Monitoring Colorado's Groundwater for Agricultural Chemicals and Long-Term Contamination Trends

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The Agricultural Chemicals & Groundwater Protection Program

"…to protect groundwater and the environment from impairment or degradation due to the improper use of agricultural chemicals while allowing for their proper and correct use…" SB 90-126

- Multi-agency cooperation:
  - CO Dept. of Agriculture (lead)
    - Regulation of bulk containment and mixing/loading pads
    - Groundwater monitoring
  - Colorado State University Extension
    - Research, education outreach, publications
  - CO Dept. of Public Health & Environment
    - Review, analyze, and interpret monitoring data
    - Provide external perspective

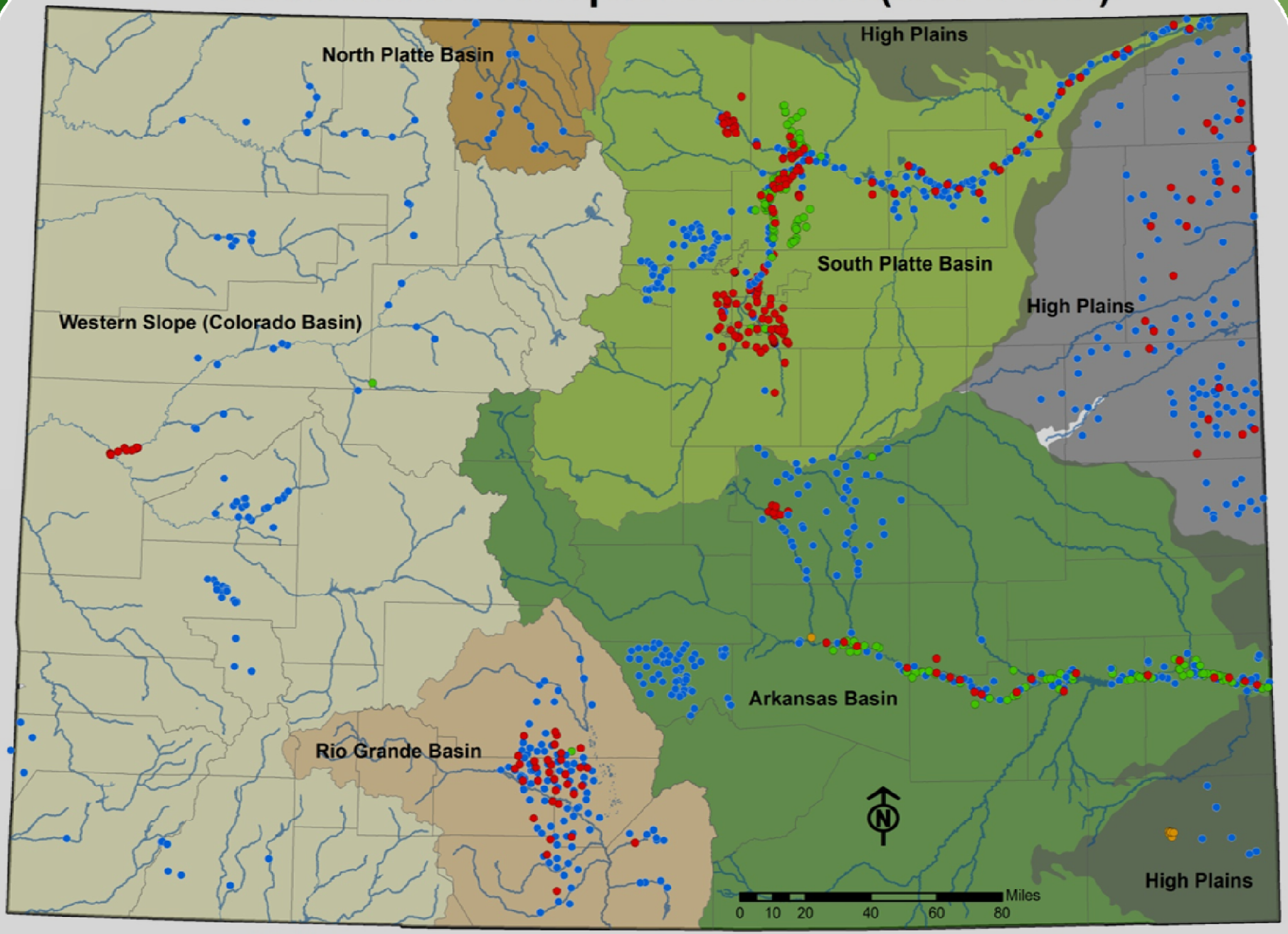
The Agricultural Chemicals & Groundwater Protection Program

- Groundwater monitoring since 1992
  - 2400+ samples collected from nearly 1300 wells
  - Key irrigated agriculture and urban environment areas
  - Online database
    - Link at **http://tinyurl.com/CDAGroundwater**
  - Several long-term monitoring well networks
    - Weld County (South Platte River Basin)
    - Arkansas Valley (Arkansas River Basin)
    - Front Range Urban (Fort Collins & Colorado Springs)
    - High Plains (Ogallala Formation)

