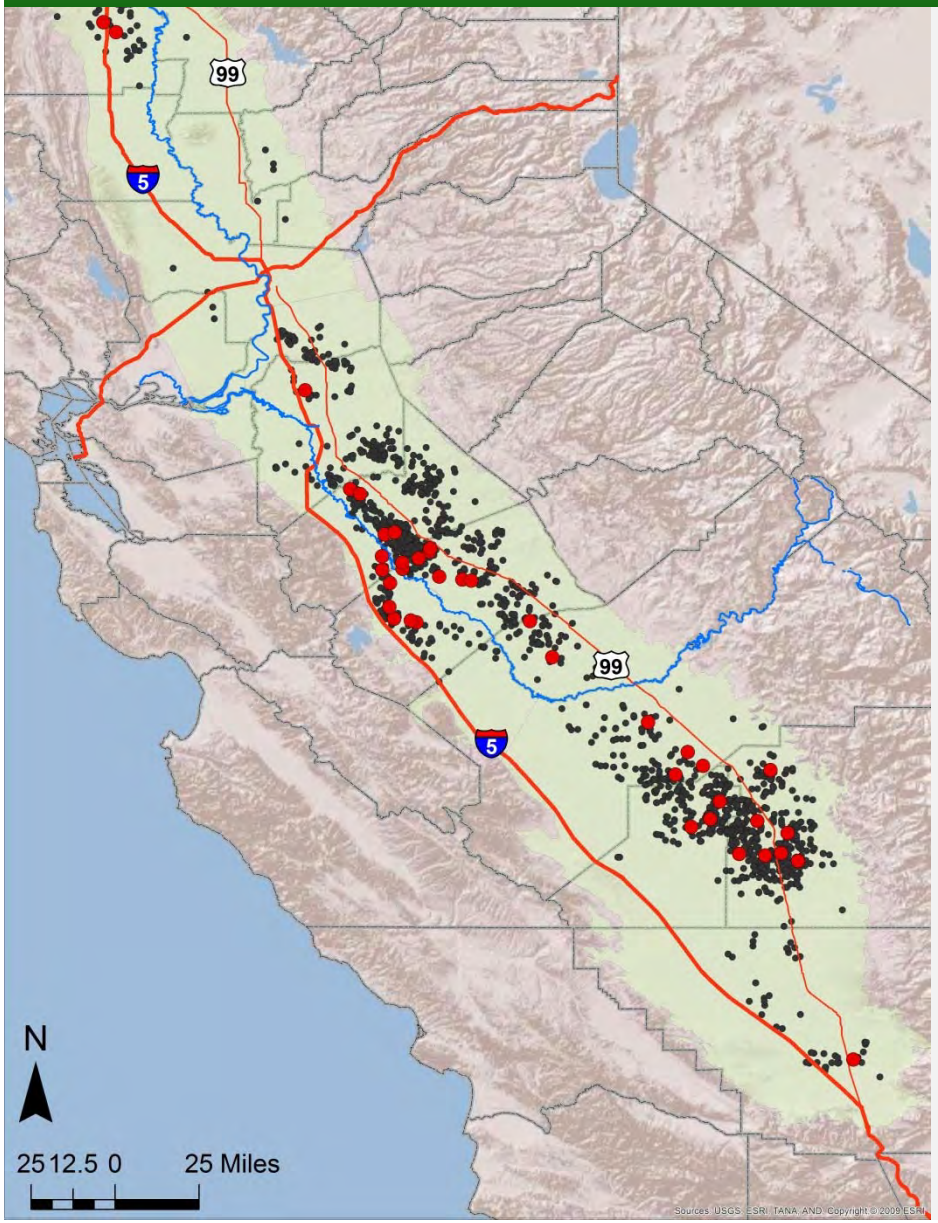
Central Valley Dairy Representative Monitoring Program – Status Update



Stakeholder Meeting

Central Valley Regional Water
Quality Control Board

11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670

September 2, 2015

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Presentation Overview

1. **Representative Monitoring Program Overview**
2. **Initiatives & Activities**
   - Lagoon Performance Evaluation
   - Improving Nitrogen Management
   - Collaboration with Lawrence Livermore National Laboratory
3. **Summary**

Representative Monitoring Program

- A regulatory compliance monitoring program in response to the Dairy General Order (2007, reissued 2013)
- An alternative to monitoring well installation and management practices evaluation at ~1,175 individual dairies
- Collects data on a subset of dairies representative of the industry and pertinent site conditions
- Develops management practices recommendations for all Central Valley dairies

