Preliminary Risk Analysis of Nitrate Contamination in the Salinas Valley and Tulare Lake Basin of California, Including the Implementation of POU Devices in Small Communities and a Review of Regulatory and Funding Options to Mitigate Nitrate Contamination

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i Abstract

Nitrate is a drinking water contaminant prevalent in the Salinas Valley and Tulare Lake Basin (the study area), mainly due to fertilizer use in agriculture and manure application from dairies. U.S. EPA's process for establishing drinking water standards for contaminants (including nitrate) is detailed in the first section. The public health effects from nitrate ingestion and the extent of nitrate contamination in the study area is described. Next, the public health risk of methemoglobinemia in infants and gastric cancer in adults is estimated for water systems in the study area based on available nitrate monitoring data. While there are many options for dealing with nitrate contamination in drinking water, point-of-use devices are evaluated as an option for decreasing public health risk. Finally, current regulatory, planning, and funding programs to manage nitrate in groundwater contamination in California are reviewed and suggestions to help form a state-wide solution are made.

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iii Table of Abbreviations

Abbreviation	Full Name
AB	Assembly Bill
AMBAG	Association of Monterey Bay Area Governments
AQUA	Association of People United for Water
ARRA	American Recovery and Reinvestment Act
AWP	Agricultural Waiver Program
BMP	Best Management Practices
CAA	Cleanup and Abatement Account
CalEPA	California Environmental Protection Agency
CalNRA	California Natural Resources Agency
CCR	California Code of Regulations
CCR	Consumer Confidence Report
CDBG	Community Development Block Grant
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health
CoBank	Cooperative Bank
CRWA	California Rural Water Association
CV-SALTS	Central Valley Salinity Alternative for Long-Term Sustainability
CVSC	Central Valley Salinity Coalition
CWA	Clean Water Act
CWC	Community Water Center
CWSRF	Clean Water State Revolving Fund
DPEIR	Draft Program Environmental Impact Report (of the Central Valley ILRP)
DPR	California Department of Pesticide Regulation
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
DWSRF	Drinking Water State Revolving Fund
EDA	U.S. Economic Development Administration
EPG	Expense Reimbursement Grant Program
ERP-ETT	Enforcement Policy Response and Enforcement Targeting Tool
FFLDERS	Feed, Fertilizer, Livestock, Drugs, Egg Quality Control Regulatory Services
FMIP	Fertilizing Materials Inspection Program
GAMA	Groundwater Ambient Monitoring and Assessment
HAC	Housing Assistance Council
HSNC	Historical Significant Non-Compliers
HUD	U.S. Department of Housing and Urban Development
I-Bank	California Infrastructure and Economic Development Bank
ILRP	Irrigated Lands Regulatory Program
IRWM	Integrated Regional Water Management

ISRF	Infrastructure State Revolving Fund
KCWA	Kern County Water Agency
LLNL	Lawrence Livermore National Lab
MCL	Maximum Contaminant Level
MCWA	Monterey County Water Resources Agency
MHI	Median Household Income
MUN	Municipal or domestic water supply (beneficial use)
NDWC	National Drinking Water Clearinghouse
NMP	Nutrient Management Plan
NPDES	National Pollutant Discharge Elimination System
NRWA	National Rural Water Association
NWG	Nitrate Working Group
OW	EPA's Office of Water
PES	Payment for Ecosystem Services
PHG	Public Health Goal
POE	Point-of-entry treatment
Porter-Cologne	Porter-Cologne Water Quality Control Act (California Water Code § 13000 et seq.)
POU	Point-of-use treatment
PPL	Project Priority List
PWS	Public Water System
RCAC	Rural Community Assistance Corporation
RCAP	Rural Community Assistance and Partnership
RUS	Rural Utilities Service
SB	Senate Bill
SDWA	Safe Drinking Water Act
SDWSRF	Safe Drinking Water State Revolving Fund
SEP	Supplement Environmental Program
SHE	Self-Help Enterprises
SRF	State Revolving Fund
U.S. EPA	United States Environmental Protection Agency
U.S.C.	United States Code
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
WARMF	Watershed Analysis Risk Management Framework
WDR	Waste Discharge Requirements
WEP	Water Environmental Program
WMP	Waste Management Plan

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1 Introduction

Risk based procedures are used by the U.S. Environmental Protection Agency (U.S. EPA) to set drinking water quality standards for public water systems. Their procedures differ depending on whether the contaminant is cancer-causing or noncancerous. Section 2 of this paper provides a summary of the contaminant evaluation and risk assessment process used by EPA to determine drinking water quality standards. After the general standard setting process is understood, in Section 3 we look closely at nitrate contamination in drinking water and use California's Salinas Valley and Tulare Lake Basin as a case study of the problem. In this study area we describe the scope of nitrate contamination and explain why drinking water users in these regions are particularly susceptible to nitrate contamination. Next, Section 4 describes one possible solution for communities faced with nitrate contaminated drinking water: the installation of Point of Use (POU) drinking water treatment devices. While POU devices are only feasible (and currently in California, are only allowed) for water systems with less than 200 connections, they may help reduce the health risk of drinking contaminated water. Section 4 gives a background of the regulatory environment and feasibility of POU devices as a compliance technique for meeting drinking water standards. In this section, we also estimate the current public health risk in the study area for drinking nitrate contaminated water, currently and with the implementation of POU devices in all public water systems with less than 200 connections (regardless of nitrate level). Sections 5 and 6 summarize the current regulatory and funding programs, respectively, to manage nitrate in groundwater contamination in California and make suggestions to help inform a state-wide solution.

2 Drinking Water Standards

The Safe Drinking Water Act (SDWA), passed in 1974 and amended in 1986 and 1996, protects the public health by regulating drinking water and its sources. The first passage of SDWA focused on treating drinking water to meet safe standards by authorizing U.S. EPA to establish National Primary Drinking Water Regulations (NPDWRs) for contaminants that pose a health concern. The 1996 amendments re-focused the regulatory program on risk-based priority setting and added benefit-cost analysis requirements to setting standards. They also recognized the importance of protecting source water, training drinking water system operators, funding water system improvements, and educating the public.

The NPDWRs are separated into two categories based on enforceability of the standard. The first, Maximum Contaminant Level Goals (MCLGs), are recommended purely from a health standpoint. This is the level at which "no known or anticipated adverse effects….occur and which allows for an adequate margin of safety" (SDWA Section 1412(b)(4)(A), 1974). The second category established by the NPDWRS is the Maximum Contaminant Level (MCL) and is defined as the "level which is as close to the maximum contaminant level goal as is feasible" (SDWA Section 1412(b)(4)(B), 1974). Compared to MCLGs, the MCLs are often less stringent because they consider the economic impact to public water systems of treating or blending to meet the standard. They also must be set at a level which is measurable with current available technologies. The MCL is the mandatory maximum level of contaminant that can be delivered by a public water system to a household. Public water systems face severe fines for any MCL violations.

The drinking water regulations are developed through a long and careful risk-based analysis. EPA's definition of risk from the Integrated Risk Information System is the "probability of injury, disease, or death from exposure to a chemical agent or a mixture of chemicals". The emphasis is on the probability of the adverse effect and not on the actual effect. In other words, one adverse effect is not weighted stronger than another "less serious" effect. This section will describe risk in more detail and outline the process through which EPA develops, sets, and evaluates drinking water standards from a public health risk assessment perspective.

2.1 Evaluating a Contaminant

The EPA uses three criteria when deciding whether or not a NPDWR should be established for a particular contaminant. The general questions they ask are:

- Does the contaminant harm human health?
- Is the contaminant detectable in drinking water?
- Is the contaminant known to occur in drinking water?

To be regulated, a contaminant must be positive for the above three questions. The EPA will look at the health research that has been conducted on a contaminant and then evaluate whether or not it would pose a significant risk to humans. The review of health research enables experts to estimate the amount of a contaminant that may be harmful to an individual over a lifetime of exposure. Current technology must be available to detect the contaminant in water, otherwise establishing a maximum limit is futile. In addition, the contaminant must obviously be present in drinking water supplies. While these questions must be answered for all contaminants under review, the standards are established slightly differently for noncancerous and for cancer-causing chemicals.

2.1.1 Noncancerous Chemicals

Drinking water contaminants that do not pose a cancer threat are evaluated based on the daily amount that an individual drinking 2 liters of water daily for 70 years could safely ingest (Cotruvo 1988). This amount plus a conservative margin or safety is called the acceptable daily intake. The MCLGs and MCLs for noncancerous chemicals are established from the process described above.

2.1.2 Cancer-Causing Chemicals

The SDWA amendment of 1974 enforces a MCLG of zero for probable human carcinogens. EPA's 1986 Guidelines for Carcinogen Risk Assessment assumes a "low-dose linearity to extrapolate the cancer risk range" (Bennett 2000). In other words, EPA assumes that carcinogenic effects do not have a threshold and any exposure to carcinogens is a threat to humans. This assumption is also made for microbiological contaminants, so MCLGs for carcinogens and microbes are set at zero (Dozier & McFarland 2006).

However, a zero level is usually not possible to achieve, so MCLs must be set at a level based on the desired level of acceptable risk. For example, the EPA will try to set MCLs for cancerous contaminants at a concentration that is estimated to cause a 10^{-6} level of cancer risk (i.e., the probability that an individual will develop cancer as a result of a lifetime of exposure is one in 1,000,000) (Munro & Travis 1986). Regulators can estimate toxicity of a contaminant at a given level by performing a risk assessment.

2.2 Risk Assessment

US EPA uses the format established by the National Academy of Sciences in 1983 to describe its risk assessment process. This process provides information on potential health risks and has four main elements:

1. Hazard identification
2. Dose-response assessment
3. Exposure assessment
4. Risk characterization

These four elements directly influence EPA's drinking water standard development (U.S. EPA 2010a).

2.2.1 Hazard Identification

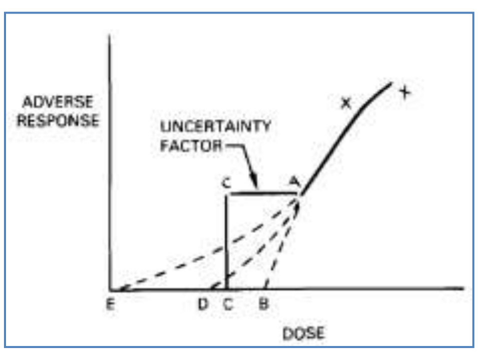
During the hazard identification stage, EPA will determine whether or not human exposure to a specific drinking water contaminant can cause an increase in the incidence of an adverse health effect. Epidemiological studies can sometimes be performed to statistically evaluate the association between exposure and adverse health effects. More frequently, however, results from animal studies are extrapolated to humans after careful consideration of the uncertainties in the experiment. Hazard identification weighs the evidence of adverse health effects to determine if a qualitative threshold like "Carcinogenic to Humans" can be applied with confidence. These descriptive thresholds enable policy makers to label contaminants in a way that is comprehensible to the general public.

2.2.2 Dose-Response Assessment

The second step of a risk assessment involves a dose-response assessment in which a quantitative relationship is derived between the human exposure (the dose) and the probability of an adverse health effect (the response). This assessment compares the likelihood and intensity of adverse health effects at different levels of exposures. This is often difficult because it involves gathering detailed information on water and food consumption patterns while controlling for age, weight, health, and other life-style factors. Additionally, it is impractical to study and develop dose-response curves for all possible health effects, so after experts perform a few crucial studies, the adverse effect that occurs at the lowest level of exposure will be selected as the critical effect for the risk assessment process.

After dose-response relationship data (for humans and/or animals) are gathered and synthesized, toxicologists must extrapolate the data to estimate the risk below the lower range of available information to infer the critical region where the contaminant concentration would begin to cause an adverse health effect in humans. As an example, the dose response curve in Figure 1 shows data collected from point X to point A. Points B, C, D, and E are all presumed exposure thresholds for an adverse effect in humans. Based on the nature of the "mode of action" (sequence of events from contaminant interaction with a cell to the resulting effect, e.g. cancer formation), the EPA will extrapolate the data through either a non-linear or linear dose-response assessment.

Figure 1. An example dose response curve (Cotruvo 1988)



A non-linear assessment is used when the mode of action suggests that the toxicity has a threshold, i.e. there is a contaminant concentration below which no adverse effect is expected. The dose-response curve will have a slope of zero from a dose of zero to some finite value. In Figure 1, if the curve is expected to follow line A-D, no adverse effect will occur between concentrations of E and D. If available studies do not allow for the calculation of a dose level where no observed adverse effect occurred (the NOAEL), mathematical modeling can be used to develop a Benchmark Dose Lower-confidence Limit (BMDL). The BMDL is a statistical lower confidence limit on the dose that produces a selected change (generally 1-10%) in the response rate of an adverse effect (U.S. EPA 2010a). The resulting NOAEL or BMDL is then divided by a safety factor to determine the reference dose (RfD), or "the estimate of a daily oral exposure to the human population (including sensitive groups…) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (U.S. EPA 2010a). The safety factor is equal to the following uncertainty factors multiplied together: uncertainty from differences between effects on humans and on animals (generally 10x), variability in the human population (generally 10x), and the absence of key toxicity duration or effects (U.S. EPA 2010a). In Figure 1, point C is the acceptable daily intake concentration determined through application of a safety/uncertainty factor to the dose at point A. The EPA uses guidelines adopted by the National Academy of Sciences for choosing safety factors in the development of drinking water standards. The general guidelines are:

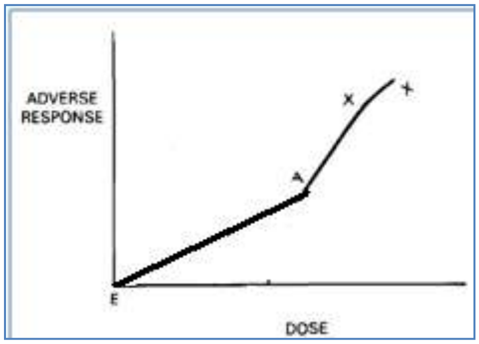
> **10 Factor:** Valid experimental results from studies on prolonged human ingestion with no indication of carcinogenicity.
>
> **100 Factor:** Experimental results from studies of human ingestion not available or scanty. Valid results from long-term feeding studies on experimental animals or, in the absence of human studies, on one or more species. No indication of carcinogenicity.
>
> **1000 Factor:** No long-term or acute human data. Scanty results on experimental animals. No indication of carcinogenicity.
>
> (Cotruvo 1988)

A linear dose-response assessment is used when the mode of action data suggest that the toxicity does not have a threshold and that any amount of the contaminant is harmful. To extrapolate for linear assessments, a straight line is drawn from the last point of observed data to the origin. This is represented by line A-E in Figure 1and is characteristic of all carcinogens. The slope of this line is called the slope factor or cancer slope factor and enables the calculation of excess lifetime cancer risk through the following equation:

$$\text{Cancer Risk} = \text{Dose} \times \text{Slope Factor}$$

This risk is also described as the probability that an individual will contract cancer over a lifetime.

Figure 2. A linear assessment of a dose response curve (adapted from Cotruvo 1988)



2.2.3 Exposure Assessment

After assessing the dose-response, an exposure assessment is performed by the EPA to evaluate the human exposure to the contaminant. This process will: "identify the exposed population, describe its composition and size, and present the type, magnitude, frequency, and duration of exposure" (U.S. EPA 2010a) or can estimate future exposures for a contaminant. The assessment will include uncertainties because exposure usually must be measured indirectly through models of chemical transport and estimates of human intake. EPA policy mandates that exposure is assessed at two levels: "High End" and "Central Tendency". High End exposure is the highest dose estimated to be experienced and is usually approximated at the 90^{th} percentile exposure level for individuals. Central Tendency exposure is the estimated average exposure for the affected population.

2.2.4 Risk Characterization

The last step in a risk assessment is risk characterization. During this stage, the *extra* risk of health problems from a drinking water contaminant is evaluated in the exposed population. Exposure and dose-response assessments are combined to reach a quantitative risk assessment and the "strengths and weaknesses, major assumptions, judgments, and estimates of uncertainties are discussed" (U.S. EPA 2010a). The risk characterization step is a risk analysis of the risks and uncertainties incorporated into the hazard identification, dose-response assessment, and exposure assessment. EPA's Risk Characterization Policy includes the following main principles: transparency, clarity, consistency, and reasonableness (U.S. EPA 2010a). These principles must be applied to all steps in the risk assessment.

2.3 Risk-Based Decision Making

Risk involves both the magnitude of a loss and the probability of that loss occurring. Despite the lengthy process to develop drinking water standards, it does not ensure the absolute safety of drinking water. Some risk and uncertainty are still present for many reasons. First, there is very little research on the human health effects from drinking small amounts of chemicals over long periods. In addition, most toxicity studies are performed on animals and then extrapolated to humans, with hopes that the health analyses will adequately carryover to humans. Also, the presence of other contaminants in drinking water may increase or decrease the toxicity of a contaminant. Even if the toxicity study and human health assessment results are accurate, the final standard setting process can become convoluted with political, social, and economic concerns.

During the risk assessment process described above, information on potential health risks is gathered. After this information is known, regulators must synthesize the results and rationally reach a decision. Risk-based decision making is often about weighing options and balancing tradeoffs. Different organizations approach risk evaluations from different perspectives: from the point of view of the individual and/or the total exposed population. In addition, as with most decisions, costs and benefits must also be carefully balanced when developing drinking water standards. Each organization or rule making authority must decide on the appropriate balance of methods and options to meet *their own* goals.

2.3.1 Individual Risk vs. Population Risk

Individual risk does not account for the number of exposed individuals. It can be expressed as a risk of fatality or for cancerous contaminants, as a lifetime risk of developing cancer. For example, an individual cancer risk of 10^{-6} means that there is a one in a million chance that a chronically exposed individual will develop cancer over their lifetime. Population risk, on the other hand, does account for the number of exposed individuals. For cancer-causing contaminants, population risk is expressed in cancers per year in the exposed population.

Current EPA policy is to target an individual cancer risk of 10^{-6} to 10^{-4} for drinking water (U.S. EPA 1992). They do not consider population risk because of the poor availability of data and the relative difficulty of collecting population risk data as compared to individual risk data. Regulating by population risk might be more consistent across multiple contaminants than regulating by the more variable individual risk (Munro & Travis 1986).

2.3.2 Cost-Benefit Analysis

When deciding on an appropriate stringency for a MCL, the EPA uses a cost-benefit analysis as an analytical tool. The MCL is to be set at a level that “maximizes health risk reduction benefits at a cost that is justified by the benefits” (SDWA Section 1412(b)(6), 1996). To reach this maximum, the many costs and benefits associated with drinking water regulations must be quantified.

The cost side of the analysis includes expenditures needed to comply with new regulations and of the market effects of these expenditures. Specifically: the costs of installing, operating, and maintaining contaminant removal technologies; contaminant monitoring costs; expenditures to report contaminant levels to the State/EPA; and annual household water bill increases.

The EPA identifies four main benefit categories which may be affected by drinking water regulations:

1. **reduced health risks**, including decreased risks of premature death, illness, or other health impacts,

2. **improved aesthetic qualities**, including tap water taste, odor, and appearance,

3. **reduced damages to materials**, primarily related to reduced corrosion of water system piping and equipment, and

4. **improved qualities for commercial and industrial use**, for example, in cases where contaminants would adversely affect production processes if not removed by the water supplier.

(U.S. EPA 1997a)

There is difficulty and uncertainty in putting monetary value on illness and human life. In the case of drinking water quality, dose-response curves can sometimes be used to estimate deaths or diseases avoided. The “cost of illness avoided” includes quantitative measurements like medical costs and lost pay from missed work. Benefits can also be determined by willingness to pay surveys. For example, instead of placing a dollar value on individual lives, the EPA uses willingness to pay estimates for a small reduction in an individual’s risk of dying from drinking water contamination. This estimate is referred to as the value of a statistical life or more accurately, the value of mortality risk reduction” and represents a dollar amount that a large group of people would be willing to pay collectively so that one less death occurs among the group per year (U.S. EPA 2010b). For example, if 100,000 people were willing to pay $100 on average to prevent the certain death of one person over the next year, the value of the statistical life would be $100 per person x 100,000 people, or $10 million. EPA’s published value of a statistical life is $7.4 million ($2006) (U.S. EPA 2010b).

If the total benefits of lowering an MCL for a contaminant exceed the total costs of implementing that MCL, the drinking water standard has passed the cost-benefit test. However, this test does not consider the distribution of benefits and costs among affected individuals and while some individuals will “win”, others will “lose” (i.e. suffer negative health effects).

2.3.3 Major Findings and Conclusions: Risk-Based Decision Making

The EPA uses a combination of deterministic and probabilistic procedures for evaluating potential drinking water contaminants, performing a risk assessment, and making a risk-based decision. Currently, Monte Carlo analyses are used for exposure assessments, but have not yet been approved for application to dose response evaluation for human health risk (U.S. EPA 1997b). Further studies on probabilistic techniques would enhance EPA’s abilities to analyze variability and uncertainty in risk assessments. Monte Carlo techniques could identify key sources of variability and uncertainty and could help quantify the relative contribution of these sources to the overall variance in risk assessment modeling results. Currently, EPA’s detailed and well-established procedures allow for a consistent determination of drinking water standards, but given the uncertainty inherent in drinking water regulations development, it seems prudent to continue gathering health data and updating policies.

As an example, risk-based decision making is applied in Section 4 to better understand the costs and benefits of using a point of use device to treat contaminated drinking water and reduce public health risks. Nitrate contamination in the Salinas Valley and Tulare Lake Basins of California is looked at specifically in the following section because of the extent and current relevance of this contaminant in these areas.

3 Nitrate in the Salinas Valley and Tulare Lake Basin

Now that the process for determining drinking water standards is understood, we will look at one particular drinking water contaminant (nitrate) and its effects on communities in California's Salinas Valley and Tulare Lake Basin.