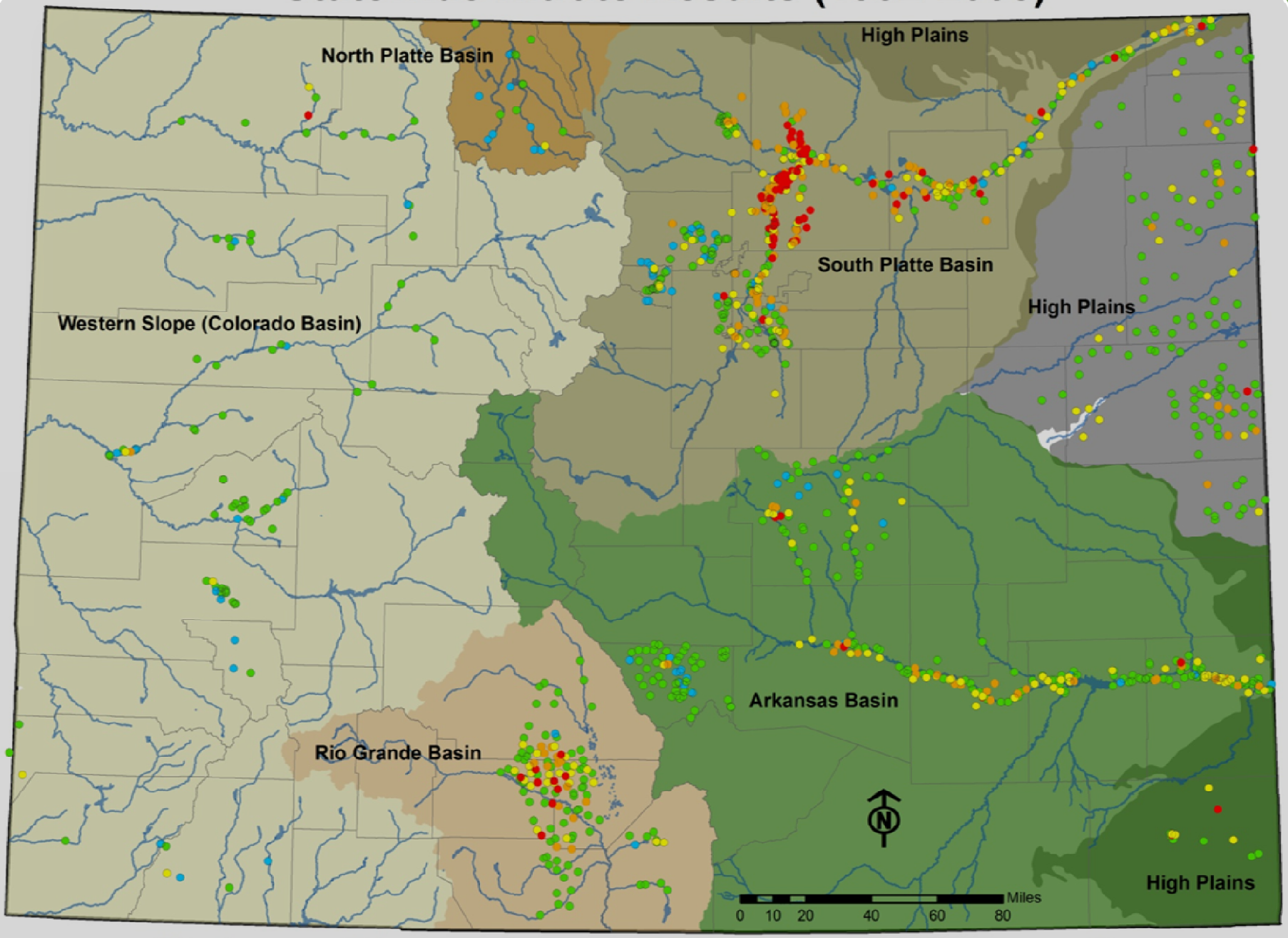
The Agricultural Chemicals & Groundwater Protection Program

- Where/When do we monitor?
  - Areas with vulnerable groundwater
    - Soil & Hydrology: infiltration, depth to water, O.M.
    - Intensity of chemical use
    - Areas under irrigation
  - Areas where groundwater is a key water source
  - Land or well owner cooperation
  - Sampling frequency differs for each network
    - Long-Term Monitoring Plan

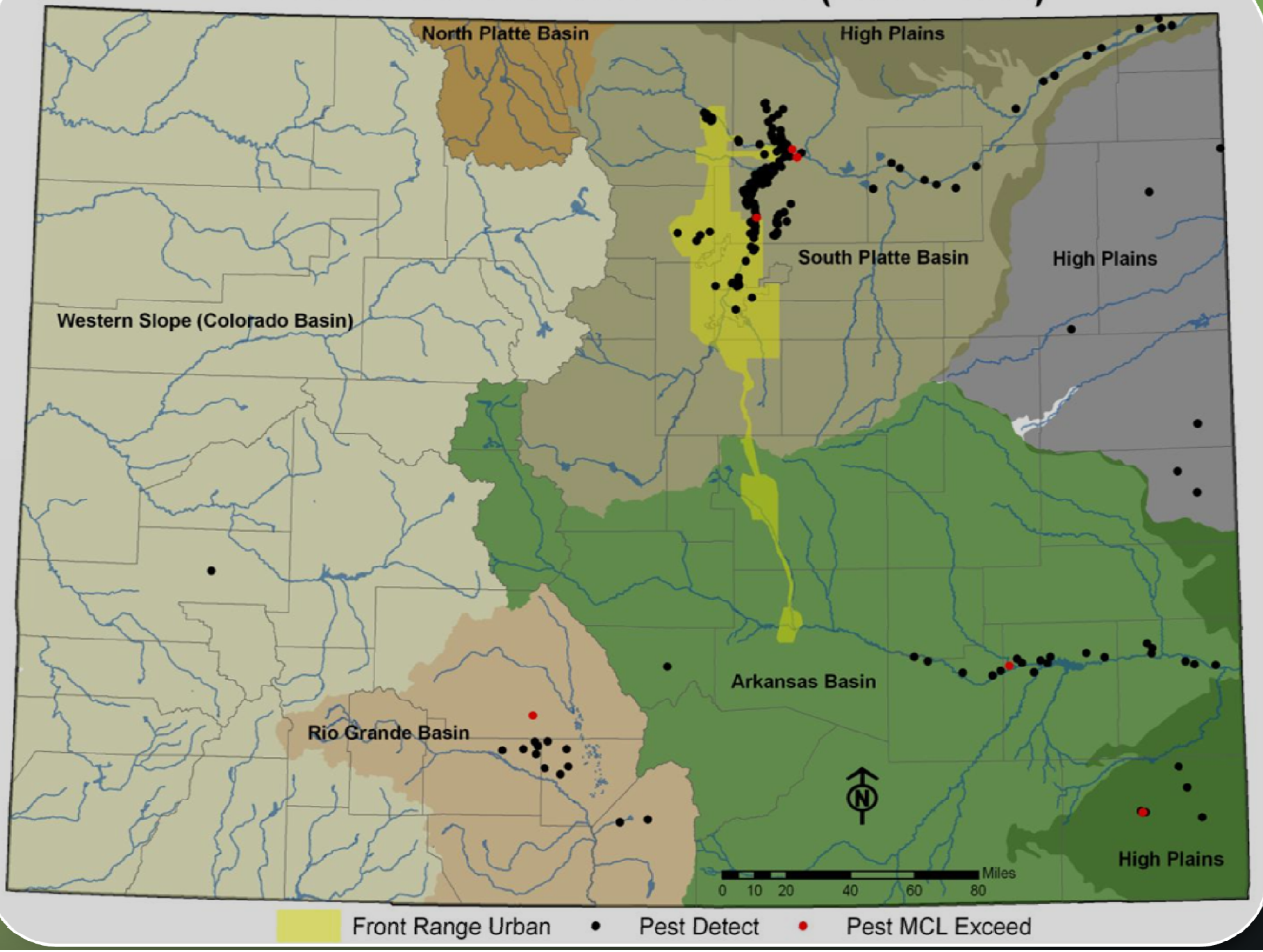
Groundwater Sample Locations (1992-2008)



