WebH$_2$O: A Web-Based Environmental Information Management and Data Analysis System

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Outline

- Background and motivation: The Central Valley Salinity Study
- What is WebH$_2$O and how does it work?
- WebH$_2$O as a community-based application tool – Sonoma Valley
- Our vision for WebH$_2$O

Salinity

- Globally, 7% of the land area is salinity-impacted (soil or groundwater)
- Regions: Eastern Europe, Mediterranean, Australia, Arizona...
- Sources: natural, municipal, industrial, agricultural

Salinity in Central Valley

older estimate:

Figure 1. Salt accumulation in the San Joaquin Valley totals about 11 semi-trailers an hour at 25 tons per truck. From Salt balance in the San Joaquin Valley, 2001. *Water Facts*, Department of Water Resources.

Regional Water Quality Control Board, 2006: Salinity in Central Valley-An Overview.

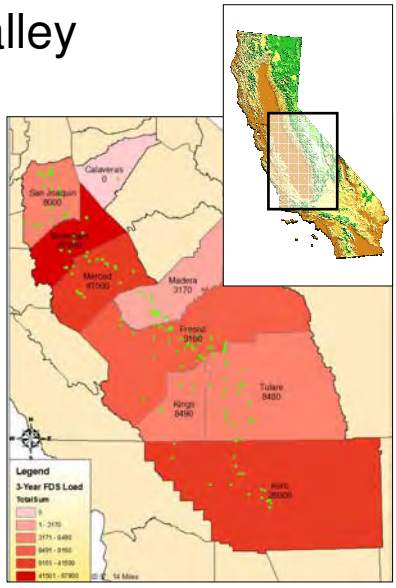
Input
Tulare Lake & San Joaquin River Basins
>2 million tn/yr = 228 tn/h = 9 trucks
+ Sacramento River Basin 0.8 million tn/yr?

Output
Sacramento & San Joaquin Delta
700,000 tn/yr = 3 trucks

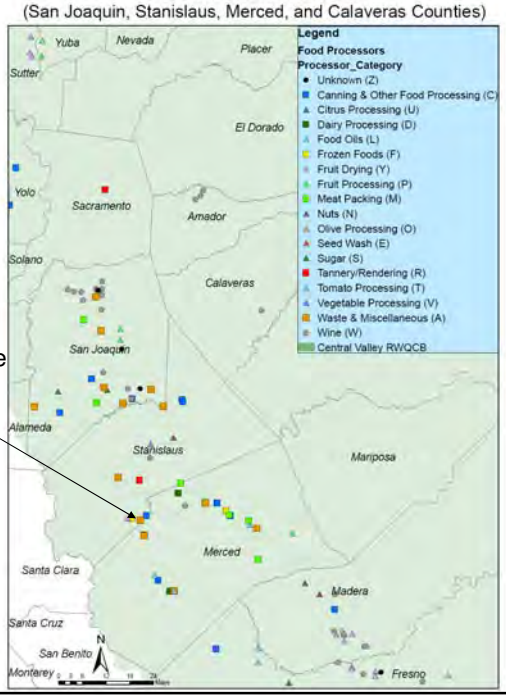
Groundwater
San Joaquin Basin
400,000 tn/yr

Food Processing Wastewater in the Central Valley

- Over 600 facilities
- >$62 billion in revenue
- Water use: 80 million m^3 yr^{-1}
- High in salinity (FDS), organic carbon, and nitrogen
- Typical disposal method: land application for irrigation
- Discharged to alluvial fan and floodplain deposits



Food Processors in Area A
(San Joaquin, Stanislaus, Merced, and Calaveras Counties)

