Assessing the Impact of Dairies on the Drinking Water of Disadvantaged Communities in the San Joaquin Valley

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Any errors contained in this report are mine alone.

EXECUTIVE SUMMARY

This report seeks to assist drinking water advocates and the Central Valley Regional Water Quality Control Board in protecting the drinking water of disadvantaged communities from contamination by dairies in the San Joaquin Valley and particularly the Tulare Lake Basin. It identifies 124 dairies within 2.4 kilometers of 45 disadvantaged unincorporated communities in Fresno, Kern, Kings, Madera, and Tulare Counties. It also compiles information on dairies' nutrient management practices, hydrologic vulnerability, regulatory compliance, and on-farm water quality monitoring.

This report documents the risk that the region's dairies pose to the drinking water of disadvantaged communities. For example, 55 dairies near disadvantaged communities are located in vulnerable groundwater areas. 47 have on-farm wells with nitrate concentrations above the MCL. 23 have been cited by the Regional Board for violations of the General Order. 15 report nitrogen budgets above 1.4, the ratio between applied nitrogen and harvested nitrogen set out in the General Order.

9 disadvantaged communities have five or more dairies located or spreading manure on land within 2.4 km of their borders. Riverdale in Fresno County has 12. But manure from just one dairy can contaminate groundwater, and so this report utilizes several risk indicators to assess the degree to which dairies threaten the drinking water of disadvantaged communities.

This report recommends that the Regional Board explicitly consider dairies' proximity to disadvantaged communities when deciding how to prioritize facility inspections. That prioritization can start immediately with the 106 active dairies listed in Appendix A. This report also calls for the Regional Board to require dairies near communities with contaminated groundwater to conduct additional water quality testing. It also recommends that the Regional Board institute electronic, standardized reporting to make data on dairies' nutrient management practices more accessible to the public.

INTRODUCTION

San Joaquin Valley dairies present a significant threat to drinking water, and disadvantaged communities are especially at risk. This report evaluates the risk presented by dairies and faced by disadvantaged communities in the Tulare Lake Basin.

Part I begins by discussing the connections between race, poverty, and drinking water in the San Joaquin Valley. It reviews the literature on dairies role in water quality contamination. This research informs the methods, outlined in Part II, used to identify the dairies that pose the greatest threat to the drinking water of disadvantaged communities in the Tulare Lake Basin and to evaluate those dairies' nutrient management practices. Part III summarizes information collected on 124 dairies located near 45 disadvantaged communities. Part IV offers recommendations to the Central Valley Regional Water Quality Control Board (Regional Board), including ways to incorporate dairies' proximity to disadvantaged communities into inspection and enforcement decisions.

I. Background

A. Drinking Water and Disadvantaged Communities

Disadvantaged communities in the San Joaquin Valley experience disproportionate exposure to a range of environmental harms.[1] Disadvantaged unincorporated communities (DUCs) are especially vulnerable.[2] These communities have median household incomes less than 80% of the state average and are settled at urban densities.[3] Unlike incorporated towns and cities, however, they are served by only one layer of local government: the county. County governments are often oriented towards serving rural areas and so find themselves ill-suited to meet the needs of DUCs.[4] DUCs often lack the basic infrastructure taken for granted in incorporated areas such as sidewalks, streetlights, and connections to sewer and water lines.[5] In California, persons of color make up 65% of the population of DUCs.[6] Discriminatory annexation patterns have created "fringe" and "island" DUCs while farmworker communities form "legacy" DUCs in otherwise rural areas.[7]

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[1] JONATHAN LONDON, ET AL., UC DAVIS CTR. FOR REGIONAL CHANGE, LAND OF RISK, LAND OF OPPORTUNITY: CUMULATIVE ENVIRONMENTAL VULNERABILITIES IN CALIFORNIA'S SAN JOAQUIN VALLEY (2011).

[2] Camille Pannu, *Drinking Water and Exclusion: A Case Study from California's Central Valley*, 100 CAL. L. REV. 223, 231-34 (2012); *see* Michelle Wilde Anderson, *Mapped Out of Local Democracy*, 62 STANFORD L. REV. 931 (2010); Michelle Wilde Anderson, *Cities Inside Out: Race, Race Poverty, and Exclusion at the Urban Fringe*, 55 UCLA L. REV. 1095 (2008).

[3] CHIONE FLEGAL ET AL., POLICYLINK, CALIFORNIA UNINCORPORATED: MAPPING DISADVANTAGED COMMUNITIES IN THE SAN JOAQUIN VALLEY (2013).

[4] Anderson, *Cities Inside Out*, *supra* note 2, at 1145-58.

[5] *Id.* at 1149-54; Bernice Yeung, *Neglected for decades, unincorporated communities lack basic public services*, CALIFORNIA WATCH (Apr. 6, 2012), http://tinyurl.com/73rmydh.

[6] FLEGAL, *supra* note 3, at 9.

[7] *Id.* at 21-22; Anderson, *Cities Inside Out*, *supra* note 2, at 1125-29.

In the San Joaquin Valley, disadvantaged communities, and DUCs in particular, are disproportionately burdened by groundwater nitrate contamination.[8] Of the public water systems in the Salinas Valley and Tulare Lake Basin delivering drinking water with nitrate concentrations above the Maximum Contaminant Level, 80% of those systems serve communities with median household incomes less than 80% of the state average.[9] Race matters, as well. Higher nitrate concentrations in drinking water delivered by small water systems in the San Joaquin Valley correlate with higher percentages of Hispanics in these water systems' service areas.[10]

Several factors account for these higher rates of contamination. Farmworker communities are often located near large agricultural operations responsible for nitrogen loading to groundwater.[11] Moreover, many residents of these communities receive their water from either shallow private wells or small community water systems with only one or two source wells, both of which are more susceptible to nitrate contamination than deeper wells and larger systems.[12] Small water systems at times lack the technical capacity to manage the complex challenges presented by nitrate contamination.[13]

Disadvantaged communities are also more financially vulnerable to nitrate contamination. Although nitrate concentrations can be reduced through blending or treatment, small water systems cannot pass the cost of major infrastructure improvements on to their low-income customers.[14] Customers of these systems pay for both unusable water from their taps and bottled water to replace it. A survey in one San Joaquin Valley community found that respondents' water expenditures consumed an average of 3.9% of their median household incomes, well above the 1.5% that the California Department of Public Health considers affordable.[15]

B. Dairies and Water Quality in the San Joaquin Valley

1. The dairy industry in the San Joaquin Valley

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[8] Rose Francis & Laurel Firestone, *Implementing the Human Right to Water in California's Central Valley: Building a Democratic Voice Through Community Management in Water Policy Decision Making*, 47 WILLAMETTE L. REV. 495, 496-500 (2011).

[9] KRISTIN HONEYCUTT ET AL., ALTERNATIVE WATER SUPPLY OPTIONS FOR NITRATE CONTAMINATION: TECHNICAL REPORT 7 AT 44 *in* THOMAS HARTER, ET AL., UNIV. OF CAL. AT DAVIS GROUNDWATER NITRATE PROJECT, ADDRESSING NITRATE IN CALIFORNIA'S DRINKING WATER– REPORT FOR THE STATE WATER RESOURCES CONTROL BOARD REPORT TO THE LEGISLATURE (2012) [hereinafter UC DAVIS NITRATE REPORT].

[10] Carolina Balazs et al., *Social Disparities in Nitrate-Contaminated Drinking Water in California's San Joaquin Valley*, 119 ENVTL. HEALTH PERSPECTIVES 1272, 1275-76 (2011).

[11] Francis & Firestone, *supra* note 8, at 499.

[12] JOSHUA H. VIERS, ET AL., NITROGEN SOURCES AND LOADING TO GROUNDWATER: TECHNICAL REPORT 2 AT 236 *in* UC DAVIS NITRATE REPORT, *supra* note 9 (noting that most private wells in the Tulare Lake Basin are shallower than agricultural and municipal wells).

