Groundwater Monitoring Protocols for Seawater Intrusion

Example of Challenges and Experiences in a Coastal Groundwater Basin

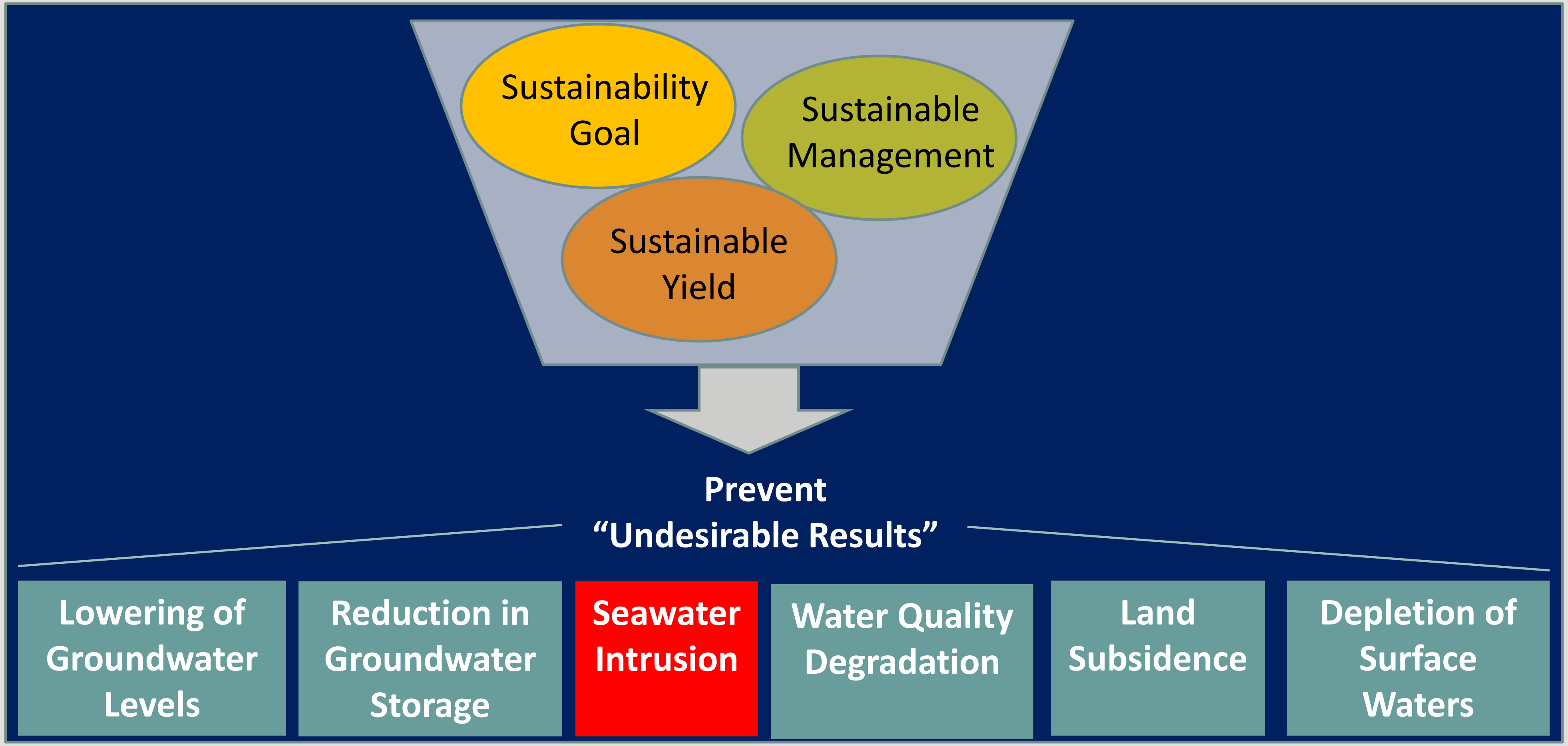
KATHLEEN KUEPPER

UNITED WATER CONSERVATION DISTRICT

Outline

- Sustainable Groundwater Management Act (SGMA)
  - Seawater Intrusion: minimal thresholds; monitoring network
- Oxnard Plain
- Previous Studies
  - Major and minor-ion chemistry,
  - Trace element analysis,
  - Specific isotope chemistry,
  - Depth dependent water quality sampling, and
  - Surface geophysical methods.
- Conclusions: What did we learn?
- References

2014 Sustainable Groundwater Management Act (SGMA)



Seawater Intrusion

“Seawater intrusion refers to the advancement of seawater into a groundwater supply that results in degradation of water quality in the basin, <u>and includes seawater from any source</u>.” – GSP Emergency Regulations

Seawater Intrusion

GSP Emergency Regulations:

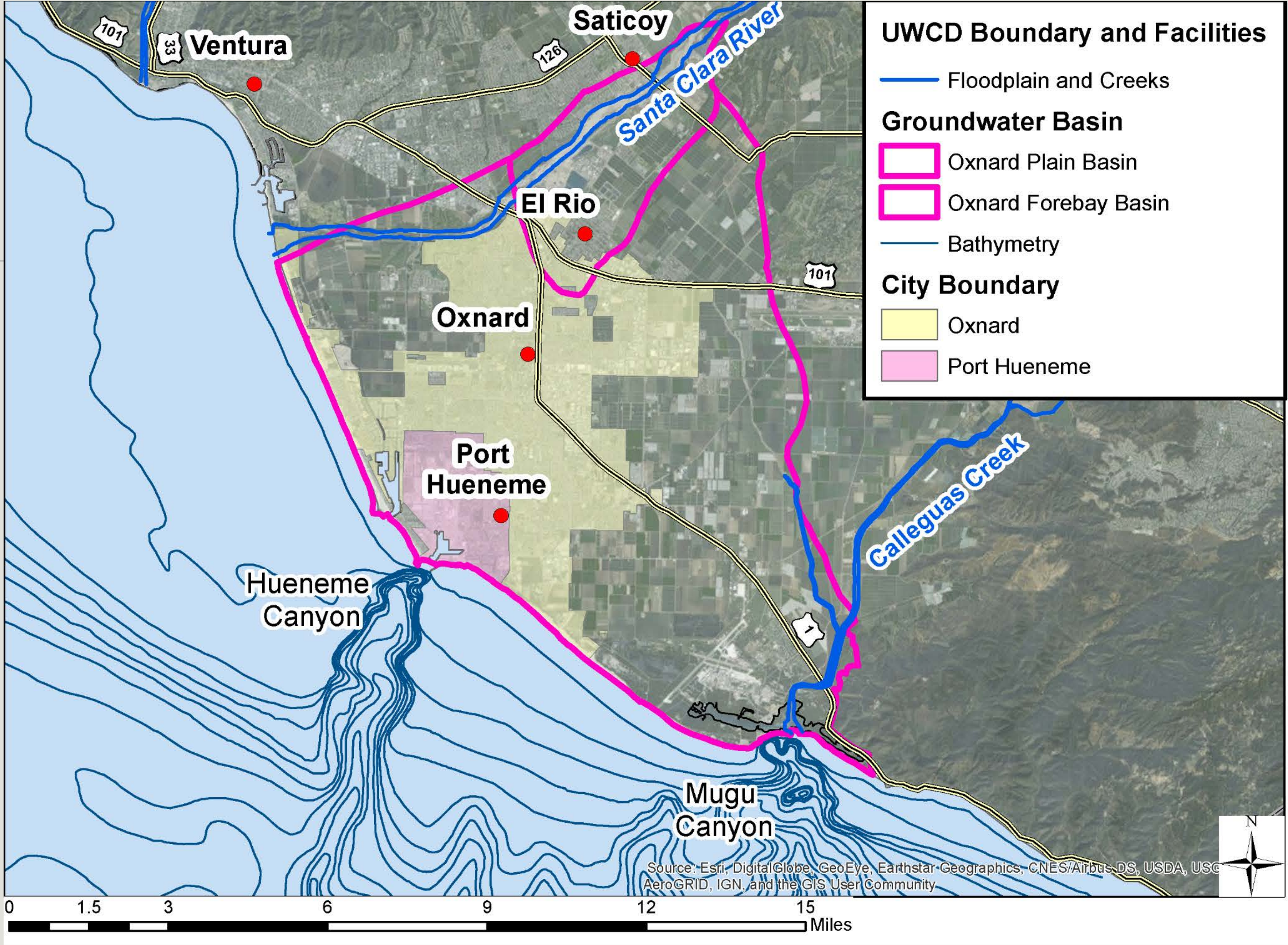
<u>§ 354.28. Minimum Thresholds</u>

(3) Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour…

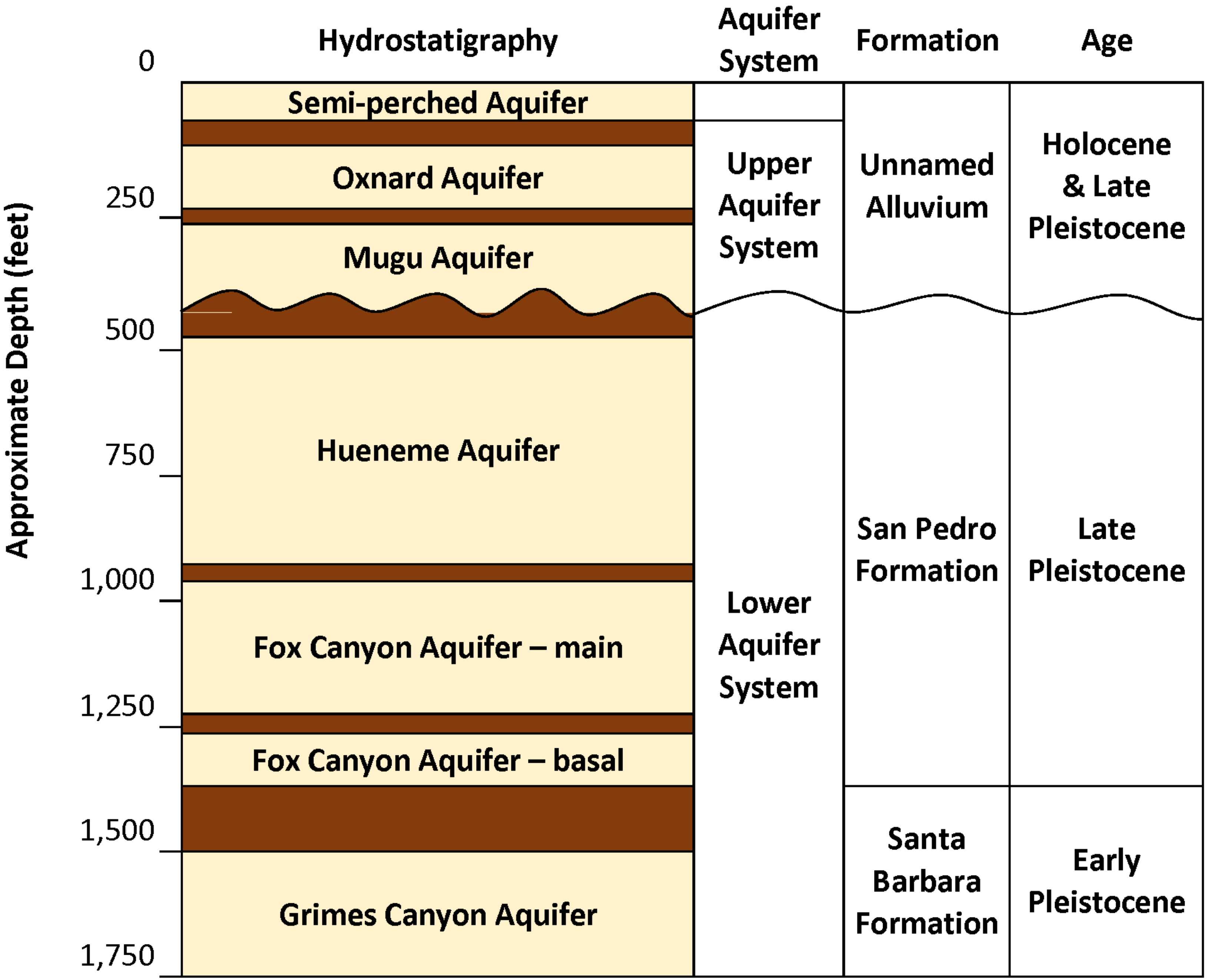
<u>§ 354.34. Monitoring Network</u>

(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations…

Oxnard Plain basin

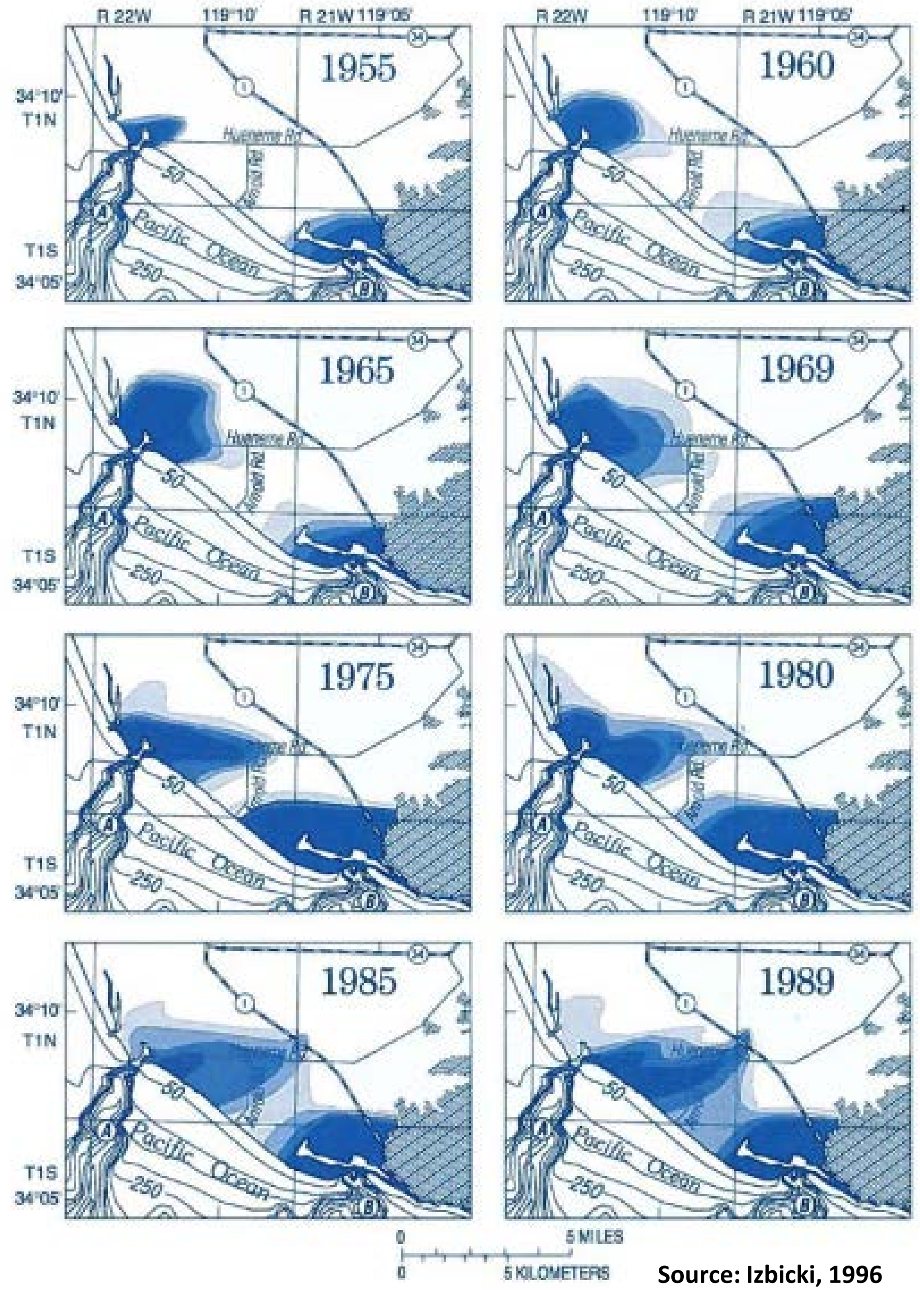


Stratigraphy of Oxnard Plain



Historic High Chloride Levels

- First observed in 1930s
- 100 mg/l chloride defined leading edge
- Used existing production wells and older abandoned wells as monitoring points.
  - Misrepresentation: Some samples with high chloride concentrations were related to poor quality water leaking from the Semi-perched aquifer