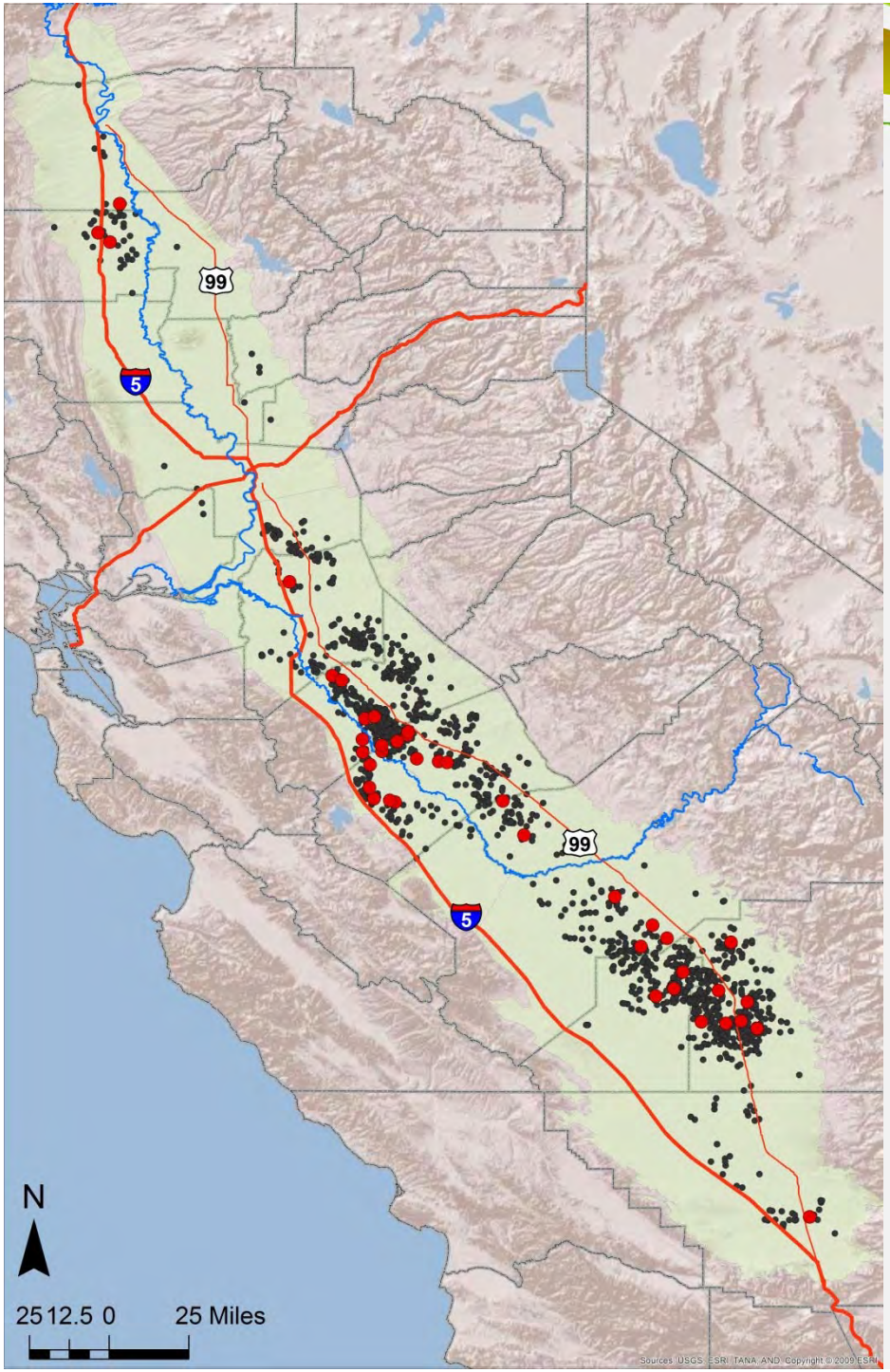
Representative Monitoring Program

Required

- Monitoring and annual reporting
- Summary Representative Monitoring Report (SRMR) due April 2019

SRMR is to:

- Identify management practices that are protective of groundwater quality for the range of conditions found at dairies covered by the RMP
- Provide implementation schedules for practices that are as **short as practicable**, supported with appropriate technical or economic justification, **not to exceed** 10 years from SRMR approval



- 42 monitored dairies
- 443 dedicated monitoring wells at 279 well sites
- Phased approach started Jan. 2012 (18 dairies)
- Fully implemented Jan. 2013 (+24 dairies)
- Monthly GW level monitoring
- Groundwater quality monitoring
  - quarterly: 9 constituents
  - annual: 22 constituents
- >16,000 raw data points per year