[13] HONEYCUTT ET AL., *supra* note 9, at 45.

[14] *Id.*; ENVTL. JUSTICE COALITION FOR WATER, THIRSTY FOR JUSTICE: A PEOPLE'S BLUEPRINT FOR CALIFORNIA WATER 78 (2005).

[15] ELI MOORE & EYAL MATALON, PAC. INST., THE HUMAN COSTS OF NITRATE-CONTAMINATED DRINKING WATER IN THE SAN JOAQUIN VALLEY 28 (2011).

California's $6.9 billion dairy industry produces 21% of the nation's milk, more than any other state.[16] 75% of the state's 1,563 dairies and 87% of its 1.8 million adult cows are located in the San Joaquin Valley.[17] Tulare Lake Basin dairies house more cows (about 1 million total) on larger dairies (1703 adult cows per facility) than San Joaquin Basin Dairies (556,025 cows stocked at 962 head per facility).[18]

The Valley's rise to dairy prominence is relatively recent. In 1950, the Tulare Lake Basin had a little over 100,000 adult cows.[19] By 1992, that number rose to 408,631, and by 2007 it had grown to 877,621.[20] This growth in part reflected an emigration of dairies from the Chino Basin driven by land use pressure and regulation.[21] Pasturing was common until the 1970s when the confinement, lagoon, and land application model was implemented to accommodate the increasing herd density.[22]

Recently, the industry has undergone a wave of consolidation, with the number of Tulare Lake Basin dairies dropping 6.6% just between 2011 and 2012.[23] The number of cows has not fallen significantly, though.[24] Strong milk prices of late have reversed industry fortunes, though the drought threatens to drive up the cost of production.[25]

2. Dairies and nitrate contamination

Groundwater nitrate contamination is widespread throughout the San Joaquin Valley.[26] 96% of nitrogen loading to groundwater in the Salinas Valley and Tulare Lake Basin originates with cropland agriculture.[27] Land applications of dairy manure account for about one-third of that loading.[28] In Tulare County, however, dairy manure applications comprise 2/3 of nitrogen loading.[29]

Historically, neither the design nor operation of the region's dairies sought to minimize groundwater contamination.[30] Consequently, dairies have caused groundwater nitrate contamination in the San Joaquin Valley.[31] Research is ongoing to identify the

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[16] CAL. DEP'T OF FOOD & AGRIC., CALIFORNIA DAIRY STATISTICS: 2012 DATA 6-7 (2013).
[17] *Id.* at 9.
[18] *Id.*
[19] VIERS, ET AL., *supra* note 12, at 135.
[20] *Id.*
[21] FOOD & WATER WATCH, WHAT'S IN THE WATER?: INDUSTRIAL DAIRIES, GROUNDWATER POLLUTION AND REGULATORY FAILURE IN CALIFORNIA'S CENTRAL VALLEY 4 (2011).
[22] VIERS, ET AL., *supra* note 12, at 149.
[23] CAL. DEP'T OF FOOD & AGRIC., *supra* note 16, at 9.
[24] *Id.*
[25] Bill Tomson, *Good Times Mean Higher Milk Prices*, POLITICO (Feb. 2, 2014), http://tinyurl.com/lldz4lq.
[26] *See, e.g.*, K.M. Lockhart et al., *Identifying Sources of Groundwater Nitrate Contamination in a Large Alluvial Groundwater Basin with Highly Diversified Intensive Agricultural Production*, 151 J. CONTAMINANT HYDROLOGY 140, 145 (2013) (finding that 46% of 100 wells surveyed in Tulare and Kings Counties had nitrate concentrations in excess of the MCL).
[27] UC DAVIS NITRATE REPORT, *supra* note 9, at 17-19.
[28] *Id.* at 18-19.
[29] VIERS ET AL., *supra* note 12, at 19.
[30] Thomas Harter et al., *Shallow groundwater quality on dairy farms with irrigated forage crops*, 55 J. CONTAMINANT HYDROLOGY 287, 290 (2002) [hereinafter Harter et al., *Shallow groundwater quality*] ("Dairy operators have commonly managed the land application of manure as a waste disposal system, not as a nutrient management system.").
[31] *Id.* at 312; CENT. VALLEY REG'L WATER QUALITY CONTROL BD., ORDER R5-2013-0122, REISSUED WASTE DISCHARGE REQUIREMENTS GENERAL ORDER FOR EXISTING MILK COW DAIRIES IS-19 (2013)

precise mix of dairy practices and hydrogeologic characteristics that pose the greatest threat to groundwater.[32] A recent study showed that wells' proximity to dairies was correlated with higher nitrate concentrations for wells in Merced and Stanislaus Counties.[33] This relationship did not hold for the study's Tulare and Kings County wells because, the authors hypothesized, most nearby dairies were not located in vulnerable groundwater environments.[34] They also questioned whether dairy herd and facility density, which they did not measure, might be associated with nitrate contamination.[35] Despite this uncertainty at the margins, the literature provides insights on how nitrate leaching occurs from each of the three dairy management units: animal holding areas, wastewater ponds, and cropland.

The Valley's dairies concentrate a large number of animals on a small amount of land. Each adult cow produces 120 pounds of manure each day, the equivalent of 20 to 40 people.[36] A milk cow excretes 0.99 lbs (462 g) of nitrogen per day.[37] Non-lactating, or dry, cows excrete about half as much nitrogen as milk cows.[38] Support stock (bred heifers, unbred heifers, and calves) generate less.[39]

On industrial dairies, cows deposit their manure in one of two places: freestalls or corrals. Concrete-floored freestalls are lined with flushlanes that carry manure and urine to wastewater ponds.[40] Animals can move between the freestalls and open-air, packed-earth corrals.[41] Solid manure is periodically scraped from corrals. That manure is either used on-farm as animal bedding or soil amendment, or it is exported to other farms or compost operations.[42] The General Order requires corrals to be graded to minimize infiltration of urine and stormwater and to channel those liquids into wastewater ponds.[43] Nevertheless, leaching from corrals to groundwater reaches an estimated 1,700 tons of nitrogen per year.[44]

Ponds collect the stormwater that contacts manure and the process wastewater used to clean freestalls and milking parlors. Ponds must be large enough to hold the wastewater generated between land applications plus the precipitation from a 25-year, 24-

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[hereinafter GENERAL ORDER] ("The [Regional] Board acknowledges that significant degradation at dairies has occurred throughout the Central Valley Region due to historic practices.").

[32] The Representative Monitoring Program is a multi-year effort with monitoring wells at several San Joaquin Valley dairies. *General Order Guidance*, CENT. VALLEY REG'L WATER QUALITY CONTROL BD., http://tinyurl.com/l673syg (last visited June 6, 2014). Thomas Harter at UC Davis is also in the process of analyzing data from dairy's Annual Reports and hopes to circulate results later this summer.

[33] K.M. Lockhart et al., *supra* note 26, at 147-48.

[34] *Id.* at 148.

[35] *Id.* at 151.

[36] *Animal Waste: What's the Problem?*, U.S. ENVTL. PROTECTION AGENCY, http://tinyurl.com/3cztvrb (last visited June 7, 2014).

[37] UNIV. OF CAL., DIV. OF AGRIC. & NATURAL RES., COMM. OF EXPERTS ON DAIRY MANURE MGMT., MANAGING DAIRY MANURE IN THE CENTRAL VALLEY OF CALIFORNIA 20 (2003) [hereinafter COMMITTEE OF EXPERTS REPORT].

[38] *Id.* (average daily nitrogen excretion of dry cows is 195 g/head/day).

[39] AM. SOC'Y OF AGRIC. ENG'RS, ASAE D384.2, MANURE PRODUCTION AND CHARACTERISTICS 2 (2005), *available at* http://tinyurl.com/p53zvgg.

[40] Harter et al., *Shallow groundwater quality*, *supra* note 30, at 290.

[41] *Id.*

[42] *Id.*

[43] GENERAL ORDER, *supra* note 31, at 19.

