CENTRAL VALLEY SALINITY ALTERNATIVES FOR LONG-TERM SUSTAINABILITY (CV–SALTS)

Nitrate Implementation Measures Study (NIMS)

Revised Final Work Plan

August 7, 2015

Prepared for
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Acronyms and Abbreviations

CAFOs	concentrated animal feeding operations
CASGEM	California Statewide Groundwater Elevation Monitoring
Central Valley Water Board	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CVSC	Central Valley Salinity Coalition
CWA	Clean Water Act
DAC	disadvantaged community
DUC	disadvantaged unincorporated community
DWR	California Department of Water Resources
GAR	Groundwater Quality Assessment Report
IAZ	Initial Analysis Zone
ICM	Initial Conceptual Model
ILRP	Irrigated Lands Regulatory Program
IRWM	Integrated Regional Water Management
MCL	maximum contaminant level
MPEP	Management Practices Evaluation Programs
NIMPS	Nitrate Implementation Measures Prioritization Score
NIMS	Nitrate Implementation Measures Study
SNMP	Salt and Nitrate Management Plan
SRWP	State Recycled Water Policy
SSALTS	Strategic Salts Accumulation Land and Transportation Study
State Water Board	State Water Resource Control Board
TAC	Technical Advisory Committee
TDS	total dissolved solids
TRC	Technical Review Committee
USEPA	US Environmental Protect Agency

Section 1
Project Overview

"…[It is] the established policy of the state that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." Assembly Bill No. 685[1].

1.1 Background

The Central Valley Salinity Alternatives for Long Term Sustainability (CV-SALTS) is developing a comprehensive regulatory and programmatic approach to the management of salt and nitrate as nitrogen[2] in the Central Valley that is not only consistent with the State Recycled Water Policy (SRWP) but meets the broader goals of CV-SALTS to develop a workable, comprehensive plan to address salinity, including nitrates, throughout the region in a comprehensive, consistent, and sustainable manner. In this regard, participants in CV-SALTS have established goals to (a) sustain the Valley's lifestyle; (b) support regional economic growth; (c) retain a world-class agricultural economy; (d) maintain a reliable, high-quality urban water supply; and (e) protect and enhance the environment. The work of CV-SALTS is being done with the Central Valley Regional Water Quality Control Board (Central Valley Water Board), the State Water Resources Control Board (State Water Board), the Central Valley Salinity Coalition (CVSC), and other stakeholders.

The CV-SALTS Strategy and Framework document states that the strategy to fulfill the requirements of the SRWP is to adopt a Central Valley Salt and Nitrate Management Plan (SNMP) and revise the Basin Plans applicable to the Central Valley to facilitate implementation of the SNMP. Fulfillment of this strategy will establish the basis for short- and long-term management of salt and nitrate across the Central Valley.

The SRWP states the following:

> *"It is the intent of this Policy that salts and nutrients from all sources be managed on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses….the appropriate way to address salt and nutrient issues is through the development of regional or subregional salt and nutrient management plans rather than through imposing requirements solely on individual recycled water projects."*

Among other things, the SRWP requires that development of the SNMP include the following element (SRWP Section 6.b.3 (e)): "Implementation measures to manage salt and nutrient loading in the basin on a sustainable basis."

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[1] An Act to add Section 106.3 to the Water Code, relating to water. [Approved by Governor September 25, 2012. Filed with Secretary of State September 25, 2012] http://www.leginfo.ca.gov/pub/11-12/bill/asm/ab_0651-0700/ab_685_bill_20120925_chaptered.pdf

[2] By convention, nitrate will be expressed in terms of nitrate as nitrogen in the NIMS. "Nitrate," "nitrate," and "NO_3-N" all refer to nitrate as nitrogen, with a maximum contaminant level (MCL) of 10 milligrams per liter (mg/L).

Salt disposal and implementation strategies were developed previously by CV-SALTS in the three-phased Strategic Salt Accumulation Land and Transportation Study (SSALTS) (CDM Smith, 2013, 2014, and In Preparation). The purpose of SSALTS was to identify the range of viable Central Valley alternatives for salt disposal to provide input for consideration during development of the SNMP for the region under the jurisdiction of the Central Valley Water Board, and establish salt management implementation measures for inclusion in the SNMP.

This work plan for the Nitrate Implementation Measures Study (NIMS) addresses nitrate contamination in the groundwater basins of the Central Valley and appropriate implementation measures to mitigate nitrate contamination using a phased approach that includes providing safe drinking water, reducing or eliminating impacts to drinking water sources and implementing managed restoration activities where needed to restore beneficial uses in groundwater. These implementation measures will be incorporated into the SNMP. The findings from both the SSALTS and the NIMS will be used to guide discussions regarding the need for changes to the existing Basin Plan to facilitate salt disposal and mitigation measures for nitrate in a manner that is most beneficial to the region covered by the SNMP.

1.2 Work Plan Purpose and Objectives

The findings from the completion of the NIMS will provide input to policymakers regarding implementation measures to reduce current ambient nitrate concentrations in groundwater to protect and restore beneficial uses. The implementation measures will be phased and a prioritization methodology will be used to rank groundwater basins in order of priority – where risk reduction from nitrate in groundwater is optimized to facilitate use of the limited resources available. The specific objectives of this study include the following:

1. Summarize salient information about the occurrence, distribution, groundwater remediation, and drinking water treatment of nitrate from the literature. This information will be incorporated by reference. The NIMS will focus on the application of information in the literature to groundwater basins in the Central Valley.
2. Summarize information about existing or planned nitrate mitigation programs and show how they will be integrated into the outcome of NIMS.
3. Develop a proposed phasing approach for implementation of various nitrate implementation measures to provide safe drinking water, reduce or eliminate impacts to drinking water sources, and where needed restore beneficial uses.

Definition of Terms

Groundwater Basins and Subbasins. DWR's Bulletin 118 series "identified groundwater basins, subbasins, and what were referred to as "areas of potential ground water storage" in California as well as maps showing their location and extent…basin boundaries were based on geologic and hydrogeologic conditions except where basins were defined by a court decision." (DWR, 2003)

Groundwater Management Zones. "The Board could delineate 'management zones' which would be portions of existing waterbodies where alternate regulatory measures would apply. The Board would develop specific implementation plans to address salt and nitrate concerns within these zones." http://www.waterboards.ca.gov/centralvalley/water_issues/salinity/salt_management_efforts/cvsalts_2013aug28_ceqa_staffrpt.pdf

4. Define a prioritization methodology, wherein groundwater basins, subbasins or management zones are ranked based on existing nitrate impacts and potential for future impacts to users of groundwater as a water supply.

5. Estimate concept-level costs and establish milestones for implementation of specific nitrate implementation measures. Nitrate implementation measures could include source control measures[3], managed aquifer restoration, pumping and applying for fertilize value, blending, drilling deeper wells, *in situ* treatment, providing alternate sources of drinking water, and treatment of pumped groundwater for potable use.

6. Establish nitrate implementation measures in coordination with the interim and long-term salt management implementation measures proposed by SSALTS. The outcome of this effort will be an SNMP salt and nitrate implementation program that links both nitrate and salt priorities together.

7. Support SNMP development by providing a menu of acceptable or required nitrate and salt implementation measures consistent with SNMP implementation requirements. These implementation measures, which may provide the basis for establishment of a WDR or the nitrate management strategy for a management zone, may differ depending on whether the target is providing safe drinking water, reducing or eliminating impacts to groundwater or implementing a managed restoration in a particular basin, subbasin or management zone.

8. Provide input to Executive Committee policy discussions regarding acceptable salt and nitrate implementation measures.

[3] For example, the Management Practices Evaluation Programs (MPEPs) that will be developed by the Irrigated Lands Regulatory Program (ILRP) coalition groups.

Section 2

Tasks to Define Nitrate Implementation Measures

This introduction summarizes the key project tasks planned for completion under this project:

- **Task 1** will include project set-up and management tasks and meetings.
- **Task 2** will review the nitrate programs that are already in place or are being planned and will provide the context for how NIMS will utilize existing information gleaned from those programs.
- **Task 3** will develop a proposed phased approach and performance target for nitrate in groundwater. This will determine when certain implementation measures would be undertaken to achieve those performance targets.
- In **Task 4**, various criteria will be evaluated to determine the priority ranking of groundwater basins for nitrate mitigation.
- Nitrate implementation measures for groundwater, including source control measures, groundwater remediation, and alternate water supplies will be reviewed in **Task 5**. Task 5 will also include the development of a nitrate balance model. The nitrate balance model will be used to determine how much mass of nitrate would need to be pumped and treated to achieve the Phase 2 and 3 goals discussed in Task 3. For a pilot study area, a similar estimate will be made to mitigate nitrate from only those portions of a groundwater basin that currently exceed the performance target. The pilot study would be a groundwater basin or management zone.
- **Task 6** will describe the nitrate implementation measures selection process for a pilot study area, developing the check-list of implementation measures that would be evaluated.
- **Task 7** will develop joint nitrate and salinity implementation measures.
- **Task 8** is a technical memorandum documenting the findings from all project tasks.

2.1 Task 1. Project Set-up and Management

CDM Smith will perform all project management services for NIMS, including resource allocation and scheduling, cost controls, monthly invoice preparation and review, and the preparation of monthly status reports. Richard Meyerhoff, PhD will serve as the project manager, while Joe LeClaire, PhD will be the technical lead. The establishment of a project committee to work on nitrate implementation measures and to assist with the linkage of NIMS and SSALTS is recommended. CDM Smith will lead and/or participate in the following meetings:

- **Project Kick-off Meeting**. This meeting will be conducted by conference call and will take place within two weeks of the notice-to-proceed.