Initiatives & Activities

1. Lagoon Performance Evaluation
2. Improving Nitrogen Management
3. Collaboration with Lawrence Livermore National Laboratory

Lagoon Performance Evaluation

Seepage rates & subsurface mass emissions

1. In-situ seepage quantification via water balance testing

Effects on groundwater, extent of impact

2. Lagoon perimeter hydrogeologic investigation
3. Geophysical surveys: electrical resistivity tomography (ERT), electromagnetic (EM)

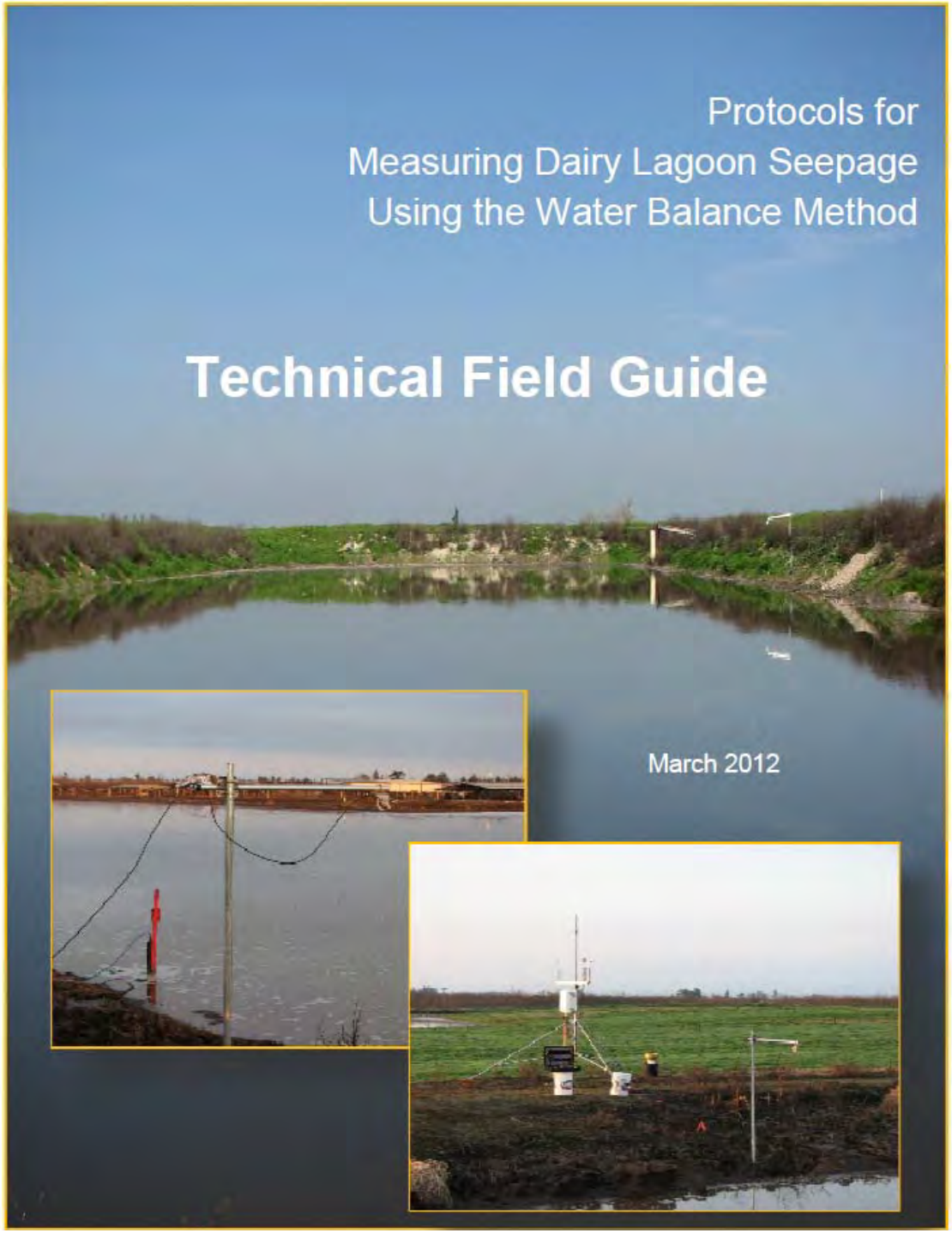
All field work completed – Reports forthcoming in 2015

Lagoon Performance Evaluation

Motivation

- Lagoon seepage often not evident or inconclusive based on groundwater chemical characteristics in monitoring wells.
- Absence of detectable impacts to groundwater quality does not provide conclusive evidence for zero-seepage or no impact to groundwater quality.

