Conclusions of the Agricultural Expert Panel

Recommendations to the State Water Resources Control Board pertaining to the Irrigated Lands Regulatory Program

in fulfillment of SBX 2 1 of the California Legislature

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EXECUTIVE SUMMARY

The Agricultural Expert Panel (Panel) was convened to address thirteen questions posed by the State Water Resources Control Board (State Water Board). The questions were primarily technical in nature, and are abbreviated below. The full text of the questions is included in *Section* 2*: Questions for the Panel.*

The Panel's responses deviate significantly from the order and specific content of the original questions. However, the subject matter of each original question is addressed within this report; wherever the subject of a specific question is discussed, a footnote will appear within the text (e.g., the footnote $_{[Q10f]}$ indicates that the text is addressing part "f" of the original Question #10). An index is included at the end of the report to facilitate finding these references.

Questions Posed to the Expert Panel

1. How can risk to or vulnerability of groundwater best be determined in the context of a regulatory program such as the Irrigated Lands Regulatory Program (ILRP)?
2. Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of groundwater.
3. How can risk to or vulnerability of surface water best be determined in the context of a regulatory program such as the ILRP?
4. Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of surface water.
5. What management practices are expected to be implemented and under what circumstances for the control of nitrogen?
6. What management practices are recommended for consideration by growers when they are selecting practices to put in place for the control of nitrogen?
7. Evaluate and make recommendations regarding the usage of various nitrogen management and accounting practices.
8. Evaluate and make recommendations regarding the most effective methods for ensuring growers have the knowledge required for effectively implementing recommended management practices.
9. What measurements can be used to verify that the implementations of management practices for nitrogen are as effective as possible?
10. Evaluate and make recommendations regarding the usage of various verification measurements of nitrogen control.
11. Evaluate the relative merits, and make recommendations regarding the usage of, surface water measurement systems derived from either receiving water or a discharge monitoring approach to identify problem discharges.
12. Evaluate and make recommendations on how best to integrate the results of the Nitrogen Tracking and Reporting System Task Force with any above recommendation regarding management practices and verification measures.
13. Evaluate and make recommendations on the reporting requirements to report budgeting and recording of nitrogen application on a management block basis versus reporting aggregated numbers on a nitrate loading risk unit level.

General Understanding by the Panel

The Panel reviewed a large volume of material from various coalitions, regional boards, agricultural groups, environmental groups, and other organizations. The Panel also received valuable input throughout the Public Meetings process in the form of both written and verbal testimony and critique. The Panel recognizes the tremendous efforts that have been made historically in attempts to understand and begin to regulate groundwater nitrate problems.

The Panel also believes that the primary future source of nitrate additions to the groundwater will be via leaching from agricultural fields. [Q1] The fundamental reason for the emphasis shift lies in the word "future."

Having benefited from the ability to view the regulatory process in hindsight, and without being burdened by the weight and bruises of historical battles on the subject, this Panel believes that the State Water Board has reached an opportune moment to optimize efforts by shifting the emphasis of regulatory efforts.

Specifically, it appears to the Panel that many of the proposed regulatory efforts and investments are related to better understanding the regulatory value itself (i.e., detailed understanding of groundwater nitrate concentrations and changes thereof in response to regulations). The Panel observes that the currently pursued regulatory investigative and data collection efforts put a large emphasis on understanding how nitrate moves into first-encountered groundwater, how the groundwater moves, and how nitrate levels in the groundwater might be related to surface discharges. [Q3]

In the opinion of the Panel, this emphasis will be ineffective in addressing the groundwater nitrate problem. Specifically, it is reactive, rather than being proactive. The facts are: [Q9]
1. What is seen in the groundwater today is, by nature, the result of history. It does not necessarily indicate the impacts of current farming practices.
2. The nitrate levels in groundwater, while providing a regulatory trigger, will be merely symptoms of surface (e.g., farming) practices.
3. Attempts to completely understand the groundwater and vadose zone characteristics and movement, plus the associated nitrate movement, are extremely expensive, inexact, and do little to solve the problem.

The Panel therefore proposes a comprehensive regulatory program that is proactive. [Q9] It focuses on efforts to minimize the loads of nitrates to the groundwater, without trying to understand all the details of the groundwater itself. [Q10] There are several overriding principles that have guided this Panel's development of a recommended program:
1. This is a non-point-source pollution problem, which requires a significantly different approach than the State and Regional Water Board programs that have focused on point-source problems. This is discussed in more detail in the body of this report.
2. Good nitrate management is essential across the board for agriculture, and should not just be restricted to areas that presently have high levels of detected nitrate in groundwater. [Q5]
3. Nitrate does not move below the crop root zone unless water deep percolates. The mechanism of nitrate transport requires water. Therefore, good irrigation management is an essential part of the solution. [Q6][Q10f]

4. The whole process of nitrate leaching by irrigation and rain water is extremely complicated, has a variety of poorly or uncontrolled aspects (such as timing and amounts of rainfall), and will require active participation by, and innovation from, the agricultural community. There is a definite social aspect to this regulatory program. [Q6]
5. If more nitrogen is applied to a field than is removed, over the long term, most of the excess nitrogen applications will be leached to groundwater. This is a simple concept that does not require modeling to illustrate. [Q6]
6. As a corollary, there have been decades of demonstrations, research, and practical implementation of practices that reduce deep percolation of irrigation water. [Q10f] The fact that this historical research and active implementation by progressive farmers is not widely known does not justify repeating the research to prove that there is a link between surface practices and groundwater contamination.
7. The Panel recommends a relatively simple metric to identify progress for this particular regulatory issue. [Q7a][Q9] The reasons for recommending this metric, as opposed to other proxy values or metrics, are discussed in detail in this report.

   The metric, to be measured and reported by farmers is the "A/R ratio", where:

$$A/R = \frac{\text{Nitrogen Applied}}{(\text{Nitrogen removed via harvest}) + (\text{Nitrogen sequestered in the permanent wood of perennial crops})}$$

   Where "Nitrogen Applied" includes nitrogen from any source. Example sources are organic amendments, synthetic fertilizer, and irrigation water. [Q4b]

8. Advances can be made immediately. However, it will take many years to develop and implement a complete program. Education and knowledge transfer must be on-going. [Q8] There must be a strong appreciation by the regulating agencies of such facts as:
   a. Historical university and consultant recommendations for nitrogen applications have focused on maximizing yield, rather than simultaneously minimizing nitrate leaching.
   b. Appropriate A/R values to be expected under different climate, crop, and other conditions, are essentially unknown.
   c. Information of existing A/R ratios is minimal.
   d. More fundamentally, it has not yet been determined how to best measure the nitrogen removed via harvest, for proper reporting of the A/R ratios for a wide assortment of crops.
   e. From the above, it is clear that there is significant work to be done before A/R ratios will begin to broadly provide useful guidance to the agricultural community, and even more before they can reasonably be used for regulatory purposes. Nevertheless, the Panel believes that this is the correct direction to pursue.
9. Annual reported values of the A/R ratio have minimal value in evaluating the effectiveness of nitrogen management because of the large seasonal variations in crop yields (removal), precipitation, nitrogen transformations in the soil, etc. However, multi-year averages of the A/R ratio will provide valid information for assessment. [Q9]
10. Sustainable irrigated agriculture requires some leaching of the root zone to remove accumulated salts. Nitrates will of course also be leached along with the salts. Therefore, it is impossible to completely avoid nitrate deep percolation.

11. The Panel does not recommend the development of a "scientifically based evaluation of the link between *(a)* proxy metric and actual discharge via a 'Representative practice evaluation'", which appears to be the concept behind the Management Practices Evaluation Program (MPEP) in the Central Valley RWQCB ILRP Orders (found on page 17, Attachment B, Tulare Lake Basin Order R5-2013-0120). Instead, the Panel recommends the use of the A/R ratio, averaged over multiple years after implementation of comprehensive, customized nitrogen/water management plans. [Q9]

The recommended program is summarized below.

RECOMMENDED REGULATORY PROGRAM

The key elements of the recommended regulatory program are:

1. Establishment of coalitions to serve as the intermediate body between farmers and the Regional Boards.
2. Adoption of the A/R ratio as the primary metric for evaluating progress on source control, with eventual impact on the groundwater quality. [Q9]

$$A/R = \frac{\text{Nitrogen Applied}}{(\text{Nitrogen Removed via harvest}) + (\text{Nitrogen sequestered in the permanent wood of perennial crops})}$$

3. Development of a very strong, comprehensive, and sustained educational and outreach program. Such a program will require different materials and presentation techniques for different audiences, such as individuals who may need certification, managers of irrigation/nutrient plans, irrigators, and farmers/managers. [Q8]
4. Creation <u>and</u> implementation of nitrogen/water management plans that are truly plans rather than just a listing of best management practices. These must be customized by features such as crop and locale. [Q5][Q6]
5. Reporting of key values (i.e., crop type, acreage, total nitrogen applied, and total nitrogen removed) by farms to the coalitions. [Q9]
6. Trend monitoring of groundwater nitrate concentrations to track general aquifer conditions over multiple years. [Q9]
7. Targeted research that will directly help the agricultural community to maintain and/or improve yields while simultaneously decreasing the A/R ratio on individual fields.
8. Use of multi-year reported values and monitored trends by the coalitions to inform the agricultural community of progress, to improve understanding of what is reasonable to attain and expect, and to sharpen improvement efforts. [Q9]

LIST OF ABBREVIATIONS

A/R	Ratio of Nitrogen Applied to (Nitrogen Removed + Nitrogen Sequestered in Permanent Wood)
AW	Applied Water
BMP	Best Management Practice
CCA	Certified Crop Advisor
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CVRWQCB	Central Valley Regional Water Quality Control Board
DU	Distribution Uniformity
ESJWQC	East San Joaquin Water Quality Coalition
ET	Evapotranspiration
GWPA	Groundwater Protection Area
ILRP	Irrigation Lands Regulatory Program
ITRC	Irrigation Training & Research Center, Cal Poly, SLO
LF	Leaching Fraction
MCL	Maximum Contaminant Level
MPEP	Management Practices Evaluation Program
MRP	Monitoring and Reporting Program
N	Nitrogen
NHI	Nitrogen Hazard Index
NKWSD	North Kern Water Storage District
NMP	Nitrogen Management Plan
NTRSTF	Nitrogen Tracking & Reporting System Task Force
Panel	Agricultural Expert Panel
PCA	Pest Control Advisor
UC	University of California
UCCE	University of California Cooperative Extension
UST	Underground Storage Tank
WDR	Water Discharge Requirements
WQ	Water Quality

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1 BACKGROUND

1.1 Call for a Panel

Chapter 1 of the Second Extraordinary Session of 2008 (SBX2 1, Perata), required the State Water Board to develop pilot projects focusing on nitrate in groundwater in the Tulare Lake Basin and Salinas Valley, and to submit a report to the Legislature on the scope and findings of the pilot projects, including recommendations. The State Water Board made fifteen recommendations in four key areas to address the issues associated with nitrate contaminated groundwater. The key areas to address these issues are:

1. Providing safe drinking water
2. Monitoring, notification, and assessment
3. Nitrogen tracking and reporting
4. Protecting groundwater

Recommendation 14 of the State Water Board's report to the Legislature was to convene a panel of experts to assess existing agricultural nitrate control programs and develop recommendations, as needed, to ensure that ongoing efforts are protective of groundwater quality.

The State Water Board in its subsequent adoption of Order WQ 2013-0101 also tasked the Panel with certain issues related to impacts of agricultural discharges on surface water.

1.1.1 Regulatory Context

The charge and questions below directed to the Agricultural Panel were done so in the context of the State Water Resources Control Board's Policy for Implementation and Enforcement of the Non-point-source Pollution Control Program, May 20, 2004, and Regional Water Quality Control Boards' Irrigated Lands Regulatory Programs as implemented through various separate orders.

1.1.2 Charges to the Panel

Assess existing agricultural nitrate control programs and develop recommendations, as needed, to ensure that ongoing efforts are protective of groundwater quality. (Recommendations Addressing Nitrates in Groundwater, State Water Board's Report to the Legislature, February 20, 2013)

- and –

Provide a more thorough analysis and long-term statewide recommendations regarding many of the issues implicated in State Water Board Order WQ 2013-0101, including indicators and methodologies for determining risk to surface and groundwater quality, targets for measuring reductions in risk, and the use of monitoring to evaluate practice effectiveness.

1.2 Agricultural Expert Panel

Recommendation 14 of the State Water Board's report to the Legislature was to convene a panel of experts to assess existing agricultural nitrate control programs and develop recommendations, as needed, to ensure that ongoing efforts are protective of groundwater supply quality. The State Water Board contracted with the Irrigation Training & Research Center (ITRC) to assemble a Panel of up to 10 persons. Recommended Panel types were to include, but not be limited to:

- Irrigation Specialist /Ag Engineer – specializing in irrigation systems including drip, sprinkler, furrow, and flood irrigation systems and the use of fertigation.
- Soil Scientist – specializing in soil conservation, soil fertility management and movement of water and nitrogen through the soil.
- Hydrogeologist – specializing in aquifer contamination and contaminant movement within groundwater.
- Certified Crop Advisor – specializing in the application of synthetic and organic fertilizers.
- UC Cooperative Extension Farm Advisor – specializing in annual and perennial crops.
- Grower – experience in both annual and perennial crops.
- Agronomist – specializing in California agricultural production, nitrogen uptake and yields.
- Agricultural Economist – specializing in economic analysis of California agriculture with some experience in the economic analysis of air and water quality regulations.

1.2.1 <u>Role of Panel</u>

The role of Panel members is as follows:

- Review the Irrigated Lands Regulatory Program (ILRP).
- Evaluate ongoing agricultural control measures that address nitrate in groundwater and surface water.
- Evaluate and address other risks to water quality posed by agricultural practices.
- Address questions posed by the State Water Board in its order regarding the petitions of the Central Coast Regional Water Board.
- Address questions developed by an Advisory Committee, other agencies and the public as approved by the State Water Board.
- Propose new agricultural control measures, if necessary.
- Hold meetings with the Advisory Committee as necessary.
- Conduct three public meetings to take public comment.
- The ITRC was mandated to write the final report on findings and summary of project discoveries and recommendations.

Note: The Panel was given no authority or power to write regulations or requirements of any nature.

1.2.2 Panel Members

The Panel was made up of eight members that matched the qualifications requested by the State Water Board. A brief biography of each panel member is provided in **Appendix A**. Members were:

- Dr. Charles Burt (Panel Chairman), Irrigation Engineer, Irrigation Training and Research Center, California Polytechnic State University, San Luis Obispo
- Dr. Robert Hutmacher, Extension Specialist, UC Cooperative Extension, Westside Research and Extension Center, Five Points
- Till Angermann, Hydrogeologist, Luhdorff & Scalmanini Consulting Engineers, Woodland
- Bill Brush, Certified Crop Advisor, Almond Board of California, East San Joaquin Water Quality Control Board, Modesto
- Daniel Munk, Farm Advisor, UC Cooperative Extension, Fresno
- James duBois, Grower, Reiter Affiliated Companies, Santa Maria and Oxnard
- Mark McKean, Grower, Central Valley Region, Riverdale
- Dr. Lowell Zelinski, Agronomist, Precision Ag Consulting, Paso Robles

1.3 Meetings and Sessions

1.3.1 Public Comment Meetings

In May of 2014, the Agricultural Expert Panel called by the California State Water Board held a series of three meetings to invite and hear public comment on nitrate groundwater issues, and to publicly discuss the topic. The Panel was tasked with collecting input and information that centered on 13 previously developed questions that the Panel had been asked to address. Due to the large number of people who wanted to comment verbally, comment duration was limited. Commenting time was truncated by the Chair if the speaker appeared to deviate from the topics that were to be addressed by the Panel.

The meetings were held in San Luis Obispo (May 5-6), Tulare (May 7), and Sacramento (May 9) to facilitate public access. An additional public comment meeting was held July 18 in Sacramento following the release of the draft report. The meeting sessions were videotaped and posted online at www.itrc.org/swrcb/ in accordance with the Bagley-Keene Open Meeting Act.

1.3.2 Work Sessions

Three open work sessions were held at the Cal Poly ITRC (on June 9, June 23, and July 1) by the Agricultural Expert Panel for the purpose of developing a draft report. Public comments were invited, but were restricted to two minutes per person due to limited time. A final work session to address comments on the draft report was held at the ITRC on August 20.

1.3.3 Additional Public Input

Written comments provided by the public, as well as the Panel meeting schedule, background information, reports, relevant agency contacts, and other notices were maintained by ITRC on a public website at www.itrc.org/swrcb/. Agendas and speaker lists for all meetings are available on that website at www.itrc.org/swrcb/Presentations/downloads.htm#Agendas.

2 Questions for the Panel

The State Water Board provided the Panel with a list of questions. The Panel was instructed that those questions (listed below) were for guidance, and that the Panel could combine answers to related questions, address other questions that the Panel members felt were important, and even question the validity of individual questions or assumptions behind the questions.

2.1 Vulnerability and Risk Assessment

Regulatory programs are most effective when they are able to focus attention and requirements on those discharges or dischargers (i.e. growers) that pose the highest risk or threat because of the characteristics of their discharge or the environment into which the discharge occurs. The various ILRP orders issued throughout the state by the Regional Water Boards have taken different approaches in their prioritization schemes, some using specific criteria or methodologies, others utilizing measurements of previous known impacts.

1. How can risk to or vulnerability of groundwater best be determined in the context of a regulatory program such as the ILRP?
2. Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of groundwater:
    a. Nitrate Hazard Index (as developed by the University of California Center for Water Resources, 1995),
    b. Nitrate Loading Risk Factor (as developed by the Central Coast Regional Water Quality Control Board in Order R3-2012-0011),
    c. Nitrogen Consumption Ratio,
    d. Size of the farming operation,
    e. High Vulnerability Areas Methodology (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP).
3. How can risk to or vulnerability of surface water best be determined in the context of a regulatory program such as the ILRP?
4. Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of surface water:
    a. Proximity to impaired water bodies.
    b. Usage of particular fertilizer or pesticide materials.
    c. Size of farming operation.
    d. High Vulnerability Areas Methodology (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP)

2.2 Application of Management Practices

The application and use of management practices for the control of non-point-source pollution is a fundamental approach taken by many Water Board orders, and considered a key element in the State Water Board's Policy for Implementation and Enforcement of the Non-point-source Pollution Control Program, May 20, 2004. Management practices that are cost-effective and are easy to implement have the best chance of being adopted and successful. However, when comparing management practices, consideration should also be given to the likelihood that a management practice will be effective in reducing nitrogen loading to surface and groundwater. The Regional Water Boards have included specific management practices in their various orders, as well as requiring the growers to identify and implement management practices on their own.

5. What management practices are expected to be implemented and under what circumstances for the control of nitrogen?
6. What management practices are recommended for consideration by growers when they are selecting practices to put in place for the control of nitrogen?
7. Evaluate and make recommendations regarding the usage of the following management practices:
    a. Nitrogen mass balance calculations and tracking of nitrogen applied to fields. This should include consideration of measuring and tracking Nitrogen:
        i. Applied to crops or fields.
        ii. In soil.
        iii. In irrigation water.
        iv. Removed from field.
        v. Estimation of losses.
    b. Templates for determining nitrogen balance.
    c. The usage of nitrogen balance ratios.
    d. Nitrogen management plans.
8. Evaluate and make recommendations regarding the most effective methods for ensuring growers have the knowledge required for effectively implementing recommended management practices. Consider the following:
    a. Required training.
    b. Required certifications.
    c. Workshops sponsored by third parties such as: CDFA, County Agricultural Commissioners, Farm Bureau, UC Cooperative Extension, Cal Poly ITRC.
    d. Usage of paid consultants – e.g., CCAs/PCAs.
    e. UC Cooperative Extension specialists.

2.3 Verification Measures

Utilization of verification measures to determine whether management practices are being properly implemented and achieving their stated purpose is another key element to the success of a non-point-source control program. Because of the nature of non-point-source discharges, direct measurements are often difficult or impossible to obtain and other means of verifications may be required.