3.1 Nitrate as a Contaminant

In the past, nitrate was not considered a high priority contaminant in drinking water. However, nitrate is currently the most common chemical contaminant in the world's groundwater aquifers and has significant potential to harm human health (Spalding & Exner 1993). Nitrate leaches into the groundwater predominantly from nitrogen-based fertilizer applied to agriculture and from organic fertilizer (manure) in California. While these are the main sources of nitrate contamination to the groundwater in California, some localized sources of contamination also exist: animal feeding lots, discharges from wastewater, and septic systems. Groundwater nitrate concentrations of more than about 10-15 mg/L as nitrate usually indicate anthropogenic nitrate sources (Mueller 1995).

The MCL for nitrate in drinking water was set by CDPH in 1994 at 45 mg/L as nitrate. This is equivalent to the federally mandated MCL of 10 mg/L nitrate as nitrogen, decreed in 1991 by OEHHA (CA EPA 1997). The equivalent limits, set by CDPH and OEHHA, imply that overall, CDPH believes that the economic and technical costs to this MCL are not enough to outweigh the potential public health risks of raising the MCL.

Nitrates ingested through drinking water are considered a health hazard mainly because of their correlation to methemoglobinemia. Bacteria in the stomach can convert nitrate to nitrite which then causes the oxidation of normal hemoglobin to methemoglobin, hindering the transport of oxygen from the lungs to tissues. The occurrence of methemoglobinemia in infants who are given formula mixed with nitrate contaminated water, is commonly referred to as "blue baby" syndrome. Infants less than six months are particularly susceptible (Bosch *et al.* 1950) because of various factors including: stomachs with a higher pH that allows for nitrate-to-nitrite converting bacteria to proliferate, the easier oxidation of fetal hemoglobin, and a reduced capability of metabolizing excess methemoglobin (CA EPA 1997). For breast-fed infants, total nitrate exposure is negligible (CA EPA 1997).

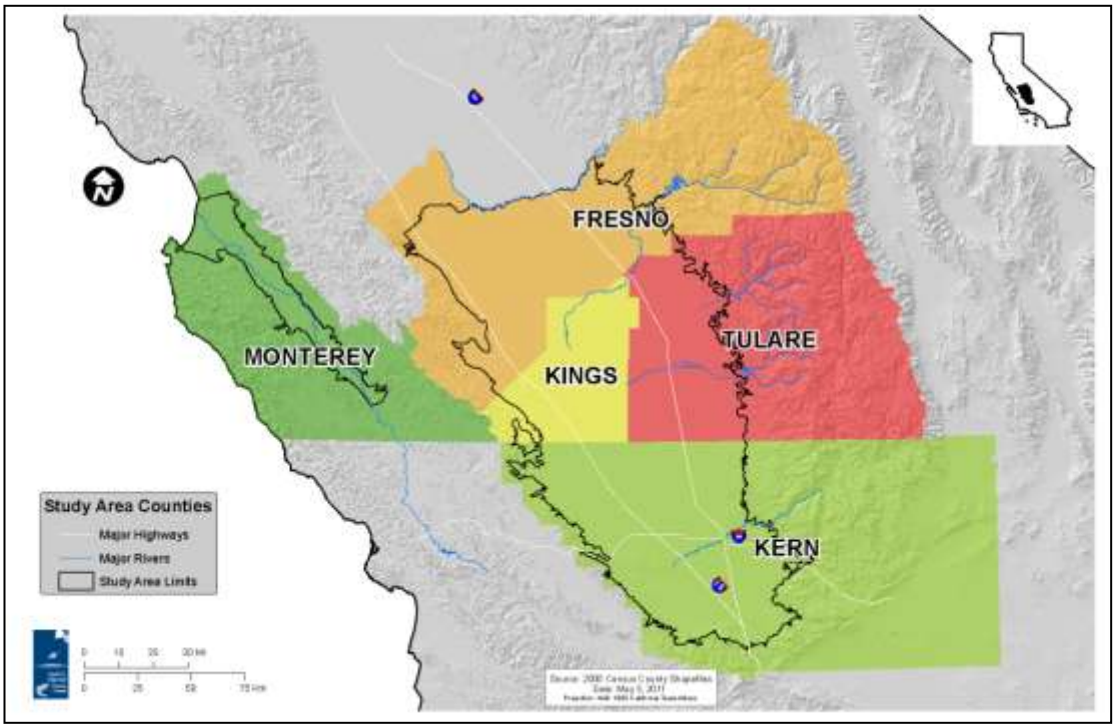
Nitrates in drinking water are also considered a health risk for individuals whose health situation may promote the development of methemoglobinemia, including: pregnant women, adults with glucose-6-phosphate dehydrogenase deficiency, adults with reduced gastric acidity (for example, individuals with heart or lung disease), and those with a lack of methemoglobin reductase (National Research Council 1995; CA EPA 1997). According to the EPA, long-term exposure to water with high nitrate levels may cause diuresis, increased starchy deposits, and hemorrhaging of the spleen (State Water Resources Control Board: Division of Water Quality GAMA Program 2010). Other studies suggest a possible association between high nitrate concentrations in drinking water and: cancer of the bladder and stomach (Morales Suarez-Varela *et al.* 1993; Morales-Suárez-Varela, Llopis-Gonzalez, & Tejerizo-Perez

1995); development effects in offspring (National Research Council 1995); and non-Hodgkin's lymphoma (Ward *et al.* 1996), but no cause-and-effect relationships have been shown in these cases.

3.2 Study Area Description

While nitrate is a potential health concern, people living in the Salinas Valley and Tulare Lake Basin in California (black outline in Figure 3) are faced with higher levels of nitrate than the statewide CA average. These areas were chosen for a case study to evaluate solutions to nitrate contaminated drinking water in an area of high susceptibility.

Figure 3. California's Salinas Valley and Tulare Lake Basin (Honeycutt 2011)



Drinking water users in the Salinas Valley and Tulare Lake Basin regions are particularly susceptible to nitrate contamination for three main reasons: lack of monitoring of small water systems, magnitude of contamination, and low socioeconomic status.

Monitoring. Many small communities and rural households are on local small systems (unregulated by the State) or on unregulated wells. While community public water systems (serving 15 or more connections) are required by the California Department of Public Health (CDPH) to monitor quarterly nitrate levels, along with some state-small systems (5-14 connections), smaller systems often have no monitoring requirement. Approximately 12% of the Tulare Lake Basin population and 10% of the Salinas

Valley receive drinking water from a groundwater well supplying water to fewer than five households.[1] Honeycutt *et al.* (2012) find that approximately 254,000 people in the study area are susceptible to nitrate contamination of drinking water. Of this total, 220,000 are on community public water systems (>15 connections) or state-small water systems (4-14 connections); and 34,000 are self-supplied (domestic wells) or local-small water systems (2-4 connections).

Contamination. These regions have more and larger nitrate contamination sources than most other regions in California. Major sources of groundwater nitrate contamination are fertilizer and animal manure use on agricultural lands, with some localized contributions from animal farming operations, wastewater treatment plants, food processing facilities, and septic systems. Four of the study area counties rank among the nation's top five counties for 2007 agricultural sales (crop and livestock sales): Fresno ($3.7 billion), Tulare ($3.3 billion), Kern ($3.2 billion), and Monterey County ($2.2 billion) (USDA 2007).

Socioeconomics. Over 17% of the Tulare Lake Basin population and over 10% of the Monterey County population live in poverty (USDA 2008). Many low-income communities cannot afford adequate drinking water treatment or alternative water supplies when nitrate levels exceed the maximum contaminant level (MCL) for drinking water, particularly when served by unregulated state and local small water systems. Increased costs and reduced water quality are often linked to the lack of technical, managerial, and financial capacity in small and disadvantaged communities. A recent study showed that community public water systems in areas of the Central Valley with a higher minority population or a lower socioeconomic status have statistically higher nitrate levels and that this disparity is especially prevalent among smaller public water systems (Balazs *et al.* 2011).

One solution to nitrate contaminated drinking water is to install point of use devices to treat drinking water at household taps. This can be implemented by individual households on their own or as a community-managed effort. For a community-wide implementation by a public water system, state regulations must be followed (see Section 4.1). Regardless of the scale of implementation, using a POU device as a means for complying with the drinking water standards may reduce public health risk. Section 4 below details one possible method for quantifying this reduction in risk.

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[1] Census block group data from 1990 (U.S. Census Bureau 2011). Refer to Honeycutt *et al.* (2012) for a formal definition.

4 Evaluation of the Public Health Risk of POU Devices for Nitrate Treatment

4.1 Background: POU Devices and Regulations

Point-of-use (POU) devices are drinking water treatment systems placed in each household at the point where water is to be drawn for drinking and cooking purposes. The system is either stored on the kitchen counter or under the sink and must be certified by CDPH. Depending on the desired contaminant removal, different treatment options are available: granular activated carbon, reverse osmosis, carbon block, ozone, ion exchange, etc (CDPH 2011a). Only reverse osmosis POU devices are currently certified by CDPH to treat for nitrate contamination.

Currently, POU devices are typically installed by individual household owners. They are rarely installed community-wide by public water systems because of the regulatory restrictions on their use in California. A public water system is a system that provides drinking water to at least fifteen service connections or regularly serves at least 25 people at least 60 days of the year (U.S. EPA 2011b). It is common for smaller systems (not “public”) to use POU devices since they require relatively low capital investments. These small systems typically receive water from a small community or household well and do not treat enough water to make large centralized treatment systems economically feasible.

The SDWA and its amendments do not recognize the right of public water systems to use point of use devices to meet the national drinking water standards.

Title 40 Section 141 of the Code of Federal Regulations (CFR), passed in 1987 and 1988, allows point-of-entry (but not point-of-use) devices as an alternative to centralized treatment. Point-of-entry devices differ from point-of-use devices in that they are installed at the entry point of a water distribution line into a house. They treat all water entering a home while point-of-use devices only treat the water used for potable uses. Title 40 does not mention the allowance of point-of-use devices as a means to complying with drinking water standards. 40 CFR Section 141.2 (f) allows a water system to use a point-of-use device in addition to a “non-preferred” treatment method to “avoid an unreasonable risk to health”, but only if the department determines that the combination of treatment systems will be appropriate.

Federal law 42 U.S.C. 300g-1(b)(4)(E)(ii) passed in 2007, on the other hand, allows the use of point-of-use systems as a means of reaching the necessary drinking water quality levels, but only for small systems of less than 10,000 people. Point-of-use devices are allowed by these small systems as an MCL compliance technique as long as the device is still “owned, controlled, and maintained by the public water system….to ensure proper operation and maintenance and compliance with the maximum contaminant level” (42 U.S.C. 300g).

While the US EPA has allowed the use of POU devices for public drinking water systems to meet drinking water regulations, California had not until the passage of Assembly Bill No. 2515 (AB2515) on September 30th, 2010 (Collins 2010). AB2515 authorizes the California Department of Public Health (CDPH) to adopt emergency regulations permitting the use of Point-of-Use (POU) devices by public water systems with less than 200 service connections as an appropriate method for meeting drinking water standards for three years or until funding for centralized treatment or an alternative water supply is made available, whichever comes first. These new regulations add Section 116380 (b) to the Health and Safety Code (H&SC), which directs CDPH to adopt emergency regulations that govern the use of point-of-entry and point-of-use devices in lieu of centralized treatment and lays out the requirements for compliance. Health and Safety Code (H&SC) Section 116761.25 is also updated, establishing an appropriation scheme for funding the new regulations.

California's new POU emergency regulations give smaller systems an additional method for meeting drinking water standards in the short term. It is theoretically economical to use POU devices which only treat the water intended for drinking and cooking because only 1-3 percent of total household water use is typically used for direct potable consumption (Arizona Department of Environmental Quality 2005). The water system, however, must have enough liquidity to fund the initial installation cost of all POU devices and be able to establish a reserve fund to be used for testing, maintenance, and repairs. While disadvantaged communities are allowed under the new regulations to apply to the State Revolving Fund for help with the initial capital costs of purchasing the devices, no funds are available for maintenance expenses, continued testing, or to purchase replacement systems/filters.

Currently, CDPH only intends for POU devices to be used as emergency regulations in the interim while a more centralized treatment plan can be developed. A thorough evaluation of the efficiency, effectiveness, and capability of POU devices to reduce the public health risk of drinking water contaminants needs to be conducted before they are either approved or denied as a permanent solution for public water systems to reach SDWA compliance. Section 4.2 details one possible method for evaluating the public health risk of using POU devices for nitrate contaminated water.

4.2 Methods

To analyze the public health risk of nitrate contamination in the Tulare Lake Basin and Salinas Valley, methods described in Lee (1992) are adapted and utilized. The specific equations are detailed in this section. CDPH's PICME dataset was used for the drinking water quality monitoring data. The PICME (Permits, Inspection, Compliance, Monitoring, and Enforcement) database contains water quality monitoring data from public water systems (15 or more service connections). Public water systems in California must report water quality to CDPH as required under the federal and state Safe Drinking Water Acts. For this study, all community public water systems in the Salinas Valley and Tulare Lake

Basin with data available in PICME whose status was either an active system or a pending system,[2] and that had at least one groundwater source, were used in the following analyses. There are 369 systems total, but only 318 have nitrate data available and can be used in the following analyses. The 318 systems represent a population of 2.3 million. To capture the worst-case and to account for the systems with missing data, the highest delivered nitrate concentration for each system with data was used. The methods for determining delivered water quality per system and for characterizing vulnerability of these systems is described in more detail in Honeycutt et al. 2012.

As mentioned in Section 3.1, nitrate contaminated drinking water poses a public health risk for two reasons: methemoglobinemia risk for infants less than six months and gastric cancer risk for adults. One method to calculate the risk of methemoglobinemia in infants is to use the hazard index method suggested by Lee (1992):

HI = DE / RfD

where DE is the amount of daily nitrate as N intake from drinking water (mg/day) and RfD is the reference dose (the estimated daily exposure that is not expected to produce an adverse health effect in infants, see Section 2.2.2). DE is calculated by multiplying the concentration of nitrate as N (mg/L) by the volume of water consumption per day (L/day). An infant is assumed to drink 0.64 liters of water per day (Dourson *et al.* 1991). The reference dose is calculated as follows:

RfD = (NOAEL * Daily Water Consumption) / (Uncertainty Factor) (Lee 1992)

RfD = (10 mg/L NO3 as N * Daily Water Consumption) / 1

The NOAEL (no observed adverse effects level, see Section 2.2.2) is the level where no statistical or significant increases in adverse effects occur, and it is assumed to be 10 mg/L for nitrate (Lee 1992). The uncertainty factor for infants is 1.0 because they are the most sensitive population.

To estimate the individual lifetime probability of developing human gastric cancer, we will use the following equations for the upper-bound (Y1) and lower-bound (Y2) estimates (Lee 1992):

$$Y1 = \frac{1}{1 + e^{Z1}}$$

$$Y2 = \frac{1}{1 + e^{Z2}}$$

$$Z1 = 3.331 - 3.429 * \ln(NW + NF) - (1 - h) * [1.138 + 0.881 * |\ln(NW + NF)|]$$

$$Z2 = 3.331 - 3.429 * \ln(NW + NF) + (1 - h) * [1.138 + 0.881 * |\ln(NW + NF)|]$$

---

[2] A pending system is pending approval by the State and is not yet active.

where h is the membership degree[3] (0≤h≤1), NW is the nitrate(as NO3) intake from drinking water (g/day), and NF is the nitrate (as NO3) intake from sources other than drinking water (g/day). A membership degree of 0.5 is used because it is neither optimistic nor pessimistic. Adults are assumed to consume 1.9 liters of water daily (Lee 1992). A value of 0.15 is used for NF (ECETOC 1988). Population risk (cancers/year) can then be calculated by multiplying the individual risk by the population served by the system.

The analysis by Travis et al. (1987) describes the different levels of cancer risk that trigger regulations. They attempt to differentiate between de manifestis risk (obvious risk) and de minimis risk (acceptable level or risk that does not need regulatory attention). Travis et. al plotted 132 regulatory decisions (on chemical carcinogens) on a graph of individual risk vs. population risk. From this plot, they were able to tease out the likely placement of a de manifestis risk line and a de minimis risk line and define four main areas: 1) regulatory action should be taken (de manifestis); 2) no regulatory action is taken; 3) regulatory action should be taken if the cost is below $2 million per life saved (equivalent to $3.9 million in 2010 dollars); and 4) infeasible area. They concluded that most federal agencies were consistent in adopting regulations under similar cancer risk levels, but that no one has ever explicitly defined the levels of de minimis and de manifestis risk. Travis et. al suggests that it would be more effective for the federal agencies to agree upon a standard, since they are already implicitly defining similar regulatory thresholds.

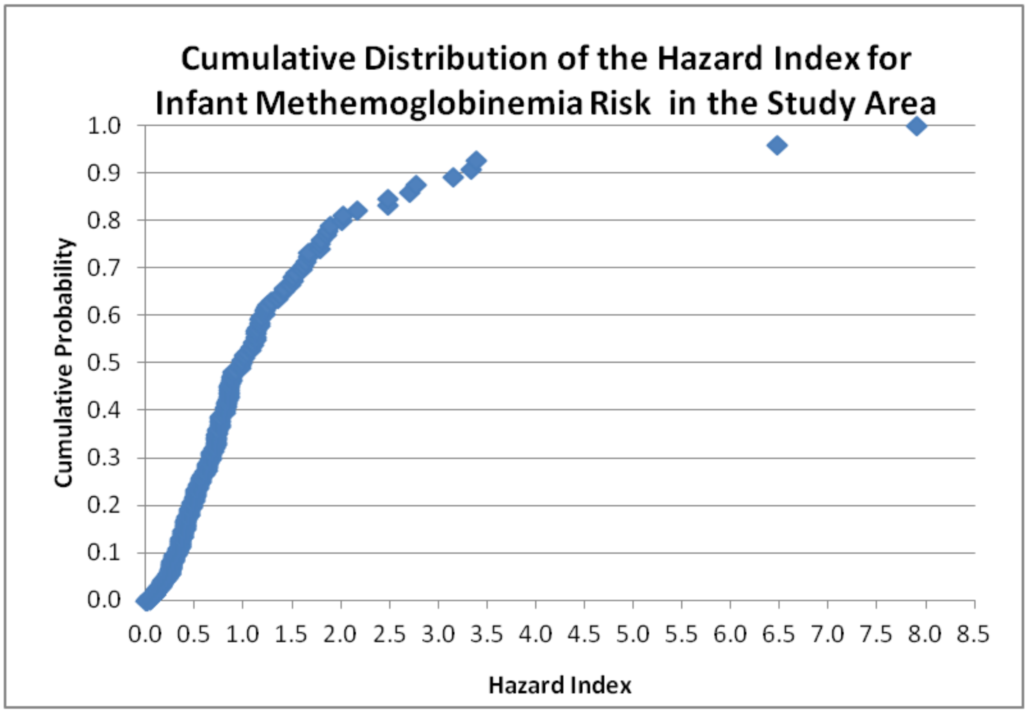
To see how health risks from nitrate levels in the study area compare to the regulatory decision lines defined in Travis et. al, the hazard index for the maximum delivered nitrate level for each public water system (using all available data from the PICME dataset) was plotted on the same graph used in Travis et. al. The results are shown below in Section 4.3.

4.3 Results

The hazard index for infant methemoglobinemia from nitrate in drinking water of public water systems in the study area can be described by the cumulative distribution function in Figure 4. As shown in the figure, 50% of the study area systems have a hazard index (HI) less than 1.0. A HI less than 1.0 is considered low risk for infant methemoglobinemia, a HI greater than 1.5 is high risk, and a HI between 1.0 and 1.5 is inconclusive. Households with sensitive populations (infants less than six months, pregnant women, etc.), are encouraged to find alternative sources of water if the HI is greater than 1.0, and especially after it reaches 1.5.

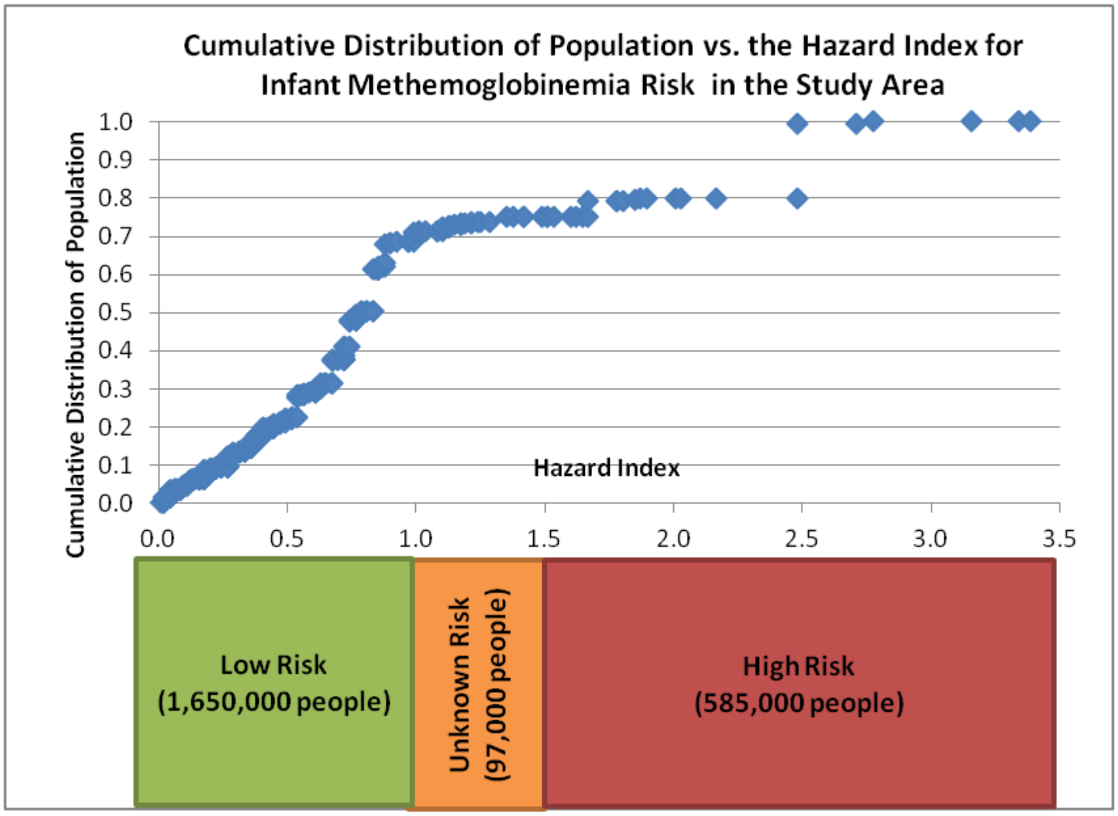
[3] A fuzzy-set approach concept where the degree of membership refers to the extent that a given element belongs to a set.