- Past guidelines, construction design standards and applicable laws intended to control seepage from earthen lagoons but not to stop it; therefore, some seepage is expected
- A comparative assessment between lagoon and field emissions is necessary for evaluating strategies for reducing overall subsurface mass loading of nitrate and salts on dairy farms



Water Balance Testing

2008 Comprehensive literature review on lagoon seepage, Technical Memorandum

2010-2011 Intensive field work verified that mechanistic quantification of lagoon seepage with specified statistical confidence is possible

2012 Technical Field Guide

2013/14 & 2014/15 Systematic lagoon testing

Lagoon seepage results from 50 tests (17 lagoons) are consistent with academic literature

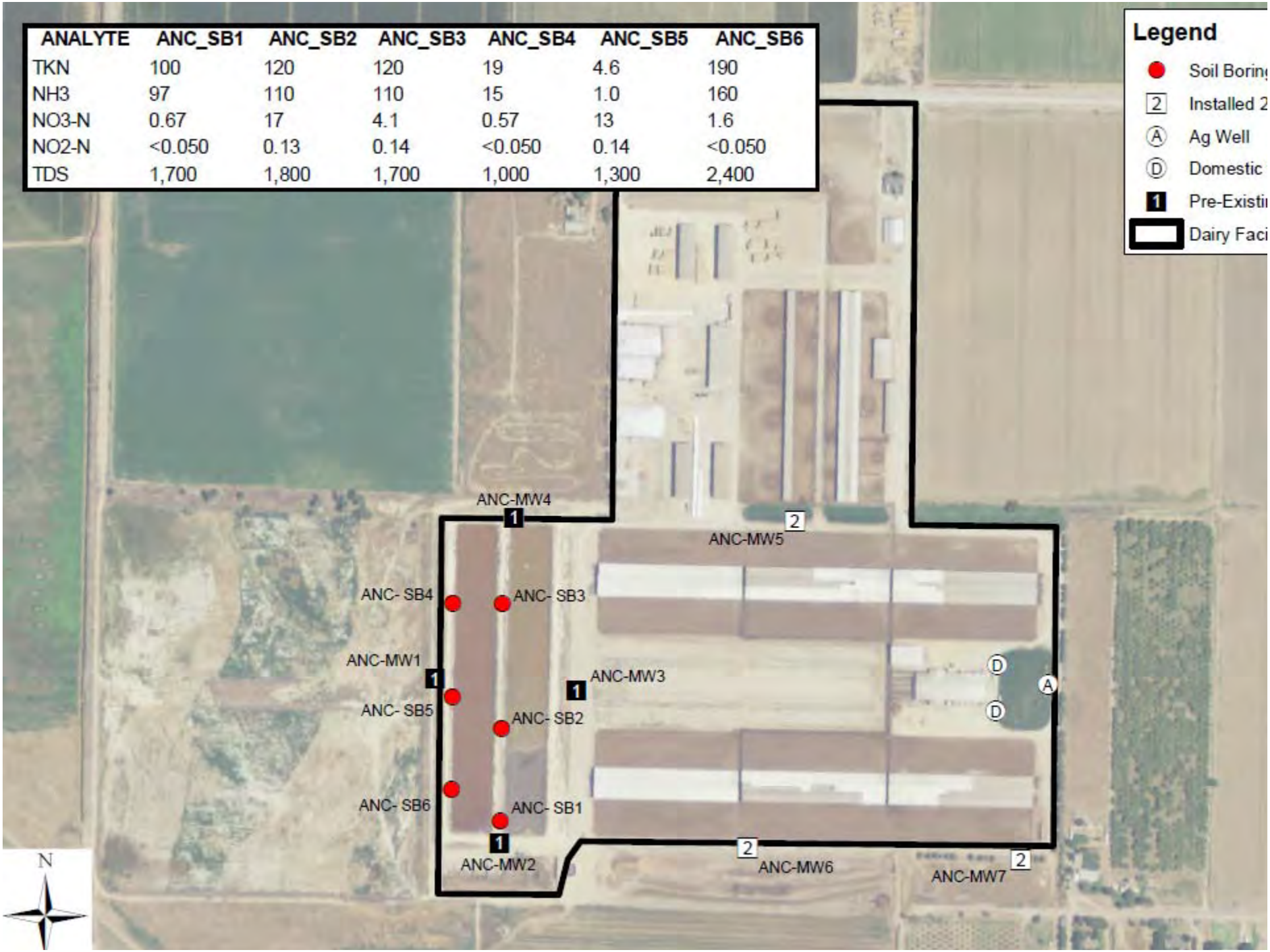
- Lagoons constructed 1960s – 2005
  - construction documentation available for two lagoons
- Soil types: sand to silty clay
- No correlation to pond age, soil type, construction
- Seepage variability is small; greater when recently filled