Statewide Nitrate Results (1992-2008)



Statewide Pesticide Results (1992-2008)

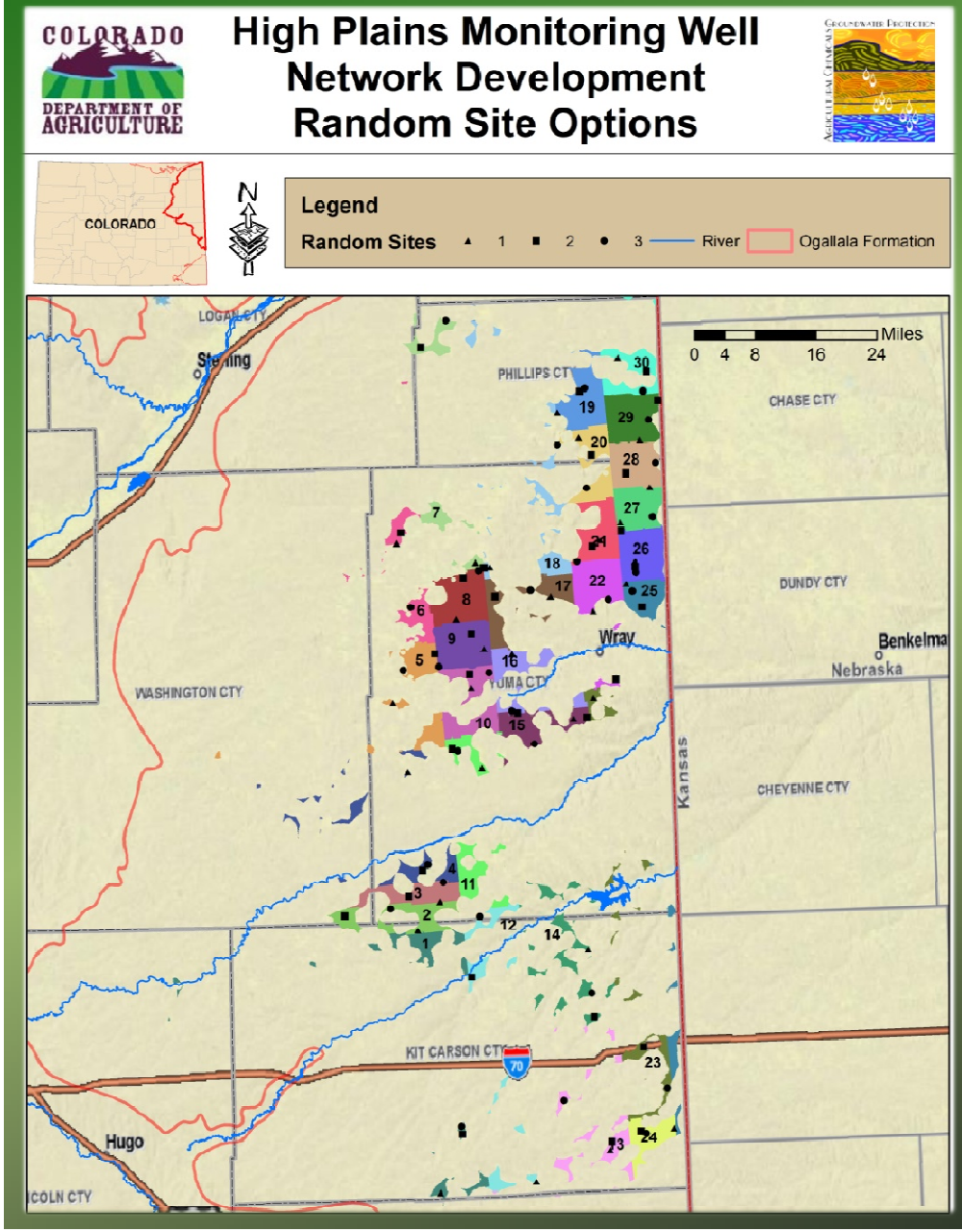


High Plains Monitoring Well Network

High Plains Monitoring Well Network

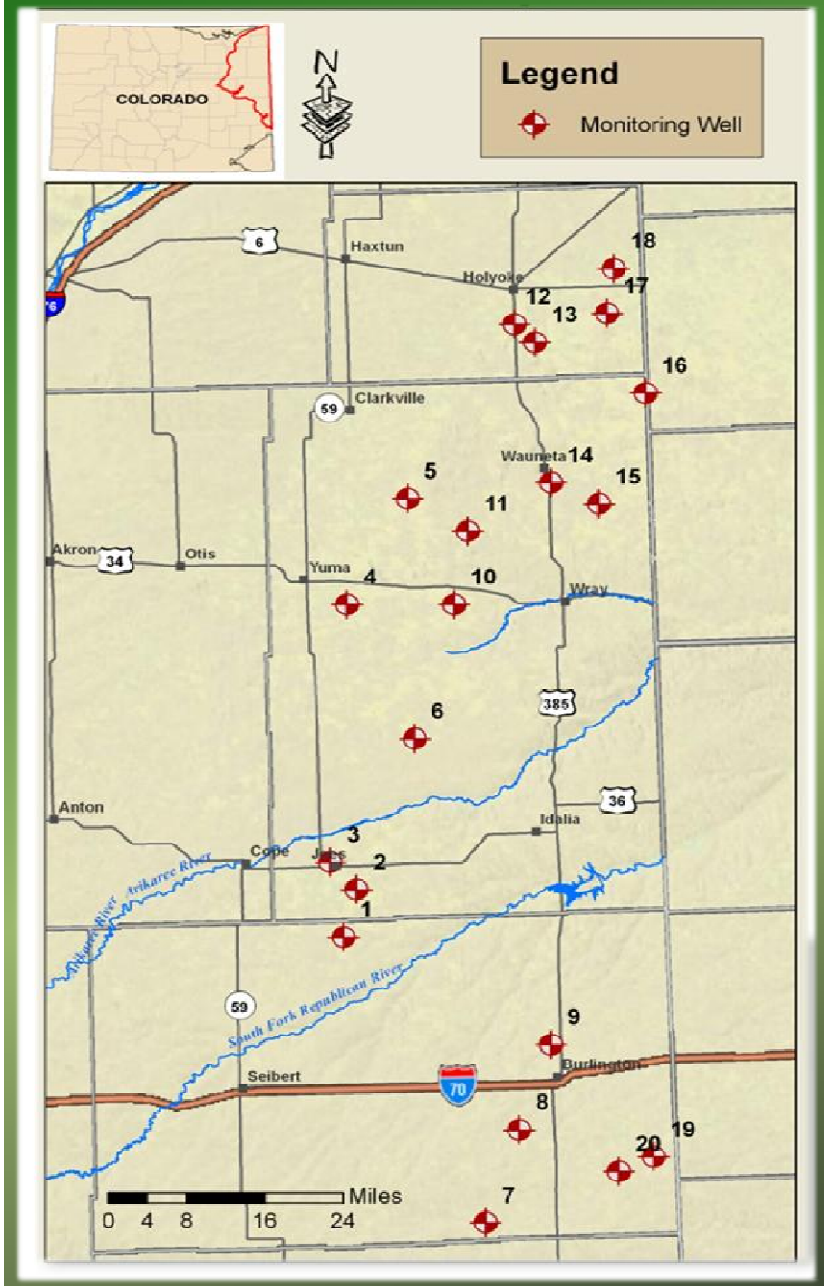
- Last sampled in 1997 using domestic, irrigation, and municipal/industrial wells
- Contracted USGS for assistance in network delineation
  - This resulted in accurate interpretation of the Ogallala Formation and installation of a representative sampling network

High Plains Monitoring Well Network



- Suitable area divided into 30 equal area polygons
- Random sites generated
- Landowners near sites contacted
- Permission granted for 20 locations to be installed