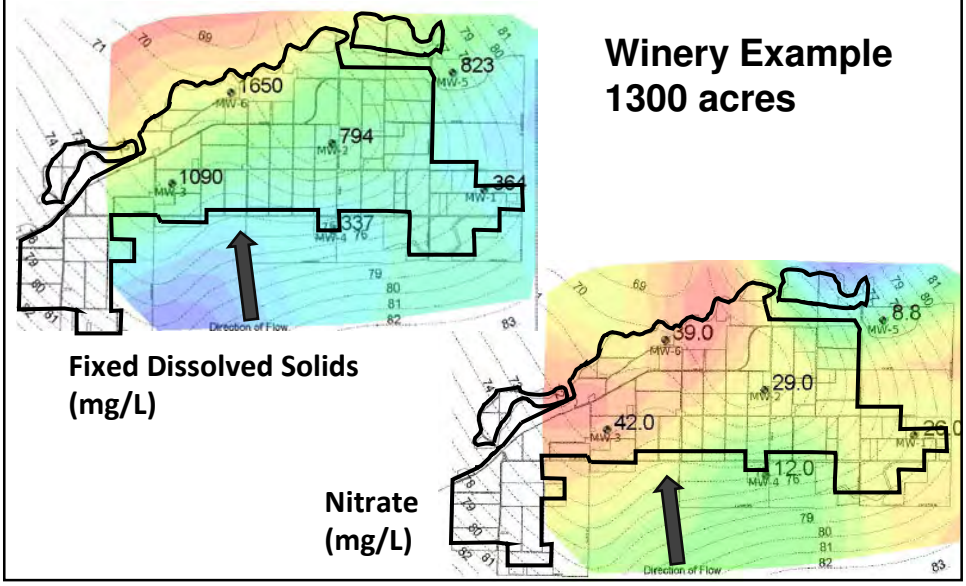


Hilmar Cheese

An Environmental Threat?

Metric	Municipal Waste	Tomato Canner
BOD (mg-O_2 L^{-1})	450	820
FDS(mg L^{-1})	720	1680
pH	6.7	5.4
Nitrogen (mg-N L^{-1})	25	51
Flow Rate (gal d^{-1})	2.6 x 10^7	1.5 x 10^6
Pathogens present?	Virtually certain	Very unlikely
Sources: food, disinfectants, processing chemicals		

Groundwater Degradation?



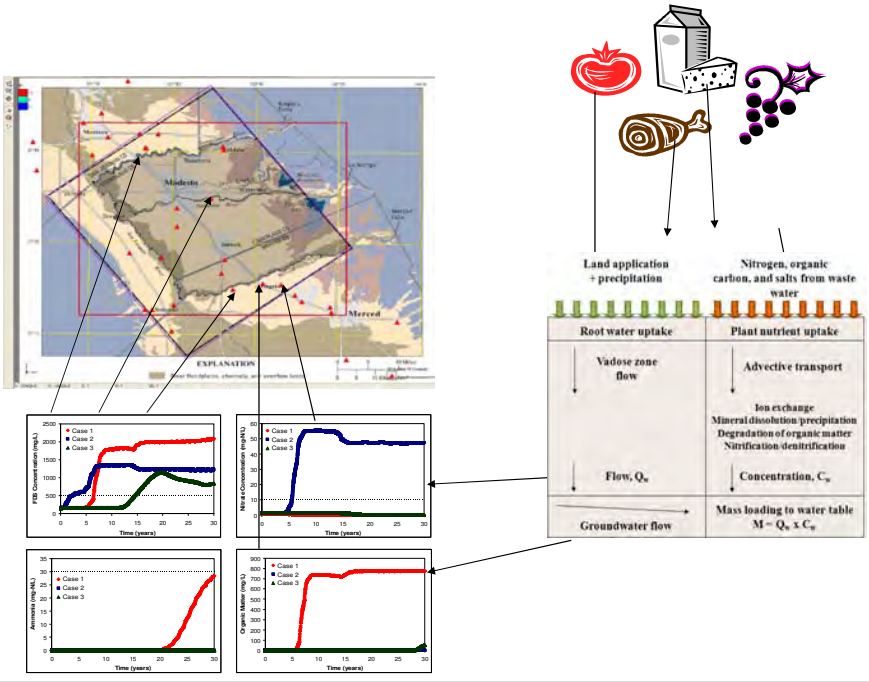
Winery Example
1300 acres

Fixed Dissolved Solids (mg/L)

Nitrate (mg/L)

	Volume (kgal)
Industry Average Daily Flow	68665
Industry Yearly Flow	25062854
Hilmar Daily Flow	1525
Hilmar Yearly Flow	556714

