

CSU Water Conference 2024

# ESTIMATION OF NITRATES ( $\text{NO}_3^-$ ) AND SULFATES ( $\text{SO}_4^{2-}$ ) ACROSS SOUTHERN CALIFORNIA WATER SUPPLIES

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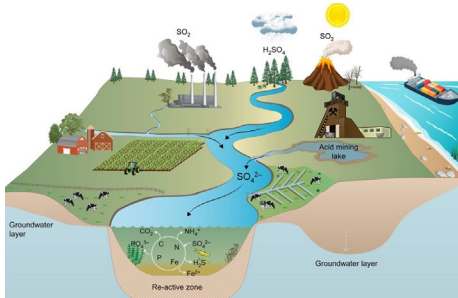
STUDENT TEAM @ RIVERSIDE CITY COLLEGE (EMILY NAJERA, ROCCO SCARMACK, ARIANNA GONZALEZ, TATIANNA LOPEZ, ANGEL ZAROBINSKI)



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# Background, the Problem and Standards



Do Nitrates and Sulfates in the water pose ***Environmental Health Risk for Southern Californians? Quantify the risk.***



Treated Wastewater and surface water used to recharge groundwater can be sources for Nitrate contamination and pose risks to urban drinking water supplies<sup>2</sup>.

Credits:

<https://www.americanscientist.org/article/the-blue-baby-syndromes>

<https://www.sciencedirect.com/science/article/pii/S001282522030492X>



CA State ***Maximum Contamination Level (MCL), 45 mg/L as Nitrate (or) 10 mg/L as total Nitrogen<sup>2</sup>, Secondary MCL for Sulfates at 250 mg/L.***



# Nitrate Fact Sheet

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

Updated May 2014

## What are nitrates?

Nitrates can be found in drinking water supplies. Their presence in groundwater is generally associated with septic systems, confined animal feeding operations or fertilizer use. These sources of nitrate contamination are more associated with rural settings and are often subjects of drinking water source protection programs.

## Where's nitrate been found in drinking water in California?

Nitrate in drinking water is widespread in numerous areas of the country. About 98% of the population served by all community drinking water systems in California uses drinking water that meets health-based standards.

Public water systems, because they are regulated by the state, (unlike private wells), are required to analyze for nitrates and report the results to CDPH.

**Nitrates: Methemoglobinemia**

**Sulfates: Dehydration and Laxative Effects  
in sensitive sub populations**

California Department of Public Health<sup>1</sup>



- Anaheim
- Buena Park
- Costa Mesa
- Fullerton
- Irvine
- Laguna Beach
- Santa Ana



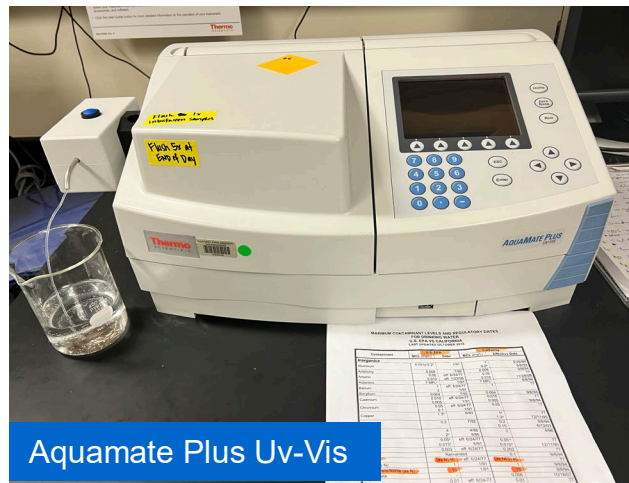
- Baker
- Bloomington
- Chino
- Fontana
- Hesperia
- Highland
- Lenwood
- Loma Linda
- Ludow
- Needles
- Nipton
- Ontario
- Rancho Cucamonga
- Redlands
- Rialto
- San Bernardino
- Upland
- Victorville
- Yermo



- Eastvale
- Menifee
- Moreno Valley
- Palm Springs
- Riverside
- Temecula
- Thousand Palms

# The Approach, back to the Fundamentals

- We applied **UV-Visible Spectrophotometric methods** in our CSUSB water resources lab to assess for water quality parameters.
- Best method to collect our own data and can be used to validate with other secondary sources.
- **GIS techniques** to map the spatial data.





