Reduction of Nitrates in Groundwater

Conclusions of the Agricultural Nitrate Expert Panel

for the California State Water Resources Control Board
In fulfillment of SBX 2 1 of the California Legislature

July 2014

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moving water in new directions

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DRAFT Final Report

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EXECUTIVE SUMMARY

The Expert Panel was convened to address thirteen questions posed by the staff of the State Water Board. The questions were primarily technical in nature, and are abbreviated below.

1.1 *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 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 the following 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 recommendation 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.

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1.2 *Programmatic Recommendations from the Expert Panel*

The Expert Panel recommends a paradigm shift in its regulatory attempts to reduce nitrate levels in groundwater. The essential elements of this shift are:

1. All farmers should have good irrigation and nitrogen management plans, not just those with lands above aquifers with high nitrates, or those that in the past have been

historically been identified to be in a high vulnerability area, or those with a certain size farm or field. This recommendation comes with the caveat that certain groups (such as the rice growers on clay soils) may be exempt because of very unique chemical situations, and that the groundwater quality some areas may be declared exempt from drinking water standards.

2. Reporting by farmers should be simple yet effective. The basic elements of reporting are reporting unit location, total nitrogen applied, crop type, and acreage.
3. Individual fields can be grouped into units for reporting purposes, in which all fields have the same crop, same irrigation and nitrogen management plan, same irrigation water quality, same irrigation method, and similar soils and same general geographic area.
4. Meaningful education programs for farmers, and of persons who develop irrigation and nitrogen management plans, must be developed and implemented. Training for farmers may need to be required (in an enforceable manner) to ensure success.

1.3 *General Understanding by the Expert Panel*

The recommendations of the Expert Panel are dependent upon the interpretation and understanding by Panel members of many surrounding issues. Some of the background consensus points among the members include the following

1. Just collecting data does not necessarily improve or help clarify the situation.

2. Accurate and practical collection of data and its proper interpretation, regarding nitrogen balances and conversions (e.g., the "nitrogen cycle), is extremely difficult at the field level.

3. Collecting data on changing nitrate levels in the groundwater, to indicate success or failure of on-surface N management practices, is typically problematic at best.

4. An increase in nitrate concentrations at the very upper surface of an aquifer may indicate better nitrate management rather than poorer nitrate management.

5. The data that is currently available regarding nitrate levels in groundwater often comes from poor quality data sources.

6. Complete nitrate balances are very difficult to construct, on a seasonal basis, for many crops. There are numerous unknowns.

7. Even on a large spatial scale, which should be considerably easier than on an individual field scale, there are challenges in exhibiting a proper nitrogen balance by researchers and academics with a large budget and expertise.

8. Graphs and figures regarding the nitrate issues rarely delineate the uncertainties in the data.

9. The data which have been cited in many reports are dated; caution must be used in making policy based on outdated data.

10. 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 cannot be successfully accomplished in just a few years.

11. Due to human nature, varying abilities of people to assimilate new information of various complexity, difficulty of properly communicating instructions, lack of information, etc., some changes in practices and procedures and behavior cannot be successfully accomplished in a few years.

12. There are major differences between individual perceptions regarding the ease and quality of available data. As an example, one might consider the tonnage of nitrogen that is removed annually via crop harvest.

13. There are some critical flaws in the current regulatory approaches, because they do not take into account three overarching observations of fact.

14. The subjects considered by the Expert Panel are highly complex and no "one-size-fits-all" solution is possible.

1.4 *Key Points of the Expert Panel, Related to the Specific Questions Posed by the State Water Board Staff.*

The Expert Panel determined that many of the answers and recommendations were pertinent to multiple questions. The table below provides the linkage between various questions from the State Water Board Staff, and Key Points provided by the Expert Panel.

Table 1. Key points related to original questions

Questions from State Water Board Staff	Applicable Key Points From the Expert Panel
Vulnerability and Risk Assessment	
1	A, B, C, D, E, F, G
2	A, B, C, D, E, F, G
3	B, AA
4	B, AA, I
Application of Management Practices	

5	H,J, L
6	H, J, L
7 (a-d)	H,J, L, X
8 (a-e)	K, M, N, O, P
Verification Measures	
9	Q, R, S
10 (a-f)	Q, R, S
11	AA
Reporting	
12	T, U, V, W, X, Y, Z
13	T, U, V, W, X, Y, Z

Key Points regarding Vulnerability and Risk

A. The definition of "high vulnerability area" 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.

B. The Panel was not confident that the designation of high or low "risk" or "vulnerability" should even be relevant for regulation.

C. There is no reliable and practical method available, that is generally applicable, to accurately pinpoint the causes and sources of groundwater nitrates found at any point (horizontal and vertical) in an aquifer.

D. Using a hazard index of conditions above ground such as with NHI, or an index based on groundwater nitrate levels, are both poor proxies to answering two basic questions on farms/fields: Are the (i) nitrogen and (ii) water needs of the crop(s) being managed in a reasonably good manner?

E. Rather than use proxy measures such as NHI index or groundwater nitrate concentrations, it is best to obtain direct data of the nitrogen applied by field/crop.

F. Coalitions should define a process/procedure that they can use to identify the location of the source of water quality impairment.

G. It is incorrect to assume that accurate estimates of deep percolation on individual fields can be made.

Key Points Regarding Nitrogen Management Practices

H. The only way to reduce nitrate deep percolation from crop root zones is to reduce the volume of deep percolation water (irrigation or rainfall), and to also match the available nitrogen management to the plant needs.

I. Regulatory programs must meet the challenge of being meaningful without being overly complex. Programs with excess complexity and excessive data collection/reporting will likely fail.

J. Irrigation water and nitrogen management plans are an essential management practice. The Expert Panel believes that the management plans must be individualized and developed by competent professionals.

K. The development of excellent, pragmatic education/awareness/training programs will be an essential ingredient for successful development and implementation of irrigation water and nitrogen management plans.

L. All management plans must include estimates of nitrogen applied, nitrogen removed, the distribution uniformity (DU) of the irrigation system, and the volume of water applied to a field.

M. An essential detail for nutrient and irrigation management plan development is "Who will be deemed qualified to create and evaluate these plans"? The Panel believes that the state and regional Boards should agree on the qualifications of the individuals who will create and evaluate these plans, and the basic simple requirements of the plans. But the Board staff will not approve individual plans. Individual management plans must be available for Board staff to review, if needed.

N. The Expert Panel defined a variety of details that must be addressed in the development of a pragmatic educational/awareness/training program.

O. Excellent attendance of the educational programs will be essential. A variety of ways to ensure attendance were contemplated. This will be a challenge.

P. Common terminology and recommendations for Nitrogen applications that farmers are accustomed to hearing (often related to nutrient uptake), currently are not consistent in focusing on matching N applications with N removal from fields. This results in differences in methods to identify target amounts for N fertilizer applications.

Key Points Regarding Verification Measures

Q. The Regional and State Boards need some metric (index or tool) to evaluate the effectiveness of fertilizer management programs. 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.

R. The Panel recommends water quality monitoring of receiving water and understanding the watershed hydrology. Individual point discharge measurements/monitoring would be used if individual points are identified as being serious contributors to water quality problems, based on working upstream in the watershed. The program would not start

with discharge monitoring – that is a form of proving innocence on a continual basis and has technical problems.

S. The Panel emphasizes that such N application data should only be used to provide a multiple-year picture of nitrogen use in an entire region. Data should not be compared year-to-year, but rather examined as multi-year trends (over 5-10 years) in a region.

Key Points Regarding Reporting

T. The cost and hassle of data collection for a farmer is the same whether it must be reported or not.

U. Details about the blends of fertilizer and the timing of fertilizer applications are considered to be the same as trade secrets by most farmers. Details of this type do not needed to be shared for any reasonable nitrogen management reporting program.

V. It is highly unadvisable to require annual nitrogen cycle computations for fields.

W. 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 16 – 10 acre produce crop fields.

X. A unit-based reporting of the total nitrogen applied (along with the crop type and acreage) is recommended as best because it is relatively simple, and considers three points:
   - S.1. The State and Regional Boards will have good data that demonstrates if trends are indeed occurring.
   - S.2. Farmers will need to develop this information, in any case, so it will not require extra data collection.
   - S.3. Coalitions (discussed later and if used) can provide simple information to farmers that allow them to compare their nitrogen applications for a crop against the nitrogen applications of others with the same crops.

Y. A "reporting unit" could 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/nutrient management styles. Alternatively (ii) a reporting unit could be defined as an individual field.

Z. The time period for a report should encompass about a year, and should consolidate monthly or short-season values into single values.

Key Point Regarding Surface Water Discharge Monitoring

AA. A network of sampling points in drains and streams throughout a watershed, with emphasis on downstream areas, is recommended to identify if there are pollution problems upstream. This is recommended rather than sampling at each discharge point.

TABLE OF CONTENTS

Executive Summary ii
1.1 Questions Posed to the Expert Panel ii
1.2 Programmatic Recommendations from the Expert Panel ii
1.3 General Understanding by the Expert Panel iii
1.4 Key Points of the Expert Panel, Related to the Specific Questions Posed by the State Water Board Staff. iv

1 Background 1
1.1 Call for an Expert Panel 1
1.1.1 Regulatory Context 1
1.1.2 Charges to the Expert Panel 1
1.2 Expert Panel 2
1.2.1 Role of Expert Panel 2
1.2.2 Panel Members 2
1.3 Public Meetings 3
1.4 Work Sessions 3
1.5 Additional Public Input 3

2 Questions for the Panel 4
2.1 Vulnerability and Risk Assessment 4
2.2 Application of Management Practices 4
2.3 Verification Measures 5
2.4 Reporting 6

3 Panel Findings 7
3.1 Essential Background Concepts 7
3.2 Key Points and Recommendations by Expert Panel 16
3.2.1 Risk and Vulnerability 16
3.2.1.i The Concept of Vulnerability 17
3.2.1.ii The Concept of Risk 18
3.2.1.iii Key Point Summary for Vulnerability and Risk 19
3.2.2 Application of Management Practices 20
3.2.2.i Management Practices 20
3.2.2.ii Education and Training 21
3.2.2iii Key Point Summary for Application of Management Practices 27
3.2.3 Verification Measures 28
Key Point Summary for Verification Measures 28
3.2.4 Reporting 28
Key Point Summary for Reporting 31

4 References 34

Appendix A. Expert Panel Members
Appendix B. Information Given to Expert Panel
Appendix C. Definitions and Clarifications for Expert Panel
Appendix D. Additional Details on Agricultural Expert Panel Questions 3, 4 and 11
Appendix E. Meeting Agendas

LIST OF FIGURES

Figure 1. Cross-sectioned view of lithologic well-log data along azimuth of 50 degrees between Stanislaus and Tulolumne Rivers 8
Figure 2. Crop type maps of North Kern Water Storage District, 1990 and 2012. Provided by Dr. Joel Kimmelshue 9
Figure 3. Graphs of major changes in pistachio acreages and yield in the Tulare Lake Basin (*from CDFA*) 10
Figure 4. Graphs of major changes in almond acreages and yield in the Tulare Lake Basin (*from CDFA*) 11
Figure 5. Graphs of major changes in tomato acreages and yield in Fresno, Kings, and Kern Counties (*from CDFA*) 11
Figure 6. Three-year running annual average fertilizer purchases in the Tulare Lake Basin, 1991-2011 12
Figure 7. Total nitrogen mass in commercial fertilizer purchased in California and other states for 2003 to 2011 12
Figure 8. Mass balance of cropland nitrogen 13

LIST OF TABLES

Table 1. Key points related to original questions iv

1 BACKGROUND

1.1 *Call for an Expert 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 15 recommendations in 4 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 Expert 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 Expert Panel were done so in the context of the State Water Resources Control Board's Policy for Implementation and Enforcement of the Nonpoint 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 Expert 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 *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 and Research Center (ITRC) to assemble the Expert Panel of up to 10 persons. Recommended Expert 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 contaminate 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, nutrient 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 Role of Expert Panel

The role of Expert Panel Members is as follows:

- Review the Water Boards' Irrigated Lands Regulatory Program.
- 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 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.
- ITRC was mandated to write the Final Report on findings and summary of project discoveries and Recommendations

This report contains observations, recommendations, and comments of an advisory nature for the State Water Board staff to consider or discard at staff discretion. The Expert Panel was given no authority or power to write regulations or requirements of any type.