Figure 4. Cumulative distribution function of the hazard index for infant methemoglobinemia in the Salinas Valley and Tulare Lake Basin



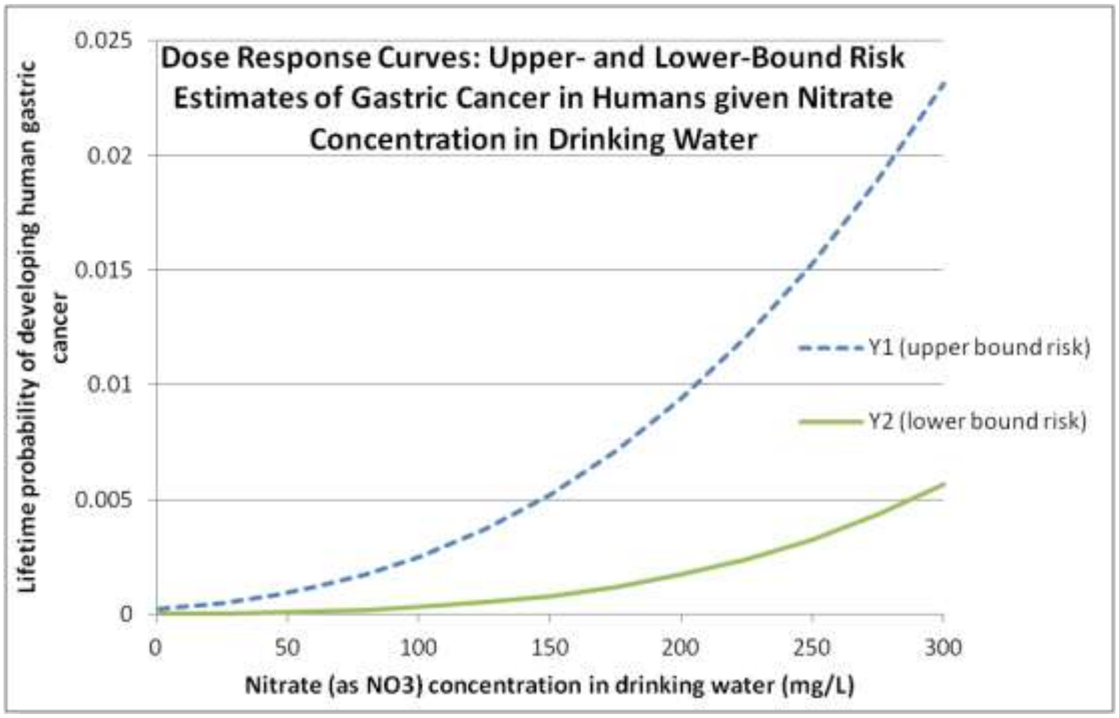
A cumulative distribution of the study area population versus the hazard index is shown in Figure 5. Approximately 70% of the population has a hazard index of less than 1.0. The risk characterization of the population for methemoglobinemia risk is shown at the bottom of Figure 5. The population-weighted averaged hazard index for the study area is 1.06, just slightly above the low risk zone. The estimated population in the "High Risk" zone for methemoglobinemia is an over-estimate because methemoglobinemia is currently thought to only occur in infants and people with compromised immune systems. The population would have to be studied in more detail to estimate this highly susceptible sub-population.

Figure 5. Cumulative distribution of study area population vs. the hazard index for infant methemoglobinemia



While adults in good health condition are not susceptible to methemoglobinemia, there is a risk of developing gastric cancer. The upper- and lower-bound risk estimates of gastric cancer in adults are calculated under varying concentrations of drinking water (see Figure 6). The bounded estimates are calculated using the Y1 and Y2 equations described above. The maximum delivered nitrate concentration recorded in the PICME data is 300 mg/L, which has a higher-bound lifetime gastric cancer risk of around 2% (or a 1 in 50 chance that the person will develop cancer). For the probability of gastric cancer risk to increase to 10%, an adult would need to ingest 1.15 grams of nitrate per day. To ingest 1.15 grams of nitrate per day, one would have to increase intake of food products containing nitrate, keep food intake constant and consume 1.9 liters per day of drinking water with a nitrate concentration of 525 mg/L (as NO_3), or increase both food and contaminated water intake.

Figure 6. Upper- and lower-bound risk estimates of gastric cancer in humans, given nitrate concentration in drinking water.



The maximum delivered nitrate level per system in the study area is used to calculate the upper-and lower-bound gastric cancer risks based on Lee (1992). The lower-bound individual risk and population risk is plotted in Figure 7. Also shown, are the regulatory action lines described above and in Travis et al. (1987), to better understand how the delivered nitrate levels in the study area fall within other regulatory patterns. A characterization of these regulatory action areas is pictured in Figure 8. Most of the systems in the study area fall into the “no regulatory action” or “no regulatory action if cost >$2 million per life saved” categories. A few systems have very high delivered nitrate levels (287 and 250 mg/L), and are placed in the “regulatory action” category. All of the systems in the middle area (regulate if <$2 million) have delivered water with a nitrate concentration that exceeds the MCL. A water system that delivers water with 55 mg/L nitrate will fall just above the green y=0.0001 line (Figure 7) (regulate if <$2 million). Water systems with lower delivered nitrate levels can also be pushed up into this category if they serve a large population.

Figure 7. Individual risk versus population risk of gastric cancer in adults

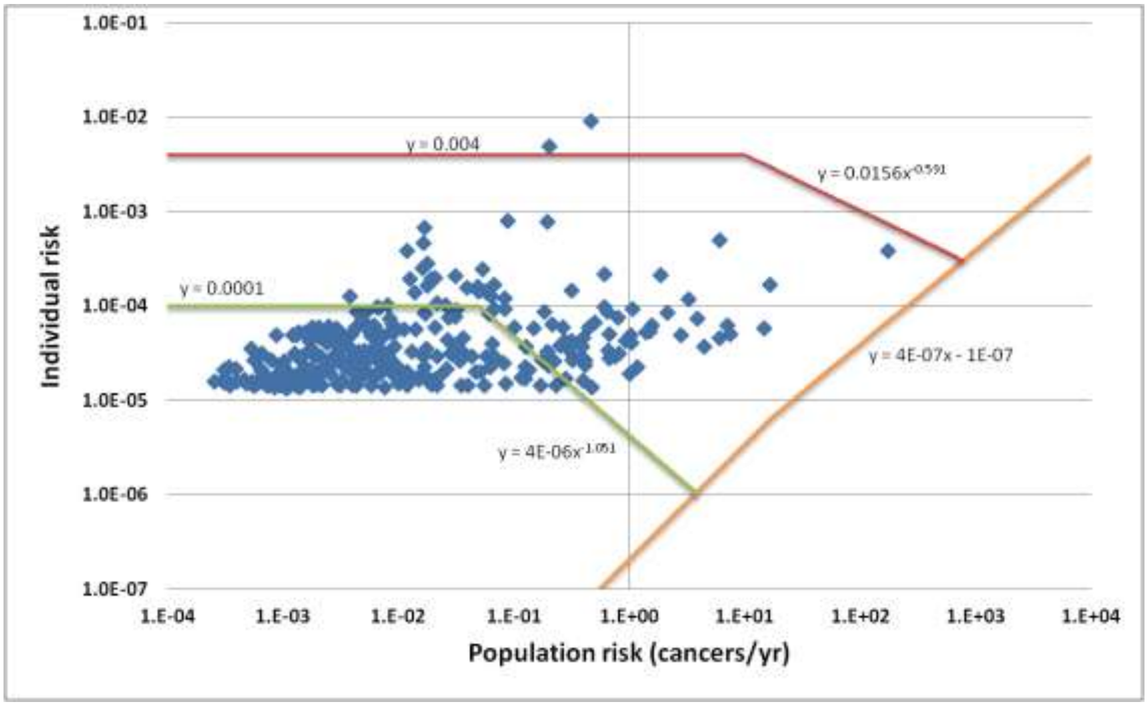
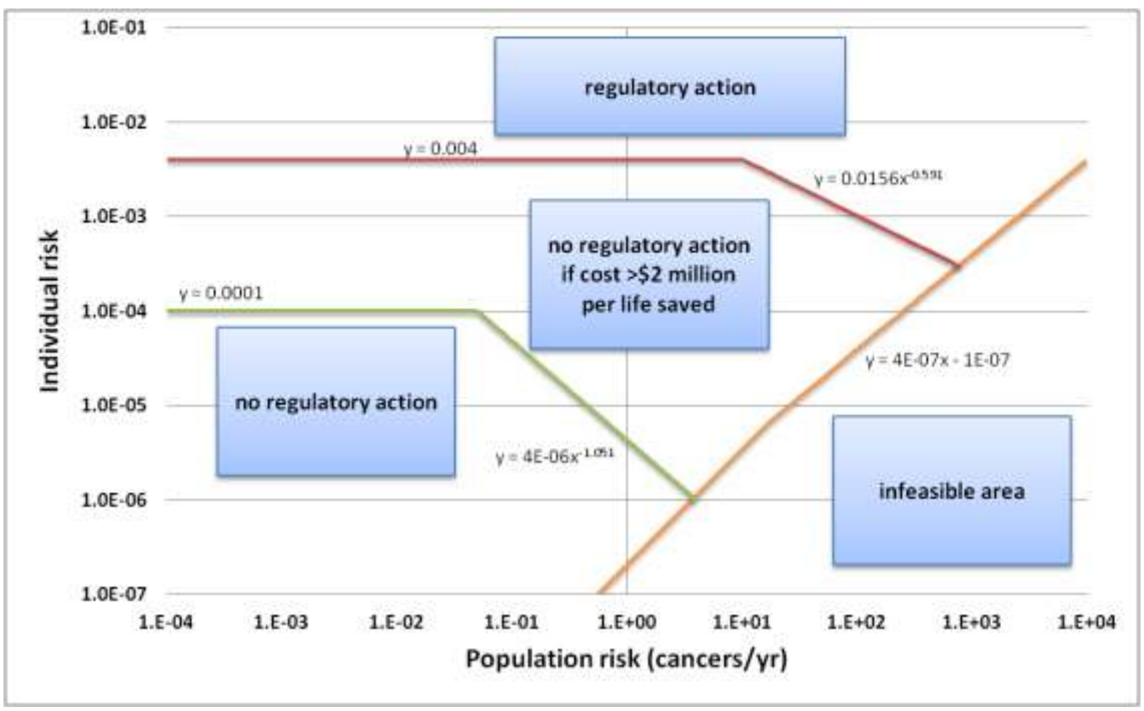
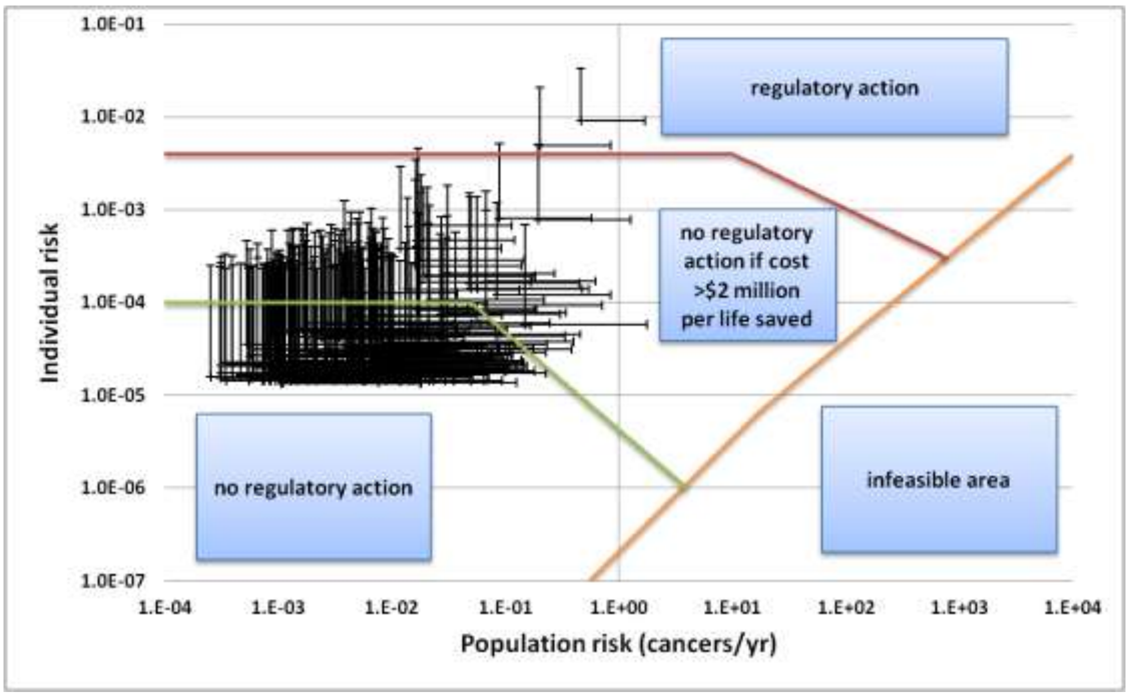


Figure 8. Regulatory action areas based on cancer risk. Adapted from Travis et al. (1987)



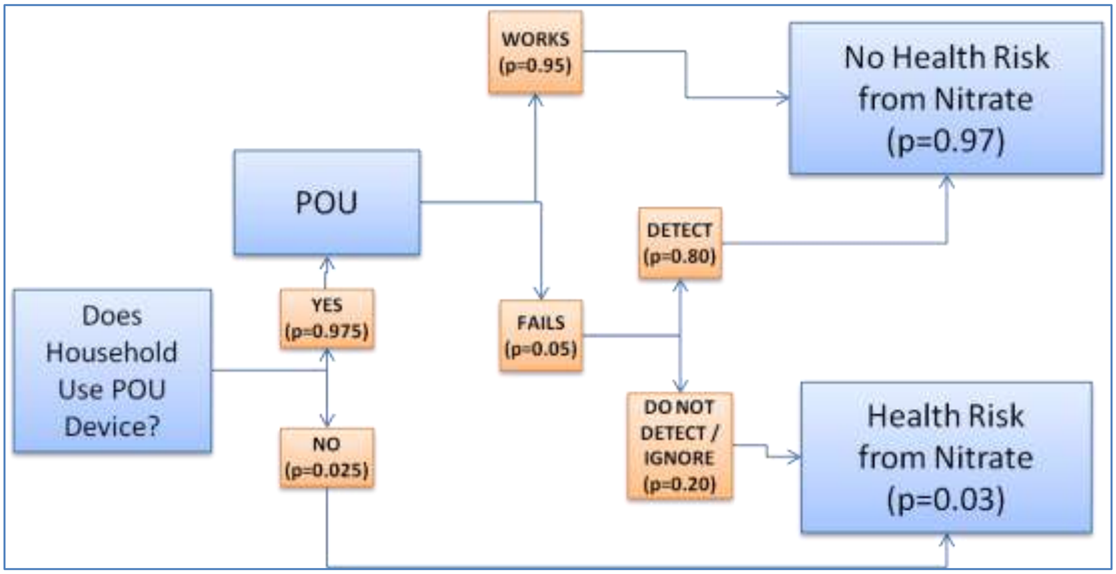
The individual points placed on Figure 7 are the lower-bound estimates for individual and population risk. Including the upper bound estimates for individual and population risk are considered, the feasible area for an estimated location of these points is actually much larger. To visualize the range of gastric cancer risks for public water systems in the study area on the regulatory action level graph, the upper-bound risk estimates must also be added. The horizontal and vertical lines shown in Figure 9 extend outward from the lower-bound estimate and define a feasible rectangular location of risk for each water system point. As expected, when the upper-bound estimate is considered, the risk level moves closer to the regulatory action zone. The upper-bound of the population-weighted average individual risk in the study area is 1.099E-3 (lifetime probability of gastric cancer in adults). The study area-wide high estimate of the population risk for gastric cancer is 2,563 excess cancers per year.

Figure 9. Low to high range of regulatory action levels for individual and population risk



Now we can estimate how implementing POU devices in the study area would affect the estimated current public health risk from nitrate contamination (as determined above). We assume that POU devices are implemented in all communities with less than 200 connections, since this is the estimated minimum number of service connections where centralized treatment becomes as cost effective as POU treatment (Kommineni, Narasimhan, & Burbin 2002). Two-hundred connections is also the maximum number allowed under the current California POU emergency regulations. There are 201 systems (36,000 people) in the PICME dataset with less than 200 connections. To estimate the total health risk reduction occurring with the implementation of POU devices, the flowchart shown in Figure 10 was developed. When POU devices are installed in a community, some members may still decide not to use them. A 97.5% acceptance rate is chosen, based on NSF International (2005). For those households that do accept the device, a 5% probability of failure is estimated. When the device fails, we estimate that 20% of the failures will either not be recognized or will be ignored. While these probabilities are estimated and other assumptions could be used, the analysis is informative and shows how public health risk from nitrate contamination in drinking water may be decreased with the installation of POU devices.

Figure 10. Estimated probability of health risk reduction from POU devices.

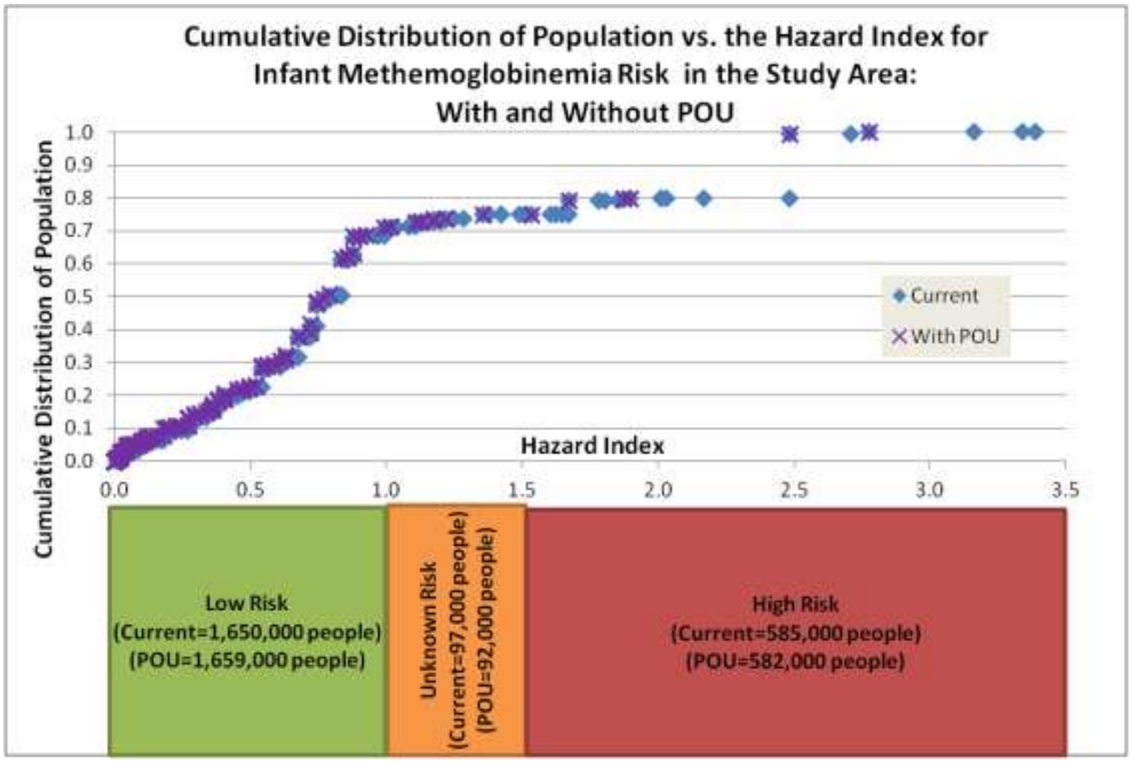


The 3% probability of nitrate health risk (from Figure 10) is applied to the risk calculations described above for both methemoglobinemia and for gastric cancer. Only systems with fewer than 200 connections are given the 97% reduction in risk. The expected value (EV) of risk for either methemoglobinemia in infants or gastric cancer in adults for these small systems is:

EV(Estimated Risk with POU) = 0.03 * (Calculated Current Risk without POU)

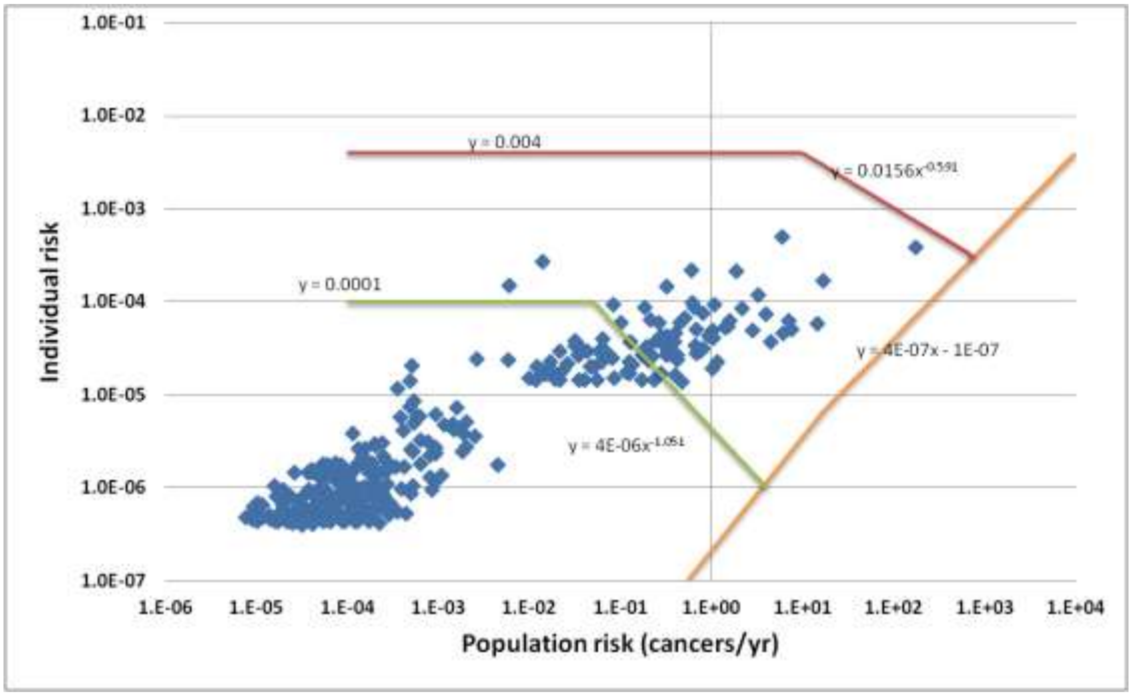
The new cumulative distribution of the population in the study area for the hazard index of methemoglobinemia is shown in Figure 11. The population in the high risk zone decreases by about 3,000 people and the population-weighted average hazard index decreases very slightly to 1.05. This small change is because only the small systems (<200 connections) were affected by the implementation of POU devices.