# Series of Known Standards Prepared in the Lab

## Nitrates



## Sulfates



# Data from California Laboratory Intake Portal (CLIP)<sup>3</sup>

| Regular    | Water S  | Water Sys     | System | Water S | Principal County | Popula | Service | PS Cod   | SamplI    | Facility | Facility | Sample | Sample    | Sample   | Analys    | ELAP C | Lab Na    | Analyte | Analyte | Result | Counti | Units |
|------------|----------|---------------|--------|---------|------------------|--------|---------|----------|-----------|----------|----------|--------|-----------|----------|-----------|--------|-----------|---------|---------|--------|--------|-------|
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | EXTRACTI  | WL       | I        | RT     | 2/8/2023  | 10:25:00 | 2/9/2023  | 2813   | EUROFINS  | 1040    | NITRATE | 200    | 200    | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | EXTRACTI  | WL       | I        | RT     | 5/2/2023  | 8:43:00  | 5/3/2023  | 2813   | EUROFINS  | 1040    | NITRATE | 200    | 200    | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | IX AND RC | TP       | A        | RT     | 3/21/2023 | 6:15:00  | 3/22/2023 | 2698   | E.S. BABC | 1040    | NITRATE | 110    | 110    | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 15   | WL       | A        | RT     | 9/12/2023 | 8:30:00  | 9/13/2023 | 2698   | E.S. BABC | 1040    | NITRATE | 98     | 98     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 15   | WL       | A        | RT     | 8/8/2023  | 7:53:00  | 8/9/2023  | 2698   | E.S. BABC | 1040    | NITRATE | 81     | 81     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 05   | WL       | A        | RT     | 5/9/2023  | 9:15:00  | 5/10/2023 | 2698   | E.S. BABC | 1040    | NITRATE | 79     | 79     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 15   | WL       | A        | RT     | 8/23/2023 | 10:30:00 | 8/24/2023 | 2698   | E.S. BABC | 1040    | NITRATE | 76     | 76     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 05   | WL       | A        | RT     | 6/13/2023 | 8:42:00  | 6/14/2023 | 2698   | E.S. BABC | 1040    | NITRATE | 74     | 74     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 05   | WL       | A        | RT     | #####     | 12:27:00 | #####     | 2698   | E.S. BABC | 1040    | NITRATE | 74     | 74     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 05   | WL       | A        | RT     | 7/11/2023 | 9:42:00  | 7/12/2023 | 2698   | E.S. BABC | 1040    | NITRATE | 73     | 73     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 05   | WL       | A        | RT     | 7/13/2023 | 8:40:00  | 7/15/2023 | 2698   | E.S. BABC | 1040    | NITRATE | 73     | 73     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 05   | WL       | A        | RT     | 1/9/2024  | 8:25:00  | 1/10/2024 | 2698   | E.S. BABC | 1040    | NITRATE | 73     | 73     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 05   | WL       | A        | RT     | #####     | 11:35:00 | #####     | 2698   | E.S. BABC | 1040    | NITRATE | 73     | 73     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | EXTRACTI  | WL       | I        | RT     | 5/3/2023  | 11:39:00 | 5/5/2023  | 2813   | EUROFINS  | 1040    | NITRATE | 73     | 73     | MG/L  |
| DISTRICT 1 | CA361007 | CHINO BASIN A | C      | C       | SAN BERNARDINO   | 0      | 3       | CA361007 | WELL 05   | WL       | A        | RT     | 3/14/2023 | 7:05:00  | 3/15/2023 | 2698   | E.S. BABC | 1040    | NITRATE | 72     | 72     | MG/L  |

Over 100,000 records of data

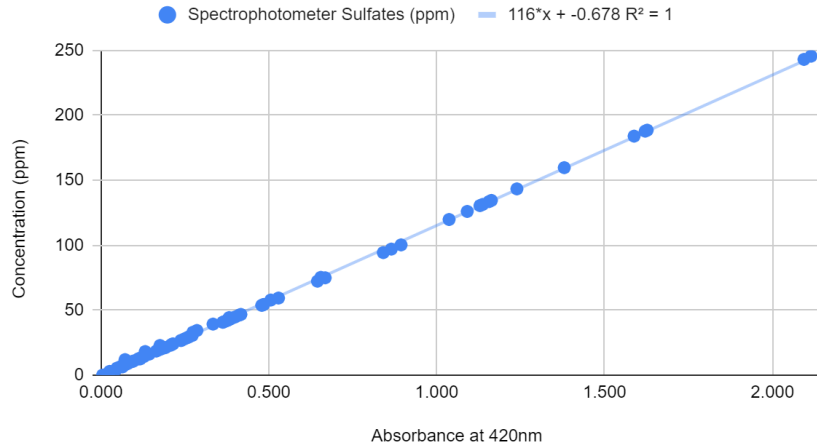
# Sample data collected by the CSUSB teams in the lab