9. What measurements can be used to verify that the implementations of management practices for nitrogen are as effective as possible?
10. Evaluate and make recommendations regarding the usage of the following verification measurements of nitrogen control:
    a. Sampling first-encountered groundwater via shallow monitoring wells.
    b. Direct sampling of groundwater from existing wells, such as an irrigation well or domestic drinking water well, near the field(s) where management practices for nitrogen are being implemented.
    c. Sampling of the soil profile to determine the extent to which nitrogen applied to a field moved below the root zone.
    d. Representative sampling of a limited area and applying the results broadly.
    e. Sampling water in surface water containment structures for their potential discharge to groundwater.
    f. Estimating discharge to groundwater based on nitrogen balance model and measured irrigation efficiency.
11. Evaluate the relative merits, and make recommendations regarding the usage of, surface water measurement systems derived from either receiving water or a discharge monitoring approach to identify problem discharges.

2.4 Reporting

The ILRP orders issued by the Regional Water Boards require reporting to both determine compliance and inform overall management of the discharges associated with agriculture. Also, specifically in regards to nitrogen, the California Department of Food and Agriculture convened the Nitrogen Tracking and Reporting System Task Force, called for by Recommendation 11 of the State Water Board's report to the Legislature, which makes recommendations on a potential reporting system.

12. Evaluate and make recommendations on how best to integrate the results of the Nitrogen Tracking and Reporting System Task Force with any above recommendation regarding management practices and verification measures.
13. Evaluate and make recommendations on the reporting requirements to report budgeting and recording of nitrogen application on a management block basis versus reporting aggregated numbers on a nitrate loading risk unit level. (Definitions of "management block" and "nitrate loading risk unit" are contained in State Water Board Order WQ 2013-0101.)

3 BACKGROUND DISCUSSIONS

The Panel understands that the State Water Board is mandated to protect both surface and subsurface water quality. Legally, the State Water Board is vested with the authority to require potential polluters to modify practices if there is even a possibility that those practices would negatively impact beneficial uses and public health. The State Water Board can also require that potential polluters conduct research to prove that certain practices are not detrimental to water quality or human health. On the other hand, the State Water Board must be careful to not impose unduly severe regulations and thereby disenfranchise (in this case) the agricultural community.

The Panel understands its mission as one of providing recommendations to the State Water Board that will improve/maintain water quality, while simultaneously engaging the agricultural community in a positive manner. The recommendations of the Panel were influenced by members' interpretations and understandings of many background concepts and issues, which together create a group consensus of what is reasonable, effective, and proper.

Due to human nature, varying abilities of people to assimilate new information of various complexities, difficulty of properly communicating instructions, lack of information, etc., many changes in practices and procedures and behavior require several years, at a minimum, to properly implement. The subjects considered by the Panel are highly complex and no "one-size-fits-all" solution involving specific irrigation and fertilizer practices is possible. [Q4b] However, the Panel does recommend a universal approach in the sense that a good customized irrigation and nitrogen management plan should be required for each crop mix, and a strong outreach/education/awareness/training/certification effort will need to be devised and implemented. [Q7d] The details of what specific irrigation and nitrogen management practices are best for individual fields should be addressed with customized plans. It is unrealistic to believe that the nitrate problem can be solved with exhaustive lists of so-called Best Management Practices (BMPs) that are checked off and reviewed by an individual who is remote to the actual farm operations and conditions. [Q5][Q6]

The Panel believes that the development of a good regulatory program requires an understanding of both the strengths *and* weaknesses of various approaches. Furthermore, the Panel believes that an effective regulatory program must be developed in light of how well it will be accepted, and how effectively it can be implemented, by the regulated entities. The complexity of irrigation and fertilizer management is so great that success of any regulatory program will be highly dependent upon acceptance and understanding of that program by the regulat<u>ed</u> entities. It is simply impossible for a regulatory agency to properly dictate and verify the details of irrigation and nitrogen management for thousands of individual fields; positive grower participation is an absolute requirement. <u>**This is one of the essential aspects of a non-point-source pollution regulatory program related to nitrate in groundwater.**</u>

For these reasons, the Panel's recommendations deviate from the format and specific inquiries of the questions from the State Water Board. The background discussions in this section will address the reasoning behind the Panel's recommendations. The recommendations themselves are detailed in *Section* 4*: Recommendations.*

3.1 Point-Source vs. Non-Point-Source Pollution Regulation

As mentioned previously, the questions posed to the Panel deal with a non-point-source pollution problem. There is a relatively long history of development of monitoring / regulatory approaches for point-source pollution, but the approaches are not necessarily transferable to non-point-source monitoring and regulation. In the opinion of this Panel, the approach of the agricultural orders that have been issued within the framework of the Irrigated Lands Regulatory Program (ILRP) and the Central Valley Region's Dairy General Order has been strongly influenced by historical regulation of point-source discharges. [Q4d] Specifically, we refer to the notion that there is (or should be) a particular measurement or metric (e.g., a suite of measurements and computations) that can be used as an unequivocal "tool" to determine if an individual discharger is in compliance or out of compliance with regulations. [Q2]

To some degree, the concept of this metric or tool exists even within the framework of agricultural non-point-source discharges, specifically with respect to the deep percolation of nitrate and minerals from irrigated cropland. For instance, an example of such a tool would be the strict enforcement of the nitrate MCL in first-encountered groundwater. [Q10a] Monitoring of first-encountered groundwater has traditionally been the Regional Boards' most important tool to determine compliance or noncompliance with Waste Discharge Requirements (WDRs). In the context of traditionally regulated units (e.g., underground storage tanks (UST), landfills) that can be summarized as point-source dischargers of constituents of concern not commonly found in natural groundwater systems (e.g., petroleum products, pesticides, other chemicals), or not in as high of concentrations, groundwater monitoring for regulatory compliance has proven effective.

The reason for this effectiveness is illustrated with this example: If groundwater samples retrieved from a monitoring well downgradient of a petroleum products service station shows any detection of benzene (at any measureable concentration), and the upgradient well has no such detections, it is determined that the unit is leaking. The mass rate of the UST's subsurface emissions is not subject to debate in this case. Therefore, the Regional Board's decision would be straightforward and would entail a requirement for corrective action including removal of the source (tank). Importantly, even if no particular remedial action were required, concentrations of the constituent of concern would be expected to eventually decline due to natural attenuation.

In the context of cropland nitrate and salt loading to groundwater, however, monitoring of first-encountered groundwater does not provide the same utility as in the example in the prior paragraph. [Q10a] From a technical perspective, this tool is limited to use in hydrogeologic conditions where the sampled groundwater volume can be attributed to a defined recharge area, which must be contained within the area where the regulated discharge occurs. This can be done in areas of very shallow groundwater tables, relatively steady groundwater flow directions, high recharge, large regulated units, and a strong introduced discharge signal (e.g., high concentration or unique chemical).

The opposites of these characteristics (i.e., increasing depth to groundwater, non-steady flow directions, lower recharge, smaller regulated units, and a weaker discharge signal) and a large array of other variables and processes that moderate the discharge signal constitute insurmountable technical limits to the applicability of this tool in large areas of the regulated agricultural landscape. These issues and limitations can be illustrated with an excerpt from UCANR (2013):

> *The possibility of having high chemical mass transport with a low concentration can best be described by considering salts dissolved in the water. As water is lost from the soil through evapotranspiration (ET), the salts are left behind and become concentrated. Assuming no precipitation or dissolution of salts in the soil, the concentration of salts in the water leaving the root zone (Cd) is related to the concentration of the salts in the irrigation water (Ci) by the following equation:*
>
> $$Cd = Ci/LF;$$
>
> *where LF is the leaching fraction and is defined as:*
>
> $$LF = (AW–ET)/AW,$$
>
> *where AW is the applied water that infiltrates the soil. The amount of deep percolation carrying chemicals to the ground water is equal to AW–ET. Thus, the concentration of chemical in the water leaving the root zone is inversely proportional to the amount of deep percolation. The problem is even more complex because the LF varies spatially within a field.… A conclusion that is well supported by research findings and scientific principles is that the concentration is not a valid indicator of good versus bad agricultural management practices.*

In the absence of a viable, simple numerical threshold value as described above, or a different metric of similar technical performance, it is acknowledged that the regulation of agricultural non-point-source pollution becomes much more difficult and complex.

With these basic considerations in mind, the Panel recommends a comprehensive regulatory program to minimize nitrate movement to the groundwater (it cannot be completely eliminated because some leaching is required for irrigated agriculture salinity sustainability). [Q1] A quick read of the list of recommendations in the *Executive Summary* may make it appear to be almost identical to existing programs, but it is definitely different. The remainder of this report discusses important differences, and includes many required details. The Panel also defers to the recommended coalitions, with approval from the Regional Boards, to refine many programmatic details.

3.2 Groundwater Characteristics

Although the central motivation behind the call of this Panel is the problem of nitrates in groundwater, the majority of the Panel's recommendations focus on above-ground practices and monitoring. [Q5][Q6] The basis for turning the focus of the recommendations away from groundwater monitoring stems primarily from the difficulty of correlating sub-surface contamination to surface practices.

3.2.1 Groundwater and Surface Practices

Collecting data on changing nitrate levels in the groundwater, to indicate success or failure of overlying surface N management practices on individual fields and farms directly above a data collection point, is typically problematic at best. [Q10a][Q10b] Dr. John Letey, in discussing the State Water Board's "Recommendations Addressing Nitrates in Groundwater, Report to the Legislature" (20 Feb 2013), provides a grim view of traditional nitrogen data collection at the field level:

a. *… [T]here was no significant correlation between the N concentration in the soil-water with either the drainage volume or the amount of N applied. The significance of this is that there is no value gained by measuring the N concentration in the soil-water. The concentration neither reflects the N load to groundwater nor the quality of the farm management. Indeed, as will be supported later, erroneous conclusions can be drawn from these data…*
b. *The amount of N leached is far greater for the higher irrigation (low N concentration) than the lower irrigation (higher N concentration). The amount of N leached is directly related to the water flux at the bottom of the root zone. This flux cannot be practically measured (tracked) in the field, especially for the great variation with time and location. Tracking the N load migrating to groundwater, and not concentration, is the most important factor to track, and it is impossible to track.*
c. *…[E]fforts today should be directed toward reducing the future N loads to groundwater. The load is dictated by farmer management; and therefore, the approach should be directed toward inducing good farm management, not merely tracking and reporting what is being done. This is particularly true when some of the costly tracking information is, at best, of useless value.*

In fact, an increase in nitrate concentrations at the very upper surface of an aquifer (first-encountered groundwater) may indicate better nitrate management rather than poorer nitrate management. [Q10a] This can be caused by reduced irrigation water leaching, which would result in higher concentrations of nitrate in the leachate, even though the nitrate loading may be lower. In other words, the total load depends upon both the concentration and flow (flux) of the deep percolation. Estimates of deep percolation flow rates are very inexact. In addition, due to the nature of horizontal flows, the nitrate levels at a point in a groundwater aquifer do not necessarily indicate nitrogen practices in the field directly above that point. [Q10b]

A special case would be extensive monitoring and proper evaluation of data from a shallow water table (e.g., with the water table located 5-8 feet below the soil surface), which will exhibit a rapid response to deep percolation (below the root zone) water and nitrate flows. However, even with a shallow water table, the water quality of the outflow from tile lines is often influenced by the management in neighboring fields as well as by the overlying field. Additionally, there is always the basic question that must be addressed: Just because one can examine shallow water tables and get a reasonable answer, is this the best option available for the nitrate problem?

3.2.2 Aquifer Characteristics

The following points were repeatedly discussed with regard to the role of various models and groundwater monitoring data: [Q10]

- Lag times between deep percolation of nitrates and the nitrates reaching the top of the aquifer typically range from a year to up to extremes of several hundred years.
- While there can always be exceptions, it cannot be assumed that groundwater quality even near the water table is reflective of management practices and the concentrations in deep percolating water, immediately above the groundwater monitoring point. Instead, many explanations and examples exist regarding the complex mixing of aquifer flows and the heterogeneous nature of the subsurface.
- Groundwater simulation model results are only approximate even on very large scales.
- California aquifer physical characteristics are very complex and even with large studies are poorly defined. As an example, Figure 1 shows a single transect of the Modesto area aquifer. It is obvious that the results would be quite different if multiple transects were displayed. Model results are only as good as the accuracy of the data and boundary conditions that are used in the model; Figure 1 illustrates the difficulty of properly identifying aquifer characteristics even after extensive studies have been performed.

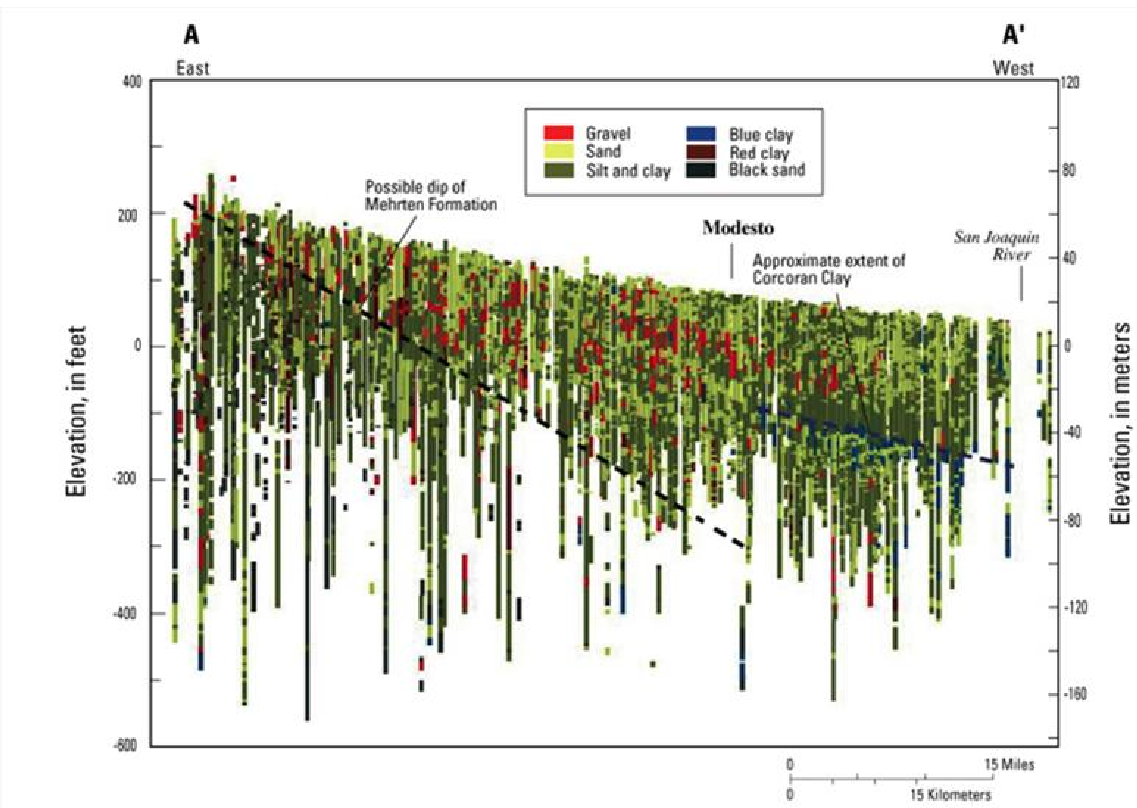


Figure 1. Cross-sectioned view of lithologic well-log data along azimuth of 50 degrees between Stanislaus and Tuolumne Rivers (Figure 10 from Burow et al. 2004)

The data collection is also complicated at the aquifer level. An aquifer typically has considerable depth, and there is unsaturated flow through the vadose zone between the root zone and the aquifer. The long travel times and the varied mixing of water of different qualities and sources within the aquifer can both result in a considerable lag time between changes in irrigation/nitrogen management practices and impacts in the aquifer. What is seen today in the aquifer is the result of historical management practices – not the result of today's irrigation/fertilizer practices. [Q4] [Q4b]

The graphs in Figure 2, provided in testimony by Dr. Joel Kimmelshue, illustrate how cropping patterns have changed in 20 years in North Kern Water Storage District. These cropping pattern changes are also associated with changes in fertilizer and water management. The point was that what is seen today in groundwater nitrate levels may have excellent, little, or no correlation to today's surface conditions. This further illustrates the difficulty in using individual groundwater data points to evaluate farming practices and highlights the need for long-term trend monitoring.

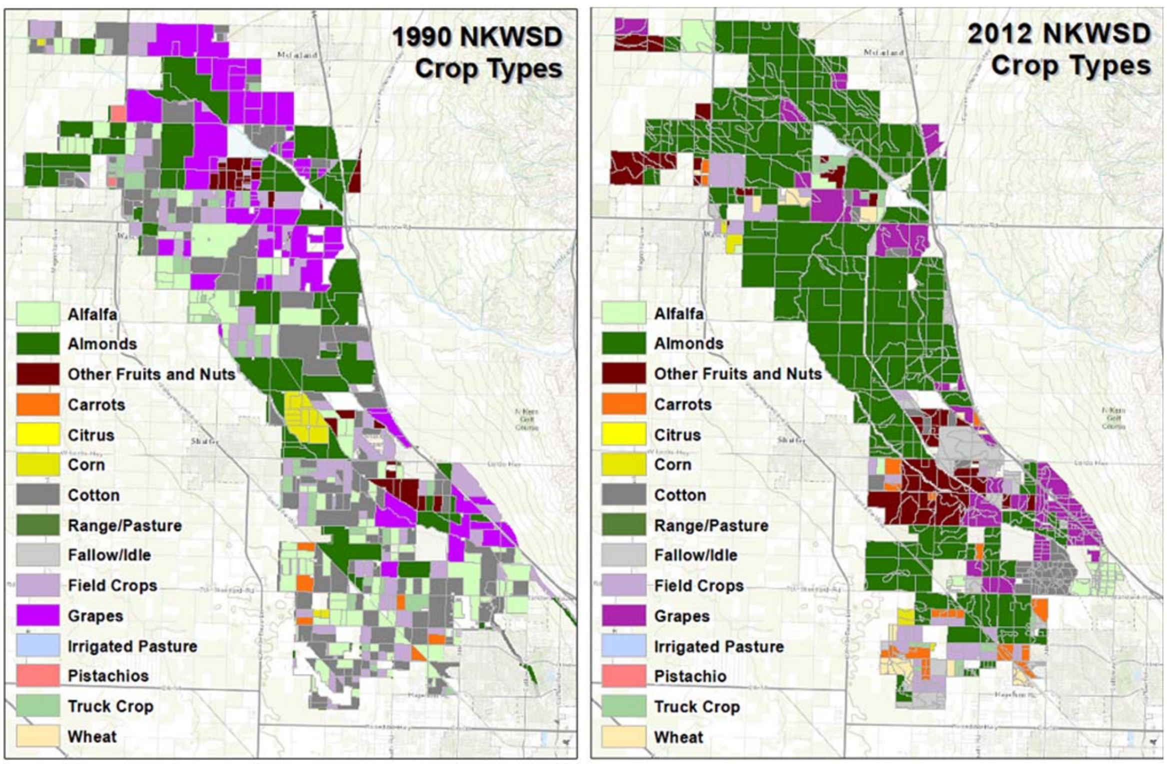
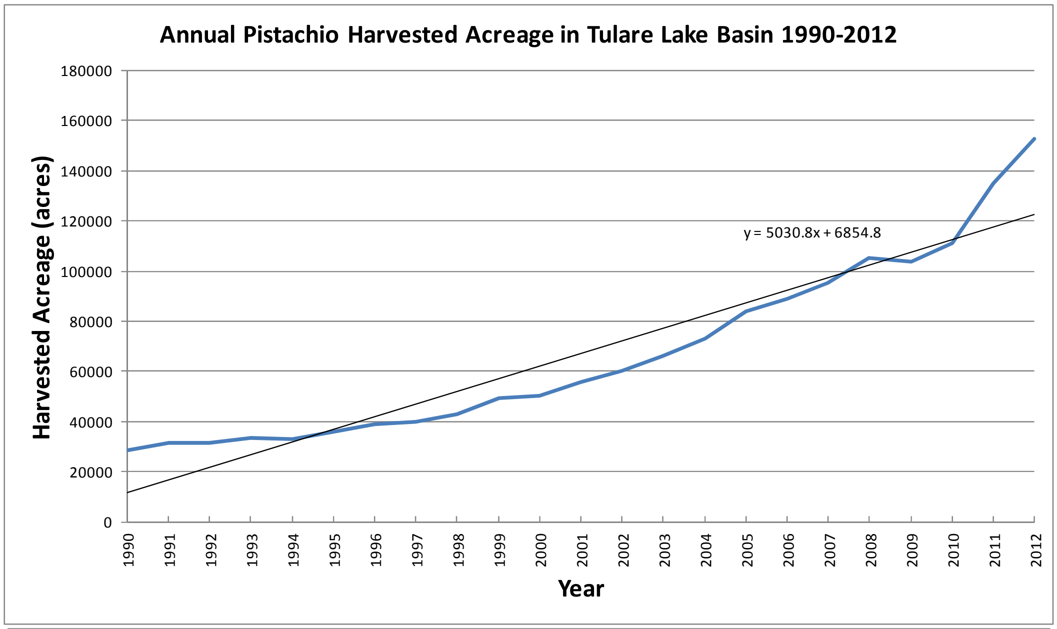


Figure 2. Crop type maps of North Kern Water Storage District, 1990 and 2012. Provided by Dr. Joel Kimmelshue

3.2.3 Historical Changes in Farming Practices

On a broader geographic scale, there have been major changes in cropping patterns in recent years. Figure 3 through Figure 5, developed from CDFA reports, illustrate some of the major changes in the southern San Joaquin Valley. Pistachio, almond, and tomato acreages have increased, and the yields for all three crops (lbs./acre) have also increased. The major changes in both acreage and yields have occurred in the last 10-15 years.