[44] VIERS ET AL., *supra* note 12, at 144.

hour storm event.[45] A pond's water level must be at least 2 feet below the lowest point of its aboveground embankment and at least 1 foot below ground surface.[46] State law requires ponds to be constructed on soil with at least 10% clay.[47] A manure sludge layer helps seal the bottom.[48] Nevertheless, ponds leak, both through permeable soil underneath and through cracks in sidewalls resulting from repeated drying and re-wetting as water levels fluctuate between irrigations.[49] Synthetic liners are less permeable, but only required for new or expanded lagoons.[50] Only 11 Central Valley dairies have installed them.[51] Nitrate leaching to groundwater from ponds contributes an estimated 220 tons of nitrogen per year.[52]

Most dairies dispose of wastewater by mixing it with irrigation water and applying it via flood or border check irrigation to surrounding cropland.[53] Some dairies use liquid manure to fertilize citrus, tree nuts, and vineyards, but the most common crop rotation consists of winter grain (triticale, wheat, or sudan grass) and summer corn.[54] Some dairies also grow a fall crop of alfalfa, but this receives little to no manure.[55] Applied manure contains both organic and inorganic nitrogen.[56] Only the latter is plant available. In the presence of oxygen, microbes both mineralize organic nitrogen, converting it to ammonium, and nitrify ammonium, converting it to nitrate. Ammonium and organic nitrogen bind to soil particles, but nitrate does not, allowing it to migrate with soil water. In this manner, nitrogen that is not assimilated by crops leaches to groundwater. 315,000 acres (nearly 500 square miles) in the Tulare Lake Basin receive manure applications.[57] As mentioned above, these land applications account for 1/3 of Tulare Lake Basin nitrogen loading to groundwater and 2/3 of Tulare County nitrogen loading.[58] This loading amounts to approximately 140,000 tons of nitrogen per year, significantly more than corrals and ponds.[59]

i. Agronomic rate for field applications

In 2003, a UC Committee of Experts concluded that to ensure a crop's full nitrogen demand was satisfied manure applications needed to contain 40% to 65% more nitrogen than the crop was expected to take up.[60] Since a summer corn / winter grain rotation

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[45] GENERAL ORDER, *supra* note 31, at 14.
[46] *Id.* at 15.
[47] CAL. CODE REGS., tit. 27 § 22562(d) (2014).
[48] BROWN, VENCE & ASSOCS., TASK 2 REPORT: TITLE 27 EFFECTIVENESS TO PROTECT GROUNDWATER QUALITY 28 (2003).
[49] *Id.* at 52; Harter et al., *Shallow groundwater quality*, *supra* note 30, at 311; M.L. van der Schans et al., *Characterizing Sources of Nitrate Leaching from an Irrigated Dairy Farm in Merced County, California*, 110 J. OF CONTAMINANT HYDROLOGY 9, 17 (2009).
[50] GENERAL ORDER, *supra* note 31, at 17-19.
[51] The Central Valley Regional Board provided a List of Tier 1 and 2 Liners that is on file with the author.
[52] VIERS ET AL., *supra* note 12, at 148, 164.
[53] Harter et al., *Shallow groundwater quality*, *supra* note 30, at 290.
[54] *Id.*
[55] VIERS ET AL., *supra* note 12, at 150.
[56] Harter et al., *Shallow groundwater quality*, *supra* note 30, at 290.
[57] VIERS ET AL., *supra* note 12, at 164.
[58] *Id.* at 19.
[59] *Id.* at 164.
[60] COMMITTEE OF EXPERTS REPORT, *supra* note 37, at 48-49.

typically requires 400 to 600 lbs N/ac, an agronomic rate of application would be between 560 and 990 lbs N/ac.[61]

Fixing the nitrogen budget between 1.4 and 1.65 protects crop yields more than water quality. The Committee of Experts observed that even at agronomic rates, manure applications could result in leachate with nitrate concentrations well above the MCL. Assuming a leaching rate of 10% of applied nitrogen leaches and 2 acre-feet of recharge per year, applying 560-990 lbs N/ac would result in leachate with nitrate concentrations of 10 to 18 mg/L NO_3^- – N.[62] The leaching rate used in this calculation is unrealistic given the surface irrigation employed by Central Valley dairies. 45%, not 10%, is a more accurate estimation.[63] Using that leaching rate, leachate would contain 47 to 82 mg/L NO_3^- – N.[64]

ii. Hydrogeology and the nitrogen budget

Researchers have yet to clarify the exact role that indicators of hydrogeologic vulnerability such as soil type and depth to groundwater play in predicting groundwater contamination. Those factors clearly matter. The East San Joaquin Groundwater Monitoring Report found that 82% of groundwater monitoring samples with nitrate concentrations in excess of the MCL were taken in Department of Pesticide Regulation-designated Groundwater Protection Areas (GWPAs) or State Water Resources Control Board-designated Hydrologically Vulnerable Areas (HVAs).[65] The Corcoran Clay also acts as a barrier in some areas, protecting deeper aquifers from the consequences of excess fertilization.[66]

Nevertheless, the mass balance approach, even without accounting for site-specific hydrogeologic factors, is still a reasonably good predictor of threat to groundwater.[67]

iii. Deconstructing the nitrogen budget

Despite its predictive power, the nitrogen budget is an imperfect indicator of nitrate leaching. Its utility is limited by four factors.

First, it fails to account for the timing of applications. Nutrient demands vary during the stages of plant growth.[68] Corn planted in early April, for instance, takes up

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[61] *Id.* at 35, 49.
[62] *Id.* at 49.
[63] van der Schans et al., *supra* note 49, at 19.
[64] Author's calculation: (lbs N applied x .45) x (453592 mg / lb) / (2447684 L) = mg N / L.
[65] LUHDORFF & SCALMANINI, EAST SAN JOAQUIN WATER QUALITY COALITION GROUNDWATER QUALITY ASSESSMENT REPORT 68 (2014).
[66] DYLAN BOYLE, ET AL., ADDRESSING NITRATE IN CALIFORNIA'S DRINKING WATER: TECHNICAL REPORT 4 AT 134 *in* UC DAVIS NITRATE REPORT, *supra* note 9.
[67] van der Schans et al., *supra* note 49, at 20; VIERS ET AL., *supra* note 12, at 150 ("This previous work showed that such a mass balance approach, while not exact, provides a valuable approximation of groundwater nitrate losses from manure applications.").
[68] COMMITTEE OF EXPERTS REPORT, *supra* note 37, at 39-40.

nitrogen most rapidly between late May and early June.[69] Nitrogen applications not synchronized with crop nutrient demands will result in more leaching.[70]

Synchronizing applications is complicated by the fact that about 1/3 to 2/3 of the nitrogen in process wastewater is organic and so not immediately plant available.[71] The mineralization rate of organic nitrogen depend upon soil temperature and carbon availability.[72] It cannot yet be predicted with full precision. [73]

Second, the Regional Board instructs dairies to calculate the whole-farm nitrogen budget based on applications and harvests during a single calendar year. If a crop is planted and fertilized in the fall, but not harvested until the spring, this will distort the ratio.[74]

Third, including nitrogen from alfalfa harvests in the nitrogen budget may skew the ratio. Alfalfa fixes nitrogen and so does not typically receive manure applications. Therefore, nitrogen harvested in an alfalfa crop may be of atmospheric rather than bovine provenance. Factoring this nitrogen in the amount harvested artificially lowers the dairy's nitrogen ratio. But this "alfalfa bump" might not be significant: when soil nitrogen is plentiful, alfalfa scavenges, rather than fixes, nitrogen. It is possible that alfalfa may be mopping up nitrogen from previous applications.[75]

Fourth, accurate nitrogen budgets require accurate estimations of the tonnage and nitrogen content of harvested crops, the volume and nitrogen content of wastewater and solid manure used for fertilization, the volume and nitrogen content of irrigation water, the amount of nitrogen stored in the soil, and the amount of nitrogen "applied" to cropland through atmospheric deposition. This menagerie of variables provides dairies with ample opportunity for miscalculation. As discussed below, the Annual Reports reviewed for this project exhibit several anomalies in nitrogen budget reporting.

iv. Best Management Practices for field applications

Although a full review of dairy water quality BMPs is outside the scope of this report,[76] my research did uncover some insights into specific nutrient management practices that may be of interest to Community Water Center.