Figure 11. Cumulative distribution of population versus the hazard index for infant methemoglobinemia risk in the study area, currently and with POU installation in communities of <200 connections.



The change in gastric cancer risk in adults can also be evaluated with the implementation of POU devices in the study area. Figure 12 shows how the risk has dropped with POU devices. The points on the left side of the graph dropped together because this is where most of the small systems with less than 200 connections were located. Many of the points dropped almost two levels of magnitude (for individual risk). When looking at the change on a population-weighted basis, the decreased risk is much less obvious because the small systems were the only systems affected by the implementation of the POU devices. The population-weighted average individual risk after implementation of POU devices is 1.088E-3 (upper-bound risk estimate) and the total cancers per year decrease by 26 incidents from the current estimate of 2,563 excess cases per year.

Figure 12. Individual risk versus population risk of gastric cancer in adults with implementation of POU devices in all public water systems with less than 200 connections in the study area.



4.4 Major Findings and Conclusions: POU Public Health Risks

A summary of the observed change in public health risk from the estimated status quo situation with the implementation of POU devices is shown in Figure 13. POU devices may have a 97% probability of reducing the nitrate health risk to a negligible amount, and may be very effective in small communities that are willing and able to keep up with the operation and maintenance. In the small communities, implementing POU devices is estimated to decrease yearly cancer incidents by 26 and the all-age population in the high risk group for methemoglobinemia by about 3,000 (Figure 13) (only the infants and those with compromised immune systems in this group of 3,000 people are actually at risk for developing methemoglobinemia). A cost analysis is needed to determine if the decrease in public health risks expected with POU devices is enough to justify the installation and operation costs. Each community has different needs and a variety of capacity levels (technical, managerial, financial), so feasibility studies are needed before implementation of a new treatment system (like POU devices).

Figure 13. Change in public health risk with the implementation of POU devices for systems with less than 200 connections.

	Current	With POU implementation for systems with <200 connections	Decrease
upper-bound population-weighted average individual risk for gastric cancer (lifetime probability)	1.099E-03	1.088E-03	1.115E-05
sum of high population risk for gastric cancer in the total study area (cancers per year)	2563	2537	26
population-weighted average Hazard Index for methemoglobinemia	1.06	1.05	0.01
population in the "High Risk" zone (HI>1.5) for methemoglobinemia	584,861	581,742	3,119

In the study area overall, implementing POU devices in all public water systems with less than 200 connections only slightly decreases the average individual risk for gastric cancer and the average hazard index. Even if POU devices are installed in the small systems where appropriate, a solution is still needed for the larger systems. When POU devices cannot be used (because of regulatory restrictions, system size, economic conditions, or personal preference), a more centralized treatment system might be necessary. An analysis of the alternative water supply options available in the study area is made in Honeycutt et al. 2012.

As mentioned above, the estimated populations in the "High Risk" zone for methemoglobinemia is an over-estimate because methemoglobinemia is currently thought to only occur in infants and people with compromised immune systems. The population would have to be studied in more detail to estimate this highly susceptible population. Current results still show, however, that there is a decrease in the population expected to be at high risk; there should be a proportional decrease in the highly susceptible population assuming this highly susceptible population is evenly distributed across study area communities.

This analysis does not include people on household wells because there is very little nitrate data that are publically available. Unfortunately, these wells likely face the highest levels of nitrate contamination because they are typically found in rural agricultural areas and are shallow. Additionally, these households do not have the benefit of multiple rate payers to raise liquid assets to pay for treatment or alternative water supplies.

Regardless of the treatment option, a water system still depends on the availability of supportive policies and funding. A wide range of planning and regulatory programs is available to manage present and future nitrate contamination in the study area, while funding programs can be used to finance solutions that prevent, remediate, or mitigate contamination. The next two sections summarize the available planning, regulatory, and funding programs available to manage the nitrate-contaminated groundwater in the study area.

5 Current Planning and Regulatory Programs for Groundwater Nitrate

Planning and regulatory programs have been implemented at the Federal, State, and local levels to reduce the adverse effects of nitrate-contaminated drinking water. These programs contain monitoring, enforcement, and other guidelines, that could provide the foundation for future programs to address both the public health and economic impacts of nitrate contamination. This section considers the strengths and weaknesses of current programs in California and recommends future actions to enhance their effectiveness.

5.1 Regulatory History of Nitrate in Drinking Water

In 1969, faced with the absence of national water pollution or contamination control legislation, California adopted the Porter-Cologne Water Quality Control Act (Porter-Cologne) (California Water Code § 13000 et seq.). Porter Cologne grants the State Water Resources Control Board (State Water Board) authority over the protection of State water quality and establishes the Regional Water Quality Control Boards (Regional Water Boards) to carry out these policies at the regional and local level. Subsequently, Congress passed the Clean Water Act of 1972 (CWA) (33 U.S.C. § 1251 et seq.) and the Safe Drinking Water Act of 1974 (SDWA) (42 U.S.C. § 300f et seq.). These acts provide the Federal regulatory framework to manage contaminants in water bodies and drinking water. While the SDWA regulates the quality of delivered drinking water in public water supply systems, the CWA regulates the discharge of contaminants into surface waters of the United States. The CWA, however, does not regulate the contamination of groundwater, which is the focus of this report.

Under the authority of the SDWA, the U.S. Environmental Protection Agency (U.S. EPA) develops and sets drinking water quality standards and oversees State or local implementation of the standards. In 1992, U.S. EPA's Phase II Rule established the Federal maximum contaminant level (MCL) for nitrate in drinking water (U.S. EPA 2011a). California's Office of Environmental Health Hazard Assessment later performed its own risk assessment of nitrate and adopted the Federal MCL in 1997 as a public health goal (PHG), or the level at which no known or anticipated adverse effects on health will occur (costs to comply with this level are not considered) (CDPH 2008).

In California, the Federal framework provided by the CWA and the SDWA are implemented through two separate agencies; the State Water Board implements the CWA, and CDPH implements the SDWA. Currently, only the State Water Board has authority to regulate activities that adversely affect the quality of drinking water sources. Although CDPH does not have authority to regulate sources of contamination to the groundwater, it still maintains groundwater programs with the ultimate goal of protecting the provision of safe drinking water. For example, CDPH's Drinking Water Source Assessment and Protection (DWSAP) program collects monitoring data on possible contaminating activities near drinking water sources (septic tanks, landfills, etc.).

In contrast to the CWA, Porter-Cologne regulates discharges to both surface water and groundwater in California. It requires the State Water Board and the Regional Water Boards (both together, the California Water Boards) to regulate waste discharge to these water bodies from both point sources and nonpoint sources. The Regional Water Boards handle National Pollutant Discharge Elimination System (NPDES) permits for point source discharges to surface water and develop various permit programs (e.g., waste discharge requirements (WDRs), discharge permits, and conditional waivers of waste discharge) for nonpoint and point source discharges to surface water and groundwater. Under the authority of Porter-Cologne, the Regional Water Boards also develop a “basin plan” that explicitly identifies all beneficial uses of individual water bodies (surface water and groundwater) within a Regional Water Board’s region and develops measures to protect these beneficial uses. Waste discharge requirements set by the Regional Water Boards must be consistent with the basin plan objectives, including the State Water Board’s anti-degradation policy (State Water Board Resolution 68-16), which requires that existing high water quality be maintained to meet beneficial uses (State Water Board 2006). Specifically, any actions that affect surface water or groundwater quality “must (1) be consistent with maximum benefit to the people of the State, (2) not unreasonably affect present and anticipated beneficial use of the water, and (3) not result in water quality less than that prescribed in water quality plans and policies.” (State Water Board 2006). Since this anti-degradation policy is a State Water Board resolution, it may be changed (with respect to groundwater)[4] at the discretion of the State Water Board and does not need new legislative authority. Despite the mandates under Resolution 68-16, currently there are no permit requirements placed on agricultural non-point source discharges to groundwater.

In the groundwater basins of the Central Valley and Central Coast regions of California, monitoring of nitrate began long before the national nitrate MCL was established. Since the early 1950s, the Department of Water Resources (DWR) has been gathering nitrate data in areas of the Salinas Valley (Snow, Mills, & Zidar 1988). In 1978, the Association of Monterey Bay Area Governments (AMBAG) published a study concluding that agricultural activities were the primary contributors to the high nitrate levels in the groundwater (AMBAG 1978). Then in 1988, the Monterey County Water Resources Agency (MCWRA) produced the first report documenting nitrate levels in groundwater in the Salinas Valley (Snow *et al.* 1988). Similarly, a 1989 study by the California Department of Food and Agriculture’s Nitrate Working Group quantified various sources of nitrate (Nitrate Working Group 1989). These reports were among the first to point out the current and future nitrate trends and how they could harm public health in these areas.

In response to the problem of nitrate in groundwater, planning, regulatory, and funding programs were developed to reduce future contamination and mitigate the health and financial effects of existing contamination. The next section reviews the existing planning and regulatory programs and Section 6 reviews the existing funding programs.

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[4] There is a federal anti-degradation policy for surface water, but not for groundwater.

5.2 Overview of Current Planning and Regulatory Programs

Many regulatory and planning programs in the study area provide regulatory structure or technical and managerial support to water systems, communities, farmers, dairies, and others who deal with nitrate contamination in groundwater. Statutes also provide a regulatory framework for nitrate contamination of groundwater and drinking water. Current regulatory/planning programs and statutes that have the ability to reduce groundwater nitrate contamination are summarized in Table 1. These programs/statutes all have components that target nitrate source reduction or groundwater remediation. Table 2 is a summary of the current regulatory programs, planning programs, and statutes, related to groundwater nitrate in sources of drinking water. These provide for data collection, information, and education on nitrate sources and groundwater nitrate. Some of these programs regulate nitrate in drinking water.

For a more detailed description of all programs refer to Appendix A: Summary of Current Planning and Regulatory Programs that Address Nitrate in Groundwater. In the study area, there are several Federal programs/statutes (Table 1 and Table 2, blue), State programs/statutes (purple), and nongovernmental programs/agencies (orange) relevant to nitrate contamination and its effects on drinking water.

Table 1. Summary of directly applicable programs and statutes for reducing nitrate contamination in groundwater

AGENCY	PROGRAM/STATUTE [year created/passed]	GOAL/PURPOSE
U.S. Environmental Protection Agency (U.S. EPA)	Supplemental Environmental Programs (SEP) [1998]	Environmentally beneficial project that a violator of environmental laws may choose to perform (under an enforcement settlement) in addition to the actions required by law to correct the violation.
State Water Resources Control Board (State Water Board)	Porter-Cologne Water Quality Control Act [1969]	Grants the State Water Board authority over State water quality policy and aims to regulate activities in California to achieve the highest reasonable water quality.
	Recycled Water Policy [2009]	Resolution No. 2009-0011: Calls for development of salt and nutrient management plans and promotes recharge of clean storm water.
Regional Water Quality Control Boards	Cleanup and Abatement Order (CAO)	CA Water Code § 13304: Allows the Regional Water Board to issue a directive to a polluter to require clean up of waste discharged into waters of the State.
Central Coast Regional Water Quality Control Board	Irrigated Lands Regulatory Program (ILRP) [2004, draft in 2011]	*General Conditional Waiver of Waste Discharge Requirements, 3-Tiered Agricultural Regulatory Program (2004):* Groundwater quality monitoring required to different degrees based on discharger's "tier". Draft (2001) requires Tier 3 dischargers with high nitrate loading to meet specified Nitrogen Mass Balance Ratios or implement a solution that leads to an equivalent nitrogen load reduction.
Central Valley Regional Water Quality Control Board	Irrigated Lands Regulatory Program (ILRP) [2003, draft in 2011]	*Conditional Wavier of Waste Discharge Requirements of Discharges from Irrigated Lands:* Interim program to regulate irrigated lands. Does not address groundwater. *Recommended ILRP Framework (2011):* Development of new monitoring and regulatory requirements (includes groundwater).
	CV-SALTS [2006]	Planning effort to develop and implement a basin plan amendment for comprehensive salinity and nitrate management.
	Dairy Program [2007]	*Waste Discharge Requirements General Order for Existing Milk Cow Dairies:* Confined animal facilities must comply with set statewide water quality regulations, and existing milk cow dairies must conduct nutrient and groundwater monitoring plans.
California Department of Food and Agriculture (CDFA)	Feed, Fertilizer, Livestock, Drugs, Egg Quality Control Regulatory Services (FFLDERS)	Manages licenses, registration and inspection fees, and a mill tax levied on fertilizer sales, to fund research and educational projects that improve fertilizer practices and decrease environmental impacts from fertilizer use.

Table 2. Summary of programs and statutes regarding groundwater nitrate in sources of drinking water (data collection, information, education, or regulation of drinking water)

AGENCY	PROGRAM/STATUTE [year created/passed]	GOAL/PURPOSE
U.S. Environmental Protection Agency (U.S. EPA)	Safe Drinking Water Act (SDWA) [1974, 1986, 1996]	Mandates EPA to set the drinking water standards and to work with States, localities, and water systems to ensure standards are met.
	Phase II Rule [1992]	Established Federal maximum contaminant level (MCL) for nitrate in public water systems.
	Enforcement Response Policy – Enforcement Targeting Tool	Focuses on high-priority systems with health-based violations or monitoring or reporting violations that can mask acute health-based violations.
U.S. Department of Agriculture (USDA)	Rural Utilities Service: National Drinking Water Clearinghouse [1977]	Provides technical assistance and educational materials to small and rural drinking water systems.
California Department of Public Health (CDPH)	22 CCR § 64431	Established State maximum contaminant level (MCL) for nitrate in public water systems.
	Drinking Water Source Assessment and Protection (DWSAP)	Evaluation of possible contaminating activities surrounding groundwater and surface water sources for drinking water.
	Expense Reimbursement Grant Program (EPG)	Education, training, and certification for small water system (serving <3,301 people) operators.
	Groundwater Ambient Monitoring and Assessment (GAMA)	Improves statewide groundwater monitoring and increases availability of groundwater quality information. Funded by Prop 50 and special fund fees.
Assembly Bill 3030	[1993]	Permits local agencies to adopt programs to manage groundwater and requires all water suppliers overlying useable groundwater basins to develop groundwater management plans which include technical means for monitoring and improving groundwater quality.
Kern County Water Agency (KCWA)	[1961]	Collects, interprets, and distributes groundwater quality data in Kern County.
Monterey County Water Resources Agency (MCWRA)	[1947]	Provides water quality management and protection through groundwater quality monitoring (including nitrate levels) and research and outreach efforts to growers to improve fertilizer management and reduce nitrate leaching.
Monterey County Health Department		Implements a tiered, regular nitrate sampling program based on increasing nitrate concentration for local small water systems and for state-small water systems.
South San Joaquin Valley Water Quality Coalition	[2002]	Protects and preserves water quality in the Tulare Lake Basin through surface water quality monitoring and dissemination of collected data. Particular focus is on agricultural discharge areas. Does not currently focus on groundwater.

Tulare County Water Commission	[2007]	Discusses water issues impacting Tulare County and advises the Tulare County Board of Supervisors. Special focus on nitrate in groundwater and improving drinking water in small communities.
Rural Community Assistance Partnership (RCAP)	[1979]	Uses publications, training, conferences, and technical assistance to help communities of less than 10,000 people to access safe drinking water, treat & dispose of wastewater, finance infrastructure projects, understand regulations, and manage water facilities.
The Waterkeeper Alliance	Monterey Coastkeeper [2007]	Collaborates with the State Water Board to ensure effective monitoring requirements for agricultural runoff and more stringent waste discharge requirements for other nitrate sources.
National Rural Water Association (NRWA)	[1976]	Offers drinking water system technical advice (operation, management, finance, and governance) and advocates for small/rural systems to ensure regulations are appropriate.
California Rural Water Association	[1990]	Provides online classes, onsite training, low cost educational publications, and other forms of technical advice for rural water and wastewater systems.
Self-Help Enterprises (SHE)	Community Development Program [1965]	Provides technical advice and some seed money to small/rural/poor communities for the planning studies and funding applications associated with drinking water system projects.
Community Water Center	Association of People United for Water (AGUA) [2006]	Advocates for regional solutions to chronic local water problems in the San Joaquin Valley. Focused on securing safe drinking water, particularly from nitrate impacted sources.

5.3 Major Findings and Conclusions: Current Planning and Regulatory Programs

Despite the long list of programs and statutes related to nitrate contamination (Table 1 and Table 2), very few can be directly applied to decreasing nitrate contamination to groundwater (Table 1). Additionally, to date, these programs/statutes have been insufficient to control nitrate contamination of groundwater. Overall, nitrate concentrations in groundwater have not decreased in the last three decades; concentrations have increased in many areas (King *et al.* 2012). Though Federal law establishes a Nitrate MCL, State law has not implemented a regulatory program stringent enough to ensure that groundwater nitrate concentrations are at or below the drinking water standard. While dischargers are supposed to be held responsible for adverse effects to groundwater (under Porter-Cologne), no current or historical regulatory program functionally holds nitrate dischargers responsible. This may develop in the near future with the current development of the Irrigated Lands Regulatory program in the Central Valley and with the 2007 Central Valley Dairy General Order, which will see stricter enforcement of agricultural nitrate discharges to groundwater over the next few years.

Some ongoing efforts with potential to reduce nitrate contamination in the future are the Agricultural Regulatory Program by the Central Coast Regional Water Quality Control Board (Central Coast Regional Water Board), the renewal of the Irrigated Lands Regulatory Program by the Central Valley Regional

Water Quality Control Board (Central Valley Regional Water Board), and the development of comprehensive salt and nitrate management regulatory programs across California under a State Water Board mandate, the Central Valley Salinity Coalition (CV-SALTS).

Some regulatory programs have recently introduced mandatory monitoring programs. While monitoring programs are essential to understanding nitrate contamination and evaluating the success of nitrate management programs, monitoring alone will not improve water quality. Monitoring programs are more likely to be successful when they are adopted in conjunction with immediate safe drinking water options or longer-term source reduction and data management actions.

Immediate safe drinking water options.

Currently, many details are still unknown about nitrate contamination. Given the physical properties of nitrate in the groundwater, it is difficult to understand how, where, and when a contamination source will affect groundwater, and ultimately, drinking water (Boyle *et al.* 2012). We know that it will take years to decades for a nitrate source reduction or groundwater remediation program to significantly improve drinking water quality (Boyle *et al.* 2012), so alternative water supply options are necessary immediate actions to ensure safe drinking water.

Organized monitoring is needed to understand who is facing the most risk, but none of the current safe drinking water regulatory programs (see Table 1, Table 2, and Appendix A) have used monitoring data to explicitly identify populations at risk of contaminated drinking water. The "closest" program is CDPH's DWSAP which identifies possible contaminating activities near groundwater sources of drinking water. While this program identifies the contamination to which the drinking water source is most vulnerable, it does not mandate action to help reduce future contamination, nor does it identify the State's most highly susceptible populations.

One option is that CDPH and the State Water Board, in coordination with DWR, issue a report every five years to identify populations at risk of contaminated drinking water and monitor long-term trends of the State's success in providing safe drinking water. This report could supplement each California Water Plan Update.

Longer-term source reduction and data management actions.

To ensure long-term protection for sources of drinking water, nitrate source reduction actions will be needed. Many current source reduction efforts such as the Dairy Program and the Irrigated Lands Program (ILRP) include plans for groundwater monitoring so that the success of these programs can be evaluated (see Table 1, Table 2, and Appendix A), but none have gathered information at the regional scale to better understand areas at high risk of contamination. The Regional Water Boards could then use these data to officially designate groundwater drinking water sources at risk for nitrate contamination.

Currently, multiple agencies under many planning and regulatory programs hold nitrate monitoring data (see Table 2 and Appendix A). This disaggregation of data holdings may lead to a duplication of data collection efforts and make it difficult to gain a comprehensive understanding of nitrate contamination of groundwater. Unfortunately, no feedback mechanism exists to assess current monitoring, planning, or regulatory programs, and therefore no method to identify data gaps or cost-effectiveness. An independently-led State Groundwater Task Force, convened by California Environmental Protection Agency (CalEPA) in coordination with California Natural Resources Agency (CalNRA) and CDPH, could evaluate the efficacy and potential overlap of such programs throughout the State.