| Spectrophotometer Nitrate Concentration (ppm) |                       |                |          |                                                            | Spectrophotometer Nitrate Concentration (ppm) |                   |    |                 |                    |                                            |                                               |                                   |                                            |                                               |
|-----------------------------------------------|-----------------------|----------------|----------|------------------------------------------------------------|-----------------------------------------------|-------------------|----|-----------------|--------------------|--------------------------------------------|-----------------------------------------------|-----------------------------------|--------------------------------------------|-----------------------------------------------|
| A                                             | B                     | C              | D        | E                                                          | A                                             | K                 | L  | M               | N                  | O                                          | P                                             | Q                                 | R                                          | S                                             |
| Sample ID                                     | County                | City           | Zip Code | Water District                                             | Sample ID                                     | ssolved gen (ppm) | pH | Phosphate (ppm) | Total Solids (g/L) | Spectrophotometer Nitrate Absorbance 220nm | Spectrophotometer Nitrate Concentration (ppm) | Nitrate Nitrogen (10N03-N/45N 03) | Spectrophotometer Sulfate Absorbance 420nm | Spectrophotometer Sulfate Concentration (ppm) |
| DR07182023_CK                                 | San Bernardino County | Loma Linda     | 92354    | City of Loma Linda                                         | 2                                             | 20                | 8  | 4               | 0.288              | 2.84                                       | 40.152                                        | 8.923                             | 0.485                                      | 54.38                                         |
| TL07142023                                    | Riverside County      | Riverside      | 92504    | Western Municipal Water District                           | 3                                             | 20                | 8  | 4               | 0.358              | 2.771                                      | 39.088                                        | 8.686                             | 0.668                                      | 74.912                                        |
| AG06122023                                    | San Bernardino County | Bloomington    | 92316    | West Valley Water District                                 | 4                                             | 5                 | 8  | 4               | 0.09               | 2.682                                      | 37.74                                         | 8.387                             | 0.272                                      | 30.507                                        |
| RS06192023_HCP                                | San Bernardino County | Highland       | 92346    | East Valley Water District                                 | 5                                             | 20                | 7  | 4               | 0.236              | 2.678                                      | 37.668                                        | 8.371                             | 0.478                                      | 53.707                                        |
| MM07102023_T                                  | Riverside County      | Riverside      | 92507    | Western Municipal Water District                           | 6                                             | 20                | 8  | 4               | 0.432              | 2.633                                      | 36.966                                        | 8.219                             | 0.645                                      | 72.301                                        |
| DR07212023                                    | San Bernardino County | Yermo          | 92398    | Yermo Water Company                                        | 7                                             | 5                 | 7  | 4               | 0.7                | 2.592                                      | 36.362                                        | 8.080                             | 2.094                                      | 243.0005                                      |
| DR07072023_EPRP                               | Riverside County      | Eastvale       | 92880    | Inland Empire Utilities Agency (FKA Chino Basin Municipal) | 8                                             | 20                | 8  | 4               | 0.258              | 2.573                                      | 36.066                                        | 8.015                             | 0.097                                      | 10.86                                         |
| DR07172023                                    | San Bernardino County | Ontario        | 91761    | Inland Empire Utilities Agency (FKA Chino Basin Municipal) | 9                                             | 20 (light)        | 8  | 4               | 0.184              | 2.565                                      | 35.938                                        | 7.986                             | 0.185                                      | 20.734                                        |
| DR07072023_CP                                 | Riverside County      | Eastvale       | 92880    | Inland Empire Utilities Agency (FKA Chino Basin Municipal) | 10                                            |                   |    |                 | 0.35               | 2.532                                      | 35.438                                        | 7.875                             | 0.080                                      | 8.9213                                        |
| RS07222023_AA                                 | Riverside County      | Thousand Palms | 92211    | Coachella Valley                                           | 11                                            | 5 (dark)          | 8  | 4               | 0.264              | 2.49                                       | 34.786                                        | 7.730                             | 0.506                                      | 57.7994                                       |
| DR07072023_EH                                 | Riverside County      | Eastvale       | 92880    | Inland Empire Utilities Agency (FKA Chino Basin Municipal) | 12                                            |                   | 7  | 4               | 0.256              | 2.473                                      | 34.54                                         | 7.676                             | 0.072                                      | 11.94                                         |
| AG06192023_AZ                                 | San Bernardino County | Bloomington    | 92316    | West Valley Water District                                 | 13                                            | 20                | 8  | 4               | 0.338              | 2.445                                      | 34.188                                        | 7.580                             | 0.483                                      | 54.132                                        |