Seepage Rates from 17 Lagoon [mm/day]	
median	0.6
mean	1.0
min	0.0
max	2.8
NRCS design seepage = 0.86	

2014 Lagoon Perimeter Hydrogeologic Investigation

- Workplan submitted June 2014
- Field work completed fall 2014
  - 53 continuous soil cores to first-encountered groundwater around 12 lagoons
  - Groundwater sampling directly at the water table, near to the source (lagoon bottom)
- Final report submitted March 2015

ANALYTE	ANC_SB1	ANC_SB2	ANC_SB3	ANC_SB4	ANC_SB5	ANC_SB6
TKN	100	120	120	19	4.6	190
NH3	97	110	110	15	1.0	160
NO3-N	0.67	17	4.1	0.57	13	1.6
NO2-N	<0.050	0.13	0.14	<0.050	0.14	<0.050
TDS	1,700	1,800	1,700	1,000	1,300	2,400



Summary of Findings

10 of 12 sites showed impacts at the water table where MWs did not

- Why? Sampling redundancy, sampling nearer to the water table and nearer to the lagoon

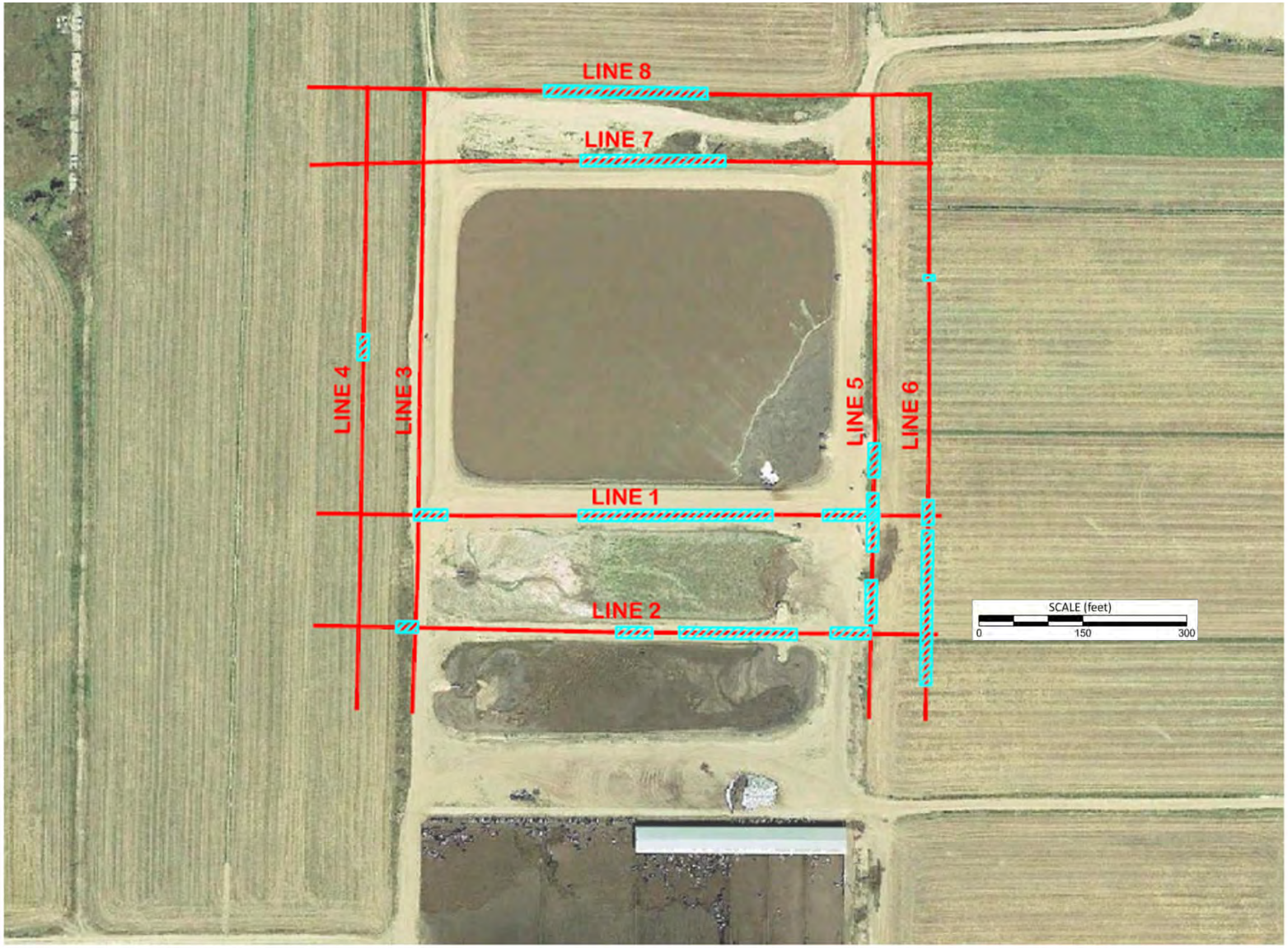
Effects of lagoon seepage on groundwater quality are minimal, localized in the immediate vicinity of the lagoons