- **CDM Smith Internal Technical Review Committee (TRC) Meeting**. An internal CDM Smith TRC meeting will be scheduled for the start of Task 5.
- **CV-SALTS NIMS Project Committee and Coordination with the CV-SALTS Technical Project Manager**. The NIMS Project Committee will meet periodically to obtain input on proposed approaches for nitrate management or coordinated nitrate/salt management to ensure consistency with CV-SALTS policy direction. CDM Smith will coordinate these meetings with the CV-SALTS Technical Project Manager, Roger Reynolds.
- **CV-SALTS Technical Advisory Committee (TAC) Meeting**. CDM Smith will present progress updates to the TAC and seek feedback; TAC meetings will be scheduled at the completion of Tasks 4 and 5. It is anticipated that the meetings would be conducted through on-line conferencing. The specific timing and content of these meetings will be coordinated with the CV-SALTS Technical Project Manager, Roger Reynolds.
- **Executive Committee Meeting**. This Executive Committee meeting will be held after Task 5 and will incorporate input from the preceding TAC meeting.

2.2 Task 2. Summarize Existing or Planned Nitrate Mitigation Programs

In Task 2, existing nitrate and salinity monitoring and mitigation programs will be summarized to identify current efforts to manage sources of salt and nitrate in the Central Valley. These programs include the Irrigated Lands Regulatory Program (ILRP), the Dairy Representative Monitoring Program, and WDRs for POTWS and other discharges. These programs will inform the NIMS process and provide the foundation upon which nitrate implementation measures identified through the NIMS can build upon existing management efforts to achieve the goals of nitrate management as described in Section 1. In other words, the NIMS is focused on developing complementary/supplementary, rather than duplicative, nitrate implementation measures that support ILRP, Dairy Representative Monitoring Program, and WDRs in minimizing future impacts to groundwater from nitrate, *e.g.*, through managed aquifer restoration to restore beneficial uses of groundwater. These implementation measures are intended for use under various regulatory programs (e.g., establishment of WDRs) and at different scales, including groundwater basins or subbasins or within a management zone.

2.3 Task 3. Develop a Proposed Phased Approach and Nitrate Performance Targets

The purpose of this task is to develop a proposed phased approach for various nitrate implementation measures and to establish the nitrate performance target in groundwater. The phased approach for the mitigation of nitrate in groundwater includes the phases shown in Table 2-1. The “Period” and “Objectives” shown in Table 2-1 are provided as examples only. The purpose of Task 3 is to define and agree on the length of time and objectives of each phase before actual development of the implementation measures occurs under Task 5.

Table 2-1 Phases of Nitrate Implementation Measures

Phase	Period (years)	Objectives
All	0 to >50	Source control measures to limit nitrate loading to the vadose zone and ultimately to groundwater
1	0 – 5	Near-Term User Protection (*e.g.*, bottled water, home water supplies)
2	2 – 15	Longer-Term User Protection (deeper wells, construction of community treatment systems)
3	5 – 20	Balance input/outflow of nitrate
4	> 20 to 50	Restore beneficial uses - managed aquifer restoration

The immediate concern in Phases 1 and 2 is user protection; reducing the risk to individuals and communities from water supplies with nitrate concentrations greater than the MCL. There is some overlap between Phases 1 and 2. Phase 1 represents interim solutions, including supplying bottled water and trucked water for home water systems. Phase 2 would represent more permanent nitrate implementation measures, *e.g.*, constructing a small community nitrate treatment facility. The mapping subtasks in Task 4 will provide some information on communities most at risk of delivering and consuming pumped groundwater with nitrate concentrations exceeding the maximum contaminant level (MCL) of 10 milligrams per liter (mg/L). Larger water utilities that pump high nitrate groundwater currently are blending or treating water to meet the MCL. Smaller communities, especially disadvantaged communities (DACs) or disadvantaged unincorporated communities (DUCs), as well as individuals with shallow domestic supply wells, are at greater risk. Public outreach and education and alternate water supplies will be necessary at least in the near term to ensure user protection for those constituencies.

Phases 2 and 3, which can overlap to some degree depending on the location, would implement measures to actively remove nitrate from groundwater and thereby lower ambient concentrations. These implementation measures will be developed in Task 5. The timeline goals for Phases 2 through 4 represent a strawman proposal for the design and construction of facilities to treat nitrate-contaminated water; achievement of target nitrate is expected to take much longer, because of the legacy nitrate in the vadose zone.

Water quality objectives have a precise definition[4]: "Pursuant to the California Water Code, these [water quality objectives] are numeric limitations or levels, *e.g.* concentrations, or narrative statements that are established to protect the beneficial uses of a water body." A performance target is not necessarily the same as a numeric water quality objective; in addition, the performance target is specific to the NIMS and is the concentration of nitrate in groundwater that could be achieved if nitrate implementation measures were fully executed. Guidance will be sought from the NIMS Project Committee to develop these target. Also, the methodology for the determination of current ambient concentrations of TDS and nitrate in groundwater are the subject of other CV-SALTS initiatives.

[4] http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf

2.4 Task 4. Define a Groundwater Prioritization Methodology

A prioritization methodology will be defined in the NIMS, wherein groundwater basins, subbasins or management zones are ranked based on the potential for nitrate impacts to users. The goal of NIMS is to reduce risk from nitrate in groundwater sources of water supply for the greatest number of users, given resource constraints. There are 118 groundwater basins and subbasins in the Central Valley, as defined by DWR Bulletin 118 (DWR, 2003). The NIMS prioritization methodology will be used to rank the groundwater basins and the score will be called the Nitrate Implementation Measures Prioritization Score (NIMPS). The proposed methodology for prioritizing the groundwater basins is based on the following criteria:

- California Statewide Groundwater Elevation Monitoring (CASGEM) Program Basin Prioritization Process and Ranking, to the extent the information is relevant to NIMS.
- Average nitrate and TDS concentrations in groundwater.
- Modeled nitrate loading to the upper groundwater aquifer.
- Vulnerability assessment from the Groundwater Quality Assessment Reports (GARs) developed by ILRP Coalition groups and from the Central Valley Dairy Representative Monitoring Program.
- The overlying population.
- Consideration of the population that may consume contaminated groundwater from shallow wells. This may be estimated by considering DACs and DUCs, and – if the data are available – evaluating the number of private wells in the groundwater basin.

Each of these criteria are proposed to be normalized to a common scale and weighted equally to determine the NIMPS. Brief descriptions of the ranking criteria are provided in the following subsections.

2.4.1 CASGEM Program Basin Prioritization Process and Ranking.

As part of the CASGEM program, DWR is required to prioritize groundwater basins in California to "help identify, evaluate, and determine the need for additional groundwater level monitoring.[5]" The CASGEM Basin Prioritization Process is based on the following eight criteria[1]:

1. Overlying population;
2. Projected growth of overlying population;
3. Public supply wells;
4. Total wells;
5. Overlying irrigated acreage;

[5] http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm

6. Reliance on groundwater as the primary source of water;

7. Impacts on the groundwater; including overdraft, subsidence, saline intrusion, and other water quality degradation; and

8. Any other information determined to be relevant by the Department.

To the extent these criteria are relevant to NIMS they will be considered during the groundwater basin prioritization process.

2.4.2 Average Concentration of Nitrate in Groundwater

The intent of this component of the prioritization methodology is to give a higher weight to groundwater basins that are most impacted by nitrate contamination. This will be done with a two-step process. First, the average concentration of nitrate in groundwater will be calculated for each groundwater basin for the period 2003 through 2014. Due to a number of factors (well type/use, land use, farming practices, soil type, hydrology, depth to water, etc.) an average concentration of nitrate may not account for the spatial distribution of nitrate in groundwater. . In the second step, an assessment will be made as to (a) the degree to which the average value is representative of the groundwater basin and to determine clustering and coverage; and (b) the impairment status of individual wells, based on nitrate MCL exceedances. Where appropriate, the ranking of groundwater basins based on average nitrate concentration may be adjusted based on the findings from this second step.

2.4.3 Nitrate Loading to the Upper Groundwater Aquifer

The Initial Conceptual Model (LWA *et al.*, 2013) provides an estimate of TDS and nitrate loading to the upper groundwater zone: "On a per acre basis, [Initial Analysis Zone] IAZs 14 through 21 in the southern Central Valley have relatively greater magnitudes of nitrate loading compared to the northern and middle portions of the Central Valley (see Table 10-4 in LWA *et al.*, 2013). For the northern and middle portions of the Central Valley, IAZs 6 and 7 have relatively higher magnitudes of loading compared to other IAZs in these two regions." The nitrate loading (kg/acre) will be assigned to each groundwater basin or subbasin within each IAZ. Each groundwater basin or subbasin will then be ranked in order of nitrate loading.

2.4.4 Nitrate Vulnerability Assessments

The GARs developed by the ILRP Coalition groups contain an assessment of the vulnerability of areas within the Coalition boundaries to nitrate leaching and impacts to groundwater. The GAR groundwater vulnerability analyses typically included factors for agricultural management systems: irrigation practices, soil characteristics and crop type and pattern. Combinations of these factors can be used to define a nitrate hazard index. Some of the GARs also accounted for current exceedances of water quality objectives in groundwater, statistically-valid trends in water quality, and proximity to DACs that rely on groundwater as a primary drinking water source.

2.4.5 Overlying Population

The 2010 Census Profile data from 2010 US Census of Population and Housing will be analyzed in ArcGIS to estimate the overlying population of each groundwater basin or subbasin.

2.4.6 Consideration of the Population that may be Vulnerable to Consuming Contaminated Groundwater: DACs, DUCs, and Private Well Owners

The intent of this component of the prioritization methodology is to assess the potential for a given population to be at risk from consuming contaminated groundwater pumped from (usually) shallow wells. DACs will be defined in a manner consistent with the preferred method for DAC identification currently under development by Central Valley Water Board staff to support IRLP implementation. In addition, where defined, the NIMS will also take into account DUCs.[6] In addition, frequency of private wells in the area will be considered to the extent such data are available.