Managing manure applications requires knowledge of the volume of each irrigation session.[77] According to Sustainable Conservation, many dairies just use the

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[69] *Id.* at 40.
[70] KRISTIN N. DZURELLA, ET AL., NITROGEN SOURCE REDUCTION TO PROTECT GROUNDWATER QUALITY: TECHNICAL REPORT 3 AT 51 *in* UC DAVIS NITRATE REPORT, *supra* note 9.
[71] Harter et al., *Shallow groundwater quality*, *supra* note 30, at 290.
[72] COMMITTEE OF EXPERTS REPORT, *supra* note 37, at 43-44.
[73] *Id.* By contrast, all of the nitrogen in inorganic fertilizer is immediately plant available, which is one reason why some dairies that export manure still purchase chemical fertilizer.
[74] *See* Tri-Star Dairy (18357 Ave 152, Porterville, Tulare County) 2012 Annual Report at 29. Tri-Star protests the method of nitrogen budget calculations, including the use of the calendar year reporting period. It reports a nitrogen budget of 0 in 2012.
[75] COMMITTEE OF EXPERTS REPORT, *supra* note 37, at 37.
[76] *See* Dzurella et al., *supra* note 70, at 42-53.
[77] Marsha Campbell Mathews, et al., *Matching Dairy Lagoon Nutrient Application to Crop Nitrogen Uptake Using a Flow Meter and Control Valve*, Am. Soc'y of Agric. Engrs. Annual Int'l Meeting Paper No. 01-2105 (2001).

design capacity of their irrigation pumps, but flow meters are more accurate.[78] Sustainable Conservation believes that the use of flow meters should be expanded.[79]

To synchronize wastewater applications with crop demands, it is preferable to engage in multiple, low-volume irrigations. Some types of irrigation systems do not allow for these low-volume irrigations.[80] Dairy operators may also base irrigation timing decisions on lagoon capacity, seeking to lower lagoon levels in advance of winter rains, and on managing salt stress in their crops.[81]

An accurate nitrogen budget depends not only on accurate measurements but also on diligent recordkeeping. Regional Board staff noted that communication breakdowns between dairymen, growers, and consultants sometimes contribute to deficient recordkeeping.[82]

3. Enforcing the General Order

Numerous statutory and common law strategies have been advanced to address the water quality impacts of Confined Animal Feeding Operations (CAFOs).[83] Clean Water Act regulations impose various restrictions that would apply to San Joaquin Valley dairies if they discharged to surface waters.[84] But the General Order prohibits such discharges, and so Central Valley dairies do not need NPDES permits.[85]

The General Order flatly prohibits dairy discharges that cause water quality objective exceedences.[86] These water quality objectives include the nitrate MCL.[87] For dairies enrolled in the Representative Monitoring Program, however, this provision is

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[78] Telephone Interview with Kathy Viatella, Eric Lee, John Cardoza, and Ladi Asigill, Sustainable Conservation (May 30, 2014).
[79] *Id.*
[80] MICAH BOWMAN, PROVOST & PRITCHARD CONSULTING GROUP, PROPER DESIGN OF DAIRY LIQUID MANURE NUTRIENT DISTRIBUTION SYSTEMS TO FACILITATE AGRONOMIC APPLICATIONS, *available at* http://tinyurl.com/p5kmvxb.
[81] Telephone Interview with Dough Patteson and Clay Rodgers, Central Valley Regional Water Quality Control Board (May 20, 2014).
[82] *Id.*
[83] Jessica Culpepper, "*Fertilizer" Manure?: Suit Against Mega-dairies Could Lead to CAFOs Complying with RCRA*, PUBLIC JUSTICE (Aug. 10, 2013), http://tinyurl.com/pqwd3js (describing RCRA suit against Washington state dairy CAFOs); Joseph Neff, *Hundreds file complaints over hog-farm waste*, RALEIGH NEWS & OBSERVER (July 7, 2013), http://tinyurl.com/kls6upg (describing nuisance suits filed against North Carolina hog CAFOs); *The 2013 EJ Summit Agenda*, N.C. ENVTL. JUSTICE NETWORK, http://tinyurl.com/mqvrqgu (last visited June 7, 2014) (panel discussion on potential Title VI suit against North Carolina hog CAFOs).
[84] 40 C.F.R. § 122.42(e)(1)(vi)-(ix) (2014) (pursuant to 40 C.F.R. § 122.23(e), establishing criteria for manure land applications); *Id.* § 122.42(e)(5) (making CAFO's nutrient management plan an enforceable part of a NPDES permit); *Id.* § 412.30-412.37 (establishing rules particular to dairies including prohibiting discharges to water of the United States from production areas); *see also* Scott Jerger, *EPA's New CAFO Land Application Requirements: An Exercise in Unsupervised Self-Monitoring*, 23 STANFORD ENVTL. L.J. 91 (2004) (critiquing the land application requirements for CAFOs).
[85] GENERAL ORDER, *supra* note 31, at 12
[86] *Id.* at 23.
[87] *Id.* at IS-7

suspended until the Summary Representative Monitoring Report is filed.[88] The SRMR is due sometime before April 2019.[89]

The General Order's practice-based limitations are effective immediately. Relevant corral and pond requirements are discussed above. Regarding land applications, the Order prohibits applications not aimed at "nutrient recycling."[90] It also requires that recipients of process wastewater agree to apply the exported nutrients at agronomic rates.[91]

Dischargers applying manure onsite must comply with certified nutrient management plans.[92] Nutrient management plans must include a nitrogen budget. The Order provides:

> Except as allowed below, application rates shall not result in total nitrogen applied to the land application areas exceeding 1.4 times the nitrogen that will be removed from the field in the harvested portion of the crop.[93]

To apply more than 1.4 times harvested nitrogen, the discharger must conduct plant tissue testing demonstrating the crops' nutrient deficit and synchronize the applications with crop demand.[94] If the discharger applies more than 1.65 times harvested nitrogen during or after the 2012 reporting year, he must "either revise the NMP to immediately prevent such exceedance or submit a report demonstrating that the application rates have not and will not pollute surface or groundwater."[95]

It would seem from the text of the Order that registering a nitrogen budget above 1.4 without plant tissue tests and above 1.65 without Nutrient Management Plan revisions or a report to the Regional Board would constitute enforceable violations. The Regional Board, however, does not consider nitrogen budget exceedences to constitute independent grounds for enforcement actions.[96]

The General Order describes the Regional Board's "progressive enforcement" approach and identifies the following high priority violations: discharges to surface water, failure to monitor or submit reports on time, and applying to lands of others without their permission.[97] Most enforcement actions are only initiated after staff inspections. Each facility is inspected on average once every three years. The Regional Board prioritizes the inspection of facilities with previous violations.[98]

III. METHODS

This report has two goals: 1) to identify the dairies with the greatest potential to contaminate the drinking water of disadvantaged unincorporated communities in the

[88] *Id.* at 23 n.7.
[89] *Id.* at 29.
[90] *Id.* at 9,
[91] *Id.* at 20-21.
[92] *Id.* at 20.
[93] *Id.* at C-10 to C-11.
[94] *Id.* at C-11.
[95] *Id.*
[96] Telephone Interview with Dough Patteson and Clay Rodgers, Central Valley Regional Water Quality Control Board (May 20, 2014).
[97] GENERAL ORDER, *supra* note 31, at IS 36-37.
[98] Telephone Interview with Dough Patteson and Clay Rodgers, Central Valley Regional Water Quality Control Board (May 20, 2014).