1.2.2 Panel Members

The Expert 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), California Polytechnic State University, San Luis Obispo, Irrigation Training & Research Center
- Dr. Robert Hutmacher, Soil Scientist, UC Westside Research and Extension Center
- Till Angermann, Hydrogeologist, Luhdorff & Scalmanini Consulting Engineers
- Bill Brush, Certified Crop Advisor, Almond Board of California, East San Joaquin Water Quality Control Board
- Daniel Munk, UC Cooperative Extension
- James duBois, Reiter Affiliated Companies, Central Coast Region
- Mark McKean, Grower, Central Valley Region (Riverdale)
- Dr. Lowell Zelinski, Precision Ag Consulting (Paso Robles)

1.3 *Public Meetings*

On May 5-9, the Agricultural Expert Panel called by the California State Water Board held a series of three meetings over four days to invite and hear public comment on nitrate groundwater issues. The Panel was tasked with collecting input and information that centered on 13 previously developed questions that the Panel has 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 they appeared to deviate from the topics that were to be addressed by the Expert Panel.

The meetings were held in San Luis Obispo (May 5-6), Tulare (May 7), and Sacramento (May 9) to facilitate public access. The meeting sessions were videotaped and posted online at www.itrc.org/swrcb/ in accordance with the Brown Act.

1.4 *Work Sessions*

Three open work sessions were held at Cal Poly ITRC (June 9, June 23, July 1) by the Agricultural Expert Panel for the purpose of developing a draft report. Public comments were invited, but were restricted to 2 minutes/person due to limited time.

1.5 *Additional Public Input*

Written comments provided by the public, as well as the Expert 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 included as **Appendix D** of this document.

2 QUESTIONS FOR THE PANEL

The State Water Board staff provided the Expert Panel with a list of questions. The Expert Panel was instructed that those questions (listed below) were for guidance, and that the Expert 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 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.

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 nonpoint 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 Nonpoint 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. Nutrient 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.
    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 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.

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 recommendation 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 PANEL FINDINGS

3.1 *Essential Background Concepts*

The recommendations of the Expert Panel were impacted by members' interpretations and understandings of many background concepts/ issues which together create a picture of what is reasonable and proper. Some of those understandings are noted below.

1. Just collecting data does not necessarily improve or help clarify the situation. This was heard repeatedly during the public hearings.

2. Dr. John Letey, in discussing Board "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. *"… there 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. *…efforts 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*."

3. Collecting data on changing nitrate levels in the groundwater, to indicate success or failure of on-surface N management practices, is problematic at best. While there is no doubt that with shallow water tables (e.g., less than 7 feet) there will be a rapid response to deep percolation (below the root zone) water and nitrate flows, it becomes almost impossible to get good numbers from deeper zones. The following points were repeatedly made:
    a. Lag times between deep percolation of nitrates and the nitrates reaching the top of the aquifer typically range from a few years to up to extremes of several hundred years.
    b. While there can always be exceptions, there is very little direct correlation between deep percolation water qualities and the aquifer immediately below that agricultural surface. Instead, many explanations and examples were given regarding the mixing of aquifer flows, and the heterogeneous nature of the subsurface.
    c. Groundwater simulation model results are approximate even on very large scales.

d. 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.

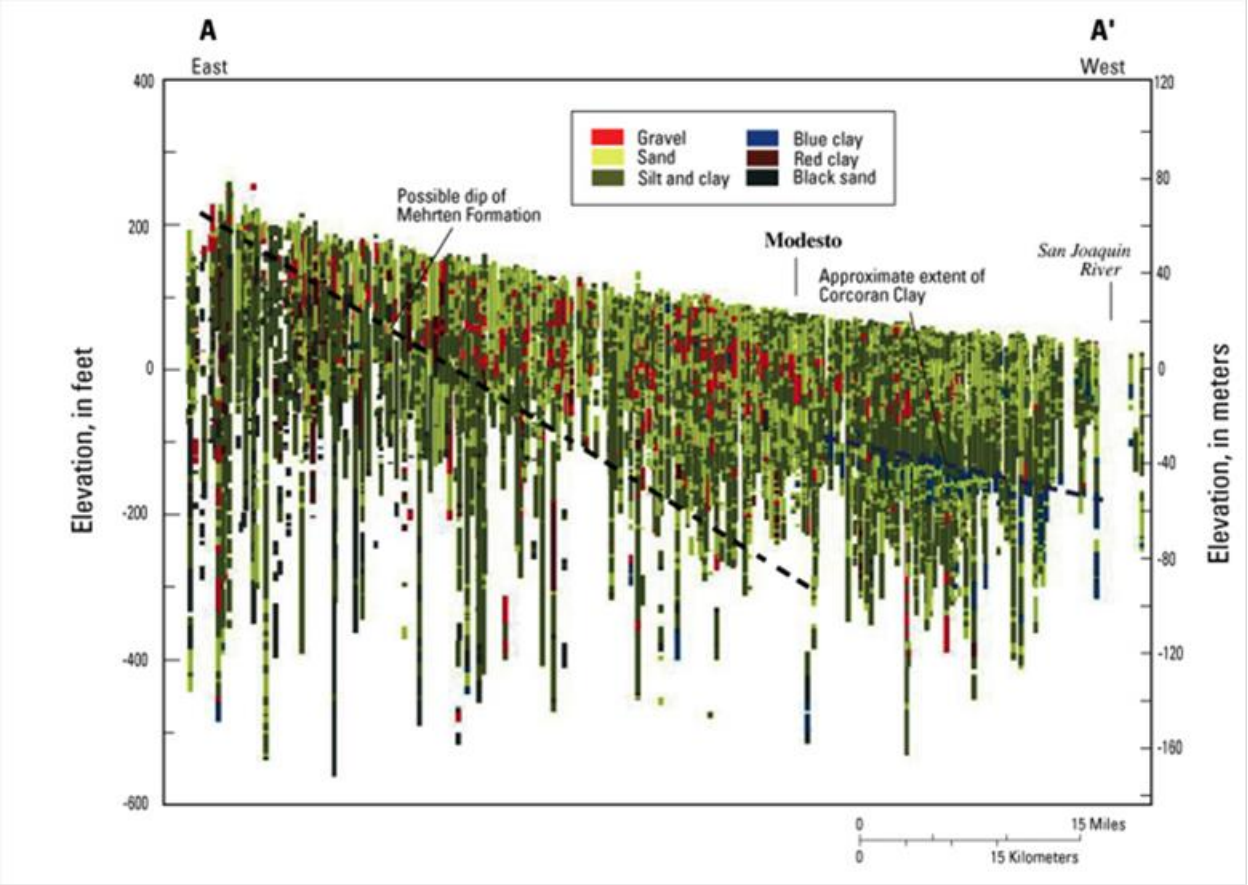


Figure 1. Cross-sectioned view of lithologic well-log data along azimuth of 50 degrees between Stanislaus and Tulolumne Rivers[1]

4. What will be seen in the groundwater for the next 20 years, on the average in the Tulare Basin, are the results of historical management practices – not the result of today's irrigation/fertilizer practices.

   The graphs in Figure 2, provided in testimony by Dr. Joel Kimmelshue, illustrate how things have changed in 20 years in North Kern Water Storage District. The point was that today what is seen in groundwater nitrate changes has little or no relationship to today's conditions.

[1] Figure 10 from Hydrogeologic Characterization of the Modesto Area, San Joaquin Valley, California, USGS Scientific Investigations Report 2004-5232, K.R. Burrow et al.

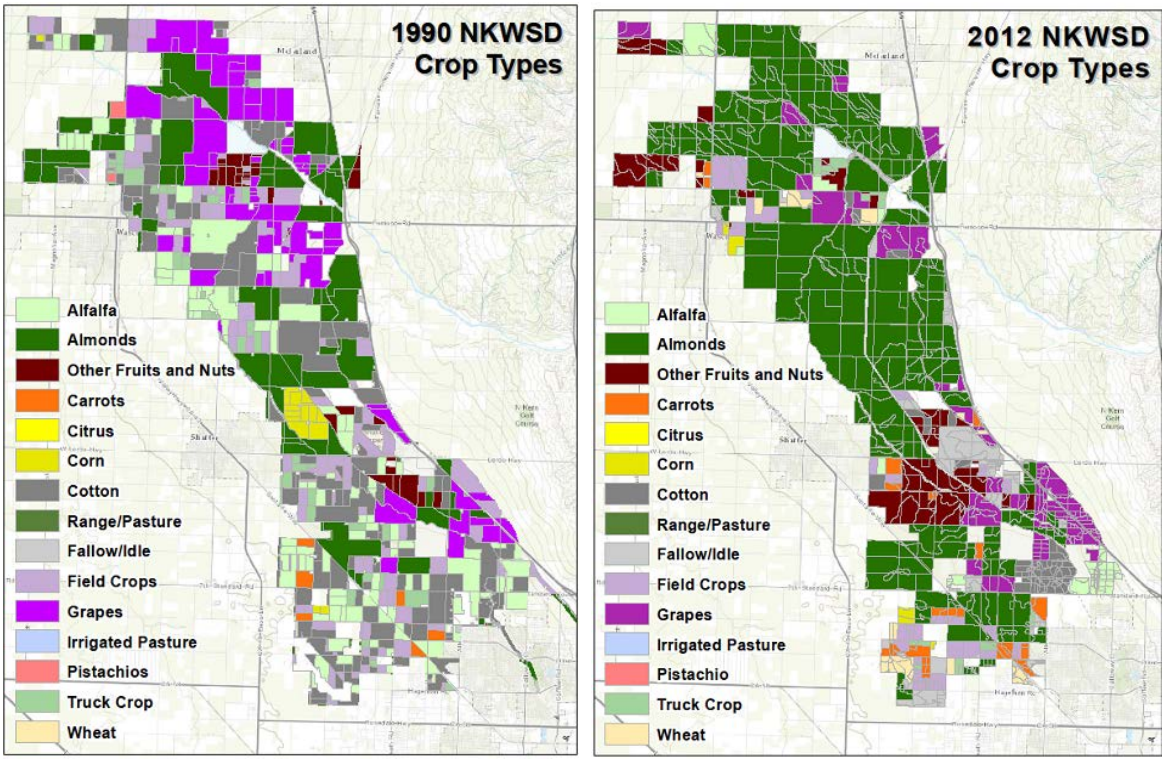


Figure 2. Crop type maps of North Kern Water Storage District, 1990 and 2012. Provided by Dr. Joel Kimmelshue

a. 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 (lb/acre) have also increased. The major changes in both acreage and yields have occurred in the last 10-15 years.

