 meters of participants' homes was associated with lower AChE activity, suggesting potential exposure to cholinesterase-inhibiting pesticides. Because both OPs and carbamates inhibit AChE, it should not be described as specific evidence of OP exposure alone.

Adult neurological outcomes & Susceptibility

17. Wang, A., Cockburn, M., Ly, T.T., Bronstein, J.M., & Ritz, B. (2014). "The Association Between Ambient Exposure to Organophosphates and Parkinson's Disease Risk." Occupational and Environmental Medicine, 71(4), 275–281. DOI: 10.1136/oemed-2013-101394.

https://pubmed.ncbi.nlm.nih.gov/24436061/

Description: Population-based case-control study of 357 incident Parkinson's disease cases and 752 controls in California's Central Valley. GIS-based pesticide-use records were used to estimate ambient exposure to 36 OP pesticides from 1974–1999. Ambient exposure to the OPs evaluated was associated with increased Parkinson's disease risk, and the researchers observed an exposure-response pattern as the number of OPs to which participants were exposed increased.

18. Manthripragada, A.D., Costello, S., Cockburn, M.G., Bronstein, J.M., & Ritz, B. (2010). "Paraoxonase 1, Agricultural Organophosphate Exposure, and Parkinson Disease." Epidemiology, 21(1), 87–94. DOI: 10.1097/EDE.0b013e3181c15ec6.

https://pubmed.ncbi.nlm.nih.gov/19907334/

Description: Population-based case-control study of 351 incident Parkinson's disease cases and 363 controls in three rural California counties. Among people carrying the PON1-55 MM genotype, which influences metabolism of some OPs, estimated residential exposure to diazinon or chlorpyrifos was associated with more than twice the Parkinson's disease risk compared with unexposed people without that susceptibility genotype; no corresponding increased risk was observed for parathion.

19. Costa, L. G., Giordano, G., Cole, T. B., Marsillach, J., & Furlong, C. E. (2013). Paraoxonase 1 (PON1) as a genetic determinant of susceptibility to organophosphate toxicity. Toxicology, 307, 115–122.

https://pubmed.ncbi.nlm.nih.gov/22884923/

Description: This review explains that PON1 variants—especially Q192R and regulatory variants affecting enzyme expression—can change PON1 activity and susceptibility to certain OP insecticides. It appropriately characterizes the human evidence as emerging rather than definitive.

Regulatory and policy context

20. European Commission. (2026). EU Pesticides Database. Directorate-General for Health and Food Safety.

https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/active-substances

Description: Official European Commission database showing current and historical EU approval status for pesticide active substances. It can document whether individual OP active ingredients are approved, not approved, expired, or withdrawn in the EU. It is regulatory-comparator evidence, not evidence of a health effect. Twelve of the 13 organophosphate active ingredients still reported used in California in 2023 are not approved for use as plant-protection active substances in the European Union. Several—including chlorpyrifos, dimethoate, ethoprophos, and phosmet—were previously approved but subsequently failed to obtain renewal. Malathion is the only one of the 13 that remains EU-approved, and its renewal assessment is still underway.

Organophosphate Pesticides Reported Used in California, 2023

CAS Registry numbers, statewide pounds, current California product registrations, leading counties, and principal uses