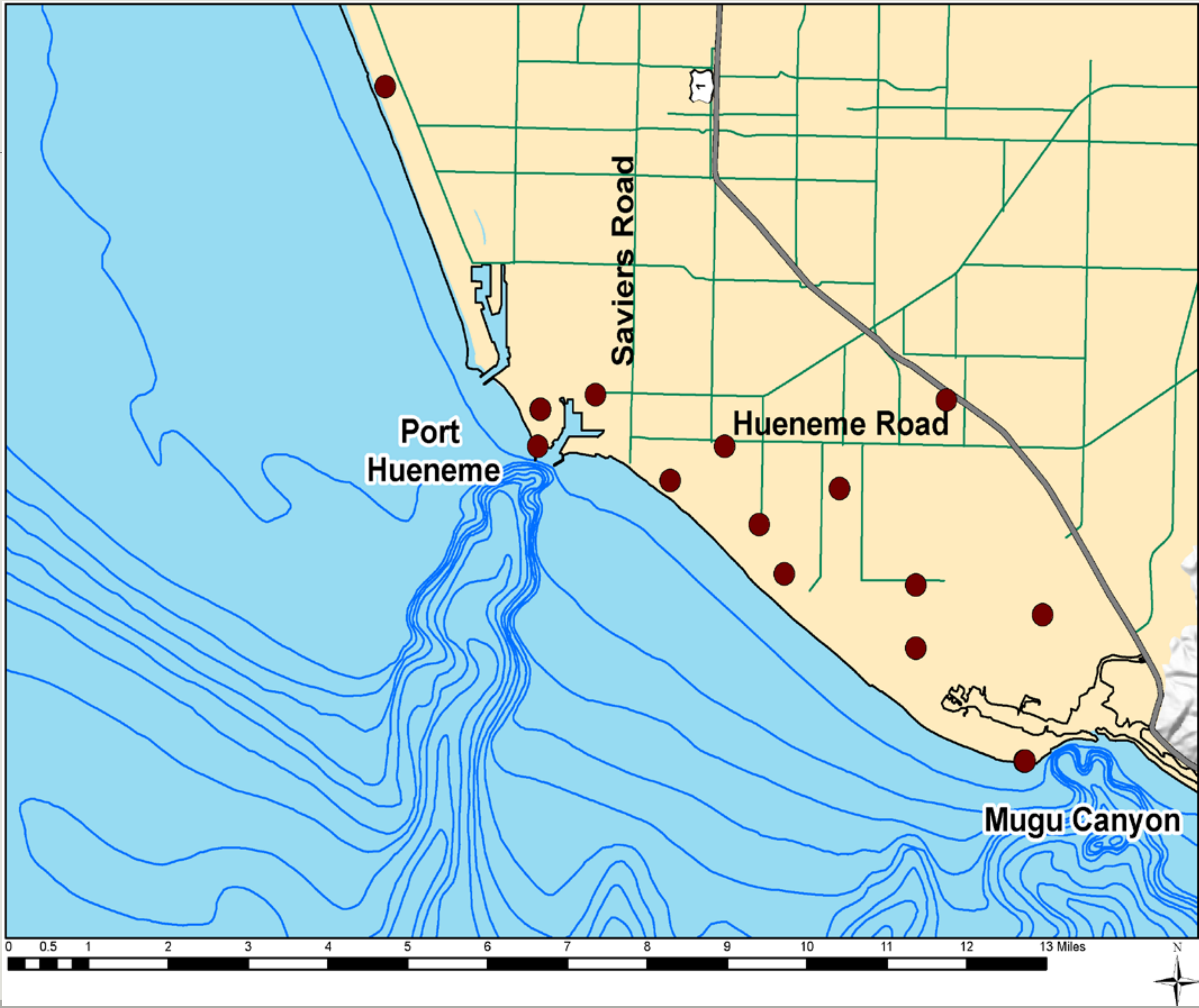
Source: Izbicki, 1996

Previous Studies

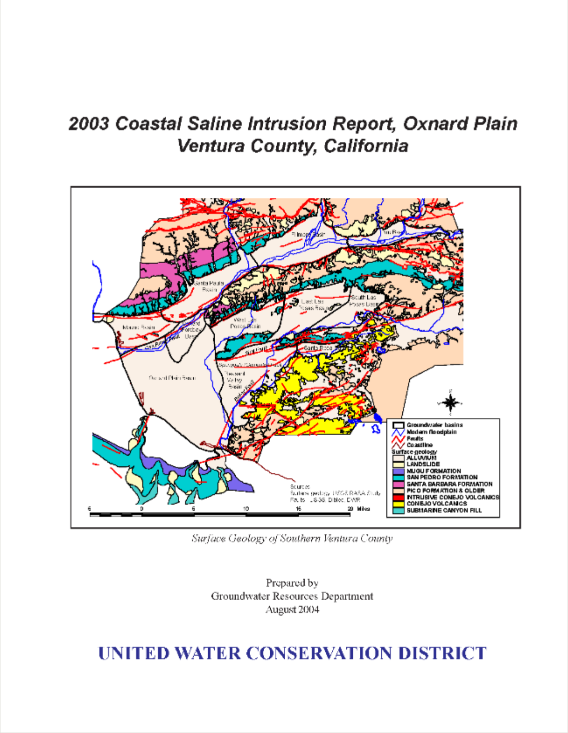
- 1989 USGS Regional Aquifer-System Analysis (RASA)

- Water quality evaluation:
  1. Major and minor-ion chemistry
  2. Trace element analysis
  3. Specific isotope chemistry
  4. Depth dependent water quality sampling
  5. Surface geophysical methods

These methods allowed differentiation between chloride from different sources of salinity.



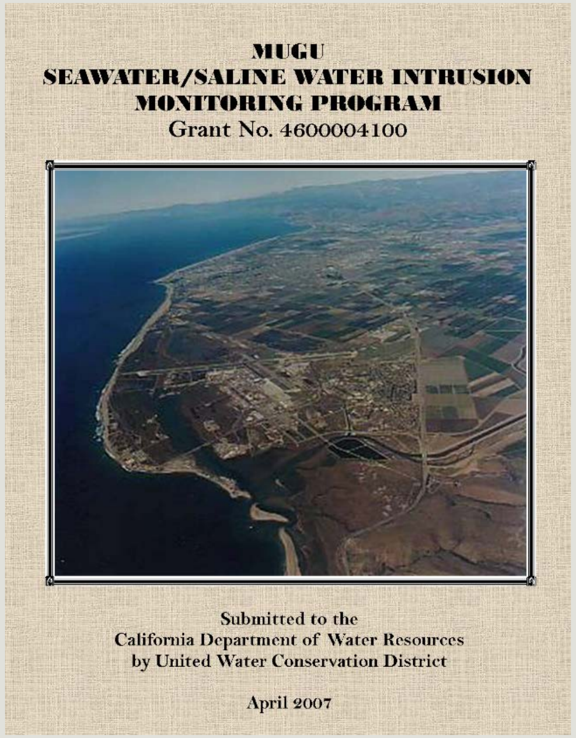
UWCD – Saline Intrusion Updates


2003 Coastal Saline Intrusion Report, Oxnard Plain
Ventura County, California

Surface Geology of Southern Ventura County

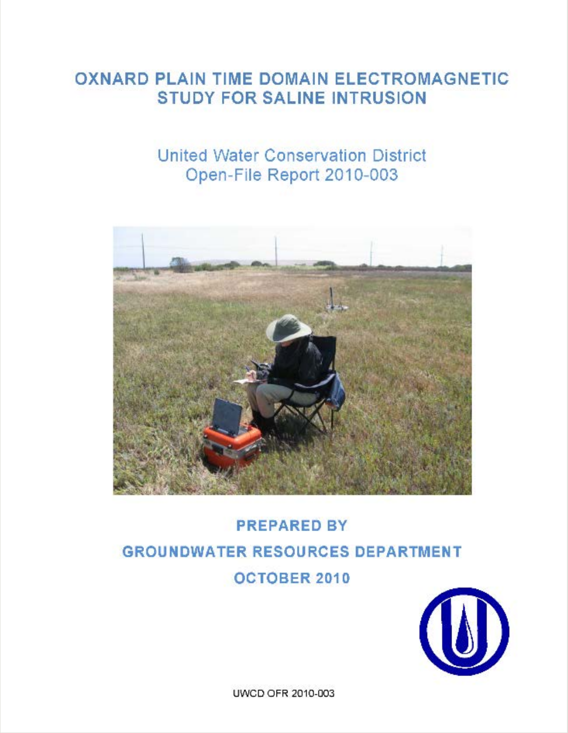
Prepared by
Groundwater Resources Department
August 2004

UNITED WATER CONSERVATION DISTRICT


MUGU
SEAWATER/SALINE WATER INTRUSION
MONITORING PROGRAM
Grant No. 4600004100

Submitted to the
California Department of Water Resources
by United Water Conservation District