2.4.7 Nitrate Implementation Measures Prioritization Score

Managed restoration is the ultimate goal for all groundwater basins and subbasins impacted by nitrate; however, for the purposes of establishing an SNMP implementation program, groundwater basins and subbasins will be prioritized to establish an implementation order that reduces the risk from nitrate ingestion of drinking water for the largest at-risk population most efficiently. Accordingly, each groundwater basin will be assigned a score for each of the six criteria and will be ranked according to their NIMPS. Groundwater basins with higher scores will have higher priority for implementation of nitrate management activities. As discussed in Section 2.7, the co-location of high nitrate and high TDS groundwater may elevate the overall priority ranking for that groundwater basin.

2.5 Task 5. Nitrate Implementation Measures

There are a number of nitrate implementation measures that will reduce nitrate loading to groundwater and reduce ambient concentrations in impacted groundwater basins and subbasins as well as protect groundwater users. These implementation measures fall into three broad categories:

- Source control measures
- Groundwater remediation[7]
- Alternate water supplies

The goal of Task 5 is to consider the most critical measures and to determine the feasibility of implementing these and developing planning level costs.

2.5.1 Develop Nitrate Mass Balance Model

As part of the NIMS, a mass balance spreadsheet model will be developed similar to the TDS mass balance developed previously (CDM Smith, 2014). The mass balance model will look at projected concentrations of nitrate in groundwater for each of the IAZs based on the results from the Initial Conceptual Model (ICM). The information from ICM Tables 10-4 and 10-5 will be used as the basis for nitrate loading in the NIMS (LWA *et.al*, 2013). The nitrate loading (kg/acre) and the area will

[6] http://www.policylink.org/sites/default/files/CA_UNINCORPORATED_2.PDF

[7] Treatment technologies such as ion exchange, reverse osmosis, electrodialysis, weak-base anion exchange, chemical and biological denitrification are summarized in the literature (*e.g.*, Jensen *et al.*, 2012) and will be included herein by reference.

be used to determine the mass loading of nitrate for each IAZ on an annual basis. The upper groundwater nitrate data will then be used in a mass balance analysis to determine the volume of groundwater that would need to be extracted to achieve various targets of nitrate in each groundwater basin. It should be noted that there is a large legacy nitrate load in the vadose zone and that the nitrate in groundwater is a result of anthropogenic activities that occurred decades ago. The NIMPS will make an assumption that loading from legacy nitrate in the vadose zone will not change for 50 years. In other words, changes in source control measures and other management practices made today to reduce nitrate leaching will not have an impact on groundwater concentrations until 2065.

2.5.2 Alternate Drinking Water Supplies

Section 2.5.2 will review options for supplying alternate water supplies to users, with emphasis on DACs, DUCs, and individual families who do not have direct access to safe drinking water. Options for blending, drilling deeper wells, packing off screen intervals with higher contamination, trucking in water, providing bottle water, connecting to an existing community water system or constructing a new community system, or providing well-head treatment will all be analyzed. Mitigating factors will be addressed for consideration in Task 6. An example could be potential increases in arsenic concentrations with depth for new well drilling requiring blending with the original shallow well.

2.5.3 Source Control Measures

There are a number of source control measures that can be applied across all sectors of nitrate contributors to groundwater, including: agricultural (croplands, dairies, feedlots), industrial, urban (outdoor water use and fertilizer application, wastewater treatment plants), food processing wastewater disposal, *etc*. (Viers, 2012).

Harter *et al.*, (2012) reviewed sources of nitrate to groundwater in the Tulare Lake Basin and the Salinas Valley (a similar distribution would be expected for the San Joaquin River Basin, as well) and identified the following nitrate sources as illustrated in Figure 2-1:

- Irrigated agriculture (croplands),
- Wastewater treatment plant and food processing waste discharges,
- On-site waste disposal systems (Septic systems),
- Urban land uses,
- Corrals, and
- Lagoons.

According to this study, the largest contributor of nitrate to groundwater in that study area was irrigated agriculture, accounting for 96 percent of the total nitrogen load to groundwater in these basins. While best management practices to reduce nitrate loading from all sources can be beneficial, at a macroscale the most significant gains for this particular area would be made by reducing nitrate loading from irrigated agriculture.

For example, groundwater protection is best accomplished by reducing nitrate leaching below the root zone to the greatest extent possible. Dzurella *et al*. (2012) state "While the complete elimination of agricultural nitrate loading to groundwater is not possible, adoption of improved farming management practices can help to mitigate this concern."

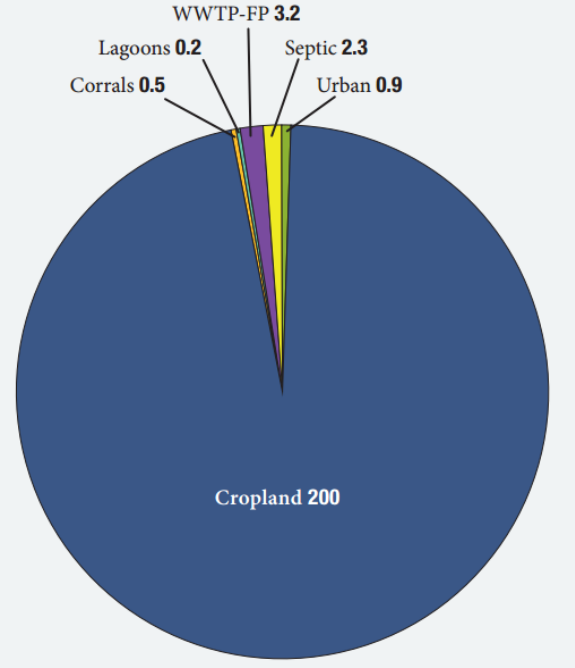

Figure 2-1 Estimated Nitrate Loading to Shallow Groundwater in the Tulare Lake Basin and Salinas Valley, in gigagrams (Gg)
Source: Harter et al., 2012

The general irrigated agriculture management practices to limit nitrate loading include:

- Design and operations & maintenance of irrigation systems to reduce deep percolation
- Optimize crop and field management (crop rotations, tillage) to reduce nitrate leaching.
- Manage nitrogen fertilizer and manure to increase crop nitrogen use efficiency and decrease deep percolation

There are a number of specific implementation measures that can be site and crop specific. The University of California Cooperative Extension will be contacted to provide expert opinions of ranges of nitrate leaching reductions that may result from the ILRP MPEP studies and subsequent implementation of enhanced management practices. A range of percent reduction of nitrate mass leached would be applied to the ICM nitrate loading values for IAZs in the mass balance model described in Section 2.4.1. The percent reduction would be adjusted based on an expected participation rate by growers, who may be reluctant to adopt new management practices for a variety of reasons (*e.g.*, converting from furrow to drip systems can be expensive). In considering source control measures for irrigated agriculture, the NIMS will take into account changes to crop

type and fallowing, to the extent that data are available for the pilot study area (see Task 6, Section 2.6).

It is important to note that while the above example illustrates best management practices that may be considered to manage agricultural sources of nitrate loading, the SNMP will be implemented at varying scales, from a local POTW to a management zone, which may be a large agricultural area. Accordingly, NIMS will evaluate best management practices for reducing nitrate loading for all primary sources, including, but not limited to wastewater and waste dischargers, septic systems and urban land uses. The outcome will be a menu of source control best management practices applicable to a range of potential nitrate loading sources.

2.5.4 Groundwater Remediation

As discussed in King *et al.* (2012) there are a number of general types of groundwater remediation strategies.

- Pump and fertilize,
- Pump and treat (aboveground, or *ex situ*), and
- In situ treatment.

2.5.4.1 Pump and Fertilize

Pump and fertilize is an implementation measure that would use existing irrigation wells to pump groundwater that contains nitrate from legacy crop fertilization and irrigation practices. The applied irrigation water will have relatively high nitrate concentrations and the grower would reduce normal fertilizer application rates and/or formulations to account for the nitrate added through the irrigation water supply. This will require careful monitoring and adaptive management by the grower, as well as an outreach and education program.

2.5.4.2 Pump with Aboveground Treatment

Pump with aboveground treatment of groundwater includes treatment using standard drinking water treatment technologies (Footnote 7), as well as other treatment systems (*e.g.*, wood chip bioreactors). Relatively localized areas impacted by point sources of nitrate contamination can be treated more efficiently than much larger areas impacted by non-point sources (*e.g.*, agricultural practices) where the nitrate is more dispersed and at typically lower concentrations. The NIMS will locate, to the extent possible, significant localized areas or sources of nitrate contamination in groundwater that would be suitable for pump and treat technologies at a plume-scale. Point sources of nitrate are typically associated with municipal and food processing waste discharge ponds, concentrated animal feeding operations (CAFOs), dairy lagoons, etc. The mass of nitrate removed from plume-scale remediation will be accounted for in the nitrate mass balance model. It will also be assumed that the extracted and treated water from such projects will be put to beneficial use, if possible for municipal or industrial supply.

Managed aquifer restoration or basin-scale groundwater remediation will be costly and will take decades to achieve. King *et al.* (2012) states that they "…do not consider this basin-scale pump and treat scenario to be either economical or feasible." NIMS will perform a similar analysis to develop concept-level cost estimates for managed aquifer restoration with two performance

targets: (i) balance of nitrate inflows and outflows and (ii) restoration of beneficial uses (nitrate at or below the performance target). These correspond to Phases 2 and 3 discussed in Section 2.3 (Task 3). This will be accomplished using the same methodology as in SSALTS (CDM Smith 2014). Nitrate will be considered a conservative species (not transformed or degraded). The alluvial aquifers in the Central Valley are generally aerobic with little microbial activity and no carbon source to support denitrification.

For a pilot study area, a similar estimate will be made to mitigate nitrate from only those portions of a groundwater basin that currently exceed the performance target. The pilot study would be a groundwater basin or management zone.

A key consideration in any large scale aquifer restoration program for remediation is what to do with the water that has been treated. Depending upon the time scale assumed, this could result in very large quantities of water to extract, treat and use/discharge. To avoid any sustained mining of the groundwater basins which are already under stress due to the prolonged draught, it is assumed that all of the water extracted and treated would be put to beneficial use. A small percentage could possibly be used for potable supply as previously described, but the rest would presumably be re-applied for agricultural use (*i.e.*, putting treatment on agricultural wells). The alternative would be to re-inject the treated water.

