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PARAMOUNT
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January 10, 2013

Via Email To:

awlaputz@waterboards.ca.gov

Dr. Karl Longley, Chair
Jon Costantino, Vice Chair
Sandra Meraz, Board Member
Jennifer Moffitt, Board Member
Carmen Ramirez, Board Member
Robert Schneider, Board Member
Pamela Creedon, Executive Officer
Clay Rodgers, Assistant Executive Officer
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670-6114

Re: Comments re draft "Waste Discharge Requirements General Order for Discharges from Irrigated Lands Within the Central Valley Region for Dischargers <u>not Participating in a Third-Party Group</u>" (November 2012 draft)

Dear Board Chair, Vice Chair, Members, Ms. Creedon and Mr. Rodgers:

These comments are submitted on behalf of Paramount Farming Company LLC and Paramount Citrus LLC and their related entities ("Paramount") on the draft "*Waste Discharge Requirements General Order for Dischargers from Irrigated Lands within the Central Valley Region for Dischargers Not Participating in a Third Party Group*" ("Draft Individual Order") released by the California Regional Water Quality Control Board, Central Valley Region ("Regional Board"). Paramount is the largest grower and processor of almonds, pistachios, pomegranates, and citrus in the United States and is just one of many agricultural operations directly and indirectly contributing to the economy of the Central Valley that will be severely impacted by the Regional Board's proposed waste discharge requirements under the long-term Irrigated Lands Regulatory Program ("ILRP").

Paramount previously submitted comments on the tentative "*Waste Discharge Requirements General Order for Growers Within the Eastern San Joaquin River Watershed That Are Members of the Third Party Group*" ("ESJ Order") and the draft "*Waste Discharge Requirements General Order for Members of a Third Party Group within the Tulare Lake Basin*" ("Draft TLB Order" and collectively, the "Third Party Orders"). The Regional Board states the Draft Individual

Order, "along with other Orders to be adopted for irrigated lands within the Central Valley, together will constitute the long-term ILRP.[1]"

Paramount is not adverse to sensible, solution-oriented regulation and we do not question the jurisdiction of the Regional Board to prevent pollution of waters of the state. But, before the Regional Board imposes onerous regulatory requirements, it should clearly define its goal and objectives and assess whether the long-term ILRP, as currently conceived in the Draft Individual Order and other draft orders being considered, can achieve those goals. The Regional Board should also assess the expenses needed to achieve the goal and a funding plan. If the goal is protection of groundwater quality, and specifically drinking water, the current approach does not directly address that issue, but will impose costly requirements on growers, including Paramount, who have no discharges of waste to groundwater. The Regional Board should clearly communicate its goal to stakeholders and cooperatively develop a workable solution, which can in part include sensible regulation on irrigated agriculture, rather than push through these regulatory requirements that have no scientific basis. Without a clear goal, the Regional Board is simply imposing costly additional regulation that will only hurt the agricultural industry.

Although part of various coalition groups at this time, Paramount feels it is necessary to submit these comments on the Draft Individual Order because it is unclear if the Regional Board will develop reasonable, scientifically justified and collaboratively reached "Third Party" administered orders for the various areas in which Paramount is a grower and landowner, however many of the comments included herein apply to the overall proposed long-term ILRP and should be considered comments to the Regional Board on its overall ILRP development as well as on the Draft Individual Order.

In many cases, the requirements set forth in the Draft Individual Order are more cumbersome than those in the Third Party Orders, but there is no justification for this approach. The individual grower is responsible for compliance and should not be penalized for choosing one method of compliance over another. If the ultimate program is solution oriented and scientifically based, the approach and requirements for individual verses third party compliance should be the same to reflect the needs to achieve the stated goal. The more onerous regulatory requirements in the Draft Individual Order appear to be nothing more than the Regional Board's attempt to force growers into a coalition for its own administrative ease and should be dismissed in favor or a solution-oriented approach.

The ILRP should analyze up front, prior to the commencement of regulatory requirements, available and developed scientific analysis that assesses specific "on the ground" irrigation and management practices and unique area characteristics (soil, depth to groundwater, groundwater quality and the presence of groundwater) to properly determine those irrigators that have a potential to discharge to groundwater and relieving those whose risk is de-minimis, or non-existent, from costly monitoring and reporting by appropriately excluding them from the long-term ILRP. The erroneous assumption that all irrigators have a potential to discharge is a costly one that is unjustified in the Draft Individual Order or any other of the draft orders as part of the IRLP. The Regional Board estimates the cost of compliance for the long-term ILRP at

[1] Draft Individual Order, pg 3, Findings 9.

$176/acre/year, which is greater than 10% of crop costs for many growers and far exceeds the total current water cost per acre for growers in many areas of the Central Valley. To assume these costs can be absorbed without significant impacts to the agricultural economy is naïve. Furthermore, it is unclear what these cost estimates are based upon, and if they reflect the true potential compliance costs. It is clear than none of the costs support drinking water solutions.

Nitrogen use and water use are significant economic factors in agricultural budgets and undergo significant analysis in Paramount's operations. To base the ILRP on the assumption that all irrigated agriculture is a discharger to groundwater is absurd and not justified based on the information presented in the Draft Individual Order. Furthermore, the Draft Individual Order, requiring, at a minimum, monitoring of "existing domestic supply wells, irrigation supply wells, and tile drainage systems" annually at the farm level is overly burdensome. The Draft Individual Order then allows for even greater potential burden stating, "if the Executive Officer requests additional groundwater monitoring data…the discharger will need to install monitoring wells and collect some samples semiannually.[2]"

Well monitoring bears no proven, or reasonable, relationship in benefits to the economic costs to the grower, violating the requirement under Water Code section 13267(b)(1)) and does not address the problem of drinking water quality for those areas where groundwater is a drinking water source. Recent expert testimony, discussed further below, was presented to the Regional Board at a November 30th hearing and workshop in Bakersfield, which detailed the ineffective and inconsistent nature of monitoring well data in determining impacts of land practices, including irrigation, on groundwater quality. Although the expert testimony was focused on Kern County, the scientific approach of analyzing the unique factors associated with irrigation activities should be used as the basis of the ILRP, whether compliance is achieved through a Third Party or on an individual basis.

The Regional Board has a real opportunity to prove it is dedicated to effective and meaningful outreach and collaboration. To date, Paramount is appalled by the Regional Board's lack of meaningful communication, education, outreach and collaboration to those that will be subject to this onerous regulation and those who are experts in the subject matter. Merely notifying "interested agencies and persons of its intent to issue this Order for discharges of waste…" and providing "them with an opportunity for a public hearing and an opportunity to submit comments,"[3] is insufficient outreach by any standard, but especially when the proposed regulatory requirements are so much more stringent than the previous program and, as currently drafted, subject millions of additional acres of irrigated agriculture not previously regulated under the existing ILRP to significant new regulatory requirements. Many growers are unaware of the scope and others are unaware that they will soon be regulated to a degree that could end their operations. Only after a loud outcry by landowners and commodity groups in the later part of 2012 did the Regional Board conduct grower workshops. Paramount has attended all local workshops and is hopeful that the additional information on regional specific issues in Kern County and the expert testimony (see attached) regarding the effectiveness of assessing current

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[2] "*Waste Discharge Requirements General Order for Dischargers from Irrigated Lands within the Central Valley Region for Dischargers Not Participating in a Third Party Group Information Sheet,*" *pg 10,portion of lines 11-14.*

[3] Draft Individual Order, pg 33, Findings 59.

practices and unique characteristics of geology and groundwater to determine a "potential to discharge" will drive the Regional Board to incorporate this effective scientific approach in drafting its regulatory program rather than relying on inconsistent, unjustified and currently undefined well monitoring.

The discretion left to the Executive Officer in approving the scope of the required monitoring and reporting is frightening, lacks scientific basis, and is an improper delegation of regulatory authority. Included in the Draft Individual Order and other orders there should be a defined measurement tool to assess whether the irrigated acreage has the potential to discharge to groundwater and therefore be subject to the ILRP, and if covered by the program, what degree of monitoring, reporting and implementation of management practices will be required for compliance. The Regional Board must meaningfully incorporate the scientific evidence, comments, concerns and recommendations of experts and stakeholders prior to the finalization of specific waste discharge requirements and the implementation of the ILRP. Implementing an ILRP that leaves the difficult questions unanswered and subject to the approval of the Executive Officer, with no reasonable estimate as to what that approval may entail, is unacceptable.

As stated above, Paramount does not question the jurisdiction of the Regional Board to prevent pollution of groundwater, however the jurisdiction of the Regional Board is not unlimited. The expert testimony of Mr. Gailey, Dr. Kimmelshue and Mr. Souther (see attached) at the November 30th workshop in Kern focused on the unique characteristics of groundwater quality, groundwater depth and current irrigation and fertilization practices for Kern County; this testimony rebuts the blanket assumption of the Regional Board in the proposed ILRP that all irrigators have a potential to discharge "waste to a degree which unreasonably affects beneficial uses". The approach described in this expert testimony should be the scientific basis of the ILRP. This approach is solution oriented and clearly defines the unique characteristics that determine if, and to what extent, a discharge of waste is occurring. The Draft Individual Order and other draft orders should reflect such an approach.

One such approach, the Nitrogen Hazard Index, has been forwarded by the Regional Board itself and affords the recognition of differences in natural features and land management practices in determining a site's vulnerability to discharge waste to groundwater. Using the Nitrogen Hazard Index would allow for the tailoring of the appropriate level of management practice implementation, monitoring and reporting needed to protect water quality. Similar risk-based methods have been used by the State Water Resources Control Board such as in the General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities to permit stormwater discharges from construction sites.

Paramount, for example, has approximately 53,000 acres on the westside of Kern County that has been studied by Mr. Souther and summarized in a report provided to the Regional Board in December 2012 (see attached). Mr. Souther demonstrated that for certain areas on the westside of Kern there is little or no usable groundwater and the groundwater which is available is of such quality to prevent its use for municipal and agricultural purposes. This acreage, and other areas with similar features, should be excluded from the ILRP, and all acreage under the ILRP should have its regulatory burden based on a scientifically-justified measure of its potential to discharge

- not based on a two-tiered system relying on inconsistent and costly well monitoring data as currently conceived in the Draft Individual Order and other draft orders.

Groundwater is key to the viability and sustainability of the Central Valley. All stakeholders, including Paramount and other irrigators subject to the proposed long-term ILRP, recognize the importance of protecting and preserving our groundwater quality, but also realize the complexity of the issue and the time, collaboration, scientific analysis and resources needed to properly evaluate and develop a strategy to protect this invaluable resource. Paramount suggests the Regional Board commit to developing, in collaboration with experts, growers, commodity groups and coalitions, a scientific approach tailored to addressing the differences in management practices and site conditions that may contribute to discharges to groundwater in which to base the ILRP requirements prior to implementation of the program.

Paramount appreciates the opportunity to submit comments and hereby joins in and incorporates those comments submitted by the Southern San Joaquin Valley Water Quality Coalition and the Kern River Watershed Coalition Authority. If you have any questions, please do not hesitate to contact Kimberly Brown or me at the contact information listed above.

Sincerely,

William D. Phillimore
Executive Vice President

Agronomic Changes and Management Impacts in the Kern Sub Basin

Central Valley Regional Water Quality Control Board Workshop

Bakersfield, CA

November 30, 2012

Joel Kimmelshue, PhD

NewFields

Structure

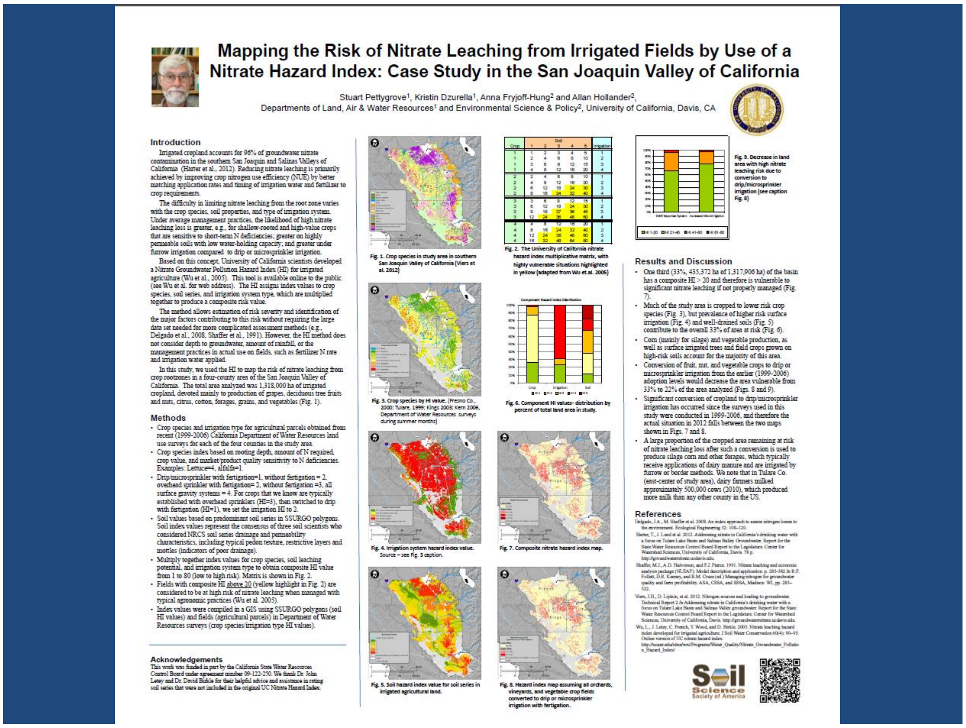
- Nitrate Hazard Index Approach
- Past Research
- Independent Analysis
- Main Influencing Factors
  - Soil Type
  - Crop Type
  - Irrigation Method
- Conclusions

Accepted Nitrogen Impact Assessment

- Nitrate Hazard Index Approach
  - Published by the Southwestern States and Pacific Islands Regional Water Quality Program and the University of California Center for Water Resources (Universities of Arizona, California, Nevada, etc.)
  - Includes decades of research/approaches (since the 1970s)
  - National Academy of Sciences Water Science & Technology Board – Chose Hazard Index as preferred method - **"It is consistent with the recommendations of the nutrient Technical Advisory Committee (TAC) appointed by the CA State Water Resources Control Board."**

Plant Accumulation of Nitrogen

- Amount of N accumulated by a crop depends on:
  - Amount of N supplied by fertilizer and soil reserves
  - Genetic potential of crop to take up N
  - Growth and yield potential of crop
  - **Ability to retain N in rooting zone (impacted by: soil type, crop type, irrigation method)**



Southern San Joaquin Valley Nitrate Hazard Index Approach

Soil, Crop and Irrigation Methods approach used to create relative Nitrate Hazard Index

Spatial Data Sources: DWR Crop Mapping - (Fresno Co., 2000; Tulare, 1999; Kings 2003; Kern 2006)

Crop	Soil 1	2	3	4	5	Irrigation
1	1	2	3	4	5	1
1	2	4	6	8	10	2
1	3	6	9	12	15	3
1	4	8	12	16	20	4
2	2	4	6	8	10	1
2	4	8	12	16	20	2
2	6	12	18	24	30	3
2	8	16	24	32	40	4
3	3	6	9	12	15	1
3	6	12	18	24	30	2
3	9	18	27	36	45	3
3	12	24	36	48	60	4
4	4	8	12	16	20	1
4	8	16	24	32	40	2
4	12	24	36	48	60	3
4	16	32	48	64	80	4

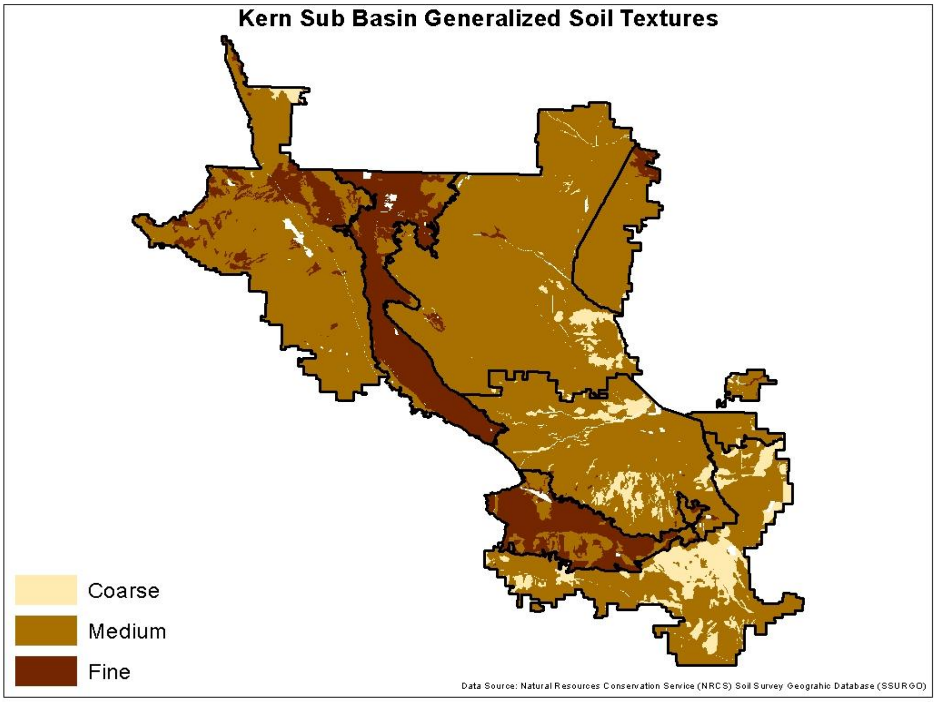
Pettygrove, et al, 2012

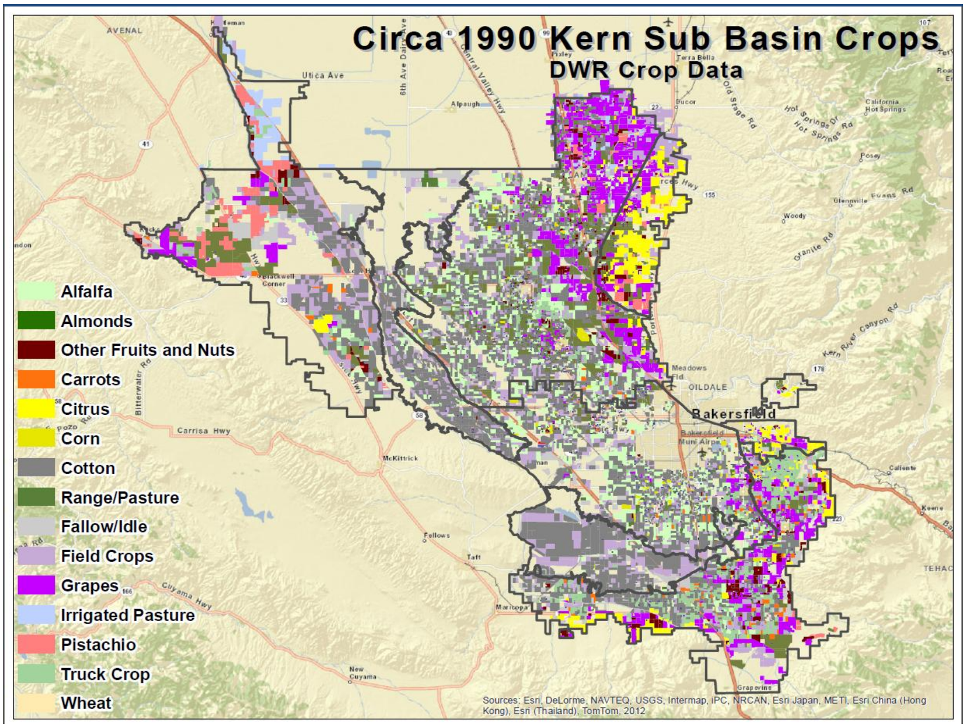
Southern San Joaquin Valley Nitrate Hazard Index Conclusions - Pettygrove, et al, 2012

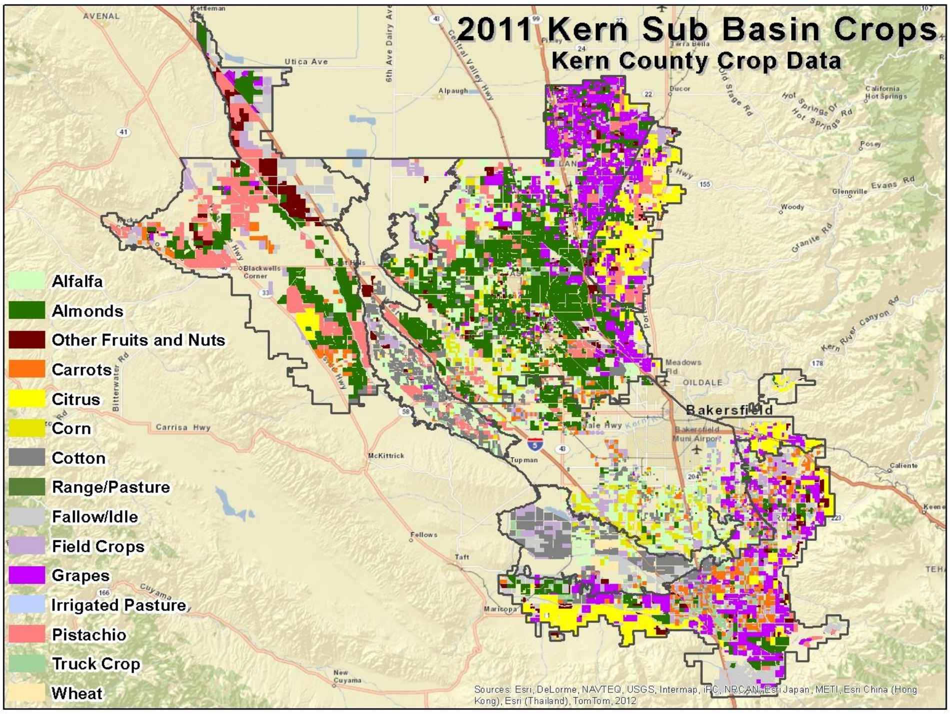
- 33% of basin has a significant N leaching potential
- That 33% is driven by gravity/surface irrigation practices on various crops and well-drained soils
- Conversion to drip/micro systems would result in a low leaching potential (Nitrate Hazard Index) for certain crops
- Significant conversion to these systems has occurred since the DWR 1999-2006 base layers (crop type and irrigation methods) were used.
- Following conversion, a large area remaining at risk is silage corn and other forages, receiving dairy manure applications via furrow or border-check methods.