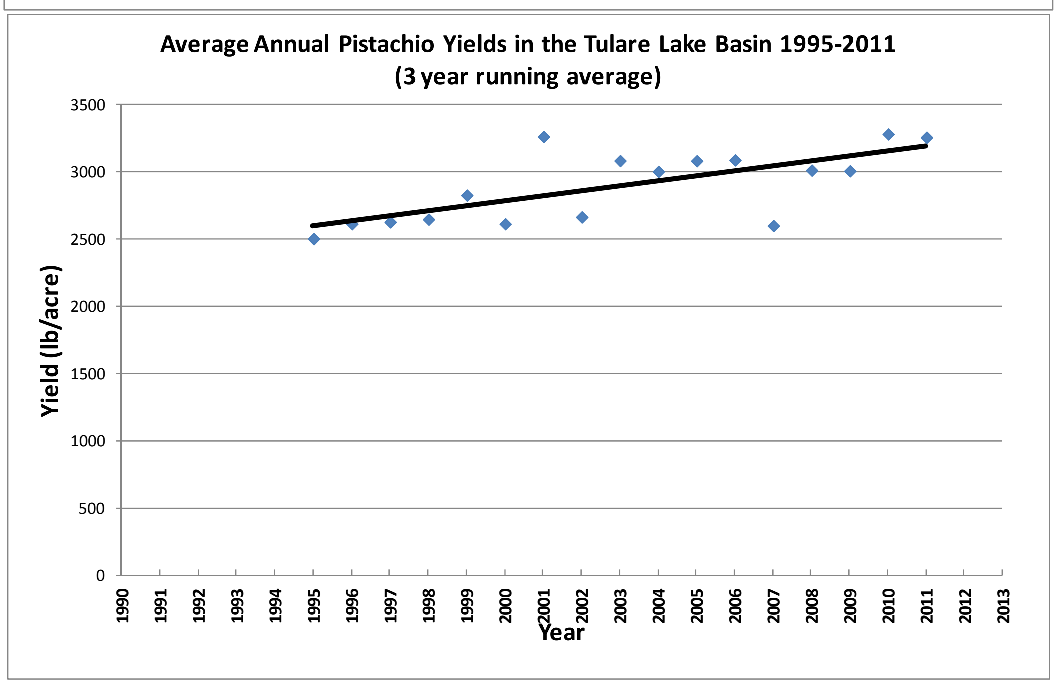


Figure 3. Graphs of changes in pistachio acreages and yield in the Tulare Lake Basin[1]

[1] Data from County of Fresno (2014), County of Kern (2014), Kings County (2014), and Tulare County (2014). Includes production from young orchards officially classified as non-bearing. Pistachio production stated in terms of In-shell Equivalents.

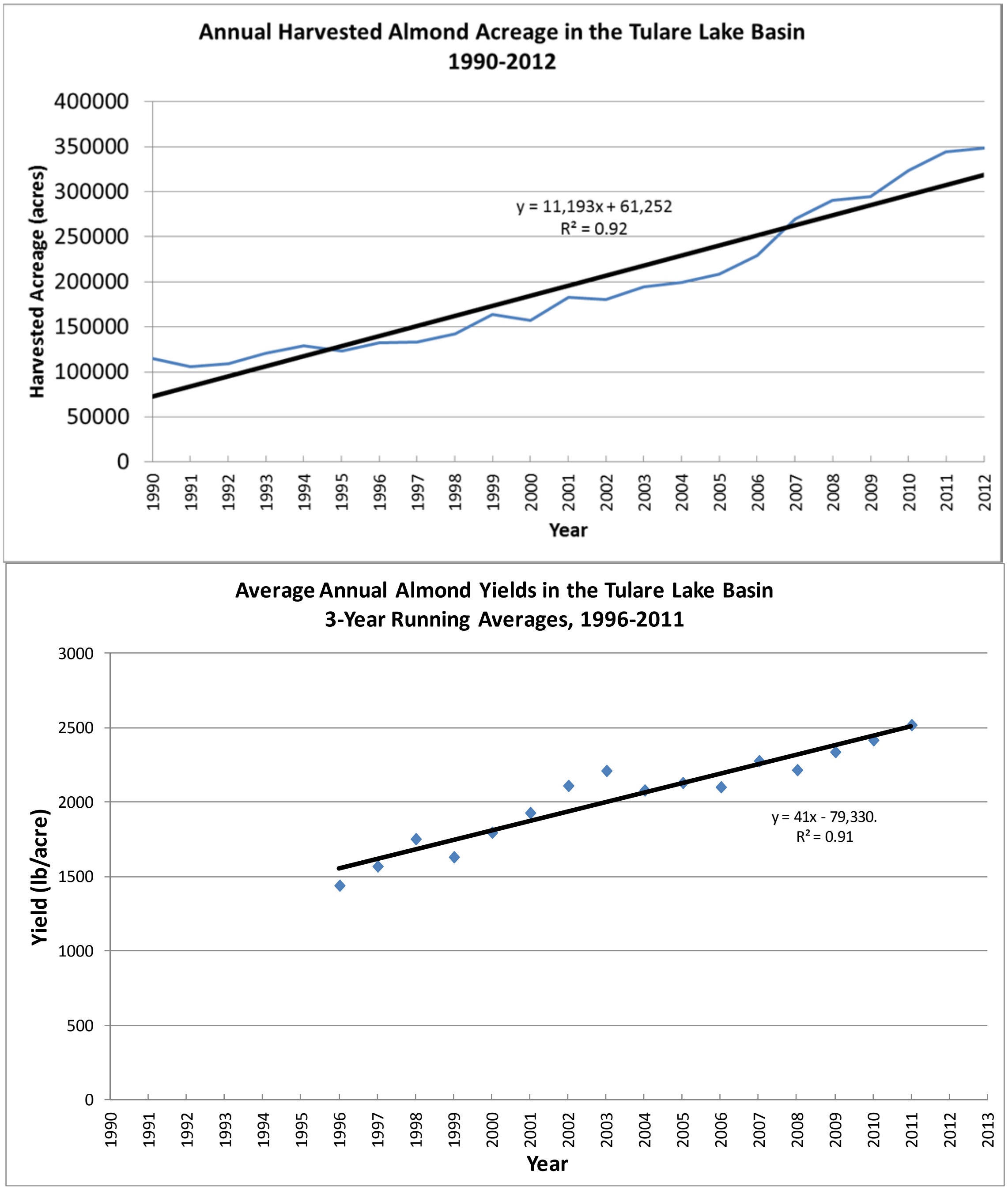


Figure 4. Graphs of changes in almond acreages and yield in the Tulare Lake Basin[2]

[2] Data from County of Fresno (2014), County of Kern (2014), Kings County (2014), and Tulare County (2014). Includes production from young orchards officially classified as non-bearing. Almond production stated in terms of Nut Meat Equivalents.

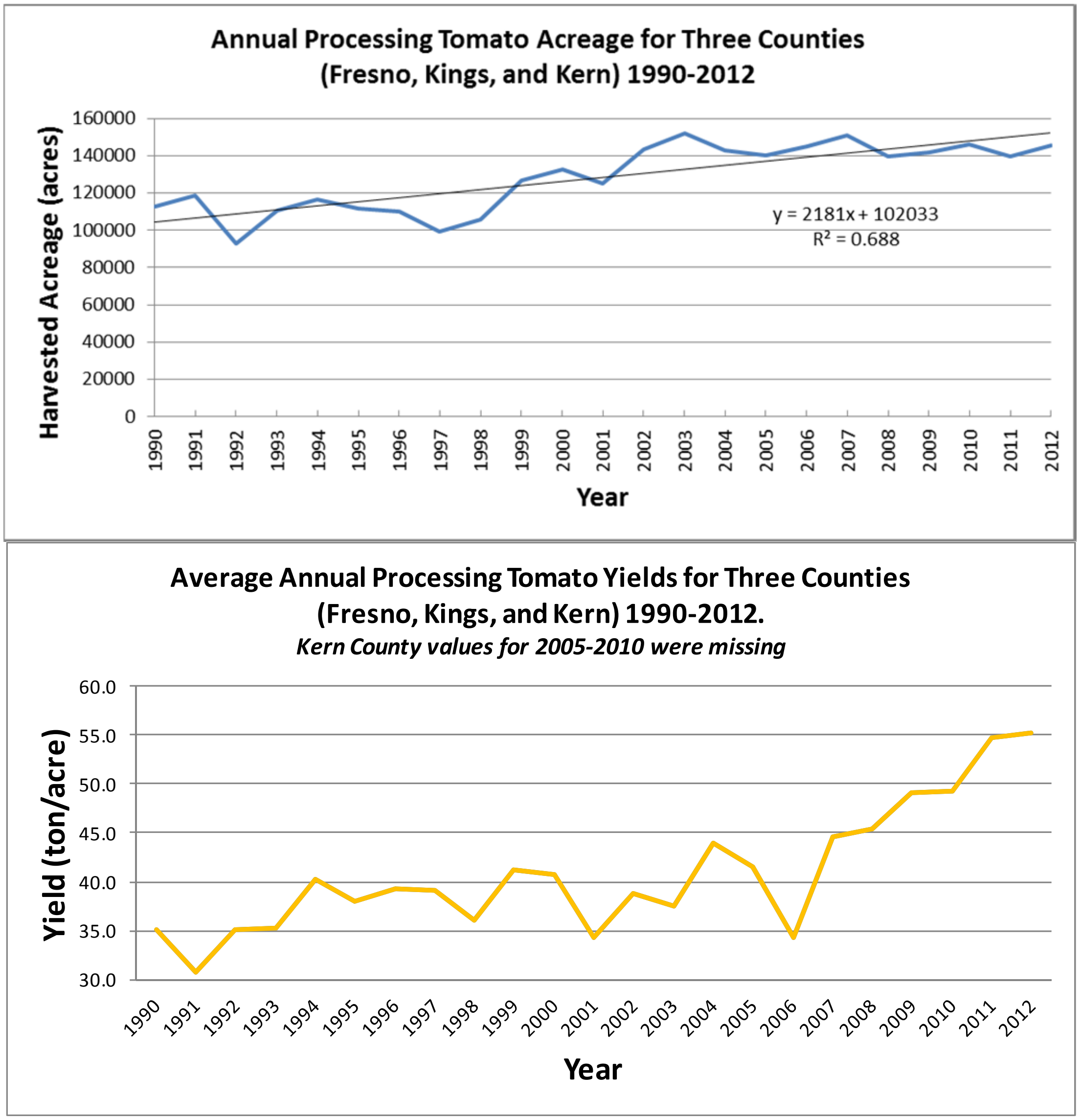


Figure 5. Graphs of major changes in tomato acreages and yield in Fresno, Kings, and Kern Counties[3]

Irrigation methods have also changed dramatically. While drip/micro systems have been widely used since the late 1970's in the San Joaquin Valley, it is now difficult to find pistachio, almond, or tomato fields that are not drip-irrigated. The big shift from surface irrigation (furrows and border strip) has occurred in the last 10-15 years.

Meanwhile, reported nitrogen fertilizer sales are about the same in the Southern San Joaquin Valley, but have reportedly dropped throughout California (see Figure 6 and Figure 7).

[3] Data from County of Fresno (2014), County of Kern (2014), Kings County (2014), and Tulare County (2014).

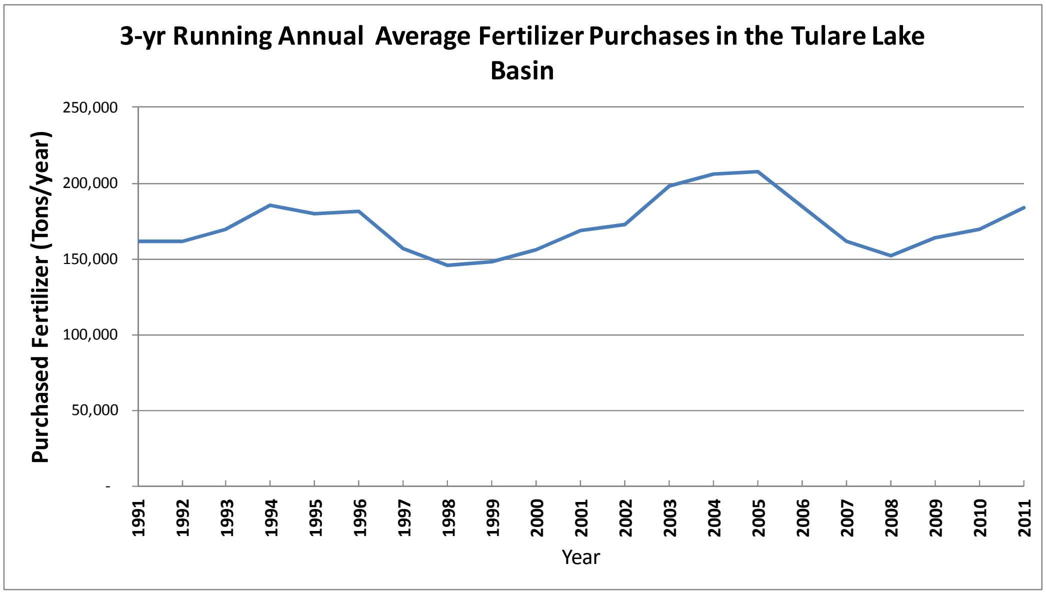


Figure 6. Three-year running annual average fertilizer purchases in the Tulare Lake Basin, 1991-2011 (data from CDFA, 2014)

State	Fertilizer purchased in 2003 (1000 kg of N)	Fertilizer purchased in 2005 (1000 kg of N)	Fertilizer purchased in 2007 (1000 kg of N)	Fertilizer purchased in 2009 (1000 kg of N)	Fertilizer purchased in 2011 (1000 kg of N)	% change from 2002-2006 to 2007-2011*
Alabama	90,956	114,387	106,729	60,319	68,225	-19%
Alaska	2,741	2,741	2,741	2,501	2,817	-2%
Arizona	96,855	89,720	71,420	89,747	60,041	-23%
Arkansas	265,684	227,586	297,798	213,021	223,361	-3%
California	792,148	694,217	670,619	609,774	672,302	-8%
Colorado	110,324	115,719	130,718	121,902	152,647	16%
Connecticut	10,791	8,284	10,634	8,889	8,480	-15%

Figure 7. Total nitrogen mass in commercial fertilizer purchased in California and other states for 2003 to 2011 (AAPFCO, 2011)

3.3 Concepts of Risk/Vulnerability

The Panel recognizes that the State and Regional Water Boards have limited resources and are interested in prioritizing regulatory oversight and assistance according to the risk posed by discharges to the environment into which the discharge occurs. [Q1] [Q2] [Q3] [Q4] As discussed in *Section 3.3.2.ii: Probability of Nitrate MCL Exceedance in Drinking Water Wells*, it is straightforward to identify areas of nitrate exceedances in drinking water, and thus, prioritize oversight and assistance. However, this effort has no technical relationship to identifying risk posed by dischargers in terms of deep percolation of nitrates. Therefore, it should be separately addressed. Furthermore, it appears that "regulatory oversight and assistance" within the framework of the present agricultural orders equates to "more data collection and/or more reporting". The Panel disagrees with this regulatory approach (see *Section 3.3.2.i: Establishing Areas of High Priority for Action/Attention*) because it cannot identify technical rationale to support it. Instead, the Panel believes that risk delineation has merits with regard to the phasing of a regulatory program, including coalitions (see *Section*

4.1: Coalitions) and other efforts such as outreach, education, and training. However, and regulatory or other efforts should ultimately apply to all growers, regardless of any risk categorization[4].

The State Water Board expressed interest in risk identification response to Harter et.al. (2012) (referred to in this report as "the Harter Report"). Recommendation 6 states:

> *The Water Boards will define and identify nitrate high-risk areas in order to prioritize regulatory oversight and assistance efforts in these areas.[5]*

Since then, the Central Valley Regional Water Quality Control Board (CVRWQCB) issued their first WDRs to growers within the Eastern San Joaquin River Watershed (R5-2012-0116-R2; revised October 2013 and March 2014). In this Order, the term "nitrate high-risk area" (or related) appears only once; and it is not defined. Instead, the term "vulnerability" or "vulnerable" (or related) appears 157 times, predominantly in connection with groundwater. This incongruence between the State Water Board and the CVRWQCB creates much confusion. Therefore, the concepts of vulnerability, as currently used by the CVRWQCB, and risk (as proposed to be used by the Panel) are discussed on the next few pages.

3.3.1 The Concept of Vulnerability

In the context of the ILRP and the development of its Waste Discharge Requirements' general orders, groundwater vulnerability has become a highly controversial concept. Part of

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[4] Exemptions or special circumstances may be considered for specific commodities or conditions if technically compelling rationale is provided.

[5] Recommendation 6 references two previous interpretive efforts that the State Water Board will invoke:

> *The Water Boards will develop a definition of a nitrate high-risk area, using both the hydrogeologically vulnerable areas identified by the State Water Board (http://www.waterboards.ca.gov/gama/docs/hva_map_table.pdf) as well as current CDPR Groundwater Protection Areas (http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpa_locations.htm), in addition to other available hydrogeologic data.* [Q1] [Q2] [Q3] [Q4]

The Panel finds that neither the State Water Board's Hydrogeologically Vulnerable Areas method nor CDPR's Groundwater Protection Areas approach can constructively contribute to a definition of nitrate high-risk area in the context of the ILRP. For example, the Hydrogeologically Vulnerable Areas method categorically excludes the entirety of the area known to be underlain by the Corcoran Clay although groundwater extraction from above this extensive aquitard is substantial both for agricultural and drinking water supply. Further, CDPR's Groundwater Protection Areas were delineated specifically to protect groundwater from contamination with pesticides, not nitrate. CDPR states:

> *A ground water protection area (GWPA) is a one-square mile section of land that is sensitive to the movement of pesticides. GWPAs can be established if any of the following are true:*
> - *previous detections of pesticides in that section*
> - *contains coarse soils and depth to ground water < 70 feet*
> - *contains runoff-prone soils/hardpans and depth to ground water < 70 feet*

Areas of pesticide application do not necessarily match those where fertilizers are applied (e.g., along railroads, highways and county roads, canals, etc.) and CDPR's groundwater protection considerations included chemical properties of pesticides, not those of nitrate [Q4b]. Also, the inclusion of runoff-prone soils/hardpans makes sense for the control of the off-site transport of pesticides to surface waters. However, these conditions tend to decrease deep percolation of water and nitrates and should, therefore, not be included in the delineation of nitrate high-risk areas.

the controversy is caused by the difficulty of agreeing on a definition, plus the difficulty of spatially determining areas of different vulnerability. The term itself is confusing. In many cases, vulnerability of an aquifer is better characterized as "rapidly responding" to a given input signal (e.g., a waste discharge to land) and the "degree of signal attenuation" that occurs between the point of discharge and point of interest within the aquifer system. However, some authors refer to these properties as the aquifer's "sensitivity." Clearly, vadose zone physical, hydraulic and chemical properties are important variables that determine aquifer vulnerability, and so are aquifer characteristics. Unfortunately, there is very little quantitative information on these properties, with the exception of highly investigated sites.