2.5.4.3 *In Situ* Treatment

Options for *in situ* nitrate treatment will be reviewed in the NIMS, including in situ biological denitrification which involves injecting bacteria and a carbon source into the groundwater system. Distributing the bacteria and carbon throughout the nitrate contaminated area and controlling the oxidation-reduction potential is often difficult. Permeable reaction barriers can also be used to denitrify nitrates in groundwater under the right circumstances. If the nitrate plume is relatively shallow, a trench or series of borings can be advanced in the path of the nitrate plume and filled with reactive media.

2.6 Task 6. Select Nitrate Implementation Measures

For a pilot study area, this task will methodically complete a checklist of implementation measures and evaluation factors that affect the implementation measures, to the extent that data and requisite information are available. This pilot process can serve as the template or archetype for other groundwater basins or management zones. For example, the findings may be used as the basis for establishing a short and long term nitrate management strategy within a management zone or provide the basis for a WDR. The checklist would include, but may not be limited to the following.

- Identify the agency, joint powers authority, or coalition that will responsible for nitrate (and possibly salt) implementation measures.
- Identify the primary sources of nitrate? Non-point sources? Point sources?
- If the sources are predominantly non-point, work with the ILRP Coalition groups and contribute to or review and comment on the MPEP process.

- Evaluate other source control measures (*e.g.*, other agriculture, municipal, food processing, domestic turf irrigation and fertilization) and how effective they may be.
- If there is a point source of nitrate (*e.g.*, a wastewater treatment plant discharge pond), define what measures can be implemented to reduce nitrate at the source (*e.g.*, optimize municipal wastewater treatment plant operations). Determine if *in situ* treatment is an option (*i.e.*, review all of the factors, including depth to water that will determine if *in situ* nitrate remediation is possible). Is pump and treat an option for the point source plume of nitrate? Evaluate various pump and treat options (reverse osmosis, ion exchange, *etc.*) Consider brine management. Will the product water be used for potable supply or blended and used for irrigation?
- For pump and fertilize, how much nitrate mass will be removed annually? Work with UC Cooperative Extension and others in education and outreach programs to assist growers in monitoring irrigation water for nitrate concentration and reducing other nitrate applied (this is not straightforward).
- Evaluate stormwater capture and recharge programs. Increased stormwater recharge will dilute nitrate concentrations in groundwater (and increase available water supply).
- Identify DACs, DUCs and to the extent possible, individuals with access only to shallow groundwater. At a macro scale, estimate costs of supply alternate water supplies to those communities and individuals (see Section 2.4.3). Consider pump, treat, and serve just to meet domestic water demands. Pump and treat in a managed aquifer restoration program requires pumping large volumes of groundwater and the high quality product water is used for irrigation or re-injection back into the aquifer. Pump, treat, and serve would be used in conjunction with pump and fertilize, and the highly treated water from pump, treat, and serve could be used to meet potable demands, especially of DACs, DUCs, and individuals without access to other safe drinking water. Education and outreach would be required so that users know not to drink from contaminated wells. For both pump and treat and pump, treat, and serve, consider brine disposal.
- Describe local, regional, state, and federal funding opportunities including, fertilizer use fees, water rate increases, grants, bonds, Proposition 1 project funds, *etc.*

The objective of Task 6 is to develop a checklist and methodology for other groundwater basins and/or management zones for nitrate implementation measures.

2.7 Task 7. Joint Nitrate and Salt Implementation Measures

The purpose of Task 6 is to define the linkage between proposed nitrate implementation measures and interim and long-term SSALTS alternatives, and propose an implementation program that considers both nitrate and salt priorities together. The treatment technologies reviewed in SSALTS (CDM Smith, 2014) will remove nitrate together with all salts. On the other hand, there are lower cost technologies that focus only on nitrate that may be more appropriate if there are areas with elevated nitrates but acceptable levels of TDS. Future emerging technologies

considered for mitigating both salt and nitrate in pumped groundwater in the Central Valley will need to evaluate if nitrate removals are acceptable. Opportunities for joint implementation measures exist where TDS and nitrate are above performance targets in a subregional area (*i.e.*, a management zone).

A map, or series of maps, will be produced that show areas (using Thiessen polygons or some other method of estimating TDS and nitrate concentrations in groundwater) where TDS exceeds 1000 mg/L, where nitrate exceeds 10 mg/L, and where both TDS and nitrate exceed their respective performance targets. These would be areas where joint implementation measures would be cost effective. All of the other nitrate implementation measures would still be evaluated with the methodology described in Task 6.

2.8 Task 8. Prepare a Nitrate Implementation Measures Technical Memorandum

CDM Smith will prepare draft and final Technical Memoranda, including all requisite figures and tables. The Technical Memoranda will state the objectives of the NIMS, provide detailed results for each component of the NIMS, and summarize key findings. The Technical Memorandum will be written to be readily incorporated into the SNMP in order to facilitate its adoption. Comments are to be submitted in writing within 14 days of submission of the draft Technical Memorandum. The final Technical Memorandum will be revised based on comments received from the CV-SALTS stakeholders within 14 days. A detailed comment and response table will be completed and submitted as an appendix to the final NIMS Technical Memorandum.

2.9 Deliverables

The deliverables for the NIMS will include the following:

- Monthly status reports (included with the invoice).
- Electronic and hard copies of PowerPoint presentations prepared for the TAC, Project Committee or Executive Committee meetings. TAC meetings are scheduled at the completion of Tasks 4 and 5.
- Meeting agenda and notes.
- Draft and final Technical Memoranda that include all of the work products from Tasks 1 through 7.

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Section 3
Schedule and Cost

Figure 3-1 is a Gantt chart that shows the schedule for the completion of the NIMS. The objective is to have the work completed by late November or early December 2015, so that it can be incorporated into the SNMP which is due in May 2016. The schedule is contingent on direction from CV-SALTS and the availability and access to data in the CV-SALTS database.

Task	Description	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
1	Project Set-up & Management					
2	Summarize Existing or Planned Nitrate Mitigation Programs					
3	Develop a Phased Approach and Nitrate Attainment Goals					
4	Define a Groundwater Prioritization Methodology					
5	Nitrate Implementation Measures					
6	Select Nitrate Implementation Measures					
7	Joint Nitrate and Salt Implementation Measures					
8	Prepare NIMS Technical Memoranda					

Notice to proceed is anticipated to be in mid-August 2015.

Figure 3-1 Schedule for the NIMS

Below is the work breakdown structure and cost estimate for the NIMS, which provides a breakdown of the level of effort by employee billing along with other direct charges (ODCs).

Table 3-1 Work Breakdown Structure and Cost Estimate for the NIMS

Task	Description	Vice President (OIC)	Vice President (Technical Review)	Associate	Scientist Grade 2	Scientist Grade 3 (GIS)	Admin	Technical Review OP	Total Labor Hours	Total Labor Dollars	ODCs	Total Task Costs
1	Project Set-up & Management	2	4				4		10	$1,870		$1,870
2	Summarize Existing or Planned Nitrate Mitigation Programs			24					24	$5,760		$5,760
3	Develop a Phased Approach and Nitrate Attainment Goals			16	4				20	$4,340		$4,340
4	Define a Groundwater Prioritization Methodology			36	12	60		8	108	$19,280		$19,280
5	Nitrate Implementation Measures		4	80	12	24		12	120	$26,480		$26,480
6	Select Nitrate Implementation Measures		4	40	12				56	$12,080	$685	$12,765
7	Joint Nitrate and Salt Implementation Measures			40		40		12	80	$16,560		$16,560
8	Prepare NIMS Technical Memoranda			40	12		8	8	60	$12,940		$12,940
	TOTAL	***2***	***12***	***276***	***52***	***124***	***12***	***40***	***478***	***$99,310***	***$ 685***	***$ 99,995***

GIS Geographic Information Systems
ODC Other Direct Charges
OIC Officer in Charge
OP Outside Professional

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Section 4
References

California Department of Water Resources. 2003. California's Groundwater. Bulleting 118. Update 2003. October 2003.

California Department of Water Resources. 2015. California's Groundwater Update 2013. A Compilation of Enhanced Water Content for California Water Plan Update 2013. San Joaquin River Hydrologic Region. April 2015.

California Department of Water Resources. 2015. California's Groundwater Update 2013. A Compilation of Enhanced Water Content for California Water Plan Update 2013. Tulare Lake Hydrologic Region. April 2015.

California Department of Water Resources. In Preparation. California's Groundwater Update 2013. A Compilation of Enhanced Water Content for California Water Plan Update 2013. San Joaquin River Hydrologic Region. In Preparation.

CDM Smith. 2013. Strategic Salt Accumulation Land and Transportation Study (SSALTS): Draft Final Phase 1 Report – Identification and Characterization of Existing Salt Accumulation Areas. Prepared for the San Joaquin Valley Drainage Authority. December 2013.

CDM Smith. 2014. Strategic Salt Accumulation Land and Transportation Study (SSALTS): Draft Final Phase 2 Report – Development of Potential Salt Management Strategies. Prepared for the San Joaquin Valley Drainage Authority. September 2014.

CDM Smith. In Preparation. Strategic Salt Accumulation Land and Transportation Study (SSALTS): Draft Final Phase 3 Report – Evaluate Potential Salt Disposal Alternatives to Identify Acceptable Alternatives for Implementation. Prepared for the San Joaquin Valley Drainage Authority. In Preparation.

Dzurella, K.N., J. Medellin-Azuara., V. B. Jensen, A. M. King, N. De La Mora, A. Fryjoff-Hung, T. S. Rosenstock, T. Harter, R. Howitt, A. D. Hollander, J. Darby, K. Jessoe, J. R. Lund, and G. S. Pettygrove. 2012. Nitrogen Source Reduction to Protect Groundwater Quality. Technical Report 3 in: *Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature*. Center for Watershed Sciences, University of California, Davis.

Jensen, V. B., J. L. Darby, C. Seifel, and C. Gorman. 2012. Drinking Water Treatment for Nitrate. Technical Report 6 in: *Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature.* Center for Watershed Sciences, University of California, Davis.