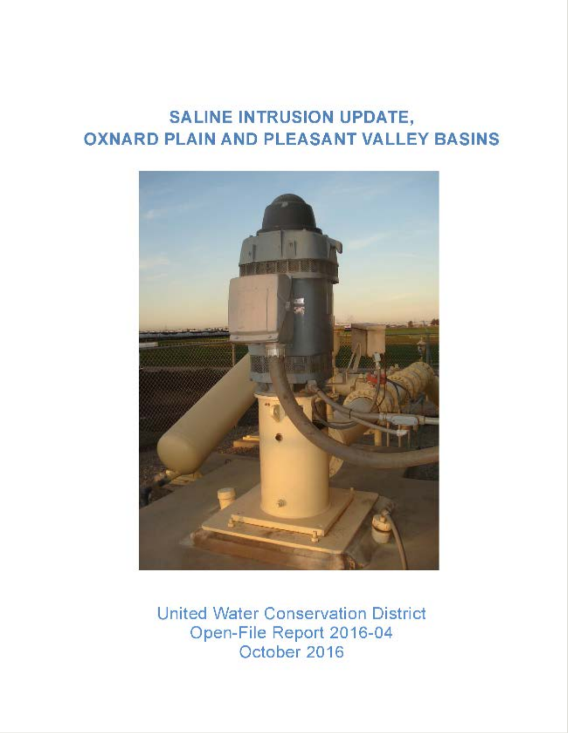
April 2007


OXNARD PLAIN TIME DOMAIN ELECTROMAGNETIC
STUDY FOR SALINE INTRUSION

United Water Conservation District
Open-File Report 2010-003

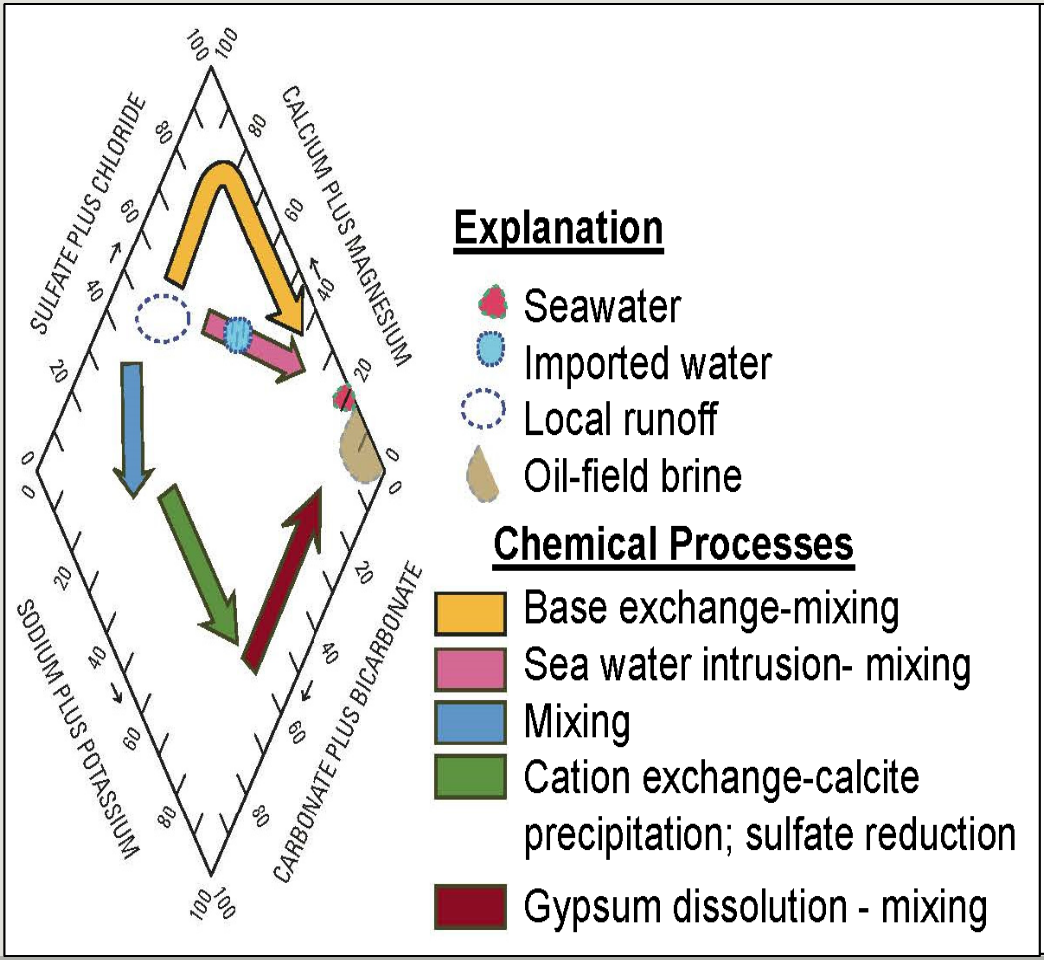
PREPARED BY
GROUNDWATER RESOURCES DEPARTMENT
OCTOBER 2010

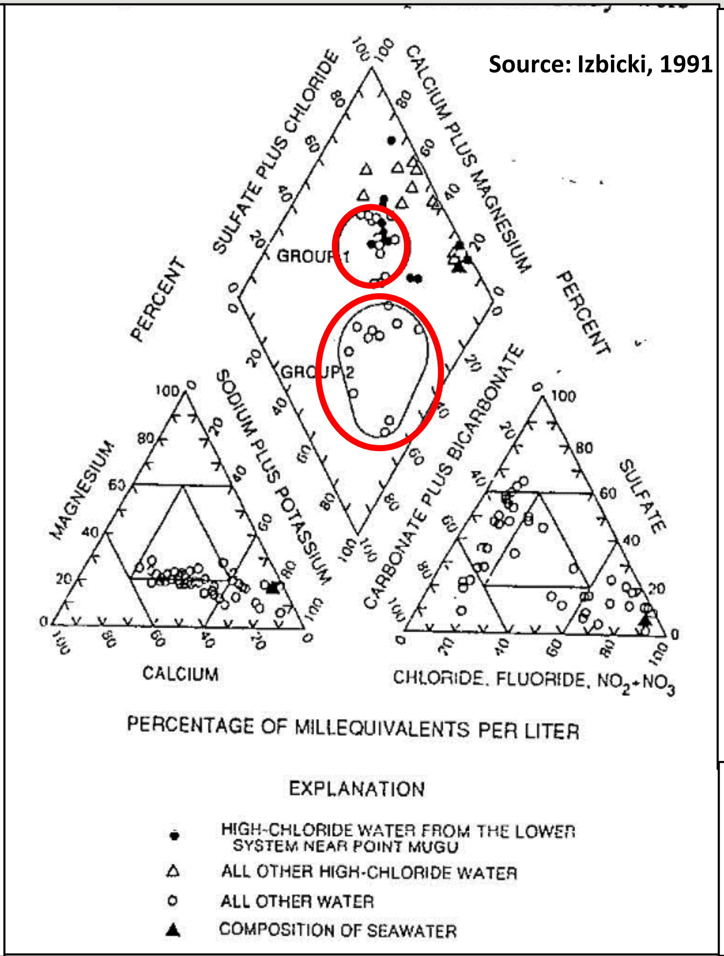
UWCD OFR 2010-003

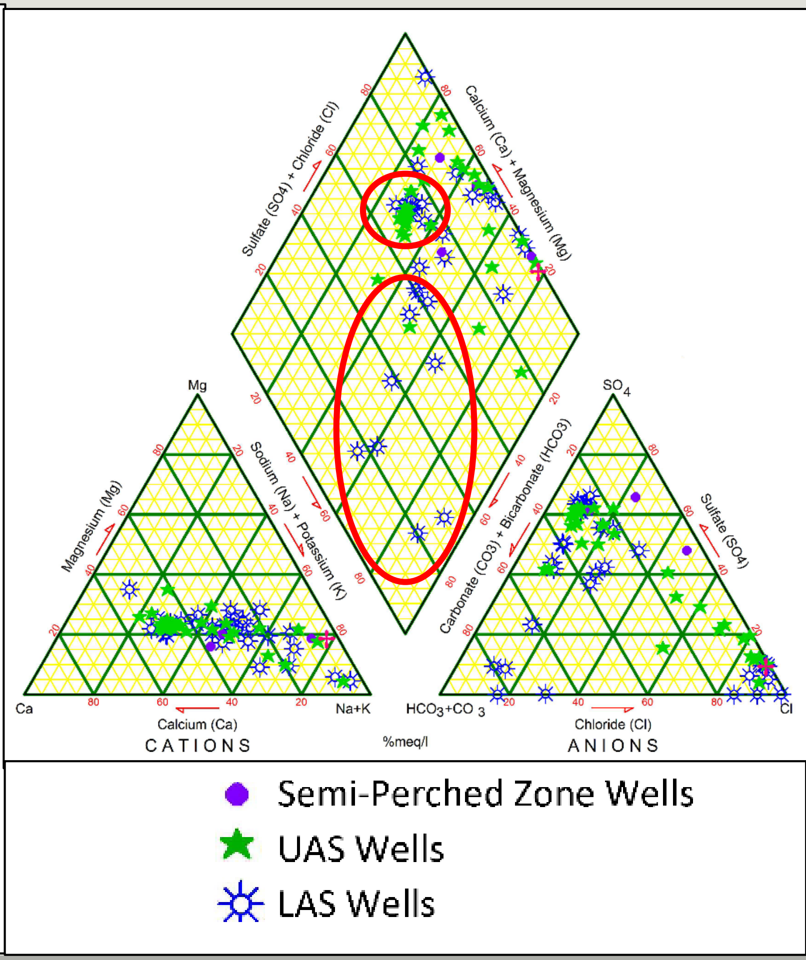

SALINE INTRUSION UPDATE,
OXNARD PLAIN AND PLEASANT VALLEY BASINS