Active ingredient	CAS Registry No.	2023 pounds used	Current active CA products	Primary 2023 counties / concentration	Major 2023 California uses / pattern
Bensulide	741-58-2	383,989	8	Monterey (~173,000 lb); Imperial (~120,000); San Benito (~14,000)	Leaf lettuce (~157,300 lb); broccoli (~67,600); head lettuce (~61,200); dry onions (~18,200); cantaloupe/arugula and other vegetables. Largest 2023 OP by pounds.
Malathion	121-75-5	272,549	17	Kings (~51,000 lb); Santa Barbara (~36,000); Monterey (~34,000)	Cotton (~53,379 lb); strawberries (~43,979); alfalfa (~38,050); leaf lettuce (~20,612); celery (~12,020); processing tomatoes (~11,761); cherries (~11,006); public health (~6,257).
Naled	300-76-5	232,889	4	Yolo (~21,100 lb); Monterey (~15,400); San Joaquin (~15,200)	Public-health mosquito control (~106,621 lb); cotton (~60,446); safflower (~24,502); strawberries (~16,569); Brussels sprouts (~6,922); broccoli (~6,594). Public health accounts for nearly half of use.
Acephate	30560-19-1	138,085	25	Fresno (~35,000 lb); Monterey (~19,000); Kings (~16,000)	Cotton (~56,900 lb across reporting units); head lettuce (~17,400); tangerines (~10,400); pistachios (~10,300); celery (~9,500). Cotton is the dominant use.
Dimethoate	60-51-5	111,215	7	Fresno (~36,500 lb); Kings (~23,400); Tulare (~12,400)	Processing tomatoes (~28,636 lb); alfalfa (~22,643); cotton (~22,560); oranges (~12,561); safflower (~5,613).
Diazinon	333-41-5	39,932	4	Colusa (~15,000 lb); Yolo (~7,400); Sutter (~3,400)	Processing tomatoes (~20,470 lb); fresh tomatoes (~7,305); dry onions (~3,957); apples (~2,171); pears (~1,769); bok choy (~1,300).
Ethoprop (Ethoprophos)	13194-48-4	13,006	3	Merced (~6,400 lb) dominates sweet-potato use; additional use in potato-growing counties; Del Norte (~700)	Sweet potatoes (~7,530 lb); potatoes (~3,904); smaller use on outdoor flowers, cabbage and dried beans.
Phosmet	732-11-6	6,615	3	Tehama (~3,000 lb); San Joaquin (~1,600); Tulare (~300)	Almonds (~3,149 lb); apples (~1,326); smaller uses on oranges, alfalfa, peaches and nursery plants.
Dichlorvos (DDVP)	62-73-7	4,068	34	Dispersed nonagricultural use; Tulare and San Joaquin are among identifiable higher-use counties	Structural pest control; animal premises; commodity/storage fumigation; warehouses. County ranking is less meaningful because use is largely non-crop.
Phorate	298-02-2	3,452	2	Kings (~2,200 lb); Del Norte (~700); Riverside (~400)	Cotton (~2,739 lb); outdoor flowers/nursery (~712). Use is highly concentrated in cotton.
Chlorpyrifos	2921-88-2	1,933	4	Dispersed low-volume use; no meaningful agricultural county concentration after phase-out	Primarily rights-of-way and other nonagricultural uses; very limited crop use. Most California agricultural uses ended in 2020.
Tetrachlorvinphos	22248-79-9	0.26	25	Trace use; no meaningful county concentration	Landscape maintenance and structural pest control; essentially non-crop use.
Coumaphos	56-72-4	0.05	1	Trace use; no meaningful county concentration	Very limited non-crop/structural use.

Notes: 2023 pounds reflect statewide reported use and can include nonagricultural categories. County entries identify the strongest 2023 county concentrations visible in DPR county summaries; approximate county pounds are rounded. For trace or predominantly structural/nonagricultural uses, a ranked county list may not be meaningful. “Current active CA products” is DPR’s current number of actively registered products containing that active ingredient (DPR active-ingredient list generated September 7, 2026).

DPR sources: 2023 PUR chemical totals; 2023 chemical-by-commodity data; 2023 county chemical subtotals; current actively registered active ingredients.
https://files.cdpr.ca.gov/pub/outgoing/pur/data/2023_pur_report_textfiles/Pesticide_use_report_lists/2023_pesticide_use_report_data_chemical_totals.txt
https://files.cdpr.ca.gov/pub/outgoing/pur/data/2023_pur_report_textfiles/Pesticide_use_report_lists/2023_pur_data_indexed_by_chemical_then_commodity.txt

https://files.cdpr.ca.gov/pub/outgoing/pur/data/2023_pur_report_textfiles/County_totals/2023_chemical_subtotals_by_county_pounds_apps_acres.txt
https://apps.cdpr.ca.gov/docs/label/actai.cfm

EU Regulatory Status of Organophosphate Active Ingredients Reported Used in California (2023)