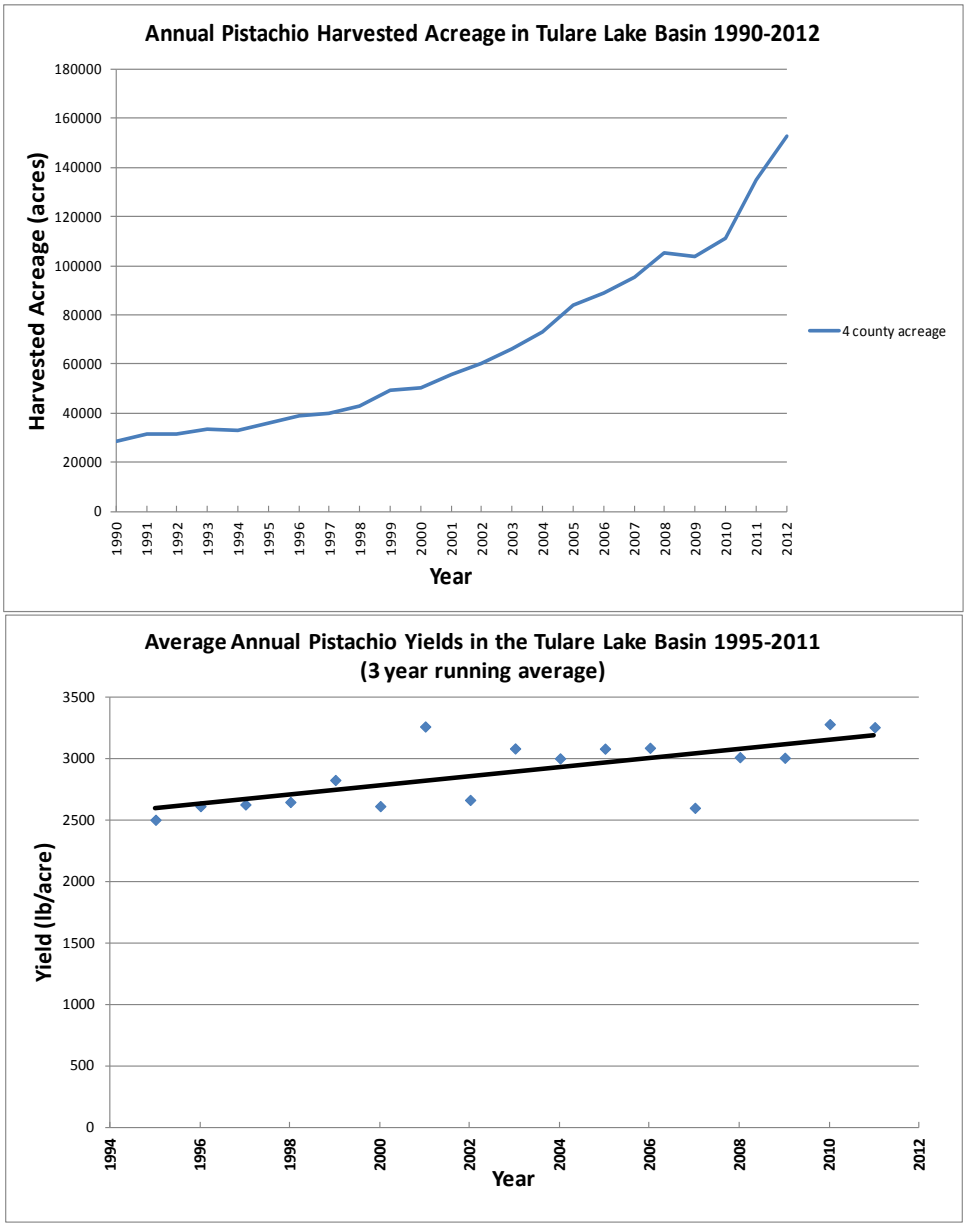
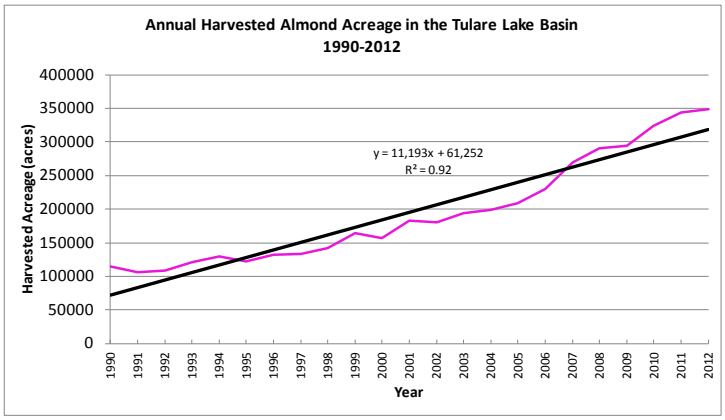


Figure 3. Graphs of major changes in pistachio acreages and yield in the Tulare Lake Basin (*from CDFA*)



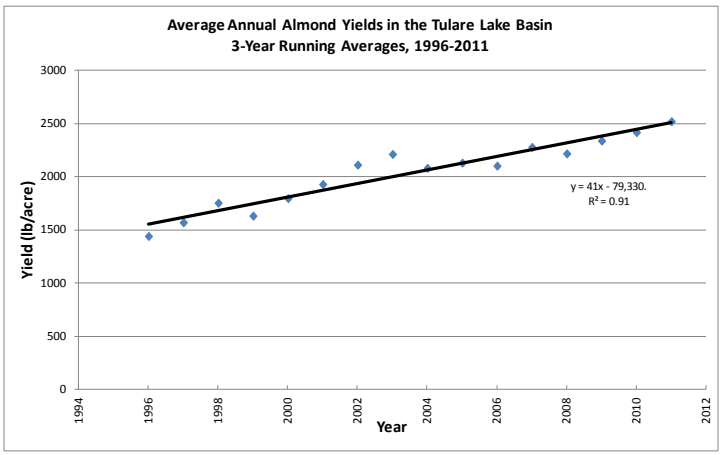


Figure 4. Graphs of major changes in almond acreages and yield in the Tulare Lake Basin (*from CDFA*)

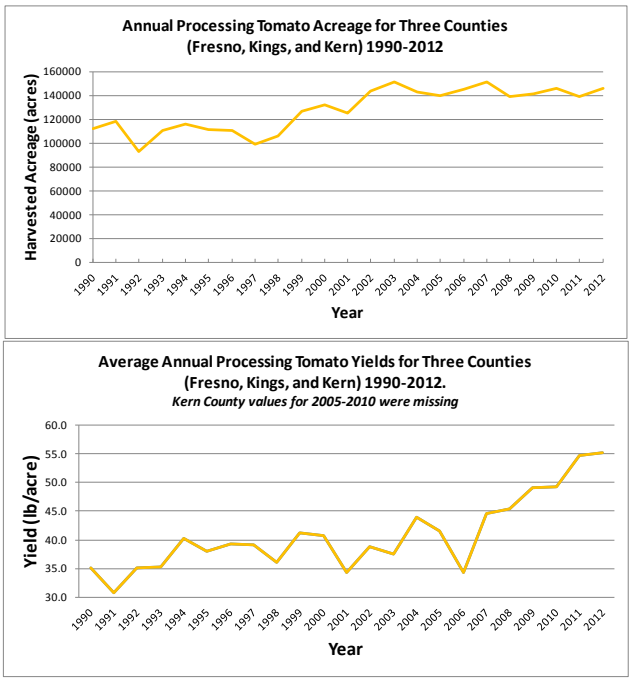


Figure 5. Graphs of major changes in tomato acreages and yield in Fresno, Kings, and Kern Counties (*from CDFA*)

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

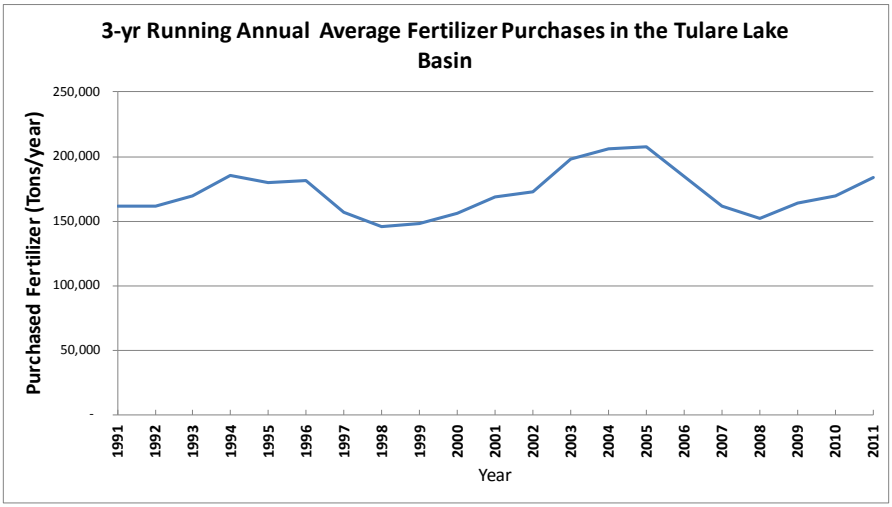


Figure 6. Three-year running annual average fertilizer purchases in the Tulare Lake Basin, 1991-2011

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[2]

5. An increase in nitrate concentrations at the very upper surface of an aquifer may indicate better nitrate management rather than poorer nitrate management. This is because with less leaching of irrigation water, the concentrations of nitrate may increase even though the load decreases.

6. The data that is currently available regarding nitrate levels in groundwater often comes from poor quality data sources. Samples come from wells for which there is often little information available regarding the depth of casing perforations, the depth of the well itself, the relative transmissivity of various zones in the aquifer, mixing between upper and lower aquifers, etc.

7. Complete nitrate balances are very difficult to construct, on a seasonal basis, for many crops. There are numerous unknowns. A wide variety of papers and testimony (such as the earlier quotes by Letey) discuss how it is almost impossible to quantify many of the N conversion details regarding mineralization, volatilization, nitrification, denitrification,

[2] Source: Commercial Fertilizers annual data, 2002–2011, maintained by the Association of American Plant Food Control Officials for The Fertilizer Institute: http://www2.epa.gov/nutrient-policy-data/commercial-fertilizer-purchased#table1

etc. as related to both synthetic and organic sources of nitrogen. The difficulties for experts are tremendous, and are therefore unrealistic expectations for farmers.