United Water Conservation District
Open-File Report 2016-04
October 2016

Major and minor-ion chemistry

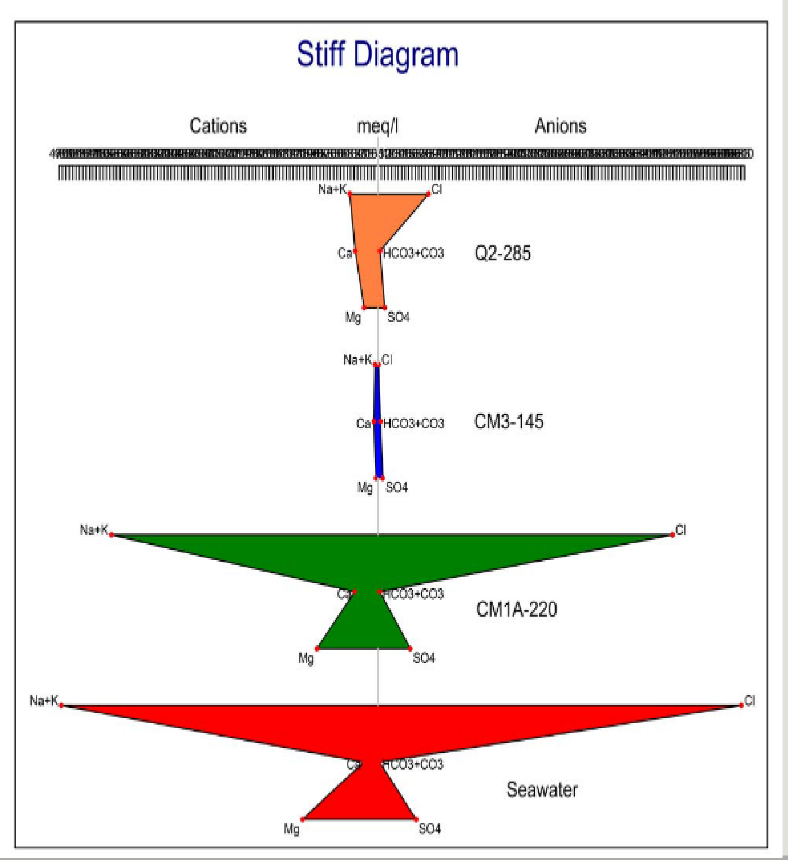




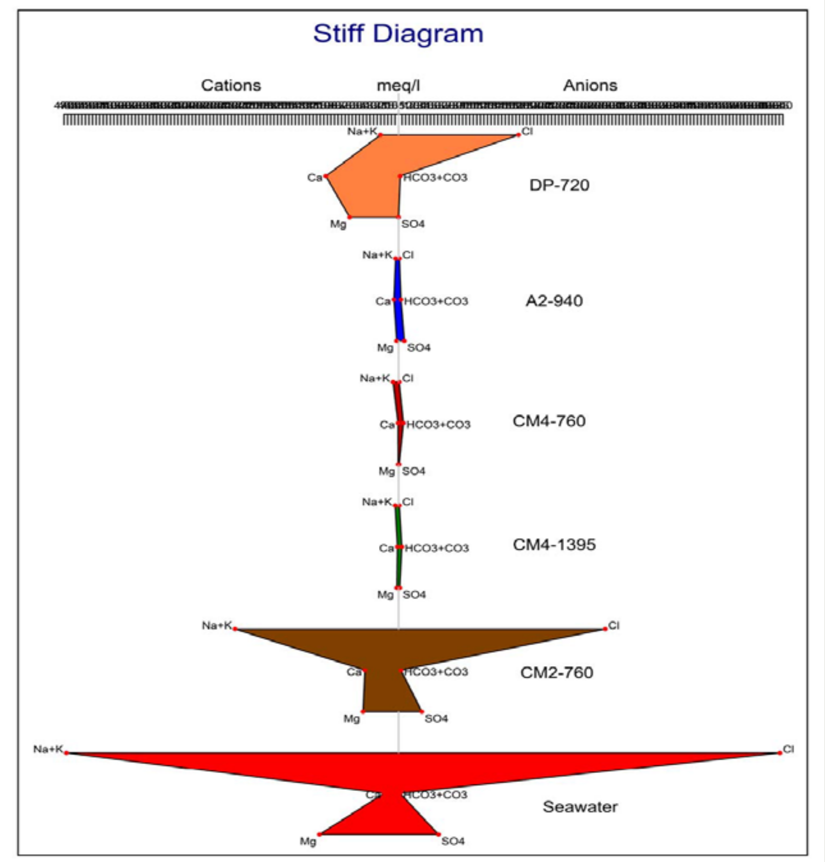


Major and minor-ion chemistry

Upper Aquifer System samples



Lower Aquifer System samples



Trace element analysis

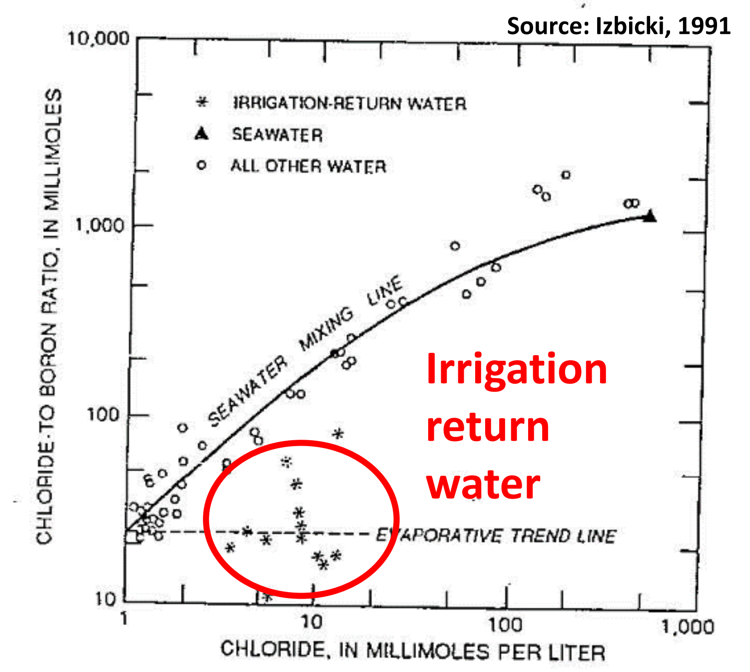


Figure 5. Chloride-to-boron ratio as a function of chloride in water from wells on the Oxnard Plain.