CVRWQCB defined "high vulnerability area" in Attachment E to R5-2012-0116-R2. This definition is the basis of the High Vulnerability Areas Methodology [Q1] [Q2] [Q3] [Q4] [Q4d]:

> *High vulnerability area (groundwater) – Areas identified in the approved Groundwater Quality Assessment Report "…where known groundwater quality impacts exist for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities." (see section IV.A.3 of the MRP[6]) or areas that meet any of the following requirements for the preparation of a Groundwater Quality Management Plan (see section VIII.H of the Order): (1) there is a confirmed exceedance (considering applicable averaging periods) of a water quality objective or applicable water quality trigger limit (trigger limits are described in section VIII of the MRP) in a groundwater well and irrigated agriculture may cause or contribute to the exceedance; (2) the Basin Plan requires development of a groundwater quality management plan for a constituent or constituents discharged by irrigated agriculture; or (3) the Executive Officer determines that irrigated agriculture may be causing or contributing to a trend of degradation of groundwater that may threaten applicable Basin Plan beneficial uses.*

The Panel finds that:

1. This definition creates ambiguity because, arguably, in most areas of the Central Valley floor "irrigated agricultural operations are a potential contributor" to nitrate concentrations in groundwater. Further, the statement "where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities" is exceedingly vague such that it carries little meaning. It also constitutes circular logic because it uses the to-be-defined term in its own definition.
2. This definition lacks technical rationale. Nitrate concentrations in water supply wells (as opposed to dedicated monitoring wells that were installed with the specific purpose of monitoring first-encountered groundwater in relatively shallow groundwater bodies) are in most cases not reflective of land uses in their immediate vicinity but rather reflect a mixture of waters of wide-ranging spatial origin and age. [Q10b] This is an amply documented fact and relates to the purposeful separation of the water intake sections from surface processes via sanitary seals; the depth, length and number of well screens; and the specific aquifers tapped; other well construction details; the integrity of the well casing; pumping rates, and total extraction volumes. Therefore, the locations of water supply wells with nitrate MCL exceedances do not provide the data needed to identify discharges or dischargers that pose a high risk or threat to groundwater resources.

[6]Monitoring and Reporting Program

3. The ILRP's focus on groundwater vulnerability confounds the spatial delineation of "risk of nitrate leaching below the crop root zone" with the concept of "impact to groundwater" at some undefined point within the aquifer.

Based on the above assessment, the Panel recommends that the CVRWQCB abandon its definition of High Vulnerability. The Panel is also of the opinion that the High Vulnerability Areas Methodology [Q4d] is an overly complex and inefficient method of inadequate foundation (i.e., CVRWQCB's definition of "High Vulnerability"). The ultimate utility of the risk delineation, as envisioned by the Panel (see *Section 3.3: Concepts of Risk/Vulnerability*) does not justify the currently invested effort by coalitions. [Q1][Q2]

3.3.2 <u>The Concept of Risk</u>

There are three important types of risk with respect to groundwater nitrate concentrations. All of them involve the likelihood or probability of an occurrence. [Q1] [Q2] [Q3] [Q4]

1. Human health risks (i.e., the probability of falling ill) associated with the ingestion of drinking water with nitrate-N concentrations exceeding the Maximum Contaminant Level (MCL) of 10 mg/L.
2. The risk (i.e., probability) of drinking water well(s) exhibiting nitrate concentrations exceeding the MCL.
3. The risk (i.e., probability) associated with growing crops of losing nitrate (including related nitrogen components) to deep percolation below the crop root zone.

An assessment of the risks to human health (*Item 1*) is not part of the charge to the Panel and therefore is not discussed. The risks defined in *Items 2* and *3* involve different processes, time scales, and solutions. Further, their assessment serves different purposes. Therefore, to effectively assess these risks, they need to be separated.

3.3.2.i Establishing Areas of High Priority for Action/Attention

There are numerous factors that might impact deep percolation – factors that can be used to create exhaustive lists of best management practices, intrinsic soil properties, etc. Some indexes (such as NHI [Q2a]) attempt to mesh both aspects: information about the soil plus something about the irrigation method. However, the use of a single index to lump numerous complex inter-relationships together is merely a proxy to answering two basic questions: Are the nitrogen and water needs of the crop being managed in a reasonably good manner?

Common measurements currently used for determining risk are proximity or operation within an impaired water body and the use of a risk calculation such as NHI [Q2a] or Nitrate Loading Factor [Q4a]. Both of these tools create output values that are used to trigger a lower or higher regulatory burden (e.g., more or less data collection and reporting), but do not give the grower much flexibility to adopt practices or otherwise make changes to operations to reduce risk or exposure. For example, a grower cannot readily change his/her crop, soil type, or irrigation source, but these are all significant and high-magnitude indicators of risk in the Region 3 Agricultural Order. Therefore, these tools have very limited ability to delineate actual risk and should be regarded as a preliminary tool before a more robust tool, namely the Application/Removal ratio (see *Section 4.2: A/R Ratio*) is developed. This more robust tool can, for example, at a later date inform geographic differences in long-term groundwater trend monitoring programs. [Q1][Q2]

3.3.2.ii Probability of Nitrate MCL Exceedance in Drinking Water Wells

Sampling and reporting of nitrate concentrations (among many other constituents) in drinking water wells is the responsibility of the operator of the regulated drinking water system and the review and evaluation of this information is the responsibility of the regulatory agency (the regulatory oversight of the drinking water program is presently transferred from CDPH to the State Water Board). [Q10b] The objective of this monitoring is to protect human health, and enforcement decisions are made based on actual nitrate concentrations rather than probabilities. An increased risk to water consumers is assumed when constituent concentrations reach one-half of the drinking water MCL; this has commonly been addressed by requiring operators of water systems to conduct more frequent sampling and reporting to the regulatory agency.

The existing data set, housed by the regulatory agency, may be usable to delineate areas where nitrate MCL exceedances in drinking water supply wells are thought to be more probable than in other areas based on, for example, straight-forward spatial autocorrelations. The regulatory agency may deem such effort necessary to implement notification of groundwater consumers of potential exposure to elevated nitrate concentrations in their water supply. However, this should not be an effort required of the regulated community (i.e., the operators of water systems or the farming community).

Probability of Nitrogen Deep Percolation Losses below the Root Zone

For any given crop, the probability of nitrogen leaving the crop root zone via deep percolation increases with increasing nitrogen input and irrigation/rainfall that exceed the crop uptake. Estimating this probability in a qualitative, comparative manner begins to address the groundwater nitrate issue (and the related salinity issue) and is congruent with the State and Regional Water Boards' need to prioritize regulatory oversight and assistance efforts in these areas. [Q5] To accomplish this task, the Panel recommends implementation of a basic data collection effort, as described in *Section 4.5: Data Collection/Reporting*. The recommended approach is guided by a basic recognition:

> *It is the mark of an instructed mind to rest satisfied with the degree of precision which the nature of the subject permits, and not to seek exactness where only an approximation of the truth is possible.* *- Aristotle (Nicomachean Ethics)*

3.3.3 Key Points Regarding Vulnerability and Risk

The Panel agrees upon the following key points related to the question of "vulnerability" and "risk." [Q1] [Q2] [Q3] [Q4]

A. There is no reliable and practical method available to accurately pinpoint the sources of groundwater nitrates found at any point (horizontal and vertical) in an aquifer. [Q2] [Q3]
B. The definition of "high vulnerability area" [Q4d] by the CVRWQCB creates ambiguity, uses circular logic, and has vague wording. It also lacks technical rationale, and confounds the spatial delineation of "risk of nitrate leaching below the crop root zone" with the concept of "impact to groundwater" at some undefined point within the aquifer.
C. The Panel is not confident that the designation of high or low "risk" or "vulnerability" is relevant for regulation. However, risk level may be considered in the administration of responsibilities of growers to the coalitions. [Q3]

D. The Panel does not believe that extensive monitoring of "first-encountered groundwater" for nitrate is appropriate due to the uncertainties involved in interpreting results. [Q10a]
E. Using a hazard index of conditions above ground such as with NHI [Q2a] , or an index based on groundwater nitrate levels, are insufficient to answer two basic questions on farms/fields: Are the nitrogen and water needs of the crop(s) in the overlying fields being managed in a reasonably good manner?
F. The Panel recognizes that regulatory agencies and coalitions need to have some means of focusing or phasing initial education and extension efforts.
G. Proxy measurements such as the NHI [Q2a] , groundwater nitrate concentrations, or total N applied per acre, may be used for focusing or phasing of initial efforts, only.
H. Long-term, the Panel recommends not using proxy measurements such as the NHI, but instead using a comparison (ratio) of the nitrogen applied to a field/crop to the nitrogen removed from the field (via harvest) or by the crop (via permanent wood growth). This is discussed in more detail in *Section 4.2: A/R Ratio*.
I. The Panel recommends against using the NHI [Q2a] , groundwater nitrate concentrations, or total N applied per acre to mandate different levels of regulatory requirements.
J. It is incorrect to assume that accurate estimates of deep percolation on individual fields can be made from complex soil water measurements. This is an important fact in the argument to not base regulatory action and regulatory decisions on modeling efforts that involve complex assumptions regarding root zone water storage, water holding capacity, crop ET, etc. [Q2]
K. It is clear that deep percolation will move nitrates below the root zone. The focus should be on practical means of minimizing deep percolation, not on the development of more models. [Q2]

3.4 Nitrogen Balances

The Panel acknowledges the importance of knowing the nitrogen transformation details for certain research projects. Knowledge of the nitrogen transformation fundamentals can also help advisors and farmers in developing good nitrogen management plans. However, there are major differences between individual perceptions regarding the ease and quality of available data. Calculations of nitrogen transformations within a root zone (e.g., mineralization, volatilization, nitrification, immobilization, denitrification, fixation) are very difficult to construct, on a seasonal basis, for many crops. There are numerous unknowns and a large range in the values of components used in the computations. Detailed nitrogen cycle computations for individual fields, for a growing season, will be fraught with error and unnecessary expense. The difficulties for experts are tremendous, and are unrealistic expectations for farmers. Therefore, the Panel does not recommend that such computations and associated data collection be required as part of the regulatory process. [Q7a][Q7b][Q7c][Q10f]

Even one aspect of the nitrogen cycle – the rates of mineralization of organic residues – is tremendously complex. [Q10c] To obtain an accurate value, one would need to know the nitrogen forms in residue, the residue concentrations at various levels in the soil, the temperatures and moisture contents in various levels, and have some indication of many key factors that influence the microbiological conversions. Similarly, nitrogen removal from the field (via harvest) is different from plant uptake. Much of the plant uptake may remain in the field after harvest. [Q7a]

As an example, one might consider the tonnage of nitrogen that is removed annually via crop harvest.

1. Almonds, with many years of focused research and simple cropping systems, have good and readily available information regarding harvested yield (meat, husks, plus shells) and removed nitrogen, plus an estimate of annual nitrogen uptake for wood growth.
2. A very similar crop – pistachios – has similar information, but that information is not readily available to the public.
3. The members of the Panel are not aware of readily available, easily usable information regarding harvested nitrogen/acre for a wide range of crops. This is especially true of produce crops (broccoli, lettuce, cauliflower) which have widely different pack-out rates, in which yield is expressed as boxes per acre rather than tons/acre, seasons are highly variable in duration, and the percentage of vegetative matter that is left in a field can change drastically depending upon the market.
4. For most crops, most farmers do not presently track the amount of harvested nitrogen. Rather, they are accustomed to a completely different way of thinking about nitrogen. Typical Extension Service recommendations are based on the amount of nitrogen needed to produce a crop rather than on harvested nitrogen rates. Or, recommendations may be based on some type of leaf or petiole sample results at specific growth stages. Reporting or accounting for harvested nitrogen is a completely new concept for farmers. This represents a much higher difficulty than what they are currently doing.
5. The further one moves from the field into research and academia, testimony indicates that the idea of accounting for harvested nitrogen sounds more and more simple.

Additionally, there are no direct measurements or metrics currently available that can be used to determine good from bad management practices in the context of agricultural, non-point-source discharges related to growing crops. There are also no surrogate measurements (i.e., proxies for direct measurements) currently available that can be used to determine mass flux of nitrogen compounds and dissolved minerals below the crop root zone on a field scale. Inherent errors and uncertainties far exceed needed precision. [Q7]

Even on a large scale, which should be considerably easier than on an individual field scale, there are challenges in exhibiting a proper nitrogen balance. For example, Figure 3 from the Harter Report is shown as Figure 8 below. [Q7a][Q7b][Q7c][Q10f]

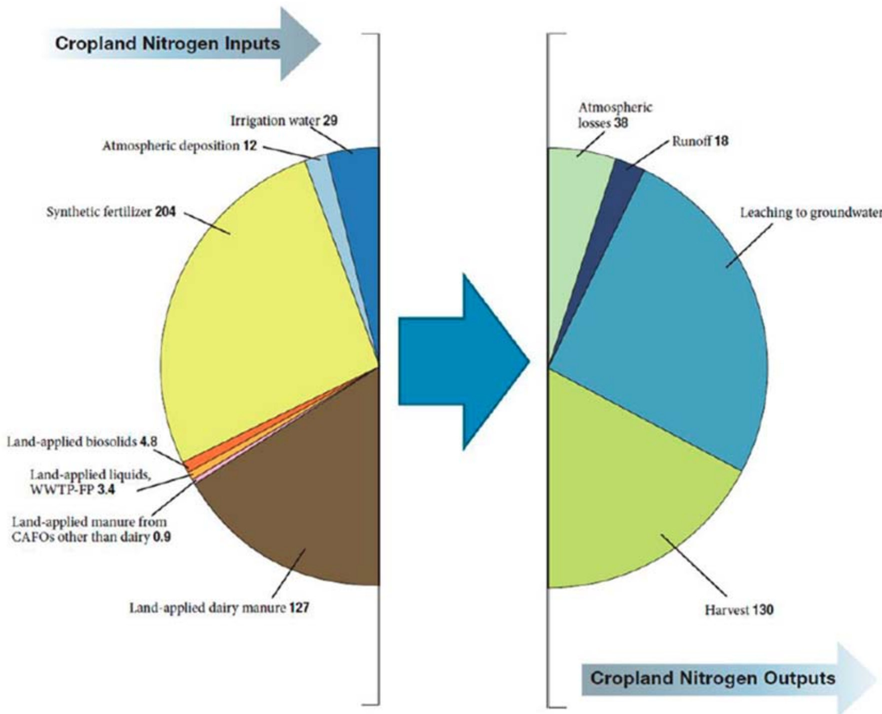

Figure 8. Mass balance of cropland nitrogen (Harter et al, 2012)

In the mass balance above, the "leaching to groundwater" is a mathematical remainder term, where:

Leaching = (everything on the left) – (everything else but leaching on the right)

While it can be desirable to provide simple depictions such as this, a logical question is: Why does the harvested nitrogen nearly equal the nitrogen in land-applied dairy manure? Surely some of the harvested nitrogen was destined to something other than manure. The study has numerous assumptions (which all studies must have), one of which is that all harvested alfalfa received all of its nitrogen from the atmosphere. However, alfalfa is generally planted in a rotation with other crops, and alfalfa will use readily available soil N before it fixes atmospheric N for its use. On a macro level, just the nitrogen in milk in the area of the pie chart is about 58,000 ton/yr. of N – accounting for a significant part of the harvested N. In other words, the depiction of a simple conceptual nitrogen balance for one intensively studied area as a product of a multi-million dollar effort suffers from a lack of clarity. The complexity of individual field nitrogen budgets is even more daunting. Research on a single plot to define nitrogen transformations as they vary with soil depth and time is very expensive, requires special university-level chemistry and biological expertise, and yet often still gives inconclusive answers.

As a side point, the graph in Figure 8 does not clearly indicate that very little manure is applied on the Central Coast (part of the study area). It would also be incorrect to extrapolate the findings from the limited study area to other areas of the state.

Graphs and figures regarding the nitrate issues rarely delineate the uncertainties in the data. Agronomic practices and crop mixes constantly change. For example, each component of the basin nitrogen depiction in the Figure 8 pie chart (which is not really a balance because not all major components are included) has a level of uncertainty. A casual reader may believe that such figures are more accurate than they really are. The Panel makes this point because it believes that regulations for groundwater nitrate must be developed with a clear understanding that much of our knowledge of the present status is limited.

Therefore, the Panel has formed its recommendations with the opinions that: [Q7a][Q7b][Q7c][Q10f]

1. It is possible to improve the knowledge of field-level nitrogen balances.
2. The simplest metric of good management is an examination of multiple-year ratios of applied nitrogen, versus crop-removed (harvested + sequestered in wood) nitrogen (the A/R ratio).
3. In general, the ranges (distribution) of most existing A/R ratio values are not currently known.
4. It will be a regulatory goal to learn what the ranges of these multi-year ratios are for multiple crops and situations, in order to define acceptable target values.
5. It will be a regulatory goal to reduce the average value of this A/R metric in regions.
6. There is insufficient knowledge at this time to assign target regulatory values to this ratio, but it certainly cannot be 1.0 or less (except in legume crops).
7. Pragmatic research is needed to identify attainable ratios for a range of crops and situations. Some of this research will be done by coalitions as they examine the reported data. Other research will be more traditional and will be related to topics such as rates and timing of nitrogen uptake and crop removal.

3.5 Education [Q8]

Due to the varying abilities of people to assimilate new information of various complexities, difficulty of properly communicating instructions, lack of information, etc., many changes in practices, procedures and behavior cannot be successfully accomplished in just a few years. Farming deals with large uncertainties because it combines numerous biological processes with unpredictable events and outcomes.

Testimony from Parry Klassen (East San Joaquin Water Quality Coalition) stated that it is a challenge to receive meaningful data from farmers on even simple details such as field locations. It did not appear that this challenge was because of reluctance to respond, but rather because it is a new task, requiring information from unknown sources, using unfamiliar procedures, with instructions that may not be crystal clear.

Because of the combination of scientific uncertainties plus the human element, it is essential to start slowly with attainable and meaningful steps. It may be determined later that these simple steps are sufficient in themselves. Undoubtedly, a sustained awareness and educational effort will be required.

All members of the Panel emphasize the high need for education, both in terms of educating growers as well as training the consultants and professionals who will be assisting growers in creating their management plans. Most importantly, growers must understand <u>why</u> the programs that are implemented are important, <u>what</u> the impacts will be to their specific operation, and <u>how</u> they can meet the requirements and recommendations that will be set forth. Additionally, any agricultural consultants, commodity groups, trade organizations, service providers, etc. need to be on the same page about the program.

Details regarding the recommended educational programming are included in *Section 4.3: Effective Educational/Awareness Programs*. In general, important rules behind an education effort for irrigation and nitrogen management plans are sometimes called the "Four Rs":

Rule 1: Right time
Rule 2: Right place
Rule 3: Right form
Rule 4: Right amount

4 RECOMMENDATIONS

The Panel recommends a shift in emphasis in regulatory attempts to reduce nitrate levels in groundwater. The shift would be toward long-term monitoring, source control, and education. The justifications for this shift are:

- Regulations designed to improve or maintain groundwater quality must focus on **source** control for avoidance or minimization of problems – rather than the point-source regulatory approach which depends upon detection of a problem, identification of the individual polluter/owner and discharge point, and enforcement of regulations.
- Because deep percolation of nitrates is universal within irrigated agriculture, a good regulatory program must encompass all irrigated areas, not only lands directly above high nitrate aquifers, those previously identified to be in a high vulnerability area, or those with a certain farm or field size. [Q1] [Q2] [Q2d] [Q3] [Q4d] [Q4][Q4c]
- Nitrate flow to groundwater can best be controlled by avoiding both excessive nitrogen applications and excessive deep percolation. [Q5][Q6] Therefore, the measurement and scheduling of irrigation water depths applied must be included in any realistic source control program.
- There is no simple feedback test that can be applied to nitrogen and water management. Therefore, the development of nitrogen/water management plans for improved source control on individual fields is best done by educated, certified individuals who are able to analyze the local complexities of fertilizer, crops, weather, soils, etc. and who can develop a pragmatic customized water and nitrogen management plan. [Q4b] This is in contrast to a program that relies on farmers checking off a list of Best Management Practices.
- The Panel also understands that high groundwater nitrate levels will not be reduced immediately, and that there is a danger of focusing on areas with high groundwater nitrates or levels of "vulnerability" (as estimated by various indices and methodologies), at the expense of missing potential new problem areas.
- The Panel does not recommend the development of a "scientifically based evaluation of the link between *(a)* proxy metric and actual discharge via a 'Representative practice evaluation'", which appears to be the concept behind the Management Practices Evaluation Program (MPEP) in the Central Valley RWQCB ILRP Orders (found on page 17, Attachment B, Tulare Lake Basin Order R5-2013-0120). Instead, the Panel recommends the use of the A/R ratio, averaged over multiple years after implementation of comprehensive, customized nitrogen/water management plans. [Q9]

The key elements of the recommended regulatory program are:

1. Establishment of coalitions to serve as the intermediate body between farmers and the Regional Boards.
2. Adoption of the A/R ratio as the primary metric for evaluating progress on source control, with eventual impact on the groundwater quality. [Q9]

$$\mathrm{A/R} = \frac{\text{Nitrogen Applied}}{(\text{Nitrogen Removed via harvest}) + (\text{Nitrogen sequestered in the permanent wood of perennial crops})}$$

3. Development of a very strong, comprehensive, and sustained educational and outreach program. Such a program will require different materials and presentation techniques for different audiences, such as individuals who may need certification, managers of irrigation/nutrient plans, irrigators, and farmers/managers. [Q8]
4. Creation and implementation of nitrogen/water management plans that are truly plans rather than just a listing of best management practices. These must be customized by features such as crop and locale. [Q5][Q6]
5. Reporting of key values (i.e., crop type, acreage, total nitrogen applied, and total nitrogen removed) by farms to the coalitions. [Q9]
6. Trend monitoring of groundwater nitrate concentrations to track general aquifer conditions over multiple years. [Q9]
7. Targeted research that will directly help the agricultural community to maintain and/or improve yields while simultaneously decreasing the A/R ratio on individual fields.
8. Use of multi-year reported values and monitored trends by the coalitions to inform the agricultural community of progress, to improve understanding of what is reasonable to attain and expect, and to sharpen improvement efforts. [Q9]

These eight recommendations are detailed in the following sections of this chapter.