Harter, T., J. R. Lund, J. Darby, G. E. Fogg, R. Howitt, K. K. Jessoe, G. S. Pettygrove, J. F. Quinn, J. H. Viers, D. B. Boyle, H. E. Canada, N. DeLaMora, K. N. Dzurella, A. Fryjoff-Hung, A. D. Hollander, K. L. Honeycutt, M. W. Jenkins, V. B. Jensen, A. M. King, G. Kourakos, D. Liptzin, E. M. Lopez, M. M. Mayzelle, A. McNally, J. Medellin-Azuara, and T. S. Rosenstock. 2012. *Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature.* Center for Watershed Sciences, University of California, Davis.

Honeycutt, K., H. E. Canada, M. W. Jenkins, and J. R. Lund. 2012. Alternative Water Supply Options for Nitrate Contamination. Technical Report 7 in: *Addressing Nitrate in California's Drinking Water with A Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature*. Center for Watershed Sciences, University of California, Davis.

King, A.M., D. Boyle, V. B. Jensen, G. E. Fogg, T. Harter. 2012. Groundwater Remediation and Management for Nitrate. Technical Report 5 in: *Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature.* Center for Watershed Sciences, University of California, Davis.

Larry Walker Associates, Inc. 2013. *Initial Conceptual Model (ICM) Technical Services: Tasks 7 and 8 – Salt and Nitrate Analysis for the Central Valley Floor and a Focused Analysis of Modesto and Kings Subregions. Final Report.* Prepared for the San Joaquin Valley Drainage Authority. Submitted by Larry Walker Associates, Inc., in association with Luhdorff and Scalmanini Consulting Engineers, Kennedy/Jenks Consultants, Plantierra, Systech Water Resources, and Carollo Engineers. September 2013.

Viers, J.H., D. Liptzin, T. S. Rosenstock, V. B. Jensen, A. D. Hollander, A. McNally, A. M. King, G. Kourakos, E. M. Lopez, N. De La Mora, A. Fryjoff-Hung, K. N. Dzurella, H. E. Canada, S. Laybourne, C. McKenney, J. Darby, J. F. Quinn, and T. Harter. 2012. Nitrogen Sources and Loading to Groundwater. Technical Report 2 in: *Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Report for the State Water Resources Control Board Report to the Legislature*. Center for Watershed Sciences, University of California, Davis.

Appendix A

Comments and Responses on the Draft, Final, and Revised Final NIMS Work Plans

Appendix A – Comments and Responses on the Draft, Final and Revised Final NIMS Work Plans

No.	Commenter	Page	Reference	Comment	Response
1	Thomas Harter UC Davis		Section 2.3.2, Volume-Weighted Nitrate Concen-tration	The Thiessen polygon method to extrapolate water quality data to make estimates of remediation volume may be overly simple. It may be more informative to use equal area cells and identify cells with NO measurements; these can be targeted for an expanded water quality network	Comment noted and the text has been revised to state that the Thiessen polygon method is a "possible" method to be used for estimating volume-weighted average nitrate concentrations. Other possible methods will be evaluated, including the USGS equal area irregular grid cell method or similar methods, stratification weighting methods, and other geostatistical methods. Emphasis will be placed on selecting a fundamental method that achieves a spatially-unbiased estimate; and if determined to be applicable or critical to calculation of a Nitrate Implementation Measures Prioritization Score (NIMPS), the method selected will allow identification of data gaps, incorporation of estimation uncertainty, and be tied to other or subsequent groundwater monitoring programs, including the surveillance and monitoring plan (SAMP).
2	Thomas Harter		Section 2.3.2, Volume-Weighted Nitrate Concen-tration	Similarly, the Thiessen polygon method may not be the best method to design a monitoring well network. Belitz *et al.* (WRR, 2010) describe in detail an excellent method for selecting wells for a spatially unbiased monitoring network (attached). The USGS has an equal area grid for the Central Valley (as a shapefile), likely available from Miranda Fram at USGS Sacramento. We also have used similar methods to create equal area cells of the Central Valley (*e.g.*, SBX2 1 UC Davis study, Technical Report 4, http://groundwaternitrate.ucdavis.edu). I can make our most recent shapefiles available (currently missing metadata)	Please see the response to Comment 1. We have contacted Dr. Fram and have scheduled a call to review the USGS equal area irregular grid cell method and to determine if the grid developed by the USGS for the Central Valley is at the appropriate scale and would meet the needs of the NIMS. Thank you for your offer of sharing your grid shapefiles; we will be contacting you to discuss this.

No.	Commenter	Page	Reference	Comment	Response
3	Thomas Harter		General	The NIMS is lacking a strong tie-in with ongoing efforts. If the outcome of this project is a nitrate implementation measures platform similar to the salt implementation measures, then - as Casey Creamer mentioned - this project would be best served if it does two VERY critical things: 1. Identify exactly how the dairy WDR, and the various ILRP activities/WDRs, including their groundwater quality assessment reports, their vulnerability assessments, and their nutrient management tracking/reporting, management practice evaluation program, and regional trend monitoring program will become an active part of the CV-SALTS nitrogen implementation measures 2. Identify all nitrogen sources OTHER than dairies and irrigated agriculture, including septic systems, wastewater treatment plants, urban stormwater runoff, and food processors that leak or discharge nitrate into surface waters and groundwater. These are not under any WDRs? Like the salt discharges, these sources need particular attention and CV SALTS may be the only program to manage these sources. Hence, it appears that CV SALTS may want to spend a significant effort, similar to the salts process it has done, or to the ILRP process, on ensuring that these sources are appropriately covered. While these sources may not be large valley-wide they have significant local contamination potential. What are the RWB's thoughts on this?	Response from Jeanne Chilcott/ Central Valley Water Board: "Thank you for providing the clarification. Please note that all the discharges that you mention under #2 below are under regulation through either individual or general waste discharge requirements. Recognizing that the multiple potential sources and relative contributions vary between geographic areas in the Central Valley is one of the reasons that CV-SALTS is trying to keep the Management Zone concept as locally based as possible when we consider implementation alternatives." The intent of both the SAMP and NIMS is to use existing nitrate and salinity monitoring and mitigation programs to develop a framework for the Central Valley. The SAMP and NIMS are not intended to be duplicative of the on-going efforts to mitigate nitrate and TDS, but will utilize the existing programs and information developed therein. As noted in the above response from the Central Valley Water Board, the other sources are under regulation through either individual or general waste discharge requirements. The intent of the NIMS would be to assess the potential sources described in Comment 3 (Item 3) for the pilot study area.

No.	Commenter	Page	Reference	Comment	Response
4	Thomas Harter		General	You mentioned that CDM is developing a regional trend monitoring program for CV-SALTS. That would be at least partially an effort duplicating four other regional groundwater trend monitoring programs: ▪ For over ten years, the California Department of Pesticide Regulations has maintained a domestic well trend monitoring program in Fresno and Tulare County. Data are available through GeoTracker GAMA. http://www.cdpr.ca.gov/docs/emon/grndwtr/ ▪ The Central Valley Representative Dairy Monitoring Programs has developed an extensive shallow groundwater monitoring program specifically to understand groundwater contributions from dairies, ▪ http://dairycares.com/CVDRMP. The program is designed to monitor shallow groundwater on 42 dairies, mostly in the San Joaquin Valley and the Tulare Lake Basin ▪ The ILRP coalitions, similar to the CVRDMP, have been asked by RWB to install regional trend monitoring networks, using domestic wells. I am not sure what the status of that is ▪ SWRCB GAMA (Diane Barclay) is developing a shallow groundwater monitoring program (statewide I believe). I am not sure of all the details in the monitoring objectives of these programs. But I strongly suggest that the SWRCB GAMA, the ILRP regional trend monitoring program, and the CV SALTS regional monitoring programs be either developed as a single network, co-designed to meet the various objectives of these programs, or that the three networks all are designed using the same standards in a coherent, joined, quasi-unified fashion. Rather than duplicating networks, it seems to make much more sense to leverage the limited funding available to maximize the knowledge to be gained from the combined network.	A Surveillance and Monitoring Program (SAMP) is being developed for CV-SALTS and will be included in the Salt and Nutrient Management Plan (SNMP). The key objective of the SAMP is to: "Develop a monitoring program that will allow for statistically-defensible Ambient Water Quality (AWQ) determinations and trend analyses. The SAMP, as part of the SNMP, is designed to fulfill the monitoring requirements of the planned Basin Plan Amendment (BPA) and support its adoption and approval. From the scope of work for the SAMP: "Utilize existing monitoring programs and existing monitoring stations in order to be cost-effective and consistent." Task 2 of the SAMP includes identifying and coordinating information with other monitoring programs; the regional programs that you cite are explicitly included in the SAMP work plan.

No.	Commenter	Page	Reference	Comment	Response
5	Bruce Houdesheldt Northern California Water Association	2-2	Section 2.2 Develop a Proposed Phased Approach and Nitrate Attainment Goals	The language in the last paragraph on Package Page 15 states, "Where the current ambient groundwater nitrate is less than the MCL, the goal would be an anti-degradation target that would preserve or maintain the current ambient nitrate concentrations and not allow a long term increase, absent a maximum benefit demonstration. Is that consistent with the assimilative capacity discussions taking place at the CV SALTS Executive Policy Committee?	The text has been modified from: "The default nitrate attainment goal in groundwater in general is the MCL. However, where current ambient groundwater nitrate is less than the MCL, the goal would be an antidegradation target that would be to preserve or maintain the current ambient nitrate concentrations and not allow a long term increase, absent a maximum benefit demonstration. If the current ambient groundwater nitrate is greater than the MCL, the target attainment goal would be to reduce average ambient groundwater concentrations to 10 mg/L. The determination of current ambient concentrations of TDS and nitrate in groundwater are the subject of other CV-SALTS initiatives." to: "Water quality objectives have a precise definition: 'Pursuant to the California Water Code, these [water quality objectives] are numeric limitations or levels, *e.g.* concentrations, or narrative statements that are established to protect the beneficial uses of a water body.' A target attainment goal is not necessarily the same as a numeric water quality objective. The target attainment goal is specific to the NIMS and is the concentration of nitrate in groundwater that could be achieved if nitrate implementation measures were fully executed. Guidance will be sought from the NIMS project committee to develop the target attainment goal. Also, the methodology for the determination of current ambient concentrations of TDS and nitrate in groundwater are the subject of other CV-SALTS initiatives."