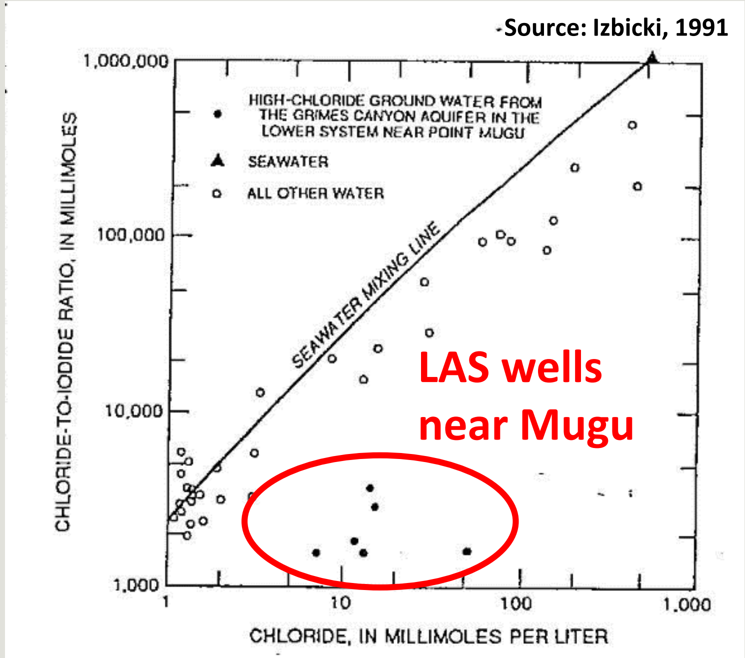
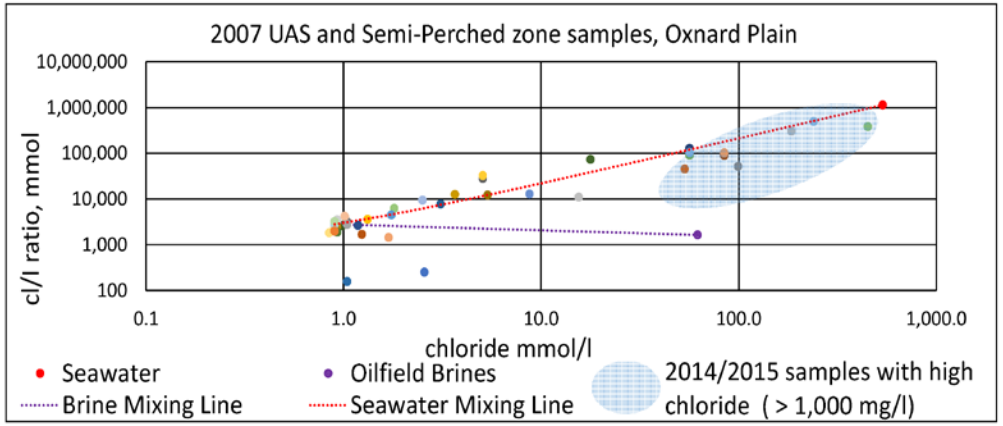
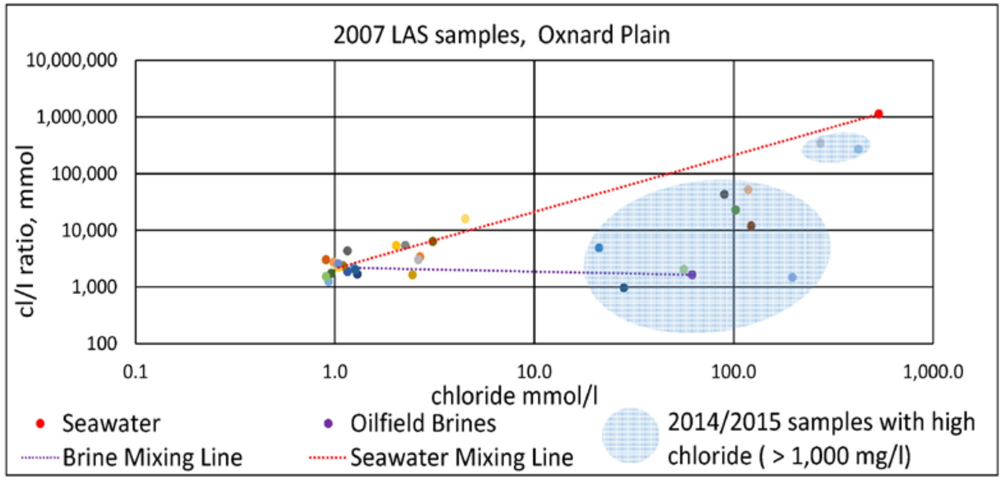
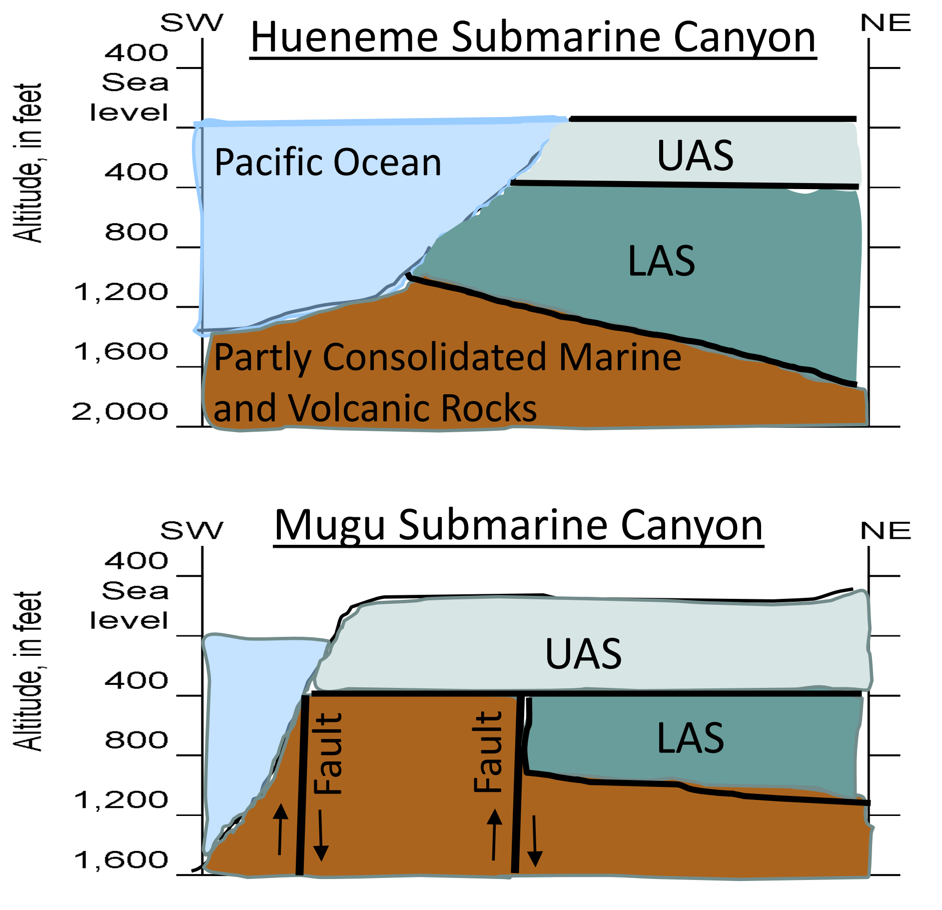


Figure 6. Chloride-to-iodide ratio as a function of chloride in water from wells on the Oxnard Plain.