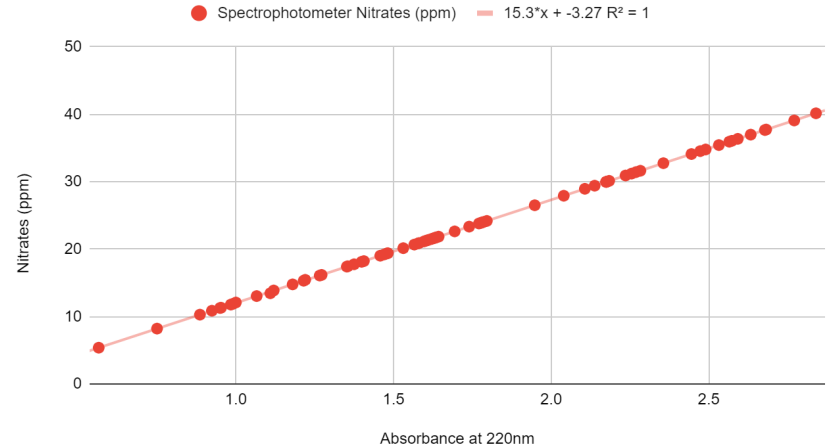
Validation Attempt of

# UV-Visible Absorption to Estimate Unknown Samples- Summer 2023

Sulfate Concentration (ppm) vs. Absorbance at 420nm

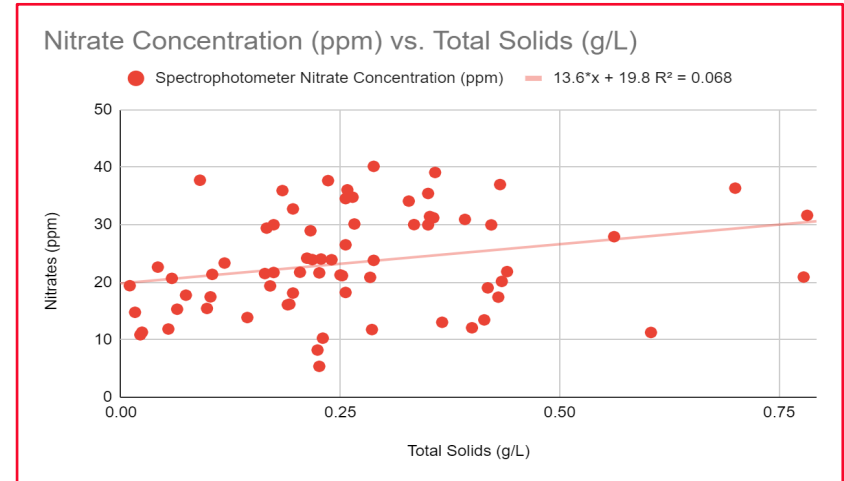
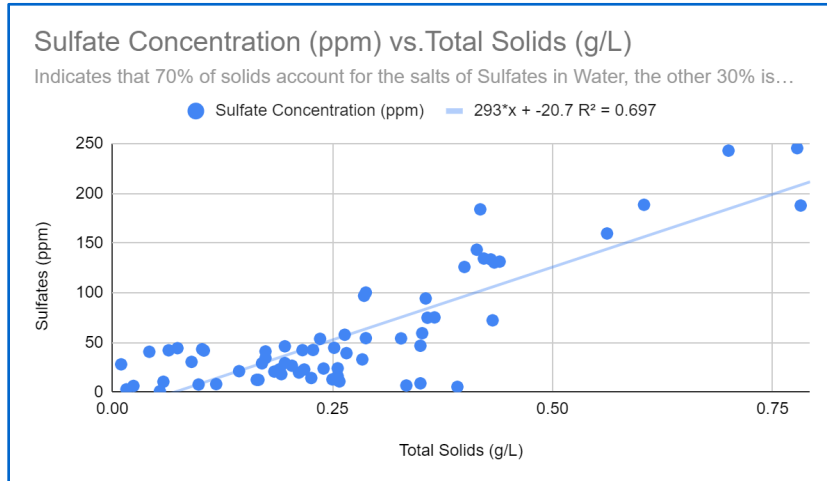