Tulare Lake Basin and 2) to collect and analyze information about the nutrient management practices of those dairies.

A. Dairies and DUCs

In a recent study, Lockhart et al. categorized dairies located within 2.4 km of San Joaquin Valley drinking water wells as having the potential for loading nitrogen to those wells.[99] The 2.4 km buffer is a conservative measure of contamination potential calculated from assumptions about well depth (61 m; 200 ft), horizontal hydrologic conductivity (30.5 m/day; 100 ft/day), hydraulic gradient (.0001), and irrigation water recharge rate (.3 m/yr; 1 ft/yr).[100] Although the actual values of each of these variables will differ from place to place, the authors selected them based on data collected from the San Joaquin Valley.[101] This report adapts Lockhart et al.'s methodology by identifying dairies within 2.4 km of DUC borders.

DUCs were located using GIS data provided by Policy Link.[102] Policy Link defines DUCs as unincorporated communities with urban parcel densities and median household incomes below 80% of the state average. Both "identified" and "potential" DUCs were included in the analysis. Although the dataset probably does not map all of the disadvantaged communities in the Tulare Lake Basin, it offers a helpful proxy for mapping the communities served by Community Water Center.[103]

The report's analysis began by running a 2.4 km buffer around DUC borders. Dairy names associated with points from the 2007 Dairy Facilities shapefile provided by the Regional Board falling within this buffer were recorded. Dairies listed as closed or vacant were removed from the list. A second buffer analysis was run on shapefiles mapping dairy facility and land application parcels for 2012. If polygons from these shapefiles fell within the buffer, the dairies to which they belonged were included in the list. These 2012 parcel files were, however, incomplete.[104] Finally, aerial imagery from ArcGIS was reviewed to visually identify dairy facilities that fell within buffers.[105] Using this combination of methods, 124 dairies were identified.

Ideally, this analysis would have run the buffers from DUC drinking water wells rather than borders. The author did not have access to well locations. It also would have intersected those buffers with a complete database of dairy facility and cropland parcels. The resulting list of dairies could be refined if additional data becomes available.

B. Dairy Nutrient Management Practices

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[99] Lockhart et al., *supra* note 26, at 152-53.
[100] *Id.*
[101] *Id.*
[102] FLEGAL, ET AL., *supra* note 3.
[103] In several instances, the Policy Link data listed more than one name for a single DUC polygon. Names were assigned according to the following procedure. If there was a name in the "Label 2010" field, that name was used. If there was no name in the "Label 2010" field and more than one name in the other fields, one name was chosen and the second name was recorded as an alternative DUC name.
[104] The Regional Board provided a spreadsheet of all application parcels. About 70% of Fresno parcels mapped in GIS, but only 58 of over 2,000 Tulare County Parcels displayed. APNs were not reported in standard format and seemingly random variation in parcel reporting thwarted efforts to clean the data.
[105] This method identified 9 additional dairies, but was not comprehensive.

The Regional Board provided scanned copies of Annual Reports filed with the Fresno office for 2007 through 2012. The files were organized by county (Fresno, Kern, Kings, Madera, and Tulare), but only named by address. Files were renamed according to both dairy address and facility name or names. Next, dairies identified through the GIS buffer analysis were matched to Annual Reports. This match was successful for all but two of the 124 dairies.

When available, information was tabulated for each dairy from its 2007 Existing Conditions Report and its 2012 Annual Report. When the 2007 ECR was incomplete, the 2007 Annual Report was used. If the 2012 Annual Report was unavailable, the 2011 Annual Report was used if available, complete, and did not indicate that the dairy was closing. If the 2012 Annual Report was incomplete (e.g. missing the whole-farm nitrogen ratio), the author attempted to manually calculate the missing information. If that was not possible, the 2011 Annual Report was used.

Dairies were marked as closed and 2012 information was not recorded if both the 2012 and 2011 Annual Reports were missing or if either the 2011 or 2012 Annual Report included a statement that the dairy was closed or closing.

The following information was tabulated from dairy Annual Reports: facility address, cropland and facility acreage, herd composition, gross nitrogen excretion, nitrogen application, nitrogen imports, nitrogen exports, and whole-farm nitrogen ratio. For 2012, a notation was made if dairies had fields on which nitrogen budgets exceeded 1.4.

The Regional Board also provided a spreadsheet with dairies' on-farm well monitoring data. If data was available for 2012, the number of wells with nitrate concentrations above the MCL was recorded. If no data was recorded for 2012, 2011 data was used. If neither 2012 nor 2011 data were available, the number of well violations was recorded as 0.

To identify dairies with General Order violations, the Enforcement Orders database of the State Water Resources Control Board's California Integrated Water Quality System (CIWQS) was queried.[106] For each Tulare Lake Basin County, a search was conducted using the ANISTCOWS (the code for the General Order) field for all types of enforcement actions both active and historical from May 3, 2007 (the day the General Order came into force) to present. The number of violations, types of violations, number of enforcement actions, and types of enforcement actions were recorded. When dairies' CIWQS profiles listed enforcement actions but no violations, the number of violations was recorded as 1.

Additional information on the data collected for each dairy can be found in the METADATA workbook of the spreadsheet included as Attachment A.

IV. RESULTS AND DISCUSSION

A. Dairies

This report identified 124 dairies within 2.4 kilometers of 45 different DUCs in the Tulare Lake Basin. 39 of these dairies are located in Fresno County, 9 in Kern

[106] *Enforcement Orders Report*, STATE WATER RESOURCES CONTROL BD., http://tinyurl.com/qc2b4p2 (last visited June 1, 2014).

County, 15 in Kings County, 4 in Madera County, and 57 in Tulare County. 18 of these facilities closed or probably closed between 2007 and 2012. The 102 dairies for which full information was available housed 254,459 cows (153,703 adult cows), for an average size of 2,495 cows per dairy (1,507 adult cows).[107] These 102 dairies spread manure on 40,285 acres. The largest dairy, Hilarides Dairy in Lindsay, Tulare County, reported 17,579 cows (10,876 adult cows) in its 2012 Annual Report. All of the lagoons at these facilities are unlined.

55 of the 124 dairies were located in either HVAs or GWPAs. 47 dairies reported having one or more on-farm wells with nitrate concentrations above the MCL. Of those 47 dairies, 29 are located in HVAs or GWPAs.

In 2012, 22 dairies applied more than 560 lbs N/ac, with 2 of those dairies applying more than 990 lbs N/ac. 7 dairies reported nitrogen budgets between 1.4 and 1.65. 8 reported nitrogen budgets over 1.65. Nitrogen budget data included several irregularities. 3 dairies reported nitrogen budgets over 1,000. 12 reported nitrogen budgets less than 0.4, and 7 of those had nitrogen budgets less than 0.3.

The Regional Board has cited 23 of the 124 dairies for violations of the General Order. The Regional Board has initiated Administrative Civil Liability actions against 3 dairies. 13 enforcement actions are active.

B. Trends

Comparing information from the 102 dairies for which there was complete information in both the 2007 ECRs and either the 2012 or 2011 Annual Reports may provide insight into trends within the Tulare Lake Basin. These insights are only tentative, however. The sample of dairies is not random, and data for 2008-2011 was not collected. Calculation methods may have also shifted over time.

Comparing 2007 to 2012 data generally shows improvements in nutrient management practices. The number of adult cows fell by about 5% (8,000 cows) over this period. 63 dairies reported nitrogen budgets over 1.4 in 2007; whereas only 15 dairies reported nitrogen budgets over 1.4 in 2012. In 2012, 77 dairies reported nitrogen budgets that were the same or lower than their 2007 nitrogen budgets, while 25 dairies reported higher nitrogen budgets. Similarly, 85 dairies reported applying less N/ac in 2012 than in 2007. In 2007, 60 dairies applied more than 560 lbs N/ac, whereas only 22 dairies were applying that much in 2012. The number of dairies using chemical fertilizers fell from 36 in 2007 to 19 in 2012, with only 6 dairies increasing their use over that period.