Land discharge area: 600 acres



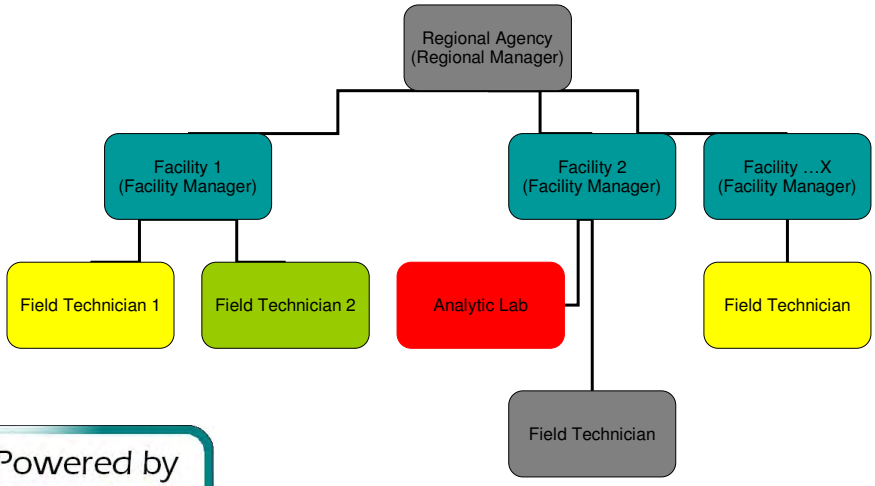
Modeling Challenges

- Modeling scale
  - 600+ producers with a large diversity in wastewater characteristics and in land application site hydrogeology
- Data Deficiency
  - Few measurements in vadose zone, none long-term
  - Regional scale hydrogeology

How to address these challenges?

- A system is needed for collecting, storing, sharing, displaying and analyzing of information
- Data sources
  - Multiple agencies and multiple facilities
    - Ontology
    - Format
  - Quality of data
- Community-based tool: Trust, Value
  - Data security and privacy: who can see what and when?
  - Encourage participation through added value

User Diagram



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Privacy and Security

Complete Control over Data Management and Accessibility

- Two complimentary aspects:
  - Labeling of data (when?)
    - Unreported / Reported / Authorized
  - Hierarchy of user roles / permissions (who?)
    - coordinator / facility manager / technician

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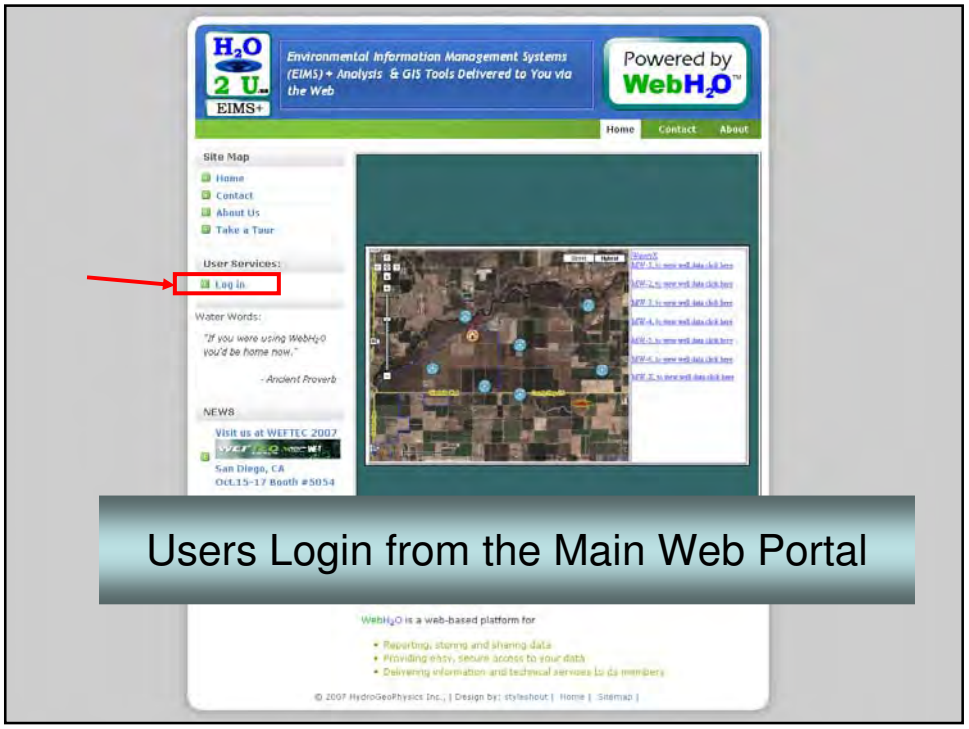
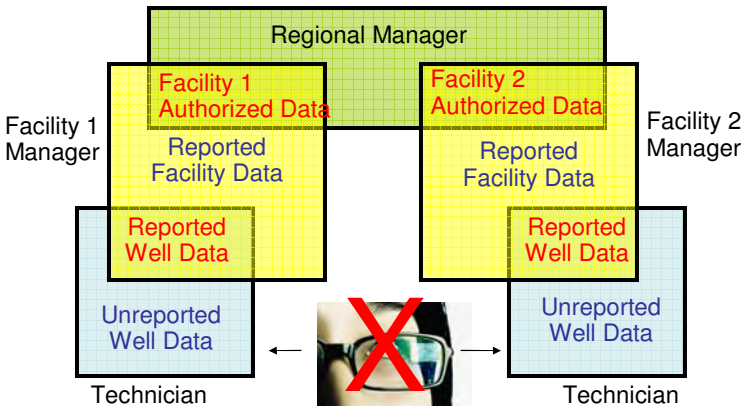