8. 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 seen below.

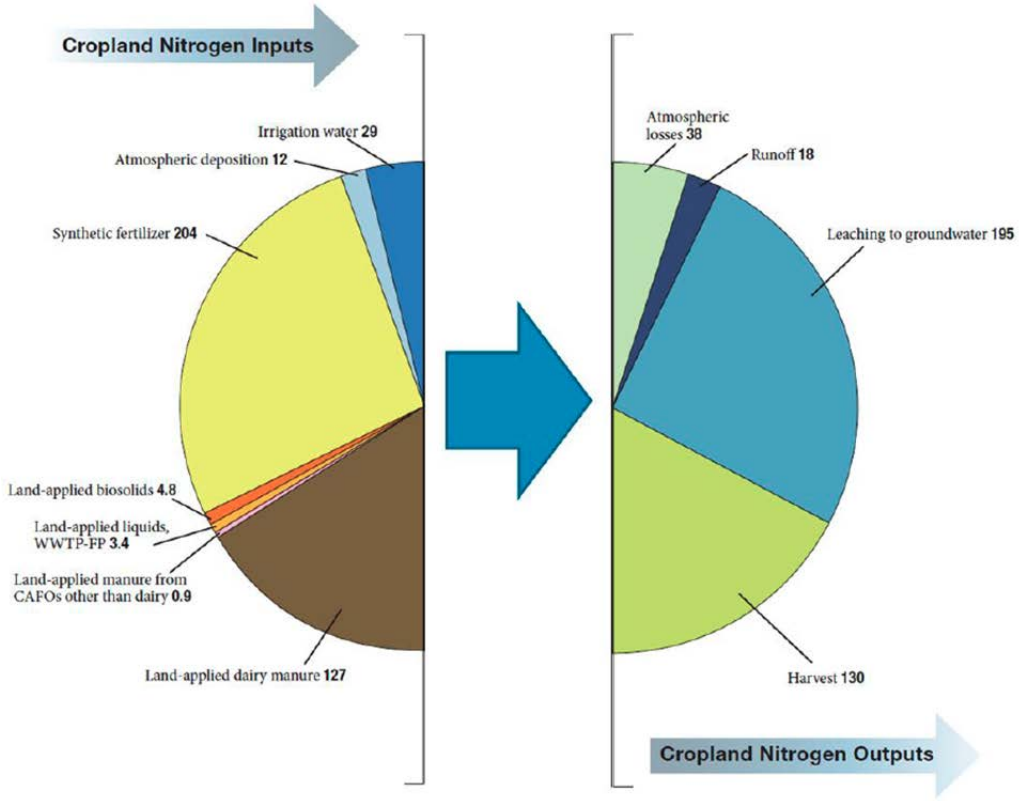


Figure 8. Mass balance of cropland nitrogen[3]

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 can be desirable to provide simple depictions such as this, a logical question is: Why does the harvested nitrogen equal the N 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 in planted in a rotation with other crops, and alfalfa will use readily available soil N before it fixes atmospheric N for its use. And 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 lack

[3] Source: Figure 3 in "Addressing Nitrate in California's Drinking Water" (2012), by Harter and Lund.

of clarity. The development of complex nitrogen budgets for individual fields has similar challenges – multiplied thousands of times and without nearly the equivalent budget and level of expertise to support them.

As a side point, the graph above does not clearly indicate that on the Central Coast, very little manure is applied.

9. Graphs and figures regarding the nitrate issues rarely delineate the uncertainties in the data. For example, each component of the pie-chart basin nitrogen depiction (which is not really a balance because all major components are not included) has a level of uncertainty.

10. The data which have been cited in many reports, such as the "Harter Report", are dated. This is not a criticism of that report - it instead points out the importance of using current, relative data/indicators to direct policy. The "Harter Report" used crop data and fertilizer data from the 2000 – 2005 time period, for example.

11. Due to human nature, varying abilities of people to assimilate new information of various complexity, difficulty of properly communicating instructions, lack of information, etc., some changes in practices and procedures and behavior cannot be successfully accomplished in a few years.

    Testimony from Parry Klassen (East San Joaquin Water Quality Coalition) showed that there is a challenge in having farmers submit meaningful data 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.

12. There are major differences between individual perceptions regarding the ease and quality of available data. As an example, one might consider the tonnage of nitrogen that is removed annually via crop harvest.

    a. 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.
    b. A very similar crop – pistachios – has similar information. But that information is not readily available to the public.
    c. The members of the Expert Panel do not have 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 harvested can change drastically depending upon the market.

d. For most crops, farmers have little-or-no idea of the tonnage of harvested nitrogen. Rather, they are accustomed to a completely different way of thinking. 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 of a much higher difficulty than what they are currently doing.
e. 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.

13. There are some critical flaws in the current regulatory approaches, because they do not take into account three overarching observations of fact:
    1. 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 (i.e., one cannot measure the mass flux of nutrients and dissolved minerals below the crop root zone on a field scale).
    2. There are no surrogate measurements (i.e., proxies for direct measurements) currently available that can be used to determine mass flux of nutrients and dissolved minerals below the crop root zone on a field scale. Inherent errors and uncertainties far exceed needed precision.
    3. The Irrigated Lands Regulatory Program (ILRP) and Dairy General Order data collection efforts that relate to nitrogen mass accounting (Nutrient Management Plan, Farm Template, etc.) assume that data collected on the farm accurately document actual conditions. That assumption is incorrect.

    The current regulatory approach requires the regulated community to carry out enormous data collection and investigative efforts with questionable utility and no indication that they will be successful in protecting groundwater quality. In other words, the Water Boards are over-tasked by their legislative charge to protect beneficial uses of groundwater in the context of the ILRP and other agricultural orders (e.g., the Dairy General Order). This informs the critical need for a paradigm shift.

    The Expert Panel recommends that a new paradigm be developed and proposes a framework in Section 3.2. In summary, the new paradigm places emphasis on training/education, irrigation and nitrogen management plans, and concise reporting.

14. The subjects considered by the Expert Panel are highly complex and no "one-size-fits-all" solution is possible; the recommendations presented in this report represent the Panel's best attempts at creating a plan that will be practical, effective, and manageable in the long term.

3.2 *Key Points and Recommendations by Expert Panel*

3.2.1 Risk and Vulnerability

The Water Boards are interested in prioritizing regulatory oversight and assistance according to the risk posed by discharges to the environment into which the discharge occurs. The State Board expressed this interest in response to Harter et al. (2012) in its Report to the Legislature entitled *Recommendations Addressing Nitrate in Groundwater* (2013). 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.*[4]

Since then, the 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 Board and CVRWQCB creates much confusion. Therefore, the concepts of vulnerability, as currently used by CVRWQCB, and risk (as proposed to be used by the Expert Panel) are discussed below.

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[4] Recommendation 6 references two previous interpretive efforts that the State 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_m ap_table.pdf) as well as current DPR Groundwater Protection Areas (http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpa_locations.htm), in addition to other available hydrogeologic data.*

The Expert Panel finds that neither the State Board's Hydrologically Vulnerable Areas method nor DPR's Groundwater Protection Areas approach can contructively contribute to a definition of nitrate high-risk area in the context of the ILRP. For example, the Hydrologically 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, DPR's Groundwater Protection Areas were delineated specifically to protect groundwater from contamination with pesticides, not nitrate. DPR 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 DPR's groundwater protection considerations included chemical properties of pesticides, not those of nitrate. 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.

3.2.1.i 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 the controversy is caused by the difficulty to agree on a definition, plus the difficulty to spatially determine 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.

> *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) 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 Expert 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 to monitor 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. 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.

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 Expert Panel recommends that CVRWQCB abandon its definition of High Vulnerability and the High Vulnerability Areas Methodology.

3.2.1.ii The Concept of Risk

There are three important types of risk with respect to groundwater nitrate concentrations. All of them involve the likelihood or probability of an occurrence.

1. Human health risks (i.e., the probability of falling ill) associated with the ingestion of drinking water with nitrate-N concentrations exceeding the MCL of 10 mg/L.
2. The risk (i.e., probability) of a particular drinking water well or wells in a certain location or area to exhibit nitrate concentrations exceeding the MCL.
3. The risk (i.e., probability) associated with growing crops to lose 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 Expert Panel and is, therefore, 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.

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). 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; and 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. 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 Water Boards' need to prioritize regulatory oversight and assistance efforts in these areas. To accomplish this task, the Expert Panel recommends implementation of an elemental data collection effort, as described later. 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*

3.2.1.iii Key Point Summary for Vulnerability and Risk

The Panel recognizes that the State and Regional Water Boards have limited resources and are seeking to identify specific geographic areas on which they should focus those resources to make the greatest impact. However, the Panel does not feel that adequate tools exist to accurately target specific areas; regulation and education efforts should apply to all growers rather than those with specific environmental characteristics. To that end, the Panel agrees upon the following key points related to the question of "vulnerability" and "risk".

Key Point Summary for Vulnerability and Risk

A. The definition of "high vulnerability area" 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.

B. The Panel was not confident that the designation of high or low "risk" or "vulnerability" should even be relevant for regulation.

C. There is no reliable and practical method available, that is generally applicable, to accurately pinpoint the causes and sources of groundwater nitrates found at any point (horizontal and vertical) in an aquifer.

D. Using a hazard index of conditions above ground such as with NHI, or an index based on groundwater nitrate levels, are both poor proxies to answering two basic questions on farms/fields: Are the (i) nitrogen and (ii) water needs of the crop(s) being managed in a reasonably good manner?

E. Rather than use proxy measures such as NHI index or groundwater nitrate concentrations, it is best to obtain direct data of the nitrogen applied by field/crop.

F. Coalitions should define a process/procedure that they can use to identify the location of the source of water quality impairment.

G. It is incorrect to assume that accurate estimates of deep percolation on individual fields can be made.

3.2.2 Application of Management Practices

3.2.2.i Management Practices

If the objective is 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 offered by the University of California extension. For example, consider the following statement in a 2009 UC extension publication:

> *Compared to most other vegetable crops, lettuce has a moderate nitrogen requirement, taking up on average only 100 to120 lb N/acre. Many replicated trials have demonstrated that, with efficient water management, seasonal nitrogen application of about 150 lb/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*.
> (http://www.ipm.ucdavis.edu/PMG/r441311411.html)

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

1. Common recommendations are phrased in terms of "requirements" 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 lb N/acre, and the recommendation of application is 150 lb N/acre – a guaranteed efficiency of 67%, not including the difference between plant uptake and plant N removed.

There is also ambiguity when distinguishing between plant uptake of N, and harvested (or removed) N. It is very difficult to know what the efficiency of N fertilizer uptake is, and information on synchronization is not widely available. Because of this, some farmers commonly apply more N than needed as a sort of "insurance" application to avoid negatively impacting crop quality and yields. Therefore, the Panel agrees that optimized nitrogen use efficiency should be the focus of management practices encouraged as a result of this report. Much of the efforts required to improve nitrogen use efficiency must stem from widespread education of growers, which will be discussed in the next section.