Status as of September 2026

Organophosphate active ingredient	EU status	Regulatory history / note
Bensulide	Not approved	Not approved under the current EU plant-protection regime; listed as non-approved.
Malathion	Approved	Only one of the 13 currently approved. Its approval period was extended in 2026 while the renewal assessment continues.
Naled	Not approved / withdrawn	EU decision in 2005 not to include naled as an approved active substance; Member States were required to withdraw product authorizations.
Acephate	Not approved / withdrawn	EU decision in 2003 not to approve acephate; Member States were required to withdraw plant-protection-product authorizations.
Dimethoate	Not approved - approval not renewed	Previously approved; the EU refused renewal in 2019 and required withdrawal of product authorizations.
Diazinon	Not approved / withdrawn	EU decision in 2007 not to include diazinon as an approved active substance and to withdraw authorizations.
Ethoprop (Ethoprophos)	Not approved - approval not renewed	Previously approved; the EU refused renewal in 2019.
Phosmet	Not approved - approval not renewed	Previously approved; the EU refused renewal in 2022.
Chlorpyrifos	Not approved - approval not renewed	Previously approved; the EU refused renewal in 2020.
Dichlorvos (DDVP)	Not approved / withdrawn	Not approved for EU plant-protection use following a non-inclusion decision; authorizations were withdrawn.
Phorate	Not approved	Not approved under current EU pesticide law.
Tetrachlorvinphos	Not approved	Listed as a non-approved active substance in the EU pesticides system.
Coumaphos	Not approved as a plant-protection pesticide	No approved plant-protection uses in the EU; separate veterinary uses are regulated under a different framework.

Key point: 12 of the 13 organophosphate active ingredients with reported California use in 2023 are not currently approved as plant-protection active substances in the EU. Malathion is the only one currently approved.

Important qualification: "Not approved" does not always mean the EU affirmatively banned a substance because of a specific safety finding. Some substances were never approved or were not supported for approval, while others were previously approved and later not renewed or withdrawn.

Primary EU database:

https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/active-substances

Selected underlying EU legal acts:

Acephate (2003 non-inclusion decision):
https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32003D0219
Naled (2005 non-inclusion decision):
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32005D0788
Diazinon (2007 non-inclusion decision):
https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32007D0393
Dimethoate (2019 non-renewal): https://eur-lex.europa.eu/eli/reg_impl/2019/1090/oj/eng
Ethoprophos (2019 non-renewal):
https://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32019R0344
Chlorpyrifos (2020 non-renewal):
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0018
Phosmet (2022 non-renewal): https://eur-lex.europa.eu/eli/reg_impl/2022/94/oj
Malathion (2026 approval-period extension):
https://eur-lex.europa.eu/eli/reg_impl/2026/372/oj/eng

Question 5. What scientific information or additional information supports your submittal?

References. Please note that the reference numbers listed below match the corresponding citations used throughout our responses to Question 4.

Dietary Exposure and Biomonitoring

1. **Chensheng Lu, Kathryn Toepel, Rene Irish, Richard A. Fenske, Dana B. Barr, Roberto Bravo; Organic Diets Significantly Lower Children's Dietary Exposure to Organophosphorus Pesticides. *Environ. Health Perspect.* 1 February 2006; 114 (2): 260–263. DOI:10.1289/ehp.8418**

   https://pubs.acs.org/evhpaz/article/114/2/260/5248420/Organic-Diets-Significantly-Lower-Children-s

   Description: This is a peer-reviewed 15-day study of 23 elementary-age children that used urinary biomonitoring to compare conventional and mostly organic diets. During five consecutive organic-diet days, metabolites of the organophosphorus pesticides malathion and chlorpyrifos fell immediately to nondetectable levels, returning after conventional foods resumed. Other metabolites also declined. The longitudinal dietary intervention indicated that diet was children's primary exposure source and that organic food provided immediate protection.

2. **Curl CL, Fenske RA, Elgethun K. Organophosphorus pesticide exposure of urban and suburban preschool children with organic and conventional diets. Environ Health Perspect. 2003 Mar;111(3):377-82. DOI: 10.1289/ehp.5754.**

   https://pmc.ncbi.nlm.nih.gov/articles/PMC1241395/

   Description: Peer-review study where researchers assessed dietary organophosphorus pesticide exposure in Seattle preschool children using food diaries and 24-hour urine samples. Children eating conventional diets had median dimethyl pesticide-metabolite levels about six times higher than those eating organic diets. Estimated exposures suggested organic fruits, vegetables, and juice could reduce children's OP pesticide exposure from above EPA guidelines to negligible-risk levels, offering parents a practical exposure-reduction strategy.

3. **Lu C, Barr DB, Pearson MA, Waller LA. Dietary intake and its contribution to longitudinal organophosphorus pesticide exposure in urban/suburban children. Environ Health Perspect. 2008 Apr;116(4):537-42. doi: 10.1289/ehp.10912. PMID: 18414640; PMCID: PMC2290988.**

   https://pmc.ncbi.nlm.nih.gov/articles/PMC2290988/

Description: The Children's Pesticide Exposure Study followed 23 Seattle-area children ages 3–11 for one year, collecting urine samples twice daily across four seasons. During five-day periods when conventional fruits and vegetables were replaced with organic options, urinary metabolites of malathion and chlorpyrifos fell to nondetectable or near-nondetectable levels. Seasonal variation also tracked fresh-produce consumption, indicating that dietary intake is young children's primary source of organophosphorus pesticide exposure.