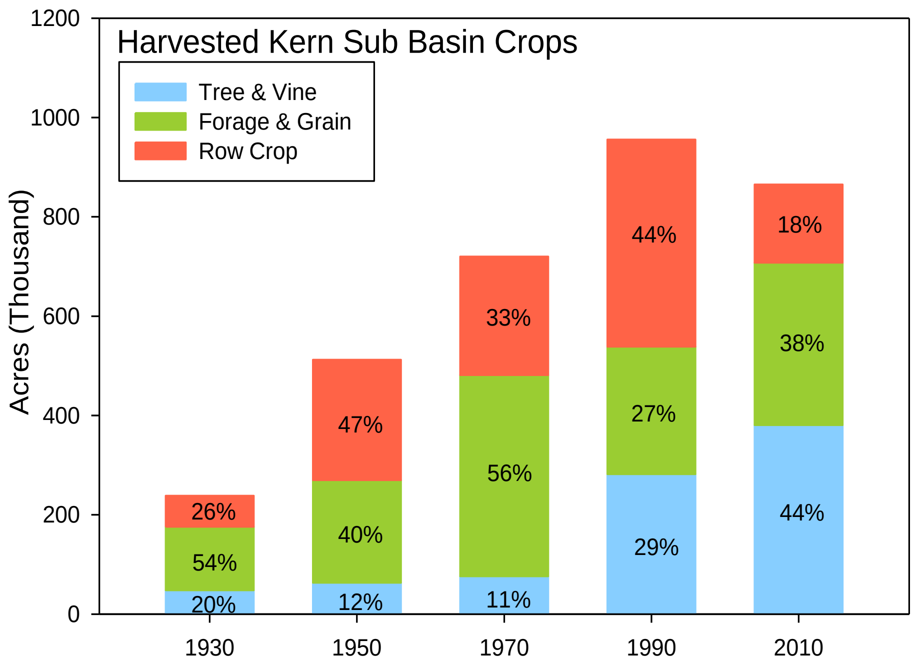
Independent Analysis

- Focuses on Kern Sub Basin area only
- Uses Kern Sub Basin specific information
  - recent (2011) Kern County crop coverage
  - local climatic conditions
  - local irrigation methods
  - local agronomic knowledge specific to the Kern Sub Basin obtained from Blake Sanden and others
- Performed analysis for representative scenarios in the Kern Sub Basin area
- Our analysis aligns well in approach and enhances conclusions of Pettygrove, et al. 2012 and other researchers

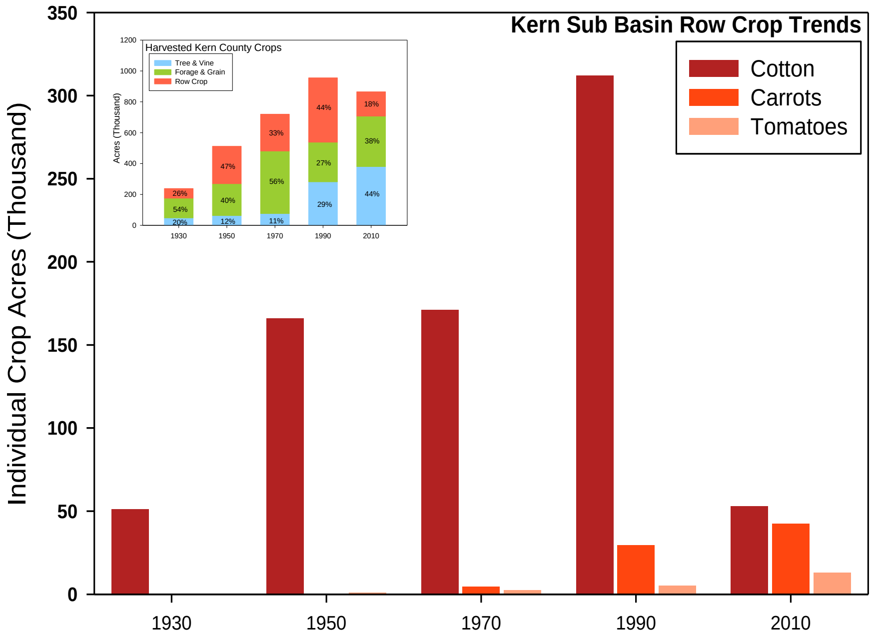

Kern Sub Basin Generalized Soil Textures
Coarse
Medium
Fine
Data Source: Natural Resources Conservation Service (NRCS) Soil Survey Geograhic Database (SSURGO)


Circa 1990 Kern Sub Basin Crops
DWR Crop Data
Alfalfa
Almonds
Other Fruits and Nuts
Carrots
Citrus
Corn
Cotton
Range/Pasture
Fallow/Idle
Field Crops
Grapes
Irrigated Pasture
Pistachio
Truck Crop
Wheat
Bakersfield
Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

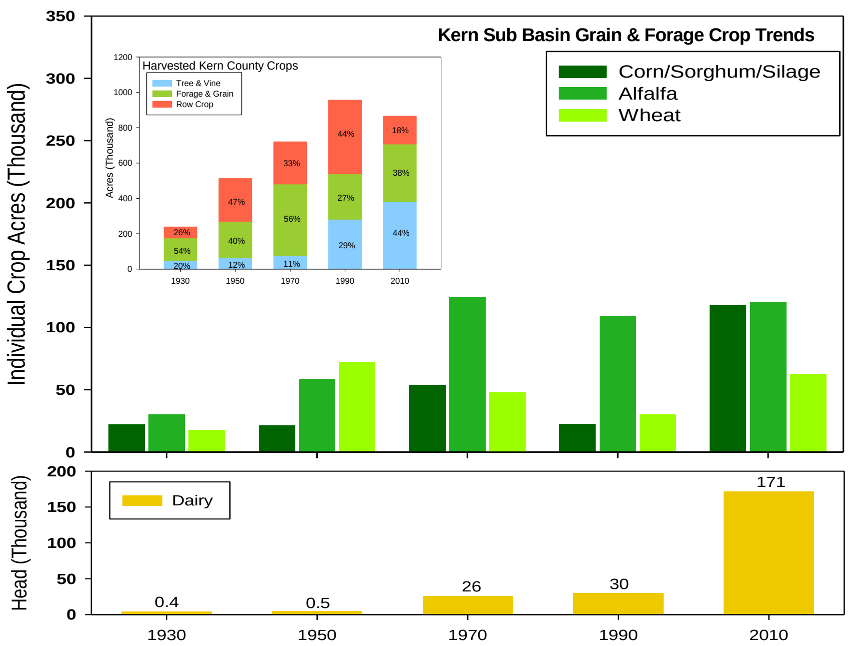




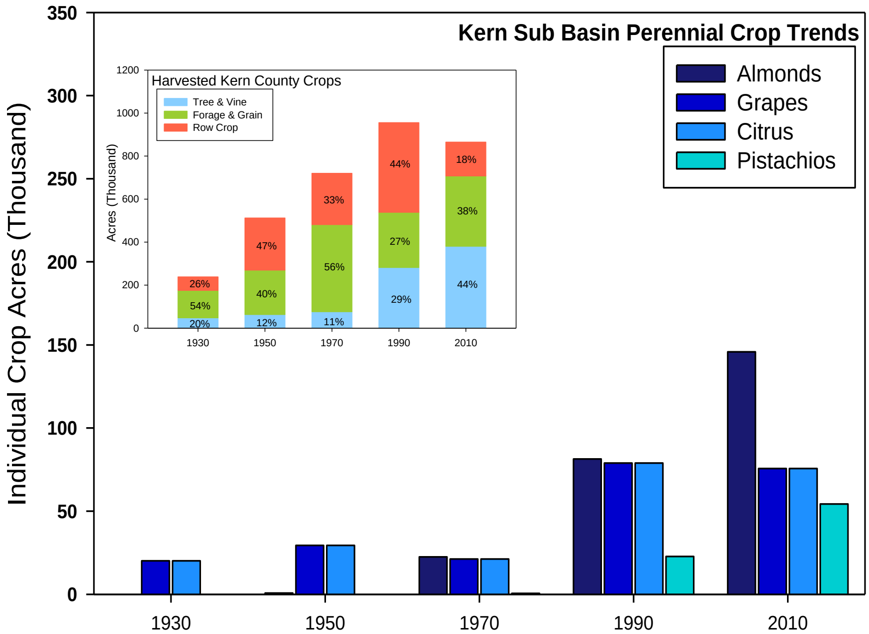
Source: Kern County Agricultural Commissioner Crop Reports – Does not include fallow land,1st leaf orchards and is Kern County only



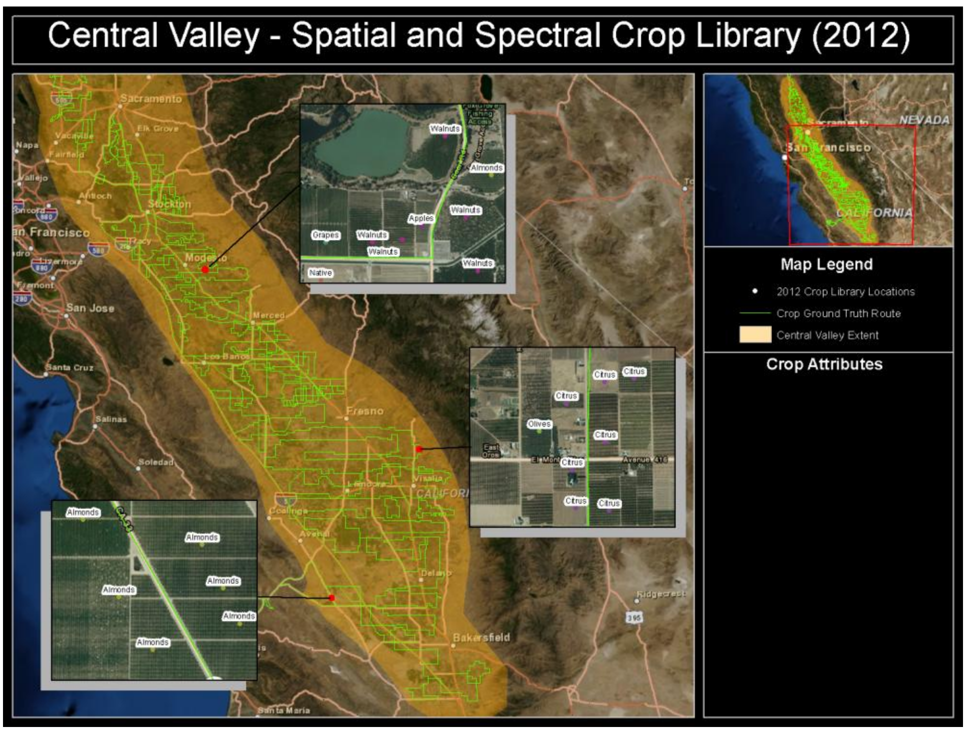
Source: Kern County Agricultural Commissioner Crop Reports – Select Crops

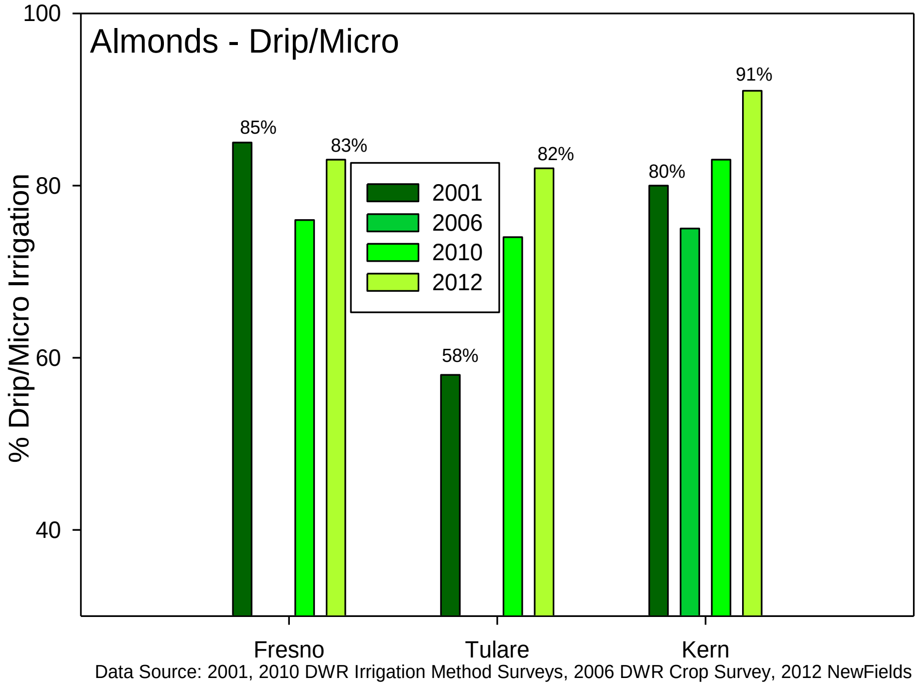


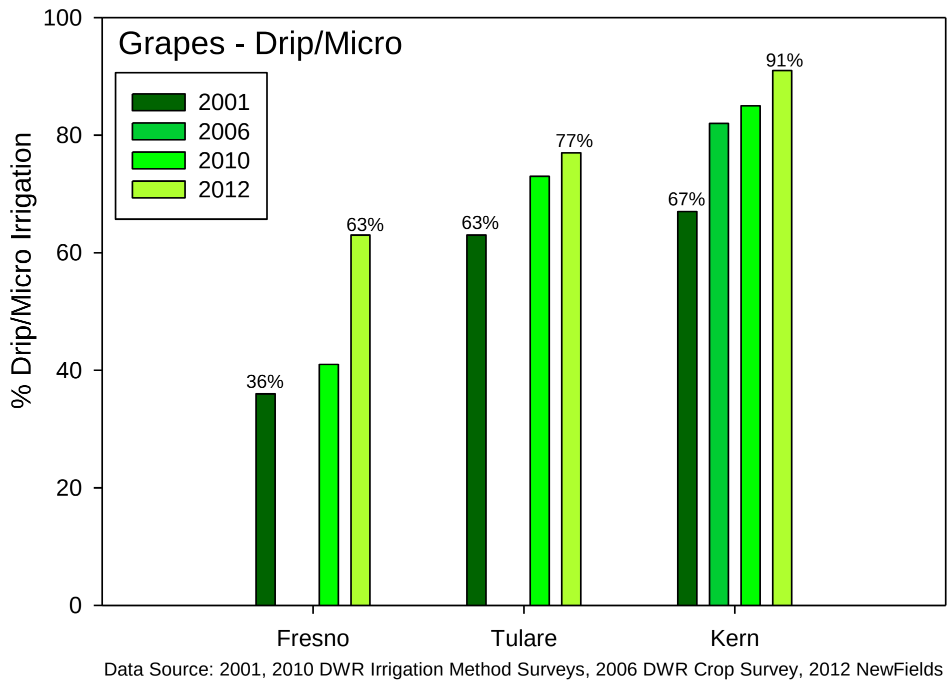
Source: Kern County Agricultural Commissioner Crop Reports – Select Crops

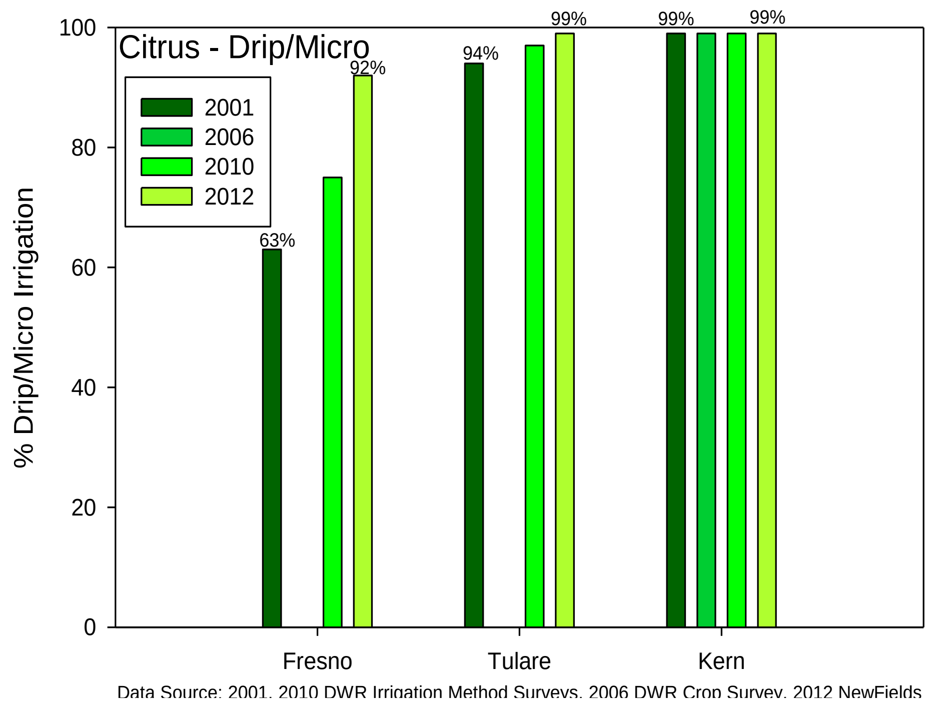


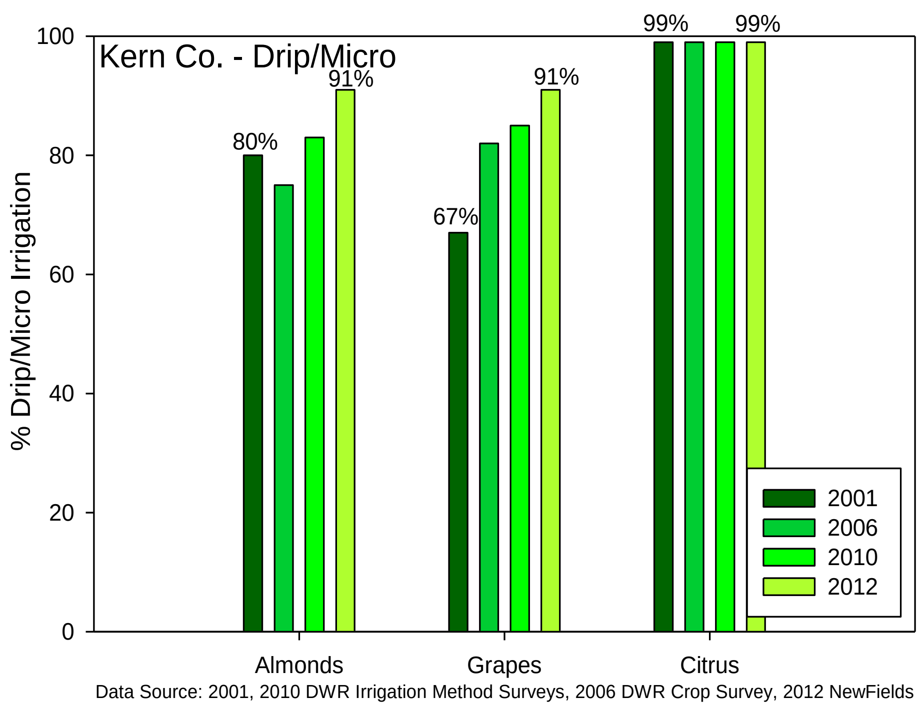
Source: Kern County Agricultural Commissioner Crop Reports – Select Crops




Almonds - Drip/Micro
% Drip/Micro Irrigation
100
80
60
40
85%
83%
58%
82%
80%
91%
2001
2006
2010
2012
Fresno
Tulare
Kern
Data Source: 2001, 2010 DWR Irrigation Method Surveys, 2006 DWR Crop Survey, 2012 NewFields


Grapes - Drip/Micro
% Drip/Micro Irrigation
100
80
60
40
20
0
36%
63%
63%
77%
67%
91%
2001
2006
2010
2012
Fresno
Tulare
Kern
Data Source: 2001, 2010 DWR Irrigation Method Surveys, 2006 DWR Crop Survey, 2012 NewFields


Citrus - Drip/Micro
% Drip/Micro Irrigation
2001
2006
2010
2012
63%
92%
94%
99%
99%
99%
Fresno
Tulare
Kern
Data Source: 2001, 2010 DWR Irrigation Method Surveys, 2006 DWR Crop Survey, 2012 NewFields


Kern Co. - Drip/Micro
% Drip/Micro Irrigation
80%
91%
67%
91%
99%
99%
2001
2006
2010
2012
Almonds
Grapes
Citrus
Data Source: 2001, 2010 DWR Irrigation Method Surveys, 2006 DWR Crop Survey, 2012 NewFields

Conclusions of Analysis

- Nitrate Hazard Index Approach
  - Universally accepted as qualitative method to estimate nitrate leaching hazard
  - Work performed recently by UC Davis (e.g. Pettygrove, et al, 2012) was unable to use current (2011/2012) land use and irrigation practices
  - It was not the purpose of this work to review historic trends/future projections
- Increase in Permanent Crops
  - Deep rooted permanent crops account for approximately 45-50% of the crop mix within the Kern Sub-Basin as of 2011 and continue to increase in plantings
  - Of these crops (almonds, pistachios, grapes, citrus, pomegranates, etc.), over 90% are irrigated with drip/micro systems and result in limited return flow to groundwater.
  - These changes have resulted in a significant reduction in the nitrate leaching hazard to groundwater over time
  - Similar conclusions were reached by other researchers

Conclusions of Analysis

- Increase in Dairy
  - Approximately one-third (30-35%) of remaining acreage is mostly associated with dairies (corn silage, alfalfa, sorghum, sudan grass, etc.)
  - This land base/crop type is separately regulated
- Decrease in Non-Dairy Related Field and Row Crops
  - Over the past 20+ years, perennial fruit and nut crops, along with dairies have significantly replaced field and row crops.
  - The remaining crops (15-25%) consist of cotton, carrots, potatoes, truck crops and other field and row crops
- Irrigation and N Use Efficiencies in Kern sub-watershed are likely the highest in the Central Valley
- Conditions in Kern Sub Basin are different than other areas of the Valley and it would appear to warrant a different regulatory approach

THE SOURCE GROUP, INC.

COMMENTS ON HYDROGEOLOGIC POINTS OF CONCERN FOR THE KRWCA AREA

IRRIGATED LANDS REGULATORY PROGRAM

November 30, 2012

Robert M. Gailey, P.G., C.HG.