The California Department of Food and Agriculture (CDFA) currently administers the Feed, Fertilizer, Livestock, Drugs, Egg Quality Control Regulatory Services (FFLDERS) program to license, register, collect inspection fees, and manage the mill tax on fertilizer sales (see Table 1 and Appendix A). However, this program does not collect data on fertilizer applications (where, how much, etc.), which could provide information for understanding groundwater nitrate contamination. Currently, the California Department of Pesticide Regulation (DPR) manages the full reporting of agricultural pesticide use (the county agriculture commissioners are required to report all agricultural pesticide use monthly), as required by State regulations (3 CCR sections 6624 – 6628) and conducts groundwater monitoring programs. This type of program is lacking in California for nitrate use, so one option could be for CalEPA to evaluate promising solutions, e.g., the creation of a new program in CalEPA to coordinate with DPR, or the expansion of the current DPR program for the reporting of nitrogen applications (including synthetic fertilizer and any organic sources of land applied nitrogen).

6 Current Funding Programs for Groundwater Nitrate

In addition to the planning and regulatory programs, several State, Federal, and local agencies, as well as nongovernmental organizations, have established funding programs related to nitrate contamination in California's groundwater. This section summarizes existing funding sources available from these agencies to reduce nitrate source loading to groundwater, remediate contaminated groundwater, and provide safe drinking water to affected communities.

6.1 Information on Current Sources of Funding

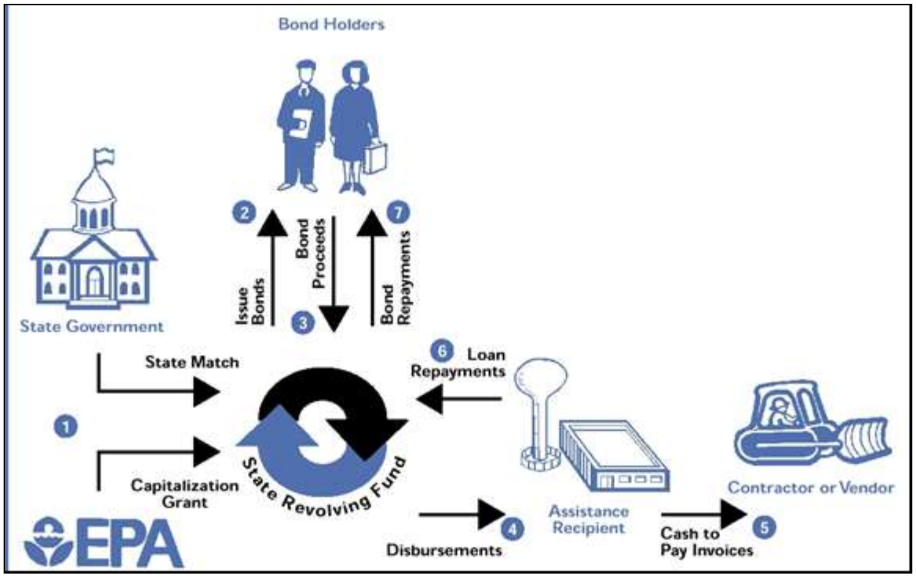
State funding for safe drinking water is currently dominated by general obligation bonds for loans through State propositions, Federal economic stimulus package grants, and State revolving fund loans.

The most recent propositions that provided loans or grants for drinking water infrastructure or water quality protection/improvement are Propositions 82 [1988], 13 [2000], 50 [2002], and 84 [2006]. All are State general obligation bonds, which are repaid through the general fund. A general obligation bond is a municipal bond secured by the use of State or local government resources to repay bond holders. Often, general obligation bonds levy a property tax or decrease local property tax revenues to meet debt service requirements.

The American Recovery and Reinvestment Act (ARRA) of 2009 created an economic stimulus package that allowed for an increase in the Federal budget deficit. This 2009 stimulus package allocated $160 million in funding to the Federal Safe Drinking Water State Revolving Fund.

State revolving funds also have been a major source of funding for projects that support safe drinking water goals. While water systems still bear most project costs, the State revolving funds subsidize a portion of the costs with low-interest loans. These programs work like environmental infrastructure banks (Figure 14) where the funding program is a self-perpetuating loan assistance authority for water quality improvement projects. It is capitalized by Federal and State contributions and the pot of money is able to continually grow through: investment and interest earnings; principal repayments; and bond proceeds from leveraging. Revenues are recycled back into the program and since grants are not allowed, the funds do not dissipate. More recently, some funding programs, like the State Revolving Fund and the Integrated Regional Water Management Programs, have targeted small and disadvantaged communities by setting aside funds specifically for these populations.

Figure 14. Structure of the State Revolving Fund (U.S. EPA CWSRF Branch 2006)



In addition to these major sources of funding for safe drinking water, some fees exist to help prevent groundwater contamination from nitrate sources. One example is CDFA's mill assessment on fertilizer, which provides funding for research and education on the use and handling of fertilizer, including environmental effects. Nongovernmental and non-profit funding also exists for drinking water, water quality, and water supply improvements. Typically, these pools of money are significantly smaller and more limited than State and Federal resources.

6.2 Summary of Current Funding Programs

A summary of existing funding sources to address problems related to nitrate in drinking water is shown in Table 3. In general, these programs are structured to provide assistance for activities related to alternative water supplies and nitrate load reduction. California has eighteen relevant State funding programs, administered by four agencies (Table 3, purple). The Federal government manages an additional three funding programs (blue). Three large nongovernmental drinking water funding programs in the study area are highlighted in orange. For a more detailed review of these programs, see Appendix B: Description of Current Funding Programs for Safe Drinking Water. Several State funding efforts for safe drinking water infrastructure are also reviewed by the California Financing Coordinating Committee.[5]

[5] http://www.cfcc.ca.gov/

Table 3. Summary of existing funding sources for safe drinking water.

AGENCY	PROGRAM [year passed or created]	FUNDING PROVIDED (in millions of dollars)
California Department of Public Health (CDPH)	Safe Drinking Water State Revolving Fund [SDWSRF] [1996] (grants and loans)	**Generally $100-$150:** Low interest loans and some grants to support water systems with technical, managerial, and financial development and infrastructure improvements.
	Proposition 84 [2006] (grants) **(fully allocated)**	**$180:** Small community improvements. **$60:** Protection and reduction of contamination of groundwater sources. **$10:** Emergency and urgent projects.
	Proposition 50 [2002] (grants) **(fully allocated)**	**$50:** Water security for drinking water systems. **$69:** Community treatment facilities and monitoring programs. **$105:** Matching funds for Federal grants for public water system infrastructure improvements.
State Water Resources Control Board (State Water Board)	Clean Water State Revolving Fund (CWSRF) [1987] (loans)	**$200 - $300 per year:** Water quality protection projects, wastewater treatment, nonpoint source contamination control, and watershed management.
	Small Community Wastewater Grants [2004, amended 2007] (grants)	**$86 (fees on the CWSRF):** Loan forgiveness to small disadvantaged communities and grants to non-profits which provide technical assistance and training to these communities in wastewater management and preparation of project applications.
	Proposition 50 [2002] (grants) **(fully allocated)**	**$100:** Drinking water source protection, water contamination prevention, and water quality blending and exchange projects.
	Agricultural Drainage Program [1986] (loans) **(fully allocated)**	**$30:** Addressing treatment, storage, conveyance or disposal of agricultural drainage.
	Dairy Water Quality Grant Program [2005] (grants) **(fully allocated)**	**$5 (Prop 50 funds):** Regional and on-farm dairy projects to address dairy water quality impacts.
	Nonpoint Source Implementation Program [2005] (grants)	**$5.5 per year:** Projects that reduce or prevent nonpoint source contamination to ground and surface waters.
	Cleanup and Abatement Account [2009]	**$9 in 2010:** Clean up or abate a condition of contamination affecting water quality.
	Integrated Regional Water Management (IRWM) [2002] (grants) **(fully allocated)**	**$380 (Prop 50 funds):** Planning ($15) and implementation ($365) projects related to protecting and improving water quality, and other projects to ensure sustainable water use.

California Department of Water Resources (DWR)	Integrated Regional Water Management (IRWM) [2002] (grants)	**$500 remaining (Prop 84 funds):** Regional water planning and implementation.
	Local Groundwater Assistance Grant [2008] (grants)	**$4.7 anticipated for 2011-2012 (Prop 84):** Groundwater studies, monitoring and management activities.
	Proposition 82 [1988] (loans)	**$22:** New local water supply feasibility & construction loans.
	Water Use Efficiency Grant Program [2001] (grants)	**$15 in 2011 (Prop 50).** Water use efficiency projects for agriculture, such as: wellhead rehabilitation, water and wastewater treatment, conjunctive use, water storage tanks, etc.
	Agricultural Water Conservation Loan Program [2003] (loans)	**$28 (Prop 13):** Agricultural water conservation projects, such as: lining ditches, tailwater or spill recovery systems, & water use measurement.
	Infrastructure Rehabilitation Construction Grants [2001] (grants) **(fully allocated)**	**$57 (Prop 13):** Drinking water infrastructure rehabilitation and construction projects in poor communities.
California Infrastructure and Economic Development Bank	Infrastructure State Revolving Fund (ISRF) [1994] (loans)	**$0.25– $10 per project:** Construction or repair of publicly owned water supply, treatment and distribution systems.
U.S. Department of Agriculture (USDA)	Rural Utilities Service - Water and Environmental Programs (RUS WEPs) (loans and grants)	**$15.5 :** Development/rehabilitation of community public water systems (<10,000 people): emergency community water assistance grants, predevelopment planning grants, technical assistance, guaranteed loans, and a household well water program.
U.S. Department of Housing and Development	Community Development Block Grant (CDBG) (grants)	**$500 in 2010 for CA:** Community development projects: feasibility studies, site acquisition and construction, and grant administration.
U.S. Department of Commerce	Economic Development Administration (EDA) (grants)	**Grants up to 50% of Project Costs:** to support economic development, planning, and technical assistance for public works projects.
Rural Community Assistance Corporation (RCAC)	Drinking Water Technical Assistance and Training Services Project (loans)	**$1.2 per year:** Administers funds from the US EPA Office of Groundwater & Drinking Water for infrastructure projects, including water.
The Housing Assistance Council (HAC)	Small Water/Wastewater Fund (loans)	**Up to $0.25 per project:** Land acquisition, site development, and construction.
Cooperative Bank (CoBank)	Water and Wastewater Loan (loans)	**$1 per project:** Water and wastewater infrastructure, system improvements, water right purchases, and system acquisitions. **$0.05-$0.5 per project:** construction costs.

6.3 Funding Example: Safe Drinking Water State Revolving Fund [6]

The Safe Drinking Water State Revolving Fund (SDWSRF), created under the Federal SDWA, is one of the largest funding sources for community water systems in California, so it is presented here as an example program.

The SDWSRF allows CDPH to provide low interest loans and other assistance to public water systems. This fund supports: (1) infrastructure improvements; (2) water system technical, managerial, and financial capacity development; and (3) water and energy efficiency projects. As part of this program, CDPH establishes an annual project priority list based on applications from water systems. From this list, they create a "fundable list" of projects they intend to fund, assuming each system can meet all program requirements.

CDPH specifically addresses disadvantaged communities and small water systems in their project priority and fundable lists. Communities with lower median household incomes are given higher priority. Disadvantaged communities can also receive the following additional assistance from the SDWSRF: 1) zero percent interest rates (compared to 3-4%), 2) extended repayment periods of 30 years (compared to 20 years), and 3) forgiveness of up to 80% of the loan principal (CDPH, 2010). With the recent adoption of AB 983, severely disadvantaged communities may now be eligible for up to 100% grant funding (AB 983, 2011).

Derived from the 2010-2011 Final Project Priority List, Figure 15 shows that in dollars per person, more money was requested for drinking water projects in the study area counties relative to all of California. Despite the host of regulated contaminants, the 2010-2011 project priority list reflects the severity of nitrate contamination in the Tulare Lake Basin and Salinas Valley. Approximately 9% of funds sought (derived from the SDWSRF list) for all drinking water projects listed in the study area are related to nitrate contamination (install new treatment facilities, upgrade existing facilities, connect a pipeline to other drinking water systems, etc.). In comparison, only 1.6% of the statewide project costs are listed for nitrate projects. Figure 15 shows that $29 per person in the Tulare Lake Basin counties and $28 per person in Monterey County has been requested for nitrate projects, while the statewide requests are only $5 per Californian.

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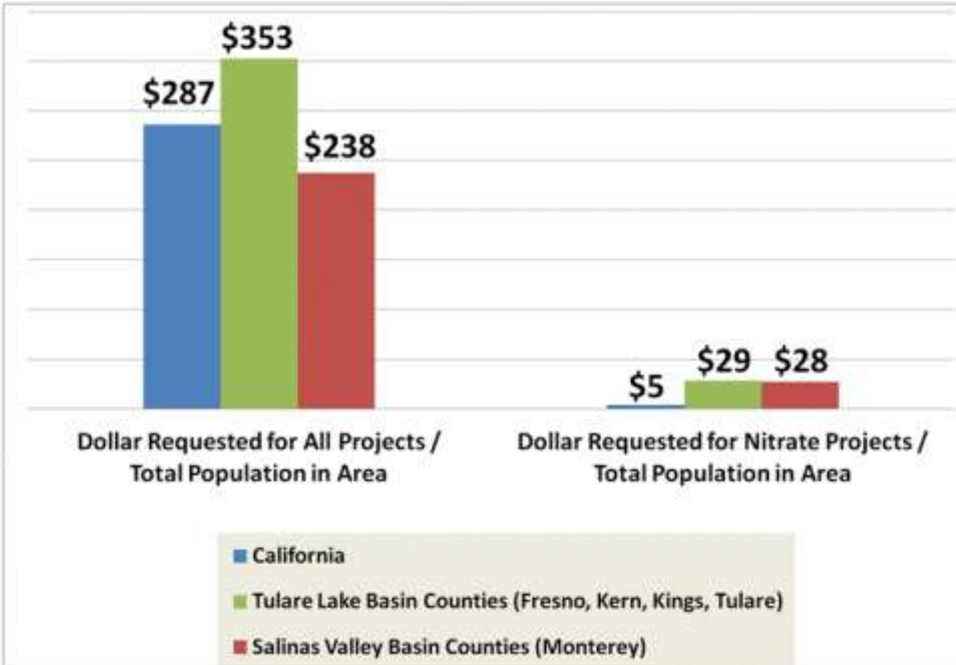
[6] (CDPH 2011b)

Figure 15. Dollar requested per person on proposals made to the 2010-2011 Safe Drinking Water State Revolving Fund (Final Fundable Project Priority List, Oct. 2010)



While this analysis only shows data from formal funding requests that have been approved, it is still useful for comparing the study area to the rest of the State. Looking solely at systems that are currently aware of their nitrate problem and who were able to apply to the SDWSRF, California will need at least $4 per person to fulfill the current statewide funding requests and around $27-28 per person in the five study area counties (Table 4, below). The total actual need for nitrate projects could be much higher when accounting for communities who were either unaware of their nitrate problem, unconcerned with the consequences, or unable to formally apply for funding.

Table 4. Unmet qualified project needs after allocation of 2010-2011 Safe Drinking Water State Revolving Fund

	Total Area Population (Department of Finance 2010)	Type of Drinking Water Project	*People with Unmet Requested Need (Millions)*	*Unmet Requested Need (Millions)*	*Dollar of Unmet Requested Need Per Total Area Population*
All of California	38,648,090	All	41.94	$ 10,859	$ 281
		Nitrate	1.29	$ 167	$ 4
Tulare Lake Basin Counties: Fresno, Kern, Kings, Tulare	2,397,451	All	1.17	$ 824	$ 344
		Nitrate	0.12	$ 66	$ 28
Salinas Valley Basin Counties: Monterey	435,878	All	0.40	$ 103	$ 236
		Nitrate	0.03	$ 12	$ 27

After the allocation of all available funds for the 2010-2011 SDWSRF, study area counties have approximately $78 million in unfilled funding requests for nitrate projects (Table 4). This can be compared to the alternative water supply cost analysis discussed in Honeycutt *et al.* (2012), which estimated a present value cost of $212-$424 million ($17-34 million *per year*) to provide safe drinking water to the 220,000 "highly susceptible" people on public water systems in the study area. The alternative water supply cost estimate is significantly larger than the requested funding for SDWSRF.

This is because the Honeycutt *et al.* (2012) estimate includes all water systems that have recorded delivered nitrate levels above the MCL, as well as those with no recorded nitrate levels. The SDWSRF project priority list only includes projects for which the community is both aware of their nitrate problems and has been able to navigate through the complicated and time-intensive funding application process.

6.4 Major Findings and Conclusions: Current Funding Programs

A variety of funding programs exist for the development of alternative water supply actions. Funding is available for capital investments in new water supplies, safe drinking water treatment, aging infrastructure replacement, water use efficiency, and water meter installation. Funds also are available to educate communities and systems about water quality contamination and to support technical, managerial, and financial capacity building. A very small amount of money is available to help systems prepare funding applications and perform pre-investment planning.

The diversity of funding sources for safe drinking water makes it difficult for water systems to navigate the litany of agencies and programs. Each program has its own funding application to understand and complete. One promising action for the State could be to combine appropriate funding programs to ease demands on community applicants (especially smaller communities), lower administrative costs, and improve overall statewide funding effectiveness. One solution might be a one-stop online center for information, assistance, and application materials.

Most safe drinking water funding programs do not provide support for operation and maintenance costs; the State of California specifically does not fund operation and maintenance activities. Additionally, not all drinking water funding programs support the regionalization[7] of multiple water systems or the consolidation[8] of smaller districts. For example, while New Mexico's Rural Community Assistance Corporation (RCAC) office receives State funding for regionalization, California's RCAC office only receives State funding for training activities like operator certification. When funding is provided for regionalization and consolidation activities, money is restricted to construction activities such as the installation of a new pipeline or water meters. California's RCAC funding does not support institutional activities such as forming a joint powers authority, hiring a facilitator to organize pilot projects (bring together water systems and evaluate the feasibility of collaboration), or hiring a technical expert to help water systems perform asset mapping and financial planning.

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[7] Regionalization: "a creation of an appropriate management or contractual administrative organization or a coordinated physical system plan of two or more community public water systems in a geographical area for the purpose of utilizing common resources and facilities to their optimum advantage" (Grigg 1989).

[8] Consolidation: "one community public water system being absorbed into, combined with, or served by other utilities to gain the resources they lack otherwise" (Raucher, Megan Harrod, & Marca Hagenstad 2004).

Current funding programs have not met systems' stated need to ensure safe drinking water in the Salinas Valley and Tulare Lake Basin (Honeycutt *et al.* 2012). These areas have disproportionately high costs to deal with high nitrate concentrations. Compared to other areas of California, groups in the study area have requested more Safe Drinking Water Funds to address nitrate contamination ($29 per person compared to $5 per person statewide, see Figure 15). Providing safe drinking water or alternative water supplies to highly susceptible populations in the study area is estimated to cost at least $20-$36 million per year ($80-$142/year per susceptible person or $5-$9/year per study area acre of irrigated land) (Honeycutt *et al.* 2012). Most current State funding for nitrate contamination problems is temporary (general obligation bonds for loans through State propositions and the Federal economic stimulus package grants) and many programs have already been fully allocated (see Table 3). Long-term funding for safe drinking water is needed.

Small water systems typically have higher per capita funding needs than larger systems. In small and rural communities, households are usually spread out; the infrastructure needed to transport water from the source to a household in a rural area is more expensive than for urban areas. This implies that unit costs of safe drinking water will be higher in rural or small communities. Small water systems also often lack the economies of scale to economically treat nitrate contaminated ground water, and the technical, managerial, and financial capacity to repay loans, complete funding applications, and pay both recurring and unexpected operation and maintenance costs. Further, many State funding programs (State Revolving Fund, State Bonds, etc.) only accept applications from water systems served by a public entity,[9] so domestic well owners and small communities with no recognized water system lack a major State funding source. This policy is inconsistent with the Environmental Justice principles in California's laws and policies, which are based on "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws and policies" (California Government Code section 65040.12).

In addition to funding programs for safe drinking water, programs are also available for nitrate source load reduction. There are programs to help convert communities from septic to sewer systems, install wastewater treatment upgrades, monitor groundwater quality, and protect receiving water quality in both surface water and groundwater. Planning activities are funded through programs like Integrated Regional Water Management. Funding for agricultural nutrient management education, training, and research also is available.

The California Department of Food and Agriculture (CDFA) oversees a mill assessment on fertilizer sales (see Appendix A). Revenues are used for research and education of proper use and handling of fertilizing materials (including environmental effects) and to support the program. Currently, the assessment is set at half of its authorized amount. Raising the assessment to the fully authorized amount would raise roughly $3 million more per year statewide, $1 million of which could be used for

[9] A legally-approved public entity is a public water system or another legal entity that has authority to contract and incur debt on behalf of the community.

the described fertilizer-use research and education, or if current statute is changed, to fund some alternative drinking water supply efforts. We suggest that this easy increase is made immediately because it requires no further legislative action.

To help alleviate the nitrate problem in the study area, a few funding actions should be considered. These actions are particularly focused on small rural communities, who generally have the most difficulty in dealing with nitrate contaminated groundwater. More financial assistance should be provided to small systems, especially to help apply for funding and pay back loans. Additionally, funding should be provided for domestic well owners and State small and local small water systems, because these systems are currently not eligible to apply for State Safe drinking water funds (they are not served by a recognized public entity). Funding programs should be consolidated to lower administrative and application costs and to improve program effectiveness. A single program will also ease demands on community applicants. For example, water supply and wastewater problems are often intertwined, and linking these sources of funding would reduce upgrade costs for small systems. More funding for regionalization and consolidation of systems should also be considered to address nitrate contaminated drinking water in small systems more effectively and at lower cost. The State and counties have an interest in encouraging regionalization and consolidation activities to avoid longer-term financial difficulties, water system service inadequacies, and public health problems.