Nitrate Concentration (ppm) vs. Absorbance at 220nm



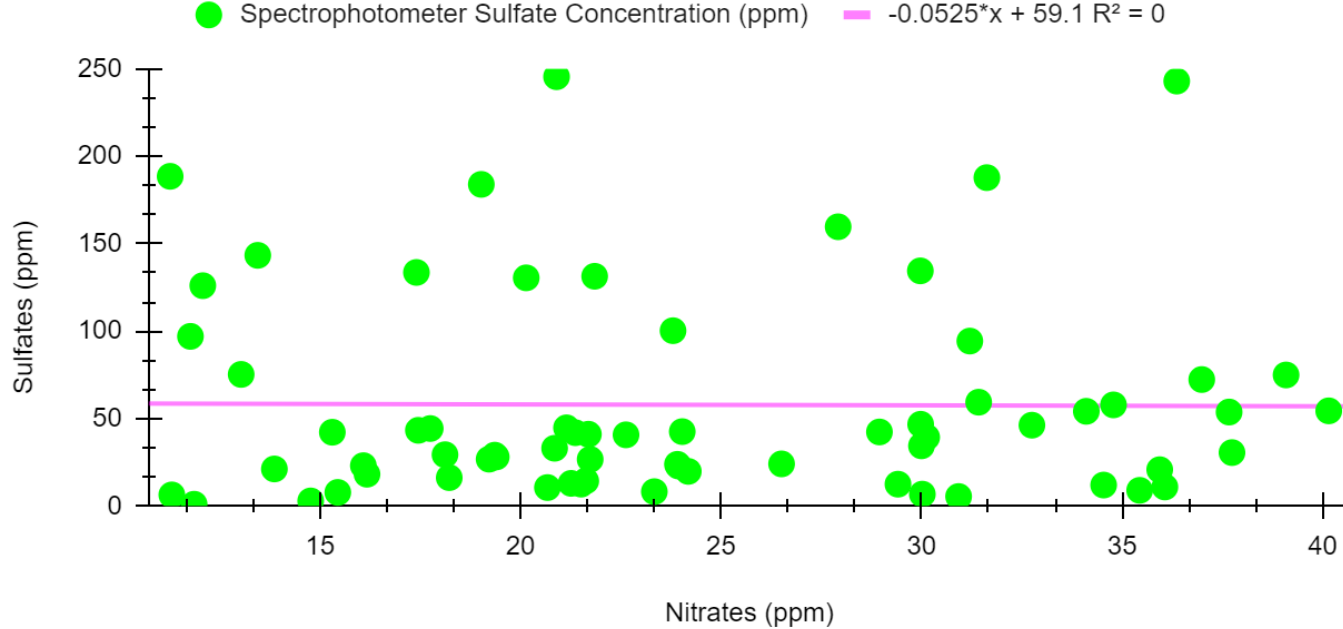


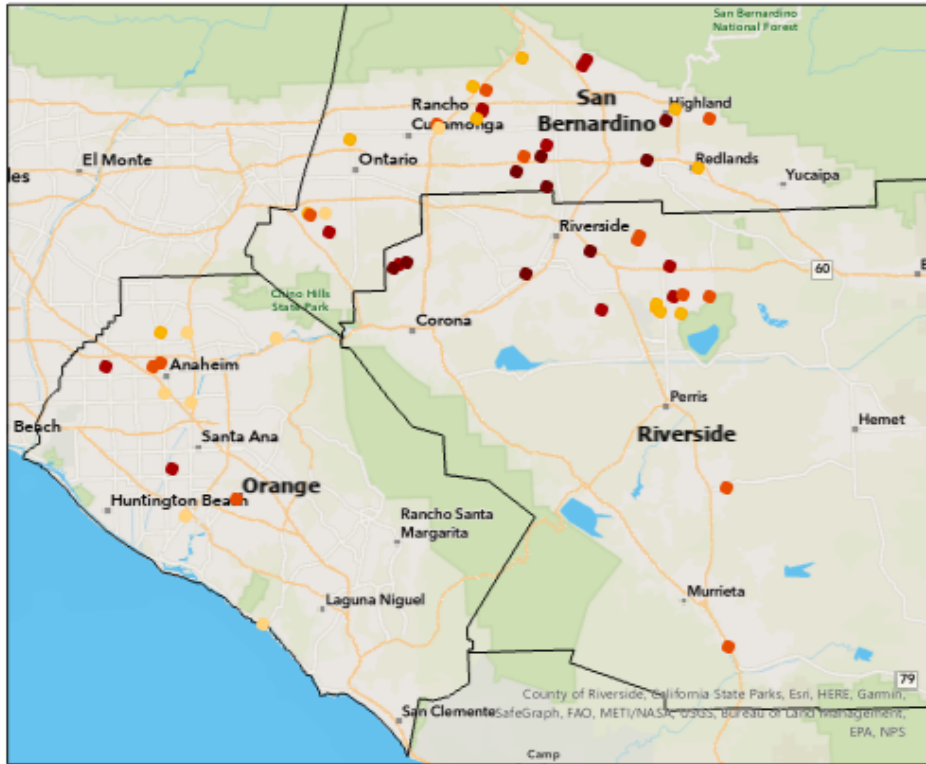
# Nitrates and Sulfates relationship to Total Solids in collected samples



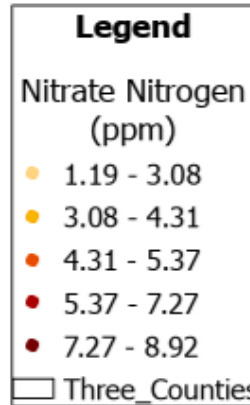
# Sulfates Vs. Nitrates

No significant relationship in the regression plot indicates the sources of two pollutants could have different origins in the drinking wat...

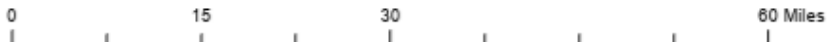


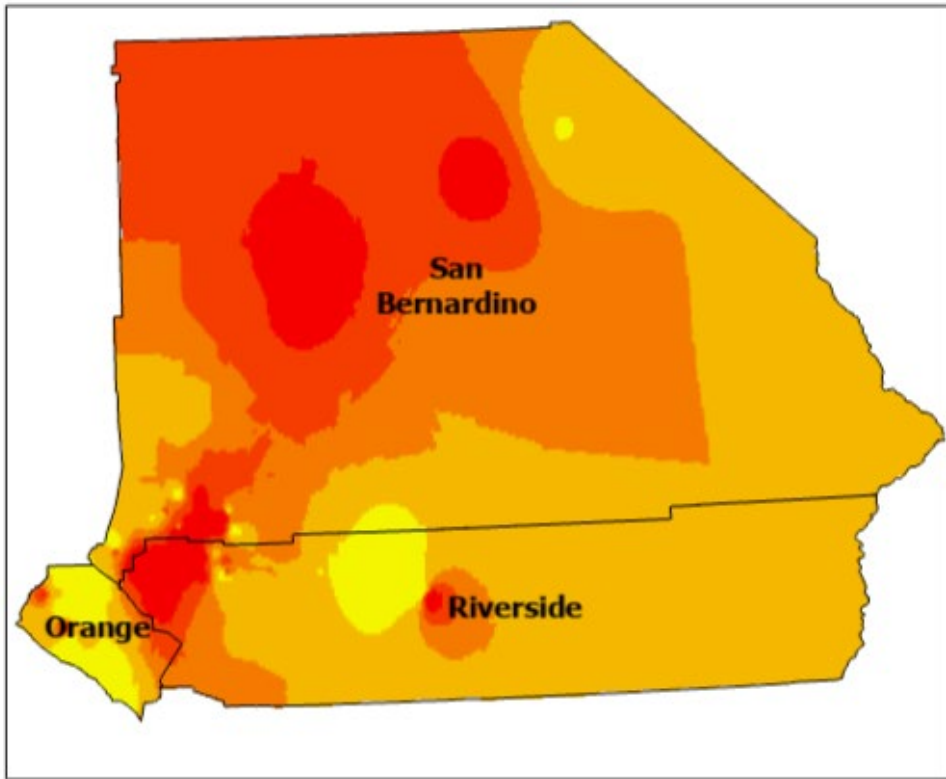


## Spectrophotometer Nitrate Nitrogen



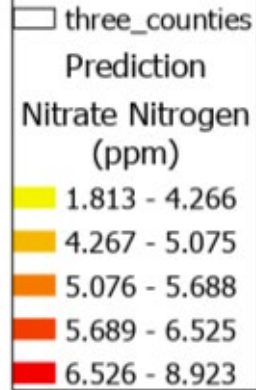
EPA maximum contamination levels for nitrate nitrogen must be under 10 ppm<sup>5</sup>