PRESENTATION OUTLINE

- UNIQUE ASPECTS OF THE KRWCA AREA
- SUMMARY OF POINTS REGARDING DRAFT ORDER GROUNDWATER MONITORING PROGRAM
- DETAILS OF SELECTED TECHNICAL POINTS

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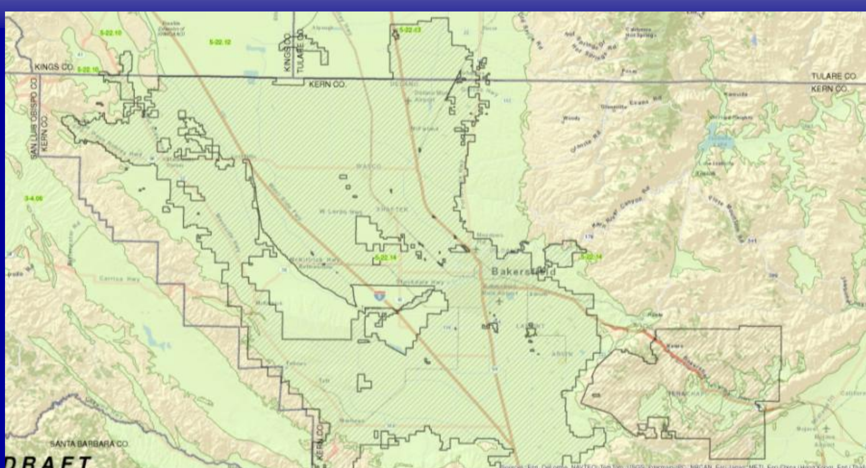
KRWCA AREA



THE KRWCA AREA IS UNIQUE AMONG REGIONS CONSIDERED FOR REGULATION

- Part of a Closed Groundwater Basin
- Groundwater Use and Management Operations
- Significant Depth to Water
- Nitrate Impact Less Pronounced

THE KRWCA AREA IS UNIQUE AMONG REGIONS CONSIDERED FOR REGULATION

- Part of a Closed Groundwater Basin
  - Water quality impacts from nitrogen accumulate unless denitrification occurs
  - Impacts from both past and present activities
  - Impacts from all industries – not just crop agriculture
- Groundwater Use and Management Operations
- Significant Depth to Water
- Nitrate Impact Less Pronounced

THE KRWCA AREA IS UNIQUE AMONG REGIONS CONSIDERED FOR REGULATION

- Part of a Closed Groundwater Basin
- Groundwater Use and Management Operations
  - Extraction from water supply wells
  - Significant recharge operations
  - Potential to move water around subbasin
- Significant Depth to Water
- Nitrate Impact Less Pronounced

THE KRWCA AREA IS UNIQUE AMONG REGIONS CONSIDERED FOR REGULATION

- Part of a Closed Groundwater Basin
- Groundwater Use and Management Operations
- Significant Depth to Water
  - Depth varies across area
  - Areas where depth is greater than to north
- Nitrate Impact Less Pronounced

AVERAGE DEPTH TO GROUNDWATER

- Analysis of DWR Data from North to South

East San Joaquin Watershed	88 feet
Kings Subbasin	87 feet
Kaweah Subbasin	102 feet
Tulare Lake Subbasin	77 feet
Tule Subbasin	159 feet
Kern Subbasin	219 feet

Note: Calculation of averages included data declustering at the township-range level

THE KRWCA AREA IS UNIQUE AMONG REGIONS CONSIDERED FOR REGULATION

- Part of a Closed Groundwater Basin
- Groundwater Use and Management Operations
- Significant Depth to Water
- Nitrate Impact Less Pronounced
  - Quality of first-encountered groundwater
  - Appears better than to north

UC DAVIS NITRATE STUDY ASSESSMENT OF NITRATE IMPACTS

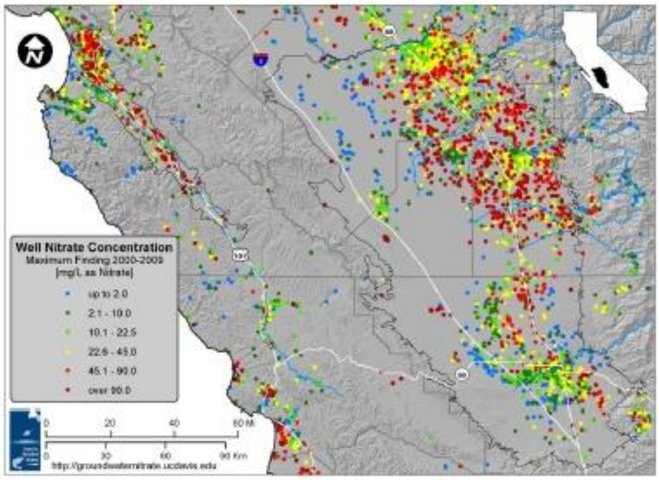
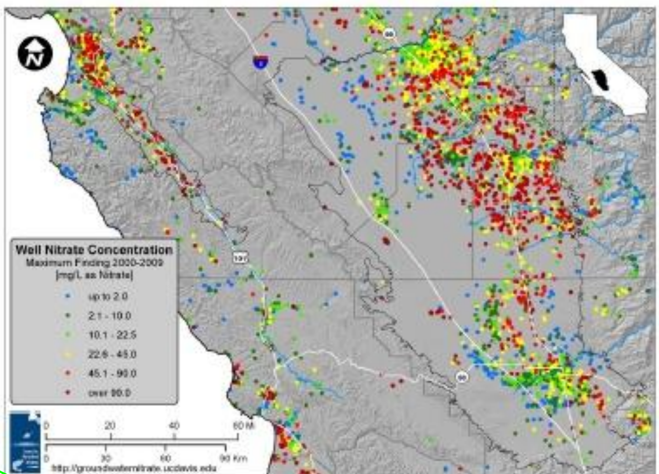


Figure 42. Maximum concentration of nitrate in wells with at least one sample during the decade 2000 to 2010

UC DAVIS NITRATE STUDY ASSESSMENT OF NITRATE IMPACTS



Worst Case

Figure 42. Maximum concentration of nitrate in wells with at least one sample during the decade 2000 to 2010

PRESENTATION OUTLINE

- UNIQUE ASPECTS OF THE KRWCA AREA
- SUMMARY OF POINTS REGARDING DRAFT ORDER GROUNDWATER MONITORING PROGRAM
- DETAILS OF SELECTED TECHNICAL POINTS

SUMMARY OF POINTS

Preliminary Findings

- There are likely to be complexities (i.e. time lags) associated with interpreting groundwater quality data in the KRWCA area.
- Implementing a large-scale monitoring program before the complexities are explored could result in significant unnecessary costs.
- Further study or an interim regulatory step would increase the likelihood that the monitoring will meet the intent of the order.

PRESENTATION OUTLINE

- UNIQUE ASPECTS OF THE KRWCA AREA
- SUMMARY OF POINTS REGARDING DRAFT ORDER GROUNDWATER MONITORING PROGRAM
- DETAILS OF SELECTED TECHNICAL POINTS

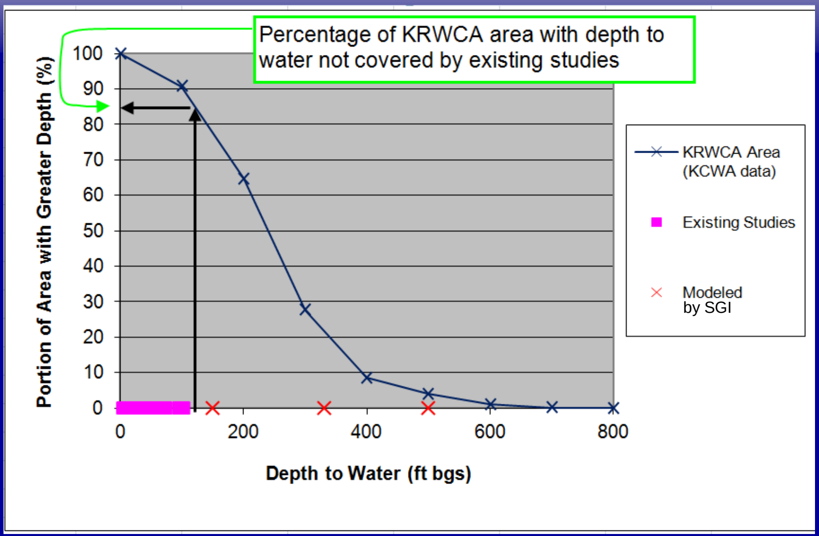
SELECTED POINTS

1. Time lags exist between agricultural activities at ground surface and changes in groundwater quality as a result of a thick unsaturated zone.
2. Nitrate residing in the unsaturated zone acts as an ongoing source to groundwater years after nitrogen is applied at ground surface.
3. The potential costs of an insufficiently planned groundwater quality monitoring program necessitate further study or an interim regulatory step before any full-scale monitoring occurs.

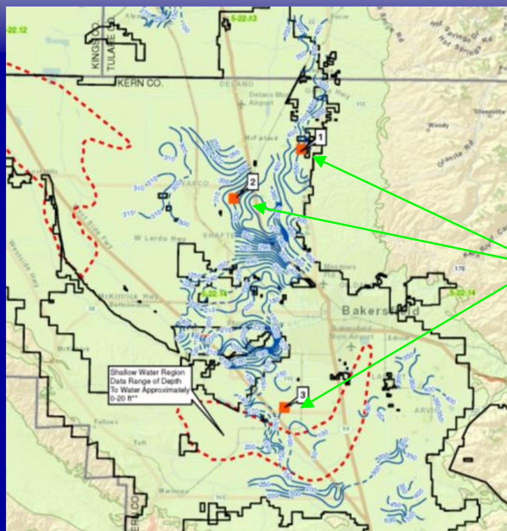
SELECTED POINTS

1. Time lags exist between agricultural activities at ground surface and changes in groundwater quality as a result of a thick unsaturated zone.
2. Nitrate residing in the unsaturated zone acts as an ongoing source to groundwater years after nitrogen is applied at ground surface.
3. The potential costs of an insufficiently planned groundwater quality monitoring program necessitate further study or an interim regulatory step before any full-scale monitoring occurs.

DEPTH TO WATER OVER KRWCA

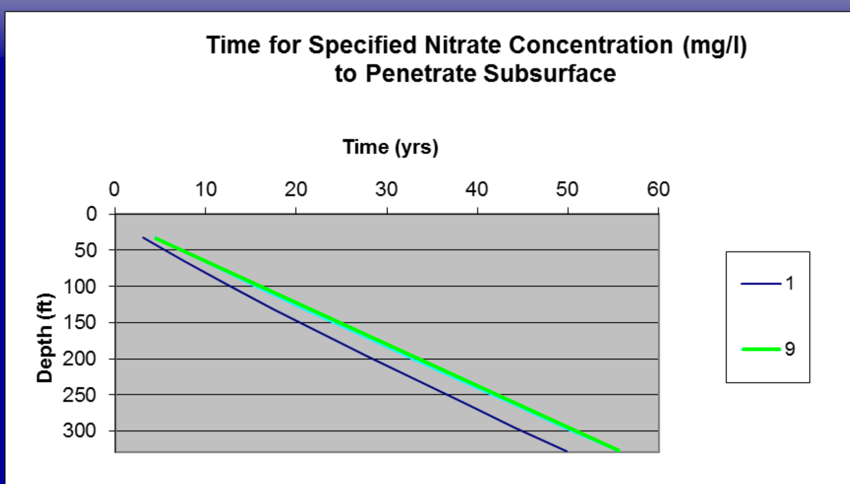


REPRESENTATIVE SITES MODELED



Preliminary modeling performed by SGI includes site-specific unsaturated zone stratigraphy.

MODELING RESULTS (Middle Depth - 330')

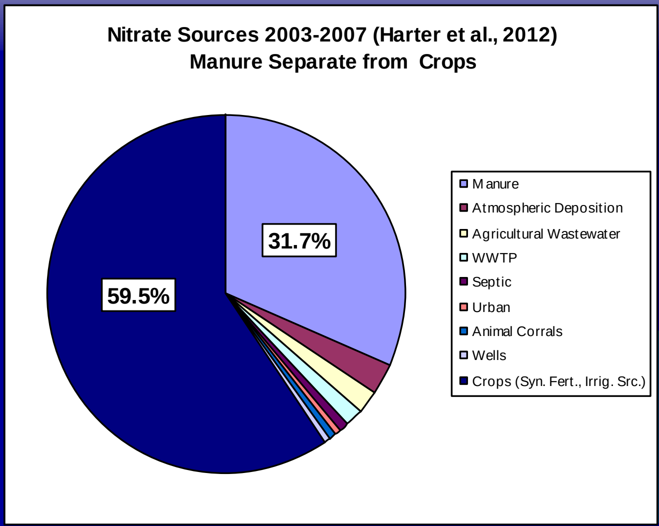


Almonds, Drip/Micro, Coarse Soil, Interlayed Clay & Sand

SELECTED POINTS

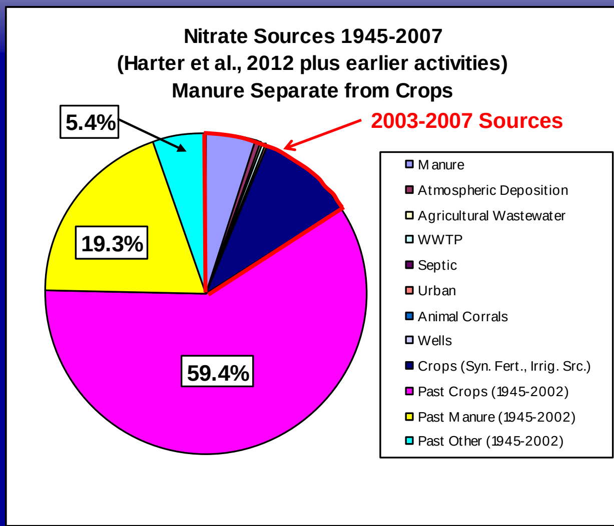
1. Time lags exist between agricultural activities at ground surface and changes in groundwater quality as a result of a thick unsaturated zone.
2. Nitrate residing in the unsaturated zone acts as an ongoing source to groundwater years after nitrogen is applied at ground surface. Thus, addressing current farming practices through this proposed regulation will have little affect on this legacy issue.
3. The potential costs of an insufficiently planned groundwater quality monitoring program necessitate further study or an interim regulatory step before any full-scale monitoring occurs.

UC DAVIS ASSESSMENT OF NITRATE LOADING TO GROUNDWATER

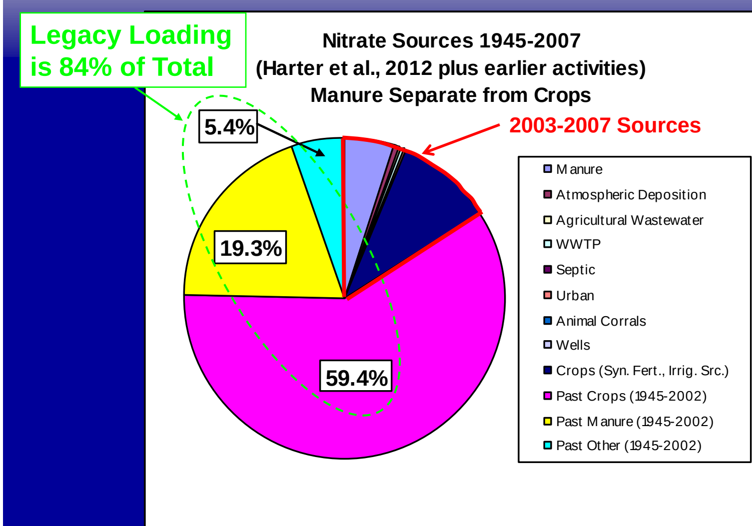


Presented only for the purposes of discussion. The details of this analysis have not been reviewed.

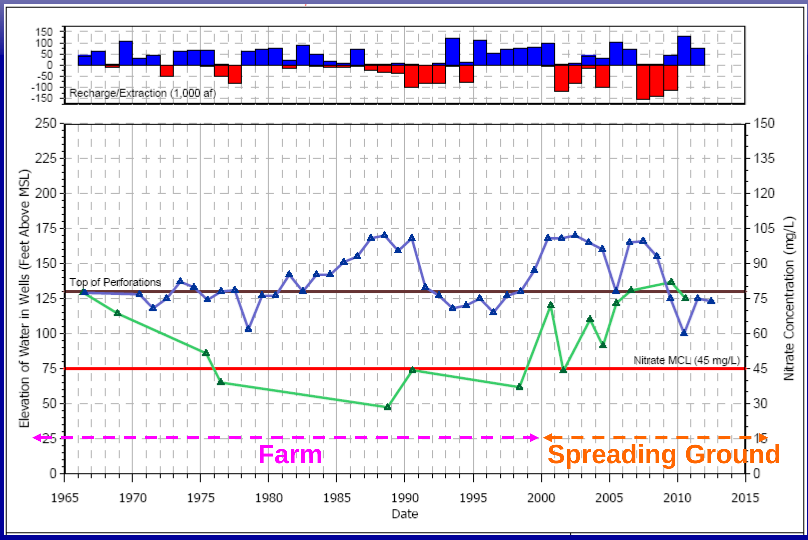
EXTENSION OF UC DAVIS NITRATE ASSESSMENT BACK IN TIME



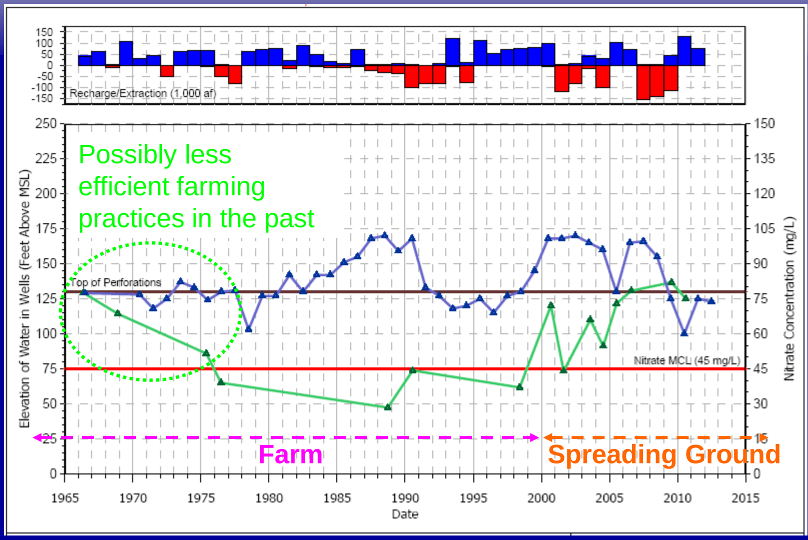
EXTENSION OF UC DAVIS NITRATE ASSESSMENT BACK IN TIME



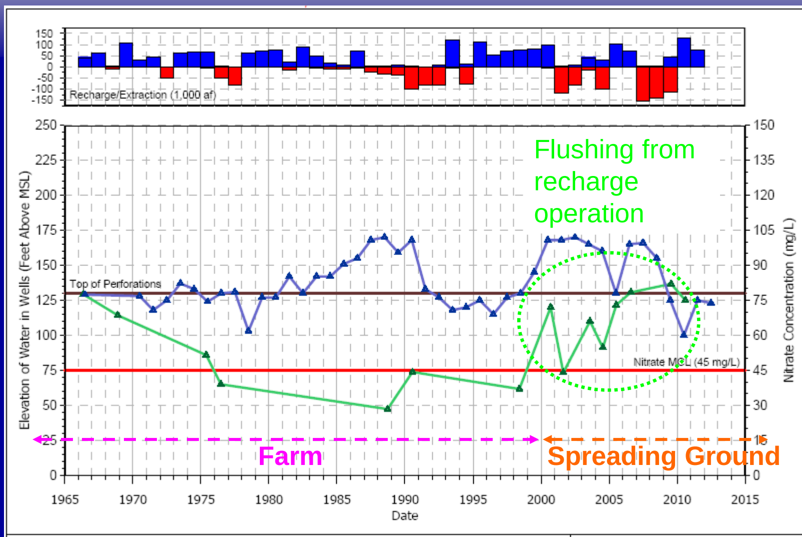
NITRATE FLUSHING FROM THE UNSATURATED ZONE



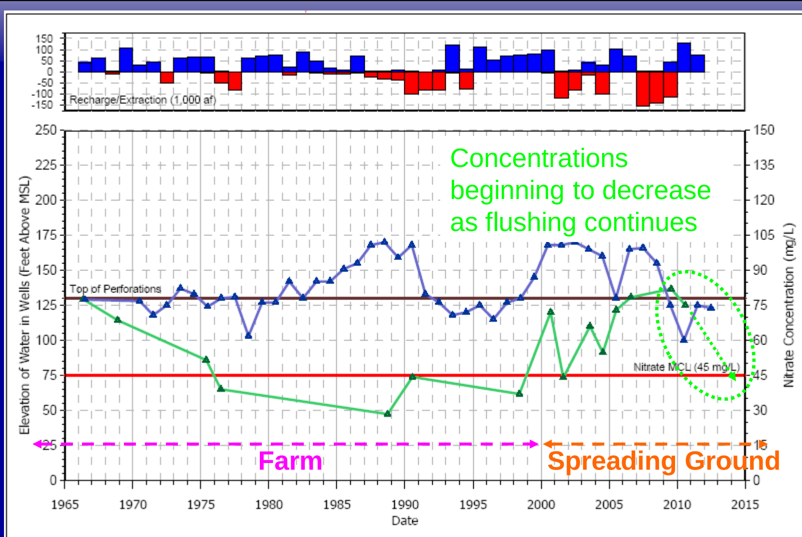
NITRATE FLUSHING FROM THE UNSATURATED ZONE



NITRATE FLUSHING FROM THE UNSATURATED ZONE



NITRATE FLUSHING FROM THE UNSATURATED ZONE



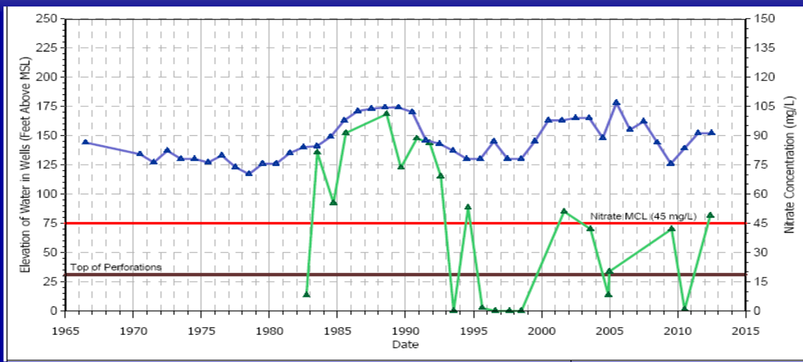
SELECTED POINTS

1. Time lags exist between agricultural activities at ground surface and changes in groundwater quality as a result of a thick unsaturated zone.
2. Nitrate residing in the unsaturated zone acts as an ongoing source to groundwater years after nitrogen is applied at ground surface.
3. The potential costs of an insufficiently planned groundwater quality monitoring program necessitate further study or an interim regulatory step before any full-scale monitoring occurs.

POTENTIAL COSTS

- Implementation of Large Groundwater Monitoring Program as Presented in Draft Order
- Impacts to Farming Practices Required Based Upon Unclear Monitoring Results

DATA FROM THE KRWCA AREA



What would we conclude from these data?

CONCLUSION

Per the information provided above, the KRWCA area is unique, groundwater quality monitoring data interpretation is expected to be complex, area-wide monitoring will be expensive, and a one-size-fits-all groundwater monitoring approach is not appropriate.