4.1 Coalitions

The Panel emphasizes that grower coalitions should be strongly encouraged by Regional Water Boards. The Panel recommends strong, local, third-party participation in all regions for the administration of whatever program is put into place.

The Panel finds that the formation of coalitions in Region 5 has been valuable. The Panel recommends their formation in other areas to serve as essential management/operation units. For example, coalitions can collect data from farmers, organize it, and present summaries to the Regional Boards. As local organizations, they can provide strong input to the specifics of their local regulatory programs' formation and modification. They will also serve as the first point of contact in notifying farmers of any apparent compliance problem. The coalitions can also coordinate, sponsor, and/or conduct research and education.

4.2 A/R Ratio

The mechanism of nitrate movement through and beyond the crop root zone is via water flow (irrigation and/or rainfall deep percolation). Therefore, management practices must attempt to minimize water deep percolation, and also match the available nitrogen to the plant needs at appropriate times. [Q5][Q6]

To reduce or maintain nitrate levels in the groundwater, improvements have to start at the surface, which means on-farm. Efforts to improve agricultural nitrogen fertilizer management will be challenging, in part because of common terminology and recommendations that have traditionally been provided to farmers. For example, consider the following statement in an extension publication:

> *Compared to most other vegetable crops, lettuce has a moderate nitrogen requirement, taking up on average only 100 to120 lbs. N/acre. Many replicated trials*

> *have demonstrated that, with efficient water management, seasonal nitrogen application of about 150 lbs./acre should be adequate to achieve high yield and quality; in fields with significant residual concentration of nitrates in the soil even lower nitrogen rates can be adequate*. (Hartz, 2009)

Although there is mention of "significant residual concentration of nitrates in the soil," the recommendation above clearly illustrates two common concepts: [Q5][Q6]

1. Common recommendations are phrased in terms of "requirement" or "demand" and talk about the N uptake from the soil – not the N removal from a field at harvest.
2. Common recommendations have a built-in inefficiency. For example, one could interpret the statement above to say that the plant needs 100 lbs. N/acre, and the recommendation of application is 150 lbs. N/acre – a guaranteed efficiency of 67%, not including the difference between plant uptake and plant N removed.

One important hurdle that must be overcome is that common terminology and recommendations for nitrogen applications that farmers are accustomed to hearing (often related to nitrogen uptake), currently are not consistent in focusing on matching N applications with N removal from fields (the ratio of Nitrogen Applied/Nitrogen Removed). These terms should be defined and emphasized in the training/awareness programs that will be discussed in the next section.

There is also ambiguity when distinguishing between plant uptake of N, and harvested (or removed) N. With some crops, most farmers are very aware of the negatives associated with excess uptake of nitrogen. For example, the yield and quality of cotton and almonds will suffer from excess nitrogen. However, it is difficult to know what the efficiency of N fertilizer uptake is, and information on synchronization is not widely available. Because of this, for other crops (which are not apparently damaged by excessive nitrogen) some farmers commonly apply more N than needed as a sort of "insurance" application to avoid negatively impacting crop quality and yields. The Panel agrees that optimized nitrogen use efficiency should be the focus of management practices encouraged.

Regardless of the difficulties outlined above, the Panel recommends a relatively simple metric to identify progress for this particular regulatory issue. [Q5][Q6]

The metric, to be measured and reported by farmers is the "A/R ratio", where:

$$A/R = \frac{\text{Nitrogen Applied}}{(\text{Nitrogen removed via harvest}) + (\text{Nitrogen sequestered in the permanent wood of perennial crops})}$$

"Nitrogen Applied" includes nitrogen from any source. Example sources are organic amendments, synthetic fertilizer, and irrigation water. [Q4b]

4.3 Effective Educational/Awareness Programs

4.3.1 General [Q8]

The Panel believes that true progress in reducing nitrate leaching will only occur if good irrigation and nitrogen management plans are developed and implemented. The Panel believes that a very aggressive, well-funded, and high-quality educational program is necessary because there simply are not enough qualified consultants and individual farmers to develop and implement good irrigation and nitrogen water management plans.

There are presently a variety of professionals who are trained in irrigation and nitrogen management. Some have academic degrees from pertinent technical university programs in soil science, agricultural engineering, agronomy, or similar subjects. Short courses are offered by universities and commodity groups. Various professional groups have certification programs. The Certified Crop Advisor program focuses on crops and nitrogen, but is weak on irrigation systems and irrigation management. The Certified Agricultural Irrigation Specialist program by The Irrigation Association focuses on drainage, irrigation systems and irrigation management, and salinity, but is weak on crops and nitrogen.

Educational programs must address two key groups:

1. Individual farmers or farm managers who are the water/nitrogen decision makers.
2. Persons who develop the irrigation and nitrogen water management plans

The Panel believes that in many cases, a single individual will fall into both groups. While the level of detail and specific topics to be addressed for each group will be different, several topics are emphasized as critical components of a good grower/farmer education program, including: [Q8a]

- Water and nitrogen needs specific to particular crops – separating uptake versus removal.
- How to create an appropriate irrigation schedule.
- How to implement an appropriate irrigation schedule.
- Irrigation distribution uniformity (DU), and influencing factors.
- Maintenance requirements of different irrigation systems.
- Correct timing of nitrogen applications.
- "Spoon-feeding" of fertilizers and other chemicals, rather than large-dose applications. Currently, most growers have neither the equipment nor adequate education to do this; however, education about and adoption of these techniques should be encouraged.
- Lower-dose, split applications of nitrogen throughout a growing season are highly recommended to reduce N fertilizer applications, if spoon-feeding is not feasible. [Q4b]
- Nitrogen management considerations with crop rotations.
- Fertigation principles – techniques, hardware, and chemicals.
- The standing of other growers in a region. In other words, what is the range of N applications/year for crop "Z"?

4.3.2 Designing the Venue and Materials

Although it is easy to say that education is needed, the "devil is in the details." Funding related to nitrogen has focused on research, to the almost total exclusion of developing strong educational programs for irrigation and nitrogen management either at the university level, or for universities to develop extension materials and programs.

It was beyond the scope of the Panel's task to develop an educational or training program, but the Panel emphasizes that an effective program must address the following: [Q8a]

1. Fill in knowledge gaps and publish them widely.
2. Make a clear decision on what the obligations of individual farmers will be, as well as the justification for those obligations.
3. Define the training venue.
4. Identify target audience(s).
5. Develop standardized training methods, materials, and examinations.
6. Define the certification process for "trainers."

These six steps are described in the next sections.

4.3.2.i Filling in the Gaps

Discussions earlier in this report identified many areas with "unknowns." The Panel acknowledges that many growers lack the information needed to fulfill the requirements of the A/R ratio regulatory program. These knowledge gaps must be identified and the information needed to fill them must be published widely, such as through farming magazines. The primary gaps in knowledge appear to be:

- Harvested (removed) N for various crops.
- Timing of uptake of N for various crops.
- Requirements for various nutrient ratios, to ensure proper N uptake.
- Justification for the difference between UC nitrogen requirement ranges, versus UC recommended application rates that incorporate about a 30% inefficiency.

4.3.2.ii Defining Obligations

In order to gain widespread acceptance of any new program, farmers must be clearly informed of what their individual obligations are, and why. [Q8a] <u>If the obligation is to develop and implement a good but simple management plan</u>, this will be a major advancement for many farmers. The plan, however, must be developed by a qualified individual: either a consultant, employee, or the farmer. [Q8d] The farmer must certify that he/she will adopt the plan and implement it fully within a specified time period or before a specified date. The key elements of each annual plan, for each representative field, could be to: [Q9][Q6]

- Keep records on all nitrogen inputs and timing.
- Keep records on all irrigation inputs (flows and volumes) and timing. This requires a means of measuring or reasonable estimation of the flow rates and volumes into individual fields – **<u>which is a major advancement for most farmers</u>**.
- Keep records of rainfall.
- Have recent measurements of the key components of the distribution uniformity (DU) of the irrigation system, or from a comparable irrigation system on the farm.
- Summarize, in a neat table, the inputs and the expected consumption of water and nitrogen.
- Create a list of improvements to be made the coming year.

4.3.2.iii Defining the Training Venue

If the educational and training programs are expected to be provided for the long term, there must be consistency over many years, with the ability to upgrade and expand training. Several different venues that currently exist or could be created are listed below. An ideal venue may contain various elements from several of the current programs.

1. **Certified Crop Advisor Workshops [Q8c][Q8e]**

   The UCCE recently implemented a workshop effort with Certified Crop Advisors. That workshop appeared to be quite successful because it was very quick and reached a large number of people. However, this type of effort would be difficult to sustain, and difficult to provide long-term with consistency because it consisted of numerous instructors who were given short notice. In addition, there was no testing, so there was no way to objectively evaluate the effectiveness of knowledge transfer.

2. **Formal, Multiple-Day Workshops [Q8c]**

   A possible approach would be to have formal 1-3 day workshops such as those offered at Cal Poly through the ITRC. These are based on structured educational material, and are usually taught by only one or two individuals. Advantages include standardized materials that ensure participants obtain a consistent message from year to year. The timing is published well in advance, so people can plan on these classes every year, and many of the classes dovetail with Irrigation Association certification programs, which require that students pass classes. Such classes would not be for farmers, but would be for advisors/consultants.

3. **Distance Learning**

   Distance learning modules that incorporate testing and accounting of registration, etc. could be developed. With distance learning, people can study on their own schedules, from any location. If the material is standardized, all participants receive the same information from year to year, and the quality of the program does not depend on the instructor. Distance learning can be augmented by written materials, local lab exercises, or could serve as a backbone training tool for an in-person training session. That is, an instructor can be present in Merced, for example, to help stimulate discussion, answer questions, etc. – but the “distance learning module” would be used as the primary teaching tool.

   Distance learning also has several disadvantages. For example, a high-quality distance learning package is much more expensive to develop than most people think. It cannot be funded by student registrations, but must be developed with up-front funds. A high-quality course also takes months to develop. It is not comparable to devising a PowerPoint presentation or video-recording a lecture.

4. **Standardized Materials Taught Locally [Q8d]**

   Standardized training materials could also be developed to be presented by local qualified individuals – not necessarily from a university. Some trade associations already do this. Such a program could allow local people to become heavily involved and invested in the program, but it may also be very difficult to get qualified people to teach the courses.

4.3.2.iv Identifying the Target Audience(s)

The training methods and materials must match the target audiences. It is clear that different audiences (for example, Certified Crop Advisors, as compared to irrigation foremen) may have different learning styles and also need to know different levels of detail.

4.3.2.v Standardized Training Materials and Examinations

Once the format(s) is/are defined, standardized training materials must be developed to provide knowledge transfer to those who will develop the irrigation and nitrogen management plans. The State Water Board should approve the curriculum that will be used by various coalitions and groups. If applicable, standardized examinations must also be developed. While the Panel understands that there must always be local customization of training, there is also a common core of knowledge that should be understood.

The core topics must be standardized and well-defined. It will be important to build upon existing knowledge and expertise, rather than start from the beginning. For example, topics might be:

- How to fill out the basic cover sheet for a management plan.
- How to determine timing of nitrogen applications.
- How to determine crop nitrogen requirements, making various assumptions about the nitrogen cycle in the soil.
- How to check for adequacy of nitrogen availability.
- Interaction of N with other nutrients.
- Fertigation principles and equipment.
- Irrigation system evaluation.

4.3.2.vi Certification Process [Q8b]

A core element of the Panel's recommended approach is to ensure that decision-makers have a good irrigation and nitrogen management plan that results in good nitrogen efficiency. Unfortunately, there are currently not enough qualified specialists available to develop thorough plans. It takes many years to develop high-quality training materials, implement a full-scale training program, and create more qualified specialists. Such development and execution requires significant funding.

Of key importance is defining the process for certification of "planners." Trainers must be well-qualified. This is a serious challenge. People who understand the plant physiology aspects of water management often mistakenly assume they also know about irrigation system design and management, which is a different topic requiring a different skill set. In a similar vein, "grandfathering" people into certification can be undesirable because years of experience does not necessarily mean that an individual has current knowledge.

A big question is if people need to have degrees in Soil Science or Agronomy. There are likely too few people who have these degrees. Another big question is if people who make management plans should already be certified in some other program.

It is vital to emphasize that simple attendance at classes is insufficient for demonstrating knowledge. Evaluation of course effectiveness is best done by evaluating (through testing) knowledge of the class participants. A simple course evaluation based on subjective statements such as "I learned a little, a lot, or nothing" is not sufficient. Exams need to be standardized, but have a good selection of randomized questions to ensure effective testing of acquired knowledge. Grading must also be standardized. This is a major effort.

No matter what form the certification takes, however, it will be difficult to maintain consistent momentum, year-in, and year-out. Therefore, there must be some official organization to manage any certification program.

4.3.3 Farmer Involvement

The Panel recognizes that if growers (farmers) or farm managers do not attend some meaningful, pragmatic training as described earlier, the desired goal of reducing nitrate leaching will not be met. <u>It was the consensus of the Panel members that compliance will be low unless there is some enforceable requirement</u>. The Panel members struggled with defining the proper incentives for grower compliance with management plan and training requirements. A variety of ideas were discussed, without a final decision for a recommendation. [Q8a]

One of the stronger ideas presented was that nitrogen fertilizer sales should be handled the same way as pesticide sales, in the sense that pesticides can only be sold to a purchaser who has a valid and current permit. There are testing and continuing education requirements to obtain and maintain the permit. The permit is issued and recorded by the county Agricultural Commissioner, and must be on file with the pesticide seller. In a similar fashion, nitrogen fertilizers could be sold only on the condition that farms have on record, at the fertilizer sales office, a form that certifies the completion of a satisfactory irrigation water and nitrogen management plan. [Q4b]

The Panel recognizes that there will likely be challenges in getting widespread compliance from growers with small farms. There is likely a need for special training, funding, and/or reporting requirements for this group.

4.3.4 Other Details

The Panel acknowledges that there are liability concerns by some specialists who might eventually develop management plans. The State and Regional Water Boards must clearly define that the developer of plans will not be responsible for the proper implementation of that plan unless that person is also the implementer. Furthermore, it must be stated that it is understood that plans will be imperfect, and will be modified/upgraded over time after re-assessment of results, and as knowledge improves.

Three important issues that were discussed, but not finalized, were:
1. The <u>timeline</u> for the various components of the educational effort.
2. Requirements for continuing education.
3. Who will review whether management plans are implemented.

4.4 Nitrogen Management Plans [Q7d]

The Panel has chosen not to create a "laundry list" of Best Management Practice (BMP) options for growers. Such lists[7] already exist, but generally lack sufficient detail to be effective on a site-by-site basis, and usually do not address the root of the problem. The Panel agrees that lists of any specific practices should be in the form of heightened awareness only, rather than requirements.

Instead, the Panel believes that future efforts should focus on the following four areas:

1. **Creation of irrigation and nitrogen <u>management plans</u> specific to each grower and similar management unit**
2. Development and execution of awareness/education programs (discussed in *Section 4.3: Effective Educational/Awareness Program*).
3. Implementation of the management plans.
4. Internal (on-farm) review and assessment of the impacts (crop quality, amount of fertilizer and water used, gross costs). [Q4b]

4.4.1 <u>Collecting Pertinent Data [Q7d]</u>

A first step (possibly requiring 1-3 years) for many management plans will be to describe and develop the data collection process (water and fertilizer) [Q4b], and data organization procedures and tools to accomplish this. The management plans will be subject to audit. Therefore, the data must be organized so that they can be easily understood by an auditor. The Panel recommends that the coalitions define the format of the data (database, tabular, spreadsheet, etc.), and the content.

The details of these plans should be used for management only, and <u>not</u> for reporting purposes to the RWQCBs. The management plans should aid growers in determining the current status of their nitrogen use, as well as developing tools and practices to optimize nitrogen applications. To begin the creation of a management plan, the irrigation/fertilizer decision makers must be knowledgeable about certain data (which should be updated at least annually). These data include: [Q5][Q6]

- How much nitrogen is being applied from <u>all</u> sources, including fertilizers, compost, irrigation water etc., plus residual nitrogen, as well as the timing and uniformity of the applications. [Q4b]
- Residual nitrogen in the soil.
- How much nitrogen is removed, by crop type. The Panel considers "N removal from fields" to include both the harvested portion and the nitrogen that is used for growth expansion on perennials (e.g., a number of 25 pounds/year/acre has been quoted for almond trees).
- The volume of water applied to a field (minus recovered tailwater for surface irrigated fields).

A subsequent step should be the organization of the prior year's irrigation and nitrogen application schedules and amounts, combined with determination of how those could be improved.

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[7] For examples, see the NRCS's Nutrient & Pest Management program (www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/npm/), or the Best Management Practices Studies compiled by the Coalition for Urban/Rural Environmental Stewardship (CURES) (http://www.curesworks.org/bmp/bmpGeneral.asp)

4.4.2 Creating the Plan [Q5][Q6] [Q7d]

From the collected data, an appropriate nitrogen management plan, an appropriate irrigation schedule, and a plan for irrigation system maintenance should be developed for the upcoming year/season based on system type and anticipated crop demand.

The Panel emphasizes the following points about the proposed nitrogen management plans:

- Having a well-designed and implemented irrigation water and nitrogen management plan is a fundamental and good farming practice. [Q7d] The Panel believes that the management plans must be individualized and developed by competent individuals, and that the plans must identify actions to be taken to improve performance.
- The Panel believes that the State and Regional Water Boards should agree on the qualifications of the individuals who will create and evaluate irrigation and nitrogen management plans and the requirements of these plans. It is recommended that individual plans will not require approval from the Water Boards, but must be available for Water Board staff review.
- All management plans must include estimates of nitrogen required, nitrogen removed, the volume of water infiltrated in a field (separated as rainfall and irrigation), and the ET of the crop. They must account for the fact that some of the variables change over the season.

A management plan will describe processes, procedures, and/or objectives that are applicable throughout each management unit/farm. For example, items such as wellhead protection, installation of new fertigation equipment, and checking distribution uniformity of systems will fall in this category. The Panel acknowledges that describing and understanding the nitrogen management of a 160-acre almond orchard is relatively simple as compared to describing and understanding the nitrogen management of sixteen 10-acre produce crop fields. While it is recommended that the same information be recorded for both situations, it is clear that requiring separate management plans for individual fields – often of an acre or less with produce crops – is unreasonable.