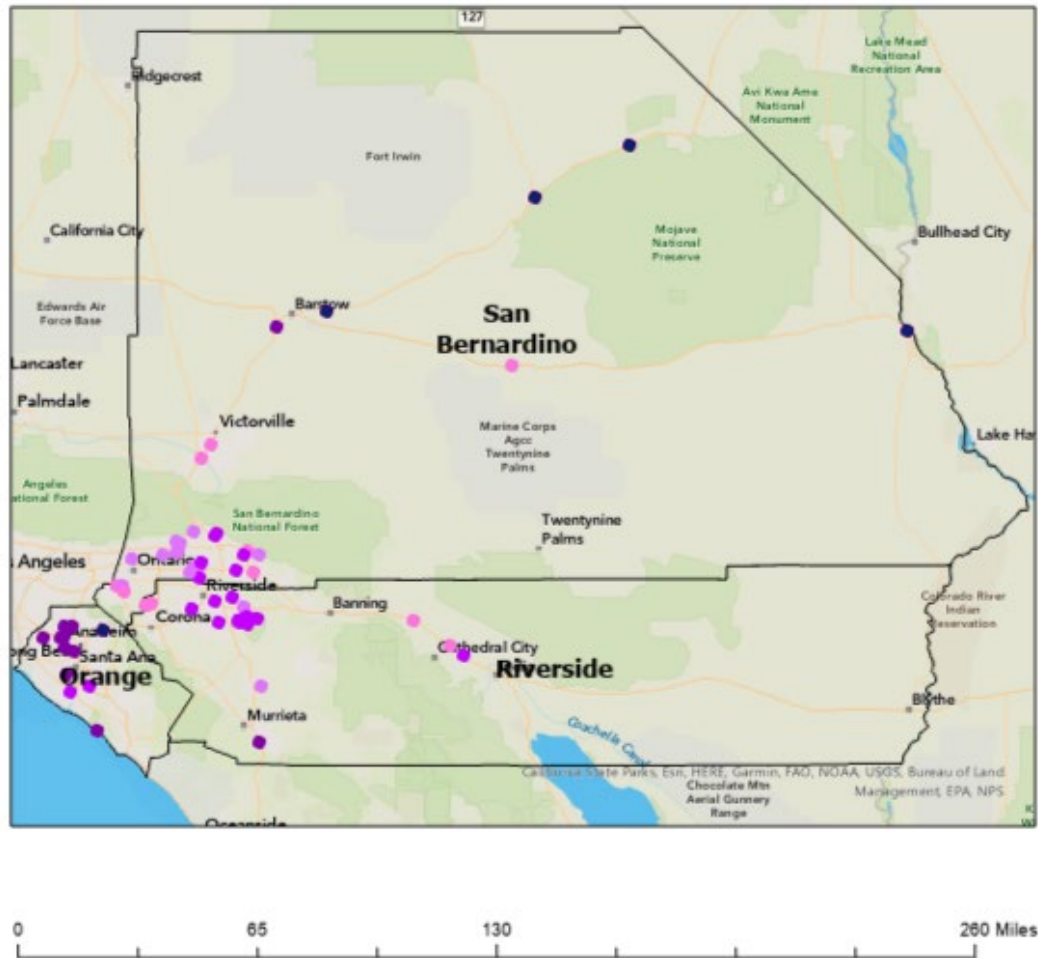
### Prediction Nitrate Nitrogen

#### Legend

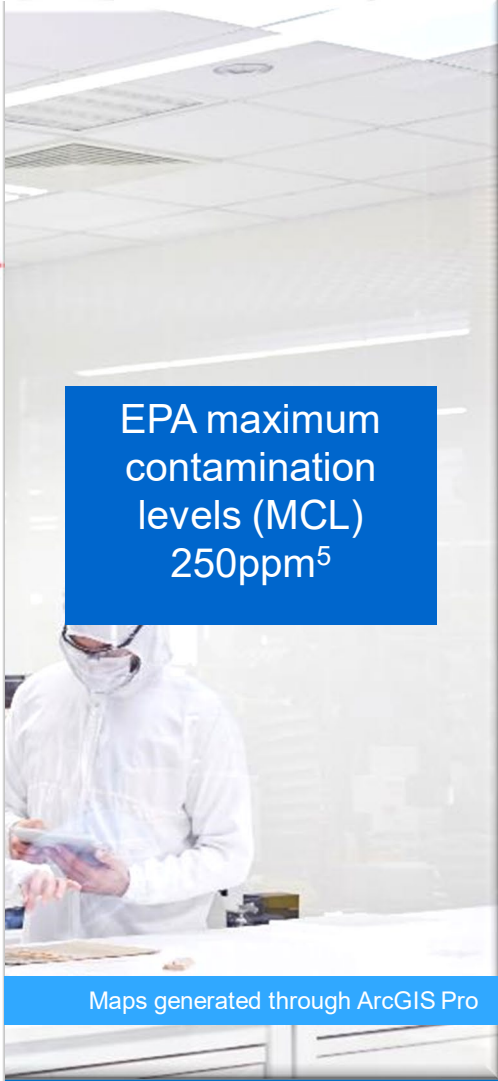
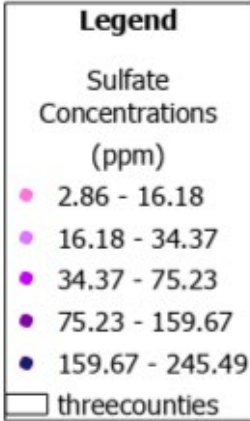