- 4 lagoons: strong evidence of seepage
- 6 lagoons: slightly/moderately elevated indicator parameters in some borings
- 2 lagoons: no evidence of seepage

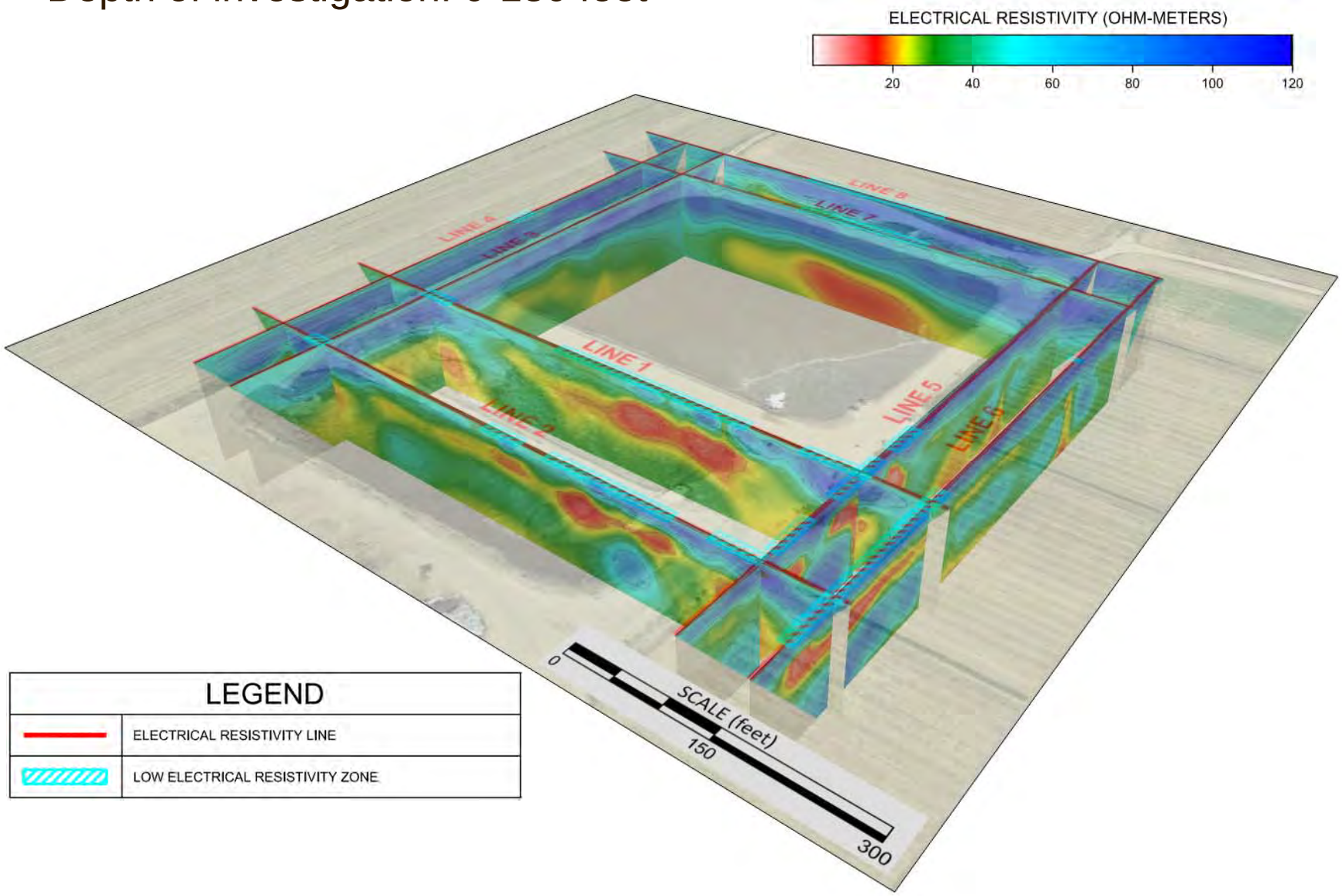
Geophysical Surveys

- Reconnaissance testing fall 2014 (ERT)
- Expanded testing in April and August 2015 (ERT & EM)
- Total of 12 lagoons surveyed

Electrical Resistivity Tomography – Setup of Lines



Depth of investigation: 0-130 feet



Upcoming Reports – Fall 2015

1. Lagoon seepage
   - Summary of results from 2013/14 & 2014/15 testing
   - Seepage rates, lagoon water sample results
   - Subsurface mass loading estimates
   - Comparison to subsurface mass emissions from fields
2. Comprehensive report on lagoon performance
   - Seepage testing
   - Lagoon perimeter hydrogeologic investigation
   - Geophysical results
   - Groundwater quality monitoring
3. Workplan: Lagoon management practice evaluation
   - Compilation of MPs
   - Implementation/environmental evaluation

Initiatives & Activities

1. Lagoon Performance Evaluation
2. **Improving Nitrogen Management**
3. Collaboration with Lawrence Livermore National Laboratory

N Management is Complex on Dairies

1. Animal system
2. Animal feed system
3. Animal housing system
4. Animal health system
5. Milk production and food safety system
6. Manure collection, treatment, recycling, and storage system
7. Manure application system
8. Forage crop production system
9. Irrigation system
10. Soil environment system
11. Atmospheric environment system
12. Surface water and groundwater environment system

Source: *Managing Dairy Manure in the Central Valley of California* (2005) - UC Committee of Experts on Dairy Manure Management

Multidisciplinary Advisory Committee

Key Recommendations

1. Increase accuracy of irrigation water measurements, nutrient inputs, and nutrient harvest removal
2. Advance ability to apply specific amounts of manure nutrients at the target rates and times they are needed