C. DUCs

45 DUCs are located within 2.4 km of dairies. 10 of these DUCs are in Fresno County, 10 in Kern, 4 in Kings, 2 in Madera, and 19 in Tulare County. 32 of the DUCs are located near one or more dairies within a HVA or GWPA. 23 DUCs are located near dairies with wells exceeding the MCL, and 16 have one or more dairies reporting nitrogen budgets above 1.4 within their buffer.

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[107] A dairy's herd consists of milking cows, dry cows, bred heifers (15 – 24 months), heifers (7-14 months), calves (4-6 months), and young calves (0-3 months). Milking cows and dry cows are considered adult cows.

9 DUCs have 5 or more dairies within 2.4 km. Paige (12 dairies) and Riverdale (11 dairies) have the highest number of dairies applying manure within their buffer zones. After Riverdale, the DUC with the most pounds of nitrogen applied by dairies within its buffer is Pixley, even though it has only 4 dairies within 2.4 km.

Several of these communities are affected by nitrate contamination. According to DPH's Small Water System Program Unit, Ducor, Yettem, and Goshen are served by systems that violated the nitrate MCL between July 2010 and November 2011.[108] The author also used GeoTracker GAMA to identify other DUCs served by water systems with MCL violations since 2000. In addition to confirming the Ducor, Yettem, and Goshen exceedences, GeoTracker GAMA data suggests that all or part of Caruthers, Lanare, Cutler, Farmersville, Plainview, Traver, Matheny and Matheny Tract, and Pixley may receive water from nitrate-contaminated wells.[109] This assessment is very provisional. More work is needed to determine whether the water received by residents of each of these 45 DUCs is contaminated.

D. Going Forward

There are likely more dairies in the Tulare Lake Basin within 2.4 km of low-income communities than identified by this study. Nevertheless, the 106 active dairies identified in this report can serve as a starting point for explicitly incorporating the protection of economically and socially vulnerable communities into the enforcement of the General Order.

The information collected in this report could be used to create risk profiles of both dairies and the DUCs they border. Appendix B provides an example. It lists the individual dairies near each DUC and key indicators of their nutrient management practices. When nitrogen budgets and lbs N/ac are above thresholds of concern, they are highlighted.

In addition to flagging potentially dangerous nutrient management practices, this report can also be used to identify anomalies in nutrient management reporting. For instance, dairies with unusually low nitrogen budgets may not be accurately reporting the amount of nitrogen applied and harvested.

It is the author's hope that the database assembled for this project can be integrated with the data and insights generated by Dr. Harter and the Representative Monitoring Program.

V. RECOMMENDATIONS

1. The Regional Board should use proximity to DUCs as a factor in determining which facilities should receive priority for inspection.

[108] *Small Water Systems Support: List of Program Plan Systems*, CAL. DEP'T OF PUB. HEALTH, http://tinyurl.com/mqurfbf (last visited June 5, 2014). The water systems are: Ducor CSD, Yettem Water System, and West Goshen MWC. Caruthers, Lanare, Riverdale, Hamblin, and Pixley are on this list for Arsenic contamination.

[109] Exceedences were identified for Caruthers CSD, Bakkman Water Co. (Lanare), Orosi High School (Cutler), Plainview MWD, Traver Water LLC, Pratt MWC (Matheny and Matheny Tract), Pixley PUD. Farmersville could be located near GAMA monitoring well TUL1076. Since GAMA GeoTracker wells are only mapped within a mile of their true location, this list may contain inaccuracies.

The Regional Board relies on inspections to determine compliance with the General Order.[110] The Regional Board aims to inspect each dairy once every three years. It prioritizes the order in which dairies are inspected based, at least in part, on past violations. The Regional Board does not formally consider proximity to DUCs. Although the General Order makes no mention of disadvantaged communities, the State Board Enforcement Policy instructs Water Boards to "[i]integrate environmental justice considerations into the enforcement of environmental laws, regulations, and policies."[111]

The Regional Board should use this information to prioritize inspections of dairies close to low-income communities. These communities are more likely to be affected by nitrate contamination and less likely to have the economic resources to cope with this contamination. Although this list is incomplete, it offers a starting point to begin integrating environmental justice into the enforcement of the General Order.

The manner in which the Regional Board incorporates disadvantaged communities into its inspection program could take several forms. For instance, the Board could prioritize inspections based solely on proximity to a disadvantaged community. It could also consider problematic nutrient management practices (e.g. nitrogen budget above 1.4 and nitrogen applications above 560 lbs N/ac) and anomalous reporting (e.g. nitrogen budget below 0.4). Inspections could prioritize facilities located in HVAs or GWPAs and those with on-farm well exceedences. Alternatively, priority could be assigned to facilities located near the most impacted disadvantaged communities. Those communities could be identified based on evidence that their residents have received nitrate-contaminated water (e.g. inclusion on CDPH's List of Program Plan Systems or GeoTracker GAMA data) or have high levels of dairy-derived nitrogen loading nearby (e.g. lbs nitrogen applied by dairies within 2.4 km). The lists provided in Appendix A can be used to implement some of these approaches to prioritization.

2. The Regional Board should demand additional water quality testing by dairies near DACs.

The Regional Board "may investigate the quality of any waters of the state within its region."[112] During these investigations, the Regional Board "may require that any [discharger] . . . furnish . . . technical or monitoring program reports which the regional board requires."[113] This testing can be used to determine if the discharger has "caused or permitted . . . a condition of pollution or nuisance," and is subject to a Cleanup and Abatement Order.[114]

The Regional Board should exercise this authority to determine if dairies are causing contamination affecting disadvantaged communities. The highest priority for these orders are the 10 dairies with on-farm wells with MCL exceedences within 2.4 km

[110] Telephone Interview with Dough Patteson and Clay Rodgers, Central Valley Regional Water Quality Control Board (May 20, 2014).
[111] STATE WATER RESOURCES CONTROL BD., WATER QUALITY ENFORCEMENT POLICY 3 (2009), *available at* http://tinyurl.com/lq7276d.
[112] CAL. WATER CODE § 13267(a) (2014).
[113] *Id.* § 13267(b)(1).
[114] *Id.* § 13304(a).

of Goshen and Yettem, two of the communities in the region listed on CDPH's List of Program Plan Systems for nitrate contamination. A list of these dairies, along with others located near DUCs with nitrate-contaminated drinking water, is provided in Appendix A.

Several disadvantaged communities in the Tulare Lake Basin receive their water from unregulated wells. Dairies near these communities with problematic nutrient management practices or recorded on-farm well exceedences should be required to test nearby private wells as part of Regional Board-initiated water quality investigations. Further research will be needed to identify these communities.

3. The Regional Board should require electronic and standardized reporting.

Dairies or their consultants complete Annual Reports using a computer. Submitting hard copies forces the Regional Board to scan them. Although the Fresno office regularly scans all of its reports, it appears that the Rancho Cordova and Redding offices may not. Even if the reports are scanned, analyzing them requires tabulating data by hand. This process makes little sense for the Regional Board or anyone else who might want to analyze this data.

At minimum, dairies should email pdfs of Annual Reports to the Regional Board to avoid scanning. The Regional Board should also create an electronic Annual Report form to facilitate the extraction and analysis of data. If developing such a form is too onerous, then dairies should at least be required to record key information (cropland acres, lbs N applied, and nitrogen budget) in a separate spreadsheet. This would take almost no effort and exponentially increase the accessibility of information about nutrient management practices.

Dairies in the Tulare Lake Basin use at least two different formats for their Annual Reports.[115] Presenting the same information in different formats makes extracting that information more difficult. More troubling is the fact that some reporting formats seem to consistently contain less information than others. The Regional Board should require the use of a standardized Annual Reporting form to ensure that required information is comparable across dairies and years.