No.	Commenter	Page	Reference	Comment	Response
6	Bruce Houdesheldt	1-1	Section 1.1	Only found one typo in the whole document on Package Page 10 the "W" and the "R" are flipped…as a Journalism major I can help proofing documents I have no expertise in. I can appreciate sound technical work that allows a layman like me to feel somewhat conversant in the subject matter.	Comment noted and the text has been modified.
7	Glenn Meeks Central Valley Water Board		1.1	The NIMS document should include the following edit at the end of the first sentence in 1.1 Background, ". . . and meets a long-term goal of environmental and economic sustainability".	Comment noted and the text has been modified.
8	Glenn Meeks		2.2	The use of 10 mg/L Nitrate as N as the attainment goal for aquifer restoration is too limiting. We need to identify a lower value for a restoration attainment "goal" (maybe somewhere between 50 to 80% of the MCL-the group may have to weigh in on what should be utilized) or link the 10 mg/l value with a decreasing trend in concentration. In irrigated lands, we use 50% of the MCL with a statistically valid increasing concentration trend to identify high vulnerability areas.	See the response to Comment 5.
9	Glenn Meeks		General	Targeted aquifer restoration (storm-water recharge, managed aquifer restoration with surface water or treated water, etc.) should be included in the groundwater remediation section as potential implementation measures for aquifer restoration.	Managed aquifer restoration is discussed in Section 2.4.2.2 Pump with Aboveground Treatment. Section 2.5 discusses stormwater capture and recharge programs as a nitrate implementation measure. Increased stormwater recharge will dilute nitrate concentrations in groundwater (and increase available water supply). These are critical considerations and will be analyzed carefully in the NIMS.

No.	Commenter	Page	Reference	Comment	Response
10	Glenn Meeks		Section 2	Suggest rearranging 2.4.3 Alternate Drinking Water Supplies to be the first item under 2.4. Also suggest including woodchip bioreactor technology as a potential implementation measures and, at the end of the document, a future technologies section that lists options on the horizon that may be utilized in the future.	We moved Section 2.4.3 Alternate Drinking Water Supplies to be 2.4.2. We thought it made sense to keep 2.4.1 Develop Nitrate Mass Balance Model as the first subsection under Section 2.4, because it defines the magnitude of the problem. But yes, it makes sense to have alternate water supplies be moved up front, because these implementation measures will be executed quickly. Wood chip bioreactors were mentioned in Section 2.4.2.2 Pump with Aboveground Treatment, but we will add a subtask for the NIMS to discuss emerging technologies.
11	Glenn Meeks		Section 2.3	The document should emphasize that the basin prioritization methodology will draw on the existing program prioritization schemes (e.g. the ILRP and the Dairy Program – which have major emphasis on addressing those areas where communities have been impacted that are dependent on groundwater as a significant source of water supply, especially DACs and DUCs.). The ILRP also looks at intrinsic susceptibility based on physical parameters and areas with a statistically valid increasing nitrate concentration trend for determining areas that work needs to be focused on.	Comment noted. The NIMS will have a very clear tie-in to the existing nitrate programs and to the extent available will use ILRP and Dairy Representative Monitoring Program (DRMP) results to inform the NIMS process and develop a framework for nitrate mitigation.
12	Glenn Meeks		General	Also, please be sure that I am included in the project committee for NIMS.	Comment noted and you will be included on the NIMS project committee.
13	Lacey L. Mount Dellavalle Laboratory, Inc.	2-9	2.4.2.1 Pump and Fertilize	Regarding the 'Pump and Fertilize' section of the draft NIMS, how do you plan to determine "normal fertilizer application rates?"	Typical fertilizer rates will vary by crop type, soil type, irrigation method, grower preferences and many other factors. Reduction of fertilizer applied will require careful monitoring and adaptive management by the grower to understand nitrate concentrations in irrigation water (which will be time varying). Education and outreach programs will be critical.

No.	Commenter	Page	Reference	Comment	Response
14	Casey Creamer Kings River Conservation District		General	I believe it is important that this report first highlight what has already been done, what will continue into the future, and the new requirements that are just being implemented. Many of the issues brought up on the call were a rehashing of the irrigated lands WDR adoption. In my opinion, we've already done the scope of work necessary for nitrate implementation through the irrigated lands, dairy order, and POTW WDR's. Those measures should be highlighted so that they are not forgotten. This should also help show how this effort is not duplicative to other efforts. Additional efforts connecting the drinking water solutions and the ACP structure would be helpful in this document. This is the regional strategy for addressing nitrates to complement the WDR efforts to minimize future pollution. The Regional Board also has a groundwater protection strategy, which may be helpful to this effort (http://www.waterboards.ca.gov/centralvalley/water_issues/groundwater_quality/index.shtml#gwstrategy) For the WDR's for irrigated lands, surface water quality issues have been addressed for successfully for 10 years through coalition efforts. For groundwater quality, new orders were adopted in late 2012 through 2014 and many of the program requirements are just beginning. Below are the requirements that have been started or will be implemented soon… **New ILRP Requirements for Coalition Groups for Groundwater** ▪ Complete a Groundwater Quality Assessment Report and update or confirm at least every 5 years (identifies high and low vulnerability areas) ▪ Conduct a Management Practices Evaluation Program (extensive study of practices/crops protective of groundwater quality)	The intent of both the SAMP and NIMS is to use existing nitrate and salinity monitoring and mitigation programs to develop a framework for the Central Valley. The SAMP and NIMS are not intended to be duplicative of the on-going efforts to mitigate nitrate and TDS, but will utilize the existing programs and information developed therein. The NIMS will have a very clear tie-in to the existing nitrate programs and to the extent available will use ILRP and Dairy Representative Monitoring Program (DRMP) results to inform the NIMS process and develop a framework for nitrate mitigation. A new Task 2 has been added to the NIMS work plan that will summarize existing or planned nitrate mitigation programs and will describe the integration of NIMS with those programs. CV-SALTS is also developing a concept for an Alternative Compliance Program/Project (ACP), "for wells that may be adversely affected by the discharge, and especially those located in areas already impaired by poor water quality, by protecting water users through other means (e.g. alternate water supply or on-site treatment)." ACPs will be integrated into NIMS. The NIMS will also account for other on-going CV-SALTS initiatives including, the definition and development of management zones and the estimates of assimilative capacity.

No.	Commenter	Page	Reference	Comment	Response
				▪ Complete and implement an individual or Comprehensive Groundwater Quality Management Plan for confirmed exceedances of groundwater quality ▪ Develop a groundwater trend monitoring plan ▪ Develop a Sediment Discharge and Erosion Assessment Report (identifies growers needing sediment plans) ▪ Compile and summarize plans submitted by members and report to the Regional Board. (Nitrogen Management Plan Summary Report, Farm Evaluation) ▪ Conduct extensive education and outreach (NMP, Practices that reduce minimize leaching, Practices identified as BPTC, Farm Evaluation, Sediment & Erosion Control Plans, etc.) **New ILRP Requirements for Members of Coalition Groups** ▪ Implement Nitrogen Management Plans on Farm (certification required in High Vulnerable Areas) ▪ Complete Nitrogen Management Plan Summary Report and submit to the Coalition (only applicable in High Vulnerable Areas) ▪ Complete the Farm Evaluation Template (every year in High, every 5 years in Low) ▪ Implement a Certified Sediment and Erosion Control Plan in identified areas ▪ Minimize application of Nitrogen to meet crop consumption ▪ Implement practices protective of water quality ▪ Implement well head protective practices	

No.	Commenter	Page	Reference	Comment	Response
15	Debbie Webster Central Valley Clean Water Association		General	In evaluating nitrate solutions, the salt impact should be considered. Options that address both if both are an issue should "rate higher" than something that may be a quick fix for one, but could create another problems. For example, the pump and fertilize option reduces Nitrate in the upper zone, but will also increase salts. If that increase will necessitate us going back to this area to address salts, then maybe that is not the best solution for that area. Think holistically. The final reports should evaluate and discuss how these nitrate management measures could impact salt levels or how if a management alternative would have salt benefits too. For example, pump & fertilizer will concentrate salts – how significantly? Will we be solving one problem to create another? Stormwater recharge needs to be considered in as a remediation tool that can help both nitrates and salts Stormwater recharge might provide dual benefits. Use this as a ranking tool. The solutions for CV-SALTS need to be holistic. Note that in 2.6, this methodology may not work especially if the aquifer as a whole is being considered. How is what is stored in vadose zone being considered?	Good comment, with two components. In terms of the basin prioritization, the analysis of volume-weighted TDS concentrations has been explicitly added. Task 7 (Section 2.7) addresses the integration of nitrate and salt implementation measures. This task addresses not only areas of opportunity (where TDS and nitrate concentrations are both high), but will also look at the potential impacts of nitrate implementation measures on water supply and salinity. Stormwater recharge will be considered in the NIMS and will be part of the portfolio of planning and implementation options. Consideration of water supply, salinity, and other constituents will be addressed in Tasks 6 and 7. The related impacts of salinity, water supply, nitrate, and other water quality issues will be discussed. Regarding the vadose zone, see response to Comment 22.
16	Debbie Webster		Section 2.2	I was a bit concerned with the timelines in the report and how they were portrayed and discussed. Certainly, short term solutions like providing bottled water should be only that – short term. However, when providing an alternative supply like a permanent community drinking water system, this type of supply could realistically take more than two years and may be more than five as described in the report. ▪ Timelines may need shifting in light of problems/solutions: – Phase I may be two parts – first phase temporary user protection 0-5 years; permanent user protection 2-15 years	Comment noted. The Phase goal is user protection; reducing risk to individuals and communities from water supplies with nitrate concentrations greater than the MCL. This can be accomplished immediately with public outreach and education and alternate water supplies (*e.g.*, bottled water, household water tanks, *etc.*). You are correct that a construction of a permanent community drinking water system will likely take longer than 5 years (the funding and design work could be longer than 5 years). This will be further reviewed in the NIMS. The table has been modified to reflect your comments. The actual timeframes may be different; suggested timeframes will be discussed by the project committee.