California birth-cohort and child neurodevelopment studies

4. **Bouchard, M.F., Chevrier, J., Harley, K.G., Kogut, K., Vedar, M., Calderon, N., Trujillo, C., Johnson, C., Bradman, A., Barr, D.B., & Eskenazi, B. (2011). "Prenatal Exposure to Organophosphate Pesticides and IQ in 7-Year-Old Children."** ***Environmental Health Perspectives*****, 119(8), 1189–1195. DOI: 10.1289/ehp.1003185.**

   https://pmc.ncbi.nlm.nih.gov/articles/PMC3237357/

   Description: CHAMACOS longitudinal birth-cohort study of predominantly Mexican-American families in California's Salinas Valley. Higher maternal urinary OP metabolite concentrations during pregnancy were associated with lower scores across several cognitive domains at age seven. Children in the highest quintile of prenatal exposure averaged approximately 7 points lower in full-scale IQ than children in the lowest quintile.

5. **Marks, A.R., Harley, K., Bradman, A., Kogut, K., Barr, D.B., Johnson, C., Calderon, N., & Eskenazi, B. (2010). "Organophosphate Pesticide Exposure and Attention in Young Mexican-American Children: The CHAMACOS Study."** ***Environmental Health Perspectives*****, 118(12), 1768–1774. DOI: 10.1289/ehp.1002056.**

   https://pmc.ncbi.nlm.nih.gov/articles/PMC3002198/

   Description: CHAMACOS study examining attention at ages 3.5 and 5 years. Higher prenatal urinary OP metabolite concentrations were associated with more attention problems and ADHD-related scores, particularly at age five; associations were generally stronger in boys.

6. **Sagiv, S.K., Harris, M.H., Gunier, R.B., Kogut, K.R., Harley, K.G., Deardorff, J., Bradman, A., Holland, N., & Eskenazi, B. (2018). "Prenatal Organophosphate Pesticide Exposure and Traits Related to Autism Spectrum Disorders in a Population Living in Proximity to Agriculture."** ***Environmental Health Perspectives*****, 126(4), 047012. DOI: 10.1289/EHP2580.**

   https://pmc.ncbi.nlm.nih.gov/articles/PMC6071837/

Description: CHAMACOS study examining whether prenatal OP exposure was associated with traits related to autism spectrum disorder, rather than clinical autism diagnoses. Maternal urinary OP metabolites and residential proximity to agricultural OP use were evaluated against parent-, teacher-, and child-based measures through age 14. The findings provided some evidence of associations between prenatal OP exposure and ASD-related traits, but results varied by exposure metric, outcome measure, age, and sex and should not be summarized as showing that OP exposure "causes autism."

7. **Gunier, R.B., Bradman, A., Harley, K.G., Kogut, K., & Eskenazi, B. (2017). "Prenatal Residential Proximity to Agricultural Pesticide Use and IQ in 7-Year-Old Children."** ***Environmental Health Perspectives*****, 125(5), 057002. DOI: 10.1289/EHP504.**

   https://pmc.ncbi.nlm.nih.gov/articles/PMC5644974/

   Description: CHAMACOS study using California DPR Pesticide Use Reporting data to estimate agricultural pesticide use near mothers' residences during pregnancy. Greater nearby use of OPs, toxicity-weighted for acetylcholinesterase inhibition, was associated with lower cognition at age seven. The OP association remained after adjustment for maternal urinary OP metabolites and other neurotoxic pesticide classes, although high correlations among pesticides made it difficult to identify individual chemicals responsible for the associations.

Independent U.S. birth cohorts

8. **Rauh, V., Arunajadai, S., Horton, M., Perera, F., Hoepner, L., Barr, D.B., & Whyatt, R. (2011). "Seven-Year Neurodevelopmental Scores and Prenatal Exposure to Chlorpyrifos, a Common Agricultural Pesticide."** ***Environmental Health Perspectives*****, 119(8), 1196–1201. DOI: 10.1289/ehp.1003160.**

   https://pmc.ncbi.nlm.nih.gov/articles/PMC3237355/

   Description: Columbia University longitudinal birth cohort in New York City. Prenatal chlorpyrifos exposure was measured in umbilical-cord blood. Each standard-deviation increase in chlorpyrifos was associated with declines of approximately 1.4% in full-scale IQ and 2.8% in working memory at age seven.