Within the management plan more detail will be provided for individual reporting units. The plan for individual reporting units will include an estimated fertilizer application schedule (amounts, timing), irrigation schedule (amounts, timing), and irrigation maintenance program. It will also define what/how data will be collected to estimate nitrogen and water application requirements. The process to annually evaluate the effectiveness of the plan should be described; this should focus on basic indicators such as the N applied versus removed.

4.5 Data Collection for Reporting Purposes

The Panel's recommended regulatory program includes the reporting of certain data. The Panel also assumes that these same data may have value to farmers in reducing fertilizer and/or water costs, and possibly improvements in yield. However, the data must be collected properly to have value. [Q9]

Some Regional Water Board testimony distinguished between data that needs to be collected, versus data that needed to be reported, versus data that needed to be maintained on-site for inspection by a farmer. Some speakers seemed to imply that as long as data were not reported, the cost to obtain that data would be small. The Panel believes that the cost and time of data collection for a farmer is similar whether it must be reported or not.

The Panel also acknowledges that much data that could be useful is often either not easily attainable, or simply unknown. For example, applied water volumes to individual fields are not known in many cases with a high degree of accuracy. Many irrigation districts in California are currently struggling to meet a +/- 12% accuracy standard for measurement of annual volumes at district turnouts. Once district water is beyond the turnout, it is often split, applied to a large number of fields, mixed with groundwater in common pipe systems, and is generally not measured to individual fields.

Therefore, the Panel is proposing a data collection effort that is simple, yet effective.

4.5.1 Purpose of Data Collection

The Panel emphasizes that reporting by growers and any data collection requirements should be coordinated by third-party coalitions where feasible, rather than having farmers report directly to the Regional Water Boards. Coalitions should be allowed to define protocols for sampling of key quantities such as harvested nitrogen.

The Panel clearly recommends that the data collected be used for education and later development of management plans, not initially for enforcement. Grower understanding and improvements are critical in the effort to reduce nitrate losses to groundwater, and growers will be reluctant to participate in programs if they risk self-incrimination. In particular, current groundwater conditions in a region or below a farm should not be considered by Regional Boards to administer different levels of on-farm data collection and/or reporting requirements. Instead, current groundwater conditions can be useful for grower awareness by providing:

- Awareness of key components of on-farm nitrogen management about which he/she must be knowledgeable.
- Knowledge of whether his/her farm is in an area that has high nitrates in the groundwater.
- Knowledge of the level of nitrates in the groundwater that he/she is using as his/her irrigation water.

The basic data collection effort proposed by the Panel provides several compelling benefits to farmers, the ILRP, and groundwater quality in the long term. [Q9] It gets to the root of the nitrate issue in a simple, timely, and attainable fashion. This data collection effort serves two main purposes:

1. Development of baseline nitrogen application information, crop-specific, and integrated regionally. This provides the basis for comparison of regional nitrogen application differences and addresses the probability of nitrogen leaving the crop root zone via deep percolation. [Q10f]
2. Identification of multi-year trends as the data collection is continued.

4.5.2 Reporting

4.5.2.i What Data Should be Collected for Reporting

Any improvements in nitrogen management on the ground must require the development and implementation of simple and pragmatic nitrogen and water management plans by farmers. A key element of any field/farm nitrogen management program is a record of the nitrogen applied to fields. [Q7a]

The recommended data collection/reporting effort seeks basic information, aggregated over the course of one year (e.g., calendar year or crop year), on a reporting unit scale. This effort purposefully limits data collection to basic information that can be easily obtained and all farmers need and should be knowledgeable of as part of their nitrogen management. The data collected should be:

1. Location of the reporting unit.
2. Crop (e.g., lettuce, wheat, almond).
3. Nitrogen removed by harvest or sequestered in permanent wood.
4. Crop acreage (acres) – The crop acreage is the total acreage on which a specific crop is grown. If three different crops are grown in succession on the same field, this field's acreage is used to compute the nitrogen inputs for each of the three different crops. Nitrogen inputs to multiple plantings of the same crop are aggregated over the year.
5. Nitrogen applications for each crop (lbs./acre) including organic applications (e.g., manure, compost), synthetic fertilizer applications, and nitrogen in irrigation water [Q4b]. This requires separate estimation and documentation of these three nitrogen sources. The nitrogen application computation should include the total nitrogen applied as:
    - Organic applications (manure, etc.)
    - Synthetic fertilizer applications
    - Irrigation water

The Panel acknowledges that this method (reporting applied N) is imperfect. For example, a crop planted after alfalfa is removed will have a smaller nitrogen requirement than one that does not follow a legume. Nitrogen requirements will depend upon many factors. As stated earlier, multiple years and multiple fields will create an averaging effect.

The Nitrogen Tracking & Reporting System Task Force (NTRSTF) provided a Final Report in December 2013 that listed recommendations for reporting. [Q12] Their list and this Panel's list are short. The NTRSTF recommends a reporting of annual residual soil nitrogen credits. The Panel does not include residual nitrogen in its reporting recommendations because it is difficult to quantify and is subject to potentially large short-term fluctuations. The multi-year approach of this Panel in effect minimizes the value of residual nitrogen for reporting purposes.

4.5.2.ii Reporting Units

The Panel recommends that the "reporting unit" be defined in one of two ways: (i) on a crop basis, which could include multiple fields that have similar soils, irrigation methods, irrigation water nitrate levels (not defined by the Panel), and irrigation/nitrogen management styles; alternatively, (ii) a reporting unit could be defined as an individual field. The Panel's recommendation for grouping of multiple fields is more restrictive that the “nitrate loading risk unit” [Q2b] [Q13], or “management block” defined by Region 3.

The recommended reporting unit provides the flexibility to farmers to group fields in a customized manner so that it makes operational sense in part because multiple fields may receive nitrogen applications simultaneously but without the infrastructural means to separate their applications. It gives the flexibility to vary the field sizes between crops and seasons. It does not necessitate mapping or farm-scale spatial analysis.

4.5.2.iii Possible Grower Concerns

The Panel understands that details about the blends of fertilizer and the timing of fertilizer applications are considered to be the same as a trade secret by most farmers. Details of this type do not need to be shared for any reasonable nitrogen management reporting program.

It was discussed whether a program that requires reporting nitrogen concentration in groundwater might provide a disincentive for farmers to use high-nitrate water. The Panel members believe that there should be no disincentive to pump high-nitrate water, and coalitions and Regional Water Boards must be especially careful to finesse guidelines that emphasis this point.

4.5.3 Data Consolidation

The time period for a report should encompass a 12-month period, and should consolidate monthly or short-season values into single reported values. However, it is recommended that this annual data be evaluated on a multi-year basis. It is emphasized that the collected data should be used to examine regional, multiple-year conditions and trends of nitrogen applications. Analysis of these data on too-short time frames (e.g., year-to-year) will introduce random error and potentially misleading results because many confounding variables, such as residual soil nitrogen and nitrogen removal rates, vary by year and by crop rotation. These differences tend to even out over multiple years. It is also emphasized that the data should not be used for regulatory enforcement because the possibility of regulatory consequences will compromise the accuracy of the data.

The Panel strongly recommends not assigning a regulatory value to the A/R ratio on an annual basis. Such ratios have merit for categorizing fertilizer management using multi-year averages. The Panel also emphasizes that the A/R ratios are not known at this time, that farmers, extension agents, and crop advisors need time to learn about these ratios, and we do not yet know the ranges of these values by region or by crop. Therefore, it is strongly recommended that such ratios not be used for regulatory action at this time.

4.6 Monitoring

The points below define the conceptual framework for an effective program that includes regulation, verification, and positive results. [Q9]

4.6.1 Farmer/Coalition Components

Farmers must be required to develop and implement good irrigation and nitrogen management plans (described previously). [Q7d] This recommendation comes with the caveat that certain groups (such as the rice growers on clay soils) may be considered for exemption because of very unique chemical situations, and that the groundwater quality of some areas may be de-designated from beneficial uses related to drinking water. This Panel asserts that a good irrigation plan, which requires measurement of volumes of water and the development of reasonable irrigation schedules, belongs in the program. The only way nitrates can move below the root zone is via deep percolated water.

The Panel recommends that reporting by farmers to the coalitions should be required, and be simple yet effective. The basic elements of reporting are reporting unit location, total nitrogen applied, estimate of nitrogen removed from the field by the identified crop, and acreage. Because of nitrogen transformations, and stored water and nitrogen (in the root zone), reporting should contain annual (or crop cycle) values rather than more frequent data. Multiple years of data (minimum of 3 years) are likely needed to ascertain trends and patterns. [Q9]

Irrigation water and rainfall volumes are not required for reporting, because the impact of good water management is evidenced by the nitrogen applied versus removal ratio. Those volumes are essential elements of an irrigation and nitrogen management plan, however. Individual fields can be grouped into units for reporting purposes, in which all fields have the same crop (or very similar crops as designated by coalitions; this is primarily targeted toward produce crops), same irrigation and nitrogen management plan, same irrigation water quality, same irrigation method, similar soils and same general geographic area.

4.6.2 Regional Groundwater Trend Monitoring

The monitoring of first-encountered groundwater is problematic, expensive, inconclusive, and in general would require a diversion of resources from important source control efforts. [Q10a] There are also serious limitations to drawing conclusions from single-year monitoring values. Such trends will not be useful for correlating the impacts of specific field practices on individual fields to underlying aquifer water quality.

Long-term monitoring of groundwater nitrate concentrations at strategically selected points throughout regional aquifer systems is important in the assessment of the long-term effectiveness of the regulatory efforts. Much thought should be given to the exact extent of such monitoring efforts. Existing and new data collection efforts should be coordinated to ensure an effective overall program without unnecessary duplication of efforts. The long-term monitoring effort should be objective-oriented and the ultimate scope of the effort (e.g., number and geographical distribution of wells, rationale for selection of individual wells, sampling protocol, data quality objectives, sampling frequency, list of constituents, and degree of integration of data collected by other entities) should be evaluated as to its ability to achieve these objectives. Multi-year values are necessary to smooth out the random fluctuations that occur on an annual basis. They also allow for the use of simplifying assumptions regarding changes in nitrogen pools within the root zone. [Q9]

4.7 Targeted Research

Pragmatic research is needed to identify attainable ratios for a range of crops and situations. Some of this research will be done by coalitions as they examine the reported data. Other research will be more traditional and will be related to topics such as rates and timing of nitrogen uptake and crop removal. The Panel also believes that research must be conducted to define sampling intervals, sampling density, and other factors. [Q10d]

4.8 Verification

The Panel recognizes that the State and Regional Water Boards must have some way of measuring progress over time on a regional basis. However, deep groundwater nitrate levels, examined over periods of less than 10-20 years, cannot be expected to demonstrate such an impact. A different metric must be used. [Q9]

Many factors, such as residual nitrogen and nitrogen removal rates, vary by year and by crop rotation. These differences tend to even out over multiple years. In collecting initial data, the Regional Water Boards will be able to report to the State Water Board a specific multi-year baseline for future comparison. This baseline can be used to indicate progress in the long term. Similarly, when viewed on a regional basis, areas with a relatively high nitrogen use can be easily identified based on this data. [Q9]

The Panel agrees that the trend monitoring of groundwater nitrate concentrations (not first-encountered groundwater) should occur, in order to track general aquifer conditions over multiple years. [Q10a] This can be done with water samples from existing wells. [Q9] *Section 4.6.2: Regional Groundwater Trend Monitoring* discusses how the data collection for trend monitoring should be defined. The Panel did not attempt to define all of the details of a monitoring program.

The metric recommended by the Panel is the long-term trend of the relationship (A/R) between nitrogen applied and nitrogen removed from the field, using information reported by farmers to the coalitions. Verification will consist of knowing if the A/R is reduced. [Q9]

4.9 Surface Water Discharges

Monitoring the water quality of surface discharges from individual fields/farms, as a general policy, has the following problems: [Q3] [Q4] [Q10e] [Q11]

1. Water quality tests are quite expensive, even with individual samples.
2. Periodic sampling of water runoff as opposed to extensive sampling has serious challenges with being able to identify events that might cause pollution of streams, because: [Q10d][Q10d]
    a. The timing of individual sample collection might not coincide with pesticide applications, or with events of high sediment runoff.
    b. It is difficult to identify, in advance, exactly when (time of day and day) there might be surface runoff. This is because irrigation schedules constantly change as field crews shift operations.

   c. Typical labor schedules for samplers require that samples be collected during daylight hours, from M-F. Other times/days may be more important.
   d. The schedule of lab operations, and constraints of sample hold times, may not coincide with irregular timing of surface discharges.
3. Continuous water sampling equipment (to collect samples, and in some cases to also analyze samples) is available for some constituents, but it is very expensive, complicated, and subject to vandalism.

With surface water discharge monitoring, there is a special appeal for some type of coalition effort because it meets the recommendation of the Panel on how to address monitoring. If individuals do not belong to a coalition, there does not seem to be any alternative to expensive sampling of every discharge point.

For surface water issues, the Panel recommends water quality monitoring of receiving water and a clear understanding of the watershed hydrology. Sufficient samples should be taken in the watershed streams to detect if problems do indeed exist. The sampling should be of sufficient density (spatially and temporally) to identify general locations of possible pollution. This is recommended rather than sampling at each discharge point. For example, a single measurement point at the downstream discharge of a very large watershed would be insufficient. When/if problems are identified, sampling should move upstream to locate the source of the problem.

Individual point discharge measurements/monitoring would be used only if individual points are identified as being serious contributors to water quality problems, based on samples taken upstream in the watershed.

Recommendations of the exact density and timing of sampling are not provided by the Panel, because the details will depend upon the size and complexity of the watershed, and upon the results of data that are collected. If, for example, an initial and sparse network of sampling points at watershed bifurcation points indicates that there are no problems, it would be unreasonable to require a more intensive sampling point network.

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APPENDIX A
Agricultural Expert Panel Members

Appendix A
Agricultural Expert Panel Members

Dr. Charles Burt (Panel Chairman) – *Irrigation Specialist/Ag Engineer*
Dr. Burt is a Professor Emeritus of Irrigation, and Chairman and Founder of the Irrigation Training & Research Center (ITRC) at California Polytechnic State University, San Luis Obispo, California. Experiences include professional work in 25 countries, three tours in Vietnam as a combat demolition specialist, work as a farm laborer in the San Joaquin Valley as a youth, designer/sales/installation in a major irrigation dealership in Fresno, partner in a consulting agricultural engineering firm, and 36 years at Cal Poly where he previously taught core irrigation classes while also leading the ITRC. Dr. Burt now focuses on applied technical assistance (with some research) through ITRC. He has written and has extensive field experience regarding on-farm irrigation system design, fertigation, water balances, irrigation efficiency, the energy-water nexus, canal automation, and irrigation project modernization.

Dr. Robert Hutmacher – *Soil Scientist*
Area of Expertise: Plant water status responses, nutrient uptake, growth responses to irrigation and nutrient management. Further expertise in cotton research and variety evaluations, interactions between production practices and pest management, alternative cropping systems including evaluations of double row planting and reduced tillage management, crop responses to and potential nitrogen losses under a range of nitrogen management practices in cotton.
Qualifications: 30+ years in the areas of agricultural research. Extensive research background on plant physiology, production practices, and nutrient uptake. UCCE State Cotton Specialist and Director of the West Side Research and Extension Center in Five Points, CA

Till Angermann – *Hydrogeologist*
Mr. Angermann is a Principal Hydrogeologist at Luhdorff & Scalmanini Consulting Engineers. His fifteen years of professional experience and expertise include (i) research methodology and conceptualization of hydrogeologic systems, (ii) groundwater hydraulic, hydrologic, hydrogeologic, hydrochemical, and statistical analysis and computations, (iii) assessment of surface water/groundwater interactions, infiltration and runoff processes, (iv) data quality objectives, sampling and testing protocols, (v) nitrogen cycling, irrigated agriculture and subsurface loading. Mr. Angermann served as lead technical expert to Western United Dairymen for the testing and implementation of a measurement-supported water balance method to determine seepage rates of working liquid dairy manure storage lagoons with quantified uncertainty, including preparation of a technical guidance manual. He was a key contributor to the conceptualization and implementation of the Representative Groundwater Monitoring Program (RMP) in response to the Dairy General Order and Technical Program Manager (TPM) to the Central Valley Dairy Representative Monitoring Program (CVDRMP) since its inception in 2010. As TPM, Mr. Angermann is responsible for all aspects of monitoring well design and design of a network of over 430 monitoring wells, data collection efforts and data management, analyses and interpretation, special studies, coordinating and leading the external Multidisciplinary and Groundwater Technical

Advisory Committees, interaction and coordination with dairy producers, services providers, and subcontractors, presentations/outreach to stakeholders, and adherence to budgets and schedules. He is the author of refereed journal articles and has reviewed manuscripts for the American Geophysical Union's Water Resources Research and the American Society of Civil Engineers' Journal of Hydrologic Engineering.

Bill Brush – *Certified Crop Advisor*

Mr. Brush has been a certified crop advisor since 1996, a pest control advisor since 1990, serves on the Almond Board of California, and the East San Joaquin Water Quality Coalition Board. Mr. Brush is an expert in soil fertility and water management, and has presented on soil fertility issues all over the world, including in the United States, South Africa, Australia, and in the Philippines. Mr. Brush currently consults on more than 100 different crops around the world, and, in California, provides consulting services on tree crops, field crops, vegetables, berries, and alfalfa. Mr. Brush also has experience with conventional as well as organic farming systems.

Daniel Munk – *UC Cooperative Extension*

Mr. Munk, M.S. has been a UC Cooperative Extension Farm Advisor for the past 23 years working in the area of irrigation, soils and cotton production. He spent his early career evaluating soil and management factors influencing water infiltration rates in San Joaquin Valley soils. He began investigating cropping systems research in the late 1990's and is currently involved in several conservation tillage projects focusing on short and long term water management elements in annual cropping systems. Mr. Munk has lead numerous deficit irrigation studies working to understand the impacts that reduced water supplies have on crop yield, crop quality and soil quality. More recently, his research and education program has been directed towards crop water use projects in almonds, processing tomatoes, and Pima cotton. He was appointed in 2012 to the Peer Review Committee for the USBR San Joaquin River Restoration Project Technical Feedback Group and serves on the steering committee for the UC/CDFA Nitrate Curriculum Development Program.

James duBois – *Grower, Central Coast Region*

Mr. duBois studied Environmental Resource Science at the University of California, Davis. He spent three years farming and supervising production research and development in the water scarce areas of Baja California. During this time, he facilitated technology exchange between growers in Spain and the US/Mexico to develop knowledge within Reiter Affiliated Companies (RAC) on Reverse Osmosis water treatment and soilless media production systems. In 2007, James relocated to Ventura County to work on various water projects throughout RAC's global enterprise. His work included collaboration with growers to increase irrigation efficiency, research on salinity management, development of recycled water sources, and co-development of soil moisture monitoring technology with external companies. His work has greatly influenced the amount of water usage and discharge in RAC's operations in coastal California (which span several thousand acres from Oxnard to Watsonville) and their global operations. Mr. duBois spearheaded a recent water technology and resource management exchange and visit to Israel involving US and Mexico growers, Panoche Water District Management, and the Israeli government.

Recently, James has collaborated with regional water districts and the ag community in the development of drought water management policy and recycled source development

Mark McKean – *Grower, Central Valley Region*

Mark McKean is a third-generation farmer from Riverdale, CA. Mark owns and operates a diversified production agricultural operation. Mark graduated from Cal Poly in 1979 with a B.S. degree and later completed a master's degree at Colorado State University, Fort Collins. McKean is the president of the Reed Ditch Company, president of the Crescent Canal Company, a director of the Murphy Slough Association, the chairman for Kings River Conservation District (KRCD) Board of Directors, a graduate of the California Ag Leadership Class XX and the president of the West Hills Community College Board. McKean has taken a leadership role as the Chairman of the Kings Basin Water Quality Coalition, which is implementing the Irrigated Lands Regulatory Program. These leadership roles have included on farm presentations to State and Regional Water Resources Control Board members.