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17	Debbie Webster		General	In writing the report be clear what are goals, firm recommendations and timelines, etc. so that they are can be used appropriately when transferred to the SNMP and regulatory implementation measures.	Implementation timelines, goals and targets will be explicitly stated in the NIMS technical memorandum, specifically Tasks 6 and 7.
18	Debbie Webster		General	To the extent available, include Nitrate information for the whole Central Valley instead of just the IAZs.	CDM Smith has been tasked with reviewing water quality in Central Valley groundwater basins that are not contained within the IAZs associated with the valley floor (an outcome of June 18 Executive Committee Policy meeting). This assessment will be conducted using the CV-SALTS database for TDS and nitrate. A summary of that assessment will be included in the NIMS.
19	Debbie Webster		General	Biosolids can provide a benefit as soil amendments.	Comment noted. This will be discussed as part of Task 2.5.3.
20	Debbie Webster		Section 2.3	On prioritization, there may be a need to look at upper level vs whole aquifer levels for prioritization, especially if that is where the majority of wells are taking their water from.	Yes, this issue will be addressed during the prioritization process and with input from the project committee. Agree that the aquifer zone where potable supply wells (municipal and community/individual) are screened in is critical. This issue is important when analyzing alternative implementation measures: blending, drilling deeper wells, treatment, etc.
21	Debbie Webster		Section 2.3.6	Just a word of caution on DAC designations – defining the boundaries of who is included in the DAC can significantly alter who is in and who is out of that designation. After initial assessment, it usually make sense to revisit the boundaries to see if what was drawn makes sense.	Comment noted. We will review and revisit the DAC and DUC designations for the pilot study area and modify as necessary.

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22	Debbie Webster		Section 2.3.3	On the mass balance model, how will the assumption that activities will not change mass for 50 years coincide with the timeline goals in described in the beginning of the report. May want to caveat the description in this section to where remediation activities have/are taking place.	The NIMPS will make an assumption that loading from legacy nitrate in the vadose zone will not change for 50 years. In other words, changes in source control measures and other management practices made today to reduce nitrate leaching will not have an impact on groundwater concentrations until 2065. The timeline goals for Phases 2 through 4 discussed in Section 2.3 represent a strawman proposal for the design and construction of facilities to treat nitrate-contaminated water; achievement of target attainment goals is expected to take much longer, because of the legacy nitrate in the vadose zone.
23	Debbie Webster		General	For POTWs, recycled water needs to be considered including different nitrate strengths that can be found.	A range of nitrate concentrations for recycled water will be assumed based on typical POTW treatment trains.
24	Debbie Webster		Section 2.8 Deliverable	On deliverable: Data within databases developed for CV-SALTS should also be available as a deliverable so that future work can use this information rather than having to recreate it.	The database used for the NIMS is the 2014 CV-SALTS database. Any data modified and/or added to the CV-SALTS database will be documented and that revised version would be submitted as a deliverable.
25	Central Valley Water Board		Section 1.2	Clarify (a) nitrate management goals include providing safe drinking water, reducing or eliminating impacts to groundwater and implementing a managed restoration program; (b) timeframes for implementation of nitrate measures needs to be specific rather than general; (c) relationship/linkage between nitrate and salt implementation measures; and (d) some nitrate and salt management alternatives may be requirements rather than guidance.	Clarification made in opening paragraph of section and edits made primarily to items 3, 4. 5. 6, and 7 in the list of specific objectives for the study.
26	Central Valley Water Board		Section 2.2	Clarify that existing nitrate management programs are source control programs and that NIMS will focus not just on nitrate sources, but legacy issues as well.	Section 2.2 task description revised accordingly.

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27	Central Valley Water Board		Section 2.3	Clarify that phasing periods may overlap; avoid use of the word "attainment" given its regulatory meaning in water quality standards regulations.	Clarifications provided; replaced "target attainment goal" verbiage with "performance target"
28	Central Valley Water Board		Section 2.4.1	CASGEM may not have relevance to some of the purposes of the NIMS prioritization process, especially in regards to water quality.	Text revised to note CASGEM information will be used where relevant; also removed Table 2-2 as its findings are not relevant to water quality and could be misinterpreted in context of NIMS Work Plan.
29	Central Valley Water Board		Section 2.4.2	Reconsider use of volume-weighted average concentration of nitrate as basis for ranking groundwater basins based on water quality. Volume-weighted approach could mask problem areas.	Revised approach to use average nitrate concentration (no volume weighting); however, two-step process built because simple averaging does not take into factors that may influence results (e.g., well clustering, well type, etc.). Once average is calculated in first step; a second step will be applied to evaluate spatial distribution of data and degree to which data result is representative of overall basin.
30	Central Valley Water Board		Section 2.4.6	Board staff are working on a preferred method for DAC identification to support ILRP implementation.	Revised text to note that DAC identification method for NIMS will be consistent with the Central Valley Water Board's preferred method.
31	Central Valley Water Board		Section 2.4.7	Clarify that even though a priority may be assigned to a groundwater basin/subbasin, the ultimate goal is managed restoration	Revised paragraph to clarify
32	Central Valley Water Board		Section 2.5.3	While management of nitrate sources in agricultural lands is important (as written), clarify that the SNMP (through NIMS findings) should address source control for all nitrate sources.	Section revised to note that menu of BMPs will be developed for all primary sources of nitrate.
33	Central Valley Water Board		General	Watch overuse of acronyms	Document cleaned up to reduce acronym usage

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34	Central Valley Water Board	1-3	Item 7	Part of the end of the section is not quite in English, likely due to the cutting and pasting, so I'm not sure exactly the point you're making.	The text has been revised from: "These implementation varies may differ depending on whether the target is providing safe drinking water, reducing or eliminating impacts to groundwater or implementing a managed restoration in a particular basin, subbasin or management zone to: "These implementation measures may differ depending on whether the target is providing safe drinking water, reducing or eliminating impacts to groundwater or implementing a managed restoration in a particular basin, subbasin or management zone."
35	Central Valley Water Board		Table 2-1	Still needs a row listing All Phases: Source Control.	The table has been modified to include this row.
36	Central Valley Water Board		Section 2.4.2	Developing targets: would like to be clear that the second step includes looking at individual well impairments as part of the overall prioritization process and not just aquifer averages.	This element has been included in the evaluation and prioritization process.
37	Laurel Firestone Community Water Center	1-1	Quote at top of page	This is actually a quote from the Human Right to Water Act that is now in the Water Code as of 2012 and is state law.	The citation for the quote has been updated.

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38	Laurel Firestone	1-2	Section 1.2 Intro	I am not clear why this Central Valley Basin prioritization is needed or how this will be used. Shouldn't these needs be addressed in each WDR and enforcement action the board considers regardless of some prioritization across the Central Valley region? Isn't implementation going to have to be by dischargers so shouldn't they be looking at mitigating and restoring the uses relevant to them rather than treating this like a program that is funded by taxpayers where we might want to look at the whole CV to prioritize where to start?	NIMS is a programmatic level study to assist with the establishment of implementation priorities for the developing Central Valley SNMP. SNMP implementation measures will include specific activities (short and long term) and milestones for completing or carrying out those activities. The prioritization task will provide data to help support the identification of these milestones and appropriate time frames for their implementation given varying nitrate conditions.
39	Laurel Firestone	1-2	Section 1.2, Objective 1	There are a number of pilot projects going on now under the Drinking Water regulatory program and any fully analyzed and official reported results should be included here for consideration, even if not yet published in a peer review journal. Cindy Forbes at the drinking water regulatory program at the state board should be able to ensure this is provided to the consultant team. I know there is some good information coming from Triple R in Tulare County, for example, on reduced cost nitrogen treatment for small systems.	Thank you for the comment; we will work with you and others during project execution to be sure we incorporate as much current information as possible in the study.
40	Laurel Firestone	1-2	Section 1.2, Objective 1	Also, a lot of literature review and application to local needs was developed in the Tulare Lake basin DAC study pilots, which can be downloaded here: http://tularecounty.ca.gov/cao/index.cfm/tulare-lake-basin-disadvantaged-community-water-study/pilot-projects/ This should all be considered as well.	Thank you for the information; it will be considered during project execution.
41	Laurel Firestone	1-2	Section 1.2, Objective 3	I don't understand what the context is and why there is a phased approach needed for the purpose of this report and CV Salts. Why not analyze what would be needed for the whole region?	The incorporation of a phased approach provides an implementation framework for the SNMP, especially with regard to the establishment of milestones. Phasing recognizes that nitrate conditions vary considerably across the Central Valley and, therefore, the requirements to achieve different outcomes (user protection versus the balance of inflow/outflow versus the restoration of beneficial uses) will also vary from one area to another. The framework not only assists with identification of milestones to achieve different outcomes, but supports the development of estimated costs to achieve these outcomes.