CVRWQCB Workshop on ILRP

Bakersfield 11/30/12

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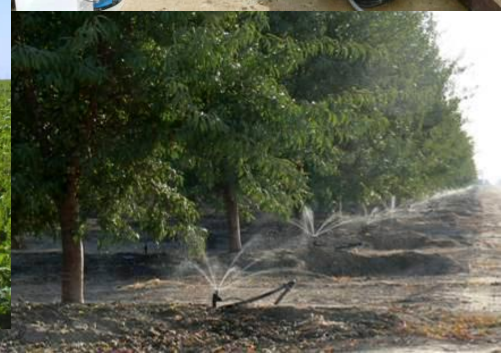
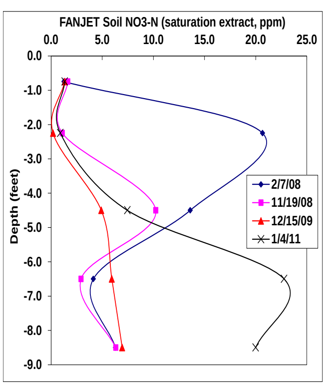




Nitrogen use efficiency (NUE) in 5 year Kern almond trial:

1) Efficiency of N retained in soil

LEACHING FRACTION ESTIMATE (from Cl concentration at depth)				Estimated Nitrogen Use Efficiency, NUE (Sanden)			
2/7/08	11/19/08	12/15/09	1/4/11	2/7/08	11/19/08	12/15/09	1/4/11
0.50	0.36	0.24	0.76	97%	97%	99%	96%
0.12	0.16	0.13	0.60	89%	99%	100%	98%
0.07	0.05	0.07	0.08	96%	98%	98%	97%
0.23	0.18	0.11	0.07	96%	98%	97%	93%
0.28	0.28	0.27	0.17	92%	92%	92%	85%
(Average Cl_{irrig} concentration = 2.2 meq/l. Total Cl @ 950 lb/yr)							

Nitrogen use efficiency (NUE) in 5 year almond trial:

2) NUE by crop export

3 Year Average Kernel Yield (2009-11):	3,743 lb/ac
Annual N Fertilizer Application:	275 lb/ac
Annual N Export from Crop:	246 lb/ac
3 Year Average NUE:	**89.6%**

Paramount Farming Company ranch-wide average applied water and soil NO3-N concentrations from 2008-12 (Note: applied water is for the whole year and less than CIMIS calculated ET for almonds)

	Almond Mature	Almond Dvlpt
EASTSIDE		
[1]Avg Applied Water	43.0	25.8
Acres	13,582	835
[2]0-4 ft Avg Soil NO3-N	5.7	--
[3]No. of samples	324	
WESTSIDE		
Avg Applied Water	48.2	0.0
Acres	22,960	0
0-4 ft Avg Soil NO3-N	4.0	--
No. of samples	700	
ALL PFC		
Avg Applied Water	**46.3**	**25.8**
Acres	**36,542**	**835**
0-4 ft Avg Soil NO3-N	**4.5**	**--**
No. of samples	**1,024**	

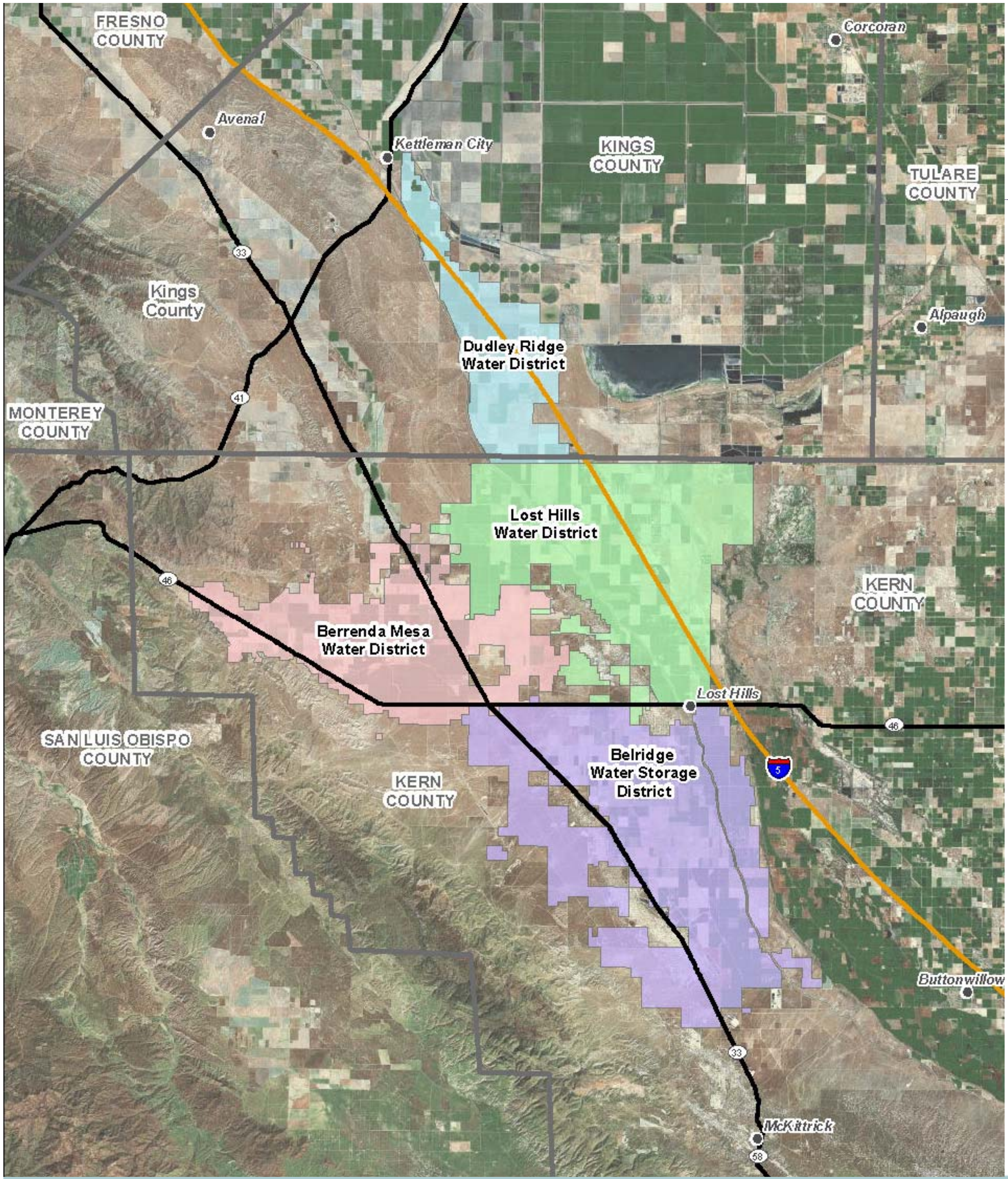
[1]Weighted 2008-2012 average annual applied water by PFC division

[2]Not all fields sampled. Some fields sampled in more than one location. Mature or development (immature) status not designated. All locations sampled in 12" increments to 4 feet. Thus, total number of field locations = No. of samples/4.

[3]Total number of samples in one foot increments from either 2011 or 2012 when the most number of samples were taken.

Westside Water Districts Preliminary Water Quality Report

Timothy G. Souther and Gary L. Kramer
AMEC Environment & Infrastructure, Inc.



Belridge Water Storage District

Berrenda Mesa Water District

Dudley Ridge Water District

Lost Hills Water District

Groundwater Quality (USGS, 1959)

District *Criterion*	TDS (mg/L)	Boron (mg/L)
Belridge Water Storage District	2,848 to 6,500	0.4 to 9.5
Berrenda Mesa Water District	1,250 to 6,800	0.3 to 11.0
Dudley Ridge Water District	584 to 4,971	0.9 to 4.9
Lost Hills Water District	2,200 to 6,660	3.4 to 10.0
MUN (SMCL)	*500 to 1,500*	---
AGR (WQA)	*450 to 2,000*	*0.7 to 3.0*

SMCL = Secondary Maximum Contaminant Level (64449, Title 22, CCR) .

<500 mg/L TDS is Recommended

<1,500 mg/L TDS is Short-Term Use Only

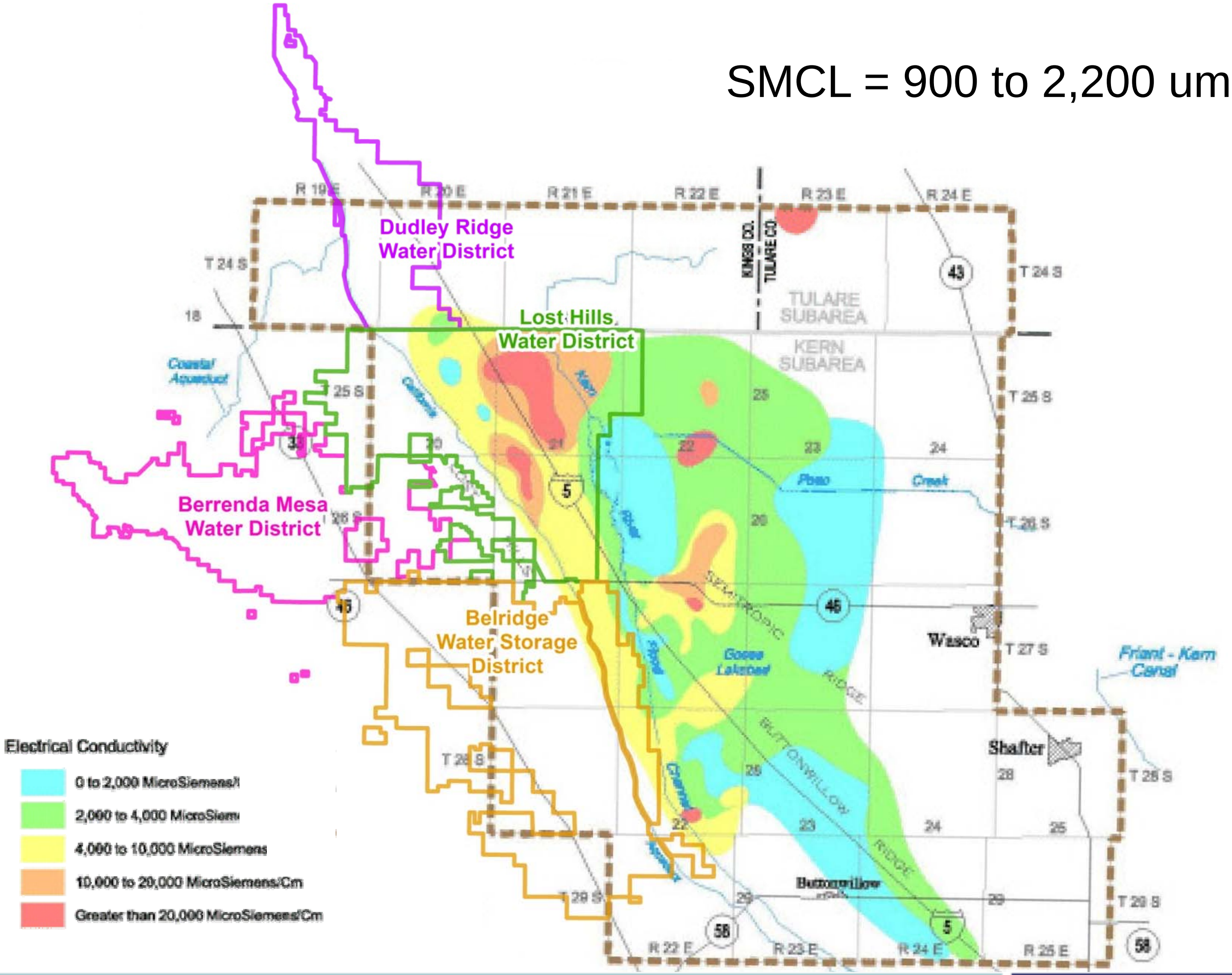
WQA = Water Quality for Agriculture, FAO Drainage Paper 29, 1994.

<450 mg/L TDS and <0.7 mg/L Boron is No Restriction

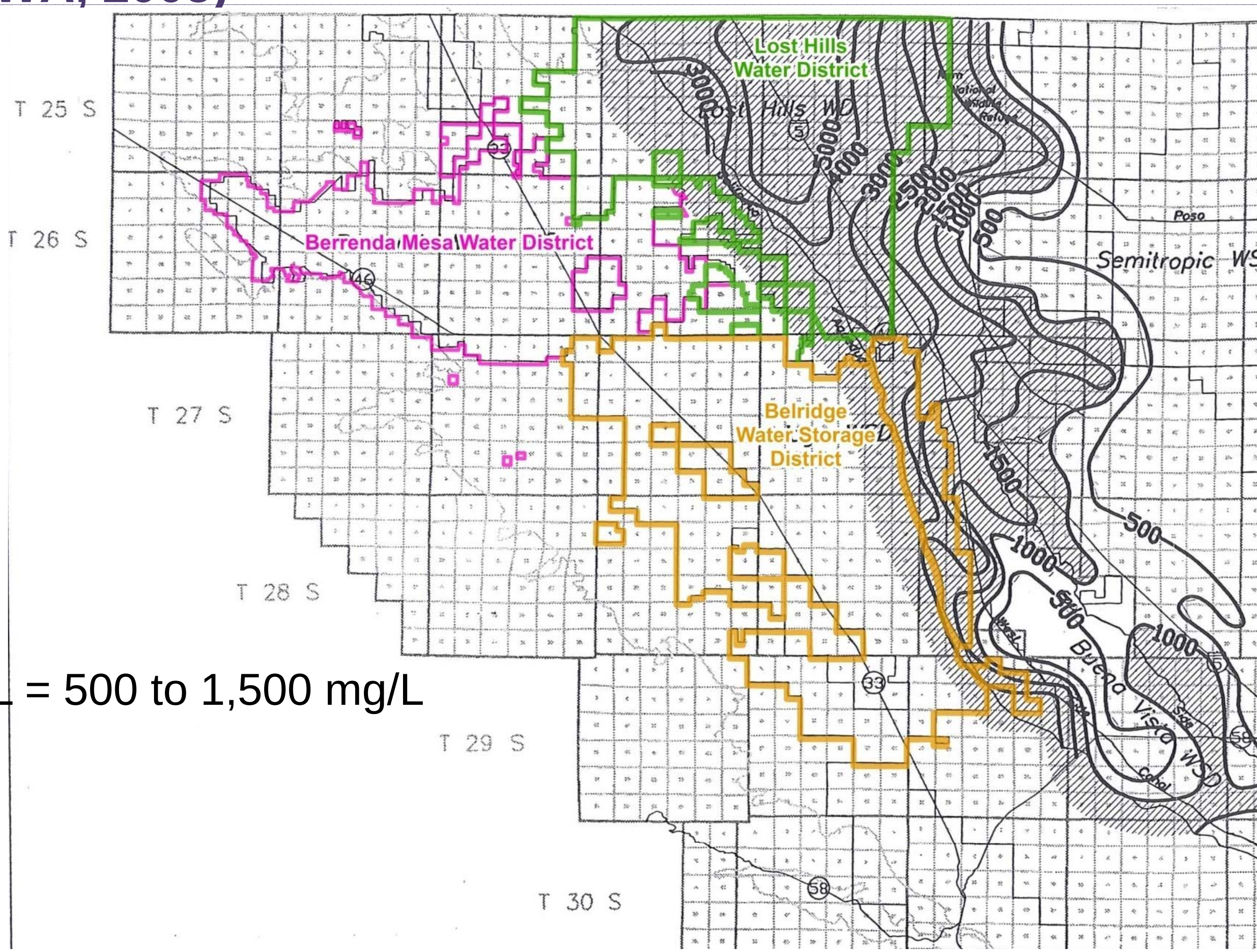
>2,000 mg/L TDS and >3 mg/L Boron is Severe Restriction

Perched Groundwater Quality Electrical Conductance (DWR, 2001)

SMCL = 900 to 2,200 umhos/cm

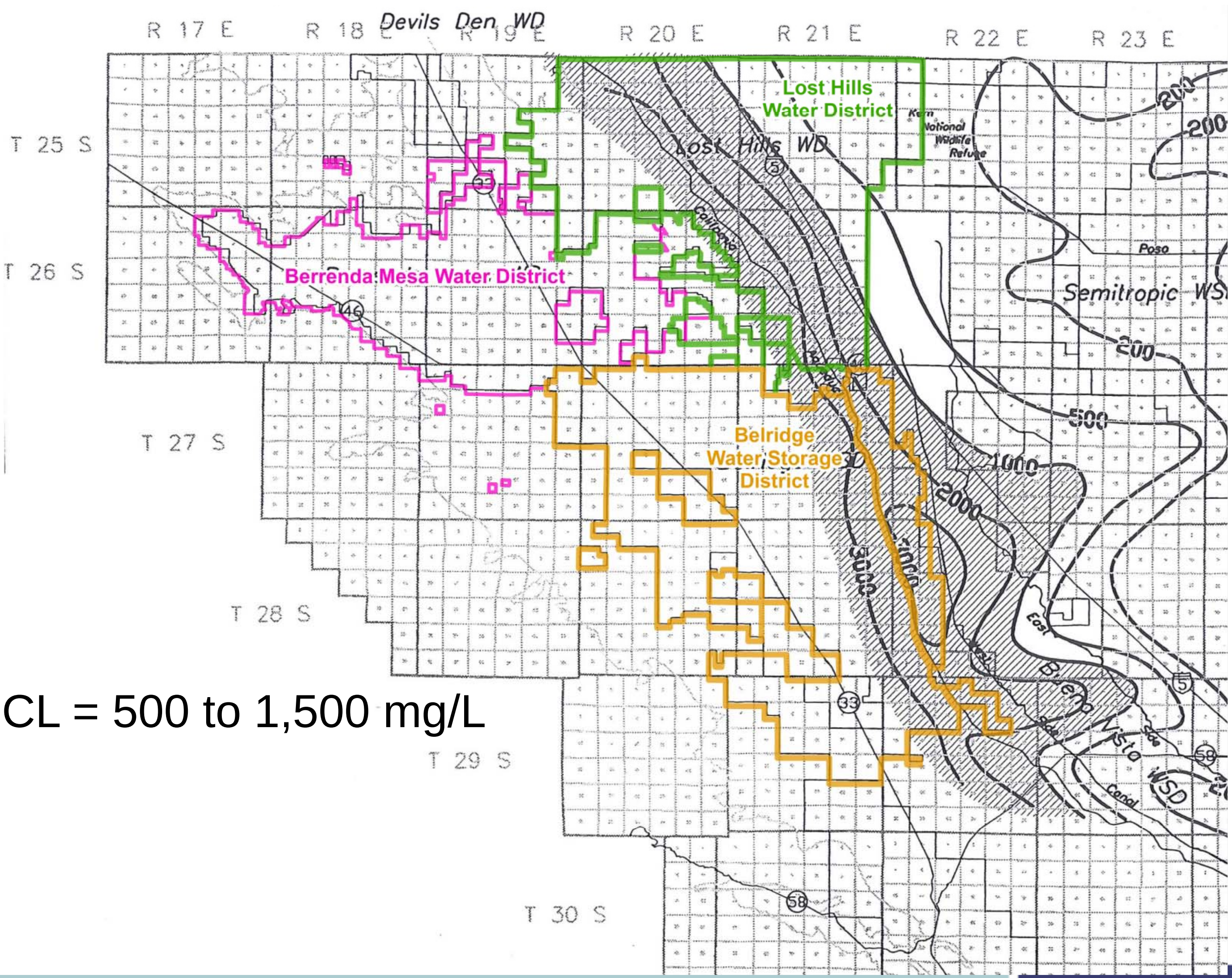


Unconfined Groundwater Quality Total Dissolved Solids (mg/L) (KCWA, 2005)



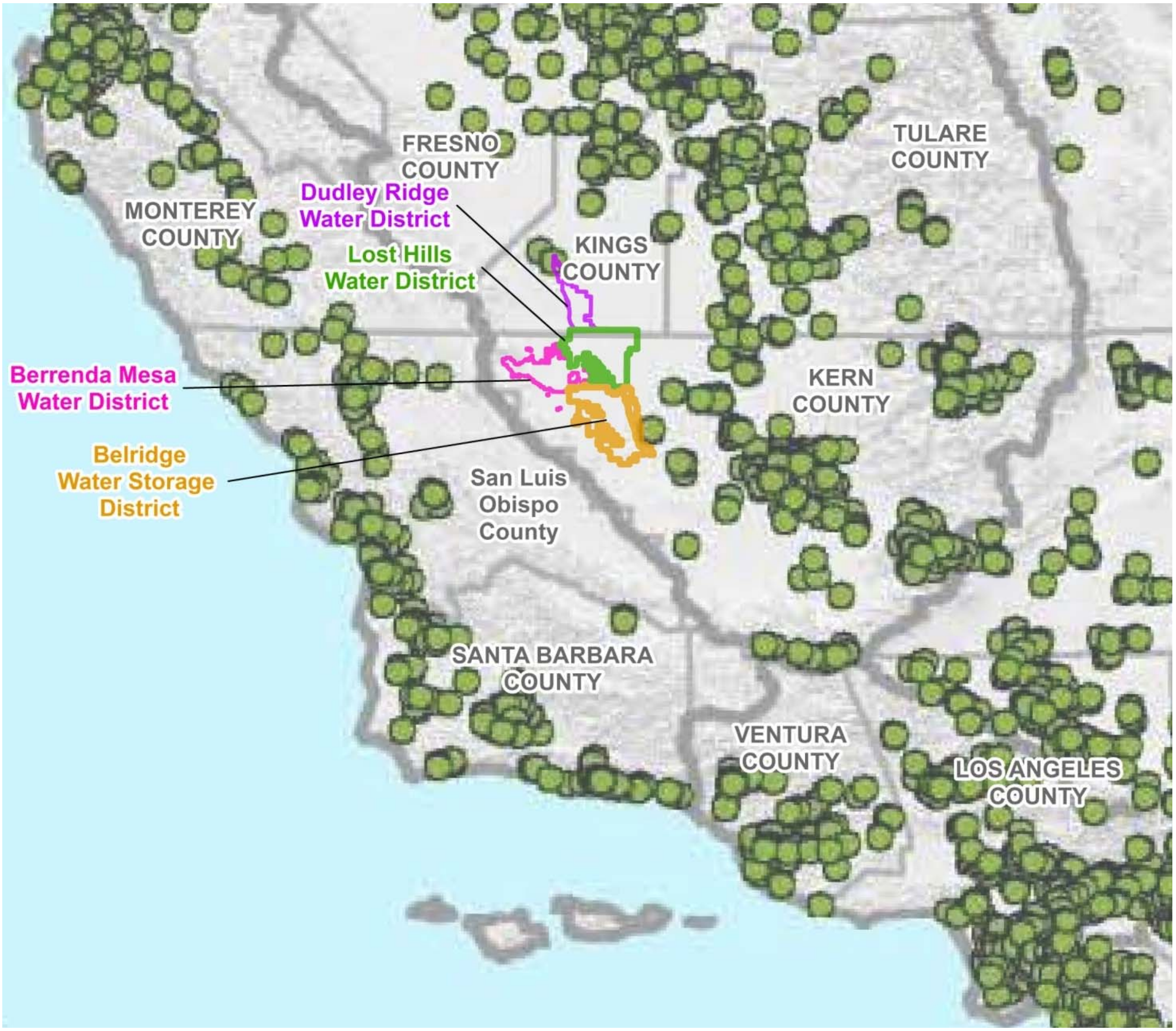
SMCL = 500 to 1,500 mg/L

Confined Groundwater Quality Total Dissolved Solids (mg/L) (KCWA, 2005)



SMCL = 500 to 1,500 mg/L

Currently Active Community Water Systems Relying on Groundwater (SWRCB, 2012)



Preliminary Findings

MUN - Groundwater within the Districts is generally of poor mineral quality (generally >2,000 mg/L TDS) and contains other mineral constituents (arsenic) that have prevented its use for drinking water. Groundwater within the Districts, except near the far northern part of DRWD (Kettleman City), is not used for municipal water supply.

AGR - The poor mineral quality of groundwater (TDS, and boron) has prevented its use for agricultural irrigation. Based on the poor quality of groundwater within the Districts, they have obtained irrigation water supply from the California Aqueduct.

WESTSIDE WATER DISTRICTS' PRELIMINARY WATER QUALITY REPORT

Prepared by Timothy G. Souther and Gary L. Kramer of
AMEC Environment & Infrastructure, Inc. and
Reviewed by Greg A. Hammett of
Belridge Water Storage District
for

Belridge Water Storage District,
Berrenda Mesa Water District,
Dudley Ridge Water District, and
Lost Hills Water District

Abstract: *Four California water districts (Belridge Water Storage District, Berrenda Mesa Water District, Dudley Ridge Water District, and Lost Hills Water District) are located along the southwestern border of the Tulare Lake Basin in western Kern and Kings Counties of California. The Districts have requested that AMEC Environment & Infrastructure, Inc. (AMEC) prepare a summary of groundwater information within the Districts to address the Irrigated Lands Regulatory Program of California Regional Water Quality Control Board, Central Valley Region (RWQCB). The most recent version of the program includes regulation of discharges to groundwater from irrigated lands. This report summarizes groundwater information for the Districts' areas from reports published by federal, state and local agencies. These published reports demonstrate that groundwater below the Districts is of sufficiently poor mineral quality that it is unsuitable for municipal water supply and is only rarely used for agricultural water supply after substantial blending with imported, high quality, surface water supplies. These poor quality groundwater conditions are consistent with several of the exceptions described in the "Sources of Drinking Water" policy (Resolution 88-63) originally adopted by the State Water Resources Control Board (1988) and subsequently by the Regional Water Quality Control Board. Based on the poor quality of groundwater in the area, the Districts ask the RWQCB to use its discretion under the "Sources of Drinking Water Policy" and other Tulare Lake Basin Plan policies to exempt farmers within the Districts from groundwater regulation under the Irrigated Lands Regulatory Program.*

The California Regional Water Quality Control Board – Central Valley Region (RWQCB) is embarking on the long-term Irrigated Lands Regulatory Program (ILRP) for the Tulare Lake Basin (Basin) in central California. The most recent versions of the ILRP (RWQCB, 2012) propose to regulate discharges to groundwater from irrigated agriculture. Four water districts along the western edge of the Basin (Belridge Water Storage District, Berrenda Mesa Water District, Dudley Ridge Water District, and Lost Hills Water District, collectively identified as the Districts and shown on Figure 1) have retained AMEC Environment & Infrastructure, Inc. (AMEC), to prepare a summary report describing groundwater resources within the Districts to assist the RWQCB in considering how to implement the ILRP along the western edge of the Basin. This white paper is the first installment of AMEC's work on behalf of the Districts and includes a summary of area geology, climate, surface waters, and groundwater on a regional scale based on review of published regional reports.

In the California Water Plan, the Department of Water Resources (DWR, 2009) found: "In the western (San Joaquin) valley area, groundwater quality is often poor, and availability is highly variable. In addition, drainage problem areas have developed with high water tables with high total dissolved solids." Groundwater below the Districts is naturally of poor mineral quality, primarily due to contact with marine sediments derived from the Temblor Range that borders the San Joaquin Valley on the west. Those marine sediments and their associated salts have been transported by alluvial processes into the valley. Groundwater in the Districts occurs in perched, unconfined, semi-confined, and confined aquifers. Groundwater quality in each of these zones typically exceeds 2,000 milligrams per liter (mg/L) of total dissolved solids (TDS) and contains other inorganic chemicals (arsenic) that prevent use of groundwater as a potable water supply. For municipal water supply, water is imported into the Districts and treated as necessary. Groundwater use for agricultural irrigation is limited by high TDS and boron concentrations. As such, groundwater irrigation has been almost completely replaced by imported surface water irrigation from the State Water Project (SWP) (California Aqueduct).