The Panel has chosen not to create a "laundry list" of Best Management Practice (BMP) options for growers. Such lists generally lack sufficient detail to be effective on a site-by-site

basis, and usually avoid the root of the problem. The Panel agrees that lists of any specific practices should be in the form of heightened awareness for consideration only, rather than requirements.

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

1. Creation of irrigation and nutrient management plans specific to each grower and similar management unit
2. Development and execution of awareness/education programs
3. Implementation of the management plans
4. Internal (private) review and assessment of the impacts (crop quality, amount of fertilizer and water used, gross costs).

The details of these plans should be used for management only, and not for reporting purposes. The management plans should aid growers in determining the current status of their nitrogen use, as well as develop tools and practices to minimize nitrogen applications. To begin the creation of a management plan, the grower must be knowledgeable about certain data (which should be current data that is updated at some interval). These data include:

- How much nitrogen is being applied from all sources, including fertilizers and irrigation water, as well as the timing and uniformity of the applications
- How much nitrogen is removed, by crop type
- The distribution uniformity of existing irrigation systems
- The volume of water applied to a field

A first step for many management plans will be to develop the data collection process (water and fertilizer), and data organization procedures and tools to accomplish this. From these data, an appropriate nutrient management plan, an appropriate irrigation schedule, and a plan for irrigation system maintenance should be developed based on system type and crop demand.

After the plan is implemented, progress should be checked after a certain interval, and the effectiveness of the plan evaluated for any necessary modifications.

3.2.2.ii Education and Training

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 why the programs that are implemented are important, what the impacts will be to their specific operation, and how 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.

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

Effective Educational/Awareness Programs - General

The Expert Panel believes that true progress in reducing nitrate leaching will only occur if good irrigation and nitrogen management plans are developed and implemented. The Expert Panel believes that a very aggressive, high quality education, and well funded 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. 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 it is weak on crops and nitrogen.

In California, there are two major university irrigation and nutrient management education groups. Each of these two groups has specialized in different topics.

1. Cal Poly's Irrigation Training and Research Center (ITRC) has focused on the related topics (for this discussion) of:
   a. Irrigation System Evaluation
   b. Irrigation System Design
   c. Irrigation System Maintenance
   d. Irrigation Scheduling
   e. Fertigation – including hardware, chemicals, and practices

   ITRC has developed high quality web-based courses for portions of these topics, and has about 60 short courses/year.

2. The University of California's Cooperative Extension service has classes that are formatted quite differently from those at ITRC. UCCE's efforts are focused more on the agronomic aspects than are ITRC's. Typical UCCE areas of focus include:
   a. Crop nutrient requirements
   b. Irrigation scheduling
   c. Crop varieties, pruning, planting, etc.

Educational programs must address two key groups:

1. Individual farmers or farm managers
2. Persons who develop the irrigation and nutrient water management plans

The Expert Panel believes that in many cases, these can be the same persons. However, the level of detail and specific topics to be addressed for each group will be different.

Several topics were emphasized as vital components of a good grower/farmer education program, including:

- Water and nitrogen needs specific to particular crops – separating uptake versus removal.
- How to create an appropriate irrigation schedule.
- The standing of other growers in a region. In other words, what is the range of N applications/year for crop "Z"?
- Correct timing of nitrogen applications
- "Spoon-feeding" of fertilizers and other chemicals, rather than large-dose applications, should be emphasized. 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. This is similar in concept to "spoon-feeding".
- Maintenance requirements of different irrigation systems.
- Fertigation principles – techniques, hardware, and chemicals
- Irrigation distribution uniformity
- Irrigation scheduling

Effective Educational/Awareness Programs – Designing the Venue and Materials

Although it is easy to say that education is needed, the devil is in the details. And 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 Expert Panel to develop an educational/training program. But the Expert Panel emphasizes that a good education/awareness/training program must address the following:

1. Fill in knowledge gaps and publish them widely – perhaps in farming magazines. Although some points may be well known by some people, they are certainly not well advertised. The primary gaps in knowledge are:
    a. Harvested (removed) N for various crops.
    b. Timing of uptake of N for various crops
    c. Requirements for other nutrient balances, to ensure proper N uptake.
    d. Justification for the inherent inefficiency that is embedded in UC recommendation of fertilizer applications, that assume a 30% or so inefficiency.

2. Make a clear decision on what the obligations of individual farmers will be, and the justification for those obligations. If the obligation is to develop and implement a good but simple management plan, 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). The farmer must certify that he/she will adopt the plan and implement it fully by 2017, as an example. The key elements of each annual plan, for each representative field, could be:

a. Keep records on all nitrogen inputs and timing.
b. 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 – **which is a major advancement for most farmers**.
c. Have recent measurement of the distribution uniformity of the irrigation system, or from a comparable irrigation system on the farm.
d. Summarize, in a neat table, the inputs and the expected consumption of water and nitrogen.
e. A list of improvements to be made the coming year.

3. Define the training venue. If this is to be a long-term program, there must be consistency over many years, with the ability to upgrade and expand training. There are several different venues:
    a. One would be the approach that UCCE used in its recent workshop effort with Certified Crop Advisors. Benefits appear to include:
        i. It was very quick.
        ii. It reached a large number of people.

        Disadvantages are:
        i. This is difficult to sustain, and difficult to provide over the long haul with consistency because it consisted of numerous people who were evidently quickly pulled together.
        ii. There was no testing, so there was no way to objectively evaluate the effectiveness of knowledge transfer.
    b. A second approach would be to have formal1-3 day workshops such as some that Cal Poly has at ITRC. These are based on structured educational material, and are usually taught by only one or two individuals. Advantages include:
        i. Because the educational material is standardized, participants obtain a consistent message from year to year.
        ii. The timing is published well in advance, so people can plan on these classes every year.
        iii. Many of the classes dovetail with Irrigation Association certification programs, which require that students pass classes.

        Disadvantages include:
        i. These classes require that people travel to San Luis Obispo.
        ii. Because these classes are often lab-intensive, they can be expensive to provide.
    c. A third approach is to develop distance learning modules, which include testing and accounting of registration, etc. ITRC has developed this type of program for several topics. Advantages include:
        i. People can study when they want.
        ii. People can study from home.
        iii. The material is standardized, so everyone receives the same information from year to year.
        iv. The teaching quality does not depend on the instructor of the moment.
        v. The distance learning can be augmented by written materials, or local lab exercises.

vi. A "distance learning package" can 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 use the "distance learning module" as the primary teaching tool.

Disadvantages include:

i. A high quality distance learning package is much more expensive than most people think. You can't pay for these from student registrations. They need to be developed with up-front funds.

ii. A high quality distance learning module takes months to develop. It is not the same as throwing together a powerpoint presentation or video-recording a lecture.

d. A fourth approach is to develop standardized training materials, and then have local qualified individuals – not necessarily from a university – lead the training. Some trade associations do this. Advantages include:

i. This can get local people heavily involved.

Disadvantages include:

i. It is often very difficult to get qualified people to teach the courses

e. Some mix of 1-4.

4. Once the format(s) is/are defined, develop standardized training materials to provide knowledge transfer to those who will develop the irrigation and nitrogen management plans.
    a. A key item will be to build upon existing knowledge. For example, UCCE has a strong track record in materials and short courses regarding crop nutrient requirements. ITRC has been teaching a short course on Fertigation, and another on Irrigation Evaluation, for about 30 years.
    b. The specific topics must be standardized and well defined. For example, topics might be:
        i. How to fill out the basic cover sheet for a management plan.
        ii. How to determine timing of nitrogen applications.
        iii. How to determine lbs/acre needed, making various assumptions about the nitrogen cycle in the soil.
        iv. How to check for adequacy.
        v. Interaction of N with other nutrients.
        vi. Fertigation principles
        vii. Fertigation equipment
        viii. Irrigation system evaluation.

5. Define the process for certification of "planners". Some key principles exist:
    a. "Grandfathering" people into certification is undesirable.
    b. Simple attendance at classes is insufficient for demonstrating knowledge.
    c. 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 fairly meaningless. Most good instructors know that there is a huge difference between the student's perception of what the student knows, and what the student actually knows. Good course reviews are easy to obtain by having humorous instructors

who require very little, and if coffee and donuts are readily available during the class with lots of bathroom breaks.

d. Exams need to be standardized, but have a good selection of randomized questions to prevent cheating. Grading must also be standardized. This is a major effort.
e. 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.
f. Another big question is if people who make management plans should already be certified in some other program.
g. 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 – a very different topic, requiring a different skill set.
h. It is difficult to maintain consistent momentum, year-in, and year-out. Therefore, there must be some official organization to manage any certification program.

6. Develop the examinations, if applicable.

It was also noted that the State Board should approve the curriculum that will be used by various coalitions and groups.

Effective Educational/Awareness Programs – Farmer Involvement

It was assumed by the Expert Panel that if growers are required to have an irrigation and nitrogen management plan, there will be some type of mandatory training and examination required for those who develop the plans. In other words, mere attendance will be insufficient.

The Expert Panel also realizes that if growers (farmers) or managers do not attend some meaningful, pragmatic training, the desired goal of reducing nitrate leaching will not be met.

It was the consensus of the Expert Panel members that compliance will be low unless there is some enforceable requirement. The Expert 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.

One of the stronger ideas w as that nitrogen fertilizer sales should be handled the same way as pesticide sales, in the sense that pesticides can only be sold based on the recommendation of a Pest Control Advisor. In a similar fashion, nitrogen fertilizers, compost, etc. could only be sold if farms have on record, at the fertilizer sales office, a form that certifies the completion of a satisfactory irrigation water and nitrogen management plan.

Effective Educational/Awareness Programs – Other Details

Three important issues that were discussed, but not finalized, were:

1. The timeline for various levels of educational effort.

2. Requirements for continuing education.
3. Who will review whether management plans are implemented.

Key Point Summary for Application of Management Practices

H. The only way to reduce nitrate deep percolation from crop root zones is to reduce the volume of deep percolation water (irrigation or rainfall), and to also match the available nitrogen management to the plant needs.

I. Regulatory programs must meet the challenge of being meaningful without being overly complex. Programs with excess complexity and excessive data collection/reporting will likely fail.

J. <u>Irrigation water and nitrogen management plans</u> are an essential management practice. The Expert Panel believes that the management plans must be individualized and developed by competent professionals.

K. The development of excellent, pragmatic education/awareness/training programs will be an essential ingredient for successful development and implementation of irrigation water and nitrogen management plans.

L. All management plans must include estimates of nitrogen applied, nitrogen removed, the distribution uniformity (DU) of the irrigation system, and the volume of water applied to a field.

M. An essential detail for nutrient and irrigation management plan development is "Who will be deemed qualified to create and evaluate these plans"? The Panel believes that the state and regional Boards should agree on the qualifications of the individuals who will create and evaluate these plans, and the basic simple requirements of the plans. But the Board staff will not approve individual plans. Individual management plans must be available for Board staff to review, if needed.

N. The Expert Panel defined a variety of details that must be addressed in the development of a pragmatic educational/awareness/training program.

O. Excellent attendance of the educational programs will be essential. A variety of ways to ensure attendance were contemplated. This will be a challenge.