3. Improve on-farm record keeping to provide timely in-season computation of application amounts
4. Develop means of estimating organic N release, expected leaching losses and other dynamic nitrogen processes throughout the season and integrate this information into management decisions to identify the need for adjustment of application rates from the pre-season plan

3-Year Research Project

1. Comprehensive assessment of *as-is conditions* with regard to N management; review by outside experts
2. Identification of farm-specific challenges and strategies for improvements
3. Preparation of custom workplans; review by outside experts
4. Complete workplans for 6 test sites this year and begin implementation with the winter crop 2015/16

Example Challenges

- Excessive leaching losses
- Severe water shortages (anticipation of permanent shortages)
- Range of water delivery rates, seasonality
- Poor irrigation uniformities
- General lack of good information
- Field geometry
- Ability to export N
- Existing infrastructure
- Soil properties

Example Workplan Components

- Extensive baseline data collection with regard to irrigation and N applications, harvest removal
- Strong farmer involvement with data collection and recordation; education & training
- Close collaboration with irrigation districts
- Check-by-check irrigation water advance rate measurements for computation of irrigation uniformities, efficiencies
- Replicated trials of treatments and control for comparisons
- Installation of infrastructure (pipeline, flow meters, control valves, data loggers, irrigation automation)
- Development of sampling protocols

Initiatives & Activities

1. Lagoon Performance Evaluation
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Workplan Development

Problem

Uncertain connection between management practices and groundwater chemical characteristics where unsaturated zone is thick, travel times are long.