High Plains Monitoring Well Network

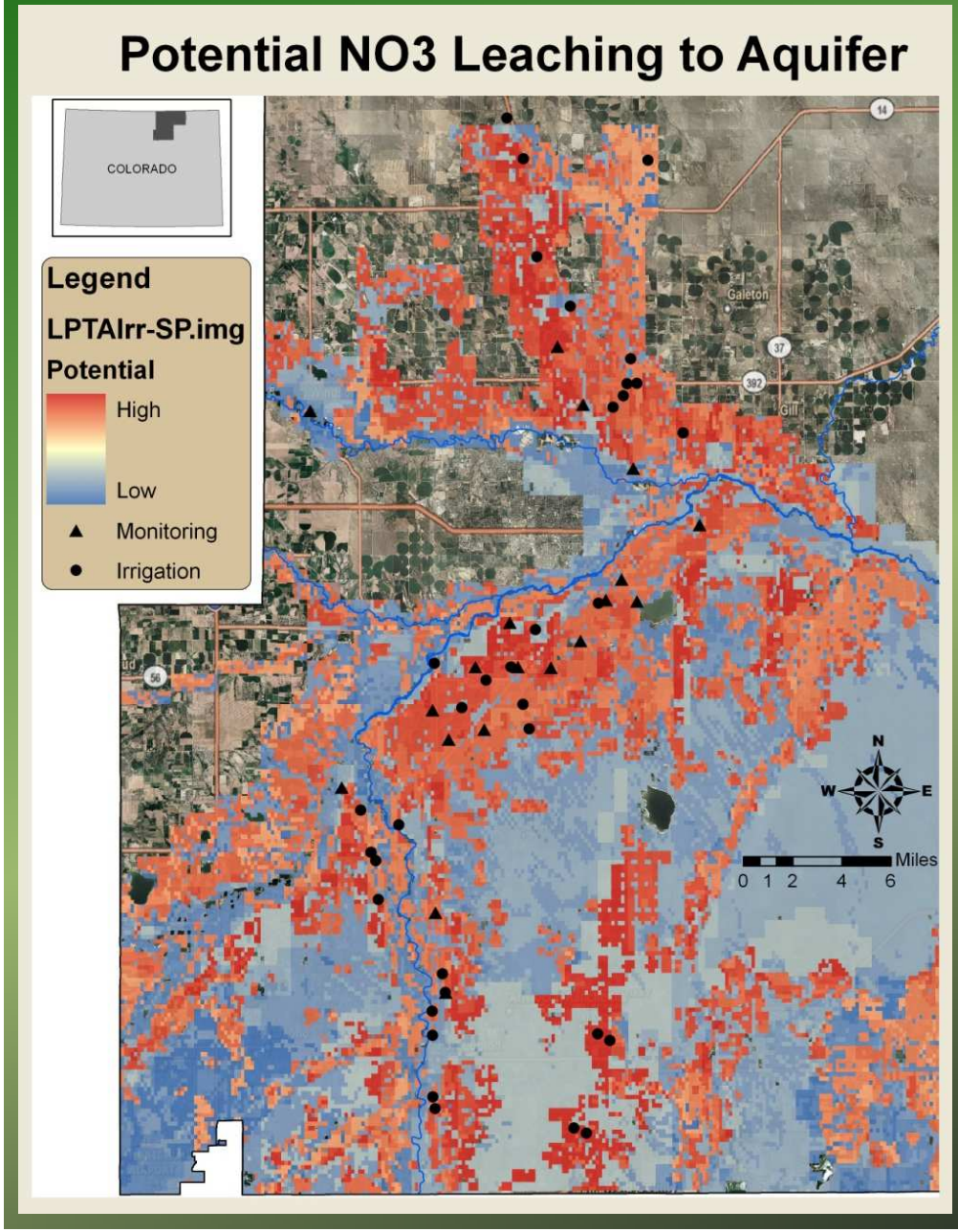


- 2008 Nitrate Results (mg/L)
  - Median = 5.83
  - Average = 7.92
  - STD = 8.18
  - Q 25% = 2.57
  - Q 75% = 10.31
  - Min = 0.32
  - Max = 32.91