THE DISTRICTS

The Belridge Water Storage District (BWSD) encompasses 92,000 acres of land in western Kern County (Figure 1). BWSD slopes from the Antelope Hills and Belridge Oil Field on the west to the California Aqueduct in the valley floor on the east. The BWSD has a contract for 121,508 acre-feet per year of irrigation water from the SWP to about 52,000 acres of developed agricultural land between Highway 33 on the west and the Kern River Floodway on the east and California Highway 46 and the community of Lost Hills on the north (BWSD, 2012). This allocation of SWP water amounts to about 2.3 acre-feet per acre annually. No established communities are present within the BWSD. Oil field operations are present along the west side of California Highway 46 and immediately south of Lost Hills. A food processing plant along Highway 46 is also within the BWSD.

Groundwater beneath the BWSD is of poor mineral quality and is not used for potable water supply, but is occasionally blended with SWP surface water and used for irrigation. Oil field operations in the Belridge Oil Field extract oil and produced water (brine) that is re-injected into exempted aquifers for disposal or use in water or steam flood enhanced petroleum recovery operations in accordance with regulations of the California Division of Oil, Gas, and Geothermal Resources (DOGGR). BWSD participates in several water banking projects, located immediately adjacent to the Kern River, to develop water supplies for use in dry years.

Berrenda Mesa Water District (BMWD) encompasses 55,440 acres of land in the upper Antelope Plain (Figure 1). BMWD extends north and west of BWSD and is bordered by California Highway 46 on the south, the Coastal Aqueduct along the north, and Lost Hills Oil Field on the west. BMWD has a contract for 92,600 acre-feet per year of irrigation water from the SWP to 49,000 acres of developed agricultural land. This SWP allocation amounts to about 1.9 acre-feet per acre annually. BMWD includes the small community of Blackwell's Corner at the intersection of Highway 46 and Highway 33 and extends southeast almost to the community of Lost Hills. BMWD also includes a food processing plant along Highway 46. Groundwater from the BMWD is of poor mineral quality and is not used for potable water supply. Groundwater is imported from the Lost Hills Utility District (LHUD) for potable supply in Blackwell's Corner; LHUD imports water from 13 miles further east and beyond the borders of any of the Districts. BMWD participates in water banking projects, located immediately adjacent the Kern River, to develop water supplies that can be available during dry years.

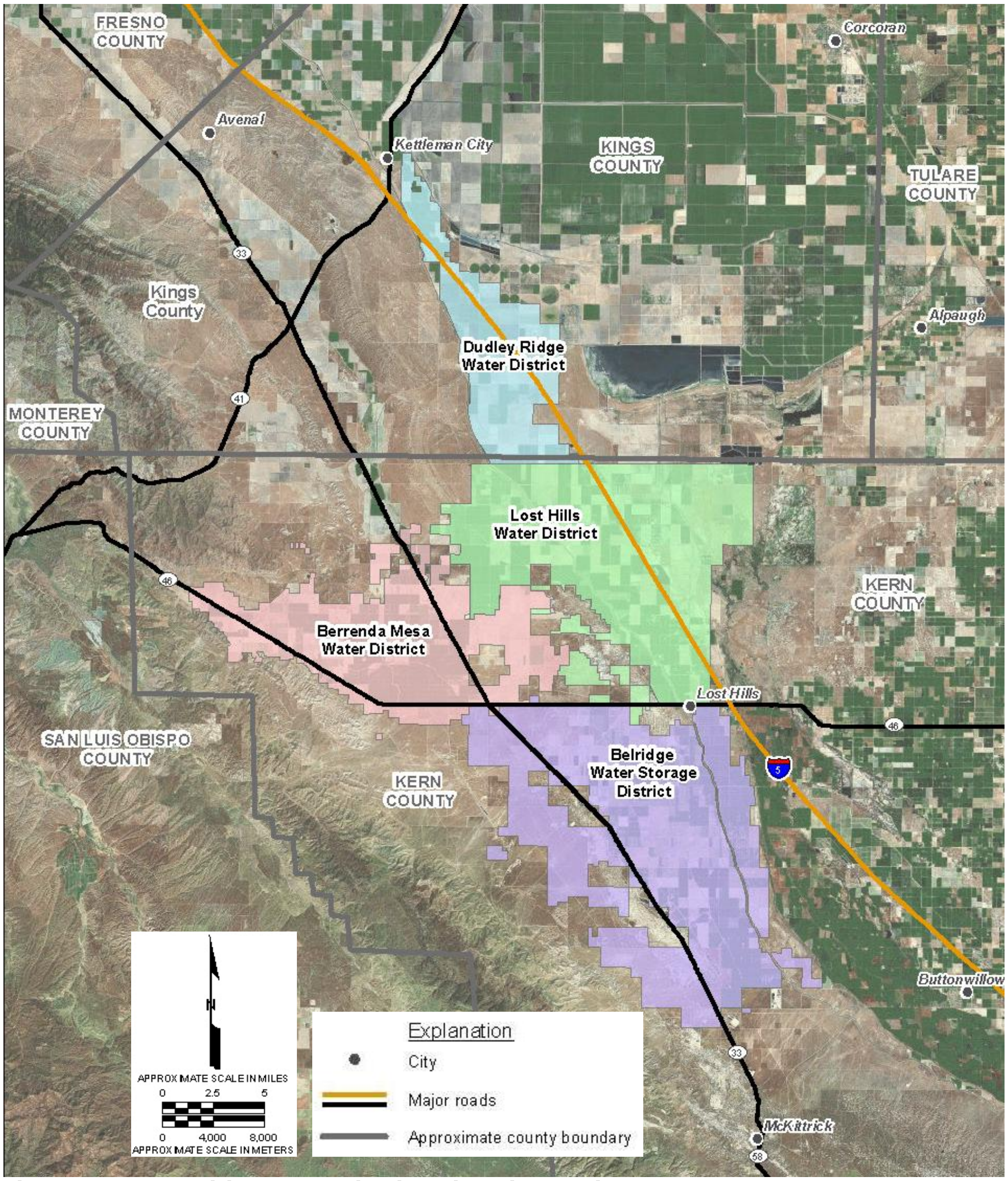


Figure 1 – Westside Water Districts (Study Area)

Dudley Ridge Water District (DRWD) encompasses 37,600 acres of land extending north of the border of Kings and Kern counties on the south, the California Aqueduct on the west, Tulare Lake Bed on the east, and a narrow strip of land on either side of Interstate Highway 5 north to (but not including) Kettleman City (Figure 1). DRWD has a contract for 50,343 acre-feet per year of SWP water that is currently used on 17,000 acres of developed agricultural land. This allocation of SWP water amounts to about 2.9 acre-feet per acre annually. DRWD does not include established communities, although its northern border abuts the community of Kettleman City. Groundwater from the DRWD is of poor mineral quality and is not used for drinking water; DRWD indicates that one well (Section 17, 23S/20E) is used for toilets and sinks (bottled water used for drinking). DRWD participates in the water banking projects, located immediately adjacent to the Kern River, to develop water supplies that can be available during dry years.

Lost Hills Water District (LHWD) encompasses 72,183 acres of land and extends east of BMWD to the Kern National Wildlife Refuge (Refuge), south to the community of Lost Hills, and north to the border of Kings and Kern counties (Figure 1). LHWD supplies 119,110 acre-feet per year of SWP water to about 56,000 acres of developed agricultural land (LHWD, 2012). This allocation of SWP water amounts to about 2.2 acre-feet per acre annually. LHWD abuts the community of Lost Hills to the south and includes a food processing plant along King Road. Devils Den Oil Field borders LHWD along the northwest and Lost Hills Oil Field borders along the south of LHWD. Oil field operators extract oil and re-inject associated brine into exempted aquifers for disposal or use in water or steam flood enhanced petroleum recovery operations. Groundwater from the LHWD is of poor mineral quality and is not used for potable water supply. Groundwater is imported from 13 miles east of LHWD for potable supply in the community of Lost Hills (KIRWMP, 2011). In water short years, LHWD purchases supplemental water.

Prior to delivery of SWP water to the Districts, the DWR prepared evaluations of the feasibility of providing water from the California Aqueduct to the Districts (DWR, 1963 and 1964). DWR's evaluation of existing surface and groundwater conditions in the Districts are provided in the following paragraphs.

> **Belridge Water Storage District, Antelope Plain and Lost Hills Water Districts**
> (Antelope Plain Water District is now the Berrenda Mesa Water District)
>
> "There is no usable surface water supply in these three districts except for sporadic flood flows. These districts are relatively undeveloped and have generally similar ground water conditions. There are no commercially irrigated lands in the Belridge Water Storage District. A few thousand acres are irrigated by ground water in the Antelope Plain Water District, and about 10,000 acres are irrigated in the Lost Hills Water District from groundwater and occasional surface water from the Kern River.
>
> The yields of existing wells are for the most part low, and the quality of groundwater is poor. Crops produced on these lands are limited to those which are tolerant to poor quality water. Any significant additional development of these districts is dependent upon an imported water supply.
>
> Ordinarily, in an area having ground water, there is the opportunity to make efficient use of imported water supplies by re-using that portion of the water which percolates beyond the crop root zone to the underlying ground water basin. In these districts, however, the material under-lying the surface is very dry, and it is believed that virtually all percolating water would be absorbed for several decades.
>
> In these districts the existing poor quality of ground water provides an additional problem. Even the percolation of additional water will not improve these waters to the point where they could be used without mixing with surface supplies. It seems highly doubtful, however, that this would have any appreciable effect prior to 1990."
>
> **Dudley Ridge Water District**
>
> "For all practical purposes, there is no local surface water supply available to the District. Only occasionally during storms do the normally dry arroyos of the Kettleman hills have sufficient runoff to reach the District.

At present, the principal water supply for irrigation of land in the District is conveyed some 40 miles from sources to the east located outside the District.

There are some producing wells in the extreme northern part of the District that supply a small portion of the present water supply. Most wells that have been drilled, however, have been abandoned due to poor yield and poor quality of groundwater. Studies made for this report indicate that it would be physically possible to recapture percolate from future imported supply, but the poor quality of water underlying the area would make it unsuitable for reuse, at least for a significant number of years. It is planned that this supply will be used outside the District after water is received from the California Aqueduct."

CLIMATE

Climate in the Districts is characterized as an inland Mediterranean climate with hot and dry summers and cool winters. The average annual precipitation at the Blackwell's Corner and Kettleman City stations is 4.5 and 6.6 inches, respectively (WRCC, 2012). The average annual reference evapotranspiration for DRWD is 58 inches and for BWSD, BMWD, and LHWD is 62 inches (CIMIS, 2009). These climatic conditions resulted in desiccation of soils before irrigation development within the Districts that restricts deep percolation of irrigation water.

SURFACE WATER

All of the Districts are within the South Valley Floor Hydrologic Unit (specifically HA 558.60 and HA 557.30) (RWQCB, 2004). Ephemeral stream beds occur in the upper reaches of the HAs and drain to the east (BWSD, BMWD, DRWD, and LHWD) into the Districts. Runoff in these streams is not controlled and typically percolates prior to reaching the valley floor. The 100-year, 24-hour storm for this area ranges from 3 to 3.5 inches (NOAA, 2012).

Irrigation canals and drainage facilities are the main surface water features within the Districts. Besides these features, the dominant surface water features in the area of BWSD, BMWD, DRWD, and LHWD are the California Aqueduct, its Coastal Aqueduct, and the Refuge. Other surface water features in the area include the Tulare Lake Bed, Goose Lake, and Kern/Buena Vista Lake.

The designated beneficial uses of surface water in South Valley Floor Hydrologic Unit are agricultural supply (AGR); industrial supply (IND); process water supply (PRO); non-contact water recreation (REC-2); warm freshwater habitat (WARM); wildlife habitat (WILD); rare, threatened, or endangered species (RARE); and groundwater recharge (GWR) (RWQCB, 2004). The uplands (above the Districts) consist of 11 relatively small watersheds of 9 to 104 square miles (Figure 2) that produce little runoff ranging from 100 to 2,700 acre-feet per year (USGS, 1983).

Wetlands occur within the Refuge and the Goose Lake wetlands. The 11,249-acre-Refuge is located just west of the LHWD and includes approximately 5,000 to 6,500 acres of seasonal wetlands, irrigated moist soil units, and riparian habitat. Upland areas of the Refuge total about 3,600 acres of grassland, alkali playa, and valley sink scrub habitats. Water supply for the Refuge is provided by the California Aqueduct. The Water Management Plan for the Refuge (USBR, 2011) indicates:

"Groundwater has elevated levels of boron, arsenic and sodium. The depth to ground water makes the pumping very expensive. All wells are inactive with deteriorated casings and only four of the wells have pumps. These wells would only be used in a short-term emergency and only if money were available to pay the pumping costs."

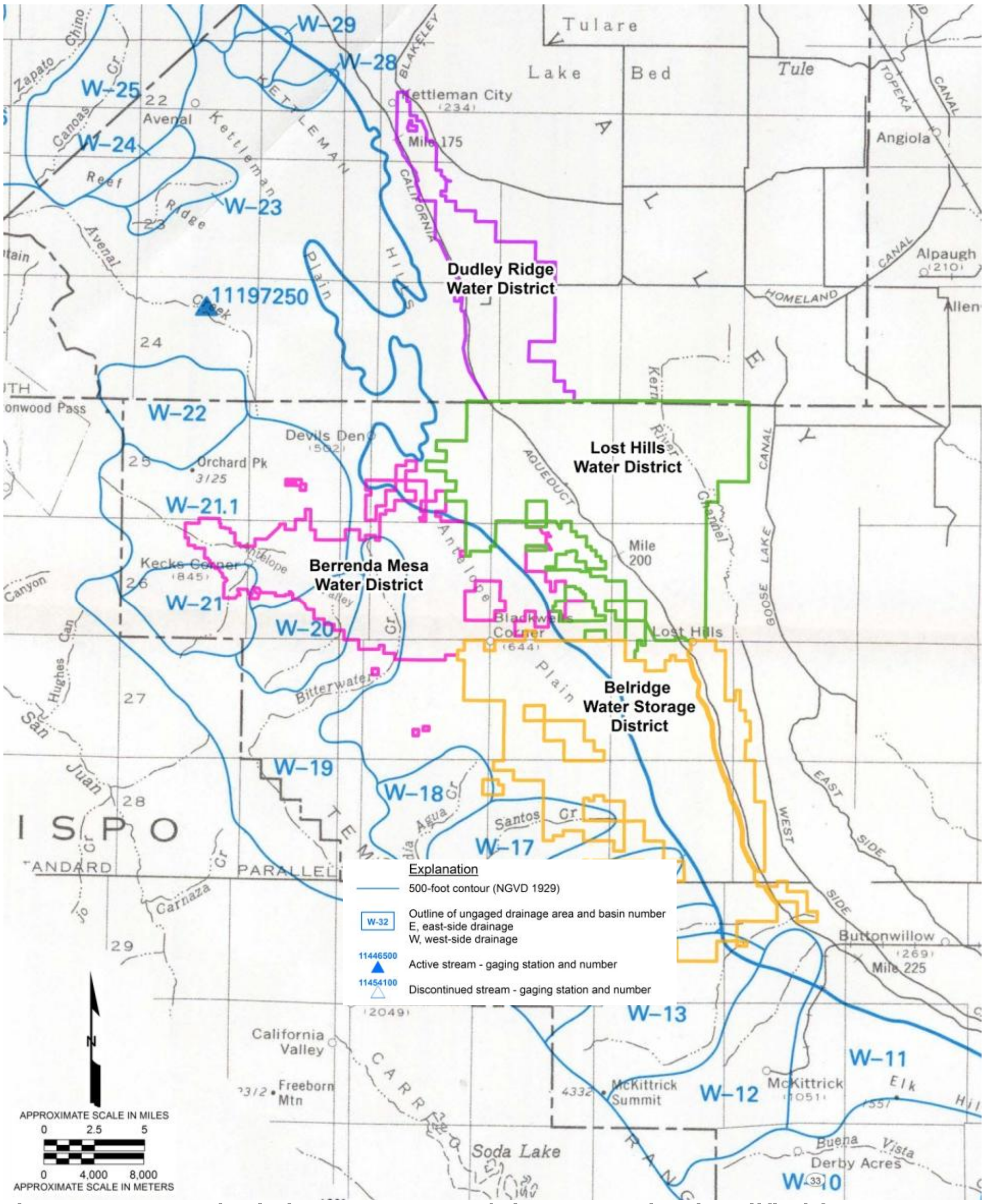


Figure 2 – Watersheds in Western Kern/Kings Counties (modified from USGS 1983)

Goose Lake is a privately held, ephemeral wetland that is habitat for threatened or endangered species. Goose Lake is located between Wasco and Lost Hills in western Kern County, but not within any of the Districts. The United States Bureau of Reclamation (USBR) is attempting to organize a management plan at Goose Lake for species protection. The USBR indicates that the wetland contains native alkali grassland and native alkali scrub habitat. Goose Lake is reportedly maintained by surface waters from a variety of sources (USBR, 2012).

SURFACE WATER QUALITY

Other than water in the California Aqueduct, very little surface water monitoring data have been collected recently within the Districts. California Aqueduct water delivered to the Districts averages 440 mg/L TDS (KIRWMP, 2011). The electrical conductance (EC) of water in the California Aqueduct at Kettleman City (Station C21) has ranged from 130 to 813 µmhos/cm and averaged about 500 µmhos/cm over the past five years (DWR, 2012). This range of ECs is roughly equivalent to a TDS range of 100 to 570 mg/L.

No Total Maximum Daily Load has been established for surface waters within the Districts (SWRCB, 2012c). The Southern San Joaquin Valley Water Quality Coalition has been monitoring a surface water station at the Main Drain Canal at Highway 46 (558MDCH46) since 2004. The TDS concentrations in the Main Drain Canal water has ranged from 270 to 2,410 mg/L over the period from 2004 through 2008 (SWRCB, 2012a).

GEOLOGY

The Districts are in the southwestern portion of the San Joaquin Valley. Regional geology in the southwestern San Joaquin Valley is characterized by a long history of structural deformation associated with tectonic movement along the continental borderland, including the prominent and still active San Andreas Fault. Uplift of the Sierra Nevada east of the valley, later uplift of the Temblor Range on west side, and formation of the deep structural trough beneath the valley floor, have resulted in the accumulation of more than 20,000 feet of marine and terrestrial sediments of Cretaceous to Holocene age throughout the basin (Maher et al., 1975).

REGIONAL STRATIGRAPHY

The stratigraphy of the southwestern San Joaquin Valley comprises marine sedimentary rocks from the Jurassic/Cretaceous through Tertiary Periods and unconsolidated non-marine sediments from Late Tertiary and Quaternary Periods (Figure 3).

The oldest marine sediments are exposed in the Temblor Range from north of Highway 41 south to Highway 58. Younger marine formations are exposed to the east, approaching the valley floor. The stratigraphic relationships of these formations are complex, owing to the significant structural deformation present on the west side of the valley.

The continental Tulare Formation overlies various marine formations along the west side of the valley. In many areas, the Tulare Formation is overlain by younger alluvium. In areas where the Tulare Formation is absent, the younger alluvium directly overlies older marine sediments.

The Tulare Formation and overlying alluvium consist of coarse-grained facies east of the Temblor Range associated with alluvial fan deposition from the upland of the Temblor Range. West of the Kettleman and Lost Hills areas, these coarse-grained alluvial facies become interbedded with fine-grained facies associated with lacustrian, fluvial, deltaic, and marshland deposits from the pre-historic and historic Tulare Lake and Goose Lake, as well as the Kern River flood plain situated between them (Croft, 1972; Page, 1983). The Tulare Formation and overlying alluvial sediments comprise the major aquifers beneath the San Joaquin Valley. These are discussed in further detail below (see Hydrogeology).

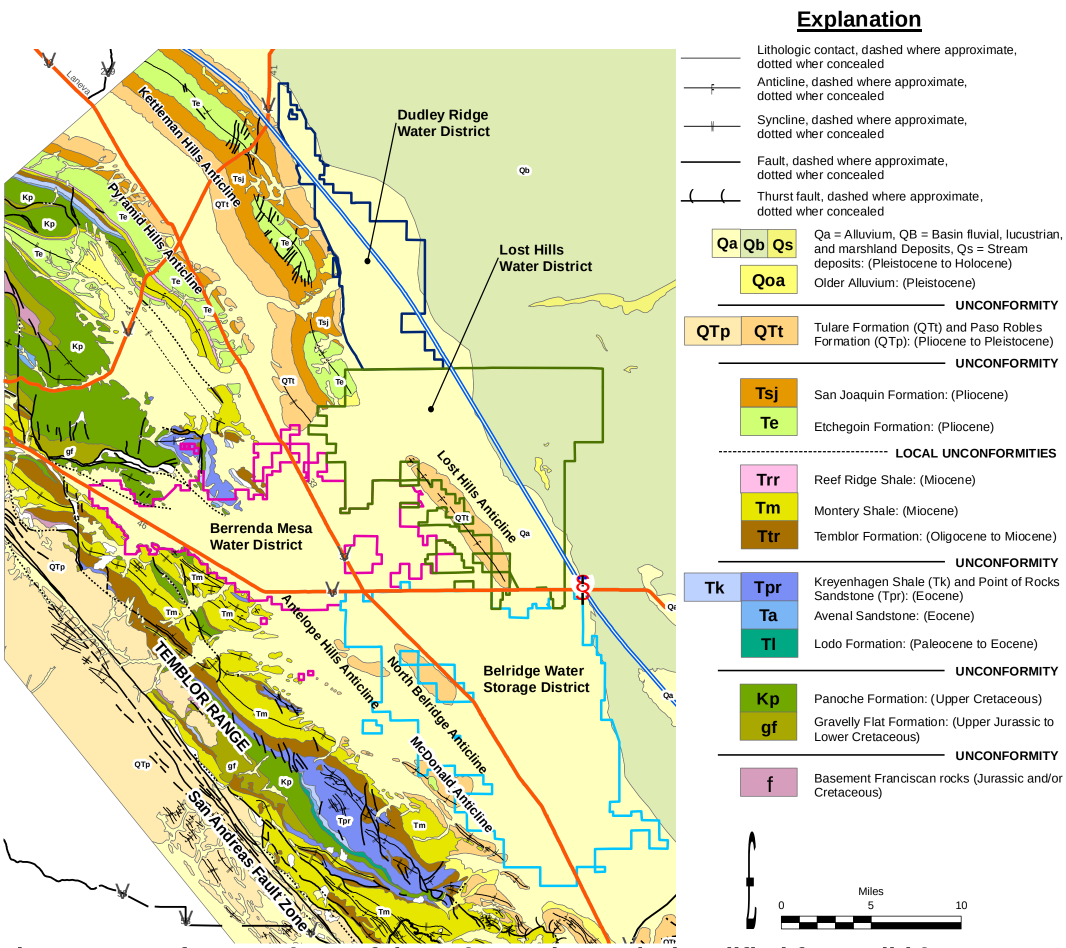


Figure 3 – Surface Geology of the Tulare Lake Basin (modified from Dibblee, 1973, Graham et al. 1999, Hilton et al. 1963, and Dale et al. 1966)

The following Figure 4 is a generalized geologic cross-section of the southern San Joaquin Valley.