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42	Laurel Firestone	1-3	Section 1.2, Objective 5	It would be helpful to provide a tool to help locals evaluate and compare costs between options and give guidance on what important factors may be determinative and how costs may change depending on the level of nitrate that has to be addressed.	Task 6 will use a pilot study area to evaluate the selection of implementation measures to achieve different water quality outcomes (see previous response). In the pilot study area, the NIMS will be provide a template for how others can select appropriate implementation measures to achieve appropriate outcomes for their area and at what cost.
43	Laurel Firestone	1-3	Section 1.2, Objective 6	"Establish nitrate implementation measures" - What does this mean?	The phrase "implementation measures" is borrowed from the Recycled Water Policy which requires that an SNMP include "Implementation measures to manage salt and nutrient [nitrate] in the basin on a sustainable basis." For our purposes, implementation measures refer to the various methods, tools, procedures that may be implemented in a given groundwater basin, subbasin or management zone to reduce nitrate concentrations to achieve the desired outcome (ranging from user protection to managed restoration). The implementation measures incorporated into the SNMP will also include milestones for their implementation.
44	Laurel Firestone	2-1	Task 5 Summary Description	Will a cost analysis be included in this and also an analysis that can be used to help evaluate to what level the aquifer could be restored (i.e. to background levels vs. to just below the MCL, etc.) and timelines that are feasible?	Yes, NIMS will develop general costs to achieve different outcomes and recommended timelines for their execution. From Section 2.5.4.2, "NIMS will perform a similar analysis to develop concept-level cost estimates for managed aquifer restoration with two performance targets: (i) balance of nitrate inflows and outflows and (ii) restoration of beneficial uses (nitrate at or below the performance target)." For the pilot study area, these costs and outcomes will be developed on a more detailed level specific to the area of study.

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45	Laurel Firestone	2-1	Task 6 Summary Description	Regarding "developing checklist" - I am concerned about developing the tools to actually evaluate them and the levels of nitrate to be restored, not just providing a check list that no one has the tools to evaluate and implement.	The "checklist" of implementation measures that could be implemented in a given area will be developed as part of Task 5. Under Task 6, NIMS will demonstrate how specific implementation measures may be selected to address the nitrate conditions identified for the Pilot Study area. The desired outcome is to show how for any area implementation measures may be selected to achieve desired outcomes, *e.g.*, short-term user protection vs. long-term restoration.
46	Laurel Firestone	2-1	Task 7 Description	Regarding "implementation measures" - Again, I am not clear what this means	See response to comment number 43
47	Laurel Firestone	2-2	Section 2.3	Regarding "nitrate performance targets" - Again, I am not clear what this means	In the context of this study, a performance target is the water quality goal to be achieved. For example if the groundwater basin, subbasin or management zone has nitrate concentrations greater than 10 mg/L, is the target to simply reduce nitrate concentrations in groundwater to a value less than 10 mg/L or something less, *e.g.*, 6 or 8 mg/L? Knowing the target is critical to the selection of implementation measures, determining the timeline for success (milestones), and what the estimated costs will be to achieve that success.
48	Laurel Firestone	2-3	Table 2-1 – Potential Phase of Implement ation	Again, shouldn't this be determined based on local conditions and feasibility? I think all need to be pursued in all cases simultaneously and the years that they take need to be based on feasibility studies appropriate to local conditions. I am concerned about what this table is suggesting. There are certainly areas where some managed aquifer restoration may be less than 20 years and others where it is more, for example.	We agree that the time frame for achieving a desired outcome will likely vary from one area to another. This study will develop a general framework for the Central Valley for inclusion in the SNMP. Actual phasing/timelines will depend on local conditions and feasibility. Making such determinations would occur as part of the development of a management zone, application for a WDR, or some other regulatory program.

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49	Laurel Firestone	2-3	Section 2.3 – 1st ¶ below Table 2-1	I am unclear how you will determine what the appropriate strategy and cost will be for interim and long-term mitigation for drinking water. That is really site specific and you should work with DFA at the State Board and groups like ours that have implemented interim solutions projects in how you develop this. Are you using the methodology used by the UC Davis TLB and Salinas basin study? I do think we have more info now on things like POU, in particular.	NIMS can develop general costs to achieve different water quality outcomes based on nitrate conditions. This information provides context for the establishment of a Program of Implementation, including milestones for the SNMP (it also provides a basis for the economic analysis that must be completed for the SNMP). The actual strategy and costs are certainly site-specific and would be determined as part of the development of a management zone, application for a WDR, or some other regulatory activity. The pilot study findings will help inform what a typical strategy and cost might look like. The methodology to determine the mass of nitrate that would need to be remediated to meet alternative performance nitrate targets is similar to that used by UC Davis. We would appreciate further discussion concerning new information that would be germane to the analysis, for example information about the POU.
50	Laurel Firestone	2-3	Section 2.3 – 2nd ¶ below Table 2-1	But the timeline feasible to restore groundwater for all areas will be evaluated and analyzed as part of this study, right, not just assumed a uniform timeline?	A general assessment for groundwater basins in the Central Valley floor will be completed. It is expected that the timeline for achieving desired outcomes will vary from one area to another, *i.e.*, it is not uniform.
51	Laurel Firestone	2-3	Section 2.3 – 3rd ¶ below Table 2-1	Regarding statement, "in addition, the performance target is specific to the NIMS and is the concentration of nitrate in groundwater that could be achieved if nitrate implementation measures were fully executed. Guidance will be sought from the NIMS Project Committee to develop these target." - Shouldn't this be established through an anti-deg analysis? What will this study be able to contribute to being able to do this analysis and determine what is feasible?	See response to Comment 47. NIMS is a programmatic level study and will identify implementation measures (and costs) to achieve selected performance targets. However, application occurs at the WDR or management zone level and certainly an antidegradation analysis would be part of the local process.
52	Laurel Firestone	2-4	Section 2.4 - 1st ¶	Regarding statement, "The goal of NIMS is to reduce risk from nitrate in groundwater sources of water supply for the greatest number of	The statement was made to recognize that the outcome of NIMS is to identify implementation

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				users, given resource constraints." - I am not clear on why this is the goal and am not sure it is appropriate. Shouldn't the goal be to determine and analyze the feasibility of nitrate implementation measure to ensure all domestic water users impacted by nitrate can access safe drinking water and aquifers impacted by nitrate are restored to support domestic use and other beneficial uses?	measures with milestones for inclusion in the SNMP. This is to cover all of the Central Valley and recognizes that resources are not available to address all concerns in all places at the same time. For any local process, *e.g.*, issuance of a WDR or establishment of a management zone, the specific goals for that area will be identified and the approach to achieving them evaluated. These goals – as identified in the NIMS work plan – are the same as stated by the comment – access to safe drinking water, reduction or elimination of impacts to drinking water sources and implementation of managed restoration.
53	Laurel Firestone	2-5	Section 2.4.3	So does this take into account loading in the vadose zone as well as on-going practices?	This study will make general assumptions regarding loading from the vadose zone and expectations from on-going practices. Decades of agricultural practices typically result in a large mass of nitrate and TDS in the vadose zone. In the UC Davis study, it is stated that, "…significant low conductivity material present in the aquifers will provide diffuse sources of nitrate for decades…" (King *et al.*, 2012). Similar observations have been made, for example, in the Chino Basin in the Santa Ana Watershed. In the Pilot Study area, these assumptions will be looked at in more detail, to the extent such data are available.
54	Laurel Firestone	2-6	Section 2.4.7	See my comments above with questions about why prioritization is needed and how this will be applied (See Comment 38).	See response to comment 38
55	Laurel Firestone	2-7	Section 2.5.1	Regarding statement, "The NIMPS will make an assumption that loading from legacy nitrate in the vadose zone will not change for 50 years." - Can't we do an analysis that actually estimates this based on data rather than just use this assumption? Shouldn't it depend on estimates of what is in the vadose zone and hydrology? I would hope this study can provide a first estimate analysis of this for the basin.	We agree that conducting studies to estimate legacy nitrate in the vadose zone is important information; however, that analysis would need to be site or area-specific. There is insufficient budget to do those types analyses (and presumes such data are readily available). The alternative is to make assumptions and these assumptions will be discussed with the Project Committee during project execution.

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56	Laurel Firestone	2-7	Section 2.5.2	Regarding, "will review options" - What does this review look like? What is this actually providing us in terms of analysis applied?	This subsection will review alternate water supplies for users of private domestic wells that may be shallow and contaminated with groundwater. The options will be described, analyzed in terms of advantages and disadvantages, and to the extent possible, costs would be assigned to each alternative.
57	Laurel Firestone	2-8	Section 2.5.4	Should also include targeted recharge.	The NIMS will address targeted recharge of stormwater and water from other sources. From Section 2.6, "Evaluate stormwater capture and recharge programs. Increased stormwater recharge will dilute nitrate concentrations in groundwater (and increase available water supply)."
58	Laurel Firestone	2-8	Section 2.5.4	What will this analysis look like? I am not clear what info will be provided.	At a macro-scale (IAZs), this analysis will estimate how much nitrate could be extracted from groundwater and used (pump and fertilize) or treated (pump with aboveground treatment). The analysis will also include an estimate of the mass of nitrate that could be denitrified *in situ*. Concept-level costs associated with these remediation strategies will be provided.
59	Laurel Firestone	2-10	Section 2.6	Regarding "checklist" - See my comments above on concern about what the product of this section will look like (See Comment No. 45).	See response to Comment 45
60	Laurel Firestone		General	When considering source control measures for irrigated agriculture, take into account changes to crop type to limit the mass of nitrate that migrates vertically past the root zone, as well as fallowing.	To the extent that data are available for an archetype area, like the Alta Irrigation District Management Zone, these measures can be discussed and evaluated. Changing crop types has an agronomic/economic impact (can a different crop type be profitably and sustainably grown in a given area?) that may require a separate analysis that is beyond the scope of NIMS.

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61	Casey Creamer		General	Make it clear in the NIMS work plan that the implementation measures are intended for use under various regulatory programs, but especially management zones	Sections 1.2 (Objective 7), 2.2 and 2.6 were revised to make this point more clear.
62	Casey Creamer		General	When developing the nitrate mass balance for groundwater basins, to what degree is nitrate uptake through crop production being considered?	The ICM analyzed nitrate loading to shallow groundwater for six nitrogen use efficiency (NUE) values. We will work with the project committee to determine appropriate nitrate loading scenarios for the NIMS, based on a bracketing range of NUEs.
63	Glenn Meeks	2-5	Section 2.4.2	Clarify that that the evaluation of the impairment status of individual wells will be based on exceedances of the nitrate MCL	Revised text as requested