- Wells will be sampled in 2011 for in depth pesticide analysis

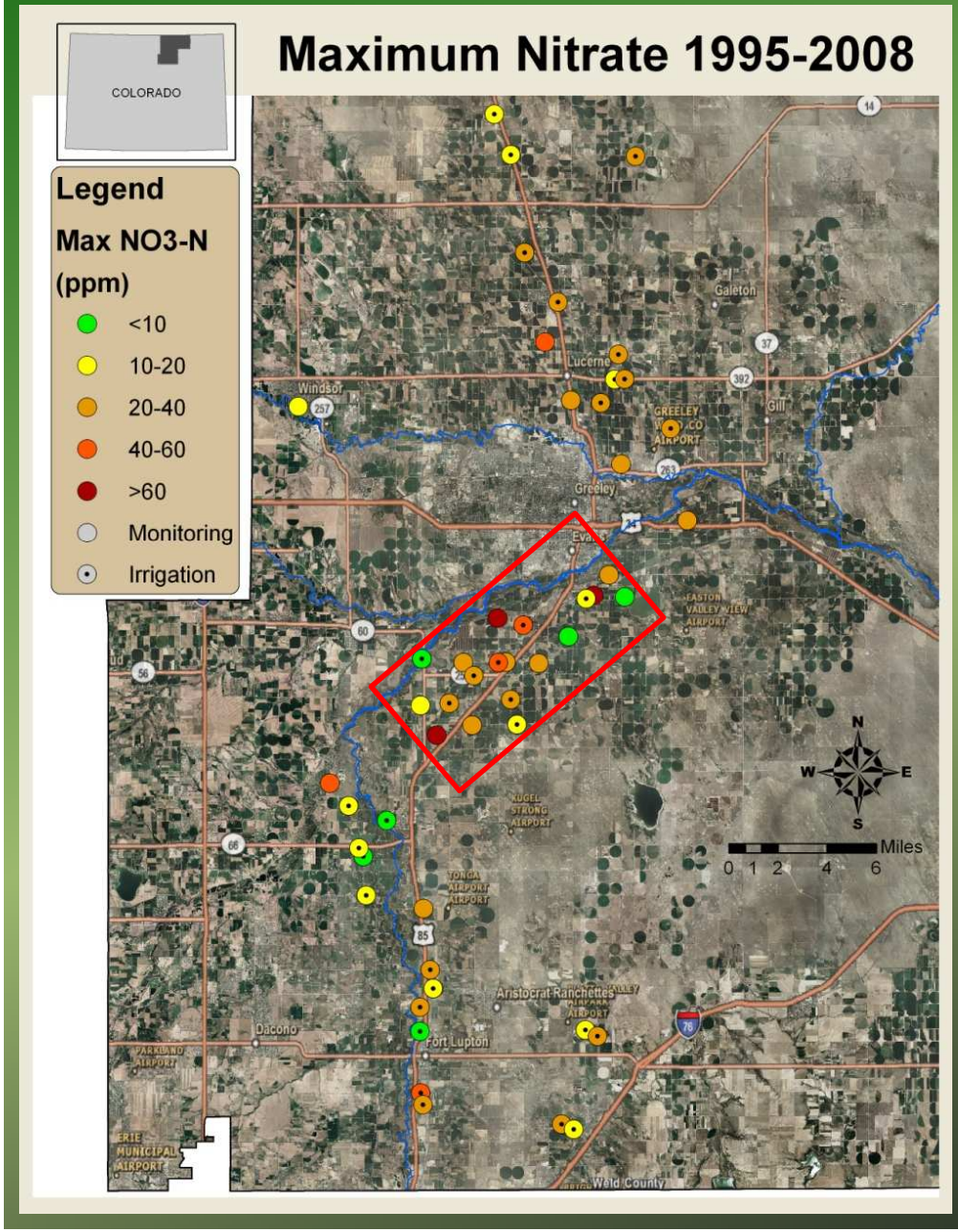
Weld County Long-Term Trend Analysis

Weld County Long-Term Trend Analysis



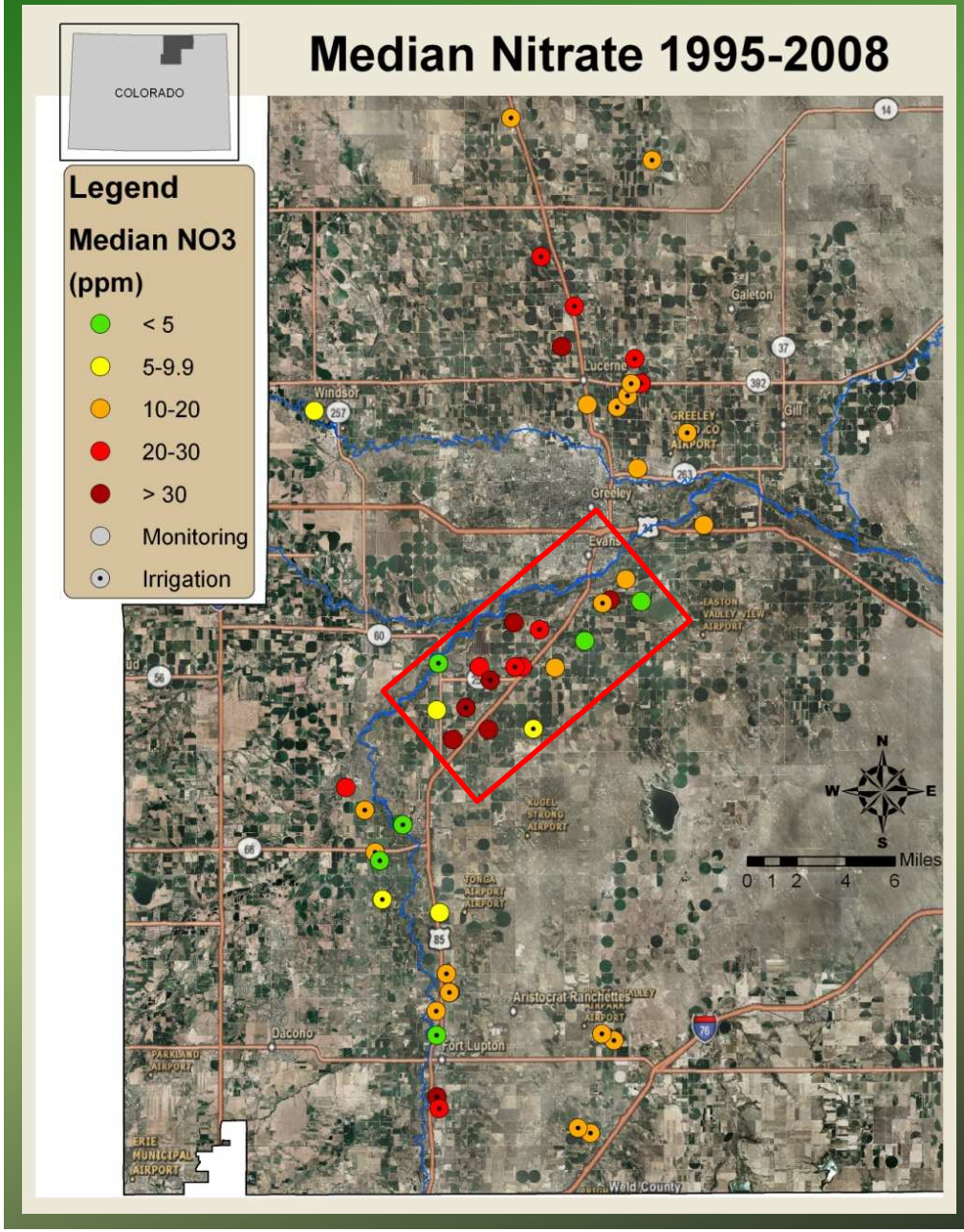
- Leaching potential map
- Networks established:
  - 19 monitoring wells
  - 35 irrigation wells