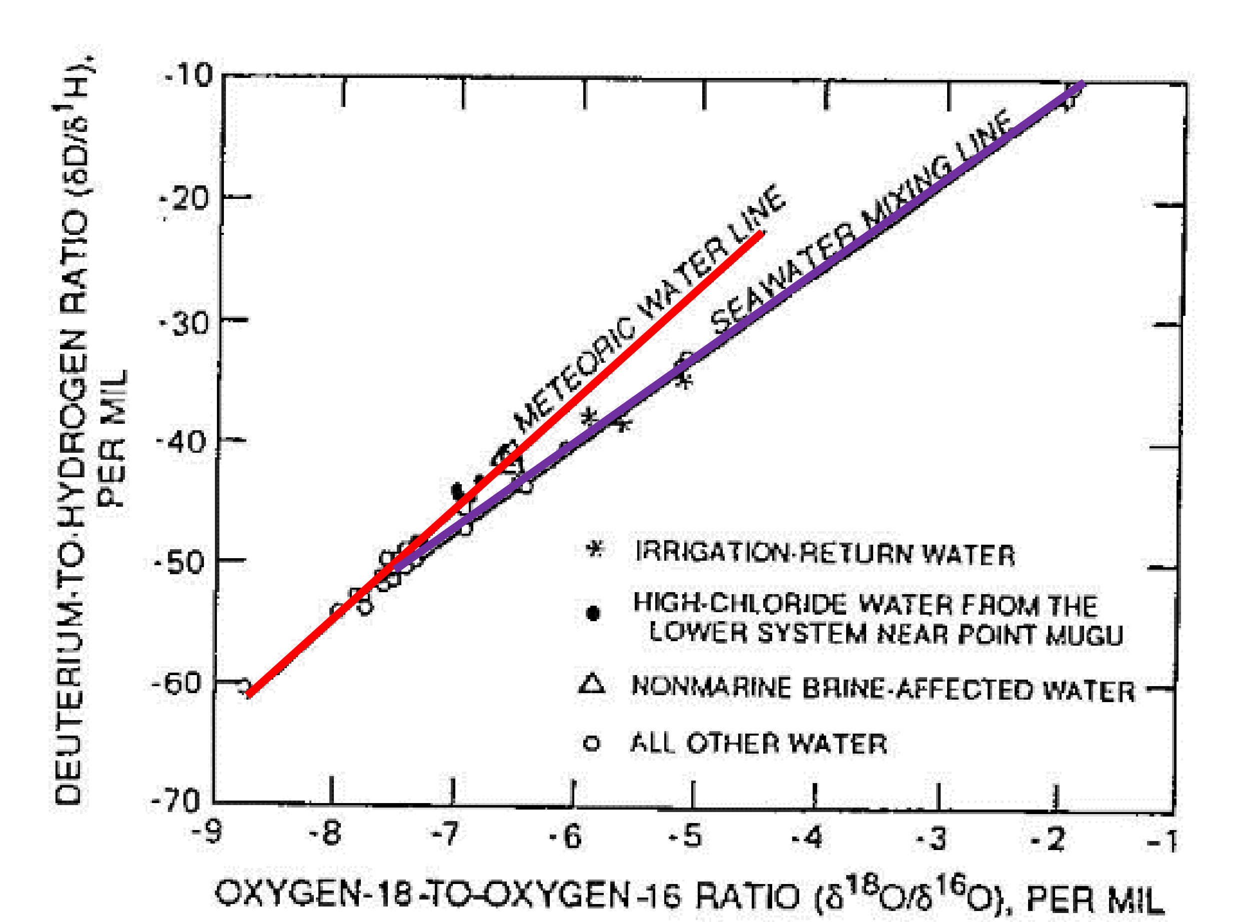




Specific isotope chemistry



Source: Izbicki, 1991



Source: Izbicki, 1991

Depth dependent water quality sampling

Pleasant Valley wells yielding high-chloride water may have been drilled too deep and directly penetrate formations having high-chloride water, or brines may have invaded deep freshwater aquifers from surrounding and underlying deposits as a result of pumping stresses

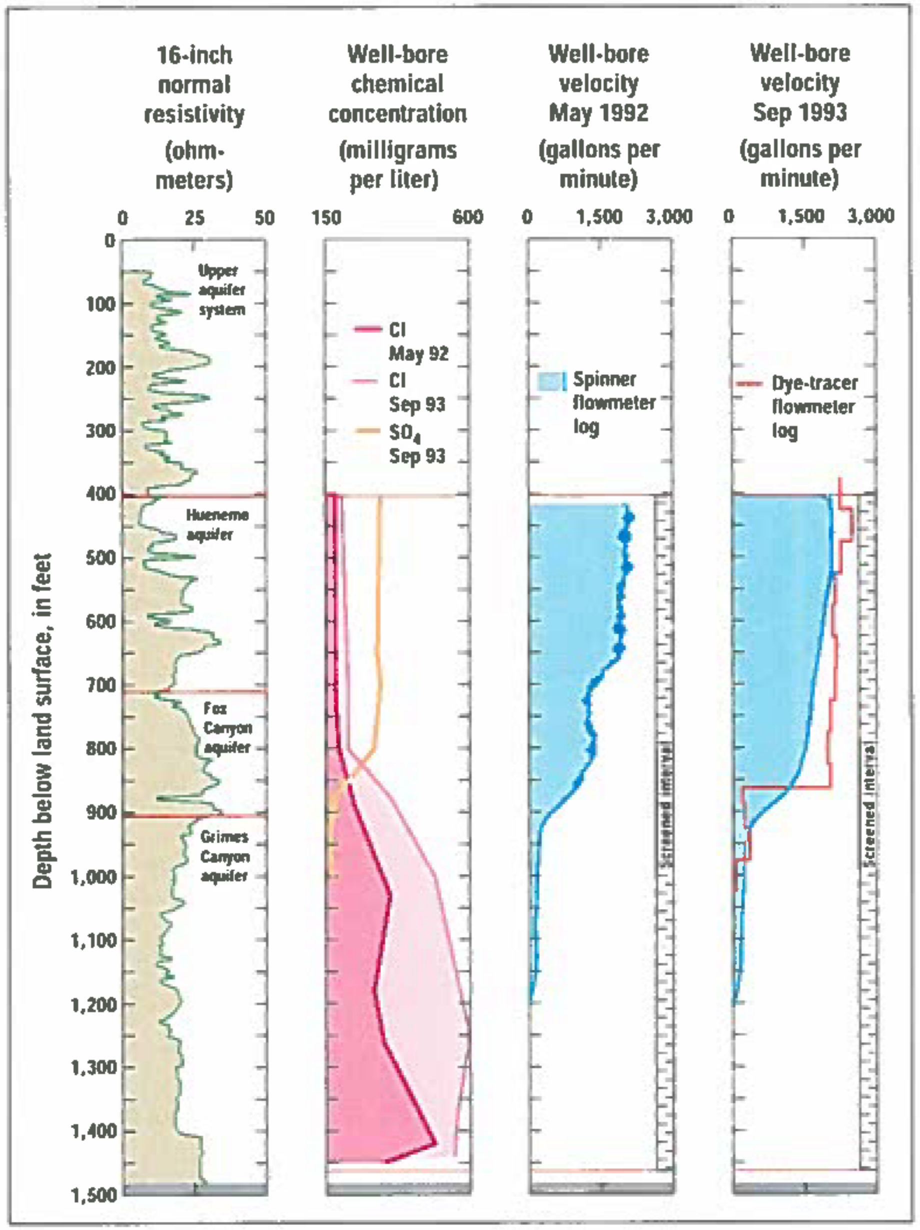
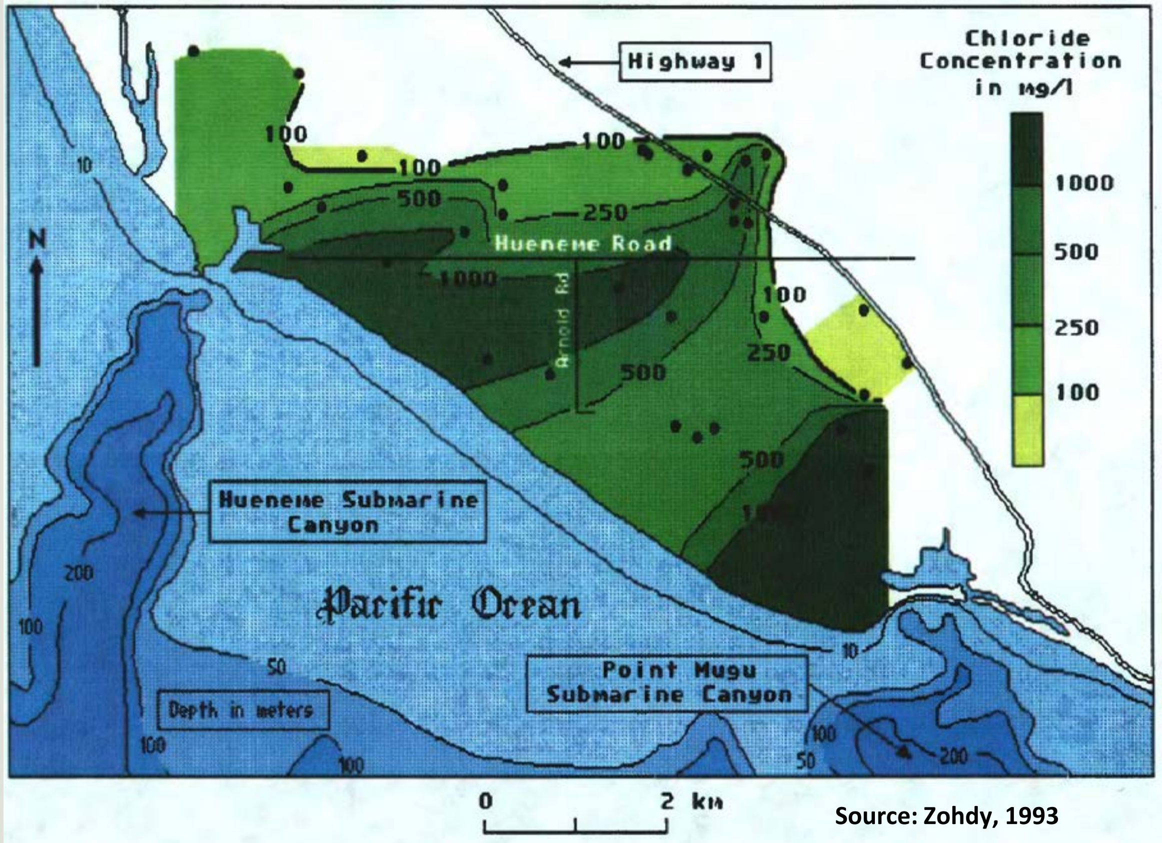


Figure 2. Example of depth-dependent flow and chemical data sampled from a deep production well.