7 Conclusions

The lack of available information and data is the major constraint to evaluating the public health risk of a drinking water contaminant, assessing the problem in particular communities, determining appropriate regulatory actions, and finding a funding source to finance a long-term solution. However, imperfect information is often still sufficient to support decision-making. When evaluating the public health risk of a drinking water contaminant, regulators are limited by the accuracy of tests, availability of study results, and the limitations of extending results from studies on mice to humans. The process described by Lee (1992) to estimate the risk of developing cancer or methemoglobinemia with a given drinking water quality is based on empirical equations developed using all available research results. While this process provides a good estimate of the public health risk, actual responses will differ. More nitrate health studies, including dose-response assessments and better identification techniques and reporting of methemoglobinemia would help inform this problem and might lead to an adjustment of the drinking water standards.

Given the current drinking water standard for nitrate, it is still difficult to access compliance across the State. Water quality monitoring data collected by the State for public water systems are often messy and missing information from all systems. The data are often disaggregated between the State, the county, and the water system, making a full assessment of the public health risk in a particular area difficult. Additionally, there is no requirement for domestic well testing or for local-small water systems (2-4 connections), so the full extent of nitrate contamination among these populations is unknown in these areas.

The adoption of sustainable regulatory actions should be coupled with a continued monitoring program. Areas of high susceptibility should be assessed through the use of more groundwater monitoring wells, better data collection practices, and improved dissemination of results. The State should focus on reducing nitrate loading to groundwater in these highly susceptible areas by encouraging or mandating decreased discharges to groundwater. In addition to expanded monitoring, regulators should further study the feasibility of community-wide POU programs and should consider removing the current time restriction on their use for complying with SDWA.

Before finding an appropriate funding source to finance a long-term solution to minimize the public health risk of drinking water, it is important to understand the costs of all alternatives. While studies have estimated the costs of both centralized treatment systems and the installation of POU devices, results depend on location and community situation. Individual community planning studies are likely needed.

Given the available information and data, it is impossible to exactly quantify the public health risk of the entire study area. Available data suggest that the nitrate contaminated groundwater in the study area currently possess a risk to public health. Additionally, high population risk from nitrate contaminated drinking water for gastric cancer could be reduced by around 26 cancers per year with the installation of POU devices for all community public water systems with less than 200 connections. A small reduction in methemoblobinemia risk is also seen, but this is only with infants or immunocompromised adults.

Continued study of the Tulare Lake Basin and Salinas Valley would help better define the extent of the problem and the true public health risk.

Even if nitrate concentrations in the groundwater significantly decreased in an area or further research were to discount the public health risk of ingesting nitrate through drinking water, other drinking water contaminants still pose a threat. These can often be removed through the use of a POU device (reverse osmosis, ion exchange, or absorptive media, depending on the suite of contaminants). The health benefits of removing these additional contaminants will further reduce the risk of acute and chronic illnesses.

Given current high levels of nitrate in the study area, available data on the public health risk of ingesting nitrate, the expected reduction in nitrate-related public health risk, and the removal of additional drinking water contaminants, POU devices seem to be a promising solution. This solution can be extended to other areas in California who face similar high levels of nitrate and who lack the economies of scale to make centralized treatment feasible. Domestic well owners and small communities (<200 connections) who currently receive nitrate contaminated drinking water should consider community-wide implementation of POU devices. The State should consider allowing POU devices as a permanent compliance technique for meeting SDWA standards.

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Appendix A: Summary of Current Planning and Regulatory Programs that Address Nitrate in Groundwater

Water quality management efforts also occur through many planning and regulatory programs, and statutes. They provide regulatory structure or technical and managerial support to water systems, communities, farmers, dairies, and others who deal with nitrate contamination in groundwater. Some only provide indirect assistance to managing nitrate contamination to the groundwater, and are marked as such.

U.S. Environmental Protection Agency (U.S. EPA)[10]

The Environmental Protection Agency (U.S. EPA) is responsible nationally for protecting human health and natural ecosystems.[11] U.S. EPA implements its authorities through ten U.S. EPA Regions, other Federal agencies, State and local governments, and tribal regulatory partners.

The Clean Water Act (CWA) of 1972 led U.S. EPA to set water quality standards for point discharges to surface waters and to control groundwater contamination by setting industry-wide effluent standards. Section 402 of the Clean Water Act, for example, required U.S. EPA to establish the National Pollutant Discharge Elimination System (NPDES) and to authorize permits under this program. The CWA does not provide a mechanism for regulating discharges to groundwater, so the permits (Waste Discharge Requirements) issued under the State Water Board are the only tool to currently regulate nitrate discharges to groundwater (see description of State Water Resources Control Board, below).

The U.S. EPA's Office of Water (OW) is responsible for implementing the Clean Water Act, the Safe Drinking Water Act, and several other statutes. They protect human health, support economic and recreational activities, and secure sufficient ecological habitat through the management of water bodies and ecosystems. The OW consists of several organizations: the American Indian Environmental Office; the Office of Wetlands, Oceans and Watersheds; the Office of Science and Technology; the Office of Wastewater Management; and the Office of Ground Water and Drinking Water.[12] The Office of Ground Water and Drinking Water maintains several activities to protect groundwater and protect public health through the provision of safe drinking water. U.S. EPA's Enforcement Policy Response and Enforcement Targeting Tool Programs are described below.

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[10] http://water.epa.gov/aboutow/org/programs/owintro.cfm

[11] U.S.EPA Office of Water Information, accessed January 2011. Available at: http://water.epa.gov/aboutow/org/programs/owintro.cfm

[12] U.S.EPA Office of Water Information, accessed January 2011. Available at: http://water.epa.gov/aboutow/org/programs/owintro.cfm

U.S. EPA: Enforcement Policy Response and Enforcement Targeting Tool (ERP-ETT)[13]

[Indirect Assistance for Nitrate in Groundwater]

Over more than the past decade, violations of Safe Drinking Water Act regulations have mounted. Often these non-compliers are small rural systems which cannot afford the fine usually imposed after a violation occurs. EPA determined that these fines were just perpetuating the problem. As a result, the EPA recently revised and put in place a new system for tracking violations and their severity for public health for a given system and then monitoring the duration from violation to correction to better identify and then focus attention and effort on those systems that consistently struggle to comply with drinking water regulations.

The goal of the new system of supervision/monitoring is to help return systems to compliance more rapidly and sustainably. These non-compliance systems are dominated by small systems, across the USA. Small community water systems (<3,300 connections) have a 40-60% higher rate of “historical significant non-compliers” (HSNC) compared to large systems (>50,000 connections). While only 2% of California CWSs are classified as HSNCs, over 90% of these HSNC systems are “small” (US EPA definition is a system of less than 3,300 connections or 10,000 people). The new ERP-ETT system assigns a weight (# of points) to each type of violation, based on its threat to public health, and includes points for persistence of the violation (tracking the # of years since the first unaddressed violation occurred), in order to rank systems with health-based violations within the monitoring system. The existing system does not differentiate level of risk of a violation, treating all violations as equal, and does not provide information about trends in violations over time or about other violations over time of the same system. In the Central Valley, the main health-based violations among “small” systems of less than 500 people (there are 771 such sized systems in the Central Valley) are bacteria, nitrate and arsenic (Connie Li, US EPA Reg 9, UC Merced talk).

U.S. EPA: Supplemental Environmental Programs[14]

A Supplemental Environmental Program is agreed to under an enforcement settlement and is an environmentally beneficial project that a violator of environmental laws may choose to perform in addition to the actions required by law to correct the violation. The environmental project must be related to the violation and accomplished in place of other penalties. EPA defines seven specific categories that may be performed by the violating company: pollution prevention, pollution reduction, public health, environmental restoration and protection, assessment and audits, environmental compliance promotion, and emergency planning and preparedness. A company may, for example, pay a community for safe drinking water treatment to resolve a previous contaminating activity that affected groundwater quality.

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[13] http://www.epa.gov/compliance/resources/policies/civil/sdwa/drinking_water_erp_2009.pdf

[14] http://www.epa.gov/oecaerth/civil/seps

United States Department of Agriculture (USDA): National Drinking Water Clearinghouse, West Virginia University[15]

[Indirect Assistance for Nitrate in Groundwater]

The National Drinking Water Clearinghouse (NDWC) is sponsored by USDA's Rural Development Program Rural Utilities Service. Their engineers and experts provide technical assistance for small and rural drinking water treatment plants. They also inform communities on topics such as available funding options and Federal and State drinking water regulations. The NDWC publishes drinking water newsletters, technical brief fact sheets, and a magazine, all of which are valuable sources of information for small and rural water systems that face nitrate or other contaminants in their drinking water.

California Department of Public Health (CDPH)

CDPH: Drinking Water Source Assessment and Protection (DWSAP)[16]

[Indirect Assistance for Nitrate in Groundwater]

Since 1997, CDPH has used $7.5 million allocated from the State Revolving Fund for evaluating possible contaminating activities (PCAs) surrounding groundwater and surface water sources for drinking water. As of 2003, 94% of public water systems in California had been evaluated. This program helps communities better understand the vulnerability of their drinking water and prioritize use of limited funds towards source reduction and cleanup.

CDPH: Expense Reimbursement Grant Program (EPG)[17]

[Indirect Assistance for Nitrate in Groundwater]

Through a grant from the U.S. EPA, CDPH provides education, training, and certification for small water system operators. CDPH contracts Cooperative Personnel Services (CPS) to carry out these tasks. Eligible systems serve a community or non-transient population of less than 3,301 people.

State Water Resources Control Board (State Water Board)[18]

The State Water Board and each Regional Water Board are the principal State agencies responsible for the coordination and control of a unified and effective water quality control program in the State of

[15] http://www.nesc.wvu.edu/ndwc/articles/OT/WI03/SRFandRUS.html
[16] http://www.cdph.ca.gov/certlic/drinkingwater/pages/dwsap.aspx
[17] http://www.cps.ca.gov/tlc/sws/
[18] http://www.swrcb.ca.gov

California (Water Code § 13001). The State Water Board formulates and adopts State policy for water quality consisting of : a) water quality principles and guidelines for long-range resource planning, including ground water and surface water management programs and control and use of recycled water; b) water quality objectives at key locations for planning and operation of water resources development projects and for water quality control activities; and c) other principles, guidelines, and objectives deemed essential by the State Water Board for water quality control to provide a suitable living environment for California residents (Water Code § 13140 and § 13142).

The State Water Board adopts the water quality control plans (Basin Plans) prepared by each of the Regional Water Boards in California (33 U.S.C. 1313 (a), Water Code § 13170) as part of the California Water Plan. Each Regional Water Board must submit to the State Water Board a Regional Water Quality Control Plan (Basin Plan), except the Central Valley Regional Water Board, which has two plans: the Sacramento and San Joaquin River Baisns and Tulare Lake Basin. These Basin Plans define beneficial uses for groundwater and surface water, set water quality levels to protect these beneficial uses, and establish programs for meeting these water quality objectives. Beneficial uses to be protected include, but are not limited to, "domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves" (Water Code § 13050 (f)). The water quality standards must be reviewed every three years under the Clean Water Act and periodically under the California Water Code.[19]

The California Water Code Section 13263 authorizes the California Water Boards to issue Waste Discharge Requirements (WDRs) for projects or activities that discharge waste to waters of the State. The Federal Clean Water Act does not contain a mechanism to regulate discharges to groundwater (only surface water), so WDRs are the only regulatory tool that can be used to ensure that discharges to California groundwater does not exceed water quality objectives. The California Water Boards may find it in the public interest to issue a waiver of a WDR instead of a WDR. A waiver is limited to five years and has explicit conditions for protecting water quality.

In October 2001, the Groundwater Quality Monitoring Act of 2001 (AB 599) was established by the California Assembly. The Groundwater Quality Monitoring Act of 2001 required the State Water Board, an Interagency Task Force, and a Public Advisory Committee to: establish a comprehensive statewide groundwater quality monitoring program; increase the accessibility of groundwater quality data to the public; and allow groundwater basin assessment. Assessment is defined by AB599 as "assessing susceptibility of groundwater to water quality degradation, characterizing current water quality in a basin, and predicting future water quality under various conditions."

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[19] Clean Water Act § 303(c) and California Water Code § 13240.

State Water Board: The Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act was adopted in 1969 and granted the State Water Board the ultimate authority over State water quality policy (Water Code § 13146). The main goal of the Porter-Cologne Act is to regulate activities in California to achieve the highest reasonable water quality; "reasonable" is defined after the demands on the waters and total values involved are considered (Water Code § 13146).

The framework of Porter-Cologne laid out the framework for future regulations and programs, including: the Dairy Waste Discharge Requirements regulatory program (focused on groundwater contamination from dairies), the Irrigated Lands Regulatory Program (initially focused on discharges to surface water only from all irrigation sources, but is now considering discharges to groundwater), and the Central Valley Salinity Alternative for Long-Term Sustainability (focused on surface water and groundwater and considers both salt and nitrate).

State Water Board: Groundwater Ambient Monitoring and Assessment (GAMA) Program[20]

[Indirect Assistance for Nitrate in Groundwater]

The GAMA Program, created in 2000, was officially mandated by the State legislature under the Groundwater Quality Monitoring Act of 2001 (AB 599) and is funded by Proposition 50 and special fund fees. It aims to improve statewide groundwater quality monitoring and increase the availability of groundwater quality information. With 95% of California's population on public water systems, and another 1.7 million on self-supply or very small systems less than 15 connections, reliant on groundwater for some or all of their drinking water, GAMA has a mandate to integrate disparate data collection efforts and initiate new programs as needed, to develop a comprehensive integrated statewide groundwater monitoring program. USGS and Lawrence Livermore National Laboratory have been collaborators on this initiative, providing scientific expertise for developing the initial monitoring plan in 2003 and leading various groundwater quality assessments.

The GAMA Program consists of:

1) GeoTracker GAMA, an on-line searchable database that standardizes and integrates groundwater quality monitoring data collected by: the California Water Boards, the California Departments of Public Health, Pesticide Regulation, and Water Resources; the United States Geological Survey; and Lawrence Livermore National Laboratory into a unified data information system. GeoTracker GAMA covers over 150,000 locations in California. GeoTracker GAMA has

[20] http://www.swrcb.ca.gov/water_issues/programs/gama/

been an important source on historical and current measurements of nitrate levels and co-constituents in groundwater in the Salinas Valley and Tulare Lake Basin study areas.

2) Priority Basin Project, focusing on 116 of 472 DWR groundwater basins in California, organized into study units, and with sampling and assessment of groundwater quality in priority basins for the presence and levels of CDPH regulated contaminants as well as other unregulated contaminants. The UC Davis Nitrate Project Study Area involves 4 GAMA Priority Basin Project Study Units: Kern, SE San Joaquin Valley, W. San Joaquin Valley, and Monterey.

3) Domestic Wells Project, a voluntary groundwater testing program for domestic wells with samples collected and tested at no cost by State Water Board staff. Over 1,000 domestic wells have been sampled so far in 5 counties, including Tulare. Tulare County domestic wells were sampled in 2006 under this project, and nitrate at or above the 10 mg/L nitrogen MCL (45 mg/L as nitrate) were found in over 40% of the sampled wells at levels up to 54 mg/L of N. Four percent of wells exceeded the nitrite MCL.

4) Special Projects, involving specialized research and study projects to measure and understand processes of groundwater contamination.

State Water Board: Recycled Water Policy[21]

In 2009, the State Water Board adopted Resolution No. 2009-0011: Recycled Water Policy. Among goals of increasing the use of recycled water and storm water by 2020, is for all regions to develop salt and nutrient management plans by 2012. These plans are to be managed on a basin-wide or watershed-wide basis. The State Water Board strongly encourages regions to include storm water use and recharge plans in their salt and nutrient management plans because storm water is typically lower in salt and nutrients. Each salt and nutrient management plan will also include a basin/sub-basin wide monitoring program dependent on the site-specific characteristics, but sufficient to determine if water quality objectives are being met.

Regional Water Quality Control Boards (Regional Water Boards)

Cleanup and Abatement Order (CAO)

Under authority of the Porter-Cologne Act, CA Water Code Section 13304 provides authority to the Regional Water Boards to compel known groundwater dischargers to clean up or cease degradation. Section 13304 states: “any person who has discharged or discharges waste into the waters of this State in violation of any waste discharge requirement …or who has caused or permitted….any waste to be

[21] http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/recycledwaterpolicy_approved.pdf

discharged or….discharged into the waters of the State….shall upon order of the regional board, clean up the waste or abate the effects of the waste". If a polluter refuses to comply with a CAO, the Regional Water Quality Control Board can request that the California Attorney General sue the polluter to force it to comply with the CAO.

Water Code Section 13304 also states that "A cleanup and abatement order issued by the state board or a regional board may require the provision of, or payment for, uninterrupted replacement water service, which may include wellhead treatment, to each affected public water supplier or private well owner." This provides authority for a regional board to require landowners contributing to nitrate risk to groundwater drinking water supplies to support drinking water actions for affected public water supplies and private wells.

Central Coast Regional Water Quality Control Board (Central Coast Regional Water Board)[22]

The Central Coast Regional Water Board has jurisdiction over Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara Counties, and parts of Santa Clara, San Mateo, Kern, and Ventura Counties; regulating activities over approximately three million hectares, with irrigated agricultural lands covering about 435,000 hectares.[23] The Central Coast Regional Water Board aims to complete the following by 2025: (1) 80% of aquatic habitat is healthy; (2) 80% of watershed lands will be properly managed to keep watersheds healthy and functioning well; and (3) 80% of groundwater will test clean according to the the Central Coast Regional Water Board's TDS and nitrate standards.[24] The Central Coast Ambient Monitoring Program (CCAMP) is the Central Coast Regional Water Board's water quality monitoring and assessment program. CCAMP gathers groundwater monitoring data from the U.S. Geological Survey, the Department of Health Services, and DWR and manages the databases to facilitate the Central Coast Regional Water Board's use. Under the Recycled Water Policy they have Salt and Nutrient Management Plan Requirements; stakeholders must develop implementation plans for meeting objectives for salts and nutrients.

To address the nitrate contamination of groundwater, the Central Coast Regional Water Board has created the Irrigated Lands Regulatory Program (also known as the Agricultural Regulatory Program) to regulate discharges from irrigated agricultural lands and encourage best management practices (BMPs), water quality monitoring, and proper implementation of corrective actions.

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[22] http://www.swrcb.ca.gov/rwqcb3/

[23] Central Coast Regional Water Board. Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands. Draft Order No. R3-2011-0006.

[24] San Luis Obispo Science and Ecosystem Alliance. Achieving Management and Conservation Goals through the Application of Ecosystem-based Management of the Central Coast of California. August 27, 2008. http://groups.ucanr.org/HumboldtBayEBM/files/59049.pdf

Central Coast Regional Water Board: Irrigated Lands Regulatory Program (ILRP)

Central Coast Regional Water Board's Irrigated Lands Regulatory Program (ILRP) specifically addresses crucial water quality issues on a priority watershed basis, continually assessing and tracking the progress of improvements in water quality and agricultural land management (Central Coast Regional Water Board, 2011). The priority watersheds are the Salinas River, Santa Maria, and Pajaro watersheds. The Conditional Waiver of WDRs for Discharges from Irrigated Lands was adopted in 2004, known as the Agricultural Waiver Program (AWP), and expired on September 30, 2011. The AWP is a voluntary negotiated agreement between the Central Coast Regional Water Board, growers, and environmental organizations. The AWP uses BMPs and rules for managing on-farm water resources to reach environmental goals, with the threat of mandatory regulatory action as incentive for a discharger to join the program. Farmers are required to complete ambient water quality monitoring, attend fifteen hours of educational classes, create a farm plan, and implement BMPs (Dowd et al., 2008). Waivers last for five years, with the quantity and quality of the reporting designated by the tier classification of the discharger. Tier 1 dischargers are are generally considered sustainable (does not use chlorpyrifos or diazinon, is far from an Imparied Surface Waterbody, and any nitrogen discharges are far from public water systems wells); Tier 3 dischargers either have a high potential to discharge nitrogen to groundwater or apply chlorpyrifos/diazinon near an Impaired Waterbody; and Tier 2 dischargers fall in between the other two categories. A Tier 1 discharger provides an updated management-practice list two and a half years through the waiver and a Tier 2 discharger submits annual progress reports identifying current management practices and projections of educational goals completion (Dowd et al., 2008). If a discharger has not completed the educational classes after three years of the waiver, they are at risk of being issued a WDR. To decrease water quality monitoring costs, the Central Coast Regional Water Board and stakeholders agreed on a monitoring program for farmers to cooperatively monitor the main stems and tributaries of the Central Coast Region, sampling nutrients, temperature, orthophosphate, chlorophyll *a*, dissolved oxygen, total dissolved solids, pH, turbidity, and discharge (Dowd et al., 2008). The existing Conditional Waiver of Waste Discharge Requirements (WDRs) for Dischargers from Irrigated Lands (Irrigated Ag Order R3-2010-0040) was extended on July 8, 2010 (Central Coast Regional Water Board, 2011), March 29, 2011, and again on September 30, 2011.

The current order (Agricultural Order No. R3-2004-0117, dated Sept. 30, 2011) has been extended through September 30th, 2012. The Central Coast Regional Water Board is currently making revisions to the 2004 Agricultural Order. The September 1st, 2011 draft of the Agricultural Order requires Tier 3 dischargers with high nitrate loading risk to meet specified Nitrogen Mass Balance Ratios or implement an alternative solution that leads to an equivalent nitrogen load reduction.

Central Valley Regional Water Quality Control Board (Central Valley Regional Water Board)[25]

The Central Valley Regional Water Board has jurisdiction over nearly 40% of the State, including all or part of 38 of the State's 58 counties and about 80% of the State's irrigated agricultural land (Central Valley Regional Water Board, 2010). The Tulare Lake Basin section of the study area is within the Central Valley Regional Water Board's Fresno Boundary of Responsibility. The three major watersheds in the Central Valley Region are the Tulare Lake Basin, and the drainages of the Sacramento River and the San Joaquin River. The Central Valley Regional Water Board supervises the following programs to protect groundwater quality and to clean up contaminated groundwater: (1) Waste Discharge Requirements (WDRs); (2) Land Disposal (Title 27) Program; (3) Underground Storage Tank Program; (4) Cleanup Program; and (5) Federal Facilities Program.