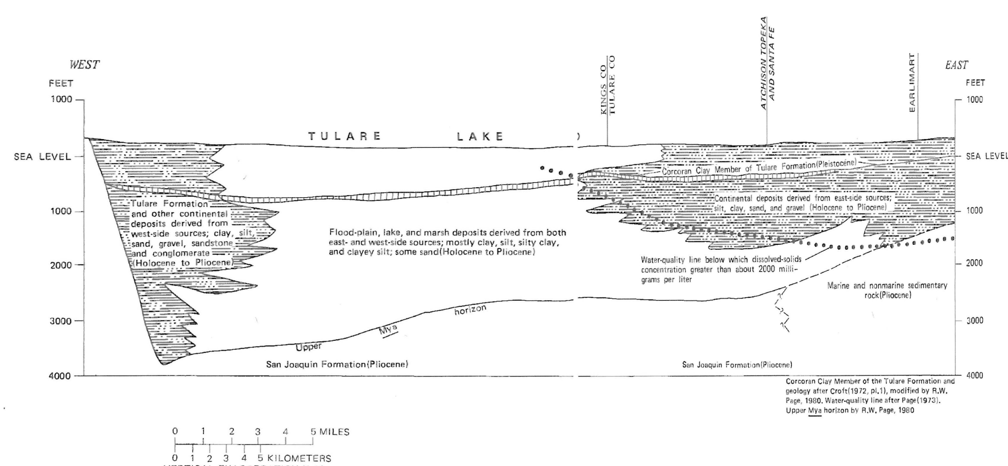


Figure 4 – Generalized Cross Section of The Tulare Formation, Southern San Joaquin Valley (Page, 1983)

REGIONAL STRUCTURAL GEOLOGY

The topography and geology of the southwestern San Joaquin Valley has been shaped by the regional tectonic environment and subsequent erosion. The dominant structure in the region is the San Andreas Fault. The regional stress field developed by slip along the irregular fault trace of the San Andreas has resulted in ancillary faulting within the Temblor Range paralleling the San Andreas. Furthermore, regional compressional forces along this margin have resulted in the uplift and formation of highly folded and faulted marine sediments in the Temblor Range and the development of a series of en-echelon anticlines and synclines east of the Temblor Range that either plunge to the southeast or are doubly-plunging toward the northwest and southeast.

Several anticlines and synclines that have been exposed in the vicinity of the Districts include: (1) the Kettleman Hills anticline west of DRWD, northwest of LHWD, and northeast of BMWD; (2) Pyramid Hills anticline and syncline north of BMWD; (3) the Lost Hills anticline bisects portions of the southeastern portion of the LHWD and is east of BMWD and north of BWSD; (4) highly folded Monterey Shale of the Shale Hills lies adjacent to the western boundary of BMWD; (5) the North Antelope Hills anticline is situated west of the BWSD; (6) the North Belridge anticline is located within the BWSD; (7) the McDonald anticline is situated west of the BWSD; and (8) the northern extension of the Elk Hills anticline lies west of the southwestern portion of the BWSD (Dibblee, 1973; and Graham et al., 1999).

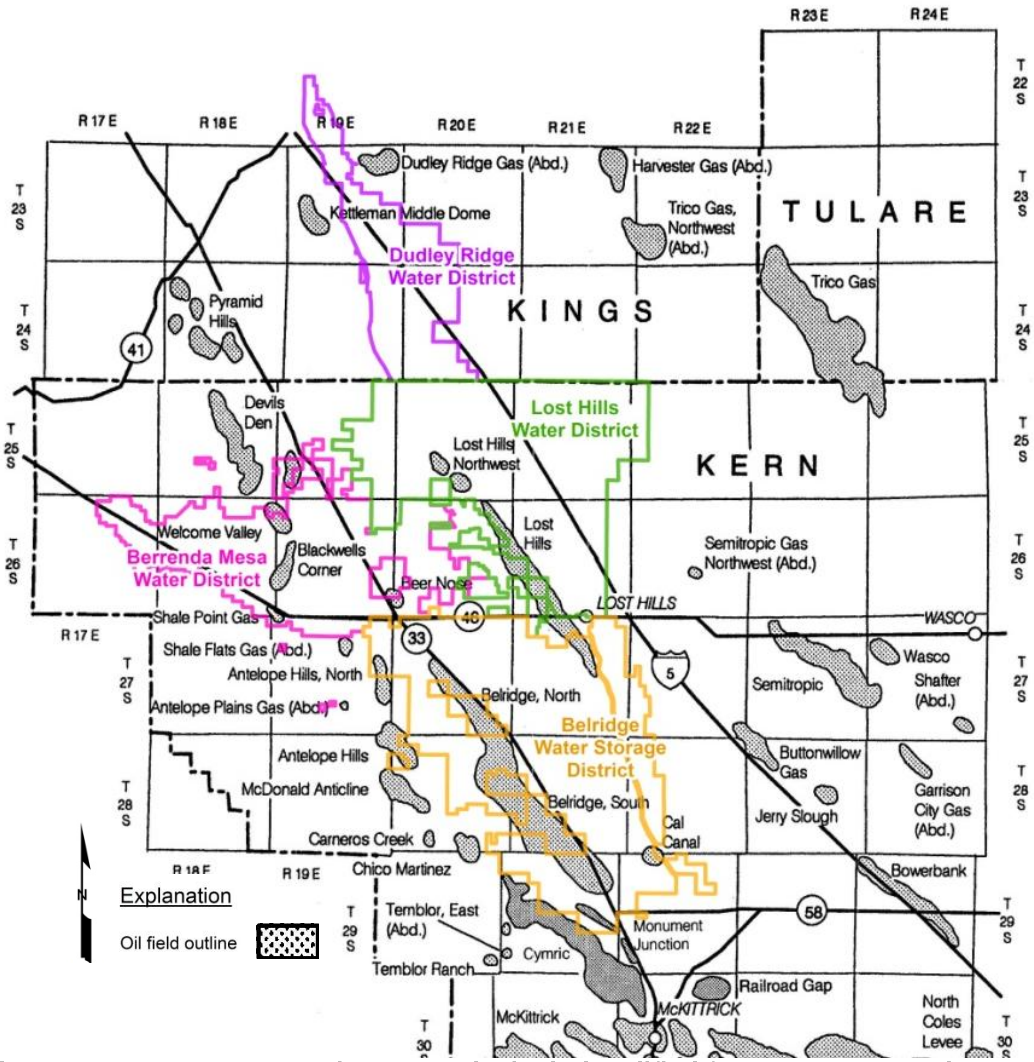
Post-Pliocene deposition of marine and terrestrial sediments occurred under the tectonic environment of the San Andreas Fault and associated developing anticline and synclines. Deposition associated with tectonic movement over time results in the incremental deformation of these sediments as the duration and magnitude of deformations progresses over time. This has implications on the occurrence and flow of groundwater in aquifers that have developed in the Tulare Formation, older alluvium, and alluvial sediments adjacent to the Temblor Range. These structures have also contributed to the localization of oil and gas resources in the region.

ECONOMIC GEOLOGY

Within the Tulare Lake Basin, mineral resources are mined to produce aggregates, precious metals, petroleum, and natural gas. For this summary, we are focusing on production of oil and gas within the Districts' areas.

Oil and gas recovery operations occur immediately adjacent to each of the Districts or historically within portions of the Districts. Designated oil fields include North Antelope Hills, Antelope Hills, McDonald Anticline, Carneros Creek, Chico Martinez, Cymric, Monument Junction, North Belridge and South Belridge Oil Fields east the BWSD; Deer Nose, Welcome Valley, Shale Point Gas, and Blackwells Corner Oil Fields adjacent BMWD; Lost Hills Oil Field between BMWD and LHWD and within portions of BWSD and LHWD; and Kettleman Middle Dome west of DRWD. Oil field operations extract various grades of petroleum, natural gas, and associated produced water (brine). The brine is re-injected into designated exempt aquifers for disposal or use in water or steam flood enhanced petroleum recovery operations in accordance with regulations of the DOGGR.

![amec logo]



Figures 5 – West San Joaquin Valley Oil Fields (modified from DOGGR, 1998)

Formations that produce oil and gas generally do not produce usable groundwater as a drinking water source because of dissolved petroleum and salts in the water. For example, the reported TDS in brine produced in the North Belridge Oil Field ranges from 21,400 to 42,000 mg/L. Current production zones range from 1,000 to more than 15,000 feet in depth. However, some of the early oil and gas production was much shallower; the average depth of production from the shallow Tulare Formation wells in Lost Hills Oil Field and South Belridge Oil field were 200 and 400 feet in depth, respectively (DOGGR, 1998). The State Water Resources Control Board (SWRCB) authorized exempted aquifers for reinjection of brine water back into these oil producing zones (DOGGR, 1981). Until recently, the RWQCB regulated percolation pond discharges of produced oil/gas brine water in westside oil fields. These discharges have affected the quality of shallow groundwater below and downgradient within the Districts (RWQCB, 2006). The following example hydrogeologic section (Figure 6) for brine ponds in Belridge Oil Field is cited in RWQCB, 2006.

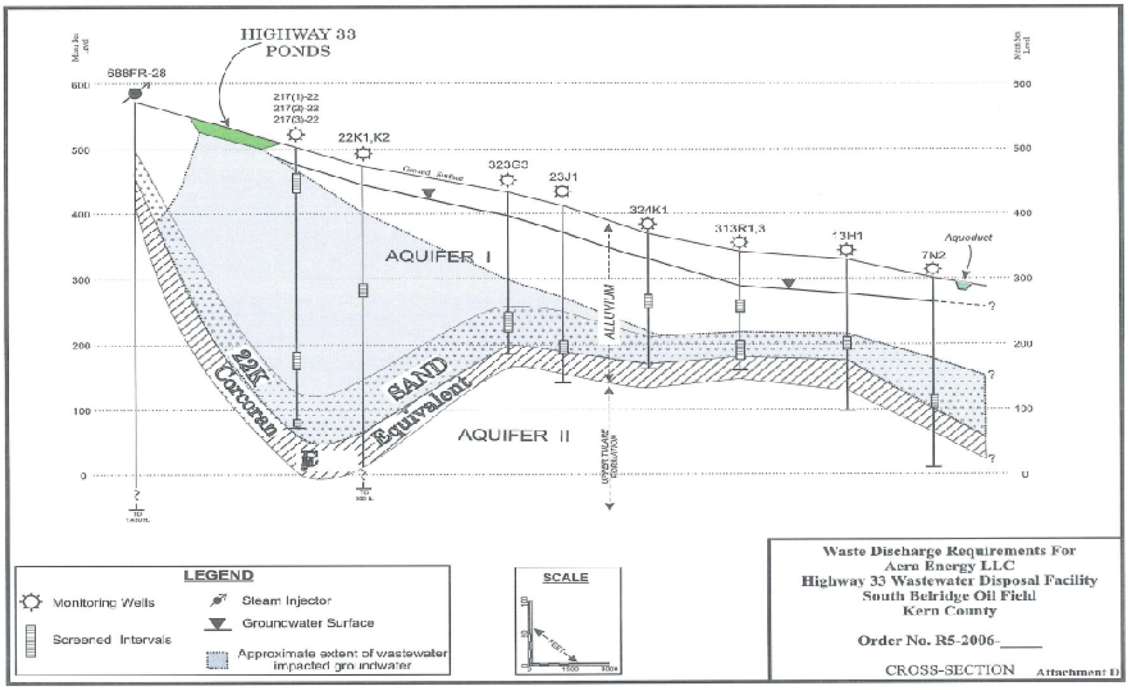


Figure 6 - West-East Geologic Cross-Section, South Belridge Oil Field (RWQCB, 2006)

This cross section shows that oil field brine ponds have affected groundwater downgradient within BWSD (between the Highway 33 ponds and the California Aqueduct). Only a few of the former oil field ponds have included such detailed groundwater monitoring. However, there is a potential that other historic or current oil field operations have resulted in similar downgradient groundwater effects within each of the Districts.

HYDROGEOLOGY

The Districts are all within Detailed Analysis Units (DAUs) designed by the Tulare Lake Basin Plan (RWQCB, 2005):

BWSD, BMWD, and LHWD in DAU 259
DRWD in DAU 246

The designated beneficial uses of groundwater in DAU 259 and DAU 246 are municipal supply (MUN), AGR, and IND (RWQCB, 2005). Groundwater in each of the Districts occurs as perched (unconfined), semi-confined, and confined groundwater.

AQUIFER SYSTEMS

Groundwater beneath the Districts occurs under perched, unconfined, and confined conditions. Areas of shallow perched groundwater within the Districts appear to correspond to the presence of a shallow clayey until (designated the A-clay) beneath the Districts. The perched aquifer consists of Pleistocene-Holocene fluvial and flood basin sediments comprised predominately of silts and clay interbedded with sand layers (Hilton et al., 1963; Croft, 1972). These sediments overlie the A-clay and grade laterally into younger alluvium to the west. The areal extent of perched aquifers appears centered on an axis along the Kern River Flood Channel between Goose Lake and Tulare Lake beds and lie east of the California Aqueduct (DWR, 2008). The lateral extents of the A-clay are poorly constrained. The A-clay reportedly has been encountered under LHWD at depths of 30 to 60 feet (PPEG, 2007).

Unconfined aquifers exist in alluvial sediments of Antelope Valley east of the Lost Hills Anticline and below the perched groundwater in the upper Tulare Formation. The unconfined aquifer consists predominately of coarser alluvial sediments flanking the Temblor Range that grade laterally eastward into finer grained fluvial, marsh, deltaic, and lucustrian deposits between Goose Lake and Tulare Lake. In areas where fluvial deposits become highly interbedded and bifurcated, semi-confined groundwater conditions may be encountered in the upper Tulare Formation. The base of the unconfined aquifer is defined by the presence of the E-clay where it is present. In areas where the E-clay is absent the unconfined aquifer extends to the top of the marine formations.

The modified E-clay described in Page (1986) forms the major regional aquitard that separates the upper unconfined aquifer from the lower confined aquifer in the southwestern San Joaquin Valley. In the Districts, it has been encountered in wells east of the California Aqueduct (Page, 1986). The E-clay is also known to underlie DRWD and portions of LHWD east of the Lost Hills Anticline, but appears absent west of this structure beneath the Antelope Plain (PPEG, 2007) and BMWD. The presence of the E-clay beneath BWSD west of the aqueduct is poorly constrained. The depth at which the E-clay is encountered varies due to the presence of anticline and syncline structures along the west side of the valley. It is encountered as shallow as 100 feet along the east limb of Lost Hills (PPEG, 2007) to as deep as 900 feet near the southwest edge of Tulare Lake bed (Page, 1986). The thickness of the E-clay ranges from 8 feet south of Lost Hills to 205 feet near the southwest edge of Tulare Lake bed (Page, 1986).

Groundwater below the E-clay is encountered in confined conditions. The Tulare Formation below the E-clay consists of unconsolidated interbedded sand, silt, and clay. The nature of these sediments ranges from coarser alluvial fan deposits near the Temblor Range to fine-grained lucustran, fluvial, and marsh deposits eastward toward the axis of the valley trough (Croft, 1972).

GROUNDWATER OCCURRENCE

The California Department of Water Resources (DWR) indicates that perched groundwater occurs below the Districts (DWR, 2011). Perched water in portions of the BWSD, LHWD, and DRWD ranges in depth from 5 to 20 feet (Figure 7). DWR does not identify perched groundwater in the BMWD, although it may be present in some areas.

The DWR does not characterize the occurrence of semi-confined or confined groundwater within the Districts due to lack of current data. However, the Kern County Water Agency (KCWA) indicates the depth to groundwater in the Districts (except BMWD and DRWD) in 2001 was between 50 and 100 feet with a general gradient to the east.

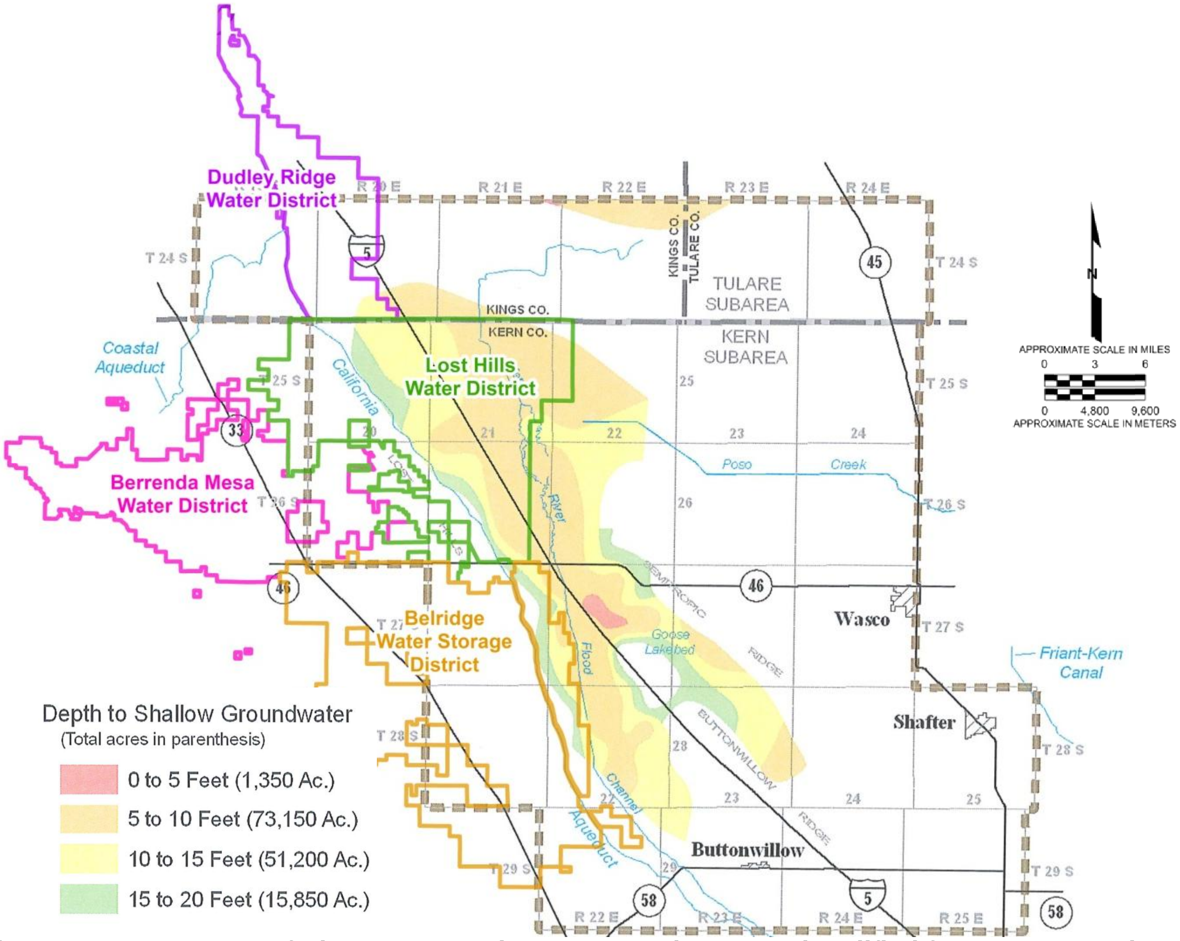


Figure 7 – 2008, Areas of Shallow Groundwater, Lost Hills Areas (modified from DWR, 2008)

GROUNDWATER QUALITY

AMEC reviewed groundwater quality data from several sources. These included the RWQCB, DWR, KCWA, United States Geological Survey (USGS), and private sector consultants and non-governmental coalitions. These materials are discussed in the following subsections.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

The designated beneficial uses of groundwater in DAU 259 and DAU 246 are MUN, AGR, and IND (Basin Plan; RWQCB, 2005). The Basin Plan indicates that "Ground waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses." For salinity, the Basin Plan indicates that "All ground waters shall be maintained as close to natural concentrations of dissolved solids as is reasonable…the water quality objectives for groundwater salinity control the rate of increase." For the Westside Hydrographic Unit (includes DAU 259 and DAU 246), the groundwater quality objective is an annual increase in electrical conductance (EC) of 1 micromho per centimeter (µmhos/cm).

For MUN, the Basin Plan specifies that "water designated MUN shall not contain concentrations of chemical constituents in excess of maximum contaminant levels (MCLs, Section 64431 through 64449, Title 22, California Code of Regulations)." For purposes of this evaluation, we compared groundwater below the Districts to the MCLs (Table 1).

Table 1
Maximum Contaminant Levels for Municipal Water Supply

Constituent	Primary/Secondary	Maximum Contaminant Level
Electrical Conductance	Secondary MCL	900 umhos/cm – Recommended 1,600 umhos/cm – Upper 2,200 umhos/cm – Short-Term
Total Dissolved Solids	Secondary MCL	500 mg/L – Recommended 1,000 mg/L – Upper 1,500 mg/L – Short-Term
Arsenic	Primary MCL	10 µg/L

Upper Maximum Contaminant Level (MCL) is acceptable if it is neither reasonable nor feasible to provide Recommended MCL water. Short -Term MCL is only acceptable on a temporary basis pending development of Recommended MCL water. µmhos/cm = micromho per centimeter, mg/L = milligrams per liter, and µg/L = micrograms per liter.

We assume that groundwater that exceeds an EC of 2,200 µmhos/cm, a TDS concentration of 1,500 mg/L, or an arsenic concentration of 10 micrograms per liter (µg/L) is not currently suitable as a source for MUN and would not be suitable for MUN in the future without expensive treatment to remove salts and/or arsenic.

The Basin Plan does not specify constituent concentrations for protection of AGR. For purposes of this evaluation, we compared groundwater below the Districts to the water quality guidelines published in *Water Quality for Agriculture* (Table 2, NATO, 1994).

Table 2
Water Quality Criteria for Agricultural Water Supply

Constituent	Irrigation Problem	Restriction on Use
Electrical Conductance	Salinity	<700 umhos/cm – None >3,000 umhos/cm – Severe
Total Dissolved Solids	Salinity	<450 mg/L – None >2,000 mg/L – Severe
Boron	Crop Sensitivity	<0.7 mg/L – None >3 mg/L – Severe
Sodium Adsorption Ratio	Infiltration	(severity varies with EC)

Based on Table 2, we will assume that groundwater exceeding an EC of 3,000 µmhos/cm, a TDS concentration of 2,000 mg/L or a boron concentration of 3 mg/L is not currently suitable for use as AGR and would not be suitable in the future without substantial dilution with fresh water. Sodium adsorption ratio (SAR) is used in conjunction with EC to evaluate irrigation water for infiltration problems; elevated salinity offsets the adverse soil infiltration effects of elevated SAR. SAR values as high as 40 are not typically a severe problem, unless EC is less than 2,900 µmhos/cm. Groundwater below the Districts has ECs ranging from 639 to 68,300 µmhos/cm and SAR should not result in an infiltration problem, except for the lower EC ground waters (less than 2,900 µmhos/cm).

The Basin Plan does not specify constituent concentrations for protection for IND, but indicates that "Uses of water for industrial activities do not depend primarily on water quality…"
For purposes of this evaluation, we assume that water quality criteria for MUN and/or AGR should normally be appropriate for IND.

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Perched groundwater quality is characterized by the DWR using EC in µmhos/cm. In the BWSD, LHWD, and DRWD, the perched water EC ranges from 2,000 to greater than 20,000 µmhos/cm (Figure 8). Compared to the Secondary Drinking Water Standard for EC (900 µmhos/cm Recommended and 2,200 µmhos/cm for Short-term Use, Section 64449, Title 22, California Code of Regulations), the quality of perched groundwater is not suitable as a drinking water source. (Generally, TDS in mg/L is approximately 0.7 of EC in µmhos/cm.)