Approach

Combined vadose zone/groundwater investigation using multiple lines of evidence

Schedule

Draft workplan expected in fall 2015

Workplan Components

1. Vadose zone residence times
   - Continuous soil coring (soil water content, porosity, etc. for Darcian flow and modeling approaches)
   - Chloride mass balance approach
   - ^{36}Cl and ^{3}H profiling
2. Groundwater age
   - $^{3}H/^{3}He$ with excess air noble gas analysis
3. Nitrogen sources and fate
   - Nitrate-^{15}N, nitrate-^{18}O, excess N gas

Summary

1. Lagoon Performance: Completed field work of a multi-year effort in 2015
   - One final report already submitted March 2015
   - Three additional reports forthcoming in 2015
2. N-Management Improvement: 3-Year research project underway
   - Early findings indicate robust CVDRMP approach to address farm-specific challenges with custom solutions
3. Successful Collaboration with LLNL
   - Draft Workplan for investigation of vadose zone residence time, groundwater age, N sources & fate expected in 2015

Summary

4. CVDRMP continues to demonstrate by action
   - Proactive, science-based, innovative, ***<u>successful</u>*** approaches and methods beyond GO-required monitoring
5. General Order's schedule is ambitious
   - CVDRMP is on track to meet 2019 deadline for Summary Report
   - Recommendations for management practices are being identified, vetted & solidified through field testing and MAC/GTAC discussions

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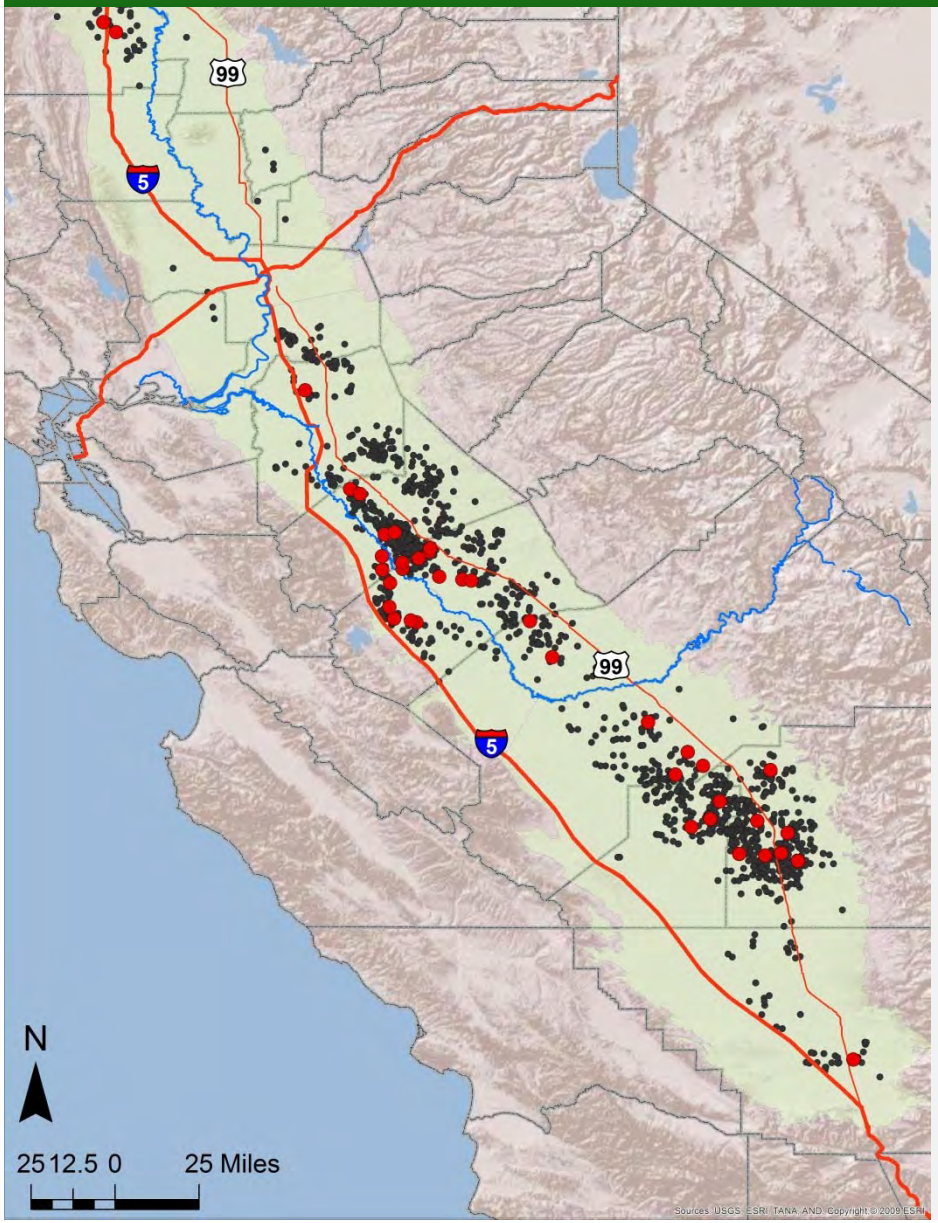

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