Dr. Lowell Zelinski – *Agronomist*

Lowell Zelinski, Ph.D. is a well-respected agricultural leader who has worked in the ag industry for over 30 years. He earned his doctorate degree in Soil Science and his bachelor's degree in Soil and Water Science from UC Davis. He also holds a master's degree in Agricultural Science from Cal Poly, San Luis Obispo. Dr. Zelinski began his career as a farm advisor for the University of California Cooperative Extension in Fresno County specializing in soil and water management and cotton production. Dr. Zelinski has now been a private agricultural consultant for over 20 years and currently owns his own business, Precision Ag Consulting, which focuses on soils, irrigation, water quality compliance issues on the Central Coast and vineyard management. He has taught at four California State University campuses: San Luis Obispo, Pomona, Fresno and Bakersfield, and is well-known for his teaching and speaking abilities. He is currently teaching Grapevine Physiology at Cal Poly SLO. He is the creator of the Central Coast VINE Symposium, which has turned into the renowned WiVi Central Coast.

APPENDIX B
Information Given to Expert Panel

Appendix B
Information Given to Expert Panel

In April of 2014, the Expert Panel was provided with a lengthy clarification of what the Expert Panel was expected to address, and what it was not expected to address. Key points include:

- The focus was on nitrates, rather than sediment, pesticides, etc.
- Groundwater was the main issue, although several questions for the Expert Panel were related to surface water monitoring.
- The Expert Panel was expected to address questions related to:
  - Proper establishment of "risk" or "vulnerability" categories for large geographic areas, fields, crop types, or farms.
  - The type of above-groundwater data collection and computations that are needed for compliance, or to estimate impacts of practices.
  - Effectiveness of management practices that have been recommended for agricultural irrigators, which might affect nitrate leaching into the groundwater.

Waste Discharge Requirements (WDRs) and Conditional Waivers to WDRs

Under the California Water Code (CWC), anyone who discharges waste (other than community water systems) that affects waters of the state must file a Report of Water Discharge (ROWD) with their Regional Water Quality Control Board (Regional Water Board). The CWC requires that the Regional Water Board prescribe the Waste Discharge Requirements (WDRs) or waive the WDRs (called a "Conditional Waiver") to anyone who is determined to be a "discharger" of waste.

Definitions:

WDR (Waste Discharge Requirement) – For the Irrigated Lands Regulatory Program (ILRP) this is a permit issued by the Regional Water Boards to geographic areas or to groups of growers of identical crops. It requires certain water quality monitoring and reporting.

Conditional Waiver – A permit issued by the Regional Water Boards. It was originally intended to serve as a precursor to the issuing of a WDR. In some regions, the "Conditional Waiver" has the same status as a WDR.

Ag Waiver/Agricultural Order – Synonyms for Conditional Waivers and WDRs that have been adopted specifically to address agricultural discharges from irrigated lands.

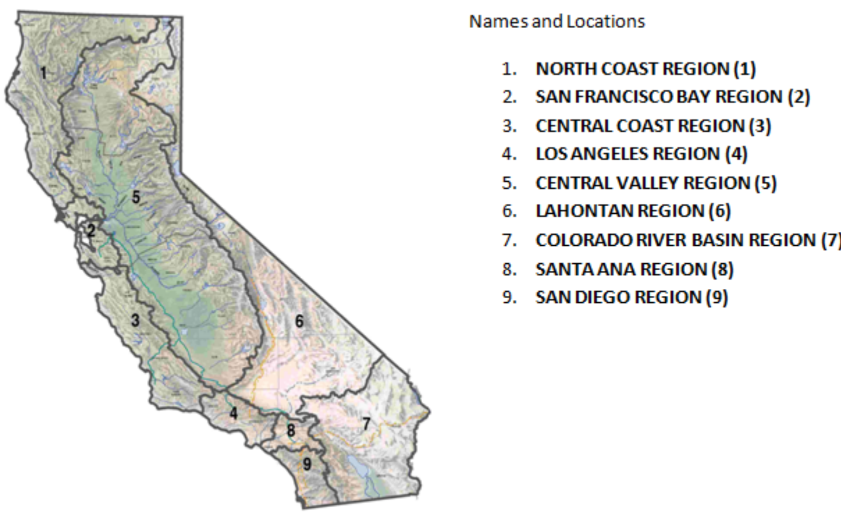

Figure B-1. California regional water board locations

Conditional Waivers and WDRs are documents that serve as a type of permit that formalize regulatory actions taken by the Regional Water Boards. Typically, a Conditional Waiver or WDR includes a list of findings establishing the need for action, followed by a list of required actions. For the ILRP, the Conditional Waivers or WDRs allow for the formation of third-party representatives, commonly referred to as “coalitions”, to represent farmers as a group to meet compliance requirements.

Through a series of events related to the passage of Senate Bill 390 (Alpert), the ILRP originated in 2003. Initially, the ILRP was developed for the Central Valley Regional Water Quality Control Board. As the Central Valley Water Board ILRP progressed, a groundwater quality element was added to the filing requirement for agricultural lands that had previously only been subjected to surface water discharge concerns. As of April 2014, all nine Regional Water Boards in the state were in different stages of the Irrigated Lands Regulatory Program as described briefly below:

- The North Coast and San Francisco Regional Water Quality Control Boards (Regions 1 and 2 respectively) were in the process of developing agricultural discharge permits (i.e., either WDRs or Conditional Waivers of WDRs).
- The Lahontan Regional Water Quality Control Board (Region 6) had not begun developing an ILRP, but will do so as agricultural-related TMDLs are implemented.
- The Santa Ana Regional Water Quality Control Board (Region 8) was working on a proposed Conditional Waiver of Waste Discharge Requirements for the Agricultural Discharges Program for Growers in the San Jacinto River Watershed.
- The Los Angeles and San Diego Regional Water Quality Control Boards (Regions 4 and 9 respectively) operated under Conditional Waivers, but these Regional Water Boards were not addressing groundwater quality, and their respective Conditional Waivers ***did not*** include groundwater-specific requirements or actions.
- The Colorado River Regional Water Quality Control Board (Region 7) had a variety of situations. Most of the region was not covered by Conditional Waivers.
    a. In 2012, Region 7 adopted a Conditional Waiver for the Palo Verde portion of the region that includes both groundwater and surface water requirements. Palo Verde

Irrigation District serves as the third-party (coalition) for the Palo Verde Conditional Waiver.

b. In 2013, Region 7 adopted a Conditional Waiver for a separate part of the region for the Bard Unit of Reservation Division in Imperial County.

- The Central Coast Regional Water Quality Control Board (Region 3) issued a new conditional waiver in 2012 for the entire region that ***did*** include groundwater. The Region 3 conditional waiver allowed the use of a monitoring group to conduct monitoring and manage fees. The 2012 conditional waiver included a provision for the use of approved third-party certification groups. There were no other coalitions for this region.
- In the Central Valley (Region 5), seven out of eight planned Waste Discharge Requirements (geographically-based) had been adopted by the Central Valley Regional Water Board as of March 20, 2014, all of which consider groundwater. Sometimes multiple coalitions were covered by the same WDR.
    a. Only one of the Region 5 coalitions (East San Joaquin Water Quality Coalition) had a Groundwater Quality Assessment Report (GAR) that had been adopted (approved) by the Regional Board. The GAR was the first work product related to groundwater that was required in the WDRs.
    b. The California Rice Commission developed a GAR at the same time it was working with the Regional Board to develop its WDR. It is unclear when the GAR will be approved.

For reference, the process used in Region 5 is outlined in **Figure B-2** on the next page. The groundwater compliance requirements for Region 5 that will be addressed by the Expert Panel are highlighted in yellow.

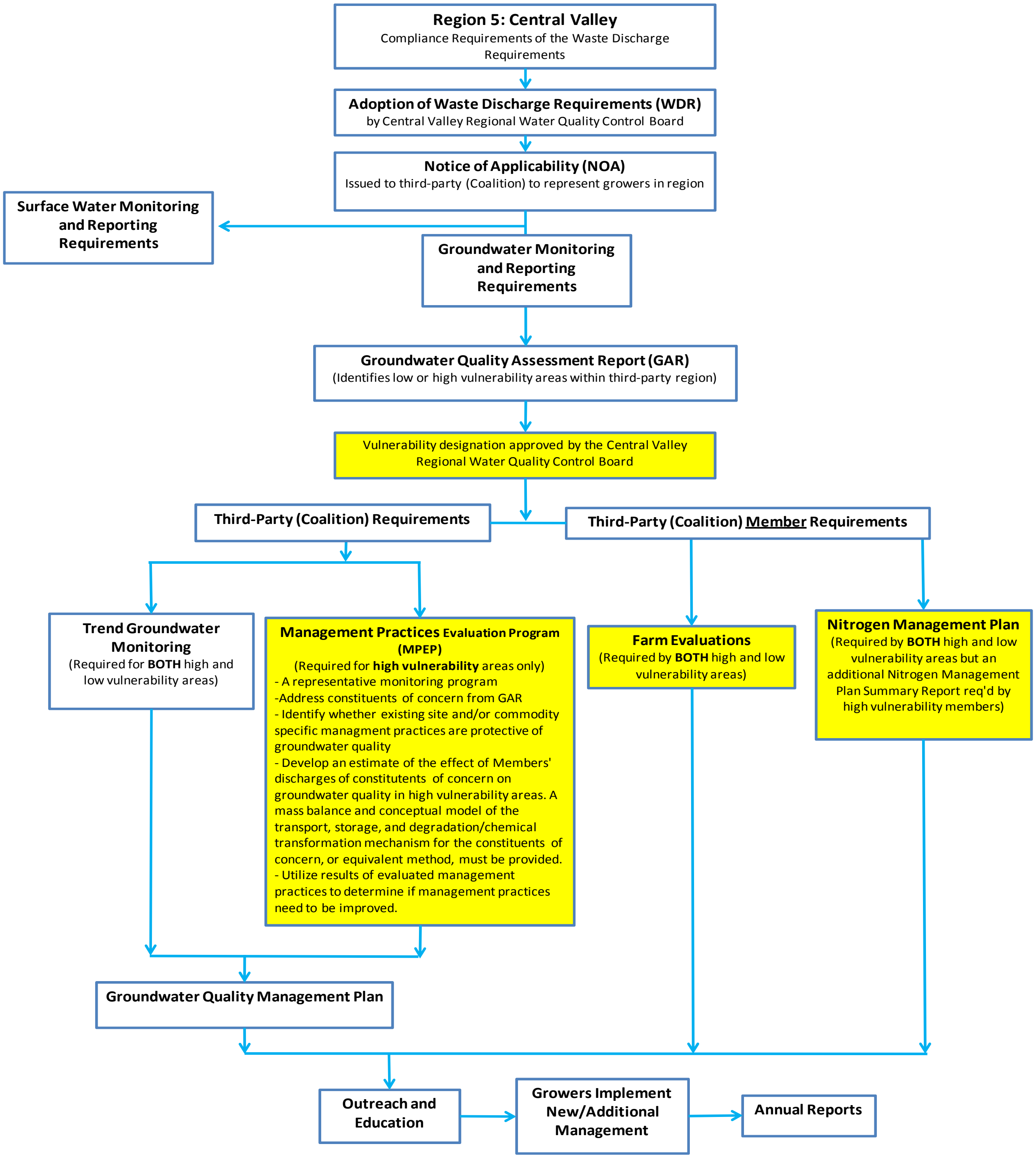

Figure B-2. Outline of groundwater portion of the WDR process for Region 5. Region 5 stresses a coalition-based approach. Only two coalitions have completed the GAR step, in which they provide a "groundwater vulnerability designation" of "high" or "low" to areas within their coalition. The highlighted boxes indicate the areas for which questions will be asked of the Expert Panel.

Major Differences between Region 3 and 5 Approaches

Most of the actions (and controversy) with groundwater requirements have taken place in Region 5 (Central Valley) and Region 3 (Central Coast). The two Regional Water Boards have taken very different approaches toward compliance requirements.

APPENDIX C
Definitions and Clarifications for Panel

Appendix C
Definitions and Clarifications for Panel

General Intent

All of the adopted Waste Discharge Requirements for the Central Valley Region (Region 5) contain the following excerpt that addresses the purpose of the Panel:

> *"The Panel will evaluate ongoing agricultural control measures that address nitrate in groundwater, and will propose new measures, if necessary. In its assessment of existing agricultural nitrate control programs and development of recommendations for possible improvements in the regulatory approaches being used, the Panel will consider groundwater monitoring, mandatory adoption of best management practices, tracking and reporting of nitrogen fertilizer application, estimates of nitrogen use efficiency or a similar metric, and farm-specific nutrient management plans as source control measures and regulatory tools." (Central Valley Regional Water Board, 2012).*

Specifically, the Panel was asked to answer a number of questions provided by the State Water Board. It was the intent of the State Water Board that the Panel's responses to these questions provide guidance to the Regional Water Boards as they continue to develop the requirements in their ILRPs.

It was understood that high nitrate levels in the groundwater cannot be lowered immediately, and that the proper management practices and evaluation techniques have uncertainties and costs. The Panel was, however, expected to provide answers that would help regulators improve the likelihood that:

1. Nitrate contamination occurs less frequently than it would have without any changes to management practices of today.
2. The nitrate contamination that does occur is less than, and occurs more slowly than, it would have been without any changes to management practices of today.

The Expert Panel focused on what can (and cannot) be done today "on the surface" to reduce nitrate discharges to both surface water and groundwater.

It was not within the scope of the Panel's assignment to:

1. Develop criteria that will result in clean drinking water in some specified number of years.
2. Address questions regarding methods for treating nitrates in surface water or groundwater to bring it to drinking water quality.
3. Address the question of whether it is possible to bring the groundwater quality to drinking water quality.

Furthermore, the Panel was expected to provide answers and recommendations that are pragmatic and essential. Specifically, the Panel was asked to weigh all recommendations in light of the fact that the requirements within the WDRs are not meant to:

1. Answer scientific questions or uncertainties, such as the details of the nitrogen cycle with dairy effluent disposal.
2. Collect data that is only useful for creating statistics.
3. Serve as research projects.

The following sections explain some terms, and provide background for specific questions.

Vulnerability and Risk

The exact definitions of "vulnerability" and "risk" are somewhat fuzzy when one compares Region 5 and Region 3 in light of requirements as of April 2014.

In regards to the term "**vulnerability**":

1. The term is generally intended to distinguish large areas that already have "high" or "low" nitrate levels in the groundwater.
2. In Region 5, areas that have a "high" vulnerability to groundwater nitrates have special requirements for the coalitions (identified as "Management Practices Evaluation Program, MPEP" in Figure 2).
3. In Region 3, there are no special requirements for coalitions because:
   a. There are no coalitions that administer programs (there are two coalitions of a different type, which are organized only to sample and analyze data).
   b. The entire region was classified as "high" vulnerability.

The two regional approaches used to designate the "vulnerability" of groundwater bodies in regards to nitrates have been:

- Region 5 allows the individual coalitions to define the "low" and "high" vulnerable areas in their areas. The Region 5 Regional Water Board works with the coalitions to determine the criteria that will be used locally. As an example, the Rice Growers Association, in its proposed GAR, submits the argument that because rice fields are flooded and nitrogen fertilizer is exclusively ammonia-based, there will be no conversion to nitrate and therefore all the groundwater under rice fields is a "low" vulnerability classification.
- Region 3's Regional Water Board staff determined that the complete Region 3 is "highly" vulnerable. There was no joint effort with formal coalitions; it was a unilateral decision by the Regional Water Board staff that did include input at public meetings.

In regards to the term "**risk**":

1. The term is used to describe the relative likelihood of serious nitrate loading into the groundwater by a field or farm.
2. *Risk assessment categorization is the basis for the prescription of best management practices for individual fields or farms*.
3. Region 3 has four established procedures for assessing "risk" (only one of which is selected by an individual farmer).
4. The level of "risk" in Region 3 is assigned using a tiering system where individual fields are categorized into one of three "tiers". Each tier requires a different level of monitoring, reporting, and best management practices.

It was not the mandate of the Expert Panel to determine, designate, or map vulnerability areas. However, the Expert Panel was asked questions regarding how risk can best be determined.

Management Practices (MPs) and Data Collection

Currently Regional Water Quality Control Boards and/or coalitions (various regions) prescribe agricultural actions to farmers in their regions that have been deemed "management practices" (MPs). In general, the MPs that are prescribed to farmers were developed by the UC Cooperative Extension.

The MPs of interest to the Panel are only those that pertain to nitrate application and control. The Panel will assess existing MPs and may recommend others if desired.

As an example, a requirement of the WDRs adopted in the Central Valley is the Management Practices Evaluation Program (MPEP). The MPEP will include evaluation studies of management practices to determine whether those practices are protective of groundwater quality for identified constituents of concern under a variety of site conditions.

The Expert Panel was asked to recommend a "suite" of management practices that should be tried to complete the requirements of the MPEP. MPs might be related to flow measurement, irrigation system Distribution Uniformity, ET-based irrigation scheduling, fertigation, or other topics. However, the Expert Panel may decide that if it can be demonstrated that only a small amount (e.g., 10%) of nitrogen is applied, above what is removed from a field during harvest, there is no need to go into the details of irrigation and other practices.

Reporting

Definitions:

- **Reporting –** This term is used by regulatory agencies to designate information that must be officially reported to the agency.
- **Data Collection and Analysis –** Sometimes regulatory agencies require that data be collected and analyzed, but not officially reported. The result to farmers is still often the same: there is an expense to set up a monitoring system, collect data, and possibly analyze the importance of the data.

Per the mandate of the State Water Board, the California Department of Food and Agriculture (CDFA) convened the Nitrogen Tracking and Reporting Task Force to address the outcomes and benefits of a nitrogen mass balance tracking system. A report (referred to in this memo as the "CDFA Report") was completed in the summer of 2013 (CDFA, 2013).

While the Panel was not intended to focus on the "reporting" that is addressed in the CDFA Report, there is a definite linkage. For example, the Panel may decide that certain types of data are interesting for statistics and reports, but they may not be economically (or practically) beneficial to significantly helping achieve the ultimate goal of reducing nitrate loading.

As an example, a variety of nitrogen computations have been proposed to be included in monitoring, identifying risk, and as BMPs. The Panel assessed the relative importance of using field-level nitrogen computations such as those described below.

1. <u>Nitrogen mass balance</u> – The general idea is to have a spreadsheet or model which incorporates all nitrogen inputs to a field, along with extractions. In general, the deep percolation of nitrates is a mathematical "remainder". Differences between various "mass balance" computations enter when one integrates factors such as:
    a. Nitrogen transformation rates
    b. Volatilization

   c. Crop removal – measured or estimated?
   d. Carry-over between crops
   e. Details of leaching factors, such as frequency and intensity of rainfall.
2. <u>Ratio of [(Nitrogen In)/(Nitrogen Removed by the Crop)]</u> – Again, there can be differences between the technique used to determine the "nitrogen removed". There are also questions regarding what ratio might be acceptable. The applicability of this type of ratio may depend upon factors such as:
   a. The type of crop. For example, trees versus vines versus leafy greens.
   b. The amount of rainfall.

<u>Groundwater Monitoring</u>

Definitions:

- **Trend monitoring** – Designates some type of groundwater monitoring on a regional scale.

The Expert Panel did not address <u>trend</u> monitoring.

- **Representative monitoring** – The "sampling" of techniques. Monitoring may be done on a "representative field", but not on all fields, if the results from that "representative field" can provide conclusions for many similar fields.
- **Individual monitoring** – Generally indicates that discharges from every field or farm must be measured.

While all three types of monitoring are common with surface water, there are questions regarding the value of using any or all of these monitoring techniques to assess groundwater nitrate loading.

The Expert Panel assessed whether or not it is reasonable to expect that groundwater monitoring will accurately assess agricultural management practice performances on individual fields.

<u>Surface Water Monitoring</u>

Definitions:

- **Discharge water monitoring** – Monitoring of the water quality and/or quantity at individual discharge points from fields, farms, etc. to creeks and other surface water bodies.
- **Receiving water monitoring** – Monitoring of the water quality and/or quantity in the creeks or other surface water bodies that receive water from farms or fields.

Two approaches have been taken to monitoring surface water. Region 3 has taken the approach of discharge water monitoring to surface water while Region 5 has taken the approach of receiving water monitoring.

The Expert Panel was asked to address a question regarding the value of both receiving water and discharge water monitoring regarding surface water monitoring (both receiving water and individual discharge).

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Additional Details on Agricultural Expert Panel Questions 3, 4 and 11

The Agricultural Expert Panel (Panel) has requested further clarification on questions 3, 4, and 11 pertaining to surface water. The following brief is in an effort to provide that requested information.