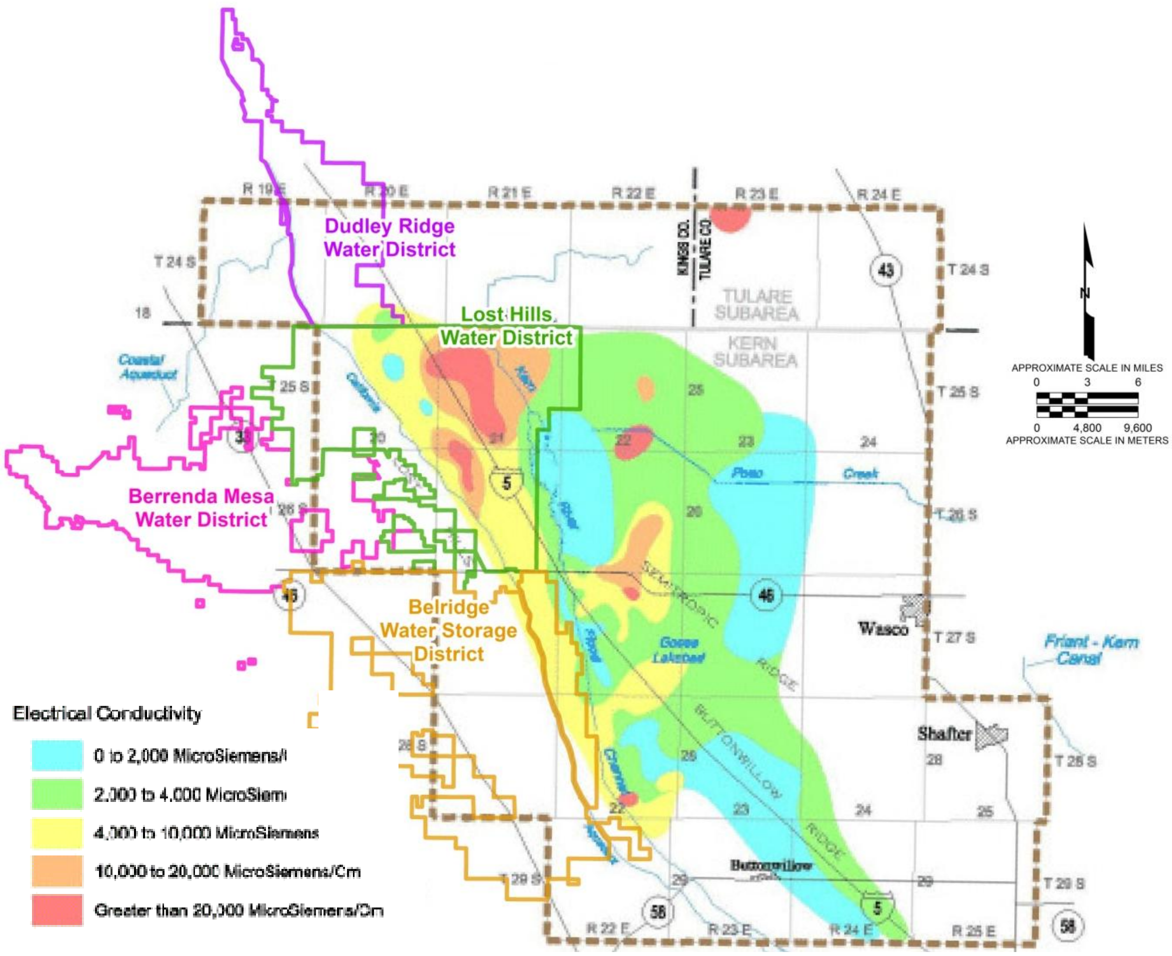


Figure 8 – 2001, Electrical Conductivity in Shallow Groundwater, Lost Hills Area (modified from DWR, 2001)

In 1993, the DWR published the results of a 1991 study of shallow groundwater in the vicinity of eastern part BWSD (DWR, 1993). Initially, DWR installed 88 shallow piezometers (20 feet deep) and 15 deeper piezometers (up to 55 feet deep) in the eastern part of BWSD and the nearby Buena Vista Water Storage District (BVWSD). In 1992, the DWR collected depth-to-water measurements and groundwater samples from the 55 piezometers. DWR found that the depth to shallow water below BWSD ranged from 5 to 10 feet on the eastern edge of BWSD to about 20 feet below the California Aqueduct. DWR indicated that groundwater generally flowed from west to east and groundwater EC varied from about 3,000 µmhos/cm along the eastern edge of BWSD to more than 18,000 µmhos/cm under the California Aqueduct (Figure 9).

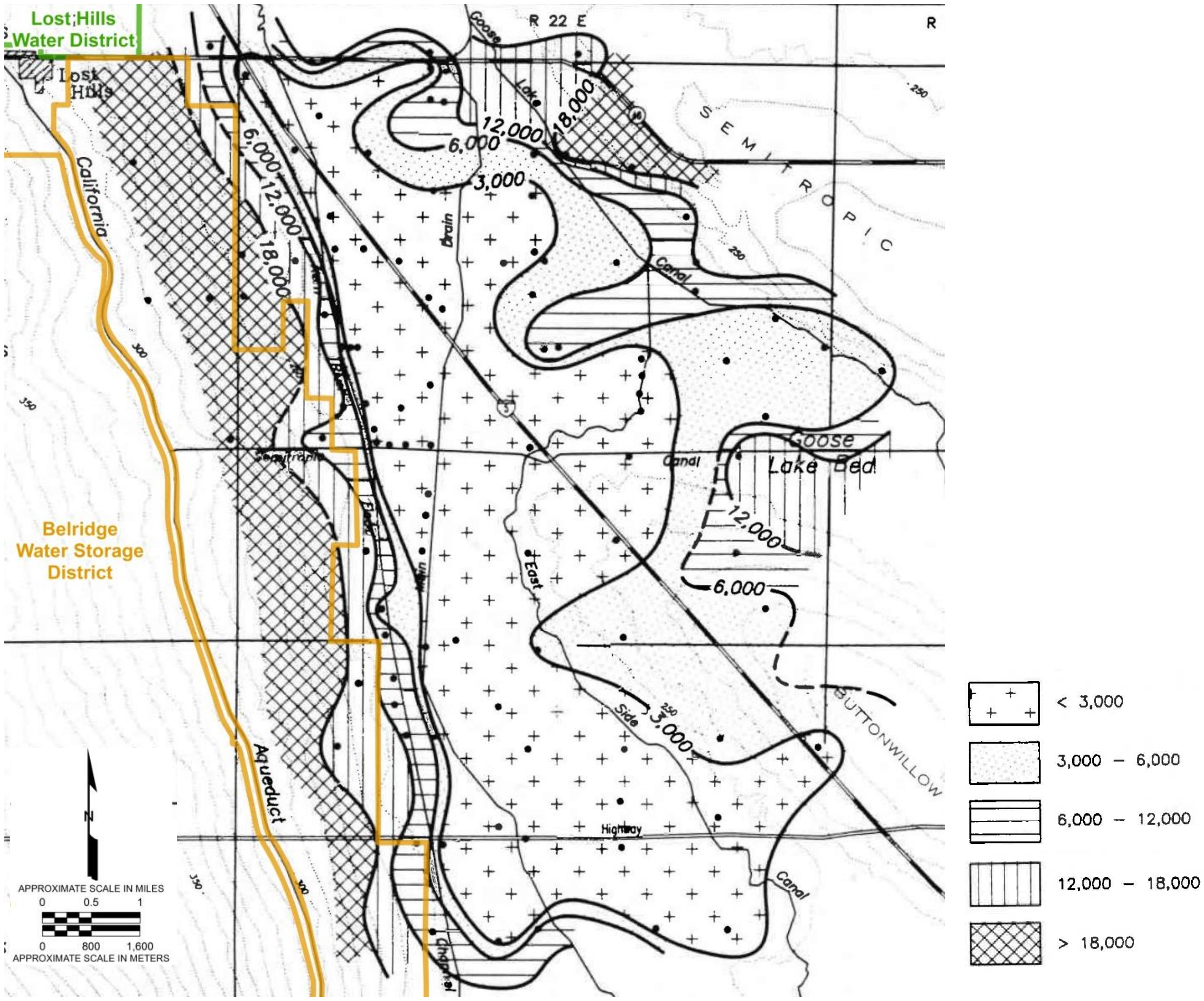


Figure 9 – Electrical Conductivity in Groundwater Below BWSD and BVWSD (modified from DWR, 1993)

DWR also arranged for analysis of 55 groundwater samples for selected inorganic chemical constituents including EC, TDS, and arsenic. Concentration ranges for samples collected below BWSD are summarized in Table 3.

Table 3
Range of Shallow Groundwater Quality, BWSD, 1992

Location	EC (µmhos/cm)	TDS (mg/L)	Arsenic (µg/L)
DWR Piezometers	639 – 68,300	365 – 61,500	0 – 336
Upper MUN	*2,200*	*1,500*	*10*
Upper AGR	*3,000*	*2,000*	*--*

These data show that groundwater below BWSD varies dramatically in areal distribution of mineral concentrations. Although isolated areas below the eastern part of BWSD may provide fair mineral quality shallow groundwater, much of the shallow groundwater below BWSD exceeded Secondary MCLs for EC (900 to 2,200 µmhos/cm) and TDS (500 to 1,500 mg/L) and the Primary MCL for arsenic (10 µg/L). Based on these data, shallow groundwater below much of BWSD is not suitable as a reliable source of MUN, without expensive treatment to remove salts and arsenic. These data also show that much of the shallow groundwater below BWSD exceeded recommended agricultural water quality criteria for EC (3,000 µmhos/cm) and TDS (2,000 mg/L). Based on these data, groundwater below most of BWSD is not suitable as a reliable source for AGR, without substantial dilution with fresh water.

KERN COUNTY WATER AGENCY

The KCWA characterized the quality of unconfined groundwater in the general area of the BWSD and LHWD using TDS (in mg/L) from historic data (Figure 10) (KCWA, 2005). Unconfined groundwater below the BWSD and LHWD ranged from 1,500 to greater than 5,000 mg/L TDS. Compared to the Secondary Drinking Water Standard for TDS (500 mg/L Recommended and 1,500 mg/L for Short-Term Use, Section 64449, Title 22, California Code of Regulations), the perched groundwater of these concentrations is not suitable as a drinking water source without expensive treatment to remove salts.

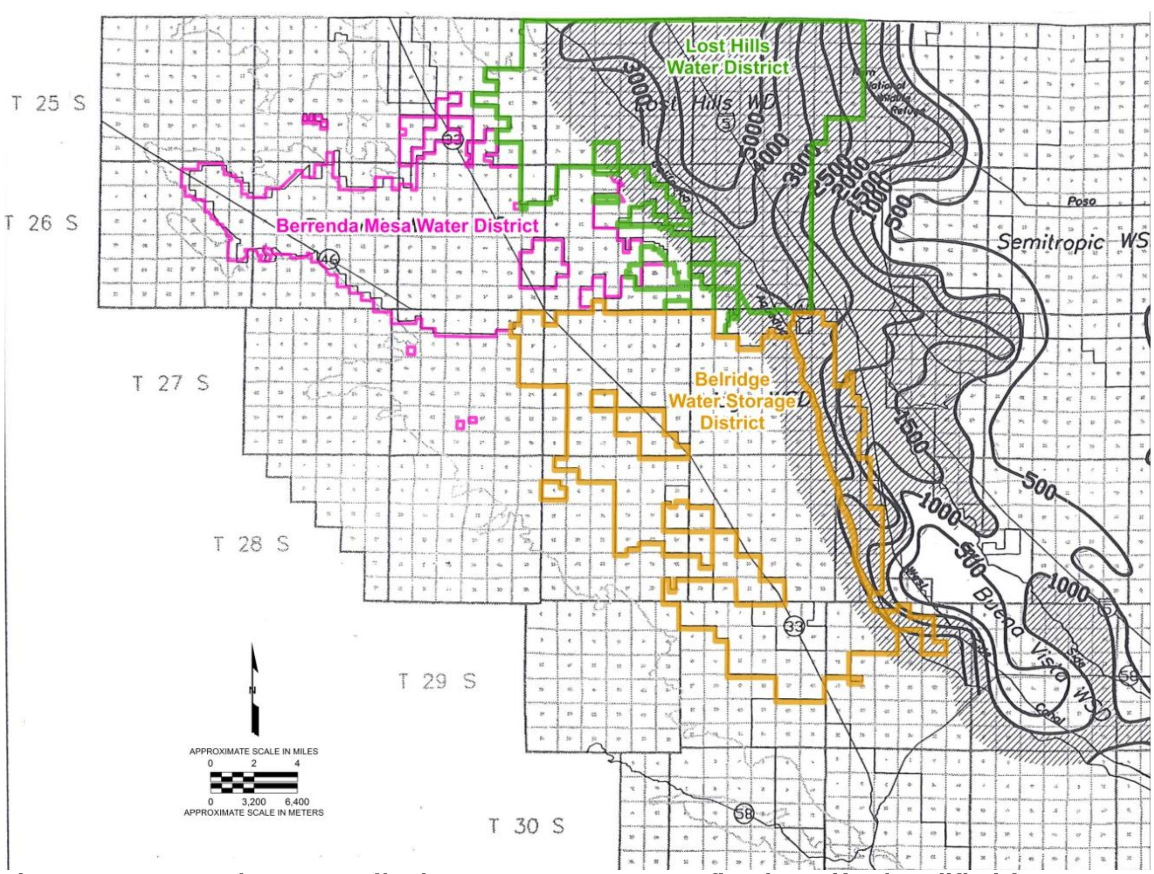


Figure 10 – Groundwater Quality in Kern County, Unconfined Aquifer (modified from KCWA, 2005)

The KCWA also characterized the quality of confined groundwater in the BWSD and LHWD using TDS in mg/L from historic data (Figure 11). Confined groundwater below the BWSD and LHWD ranged from 500 to greater than 4,000 mg/L TDS. Compared to the Secondary Drinking Water Standard for TDS (500 mg/L Recommended to 1,500 mg/L for Short-Term Use, Section 64449, Title 22, California Code of Regulations), the quality of confined groundwater is unlikely suitable as a drinking water source.

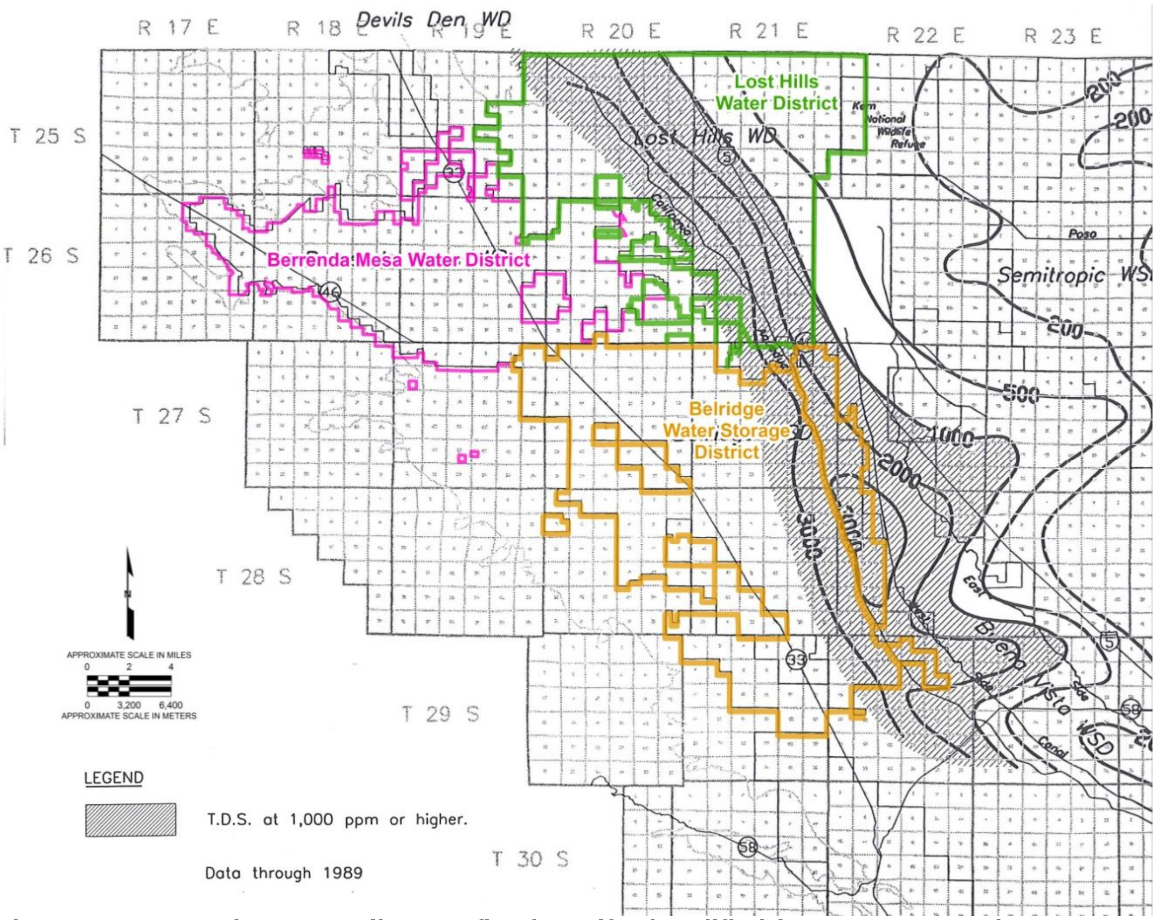


Figure 11 – Groundwater Quality, Confined Aquifer (modified from KCWA, 2005)

UNITED STATES GEOLOGICAL SURVEY

In 1989, the USGS conducted a study of groundwater quality within the Tulare Lake Basin (USGS, 1992). The study involved collection of water samples from 117 shallow wells and analysis of the samples for minerals and metals. The study report summarized TDS concentrations in shallow groundwater as shown on Figure 12.

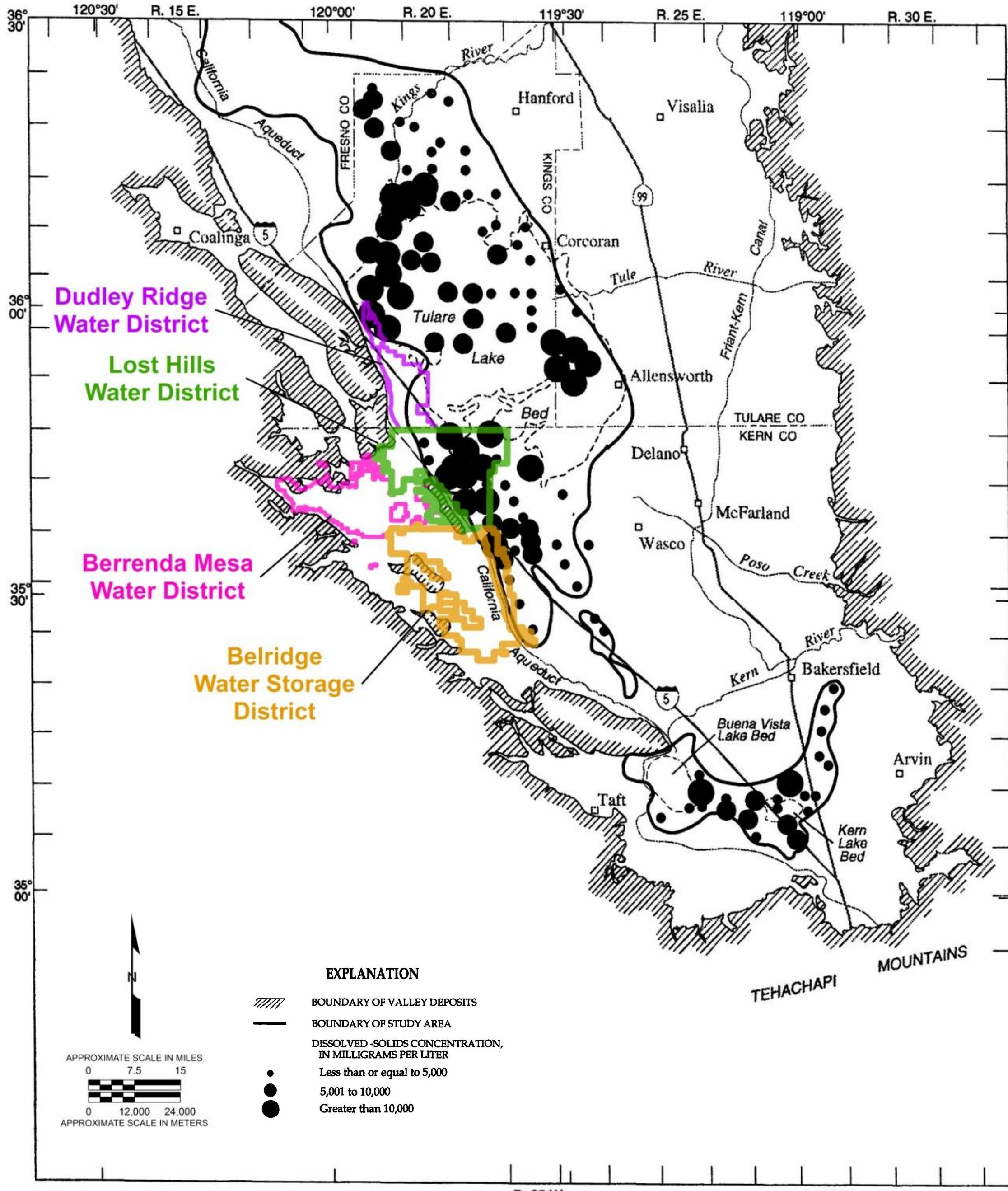


Figure 12 – Distribution of TDS in Shallow Groundwater (modified from USGS, 1992)

Figure 12 shows that TDS in groundwater within the BWSD, DRWD, and LHWD varies dramatically from less than 5,000 mg/L to greater than 10,000 mg/L. When compared to the secondary MCL of 500 to 1,500 mg/L, shallow groundwater within the BWSD, LHWD, and DRWD is not suitable for MUN, without expensive treatment for removal of salts. This report also identified reported arsenic concentrations in shallow groundwater that exceeded the corresponding MCL within the BWSD, DRWD, and LHWD.

In an earlier study of groundwater in the area (USGS, 1959), wells in BMWD and DRWD were sampled by USGS for analysis of salts. Between 1953 and 1955, the USGS sampled wells within BMWD (Township 26 and Ranges 16, 17, and 8) for general mineral analyses and generated the map summary shown on Figure 13.

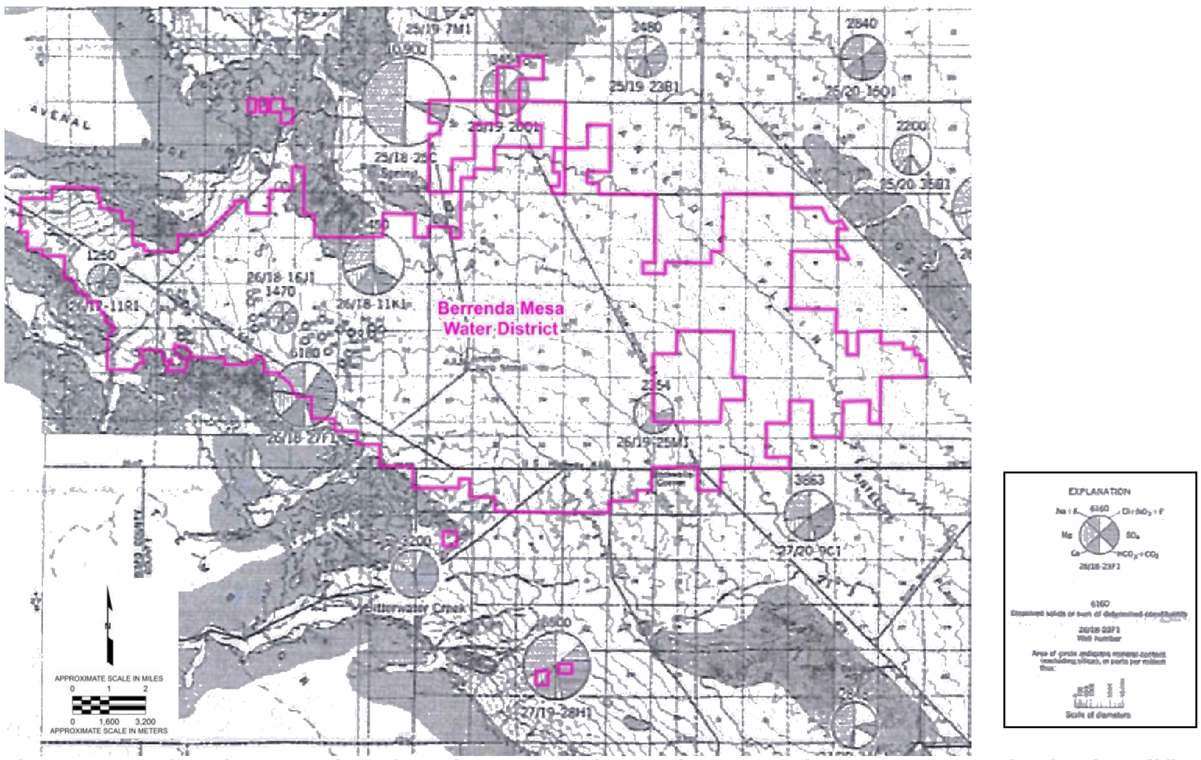


Figure 13 – Chemical Quality of Typical Groundwater in Berrenda Mesa Water District (modified from USGS, 1959)

The TDS of groundwater in BMWD ranged from 1,250 to 6,180 mg/L compared to the MCL of 500 to 1,500 mg/L, which indicates that the groundwater was not suitable for MUN, without expensive treatment to remove salts. TDS and boron (ranging from 0.3 to 11 mg/L) typically exceeded the recommended water quality criteria for agriculture (NATO, 1985) for TDS (2,000 mg/L) and boron (3 mg/L), which indicates that groundwater in this area was not suitable for AGR without substantial blending with SWP water.