9. **Rauh, V.A., Perera, F.P., Horton, M.K., Whyatt, R.M., Bansal, R., Hao, X., Liu, J., Barr, D.B., Slotkin, T.A., & Peterson, B.S. (2012). "Brain Anomalies in Children Exposed Prenatally to a Common Organophosphate Pesticide."** ***Proceedings of the National Academy of Sciences*****, 109(20), 7871–7876. DOI: 10.1073/pnas.1203396109.**

   https://pmc.ncbi.nlm.nih.gov/articles/PMC3356641/

Description: MRI study of 40 children from the Columbia cohort comparing 20 with higher and 20 with lower prenatal chlorpyrifos exposure. Higher exposure was associated with measurable differences in cerebral surface morphology and cortical thickness. Because the study was small, it is best presented as supporting neuroimaging evidence, not as a stand-alone definitive demonstration of structural brain injury.

10. **Engel, S.M., Wetmur, J., Chen, J., Zhu, C., Barr, D.B., Canfield, R.L., & Wolff, M.S. (2011). "Prenatal Exposure to Organophosphates, Paraoxonase 1, and Cognitive Development in Childhood."** ***Environmental Health Perspectives*****, 119(8), 1182–1188. DOI: 10.1289/ehp.1003183.**

    https://pmc.ncbi.nlm.nih.gov/articles/PMC3237356/

    Description: Mount Sinai birth cohort. Higher prenatal total OP metabolite concentrations were associated with poorer mental development at 12 months among Black and Hispanic children. In children ages 6–9, higher prenatal OP metabolites were associated with poorer perceptual reasoning among children whose mothers had a PON1 genotype associated with slower detoxification of chlorpyrifos oxon. The study therefore provides evidence both of neurodevelopmental effects and of differences in susceptibility related to OP metabolism.

Systematic reviews and major evidence syntheses

11. **González-Alzaga, B., et al. (2019). "Effects of Prenatal and Postnatal Exposure to Organophosphate Pesticides on Child Neurodevelopment in Different Age Groups: A Systematic Review."** ***Environmental Research*****, 176, 108546.**

    https://pubmed.ncbi.nlm.nih.gov/31041704/

    Description: Systematic review of 50 studies; 45 reported an association between OP exposure and at least one neurodevelopmental outcome. The authors concluded that the available evidence more strongly supports prenatal than postnatal exposure as a sensitive window, while also noting heterogeneity and methodological limitations across studies.

12. **Muñoz-Quezada, M.T., et al. (2013). "Neurodevelopmental Effects in Children Associated with Exposure to Organophosphate Pesticides: A Systematic Review."** ***NeuroToxicology*****, 39, 158–168. DOI: 10.1016/j.neuro.2013.09.003.**

    https://pmc.ncbi.nlm.nih.gov/articles/PMC3899350/

    Description: Systematic review of 27 studies. Twenty-six reported some adverse neurobehavioral association, with outcomes involving cognition, attention/behavior, motor function, and other neurodevelopmental domains. The review found substantial consistency across the longitudinal prenatal-exposure studies while also recognizing differences in exposure assessment and study design.

13. **National Academies of Sciences, Engineering, and Medicine. (2018). *Gulf War and Health, Volume 11: Generational Health Effects of Serving in the Gulf War.* National Academies Press. DOI: 10.17226/25162.**

https://www.nationalacademies.org/read/25162/chapter/7

Description: Independent review of the epidemiologic literature, including CHAMACOS, Columbia, Mount Sinai, HOME, and international studies. The committee concluded that there was "sufficient evidence of an association between prenatal exposure to OPs and neurodevelopmental effects." It found the evidence inadequate or insufficient for other prenatal developmental outcomes.

14. **Alqudaimi, M., et al. (2026). "The Impact of Prenatal Organophosphate Exposure on Children's Neurodevelopment: A Quantitative Analysis with Regional Comparison." *International Journal of Environmental Health Research*. DOI: 10.1080/09603123.2026.2676785.**

https://pubmed.ncbi.nlm.nih.gov/42163786/

Description: Meta-analysis of 46 publications involving 25,975 participants examining prenatal OP exposure and child neurodevelopment. The study found statistically significant associations between prenatal OP exposure and adverse neurodevelopmental outcomes, including poorer cognitive outcomes, while also examining geographic differences in results.