4. The Regional Board should require dairies to report more information about on-farm water quality monitoring.

Dairies currently report the nitrate concentrations of water from on-farm wells. Those wells are identified by name and classified as either domestic or agricultural. No other information about the wells is provided. Interpretation of that data would be aided if dairies also reported the depths at which wells are drilled and screened.

[115] The 2012 Annual Report of RichMar Farms (Kern County,1129 E Shafter Rd) is an example of the most common Annual Report format. The 2012 Annual Report of H & P Dairy (Kern County, 5021 Bear Mountain Blvd) is an example of an alternative format, which, at least in this case, did not include the tabulation of field-based or whole-farm nitrogen budgets.

VI. CONCLUSION

We cannot act on what we cannot see, and for decades California's unincorporated communities have been practically invisible. The mapping of these communities by Policy Link creates an opportunity for action. We know that disadvantaged communities in the San Joaquin Valley are disproportionately burdened by nitrate-contaminated groundwater. We know that San Joaquin Valley dairies contaminate groundwater with nitrates. This report shows that drinking water in numerous disadvantaged communities throughout the Tulare Lake Basin is susceptible to contamination from nearby dairies. Identifying those dairies enables the Regional Board to fulfill its mandate to integrate considerations of environmental justice into enforcement actions. That process should begin as soon as possible.

Appendices

Appendix A: Dairies Near DUCs
- Active Dairies
- Closed Dairies
- Dairies in Hydrologically Vulnerable Groundwater Environments
- Dairies with On-Farm Well Violations of Nitrate MCL in 2012
- Dairies Exceeding Nitrogen Budget in 2012, or with Nitrogen Budgets under 0.4
- Dairies Applying More Than 560 lbs N/ac in 2012
- Dairies Near DUCs Served by Wells With Recent Exceedence of Nitrate MCL

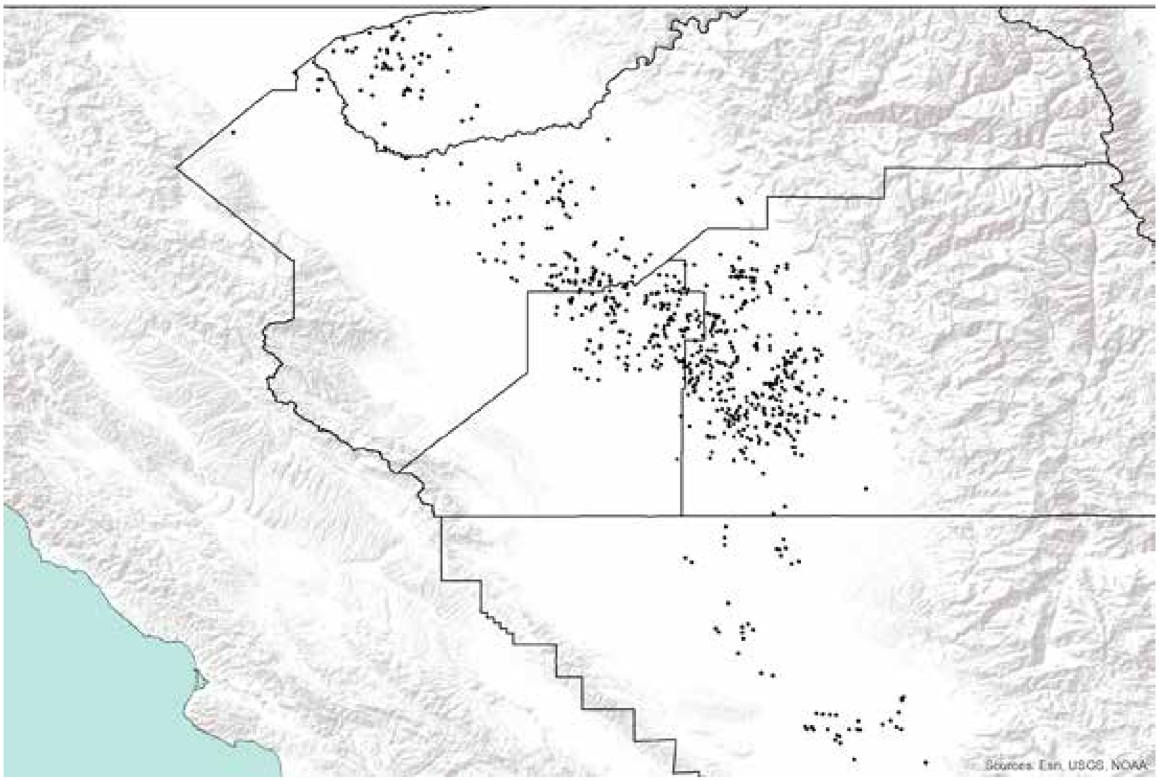
Appendix B: DUC Profiles
- List of DUCs Within 2.4 km of Dairy
- Tabulated Statistics for DUCs
- Kern County DUC Profile
- Kings County DUC Profile
- Fresno County DUC Profile
- Tulare County DUC Profile
- Madera County DUC Profile

Maps

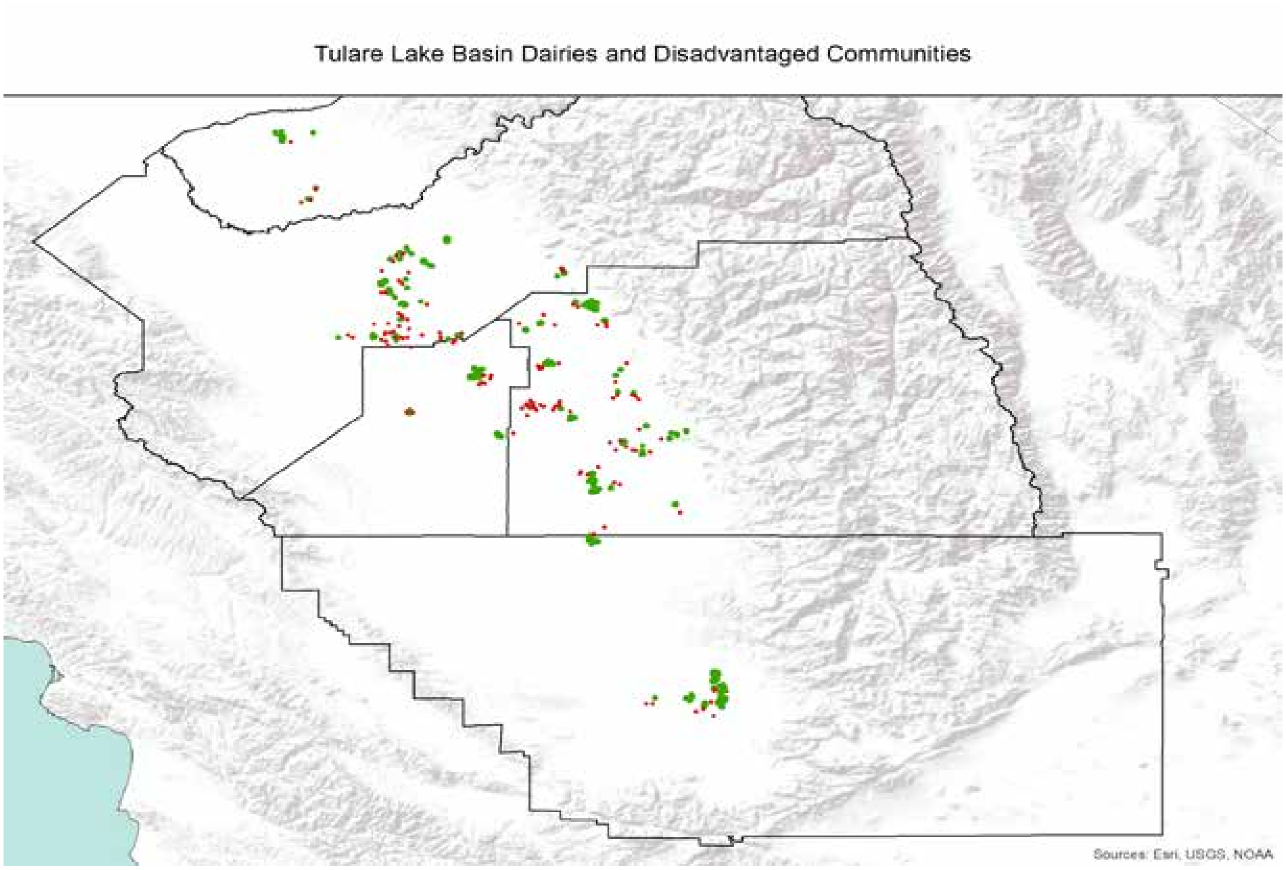
I. Tulare Lake Basin Dairies
II. TLB Dairies Near DUCs
III. 2012 Nitrogen Budgets
IV. Vulnerable Groundwater and On-Farm Well Violations

I.