0 55 110 220 Miles



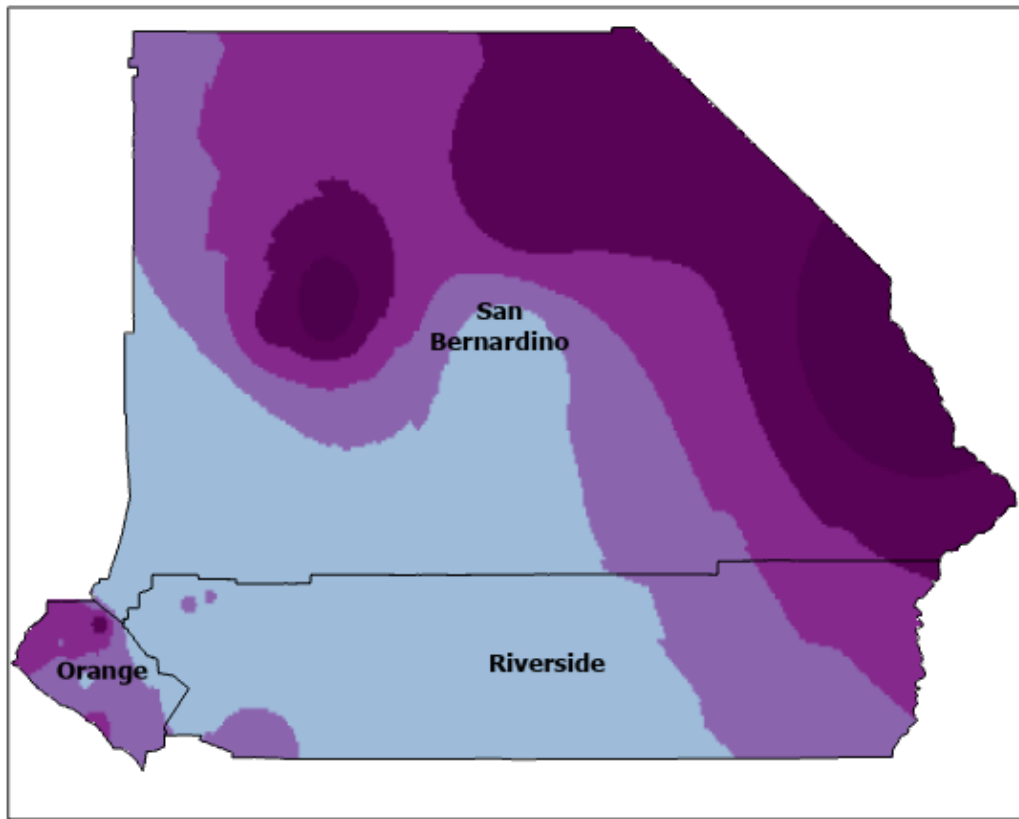


## Spectrophotometer Sulfate Results



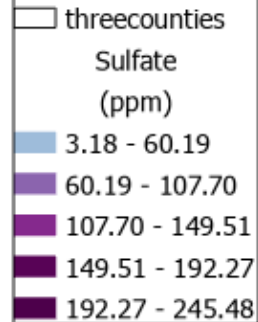
EPA maximum contamination levels (MCL) 250ppm<sup>5</sup>



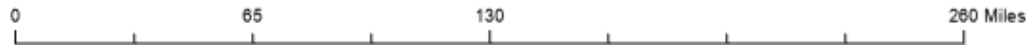


### Sulfate Prediction

#### Legend



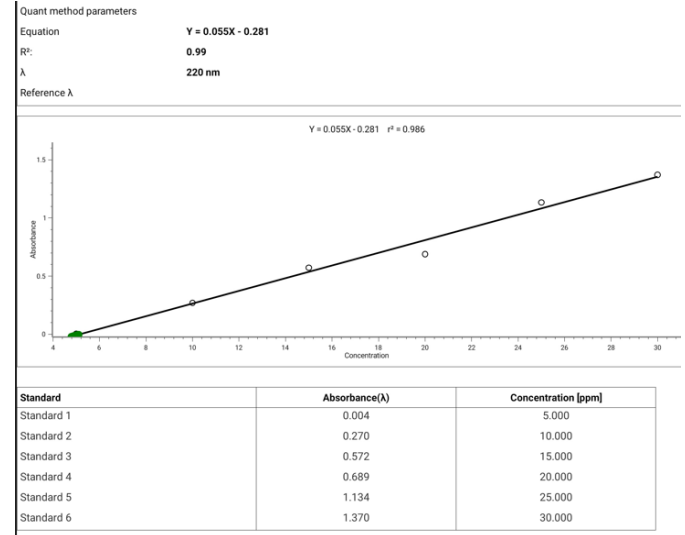
Darker the color gradient, higher the concentration value