- Sampled annually from 1995-2008
- Non-parametric statistical analysis

Weld County Long-Term Trend Analysis



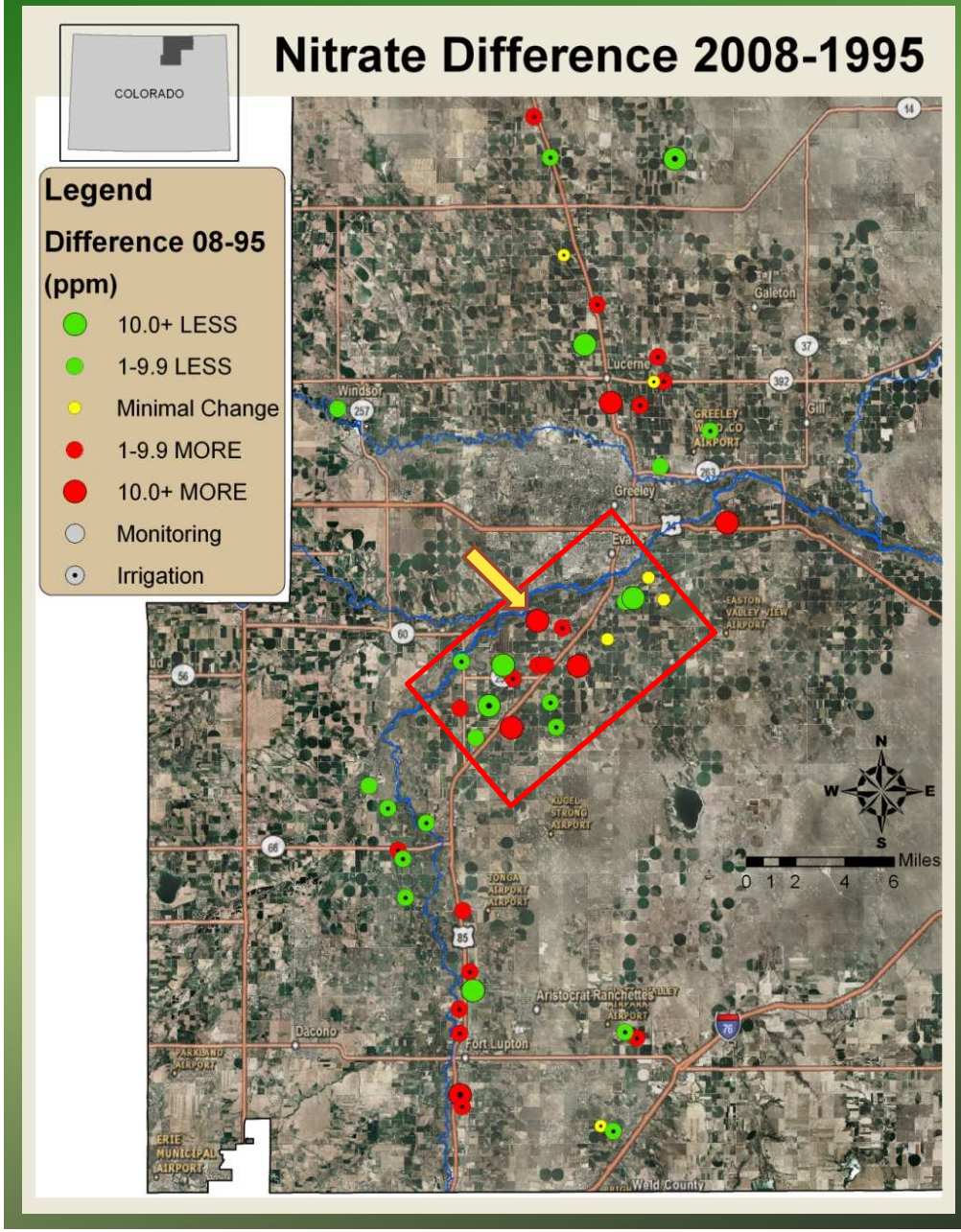
- Maximum detected concentrations for individual wells have ranged from 5.2 to 111.32 mg/L
- Key Area (red box); Gilcrest to Greeley, highest concentrations