Between 1953 and 1955, the USGS sampled wells in Township 22, Range 19 near Kettleman City and in Township 24, Range 19 in the southwest part of DRWD for general mineral analyses and generated the summary shown on Figure 14.

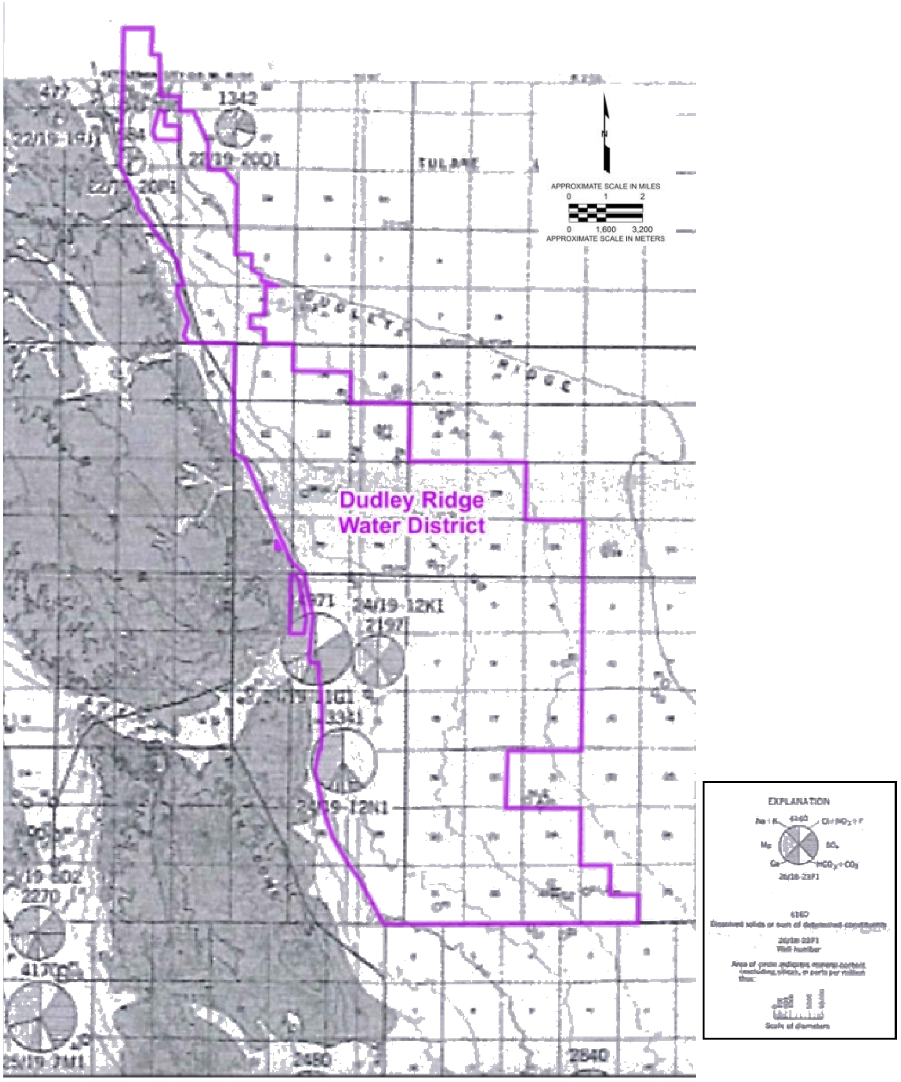


Figure 14 – Chemical Quality of Typical Groundwater for Dudley Ridge Water District (modified from USGS, 1959)

The TDS of groundwater in DRWD near Kettleman City ranged from 584 to 1,342 mg/L compared to the MCL of 500 to 1,500 mg/L, which indicates that the groundwater is marginally suitable for MUN. However, TDS in southwest DRWD ranged from 2,197 to 4,971 mg/L, which indicates that the groundwater was not suitable for MUN, without expensive treatment to remove salts. TDS and boron in southwest DRWD (ranging from 0.9 to 4.9 mg/L) typically exceeded the recommended water quality criteria agriculture (NATO, 1985) for TDS (2,000 mg/L) and boron (3 mg/L), which indicates that groundwater in this area was not suitable for AGR without substantial blending with SWP water.

In 1990, the USGS conducted some groundwater assessment work in the Tulare Lake Basin at the Refuge near LHWD. The assessment work involved installation of cluster wells at one location to assess the vertical differences in water quality, particularly for dissolved metals. The cluster consisted of wells completed to approximately 20, 50, 100, and 200 feet below ground surface and the wells were sampled in August 1990. Water samples from the well cluster near LHWD (designated 1N) were collected at 15, 57, 95, and 194 feet below ground surface, respectively. Table 4 summarizes the results for constituents the USGS analyzed from samples collected at well cluster 1N.

Table 4
Groundwater Quality with Depth N1 Well Cluster, Northeastern LHWD

Well	**EC (µmhos/cm)**	**TDS (mg/L)**	**Arsenic (µg/L)**	**Boron (mg/L)**	**SAR (unitless)**
1N-15’	1,750	1,270	6	0.87	6
1N-57’	12,000	9,280	16	9.4	29
1N-95’	6,250	4,260	10	2.1	13
1N-194’	4,540	2,620	8	1.3	10
Upper MUN	*2,200*	*1,500*	*10*	--	--
Upper AGR	*3,000*	*2,000*	--	*3*	*(varies w/EC)*

SAR calculated based on concentrations of bicarbonate, calcium, magnesium, and sodium.

The above data show that groundwater in the vicinity of the Refuge (northeastern LHWD) varies in quality with depth. The better quality shallow groundwater at 15 feet below ground surface is likely associated with imported SWP water used to maintain the wetlands that subsequently recharged from the wetlands to the shallow aquifer within the Refuge. These data show that groundwater below 20 feet in depth exceeded Secondary MCLs for EC (900 to 2,200 µmhos/cm) and TDS (500 to 1,500 mg/L) and the Primary MCL for arsenic (10 µg/L). Groundwater in this area is not suitable as a source of MUN without expensive treatment to remove salts and arsenic. These data also show that groundwater below 20 feet in depth exceeded recommended water quality criteria for agriculture (NATO, 1995) for EC (3,000 µmhos/cm), TDS (2,000 mg/L) and boron (3 mg/L). However, SAR would not appear to represent an infiltration problem because the average EC is greater than 2,900 µmhos. Groundwater in this area is not suitable for AGR without substantial dilution with SWP water. Blending groundwater with higher quality irrigation water would need to account for the effects of the elevated SAR in groundwater.

OTHER GROUNDWATER STUDIES

In 1976, Bookman-Edmonston Engineering, Inc. (BEE), evaluated groundwater conditions in BMWD (BEE, 1976). BMWD asked BEE to evaluate the feasibility of blending poor quality groundwater from the district with SWP water to provide an additional source of irrigation water supply. BEE reviewed the readily available groundwater information and found:

> “Mineral analyses of ground water are available for two wells, both of which are reported to be about 360 feet deep. Well 26/19-12L1 produced sodium sulfate water with a TDS concentration of 3,660 mg/L, a boron content of 2.7 mg/L and a chloride ion concentration of 629 mg/L. Water from well 26/19-25M1 was also sodium sulfate in character and contained 2,354 mg/L of TDS, 1.2 mg/L of boron and 505 mg/L of chloride. The total dissolved solids content is estimated to be about 3,000 milligrams per liter, which renders the water marginal to unsuitable for irrigation of most crops.”

Based on this information, BEE recommended installation and testing of a prototype groundwater extraction well (26/19-29A), which was completed in 1977 (BEE, 1977). BEE installed a 14-inch diameter well with perforations between 650 and 1,160 feet in depth. BEE pump tested the well and found:

> "…on the basis of observed data, the well is capable of producing at a short-term rate of not more than 450 gallons per minute. It is probable that prolonged pumping will cause a lowering of the water level and a coincident decline in yield."

A water sample from well 26/19-29A was collected by BEE in May 1977 and analyzed for inorganic constituents (see Table 5).

Table 5
Groundwater Quality, BMWD

Well	**EC (µmhos/cm)**	**TDS (mg/L)**	**Boron (mg/L)**	**SAR (unitless)**
26/19-29A-650/1160'	4,000	2,583	1.8	16.7
Upper MUN	*2,200*	*1,500*	--	--
Upper AGR	*3,000*	*2,000*	*3*	*(varies w/EC)*

SAR calculated based on concentrations of bicarbonate, calcium, magnesium and sodium.

These data show that groundwater in BMWD exceeded Secondary MCLs for EC (900 to 2,200 µmhos/cm) and TDS (500 to 1,500 mg/L). Groundwater in this area is not suitable as a source of MUN without expensive treatment to remove salts. These data also show that groundwater in BMWD exceeded recommended agricultural water quality criteria for EC (3,000 µmhos/cm) and TDS (2,000 mg/L). However, SAR would not appear to represent an infiltration problem because the average EC is greater than 2,900 µmhos/cm. Groundwater in this area is not suitable for AGR without substantial blending with fresh water and may not be hydraulically sustainable. Blending groundwater with higher quality irrigation water would need to account for the effects of the elevated SAR in groundwater.

In 2006, AMEC conducted a vertical characterization of groundwater quality at the proposed Westlake Farms Proposed Biosolids Composting Project, which is immediately adjacent the eastern part of DRWD near Utica Avenue. Water samples were collected from ten groundwater monitoring wells. Two of the wells are representative of groundwater quality from 11 to 26 feet (MW1) and from 80 to 100 feet (MW101). Data from these two wells are summarized in Table 6.

Table 6
Groundwater Quality with Depth, East of DRWD

Well	**EC (µmhos/cm)**	**TDS (mg/L)**	**Arsenic (µg/L)**	**Boron (mg/L)**	**SAR (unitless)**
MW1-11/26'	23,000	20,000	54	8.5	28
MW101-80/100'	16,000	16,000	38	7.4	22
Upper MUN	*2,200*	*1,500*	*10*	--	--
Upper AGR	*3,000*	*2,000*	--	*3*	*(varies w/EC)*

SAR calculated based on concentrations of bicarbonate, calcium, magnesium and sodium.

Similar to the data summarized above, groundwater adjacent the eastern part of DRWD exceeded Secondary MCLs for EC (900 to 2,200 µmhos/cm) and TDS (500 to 1,500 mg/L) and the Primary MCL for arsenic (10 µg/L). Groundwater in this area is not suitable as a source of MUN without expensive treatment to remove salts and arsenic. These data also show that groundwater adjacent the eastern part of DRWD exceeded recommended agricultural water quality criteria for EC (3,000 µmhos/cm), TDS (2,000 mg/L) and boron (3 mg/L). However, SAR would not appear to represent an infiltration problem because the EC is greater than 2,900 µmhos/cm. Groundwater in this area is not suitable for AGR without substantial blending with fresh water. Blending groundwater with higher quality irrigation water would need to account for the effects of the elevated SAR in groundwater.

MUNICIPAL WATER SUPPLY

In 2012, the SWRCB conducted a study of communities that rely on contaminated groundwater (SWRCB, 2012b). Only two community water systems with groundwater supply were identified in the immediate vicinity of the Districts; LHUD and Kettleman City Community Services District (Figure 17).

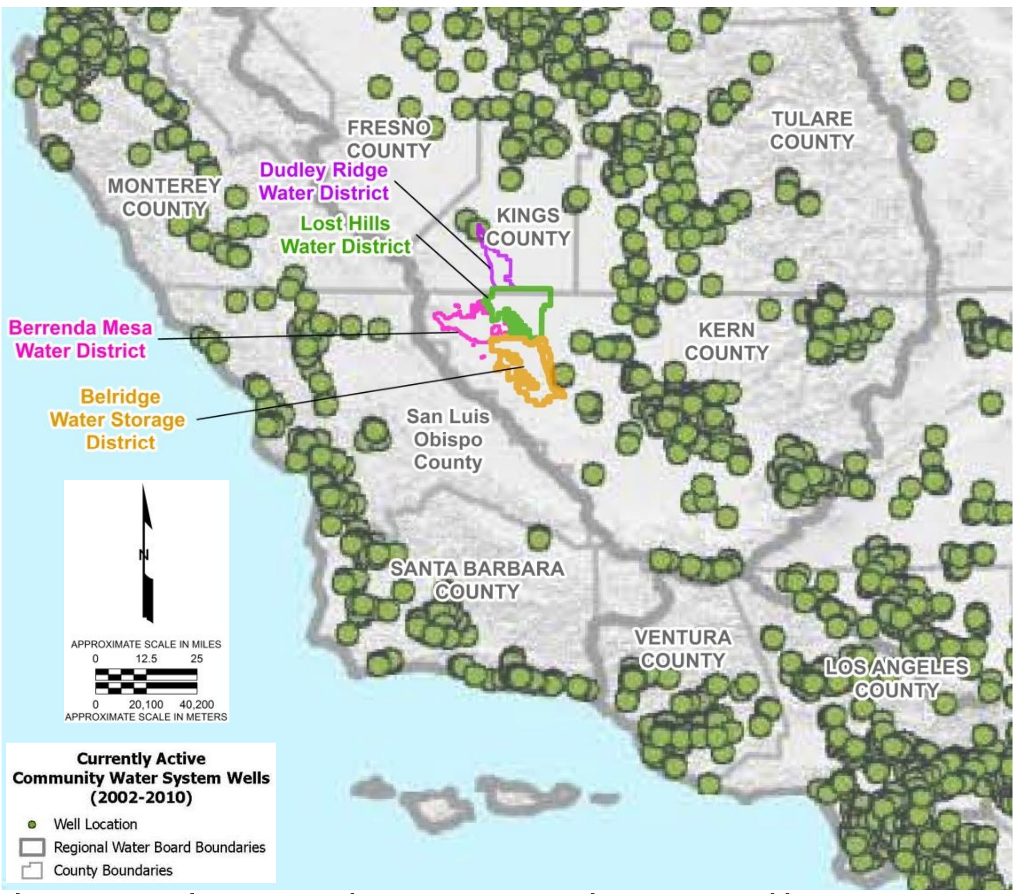


Figure 17 – Active Community Water Systems (SWRCB, 2012b)

Both communities are immediately adjacent to the Districts and listed as having contaminated wells. Lost Hills is situated between BWSD and LHWD, and Kettleman City is located just north of DRWD (Figure 18). LHUD water system was listed for elevated arsenic concentrations ranging from 12 to 51 µg/L. Kettleman City water system was listed for arsenic concentrations ranging from 12 to 160 µg/L. The well water from both communities exceeds the primary MCL of 10 µg/L of arsenic. The community of Lost Hills imports groundwater from wells 13 miles east of any of the Districts. The Kettleman City Community Services District (KCCSD) currently uses water from two local wells that are just north of DRWD. In either case, the arsenic is likely a naturally occurring condition, unrelated to agricultural irrigation. KCCSD is currently working with the California Department of Public Health to develop a treated municipal water supply from the California Aqueduct to replace groundwater (CDPH, 2012).

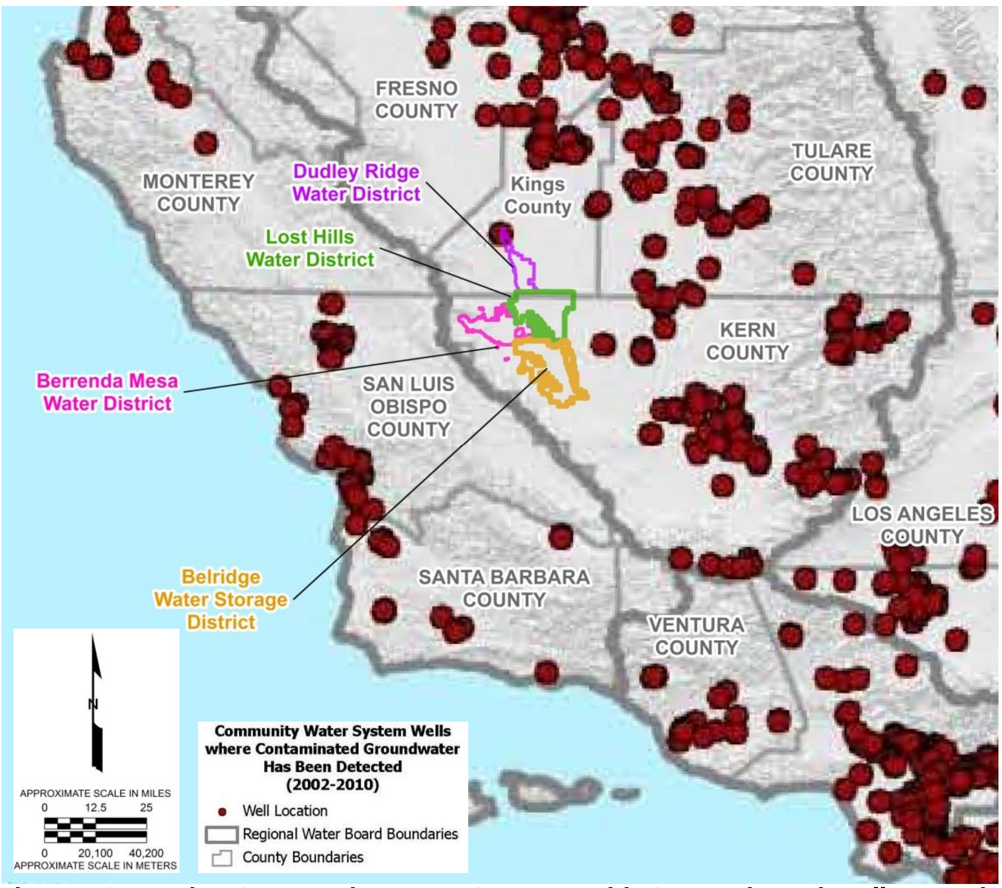


Figure 18 – Active Community Water Systems with Contaminated Well Water (SWRCB, 2012b)

AGRICULTURAL WATER SUPPLY

As described previously, the principle irrigation water supply for the Districts is the SWP from deliveries from the California Aqueduct. Alternative water supplies include groundwater banked in storage near Bakersfield and purchase of water on the open market. Groundwater is not typically used for irrigation within the Districts due to the presence of elevated salts and boron concentrations. According to the Districts, groundwater has occasionally been diluted with SWP water for irrigation, but this has apparently occurred rarely.

Crop types irrigated within the Districts have changed dramatically over the past two decades. More permanent crops have been developed in conjunction with more efficient irrigation systems. For example, LHWD indicates that cotton and other row crops (sprinkler irrigation) that were predominate in 1990 (64 percent of irrigated acreage within LHWD) have been almost completely replaced with orchards and vines (drip or fan jet irrigation) as of 2012 (99 percent of acreage in LHWD).

According to Encyclopedia of Water Science, sprinkler irrigation varies from 60 to 85 percent efficient, while drip and fan jet systems typically average 85 percent irrigation efficiency (Howell, 2003). Based on the dramatic change in cropping pattern in LHWD, development of more efficient irrigation systems, and implementation of irrigation management practices by farmers in LHWD, very little irrigation water would be expected to percolate below the root zone of crops. Irrigation efficiency and management practices have contributed to a decline in the amount of water collected in LHWD tile drains. In 1990, LHWD tile drains produced 3,088 acre feet of water that was discharged to the LHWD evaporation disposal basins (PPEG, 2012). The water volume generated from the LHWD tile drains in 2011 was only 94 acre-feet. This dramatic decline of almost 3,000 acre-feet in the volume of tile drainage is a result, at least in part, of the change to permanent crops, more efficient irrigation systems, and irrigation management practices within the district.

Similar changes to permanent crops and efficient irrigation systems have occurred in BWSD, BMWD, and DRWD. While the changes may not be as dramatic as in LHWD, the permanent crops and efficient drip/fanjet irrigation systems have also been implemented in the other Districts, to some degree. In addition, 20 percent of the formerly irrigated acreage in BMWD has returned to dry land farming, which uses no irrigation water. In the other Districts, we would expect to see a similar decline in irrigation water percolating below crop root zones, commensurate with the implementation of efficient irrigation systems, management practices, and the return to dry land farming.

PROCESS WATER SUPPLY

Industrial facilities within the Districts that require potable water (food processing plants) treat water from the California Aqueduct (RWQCB, 1996 and 1999). Groundwater within the oil fields is used for water and steam flood enhanced recovery operations and is treated, if necessary, to achieve the required water quality. Groundwater is also used for non-potable purposes at biosolids composting facilities. No other PRO uses are known within the Districts.

SUMMARY

Groundwater within the Districts is generally of poor mineral quality (generally greater than 2,000 mg/L TDS) and contains other mineral constituents (arsenic) that have prevented its use for drinking water. The quality of groundwater varies dramatically in its horizontal and vertical distribution. As such, groundwater within the Districts, except in the far northern part of DRWD (Kettleman City), is not used for municipal water supply. Imported water is used for drinking water within most of the Districts' area due to the poor mineral quality of groundwater encountered beneath them.

The poor mineral quality of groundwater (EC, TDS, and boron) has also prevented its use for agricultural irrigation. Based on the poor quality of groundwater within the Districts, they are provided irrigation water from the SWP from the California Aqueduct. According to the Districts, farmers have occasionally blended groundwater with imported SWP water to make up irrigation water. However, significant dilution is required to meet irrigation water quality objectives, rendering this practice uneconomical.

In the RWQCB's Tulare Lake Basin Plan, groundwater within the Districts is designated as having the beneficial use of MUN, in part based on the SWRCB's *Sources of Drinking Water Policy* (SWRCB, 1988). Based on the above information, groundwater within the Districts:

- range from 1,000 mg/L TDS to more than 10,000 mg/L TDS and, as such, is not used for MUN and is not anticipated to be used for MUN, except in northern end of DRWD (Kettleman City);
- is administratively exempted from MUN for the purpose of underground injection of fluids into exempted aquifers associated with the production of oil and gas in some areas of each District; and
- contains naturally occurring salts and petroleum and, in some areas, is impacted by oil field operations, such that it cannot be reasonably treated for MUN.

Based on the above, the protection of MUN uses within the Districts would not appear warranted, based on the exemptions of the Sources of Drinking Water Policy (RWQCB, 2004). The burden to farmers within the Districts, including costs, of protection for MUN would not appear to bear a reasonable relationship to the benefit to the groundwater resource that might be obtained from the proposed ILRP program. The Districts have asked AMEC to convey their request for the RWQCB to exempt farmers within the Districts from groundwater regulation under the ILRP.

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