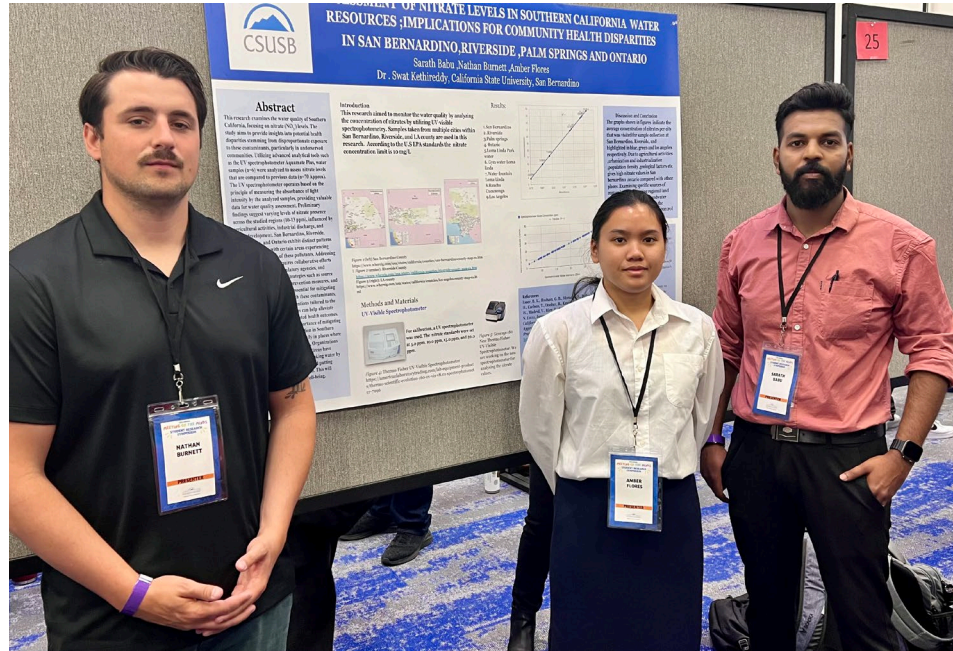


# UV-Visible Absorption to Estimate Unknown Samples-Spring 2024

- Developed new calibration on Genesis 180 spectrophotometer.



# Current student trainees research group



**CSUSB Meeting of the Minds Student Research Conference  
Awarded Best Poster for graduate student section- April 2023**

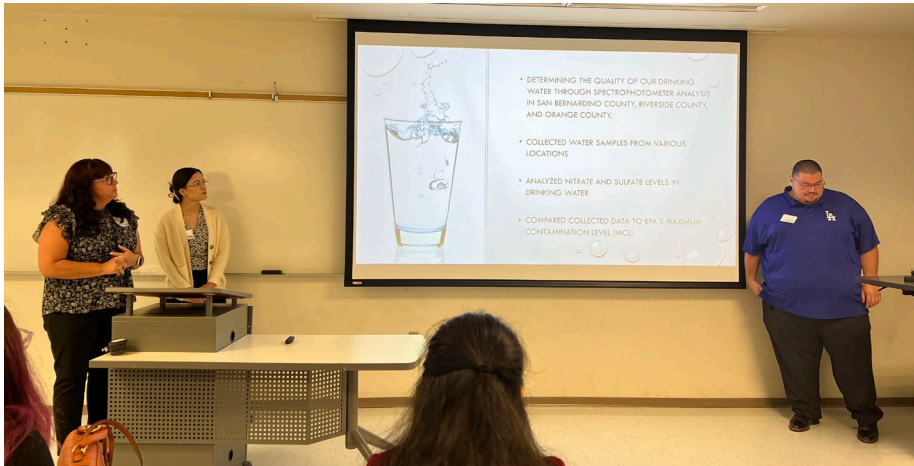
# Former Student trainees at field trip and in lab



Summer 2023



# Summer 2023 Student Research Presentation



# Conclusions

- Need improved sampling rates to evaluate temporal and spatial variations for broader southern California region.
- Improve sampling frequency at higher spatial and temporal scales.
- 15% of assessed samples showed overlapping with existing standards for nitrates.
- Sulfates appeared within the MCL levels for the collected samples.

# Conclusions

- Private well data might open new data opportunities since some well data appeared to show above 22-27 mg/L levels<sup>6</sup>.
- The outcome of this research identifies a need for continuous monitoring of water quality at the Coastal region, parts of Riverside and San Bernardino areas.





# Key References

1. Nitrate Fact Sheet, California Department of Public Health  
[https://www.waterboards.ca.gov/drinking\\_water/certlic/drinkingwater/documents/nitrate/fact\\_sheet\\_nitrate\\_may2014\\_update.pdf](https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/nitrate/fact_sheet_nitrate_may2014_update.pdf)
2. California Water Boards, [https://www.waterboards.ca.gov/gama/docs/coc\\_nitrate.pdf](https://www.waterboards.ca.gov/gama/docs/coc_nitrate.pdf)
3. EDT Library and Water Quality Analyses Data and Download Page,  
[https://www.waterboards.ca.gov/drinking\\_water/certlic/drinkingwater/EDTlibrary.html](https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/EDTlibrary.html)
4. Esser, B. K., Hudson, G. B., Moran, J. E., Beller, H., Carlsen, T., Doohar, B., Krauter, P., McNab, W., Madrid, V., Rice, D., Verce, M., & Rosenberg, N. (2011, January 10). Nitrate contamination in California groundwater: An Integrated Approach to Basin Assessment and Resource Protection. Nitrate Contamination in California Groundwater: An Integrated Approach to Basin Assessment and Resource Protection (Technical Report) | OSTI.GOV. <https://www.osti.gov/servlets/purl/1062757>
5. Maximum contaminant levels and regulatory dates for drinking water U.S ... Waterboards.ca.gov (2018, October).  
[https://www.waterboards.ca.gov/drinking\\_water/certlic/drinkingwater/documents/ccr/mcls\\_epa\\_vs\\_dwp.pdf](https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ccr/mcls_epa_vs_dwp.pdf)
6. Blue babies and nitrate contaminated well waters- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1638204/>
7. <https://www.americanscientist.org/article/the-blue-baby-syndromes>
8. World Health Organization, [https://cdn.who.int/media/docs/default-source/wash-documents/wash-chemicals/sulfate.pdf?sfvrsn=b944d584\\_4](https://cdn.who.int/media/docs/default-source/wash-documents/wash-chemicals/sulfate.pdf?sfvrsn=b944d584_4)

# Acknowledgements

- CSUSB Office of Student Research
- Dept of Health Science and Human Ecology
- Office of Community Engagement





Questions?



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