Weld County Long-Term Trend Analysis



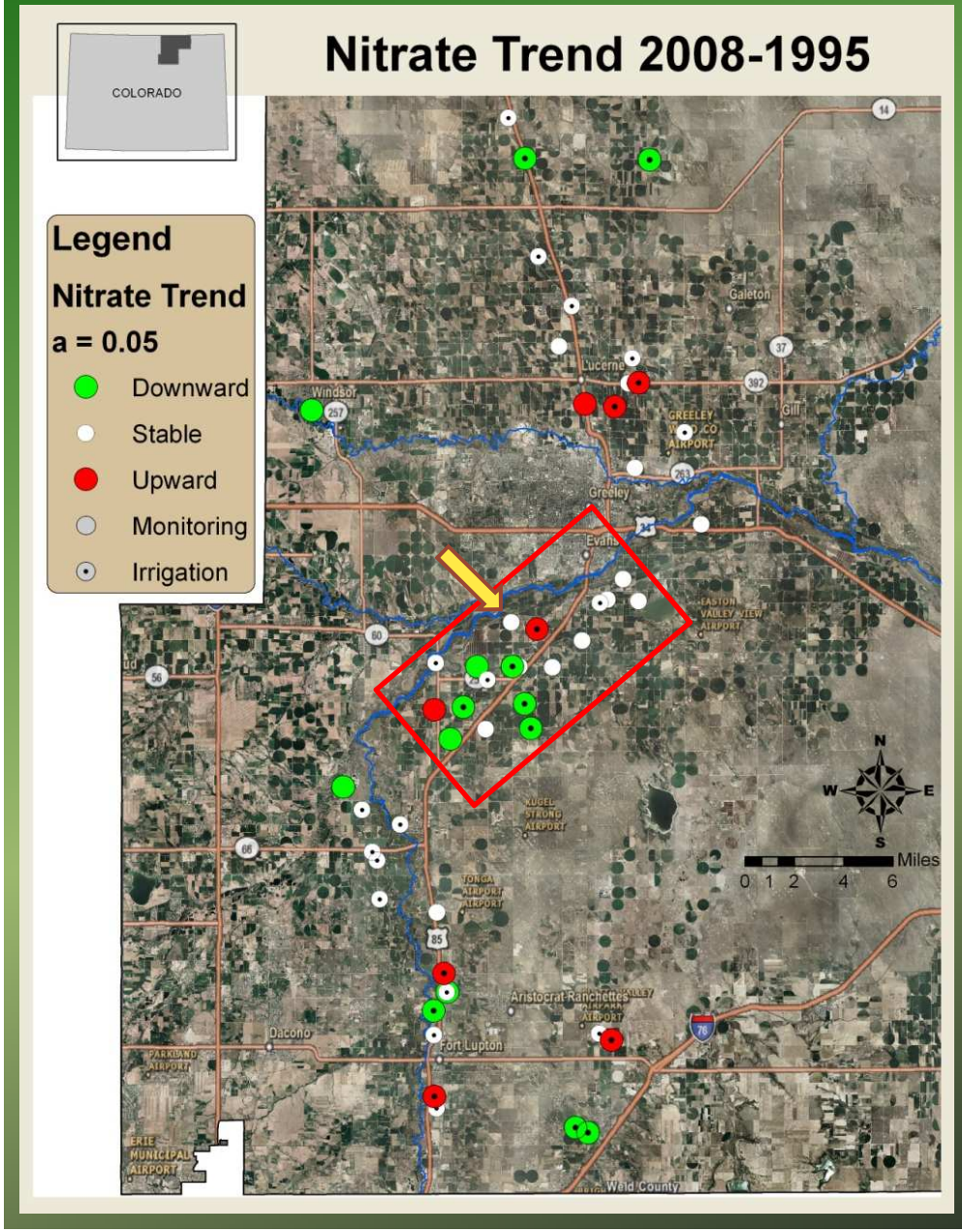
- Long-term median concentrations well over EPA Drinking Water Standard of 10.0 mg/L
- Extensive nitrate contamination throughout the study area