Questions 3 and 4 were presented to the panel as follows:

> *Vulnerability and Risk Assessment*
>
> *Regulatory programs are most effective when they are able to focus attention and requirements on those discharges or dischargers (i.e. growers) that pose the highest risk or threat because of the characteristics of their discharge or the environment into which the discharge occurs. The various Irrigated Lands Regulatory Program (ILRP) orders issued throughout the state by the Regional Water Boards have taken different approaches in their prioritization schemas, some using specific criteria or methodologies, others utilizing measurements of previous known impacts.*
>
> …
>
> 3. *How can risk to or vulnerability of surface water best be determined in the context of a regulatory program such as the ILRP?*
> 4. *Evaluate and develop recommendations for the current approaches taken to assessing risk to or vulnerability of surface water:*
>   a. *Proximity to impaired water bodies.*
>   b. *Usage of particular fertilizer or pesticide materials.*
>   c. *Size of farming operation.*
>   d. *High Vulnerability Areas Methodology (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP)*

Additional Details on Agricultural Expert Panel Question Numbers 3, 4 and 11

Upon researching this brief it was determined that one suggested revision to part d of question 4 was inadvertently omitted and it should have been presented as follows:

> *4. d. High Vulnerability Areas Methodology (for sediment/erosion risk)/Surface Water Quality Management Plan requirements (as developed by the Central Valley Regional Water Board in a series of Waste Discharge Requirements issued to agricultural coalitions in the ILRP)*

Questions presented to the Panel are derived from two sources: (1) The State Water Board's *Recommendations Addressing Nitrates in Groundwater*, State Water Board's Report to the Legislature, February 20, 2013, and (2) State Water Board Order WQ 2013-0101. While the former was focused on nitrates in groundwater, the later also included some questions for the Panel regarding surface water.

Below is the quoted section from Order WQ-2013-0101(pages 17-20) pertaining to vulnerability and risk in the context of establishing Tiering Criteria.

> ***C. Reasonableness of Tiering Criteria, Provisions 13-21***
> *The Agricultural Order assigns each discharger to one of three "tiers," which determine the requirements applicable to the discharger. The tier designations are based on a number of criteria intended to capture the risk posed by the operation to water quality, including whether the discharger uses the pesticides chlorpyrifos or diazinon, proximity of discharger's farm to a surface waterbody listed as impaired for toxicity, pesticides, nutrients, turbidity or sediment,[44] and whether the discharger grows crop types with high potential to discharge nitrogen to groundwater.[45]*
>
> *Specifically, a discharger is classified as a Tier 3 discharger – the tier expected to pose the highest threat to water quality – if (a) the discharger grows crop types with high potential to discharge nitrogen to groundwater and the farm total irrigated acreage is 500 acres or more, or (b) the discharger applies chlorpyrifos or diazinon at the farm, and the farm discharges irrigation or storm water runoff to a waterbody listed as impaired for toxicity or pesticides.*
>
> *On the other hand, a discharger is classified as a Tier 1 discharger – the lowest threat tier – if (a) if the discharger does not use chlorpyrifos or diazinon at the farm; and (b) the discharger's farm is located more than 1,000 feet from a surface waterbody listed as impaired for toxicity, pesticides, nutrients, turbidity, or sediment; and (c) the discharger either does not grow crop types with high potential to discharge nitrogen to groundwater or, if the discharger does grow such crops, the farm has less than 50 acres of total irrigated area and is not within 1,000 feet of a well that is part of a public water system that exceeds the maximum contaminant level (MCL) for nitrogen-related pollutants. Additionally, a*

discharger is classified as Tier 1 if the farm is certified by Sustainability in Practice (SIP), a sustainable agriculture program certified by a group of Central Coast vineyards, or a similar certified sustainable agriculture program approved by the Executive Officer of the Central CoastWater Board.

Dischargers that do not meet the criteria for Tier 1 or Tier 3 are classified as Tier 2 dischargers.[46]

Consistent with the expectation of threat to water quality, Tier 3 dischargers must comply with more stringent requirements than Tier 2 dischargers. Tier 2 dischargers, in turn, must meet more stringent requirements than Tier 1 dischargers. For example, while dischargers in all three tiers must prepare Farm Plans, only Tier 2 and Tier 3 dischargers are subject to annual reporting on their practices. And only Tier 3 dischargers are required to conduct and report individual surface water discharge monitoring.

The Agricultural Petitioners argue that the tiering criteria used by the Central CoastWater Board do not necessarily correlate to risk to water quality and are therefore arbitrary. They argue, for example, that there may be farms smaller than 50 acres that pose a greater risk to water quality than larger farms.[47] *They posit that some farms using diazinon and chlorpyrifos may have no discharges to surface water.*[48] *They point out that the tiers do not capture the geology of a farm's soil or the depth to groundwater, both of which affect impacts to groundwater.*[49] *They argue that the management and cultural practices of certain commodities may be a better indicator of threat to water quality than the physical characteristics of the farms.*[50] *But the Agricultural Petitioners do not appear to be advancing a proposed, well- defined, alternative, and they are not advocating for uniform requirements for all dischargers.*

The Central CoastWater Board chose to use a general order in the form of a conditional waiver, rather than farm-specific orders, to regulate agricultural discharges. The StateWater Board supports the use of a general order given the general similarity of operations and discharges for the agricultural community in the Central Coast and in particular the considerations of efficiency in regulating a large number of dischargers. A general order necessitates either a one-size-fits-all approach or a scheme for grouping the dischargers into different categories to enable assigning different requirements. With as many farms as are covered by the Agricultural Order, it is no surprise that the categories chosen by the Central CoastWater Board may not fit each circumstance perfectly. The question for the StateWater Board is not whether the Central CoastWater Board's criteria capture the risk level posed by each farm with perfect accuracy, but, rather, whether the Board chose rational distinctions between the farms to create those different categories.

We recognize that the tiering approach used by the Central CoastWater Board was not the only reasonable option available to it. There are numerous factors that determine the threat a given farm will pose to water quality and multiple variations on how those factors may be organized to provide a reasonable framework for assigning the farm to a risk category. Moreover, while the Central Coast Water Board utilized an approach based on individual farm characteristics, the Board could instead have chosen an approach based on regional characteristics, where dischargers are placed in a higher risk category commensurate with the vulnerability of the groundwater in the larger geographic area rather than individual farm characteristics.[51]

Yet, while the approach that was ultimately chosen by the Central CoastWater Board may not be perfect, it is a reasonable approach based on the evidence in the record[52] and based on a rationale articulated in the staff reports and responses to comments supporting the Agricultural Order.[53] For example, the criteria make distinctions in risk to water quality based on use of pesticides that are currently documented as a primary cause of toxicity in the Central Coast region.[54] As another example, with regard to farms growing crops with high potential to discharge nitrogen, the Central Coast Water Board analyzed the impact of size of the farm on such potential and explained that the numbers less than 50 acres and more than 500 acres were chosen as the thresholds for placing a discharger in Tiers 1 or 3 respectively because 50-500 acres represented an average loading appropriate for Tier 2 categorization.[55] The Board further articulated that, regardless of size, proximity of a farm to a public water system polluted by nitrate should trigger Tier 2 requirements consistent with proximal distances recommended by the Department of Public Health for source water assessment and protection.[56] The Central Coast Water Board also pointed out that the particular tiering criteria were selected in part because they reflect already available information and do not require additional data collection or complicated or expensive site evaluations.[57] Finally, the Central CoastWater Board included provisions that allow the Executive Officer to adjust the tier for any given farm, which helps ameliorate any potentially unreasonable result of the tiering scheme.

We are reluctant to substitute another reasonable, but imperfect, set of criteria for those selected by the Central CoastWater Board. Further, we will ask the Expert Panel to evaluate the selection of appropriate indicators of risk to water quality as one of the long-term, state-wide issues it considers. Accordingly, in the short-term, we will not disturb the tier structure set out in the Agricultural Order.

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[44] Relevant Central Coast region waterbodies are listed in Table 1 of the Agricultural Order based on the 2010 Clean Water Act Section 303(d) List of Impaired Waterbodies.

[45] The definitions section of the Agricultural Order specifies the crop types with high potential to discharge nitrogen to groundwater. (Agricultural Order, Att. A., Part C, & Prov. 10.)

[46] In general, the following categories of dischargers will be in Tier 2: dischargers that apply chlorpyrifos or diazinon at the farm, but do not discharge to a waterbody listed as impaired for toxicity or pesticides; dischargers with farms located within 1000 feet of a surface waterbody listed for impairment for toxicity, pesticides, nutrients, turbidity, or sediment, or dischargers that grow crop types with high potential to discharge nitrogen to groundwater and that are 50 acres or more but less than 500 acres or are within 1000 feet of a public water well that exceeds the MCL for nitrogen-related pollutants.

[47] Petition for Review of Farm Bureau et al. (Apr. 16, 2012) (Farm Bureau Petition), p. 67; Grower-Shipper Petition, p. 37, Request for Stay and Petition for Review of Ocean Mist and RC Farms (Apr. 16, 2012) (Ocean Mist Petition), p. 24. Ocean Mist appears to have misinterpreted the tiering criteria on this issue. Size is relevant to tiering only to the extent the farm already grows crops that have high potential to discharge nitrogen to groundwater.

[48] Grower-Shipper Petition, p. 37.

[49] Petition to Review of Jensen (Apr. 13, 2012), pp. 18-20.

[50] Grower-Shipper Petition, p. 36.

[51] This type of approach is utilized by the Central ValleyWater Board in waste discharge requirements issued to growers in the Eastern San Joaquin River Watershed. (Order R5-2012-0116, <http://www.swrcb.ca.gov/rwqcb5/board_decisions/adopted_orders/general_orders/r5-2012-0116.pdf> [as of Jun. 4, 2013].) For illustrative purposes, we take official notice of the Central Valley Water Board's order (Cal. Code Regs., tit. 23, § 648.2 and Evid. Code, § 452, subd. (c)), although we express no opinions here on the merits of its approach.

[52] Such evidence includes, but is not limited to, the following: AR Reference Nos. 35, 47, 72, 74, 75, 132, 133, 134, 137, 145, 146, 147, 148, 149, 165, 226, 227, 228, & 258.

[53] AR File Nos. 228, pp. 21-27; 232, pp. 6-16; 233; 260.

[54] See discussion of toxicity related to chlorpyrifos and diazinon at AR File No. 228, p. 23.

[55] See AR File Nos. 260, slides 18-23; 265, pp. 586-591; 283, p. 25.

[56] See AR File No. 228, p. 26.

[57] *Id.*, p. 22.

Any deliberation on questions 3 and 4 should also be informed by language contained in the Central Valley Water Board's Orders for the Irrigated Lands Regulatory Program. Below are excerpts from Order R5-2012-0166-r1:

Findings

23 *The surface water quality monitoring and trend groundwater quality monitoring under this Order are regional in nature instead of individual field discharge monitoring. The benefits of regional monitoring include the ability to determine whether water bodies accepting discharges from numerous irrigated lands are meeting water quality objectives and to determine whether practices, at the watershed level, are protective of water quality. However, there are limitations to regional monitoring's effectiveness in determining possible sources of water quality problems, the effectiveness of management practices, and individual compliance with this Order's requirements.*

Therefore, through the Management Practices Evaluation Program and the Surface Water Quality Management Plans and Groundwater Quality Management Plans, the third-party must evaluate the effectiveness of management practices in protecting water quality. In addition, Members must report the practices they are implementing to protect water quality.

Through the evaluations and studies conducted by the third-party, the reporting of practices by the Members, and the board's compliance and enforcement activities, the board will be able to determine whether a Member is complying with the Order.

Where required monitoring and evaluation does not allow the Central Valley Water Board to determine potential sources of water quality problems or identify whether management practices are effective, this Order requires the third-party to provide technical reports at the direction of the Executive Officer. Such technical reports are needed when monitoring or other available information is not sufficient to determine the effects of irrigated agricultural waste discharges to state waters. It may also be necessary for the board to conduct investigations by obtaining information directly from Members to assess individual compliance. (page 7)

III. Receiving Water Limitations

A. Surface Water Limitations[15]

1. Wastes discharged from Member operations shall not cause or contribute to an exceedance of applicable water quality objectives in surface water, unreasonably affect applicable beneficial uses, or cause or contribute to a condition of pollution or nuisance. (page 17)

[15] These limitations are effective immediately except where Members are implementing an approved Surface Water Quality Management Plan (SQMP) for a specified waste parameter in accordance with an approved time schedule authorized pursuant to sections VIII.H and XII of this Order.

VII. Required Reports and Notices – Member

C. Sediment and Erosion Control Plan

The requirements and deadlines of this section apply as specified to Members that are required to develop a Sediment and Erosion Control Plan per section IV.B.7 of this Order. The Member must use the Sediment and Erosion Control Plan Template approved by the Executive Officer (see section VIII.C below), or equivalent. The Sediment and Erosion Control Plan must be prepared in one of the following ways:

- *The Sediment and Erosion Control Plan must adhere to the site-specific recommendation from the Natural Resources Conservation Service (NRCS), NRCS technical service provider, the University of California Cooperative Extension, the local Resource Conservation District; or conform to a local county ordinance applicable to erosion and sediment control on agricultural lands. The Member must retain written documentation of the recommendation provided and certify that they are implementing the recommendation; or*

- *The Sediment and Erosion Control Plan must be prepared and self-certified by the Member, who has completed a training program that the Executive Officer concurs provides necessary training for sediment and erosion control plan development; or*

- *The Sediment and Erosion Control Plan must be written, amended, and certified by a Qualified Sediment and Erosion Control Plan Developer possessing one of the following registrations or certifications, and appropriate experience with erosion issues on irrigated agricultural lands: California registered professional civil engineer, geologist, engineering geologist, landscape architect; professional hydrologist registered through the American Institute of Hydrology; certified soil scientist registered through the American Society of Agronomy; Certified Professional in Erosion and Sediment Control (CPSEC)™/Certified Professional in Storm Water Quality (CPSWQ)™ registered through Enviro Cert International, Inc.; professional in erosion and sediment control registered through the National Institute for Certification in Engineering Technologies (NICET); or*

- *The Sediment and Erosion Control Plan must be prepared and certified in an alternative manner approved by the Executive Officer. Such approval will be provided based on the Executive Officer's determination that the alternative method for preparing the Sediment and Erosion Control Plan meets the objectives and requirements of this Order.*

The plan shall be maintained and updated as conditions change. A copy of the Sediment and Erosion Control Plan shall be maintained at the farming operations headquarters or primary place of business; and must be produced by the Member, if requested, should Central Valley Water Board staff, or an authorized representative, conduct an inspection of the Member's irrigated lands operation.

1. ***Deadline for Members with Small Farming Operations***

   Within one (1) year of the Executive Officer accepting the third party's Sediment Discharge and Erosion Assessment Report, Members with Small Farming Operations must complete and implement a Sediment and Erosion Control Plan.

2. ***Deadline for all Other Members***[20]

   Within 180 days of the Executive Officer accepting the third party's Sediment Discharge and Erosion Assessment Report, all other

Members must complete and implement a Sediment and Erosion Control Plan. (pages 25-26)

[20] Members with parcels that do not meet the Small Farming Operation definition (see Attachment E).

VIII. Required Reports and Notices – Third-Party

F. Surface Water Exceedance Reports

The third-party shall provide exceedance reports if surface water monitoring results show exceedances of adopted numeric water quality objectives or trigger limits, which are based on interpretations of narrative water quality objectives. Surface water exceedance reports shall be submitted in accordance with the requirements described in section V.D of the MRP. (page 32)

Attachment A – Information Sheet

Sediment and Erosion Control Plans

The Order requires that Members with the potential to cause erosion and discharge sediment that may degrade surface waters prepare a sediment and erosion control plan. Control of sediment discharge will work to achieve water quality objectives associated with sediment and also water quality objectives associated with sediment bound materials such as pesticides. To ensure that water quality is being protected, this Order requires that sediment and erosion control plans be prepared in one of the following ways:

- *The sediment and erosion control plan must adhere to the site-specific recommendation from the Natural Resources Conservation Service (NRCS), NRCS technical service provider, the University of California Cooperative Extension, the local Resource Conservation District; or conform to a local county ordinance applicable to erosion and sediment control on agricultural lands. The Member must retain written documentation of the recommendation provided and certify that they are implementing the recommendation; or*

- *The plan must be prepared and self-certified by the Member, who has completed a training program that the Executive Officer concurs provides necessary training for sediment and erosion control plan development; or*

- *The plan must be written, amended, and certified by a qualified sediment and erosion control plan developer possessing one of the registrations shown in Table 3 below; or*

- *The plan must be prepared and certified in an alternative manner approved by the Executive Officer. Such approval will be provided based on the Executive Officer's determination that the alternative method for preparing the plan meets the objectives and requirements of this Order.*

Table 3. Qualified Sediment and Erosion Control Plan Developers

Title/Certification	*Certifier*
Professional Civil Engineer	*State of California*
Professional Geologist or Engineering Geologist	*State of California*
Landscape Architect	*State of California*
Professional Hydrologist	*American Institute of Hydrology*
Certified Professional in Erosion and Sediment Control™ (CPESC)	*Enviro Cert International Inc.*
Certified Professional in Storm Water Quality™ (CPSWQ)	*Enviro Cert International Inc.*
Certified Soil Scientist	*American Society of Agronomy*

The sediment and erosion control plan will: (1) help identify the sources of sediment that affect the quality of storm water and irrigation water discharges; and (2) describe and ensure the implementation of water quality management practices to reduce or eliminate sediment and other pollutants bound to sediment in storm water and irrigation water discharges. The plan must be appropriate for the Member's operations and will be developed and implemented to address site specific conditions. Each farming operation is unique and requires specific description and selection of water quality management practices needed to address waste discharges of sediment. The plan must be maintained at the farming operations headquarters or primary place of business. The Order requires development of a sediment and erosion control plan template to assist Members and qualified developers in completing the plan. The Order establishes prioritization for Member completion of the plan based on farm size. Small farming operations will have additional time to complete the plan.

To assist Members in determining whether they need to prepare a sediment and erosion control plan, the third-party must prepare a sediment and erosion control assessment report that identifies the areas susceptible to erosion and the discharge of sediment that could impact receiving waters. In addition, the Executive Officer may identify areas requiring such plans based on evidence of ongoing erosion or sediment control problems. (Attachment A pages 23-24)

Question 11 for the Panel is specifically from State Water Board Order WQ 2013-0101. The question was stated as:

> *Verification Measures*
>
> *Utilization of verification measures to determine whether management practices are being properly implemented and achieving their stated purpose is another key element to the success of a nonpoint source control program. Because of the nature of nonpoint source discharges, direct measurements are often difficult or impossible to obtain and other means of verifications may be required.*
>
> 11. *Evaluate the relative merits, and make recommendations regarding the usage of, surface water measurement systems derived from either receiving water or a discharge monitoring approach to identify problem discharges.*

Excerpts from the State Water Board Order WQ 2013-0101(page 37-38) pertaining to this question are as follows:

> *We are skeptical that the Central Coast Water Board has adopted the monitoring program best suited to meet the purpose of identifying and following up on high-risk discharges. The variability in the composition of end-of-field discharges makes it difficult to characterize such discharges through sampling at a limited number of locations and in a limited number of sampling events. Further, even though the surface water discharge monitoring requirements are targeted to the highest risk dischargers, problem discharges and areas are likely to be found outside of the influence of farms operated by Tier 3 dischargers. The better approach may be to rely on receiving water monitoring data and to require the third party monitoring groups administering receiving water monitoring to pursue exceedances with increasingly focused monitoring in upstream channels designed to narrow down and identify the sources of the exceedances. Although the Agricultural Order's surface receiving water monitoring contemplates that the Executive Officer may approve additional monitoring sites to "better assess the pollutant loading from individual sources"[90] or may require toxicity evaluation "to identify the individual discharges causing the toxicity,"[91] it does not establish the type of comprehensive process necessary to identify and address problem discharges. The surface receiving water monitoring approach recently approved by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) for growers in the Eastern San Joaquin Watershed, where a detected exceedance may trigger source identification, management practice implementation, and follow up reporting,[92] perhaps more closely matches the type of monitoring that would assure pollutant discharges are actually addressed.*
>
> *We will ask the Expert Panel to consider both the receiving water and discharge monitoring approaches to identification of problem discharges.*

[90] Tiers 1-3 MRPs, Part 1, § A.9.

[91] *Id.* at Part 1, § A.13.

[92] Central Valley Water Board Order R5-2012-0116, Appendix MRP-1.