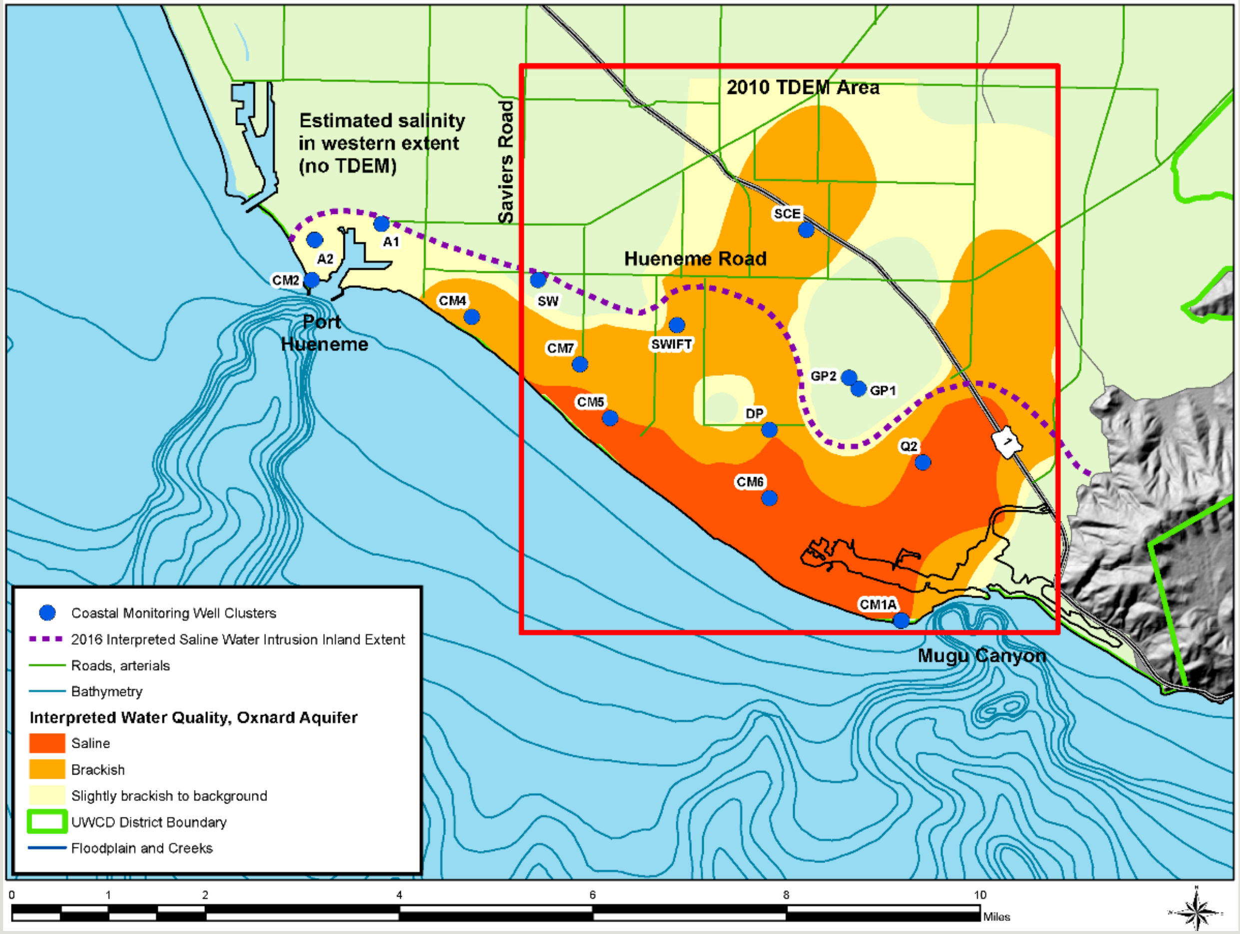
Source: Izbicki et al, 1999

Surface geophysical methods



Source: Zohdy, 1993

Figure 3. Map showing chloride concentrations (mg/l) in the Oxnard aquifer, 1989 (modified from County of Ventura Public Works Agency, 1990).



Conclusions: What did we learn?

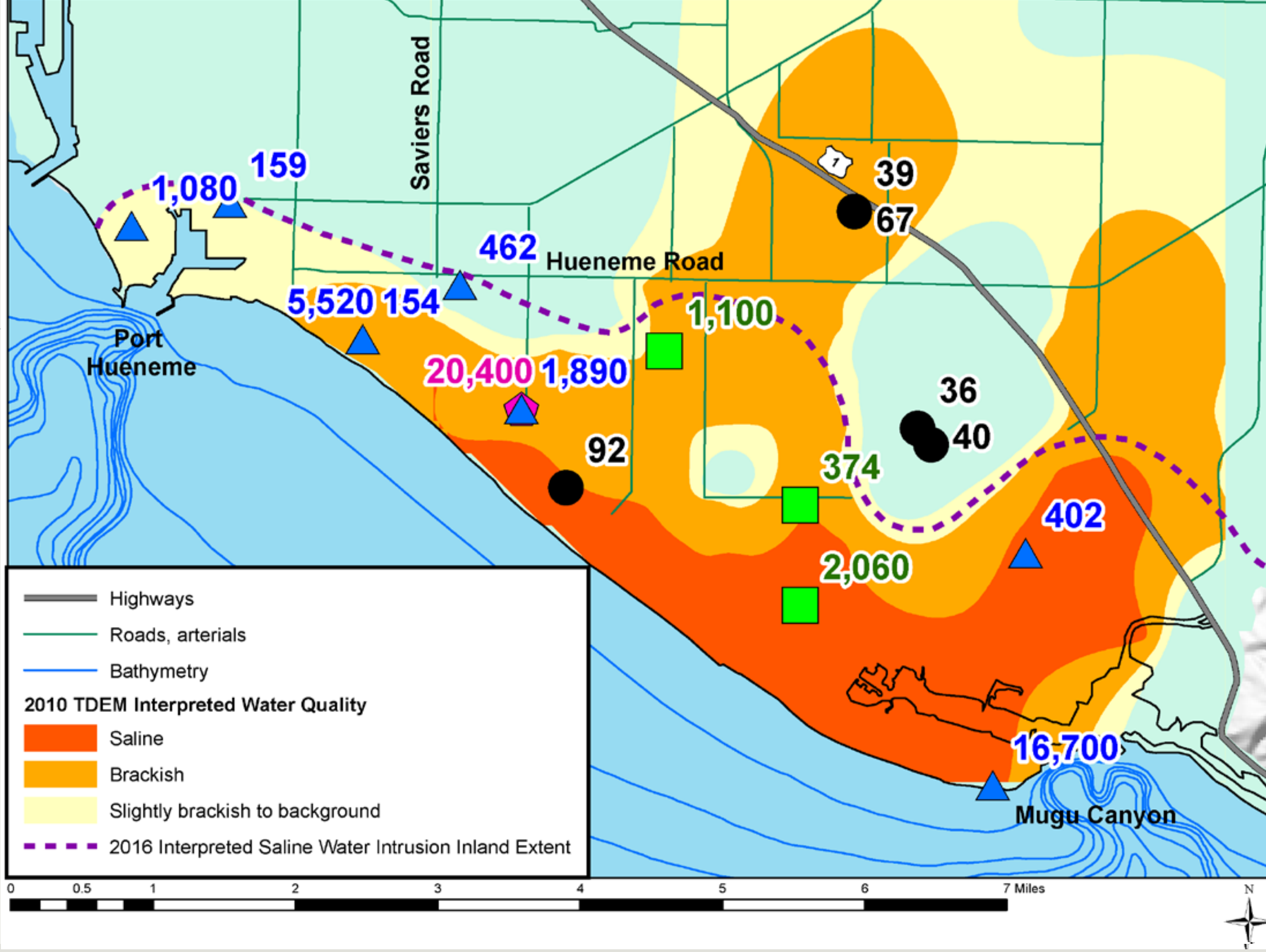
Chloride degradation in the Oxnard Plain and Pleasant Valley basins is related to four sources and processes:

1) Lateral Seawater Intrusion

2) Cross Contamination

3) Compaction of Salt-Laden Marine Clays

4) Lateral Movement of Brines from Tertiary formations



Well Location, chloride concentration (mg/l), interpreted source of elevated chloride:

- Seawater
- Sediments
- Semi-perched aquifer
- Background level

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Thank You!

KATHLEEN KUEPPER
STAFF HYDROGEOLOGIST
UNITED WATER CONSERVATION DISTRICT
KATHLEENK@UNITEDWATER.ORG