California exposure and environmental-justice evidence

15. **Rotkin-Ellman, M., Carpenter, C., Richardson, M.J., English, P.B., Gunier, R.B., & Harley, K.G. (2025). "Temporal Trends of Agricultural Organophosphate Pesticide Use in California and Proximity to Pregnant People in 2021." *BMC Public Health*, 25, 3121. DOI: 10.1186/s12889-025-23939-y.**

https://pmc.ncbi.nlm.nih.gov/articles/PMC12481947/

Description: California-wide study linking 2021 birth-certificate residential addresses with DPR pesticide-use data. 29,386 pregnant people—7.5% of California births—lived within 1 km of agricultural OP use during pregnancy. The number of different OPs applied within 1 km ranged from one to six. Exposure prevalence was particularly high in the Central Coast and among Hispanic/Latine and younger pregnant people.

16. **Suarez-Lopez, J.R., Gould, C.F., Vashishtha, D., et al. (2026). "Acetylcholinesterase Activity from Childhood to Young Adulthood." *Journal of Exposure Science & Environmental Epidemiology*, 36, 818–826. DOI: 10.1038/s41370-026-00866-7.**

https://doi.org/10.1038/s41370-026-00866-7

Description: Longitudinal study of 746 participants ages 4–26 in an agricultural region of Ecuador, based on 3,119 AChE measurements over 16 years. Its primary purpose was to establish age- and sex-specific reference values for AChE activity. Greater floriculture acreage within 300 meters of participants' homes was associated with lower AChE activity, suggesting potential exposure to cholinesterase-inhibiting pesticides. Because both OPs and carbamates inhibit AChE, it should not be described as specific evidence of OP exposure alone.

Adult neurological outcomes & Susceptibility

17. **Wang, A., Cockburn, M., Ly, T.T., Bronstein, J.M., & Ritz, B. (2014). "The Association Between Ambient Exposure to Organophosphates and Parkinson's Disease Risk."** ***Occupational and Environmental Medicine*****, 71(4), 275–281. DOI: 10.1136/oemed-2013-101394.**

    https://pubmed.ncbi.nlm.nih.gov/24436061/

    Description: Population-based case-control study of 357 incident Parkinson's disease cases and 752 controls in California's Central Valley. GIS-based pesticide-use records were used to estimate ambient exposure to 36 OP pesticides from 1974–1999. Ambient exposure to the OPs evaluated was associated with increased Parkinson's disease risk, and the researchers observed an exposure-response pattern as the number of OPs to which participants were exposed increased.

18. **Manthripragada, A.D., Costello, S., Cockburn, M.G., Bronstein, J.M., & Ritz, B. (2010). "Paraoxonase 1, Agricultural Organophosphate Exposure, and Parkinson Disease."** ***Epidemiology*****, 21(1), 87–94. DOI: 10.1097/EDE.0b013e3181c15ec6.**

    https://pubmed.ncbi.nlm.nih.gov/19907334/

    Description: Population-based case-control study of 351 incident Parkinson's disease cases and 363 controls in three rural California counties. Among people carrying the PON1-55 MM genotype, which influences metabolism of some OPs, estimated residential exposure to diazinon or chlorpyrifos was associated with more than twice the Parkinson's disease risk compared with unexposed people without that susceptibility genotype; no corresponding increased risk was observed for parathion.

19. **Costa, L. G., Giordano, G., Cole, T. B., Marsillach, J., & Furlong, C. E. (2013). Paraoxonase 1 (PON1) as a genetic determinant of susceptibility to organophosphate toxicity.** ***Toxicology, 307*****, 115–122.**

    https://pubmed.ncbi.nlm.nih.gov/22884923/

Description*:* This review explains that PON1 variants—especially Q192R and regulatory variants affecting enzyme expression—can change PON1 activity and susceptibility to certain OP insecticides. It appropriately characterizes the human evidence as emerging rather than definitive.

Regulatory and policy context

20. **European Commission. (2026). *EU Pesticides Database.* Directorate-General for Health and Food Safety.**

    https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/active-substances

    Description: Official European Commission database showing current and historical EU approval status for pesticide active substances. It can document whether individual OP active ingredients are approved, not approved, expired, or withdrawn in the EU. It is regulatory-comparator evidence, not evidence of a health effect. Twelve of the 13 organophosphate active ingredients still reported used in California in 2023 are not approved for use as plant-protection active substances in the European Union. Several—including chlorpyrifos, dimethoate, ethoprophos, and phosmet—were previously approved but subsequently failed to obtain renewal. Malathion is the only one of the 13 that remains EU-approved, and its renewal assessment is still underway.