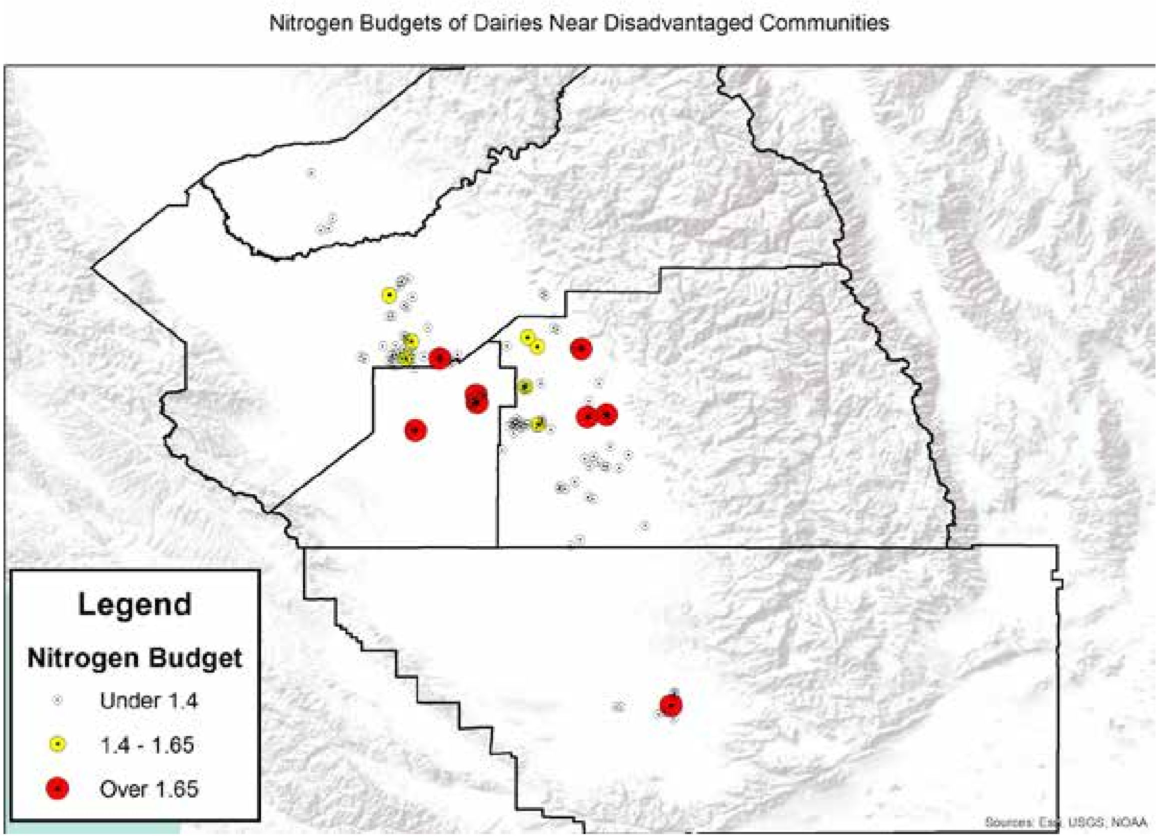
Tulare Lake Basin Dairies



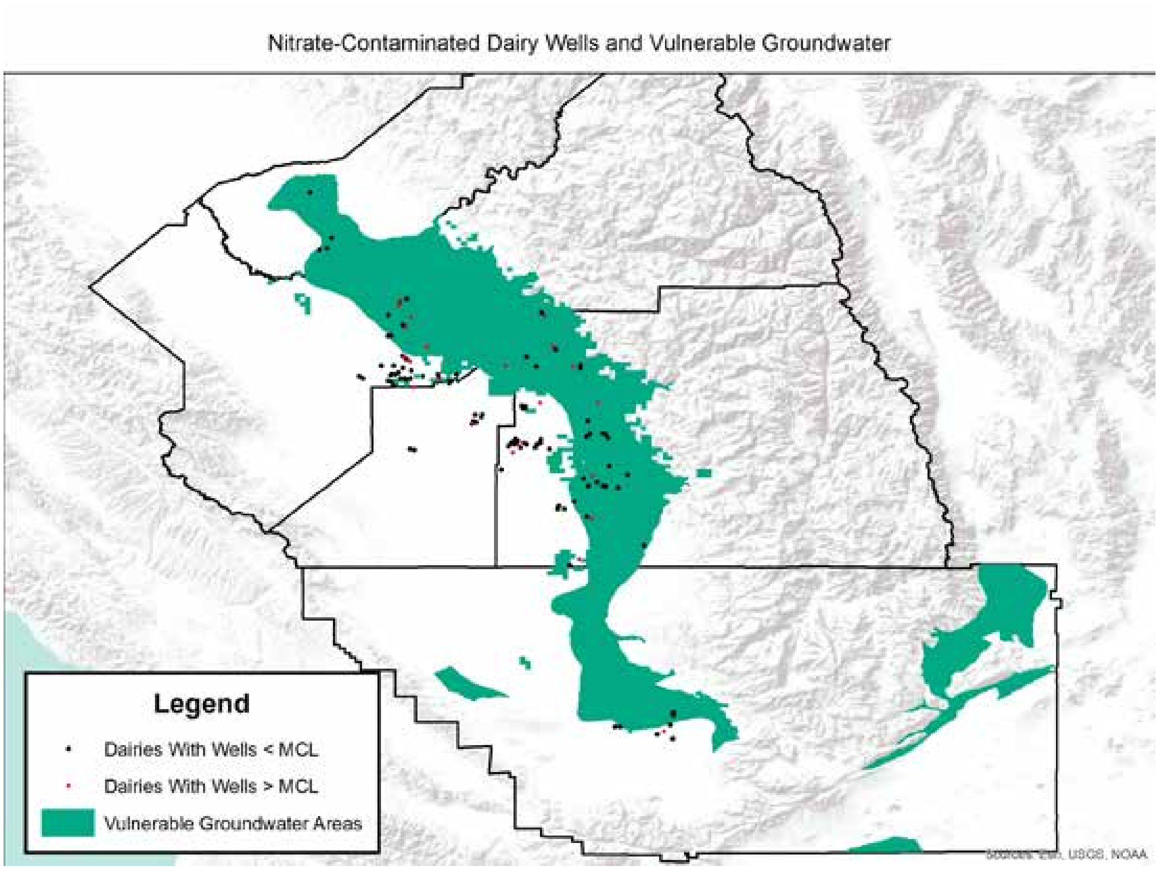
II.


Tulare Lake Basin Dairies and Disadvantaged Communities
Sources: Esri, USGS, NOAA

III.


Nitrogen Budgets of Dairies Near Disadvantaged Communities
Legend
Nitrogen Budget
Under 1.4
1.4 - 1.65
Over 1.65
Sources: Esri, USGS, NOAA

IV.


Nitrate-Contaminated Dairy Wells and Vulnerable Groundwater
Legend
Dairies With Wells < MCL
Dairies With Wells > MCL
Vulnerable Groundwater Areas
USGS, NOAA