The Central Valley Regional Water Board manages two main programs which affect ground water quality and specifically nitrate concentration: the Irrigated Lands Regulatory Program (ILRP) and the Central Valley Salinity Alternative for Long-Term Sustainability (CV-SALTS) program.

Central Valley Regional Water Board: Irrigated Lands Regulatory Program (ILRP)[26]

The current Irrigated Lands Regulatory Program (ILRP) in the Central Valley was created in 2003 as an interim program to regulate irrigated lands until 2011, when the long-term program will be completed.

The Draft Program Environmental Impact Report (DPEIR) for the long-term Central Valley ILRP was released on July 28, 2010. The Draft PEIR discusses five programmatic alternatives for regulating irrigated agriculture dischargers and their impacts, with Alternative 2[27] designated as the Central Valley Regional Water Board's Staff-Recommended Program (Central Valley Regional Water Board, DPEIR, 2010). A group of nonprofit organizations provided comments on the Draft, noting insufficient protection of water quality objectives or beneficial uses, recommending that the Central Valley Regional Water Board "revisit both its economic and environmental analyses as well as the components of the final program", and use Alternative 4[28] as the foundation of a revised program.[29] The nonprofit organizations believe an effective program can be formed from a fair and balanced analysis which

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[25] http://www.swrcb.ca.gov/rwqcb5/

[26] http://www.swrcb.ca.gov/centralvalley/water_issues/irrigated_lands/index.shtml

[27] Third party groups function as legal entities to represent the growers. The regulatory mechanisms will be established by the Central Valley Regional Water Board to be flexible to account for a variety of environmental conditions and agricultural operations.

[28] Growers or other legal entities responsible for waste discharges by a group of growers would apply to the Central Valley Regional Water Board for direct oversight with the option for regional monitoring by a third party.

[29] Community Water Center et al. Comments on the ILRP Staff Report, Economic Analysis and DPEIR, Sept. 2010

involves: (1) collection of information on baseline parameters such as farm practices and water quality; (2) farm-level education and assistance requirements, and representative monitoring to ensure best management practices; (3) accountability by enforcement to induce compliance; and (4) plans to clean-up legacy and continued agricultural contamination.[30]

Water quality plans will be required for areas where problems are known. The groundwater program would specifically look for nitrate, pathogens, and pesticides. Each grower would need to submit a farm evaluation. This plan will facilitate nitrate monitoring, increase the availability of water quality data, and ideally (through awareness) decrease the excessive application of nitrate fertilizer.

The August 2011 Recommended ILRP Framework proposes establishing three tiers: Tier 1 is for constituents that could affect, but do not pose a threat to, water quality; Tier 2 is assigned if the threat from irrigated agriculture is unknown; and Tier 3 will be assigned if irrigated agriculture is causing or contributing to a known water quality problem from a specific constituent. Tier 1 areas will generally not be required to monitor water quality, while Tiers 2 and 3 will be required to submit water quality monitoring and assessment reports. Agricultural operations in Tier 3 areas for which nitrate is the contaminant of concern will be required to prepare and maintain a farm-specific nutrient management plan (Central Valley Regional Water Board, Draft Requirements for Nutrient Management Plans in High Priority Groundwater Areas, Aug. 2011).

Central Valley Regional Water Board: CV-SALTS[31,32]

In 2006, the Central Valley Regional Water Board, the State Water Board, and affiliated stakeholders initiated an effort to address salinity and nitrate problems in the Central Valley and to establish solutions for improved water quality.[33] The Central Valley Salinity Alternative for Long-Term Sustainability (CV-SALTS) is a collaborative basin planning effort aimed at developing and implementing the policies and science to create sustainable and comprehensive salinity and nitrate management.[34] A primary goal of CV-SALTS is to update the policies and regulations of the Water Quality Control Plans “to facilitate cost effective salinity management while protecting beneficial uses of surface and ground waters”.[35] New water quality objectives for salts and nitrate will be established and where the objectives are not met a comprehensive implementation plan will be established to protect water quality and meet the objectives in the near future. In 2008, the Central Valley Salinity Coalition (CVSC) was formed to represent stakeholders collaborating with the Central Valley Regional Water Board to efficiently manage

[30] Community Water Center et al. Comments on the ILRP Staff Report, Economic Analysis and DPEIR, Sept. 2010
[31] http://www.swrcb.ca.gov/centralvalley/water_issues/salinity/index.shtml
[32] http://www.cvsalinity.org/
[25] http://www.swrcb.ca.gov/centralvalley/water_issues/salinity/index.shtml
[34] http://www.swrcb.ca.gov/centralvalley/water_issues/salinity/index.shtml
[35] http://www.swrcb.ca.gov/centralvalley/water_issues/salinity/index.shtml

salinity in the Central Valley. All efforts needed to complete the goals of CV-SALTS are administered and financed by the CVSC.

In 2010, Larry Walker Associates and others conducted the first pilot study of the CV-SALTS initiative to address the salt and nutrient management problems in the Central Valley and to guide stakeholders in creating effective salt and nutrient management plans. Input data sets were identified and assembled for the Watershed Analysis Risk Management Framework (WARMF) model to quantitatively relate salt and nitrate sources and sinks within the Yolo, Modesto, and Tule River areas.[36] The study found irrigation and fertilizer/land application to be the principal inputs of nitrate to near-surface groundwater and found nitrate is accumulating in near-surface groundwater.

A draft outline of stakeholder (i.e., polluters, environmental NGOs, etc.) proposed elements for a salt and nitrate management plan is available on the CVSC website.[37] The salinity and nitrate management plans will outline basin monitoring programs, identify salinity and nitrate sources and processes, create a nutrient budget, identify the population affected, analyze and compare trends with beneficial uses and water quality objectives, and develop policies. Basin Plan Amendments will be completed May 2015.

Central Valley Regional Water Board: Dairy Program[38]

To comply with the Porter-Cologne Water Quality Control Act (California Water Code Division 7), the Central Valley Regional Water Board created the Dairy Program, also known as the Confined Animal Facility Program, to regulate confined animal facilities, including dairies, feedlots, poultry facilities, and horse facilities.[39] Under the Dairy Program, dairies, feedlots and other confined animal facilities must comply with set statewide water quality regulations and existing milk cow dairies of all sizes must follow waste discharge requirements. Requirements for the dairy production area and land application area are outlined in the Waste Discharge Requirements General Order for Existing Milk Cow Dairies (General Order) adopted on May 3, 2007.[40] The General Order requires that all domestic and agricultural supply wells and subsurface (tile) drainage systems in the production and/or land application areas be sampled by November 3, 2007, and then annually under the General Order.[41] The General Order requires existing milk cow dairies to conduct nutrient and groundwater monitoring, measuring electrical

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[36] CV-SALTS: Salt and Nitrate Sources Pilot Implementation Study Report, February 2010. Larry Walker Associates, and others.

[37] The non-profit coalition of stakeholders, known as the CVSC, accessed December 2010. Available at: http://www.cvsalinity.org/index.php/documents/cat_view/39-docs/49-documents-related-to-salt-and-nutrient-management-planning.

[38] http://www.swrcb.ca.gov/rwqcb5/water_issues/dairies/index.shtml

[39] Central Valley Regional Water Board Dairy Program, accessed November 2010. Available at: http://www.swrcb.ca.gov/rwqcb5/water_issues/dairies/index.shtml

[40] ibid.

[41] Order No. R5-2007-0035. Waste Discharge Requirements for General Order for Existing Milk Cow Dairies. May 3, 2007. Available at http://www.waterboards.ca.gov/centralvalley/adopted_orders/GeneralOrders/R5-2007-0035.pdf

conductivity, total ammonia nitrogen and un-ionized ammonia nitrogen (NH_3-N). The General Order requires that each dairy implement their Waste Management Plan (WMP) by 2011 and their Nutrient Management Plan (NMP) by 2012. The WMP ensures "the production area of the dairy facility is designed, constructed, operated and maintained so that dairy wastes generated at the dairy are managed in compliance with WDR General Order No. R5-2007-0035 in order to prevent adverse impacts to groundwater and surface water quality".[42] The NMP is created to "budget and manage the nutrients applied to the land application area(s) considering all sources of nutrients, crop requirements, soil types, climate, and local conditions in order to prevent adverse impacts to surface water and groundwater quality".[43]

California Department of Food and Agriculture (CDFA)

The California Department of Food and Agriculture (CDFA) is the lead agency responsible for protecting California's agriculture, enforcing environmental regulations on agricultural production, and ensuring equitable marketing to consumers. In 1988, the CDFA secretary appointed the Nitrate Working Group (NWG) to study California's agricultural nitrate problem. In 1989, the NWG wrote "Nitrate and Agriculture in California", a report which identified California's "nitrate-sensitive areas", recommended a prioritized plan for those areas to start and implement nitrate management programs, and improved farming practices to decrease nitrate loads to groundwater. In 1990, the Director of the CDFA established the Nitrate Management Program (NMP) and tasked them with implementing the report recommendations. The NMP then led to the creation of the Fertilizing Materials Inspection Program (FMIP) and a Fertilizer Research and Education Program (FREP), described below.

CDFA: Feed, Fertilizer, Livestock, Drugs, Egg Quality Control Regulatory Services (FFLDERS)

The CDFA Inspection Services Division has a Feed, Fertilizer, Livestock, Drugs, Egg Quality Control Regulatory Services (FFLDERS) Branch which runs the FMIP and FREP programs. FMIP regulates the manufacture, distribution, licensing, and labeling of fertilizing materials in California, to provide safety and quality assurance. FMIP has a Fertilizer Inspection Advisory Board comprised of eight members in charge of recommending proposed regulations to the Secretary of Agriculture. The structure and functions of the FMIP could be expanded to regulate and track fertilizer use applications and to collect fees on fertilizer sales, with little need for legislative action.

FREP funds and researches methods for ensuring fertilizer use is environmentally safe and proper handling practices are followed. FREP was the first attempt at voluntary action to reduce nitrate in response to the 1989 "Nitrates and Agriculture in California" Report. FREP involves funding farmer

[42] ibid.
[43] ibid.

education and research about nutrient management. FFLDERS programs are funded from a mill tax and license, registration and inspection fees. Currently a total assessment of $0.0015 per dollar of fertilizer sales is collected, however the Food and Agricultural Code allows an assessment of up to three mills ($0.003). This $0.0015 assessment consists of a $0.0005 per dollar sales assessment on all commercial fertilizer to fund research and educational projects that improve farming practices and decrease environmental impacts due to fertilizer use[44], and a $0.001 per dollar of sales assessment to pay a "fertilizing materials" inspection assessment[45]. The fertilizer research assessment ($0.0005) currently generates about $1 M per year. This funding source could be quickly and easily increased because the code allows up to two mills ($0.002) per dollar of sales to be imposed on all licensees who sell or distribute bulk fertilizing materials and an additional assessment of up to one mill ($0.001) per dollar of sales to be imposed on all licensees to provide funding for research and education pertaining the use and handling of fertilizing material and any environmental effects.[46] Since the current assessments collected for licensing and research and educational projects is only half of the allowed amount, the assessments could be raised to the full three mill assessment.

Assembly Bill 3030 (Groundwater Management Act)[47]

[Indirect Assistance for Nitrate in Groundwater]

Since 1993, Assembly Bill 3030 has permitted local agencies to adopt programs to manage groundwater. The Central Valley Project Improvement Act further requires that all water suppliers which overlie a useable groundwater basin develop a groundwater management plan under AB 3030 guidelines. AB 3030 lists technical components which may be included, such as the identification of well construction policies, the coordination of land use planning to reduce the risk of groundwater contamination, and the identification of wellhead protection areas. The technical components of AB 3030 provide a means for local agencies to protect their local resources from nitrate contamination. Once a plan is adopted, the local agency must pass rules and regulations which maintain consistency with the plan.

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[44] The California Food and Agriculture Fertilizer Research and Education Program: The California Food and Agricultural Code Section 14611(b), accessed December 2010. Available at: http://www.cdfa.ca.gov/is/fflders/pdfs/2010_FREP_Proceedings.pdf

[45] The California Food and Agriculture Fertilizing Materials Inspection Program: Fertilizing Materials Inspection Assessment, accessed December 2010. Available at: http://www.cdfa.ca.gov/is/fflders/fertilizer.html

[46] The California Department of Food and Agricultural Code: Division 7, Chapter 5, Article 6, Section 14611, accessed January 2011. Available at: http://www.leginfo.ca.gov/cgi-bin/displaycode?section=fac&group=14001-15000&file=14611-14611

[47] http://www.water.ca.gov/groundwater/gwmanagement/ab_3030.cfm

Kern County Water Agency (KCWA) [48]

[Indirect Assistance for Nitrate in Groundwater]

The Kern County Water Agency (KCWA) monitors and reports groundwater quality and levels in Kern County. This information is primarily used in conjunction with groundwater banking and recharge projects. The KCWA monitors around 240 wells monthly and 800 semiannually. The well data are critical to understanding historical nitrate levels in the county groundwater basins and for catching future changes in water quality before contamination affects public health.

Monterey County Water Resources Agency (MCWRA) [49]

The Monterey County Water Resources Agency (MCWRA) (established as the Monterey County Flood Control and Water Conservation District in 1947 and renamed in 1990), provides flood and water quality management and protection to the people of Monterey County. The Board has nine members appointed by the Monterey County Farm Bureau, Monterey Grower-Shipper Association, the Monterey County Farm Advisory Committee, County Supervisors, and the Mayor's Select Committee.[50]

One of their six listed purposes for collecting water quality data is to evaluate nitrate in groundwater. Their nitrate monitoring program existed since 1978, with a 1995 study showing that 28% of 350 sampled wells exceeded the nitrate MCL.[51] The highest concentrations were seen in the Upper Valley, East Side, and Forebay Subareas.

For the local agriculture community, MCWRA has a water quality planning program that includes research efforts and outreach to growers to improve irrigation efficiency and fertilizer management to effectively reduce nitrate leaching. As an educational guide, they provide online access to Nitrate Management Fact Sheets that describe water and fertilizer management techniques, guidelines for handling fertilizers, and methods for accounting for nitrate already present in the soil and water. They also provide instruction on how to properly monitor and sample for nitrogen in the soil and water, as well as resources for ordering nitrogen test kits and strips.

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[48] http://www.kcwa.com

[49] http://www.mcwra.co.monterey.ca.us

[50] An article written by Monterey Coastkeeper on October 21, 2010. Available at: http://yubanet.com/california/Monterey-Coastkeeper-Sues-Monterey-County-Water-Resources-Agency-To-Protect-Water-Quality.php

[51] Water Resources Data Report: Water Year 1995. MCWRA. http://www.mcwra.co.monterey.ca.us/Agency_data/Hydrogeologic%20Reports/WaterResourcesDataReport/Section6_WaterQuality.pdf

Monterey County Health Department

[Indirect Assistance for Nitrate in Groundwater]

The Monterey County Health Department implements a tiered nitrate sampling program based on increasing concentration for local small water systems and state-small water systems. If the system has recently measured a nitrate concentration at or above the MCL, the system must increase their sampling rate from yearly to quarterly. Monterey County Health Department's nitrate sampling program is more stringent than the State regulations, which only require one-time monitoring for nitrate at the point of initial permit application (CCR Title 22).

Southern San Joaquin Valley Water Quality Coalition[52]

[Indirect Assistance for Nitrate in Groundwater]

The Southern San Joaquin Valley Water Quality Coalition was established in 2002 as a result of a request by the Central Valley Regional Water Board to create a voluntary water quality monitoring program as part of the region-wide consideration of agricultural discharge permitting. The Coalition was formed to serve the Tulare Lake Basin watershed and involves various agencies, including the Kern County Water Agency and Kings River Water Association. The Coalition publishes an annual report which documents their efforts to protect and preserve water quality supplies and water rights in the watershed. Recently, the Coalition was named a member of the stakeholder work group responsible for evaluating and updating the Irrigated Lands Regulatory Program for the Central Valley Regional Water Board.

Tulare County Water Commission

[Indirect Assistance for Nitrate in Groundwater]

The Tulare County Water Commission meets once a month to discuss water issues affecting Tulare County. The Commission includes engineers, water district managers, elected officials and community activists and serves as an advisory body to the Tulare County Board. The Commission, along with the Community Water Center, lobbied for funding to address the drinking and wastewater needs of disadvantaged communities in the Tulare Lake Basin. This $2 million project is currently underway (The Disadvantaged Community Water Study Project). A major focus of this project is identifying the overlap of disadvantaged communities and poor groundwater quality areas. This analysis will be more detailed than the rough analysis in this report (see Alternative Water Supply Report) and will evaluate community-specific solutions.

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[52] http://www.ssjwqc.org

Rural Community Assistance and Partnership (RCAP)[53]

[Indirect Assistance for Nitrate in Groundwater]

The Rural Community Assistance Partnership is a national organization of six regional partners which helps communities of less than 10,000 people, often disadvantaged and frequently with populations of less than 2,500. Through publications, training events, conferences, toolboxes, and hands-on technical assistance, RCAP helps people living in rural communities to: access safe drinking water supplies, properly treat and dispose of wastewater, finance infrastructure projects, understand regulations, and manage water facilities. They do not provide loans or grants to communities, but they provide financial operations assistance and guidance. RCAP receives funding from the U.S. Department of Agriculture Rural Development program, EPA's Office of Groundwater and Drinking Water and Office of Waste Water Management, and the Office of Community Services of the U.S. Department of Health and Human Services.

Monterey Coastkeeper

The Monterey Coastkeeper is a non-profit organization serving Monterey and Santa Cruz Counties and portions of San Mateo, Santa Clara and San Benito Counties. The Coastkeeper advocates for effective government, public policy, and active community participation for the protection of water quality. The Monterey Coastkeeper particularly seeks more effective monitoring requirements of agricultural runoff and collaborates with the State Water Board to ensure the success of the Agricultural Waiver Program. In 2010, the Monterey Coastkeeper encouraged the Central Coast Regional Water Board to adopt more stringent waste discharge requirements for the Gallo Cattle facility near Gonzales. As a result, the Central Coast Regional Water Board also required Gallo to create a groundwater management plan.

National Rural Water Association (NRWA)[54]

[Indirect Assistance for Nitrate in Groundwater]

The National Rural Water Association is the largest water and wastewater utility membership organization in the U.S. They focus primarily on systems with less than 10,000 people but they also have representatives from 94% of public water systems overall. They offer technical advice in the areas of operation, management, finance, and governance. NRWA advocates for small and rural systems to insure that rules and regulations are appropriate for everyone and that sufficient funding is available to these systems. Additionally, they have developed a library of free white papers for rural and small water

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[53] http://www.rcap.org
[54] http://www.nrwa.org

and wastewater systems. These reports are valuable to small and rural systems where data and information are often difficult to obtain.

California Rural Water Association (CRWA)[55]

[Indirect Assistance for Nitrate in Groundwater]

Incorporated in 1990, the California Rural Water Association is a state affiliate of the National Rural Water Association. CRWA provides online classes, onsite training, low cost educational publications, and other forms of technical advice for rural water and wastewater systems. They also provide legislative representation, aid in developing new rate schedules, installing new testing methods, understanding government regulations, or updating operator certification requirements specifically for small rural community water and wastewater needs.

Self-Help Enterprises (SHE)

[Indirect Assistance for Nitrate in Groundwater]

Self-Help Enterprises (SHE) helps low-income families in the San Joaquin Valley to help themselves through the improvement of their water systems, among other projects. They can provide seed money to small rural disadvantaged communities for preparing reports and studies needed for funding applications for water system construction and improvements. They also assist these communities in preparing their applications to programs providing water system funding by providing human resources and the technical assistance to develop adequate water delivery and wastewater disposal systems. Drinking water projects involving nitrate contamination have been a major part of their work. SHE partnered with the Community Water Center to offer free well testing and funding advice to the community of Monson who faced high levels of nitrate and DBCP.

Community Water Center (CWC)[56]

[Indirect Assistance for Nitrate in Groundwater]

The Community Water Center (CWC) advocates for providing safe drinking water to all communities in the San Joaquin Valley, regardless of economic condition. They lobby local and State government, support policies, educate local agencies and communities, and organize community projects. Recently, the CWC published a study of nitrate contamination of drinking water and related health effects,

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[55] http://www.calruralwater.org/CRWA.htm

[56] http://www.communitywatercenter.org/

specifically in the San Joaquin Valley. This document was designed to educate local communities so they are aware of the nitrate problem and understand their options for obtaining safe drinking water.

The CWC coordinates the AGUA Coalition (la Asociación de Gente Unida por el Agua, or the Association of People United for Water). AGUA campaigns for regional solutions to enduring water system problems in the San Joaquin Valley. They are currently focused on protecting groundwater sources for drinking water use from contaminants, especially nitrate. Recently, the CWC brought nation-wide attention to the nitrate contamination issue in the Central Valley by organizing the visit of a U.N. representative.

Appendix B: Description of Current Funding Programs for Safe Drinking Water

This appendix summarizes existing funding programs for safe drinking water in the study area. These resources are available from the national to the local level.

California Department of Public Health (CDPH)

The California Department of Public Health (CDPH) is responsible for implementing Public Resources Code (PRC) Sections 75020 through 75023 and 75025 under Chapter 2: Safe Drinking Water and Water Quality Projects. They administer both State and Federal funds to improve drinking water systems.

CDPH: Safe Drinking Water State Revolving Fund (SDWSRF)[57]

This is one of the State's major forms of funding for local capital improvements. A description of the Safe Drinking Water State Revolving Fund (SDWSRF) is found above in Section 6.3: Funding Example: Safe Drinking Water State Revolving Fund .