Weld County Long-Term Trend Analysis



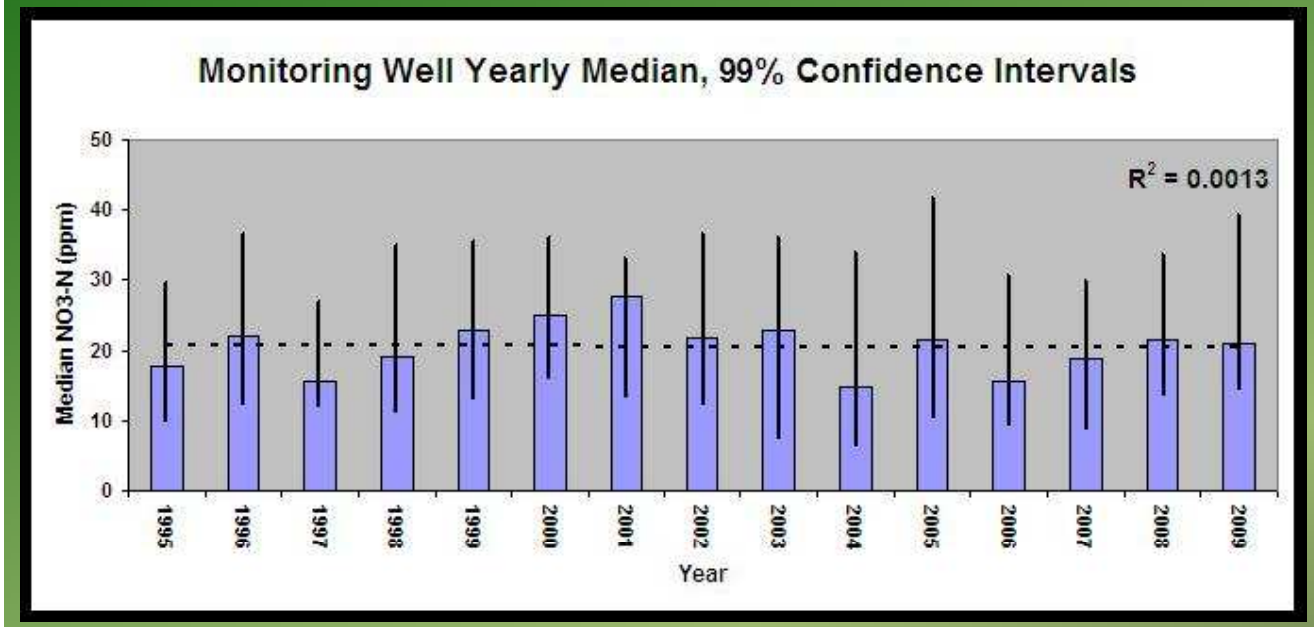
- Greater changes in monitoring network than irrigation network
- MW-007 (yellow arrow)
  - < 50 mg/L in 1997 and 2000
  - > 100 mg/L in 2003 and 2004
- No difference in median of either network

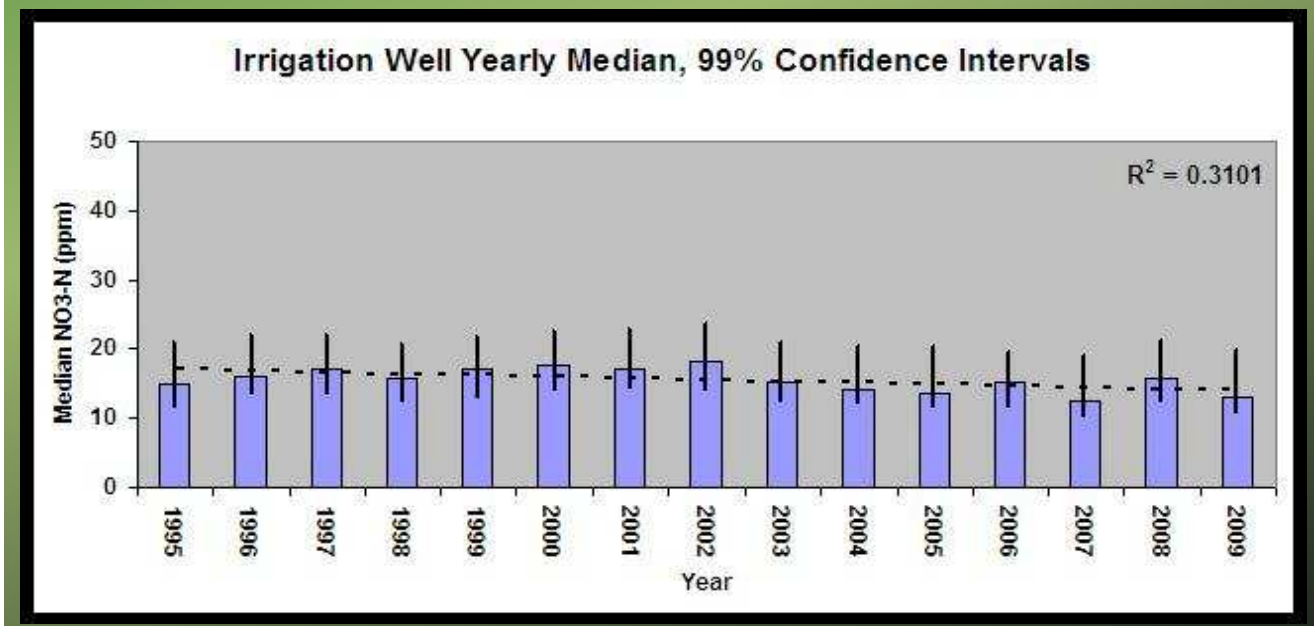
Weld County Long-Term Trend Analysis



- 9 downward trending irrigation wells *vs* 5 monitoring wells
- Red Box Area
  - Several downward trending wells
- North of Greeley
  - Cluster of upward trending wells

Weld County Long-Term Trend Analysis





- MW network still no obvious trend
- IW network shows downward trend
  - MK p-val < 0.05

Summary

- Agricultural Chemicals & Groundwater Protection Program is screening Colorado's groundwater for agricultural chemicals
- Long-Term monitoring networks are continuing to be planned and installed
  - High Plains/Ogallala Formation
- Long-term contamination trend analysis

Summary

- Nitrate data trend analysis in Weld County from 1995-2008 shows:
  - No significant trends in whole network analysis
  - Upward/Downward trends in individual wells
    - More downward trends in IWs than MWs
  - Limited spatial pattern to trend responses
- Addition of 2009 results in significant downward trend in the IW network

Integrating Trend Analysis with Research and Program Goals

- Incorporate other research data
  - Long-term crop management
    - Agrochemical use
    - Irrigation Management – Water Balance
  - General land-use change
    - Impact of Ag Converting to Urban
  - Age-dating of monitoring well samples
    - Increase understanding of past agricultural practices and/or BMP implementation

THANKS!

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