P. Common terminology and recommendations for Nitrogen applications that farmers are accustomed to hearing (often related to nutrient uptake), currently are not consistent in focusing on matching N applications with N removal from fields. This results in differences in methods to identify target amounts for N fertilizer applications.

3.2.3 Verification Measures

The Panel recognizes that the State and Regional Boards must have some way of measuring progress over time on a regional basis.

However, 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 boards will be able to report to the State 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.

The Panel agrees that the progress of groundwater nitrate concentrations should also be monitored, in order to track general aquifer conditions over multiple years.

Key Point Summary for Verification Measures

Q. The Regional and State Boards need some metric (index or tool) to evaluate the effectiveness of fertilizer management programs. 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.

R. The Panel recommends water quality monitoring of receiving water and understanding the watershed hydrology. Individual point discharge measurements/monitoring would be used if individual points are identified as being serious contributors to water quality problems, based on working upstream in the watershed. The program would not start with discharge monitoring – that is a form of proving innocence on a continual basis and has technical problems.

S. The Panel emphasizes that such N application data should only be used to provide a multiple-year picture of nitrogen use in an entire region. Data should not be compared year-to-year, but rather examined as multi-year trends (over 5-10 years) in a region.

3.2.4 Reporting

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

Current groundwater conditions should not trigger reporting or regulation of above-ground activity. Current groundwater conditions can likely be useful for grower awareness by providing:

- 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

However, measuring groundwater was deemed unreliable, because the source of the nitrates cannot be pinpointed. Fertilizer sales are also unreliable indicators of regional nitrogen applications.

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.

Detailed nitrogen cycle computations for individual fields, for a growing season, will be fraught with error and unnecessary expense. It is well known that even one aspect of the nitrogen cycle – the rates of mineralization of organic residues – is tremendously complex. 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. Even research studies have difficulties with this.

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

The Panel clearly recommends that the data collected be used for education and later development of management plans, not for enforcement. Grower understanding and improvements are vital, and growers will be reluctant to participate in programs if they fear self-incrimination.

The nitrogen application computation should include the 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. But as stated earlier, multiple years and multiple fields will create an averaging effect.

The benefit of N reporting is that it is simple and gets to the root of the issue. It also fits into the most important element – which is not enforcement. The most important element of any program is increasing awareness by fertilizer users, and improvement of fertilizer management practices. The nitrogen application values are key ingredients of any such farm 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 dis-incentive to pump high-nitrate water, and coalitions and Regional Boards must be especially careful to finesse guidelines that emphasis this point.

The recommended data collection effort seeks three basic types of information, aggregated over the course of one year (e.g., calendar year), on a farm scale.

1. Crop (e.g., lettuce, wheat, almond)
2. 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.
    - Nitrogen applications for each crop (lbs/acre) including organic applications (e.g., manure, compost), synthetic fertilizer applications, and nitrogen in irrigation water. This requires separate estimation and documentation of these three nitrogen sources.

This effort purposefully limits data collection to basic information that can be easily obtained and all farmers need and should be knowledgeable off as part of their nutrient management.

This data collection effort does not require farmers to account for nitrogen applications to individual fields. Instead, it provides the flexibility to consider multiple fields that 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.

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.
2. Identification of multi-year trends as the data collection is continued.

It is emphasized that the collected data should be used to examine regional, multiple-year (e.g., 5-10 years) 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 negate the accuracy of the data.

This elemental data collection effort provides several compelling benefits to farmers, the ILRP, and groundwater quality in the long term:

1. It gets to the root of the nitrate issue
2. It is simple and attainable in a timely fashion
3. It raises awareness because it introduces farmers to key components of on-farm nutrient management about which they need to be knowledgeable

4. It allows farmers to compare their nitrogen applications to those of their peers growing the same crops.

Key Point Summary for Reporting

T. The cost and hassle of data collection for a farmer is the same whether it must be reported or not.

U. 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 needed to be shared for any reasonable nitrogen management reporting program.

V. It is highly unadvisable to require annual nitrogen cycle computations for fields.

W. 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 16 – 10 acre produce crop fields.

X. A reporting of the applied nitrogen (along with the crop type and acreage) is recommended as the primary numerical metric because of three points:

S.1 The State and Regional Boards will have good data that demonstrates if trends are indeed occurring.

S.2 Farmers will need to develop this information, in any case, so it will not require extra data collection.

S.3 Coalitions can provide simple information to farmers that allow them to compare their nitrogen applications for a crop against the nitrogen applications of others with the same crops.

Y. A "reporting unit" could 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/nutrient management styles. Alternatively (ii) a reporting unit could be defined as an individual field.

Z. The time period for a report should encompass about a year, and should consolidate monthly or short-season values into single values.

3.2.5 Surface Water Discharges

Monitoring the water quality of surface discharges from individual fields/farms, as a general policy, has the following problems:

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. Reasons include:
    a. There is always a possibility that the timing of individual sample collection might be organized to avoid times of pesticide applications, or events with high silt 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 requires that samples be collected during daylight hours, from M-F. Other times/days may be more important.
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.
4. By requiring every discharge point to be sampled, the regulatory process becomes one of "Guilty until proven innocent". In other words, farmers must continually prove their innocence.

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

The recommendation is to take sufficient samples 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. 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 with sampling to locate the source of the problem.

Recommendations of the exact density and timing of sampling are not provided by the Expert 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.

Key Point Summary for Surface Discharge Monitoring

AA. A network of sampling points in drains and streams throughout a watershed, with

emphasis on downstream areas, is recommended to identify if there are pollution problems upstream. This is recommended rather than sampling at each discharge point.

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APPENDIX A
Expert Panel Members

Appendix A
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
Definitions and Clarifications for Expert Panel

Appendix C
Definitions and Clarifications for Expert 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 Expert Panel:

> *"The Expert 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 Expert 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 Expert 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 Expert 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 Expert 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 Expert 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 Expert Panel was expected to provide answers and recommendations that are pragmatic and essential. Specifically, the Expert 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 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 Expert Panel are only those that pertain to nitrate application and control. The Expert 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 Expert Panel was not intended to focus on the "reporting" that is addressed in the CDFA Report, there is a definite linkage. For example, the Expert 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 Expert Panel assessed the relative importance of using field-level nitrogen computations such as those described below.

1. Nitrogen mass balance – 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. Ratio of [(Nitrogen In)/(Nitrogen Removed by the Crop)] – 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.

Groundwater Monitoring

Definitions:

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

The Expert Panel did not address trend 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.

Surface Water Monitoring

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).

***Add clarifications provided by Darrin for the June 23? meeting

APPENDIX C
Meeting Agendas

Appendix C
Meeting Agendas

Agricultural Expert Panel Public Meeting #1

Monday May 5, 2014 – 9:00 AM (Convene Panel and Invited Testimony)
Tuesday May 6, 2014 – 8:30 AM (Invited Testimony and Public Comment)

Locations different for each day:
May 5: Irrigation Training and Research Center
California Polytechnic State University, SLO
1 Grand Ave, Building 08A, Room 022
San Luis Obispo, CA 93405
May 6: The Monday Club
1815 Monterey Street
San Luis Obispo, CA 93401

THIS MEETING IS A CONTINUATION OF THE EFFORTS ASSOCIATED WITH THE STATE WATER RESOURCES CONTROL BOARD CHAPTER 1 OF THE SECOND EXTRAORDINARY SESSION OF 2008 (SBX2 1, PERATA) REPORT TO THE LEGISLATURE – RECOMMENDATION 14, EXPERT PANEL AND ADVISORY COMMITTEE FORMATION. THE MEETING WILL BE CONDUCTED BY THE EXPERT PANEL. A QUORUM OF STATE WATER BOARD MEMBERS MAY BE IN ATTENDANCE, BUT NO BOARD ACTION WILL BE TAKEN AT THIS MEETING.

AGENDA (rev. 1)

May 5

I. Call the meeting to order

II. **Declaration of a quorum**
Dr. Charles Burt, Panel Chair; Dr. Robert Hutmacher; Till Angermann; Bill Brush; Daniel Munk; James duBois; Mark McKean; Dr. Lowell Zelinski

III. Housekeeping announcements

IV. Panel Introduction and opening remarks by panel members

V. Review Agenda

VI. Review the Charge of the Panel and take invited speaker comments
(public comments will not start until after 8:30 am on Tuesday May 6)

- Presentation of charge to the panel and specific questions – Darrin Polhemus, State Water Resources Control Board
- Region Water Quality Control Boards panel
  - Angela Schroeter, Central Coast Regional Water Quality Control Board
  - Clay Rodgers, Central Valley Regional Water Quality Control Board

    - Joe Karkoski, Central Valley Regional Water Quality Control Board
- Nitrate Tracking and Reporting System Task Force – Dr. Amrith Gunasekara and Dr. Amadou Ba, California Department of Food and Agriculture
- Parry Klassen, East San Joaquin Water Quality Coalition
- Dr. Joel Kimmelshue, Land IQ
- Chris Kapheim, Alta Irrigation District
- Dr. Ken Baerenklau, UC Riverside
- Paul Giboney, M. Caraten Inc/Columbine Vineyards
- Butch Massa, Comgro Soil Amendments
- Hung Le, Paramount Farming Company
- Richard Smith, UC Cooperative Extension
- Dr. Robert Mikkelsen, International Plant Nutrition Institute
- George Adam, Innovative Produce

VII. Adjourn for the Day

May 6

I. Call the meeting to order

II. Declaration of a quorum

Dr. Charles Burt, Panel Chair; Dr. Robert Hutmacher; Till Angermann; Bill Brush; Daniel Munk; James duBois; Mark McKean; Dr. Lowell Zelinski

III. Housekeeping announcements

IV. Review Agenda

V. Panel Introduction and opening remarks by panel members

VI. Review the Charge of the Panel and take invited and public comments

(this item is continued from the previous day)

- Roy Killgore Jr., San Ysidro Farms
- Salinas Valley Grower
- Public Comment (Any member of the public may present comments or remarks to the Panel. Commenters will be limited to 5 minutes or otherwise at the discretion of the Chair. Commenters will be asked to fill out a speaker card if they wished to be called to speak. Written comments are due by May 14, 12:00 pm noon.)

VII. Panel Discussion

VIII. Adjournment

Background
Chapter 1 of the Second Extraordinary Session of 2008 (SBX2 1, Perata), required the State Water Resources Control Board (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 15 recommendations in 4 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.

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 has contracted with the Irrigation Training and Research Center (ITRC), a center established within the BioResource and Agricultural Engineering Department of the California Polytechnic State University, San Luis Obispo to assemble the expert panel of up to 10 persons. The Expert Panel members have been selected and information about the panel members is available on the ITRC website at http://www.itrc.org/001/swrcb.htm . Questions to be presented to the Expert Panel for consideration are provided below.

Written Public Comments
The State Water Board will accept written comments from the public for the Expert Panel's consideration. Comments and remarks must be received by **12:00 noon on Wednesday, May 14, 2014** and addressed to:

Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
1001 I Street, 24th Floor
Sacramento, CA 95814

Comments and remarks may be submitted electronically, in pdf text format (if less than 15 megabytes in total size), to the Clerk to the Board via e-mail at commentletters@waterboards.ca.gov.