CDPH: Proposition 84[58]

[Fully Allocated]

Proposition 84 (the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006), allocated $1.5 billion of its $5.4 billion in general obligation bonds to CDPH, DWR, and the State Water Board for safe drinking water and water quality projects. CDPH received funding for four main purposes related to public water systems.

Emergency and urgent projects were allocated $10 million to ensure the immediate health and safety of drinking water supplies. Projects include: emergency interties with larger water systems; tank, pump, and well replacements; design, installation, and initial operation costs for water treatment systems, and the provision of bottled water when necessary. In 2007, this emergency fund provided approximately $81,000 for water districts within Tulare County to replace well equipment.[59]

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[57] http://www.cdph.ca.gov/services/funding/Pages/SRF.aspx

[58] http://www.cdph.ca.gov/services/funding/Pages/Prop84.aspx

[59] CDPH's Proposition 84: Emergency Safe Drinking Water Supply Program, accessed January 2011. Tulare County water districts: Ducor Community Services District, Lanare Community Services District, Tooleville MWC and West Goshen MWC. Available at: http://bondaccountability.resources.ca.gov/plevel1.aspx?id=1&pid=4

Small community drinking water system improvements to help meet the safe drinking water standards were allocated $180 million. Priority is given to projects that reduce nitrate and other chemical contaminants in disadvantaged communities. Construction grants are limited to $5 million per project. Funding also is available for feasibility studies and engineering reports, so water systems can meet application requirements for construction grants. A small amount of this funding ($5 million) is available for community technical assistance.[60]

Prevention and reduction of contamination of groundwater sources that serve drinking water systems was allocated a total of $60 million. Projects must be ready to begin implementation immediately and must protect groundwater that provides at least one third of water for a community. The maximum grant per applicant is $10 million. Additional points are given to projects that: serve disadvantaged communities, affect a population greater than 100,000, or address contaminants with acute health effects.[61,62] Additionally, $50 million was allocated to increase the SDWSRF.[63]

CDPH: Proposition 50[64]

[Fully Allocated]

Proposition 50 (the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002) awarded $3.4 billion to various State departments. CDPH was allocated $50 million for water security projects for drinking water systems. These include emergency interties, improvement and installation of treatment facilities, and monitoring programs. $69 million was set aside to help community and small community water utilities meet safe drinking water standards by providing grants for infrastructure improvements, pilot studies, and the improvement of water quality monitoring, treatment, and distribution facilities. An additional $105 million was provided as match funds for Federal grants for public water system infrastructure improvements.[65,66]

State Water Resources Control Board (State Water Board)

The State Water Board has funding programs to reduce contamination of surface and groundwater from point and non-point sources; the main programs are described below.

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[60] http://bondaccountability.resources.ca.gov/plevel1.aspx?id=2&pid=4
[61] http://bondaccountability.resources.ca.gov/plevel1.aspx?id=5&pid=4
[62] http://www.cdph.ca.gov/services/funding/Documents/Prop84/Prop84Section75025Criteria-09-17-2009.pdf
[63] http://bondaccountability.resources.ca.gov/plevel1.aspx?id=3&pid=4
[64] http://www.cdph.ca.gov/services/funding/Pages/Prop50.aspx
[65] http://www.resources.ca.gov/bond/Prop_50_Summary_of_Programs2.pdf
[66] http://www.resources.ca.gov/bonds_prop50.html

State Water Board: Clean Water State Revolving Fund (CWSRF)[67]

In 1987, an amendment to the Clean Water Act established the Clean Water State Revolving Fund (CWSRF) for water quality projects. The CWSRF is funded through Federal grants (most recently the American Recovery and Reinvestment Act (ARRA) of 2009), State funds, and revenue bonds (including Prop 84: $73.2 million to reduce or prevent contamination of impaired water bodies). The fund provides low-interest or subsidized loans for construction of publicly-owned wastewater treatment facilities, local sewers, sewer interceptors, and water recycling facilities. Up to $50 million per year is allowed for each applying agency, program, or water system. Funded projects include wastewater treatment plant upgrades and improvements, water reclamation, plant nitrification and de-nitrification facilities, and sewer replacements. This program and funding provides a source of financing for municipal and septic source loading reductions by facilitating the replacement of septic systems or treating wastewater discharges for nitrate. $200-$300 million total is dispersed annually.

State Water Board: Small Community Wastewater Grants[68]

In conjunction with the CWSRF is the Small Community Wastewater Grant program for disadvantaged small communities. This program was established in 2004 and funds up to 90% of the costs of planning, design, and construction for publicly-owned wastewater treatment and collection facilities in qualifying communities. It specifically addresses the unique needs of small communities with less than 20,000 people and with financial hardships (quantified by a median household income of less than 80% of the statewide MHI). Funds may be used to improve wastewater collection and treatment systems, including the replacement of old pipes and septic systems to reduce contamination to surface and groundwater.

This grant program has been financed with funds from Propositions 40 and 50 in the past and now receives funds from a small fee on CWSRF loan agreements. In 2009, $86 million of obtained ARRA Federal funds of the CWSRF were used to forgive the principal loan amount for 25 small and disadvantaged community wastewater projects. As part of the small community strategy, the State Water Board also makes grants to non-profit organizations (such as RCAC) to provide free technical assistance and training to small disadvantaged communities in wastewater infrastructure management and system operations, and in assessment and preparation of project applications.

State Water Board: Proposition 50[69]

[Fully Allocated]

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[67] http://bondaccountability.resources.ca.gov/plevel1.aspx?id=4&pid=4)

[68]http://www.swrcb.ca.gov/water_issues/programs/grants_loans/small_community_wastewater_grant/index.shtml

[69] http://www.resources.ca.gov/bond/Prop_50_Summary_of_Programs2.pdf

Proposition 50 awarded $100 million to the State Water Board for grants to public agencies and nonprofit organizations to improve water quality. Funds can be used for: drinking water source protection projects (including well head protection from nitrate and other contaminants), water contamination prevention programs, and water quality blending and exchange projects.

State Water Board: Agricultural Drainage Loan Program[70]

[Fully Allocated]

This loan program is for projects that address treatment, storage, conveyance or disposal of agricultural drainage that threatens waters of the State. $100,000 per project is allowed for feasibility studies with a $5 million per project cap on implementation costs. Overall, $30 million was allocated to this program and there is currently $10.4 million still available.

State Water Board: Dairy Water Quality Grant Program[71]

[Fully Allocated]

Proposition 50 included $5 million for regional and on-farm dairy projects that address water quality impacts from dairies. Water quality planning and both regional and on-farm projects were allowed. The dairy operator was required to have completed the environmental stewardship short course of CDQAP (California Dairy Quality Assurance Program). The final list of recommended projects was developed in 2006, so applications are no longer being accepted.

State Water Board: Federal Clean Water Act Section 319: Nonpoint Source Implementation Program

Through the Clean Water Act Section 319, the State Water Board provides grants (with a match requirement) for implementation of measures and practices that reduce or prevent nonpoint source contamination to ground and surface waters. Normally, individual requests up to $1 million are accepted and $4.5-5.5 million is allocated per year.

State Water Board: Cleanup and Abatement Account[72]

The Cleanup and Abatement Account (CAA) was established through Water Code Sections 13440-13443. The State Water Board is responsible for the financial management of the program. The CAA may provide funds to the State Water Board, the Regional Water Boards, and other public agencies authorized to cleanup a waste or abate the effects of a waste. The CAA funds are used to clean up a

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[70] http://www.swrcb.ca.gov/water_issues/programs/grants_loans/agdrain/agdrain_mgmt.shtml
[71] http://www.swrcb.ca.gov/water_issues/programs/grants_loans/dairy/index.shtml
[72] http://www.waterboards.ca.gov/water_issues/programs/grants_loans/caa/

waste, abate the effects of a waste, and remediate an unforeseen water contamination problem. Often, a viable responsible party has not been identified. In 2009, $12 M was provided for 24 projects, four of which were in the study area (Richgrove CSD, Mettler County Water District, North Shafter Wastewater Project, and the Central Valley Salinity Work Group). In 2010, another $9 M was provided to support 15 projects; two of these projects were located in the study area (San Jerardo Wastewater Improvement Project and Central Valley Salt and Nutrient Plan).

State Water Board: Integrated Regional Water Management (IRWM) (Proposition 50)

[Fully Allocated]

The Integrated Regional Water Management (IRWM) program was launched following the passage of the IRWM Act of 2002 (SB 1672) to encourage local agencies to work cooperatively to manage local and imported water supplies to improve the quality, quantity, and reliability. In 2002, Proposition 50 allocated $15 million for planning projects and $365 million for implementation projects related to protecting and improving water quality and other projects to ensure sustainable water use. A 25% cost share is required of all localities, programs, and other groups looking for funding from the IRWM program.

Department of Water Resources (DWR)

DWR: Integrated Regional Water Management (IRWM) Financial Assistance (Propositions 50, 84)[73]

DWR also has several Integrated Regional Water Management (IRWM) grant program funding opportunities. Proposition 50 (2002) provided $500 million specifically to DWR to fund competitive grants for projects consistent with an adopted IRWM plan (CWC § 79560-79565). Proposition 84 (2006) provided $1 billion total ($60 million to the Tulare Lake region and $52 for the Central Coast region) to DWR for IRWM Planning and Implementation (PRC §75001-75130). All Proposition 50 funds have been allocated and approximately $500 M remains of the Proposition 84 funds.[74]

DWR: Local Groundwater Assistance (Prop 50 & Prop 84)[75]

Under the Department of Water Resources' Local Groundwater Assistance program, financing is provided to local public agencies with authority to manage groundwater resources for projects that

[73] http://www.water.ca.gov/irwm/

[74] California Resources Agency. August 2011. Proposition 84 Allocation Balance Report. Accessed December 2011: http://bondaccountability.resources.ca.gov/Attachments/b1a801cb-36af-44c7-854e-3b9047a4525f/29/Prop84AllocationBalanceReport.pdf

[75] http://www.water.ca.gov/lgagrant/

involve: groundwater data collection, modeling, monitoring and management studies; monitoring programs and installation of equipment; basin management; development of information systems; and other groundwater related work. Funds were initially available from Proposition 50 ($6.4 million total and limited to $250,000 per applicant). Renewed funding from Proposition 84 was available in 2010/11.

DWR: New Local Water Supply Feasibility Study[76] and Construction Funds[77] (Proposition 82)

Managed by DWR and funded from Prop 82, this program has $22 million of loan money for feasibility study and construction activities, but only towards projects which will improve *existing* water supply (diversion, storage, or distribution) problems. Local public agencies can apply for loans for projects such as canals, dams, reservoirs, groundwater extraction facilities or other construction or improvements to their water supplies. While the maximum loan amount for feasibility studies is small, it does allow systems or communities to evaluate potential new water sources. It permits a loan up to $0.5 million per eligible feasibility study with 5 year repayment limit and up to $5 million per eligible construction project with a 20 year repayment limit. The interest rate is the rate of the State's most recent obligation bonds. Applications are processed on a continuous basis.

DWR: Water Use Efficiency Grant Program (Prop 50)[78]

Proposition 50 established $180 million for grants for urban and agricultural water conservation, recycling, and other water use efficiency programs. $105 million of this allocation was awarded to DWR for the Water Use Efficiency Program. This program supports projects to improve agricultural water use efficiency, including: research and development, feasibility studies, training and education, and technical assistance. Specific projects include: wellhead rehabilitation, new storage tanks, water and wastewater treatment, etc. Up to $3 million is available per project. Local cost share is required, but disadvantaged communities may be eligible for a waiver. $15 million will be available for the 2011 funding cycle.[79]

DWR: Agricultural Water Conservation Program (Prop 13)[80]

Loans to agriculture under the Agricultural Water Conservation Program, created by Prop 13, are also available ($28 M total) under DWR's Water Use Efficiency financial assistance programs. These cover capital outlay and construction of up to $5 million per project for agricultural water conservation, including such activities as lining or piping of ditches; automating canal structures; improvements to

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[76] http://www.grantsloans.water.ca.gov/loans/feasibility.cfm
[77] http://www.water.ca.gov/grantsloans/prop82/
[78] http://www.water.ca.gov/wateruseefficiency/finance/
[79] California Financing Coordinating Committee. 2011. Funding Fair Handbook. Accessed December 2011 at: http://www.cfcc.ca.gov/res/docs/CFCC_Handbook_WebPosting.pdf
[80] http://www.water.ca.gov/wateruseefficiency/finance/

water distribution system controls; tailwater or spill recovery systems; major improvements or replacement of leaking agricultural distribution systems; purchasing and installing water measurement devices; and capital improvements for on-farm irrigation. Irrigation application improvements are a key way to improving nitrogen application efficiency.

DWR: Infrastructure Rehabilitation Construction Grants (Proposition 13)[81]

[Fully Allocated]

The Infrastructure Rehabilitation Program is a grant program authorized under Prop 13 to provide assistance to poor communities for construction projects and feasibility studies to fix or replace failing water distribution systems that threaten the health, safety, and economy of these areas. The demand for funding far exceeded the amount of money allocated under Proposition 13. Since the program began in 2001, it received more than 71 proposals representing about $124 million during three funding cycles. Of these requests, it awarded $56.4 million for 22 feasibility studies and 20 construction projects. Presently, all program funds have been committed and the applications are closed.

California Infrastructure and Economic Development Bank (I-Bank)[82]

The California Infrastructure and Economic Development Bank (I-Bank) can issue tax exempt and taxable revenue bonds for a variety of projects which promote the revitalization of employment and the overall CA economy. One program, the Infrastructure State Revolving Fund (ISRF), provides low cost loans to public agencies for water supply, treatment and distribution projects. The ISRF funds $250,000 to $10 million per project for a 30 year loan period. Only agencies which are a subdivision of local government may apply; i.e. cities, counties, redevelopment agencies, special districts, assessment districts, joint powers authorities and non-profit corporations formed on behalf of a local government.

United States Department of Agriculture (USDA) Rural Utilities Service (RUS) [83]

The USDA Rural Utilities Service administers the Water and Environmental Programs (WEP) which supports drinking water, wastewater, and storm water facilities for rural communities of less than 10,000 people. Support includes loans, grants, and technical assistance, either directly to the facilities or indirectly through non-profit groups.

[81] http://www.grantsloans.water.ca.gov/docs/ircon/awardscon.pdf
[82] http://www.ibank.ca.gov/infrastructure_loans.htm
[83] http://www.rurdev.usda.gov/UWEP_HomePage.html

In the last eight years, RUS WEP provided more than $13 billion in loans and grants for rural water and waste infrastructure[84]. With additional funding in 2009 from the American Recovery and Reinvestment Act, RUS was able to invest $2.5 million under the Water and Waste Disposal Loan and Grant Program.[85]

The WEP has 7 main funding programs, discussed below.

USDA-RUS: Water and Waste Disposal Direct Loans and Grants

As part of the WEP, USDA-RUS manages the Water and Waste Disposal Direct Loans and Grants program. This program provides funds to public bodies and non-profit organizations to develop water and waste disposal systems in rural areas. Specifically, funds are limited to: construction, land acquisition, legal fees, engineering fees, capitalized interest, equipment, initial operation and maintenance costs, project contingencies, and any other cost needed to complete the project. Grants are given for up to 75% of eligible project costs when the service area MHI is less than 80% of the State MHI.

USDA-RUS: Water and Waste Disposal Guaranteed Loans

In addition to direct loans, guaranteed loans are also available for the construction or improvement of water and waste disposal projects. Qualifying applicants will be unable to obtain (at reasonable rates) the necessary credit without the guarantee. Public bodies and non-profit organizations benefit from these loans which are made and serviced by lenders such as banks, savings and loan associations, mortgage companies and other eligible lenders under the Guarantee Loan Program.

USDA-RUS: Water and Waste Revolving Fund Grants

Through the Water and Waste Revolving Fund Program, USDA-RUS issues grants to private non-profit corporations which have previously operated successful revolving loan funds to rural areas. These loan funds may only be issued to communities in rural areas for use with pre-development costs of water and wastewater projects or short-term small capital improvement projects not part of the regular operations and maintenance of current water and wastewater systems. A maximum of $100,000 may be made available per project.

USDA-RUS: Individual Household Water Well Program

Additional grants are provided by USDA-RUS to private non-profit corporations through the Individual Household Water Well Program. These grants establish loan programs for individuals who need capital to construct, refurbish, or service their well system. The maximum loan amount per well is $8,000.

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[84] http://www.rurdev.usda.gov/SupportDocuments/Adelstein3-23-10.pdf

[85] http://www.rurdev.usda.gov/SupportDocuments/Adelstein3-23-10.pdf

USDA-RUS: Predevelopment Planning Grants

Grants of up to $15,000 or 75% of the total project cost (whichever is lower) may be awarded to communities or water systems for assistance in preparing a water project application. Eligible applicants must provide proof that they are unable to pay the necessary predevelopment costs.

USDA-RUS: Emergency Community Water Assistance Grants

Communities which face or expect to face an abrupt and severe decrease in water quality may apply to USDA-RUS for an emergency community water assistance grant. Typical events which cause the decline in water quality are: a natural disaster such as drought, earthquake, flood, tornado, or hurricane; a disease outbreak; or a chemical spill/leakage/seepage. Projects which relieve a decline in the quantity and quality of drinking water through the construction of a new water source and/or treatment plant are eligible for full project funding up to $500,000. Communities facing emergency repairs or replacements of facilities on existing systems due to acute concerns (e.g. washed out river crossing in a distribution system, or construction of distribution lines to individuals not currently on the system, whose wells have gone dry) may apply for up to $150,000 for distribution waterline extensions, breaks or repairs on distribution waterlines, and operation and maintenance.

USDA-RUS: Technical Assistance and Training Grants

USDA-RUS manages a technical assistance and training program which funds the educational and technical capacity building programs of private non-profit and tax-exempt organizations. Applicable to the study area, organizations receiving funding for these activities are: RCAP, the National Rural Water Association, and the National Drinking Water Clearinghouse. These individual programs are described in Appendix B: Summary of Current Planning and Regulatory Programs that Address Nitrate in Groundwater. In addition to technical assistance efforts, these non-profit organizations may also use the funding to assist communities in preparing funding applications for water or waste projects.

US Department of Housing and Urban Development (HUD): Community Development Block Grant Program[86]

The Community Development Block Grant (CDBG) program, administered by the U.S. Department of Housing and Urban Development, provides grants to States to fund economic development, housing, public improvements, public services, and administrative and planning. Within the public improvement category, funds are available to construct or improve community water and sewer systems, build technical capacity, and assist nonprofit organizations who aid in community development.

[86] http://www.hud.gov/offices/cpd/communitydevelopment/programs/stateadmin/

HUD has the responsibility to ensure that the States are following Federal regulations and policies. The majority of the program responsibilities fall on the States, including: determining how to allocate funds among communities, formulating community development goals, and ensuring that at least 70 percent of its CDBG grant funds are used to benefit low- and moderate- income persons.

The CDBG program funds cities with less than 50,000 people and counties less than 200,000. The State of California may use up to $100,000 plus 50% of their incurred administrative costs per project. Up to 3% of California's total allocation from HUD may be used on technical assistance. In 2010, HUD provided almost $500 million for CDBG programs in California.

U.S. Economic Development Administration (EDA)[87]

The U.S. Economic Development Administration (EDA) is an agency within the U.S. Department of Commerce. The EDA's Public Works and Economic Development Program provides grants for the construction, expansion, or upgrade of infrastructure (including water and wastewater) in communities facing economic distress, natural disasters, or the depletion of natural resources. The goal of this program is to create and sustain long-term private sector job opportunities in distressed communities. The funds may be used for land acquisition, construction, renovation, expansion, improvement, or design of a public works facility. The grants cover up to 50 percent of project costs. During 2009, EDA awarded $13 million for public works projects across the United States.

EDA also offers technical assistance to public and nonprofit groups which work with communities on project planning and feasibility studies. During 2009, EDA awarded $135,000 for technical assistance projects in California.

Rural Community Assistance Corporation (RCAC)[88]

The Rural Community Assistance Corporation (RCAC), based in California, is RCAP's western regional partner. They focus on areas with populations of 2,000 or less, minority communities, and disadvantaged communities. Their projects help improve access to safe drinking water supplies, develop and maintain wastewater systems, protect the groundwater, and improve access to financial assistance resources. Their overarching goal is to help small water and wastewater systems to build the technical, managerial, and financial capacity necessary to comply with State and Federal regulations. Often, this assistance is financed by State and Federal contracts, and is thus free to the community.

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[87] http://www.eda.gov/InvestmentsGrants/Investments.xml
[88] http://www.rcac.org

RCAC also administers $1.2 million per year from the US EPA for water and wastewater construction loan funds. As of September 30, 2010, they have supported over 46,000 individual water and wastewater connections.

RCAC's New Mexico office has initiated and managed the regionalization of a few small water systems into larger organizations with more technical, managerial, and financial capacity. Recently, five New Mexico small drinking water systems (totaling 8,000 people) merged to form the Lower Rio Grande Public Water Works Authority Agency. Their model could be used in California to help solve the deficiencies in functioning and capacity of small community water and wastewater systems.

The Housing Assistance Council (HAC)[89]

The Housing Assistance Council administers the Small Water/Wastewater Loan Fund nationally at interest rates equal to or below the market rate. Small short-term loans of $100,000 to $250,000 are made to local nonprofits, for profits, and government entities that are developing housing for lower income rural communities. These loans can be used to finance predevelopment, land acquisition, site development, and construction phases of a water or wastewater infrastructure project.

Cooperative Bank (CoBank)[90]

The Cooperative Bank (CoBank) offers a national Water and Wastewater Loan Program for communities of fewer than 20,000 people. These loans, typically around $1 million, are used to finance new water and wastewater infrastructure projects, system improvements, water right purchases, and system acquisitions. Smaller loans of $50,000 to $500,000 are also offered to help cover initial construction costs.

[89] http://www.ruralhome.org
[90] http://www.cobank.com