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Schedule (some dates may be changed at a later date and all changes will be noticed).

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Completed	Advisory Committee Kickoff Meeting	Cal/EPA Building Sierra Hearing Room, Sacramento
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June 30th, 2014	Expert Panel Draft Report Released	N/A
July 1st – July 30th, 2014	Public Comment Period on Expert Panel Draft Report	N/A
July 18th, 2014	Expert Panel Public Meeting on Draft Report	Cal/EPA Building Byron Sher Auditorium, Sacramento
July 28th, 2014	Advisory Committee Meeting	Cal/EPA Building Sierra Hearing Room, Sacramento
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Please direct any questions about this agenda to Johnny Gonzales at (916) 341-5510 or Ashley Zellmer at (916) 341-5911.

Agricultural Expert Panel Public Meeting #2

Wednesday May 7, 2014 – 8:30

(Invited Testimony and Public Comment)

Southern California Edison Energy Education Center
4175 South Laspina Street
Tulare, CA 93274

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AGENDA

I. Call the meeting to order

II. Declaration of a quorum

Dr. Charles Burt, Panel Chair; Dr. Robert Hutmacher; Till Angermann; Bill Brush; Daniel Munk; James duBois; Mark McKean; Dr. Lowell Zelinski

III. Housekeeping announcements

IV. Review Agenda

V. Panel Introduction and opening remarks by panel members

VI. Review the Charge of the Panel and take invited and public comments

- Presentation of charge to the panel and specific questions – Darrin Polhemus, State Water Resources Control Board
- Public Comment (Any member of the public may present comments or remarks to the Panel. Commenters will be limited to 5 minutes or otherwise at the discretion of the Chair. Commenters will be asked to fill out a speaker card if they wished to be called to speak. Written comments are due by May 14, 12:00 pm noon.)

VII. Panel Discussion

VIII. Adjournment

Background
Chapter 1 of the Second Extraordinary Session of 2008 (SBX2 1, Perata), required the State Water Resources Control Board (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 15 recommendations in 4 key areas to address the issues associated with nitrate contaminated groundwater. The key areas to address these issues are:

5. Providing safe drinking water.
6. Monitoring, notification, and assessment.
7. Nitrogen tracking and reporting.
8. Protecting groundwater.

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 has contracted with the Irrigation Training and Research Center (ITRC), a center established within the BioResource and Agricultural Engineering Department of the California Polytechnic State University, San Luis Obispo to assemble the expert panel of up to 10 persons. The Expert Panel members have been selected and information about the panel members is available on the ITRC website at http://www.itrc.org/001/swrcb.htm . Questions to be presented to the Expert Panel for consideration are provided below.

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1001 I Street, 24th Floor
Sacramento, CA 95814

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Please direct any questions about this agenda to Johnny Gonzales at (916) 341-5510 or Ashley Zellmer at (916) 341-5911.

Agricultural Expert Panel Public Meeting #3

Friday May 9, 2014 – 8:30

(Invited Testimony and Public Comment)

Joe Serna Jr. – Cal/EPA Headquarters Building
Byron Sher Auditorium
1001 I Street, Second Floor
Sacramento, CA 95814

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AGENDA

I. Call the meeting to order

II. Declaration of a quorum

Dr. Charles Burt, Panel Chair; Dr. Robert Hutmacher; Till Angermann; Bill Brush; Daniel Munk; James duBois; Mark McKean; Dr. Lowell Zelinski

III. Housekeeping announcements

IV. Review Agenda

V. Panel Introduction and opening remarks by panel members

VI. Review the Charge of the Panel and take invited and public comments

- Presentation of charge to the panel and specific questions – Darrin Polhemus, State Water Resources Control Board
- Dr. Thomas Harter, UC Davis
- Brock Taylor, Certified Crop Advisor
- Dr. Melanie Harrison, NOAA National Marine Fisheries Service
- Public Comment (Any member of the public may present comments or remarks to the Panel. Commenters will be limited to 5 minutes or otherwise at the discretion of the Chair. Commenters will be asked to fill out a speaker card if they wished to be called to speak. Written comments are due by May 14, 12:00 pm noon.)

VII. Panel Discussion

VIII. Adjournment

Background

Chapter 1 of the Second Extraordinary Session of 2008 (SBX2 1, Perata), required the State Water Resources Control Board (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 15 recommendations in 4 key areas to address the issues associated with nitrate contaminated groundwater. The key areas to address these issues are:

9. Providing safe drinking water.
10. Monitoring, notification, and assessment.
11. Nitrogen tracking and reporting.
12. Protecting groundwater.

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 has contracted with the Irrigation Training and Research Center (ITRC), a center established within the BioResource and Agricultural Engineering Department of the California Polytechnic State University, San Luis Obispo to assemble the expert panel of up to 10 persons. The Expert Panel members have been selected and information about the panel members is available on the ITRC website at http://www.itrc.org/001/swrcb.htm . Questions to be presented to the Expert Panel for consideration are provided below.

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Please direct any questions about this agenda to Johnny Gonzales at (916) 341-5510 or Ashley Zellmer at (916) 341-5911.

CALIFORNIA Water Boards

EDMUND G. BROWN JR. GOVERNOR

MATTHEW RODRIQUEZ SECRETARY FOR ENVIRONMENTAL PROTECTION

State Water Resources Control Board

Agricultural Expert Panel Public Meeting #4

Monday June 9, 2014 – 8:00 AM
Irrigation Training and Research Center
California Polytechnic State University, SLO
1 Grand Ave, Building 08A, Room 022
San Luis Obispo, CA 93405

THIS MEETING IS A CONTINUATION OF THE EFFORTS ASSOCIATED WITH THE STATE WATER RESOURCES CONTROL BOARD CHAPTER 1 OF THE SECOND EXTRAORDINARY SESSION OF 2008 (SBX2 1, PERATA) REPORT TO THE LEGISLATURE – RECOMMENDATION 14, EXPERT PANEL AND ADVISORY COMMITTEE FORMATION. THE MEETING WILL BE CONDUCTED BY THE EXPERT PANEL. A QUORUM OF STATE WATER BOARD MEMBERS MAY BE IN ATTENDANCE, BUT NO BOARD ACTION WILL BE TAKEN AT THIS MEETING.

AGENDA

I. **Call the meeting to order**

II. **Declaration of a quorum**
Dr. Charles Burt, Panel Chair; Dr. Robert Hutmacher; Till Angermann; Bill Brush; Daniel Munk; James duBois; Mark McKean; Dr. Lowell Zelinski

III. **Housekeeping announcements**

IV. **Panel introduction and opening remarks by panel members**

V. **Review Agenda**

VI. **Public Comments** (Any member of the public may present comments or remarks to the Panel. Commenters will be limited to 2 minutes or otherwise at the discretion of the Chair. Commenters will be asked to fill out a speaker card if they wished to be called to speak.)

VII. **Panel discussion on questions presented to the panel and formulation of recommendations**

VIII. **Adjournment**

Background

Chapter 1 of the Second Extraordinary Session of 2008 (SBX2 1, Perata), required the State Water Resources Control Board (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 15 recommendations in 4 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.

Expert Panel

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Schedule (some dates may be changed at a later date and all changes will be noticed).

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Completed	Advisory Committee Kickoff Meeting	Cal/EPA Building Sierra Hearing Room, Sacramento
Completed	Expert Panel Public Meeting #1	San Luis Obispo Day 1: Irrigation Training and Research Center Day 2: Monday Club
Completed	Expert Panel Public Meeting #2	SCE Energy Education Center, Tulare
Completed	Expert Panel Public Meeting #3	Cal/EPA Building Byron Sher Auditorium, Sacramento
June 9th, 2014	Expert Panel Discussion Meeting	Irrigation Training and Research Center, San Luis Obispo
June 23rd, 2014	Expert Panel Discussion Meeting	Irrigation Training and Research Center, San Luis Obispo
June 30th, 2014	Expert Panel Draft Report Released	N/A
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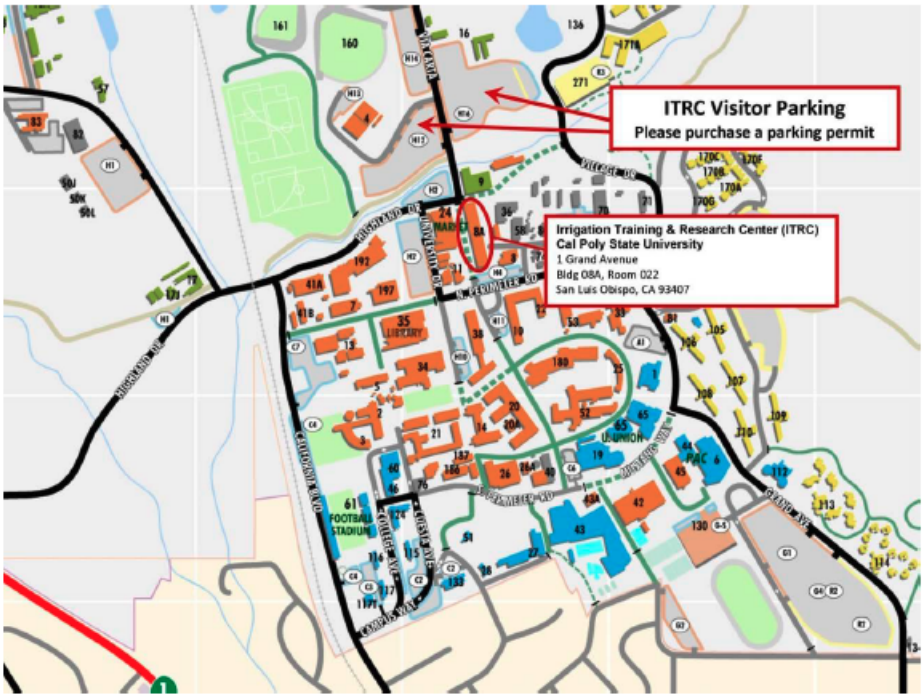
Expert Panel Public Meeting Location Map

June 9 & 23, 2014: Irrigation Training and Research Center, Cal Poly, San Luis Obispo



Building Accessibility

The ITRC Building is accessible to people with disabilities. Individuals who require special accommodations, including real-time translation services, at either of the public meetings are requested to contact Ashley Zellmer at (916) 341-5911.

CALIFORNIA Water Boards

EDMUND G. BROWN JR. GOVERNOR

MATTHEW RODRIQUEZ SECRETARY FOR ENVIRONMENTAL PROTECTION

State Water Resources Control Board

REVISED

Agricultural Expert Panel Meeting #5

Monday June 23, 2014 – ~~8:00~~ 8:30 AM

Meeting Location:
Irrigation Training and Research Center
California Polytechnic State University, SLO
1 Grand Ave, Building 08A, Room 022
San Luis Obispo, CA 93405

Teleconference Location:
Luhdorff & Scalmanini Consulting Engineers
500 First Street
Woodland, CA 95695

Teleconference Location: At least one member of the expert panel will participate in the meeting from the remote teleconference location identified above. The teleconference location is also open to the public. Members of the public are welcome to listen to the meeting from the teleconference location, and will be given an opportunity to present comments to the expert panel during the meeting's public comment period.

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AGENDA

I. **Call the meeting to order**

II. **Declaration of a quorum**
Dr. Charles Burt, Panel Chair; Dr. Robert Hutmacher; Till Angermann; Bill Brush; Daniel Munk; James duBois; Mark McKean; Dr. Lowell Zelinski

III. **Housekeeping announcements**

IV. **Panel introduction and opening remarks by panel members**

V. **Review Agenda**

VI. **Public Comments** (Any member of the public may present comments or remarks to the Panel. Commenters will be limited to 2 minutes or otherwise at the discretion of the Chair. Commenters will be asked to fill out a speaker card if they wished to be called to speak.)

VII. **Panel discussion on questions presented to the panel and formulation of recommendations**

VIII. **Adjournment**

Background
Chapter 1 of the Second Extraordinary Session of 2008 (SBX2 1, Perata), required the State Water Resources Control Board (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 15 recommendations in 4 key areas to address the issues associated with nitrate contaminated groundwater. The key areas to address these issues are:

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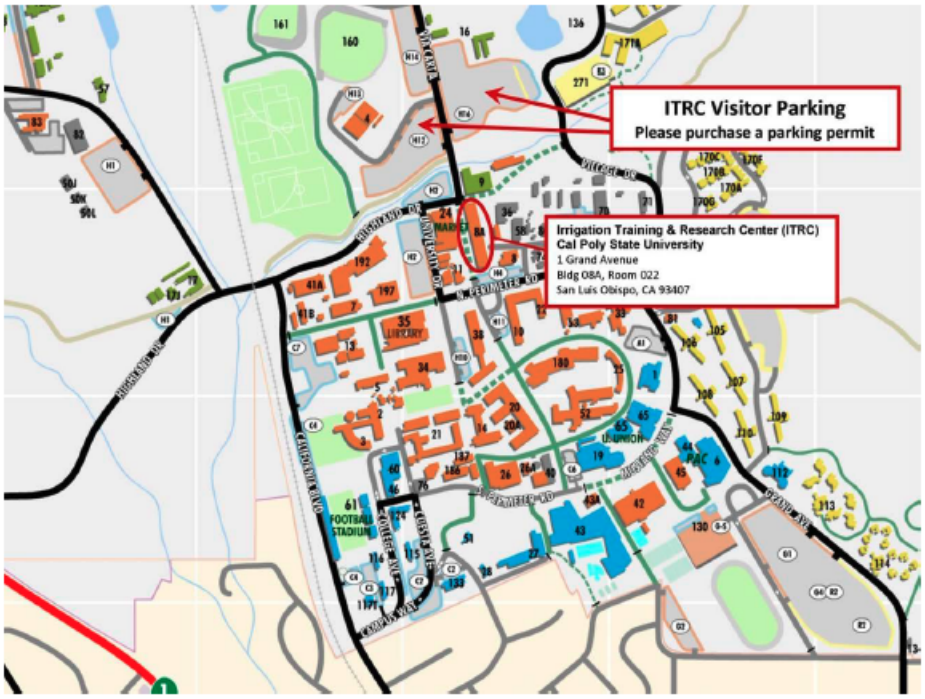
Schedule (some dates may be changed at a later date and all changes will be noticed).

Date	Event	Location
~~March 10th, 2014~~ Completed	Advisory Committee Kickoff Meeting	Cal/EPA Building Sierra Hearing Room, Sacramento
~~May 5th-6th, 2014~~ Completed	Expert Panel Public Meeting #1	San Luis Obispo 5th: Irrigation Training and Research Center 6th: Monday Club
~~May 7th, 2014~~ Completed	Expert Panel Public Meeting #2	SCE Energy Education Center, Tulare
~~May 9th, 2014~~ Completed	Expert Panel Public Meeting #3	Cal/EPA Building Byron Sher Auditorium, Sacramento
~~June 9th, 2014~~ Completed	Expert Panel Meeting #4	Irrigation Training and Research Center, San Luis Obispo
June 23th, 2014	Expert Panel Meeting #5	Meeting Location: Irrigation Training and Research Center, San Luis Obispo Teleconference Location: Luhdorff & Scalmanini, Woodland
July 1st, 2014	Expert Panel Meeting #6	Meeting Location: Irrigation Training and Research Center, San Luis Obispo Teleconference Location: BerryMex SA de CV, Mexico
~~June 30th, 2014~~ July 7th, 2014	Expert Panel Draft Report Released	N/A
~~July 1st – July 30th, 2014~~ July 7th – August 7th, 2014	Public Comment Period on Expert Panel Draft Report	N/A
July 18th, 2014	Expert Panel Public Meeting #7 on Draft Report	Cal/EPA Building Byron Sher Auditorium, Sacramento
July 28th, 2014	Advisory Committee Meeting	Cal/EPA Building Sierra Hearing Room, Sacramento
August 20th, 2014	Expert Panel Meeting #8	Irrigation Training and Research Center, San Luis Obispo
September 23rd, 2014	Expert Panel presents Final Report at Board Meeting	Cal/EPA Building Coastal Hearing Room, Sacramento

Expert Panel Report Drafting Public Meeting Location Maps
June 23, 2014: Irrigation Training and Research Center, Cal Poly, San Luis Obispo



Building Accessibility
Meeting locations are accessible to people with disabilities. Individuals who require special accommodations, including real-time translation services, at the meeting are requested to contact Ashley Zellmer at (916) 341-5911.

CALIFORNIA Water Boards

EDMUND G. BROWN JR. GOVERNOR

MATTHEW RODRIQUEZ SECRETARY FOR ENVIRONMENTAL PROTECTION

State Water Resources Control Board

Agricultural Expert Panel Meeting #6

Monday July 1, 2014 – 8:30 AM

Meeting Location:
Irrigation Training and Research Center
California Polytechnic State University, SLO
1 Grand Ave, Building 08A, Room 022
San Luis Obispo, CA 93405

Teleconference Location:
BerryMex SA de CV
Av. Benito Juarez Sur 713-B
Colonia Vicente Guerrero
Ensenada, Baja California, Mexico 22920

Teleconference Location: At least one member of the expert panel will participate in the meeting from the remote teleconference location identified above. The teleconference location is also open to the public. Members of the public are welcome to listen to the meeting from the teleconference location, and will be given an opportunity to present comments to the expert panel during the meeting's public comment period.

THIS MEETING IS A CONTINUATION OF THE EFFORTS ASSOCIATED WITH THE STATE WATER RESOURCES CONTROL BOARD CHAPTER 1 OF THE SECOND EXTRAORDINARY SESSION OF 2008 (SBX2 1, PERATA) REPORT TO THE LEGISLATURE – RECOMMENDATION 14, EXPERT PANEL AND ADVISORY COMMITTEE FORMATION. THE MEETING WILL BE CONDUCTED BY THE EXPERT PANEL. A QUORUM OF STATE WATER BOARD MEMBERS MAY BE IN ATTENDANCE, BUT NO BOARD ACTION WILL BE TAKEN AT THIS MEETING.

AGENDA

I. **Call the meeting to order**

II. **Declaration of a quorum**
Dr. Charles Burt, Panel Chair; Dr. Robert Hutmacher; Till Angermann; Bill Brush; Daniel Munk; James duBois; Mark McKean; Dr. Lowell Zelinski

III. **Housekeeping announcements**

IV. **Panel introduction and opening remarks by panel members**

V. **Review Agenda**

FELICIA MARCUS, CHAIR | THOMAS HOWARD, EXECUTIVE DIRECTOR

1001 I Street, Sacramento, CA 95814 | Mailing Address: P.O. Box 100, Sacramento, Ca 95812-0100 | www.waterboards.ca.gov

RECYCLED PAPER

VI. **Public Comments** (Any member of the public may present comments or remarks to the Panel. Commenters will be limited to 2 minutes or otherwise at the discretion of the Chair. Commenters will be asked to fill out a speaker card if they wished to be called to speak.)

VII. **Panel discussion of draft report**

VIII. **Adjournment**

Background
Chapter 1 of the Second Extraordinary Session of 2008 (SBX2 1, Perata), required the State Water Resources Control Board (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 15 recommendations in 4 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.

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 has contracted with the Irrigation Training and Research Center (ITRC), a center established within the BioResource and Agricultural Engineering Department of the California Polytechnic State University, San Luis Obispo to assemble the expert panel of 8 persons. The Expert Panel members have been selected and presented with questions for their consideration. Information about the panel members and their charge is available on the ITRC website at http://www.itrc.org/001/swrcb.htm .

Project Tools and Information
Project information, including meeting notices, agendas, meeting minutes, and other pertinent material/documents will be posted online at http://www.itrc.org/001/swrcb.htm and at http://www.waterboards.ca.gov/water_issues/programs/agriculture/.

To receive updates by email, please subscribe to our email list: Nitrate Project - SBX2 1 - Expert Panel. (Located in the "Water Quality Topics" section at http://www.waterboards.ca.gov/resources/email_subscriptions/swrcb_subscribe.shtml.)

Please direct any questions about this agenda to Johnny Gonzales at (916) 341-5510 or Ashley Zellmer at (916) 341-5911.

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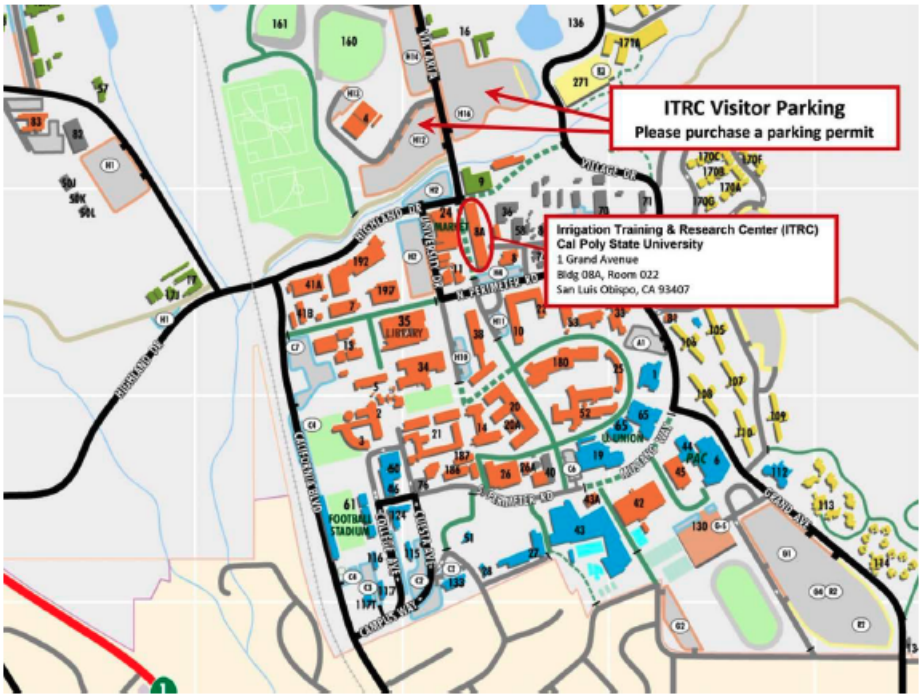

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