Different Levels of User Access

Regional Manager can NOT see Facility data unless it is "Reported"



Facilities can NOT see each other's data

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Management Tools

- Access Data from Overview Maps
- Quick-View Status Dashboards
- Rapid Report Pull-down Menu for common Reporting tasks
- Automated Alerts can sent by email/text message when preset trigger events are reported
- Powerful Querying Tools

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Access Data from Overview Maps

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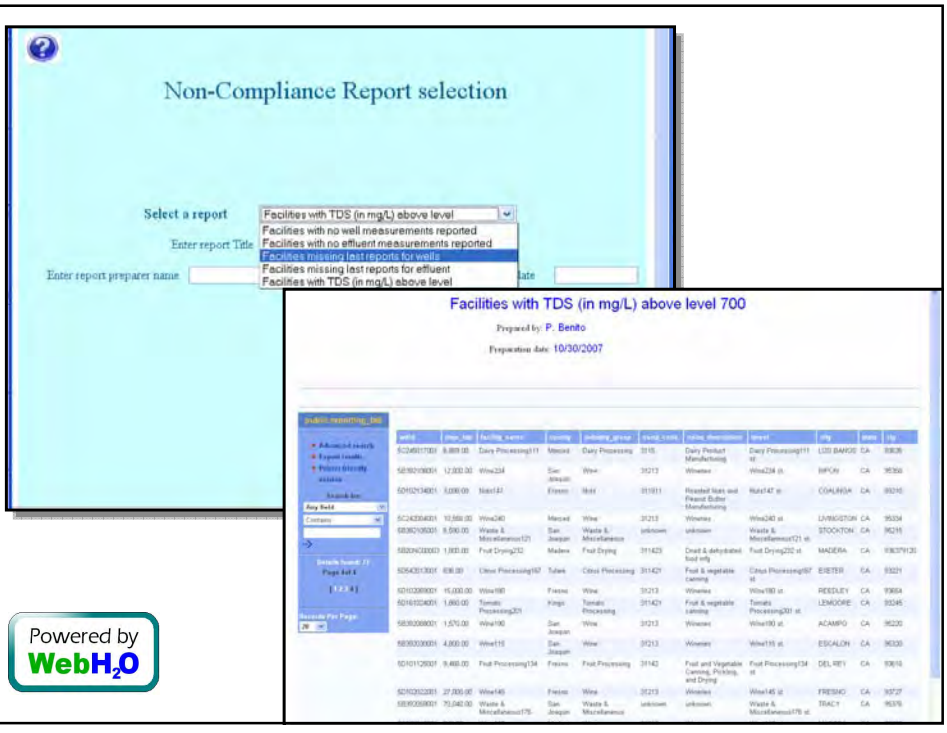
Quick-View Dashboards show Status of all monitored locations



Advanced Queries can be made on the data

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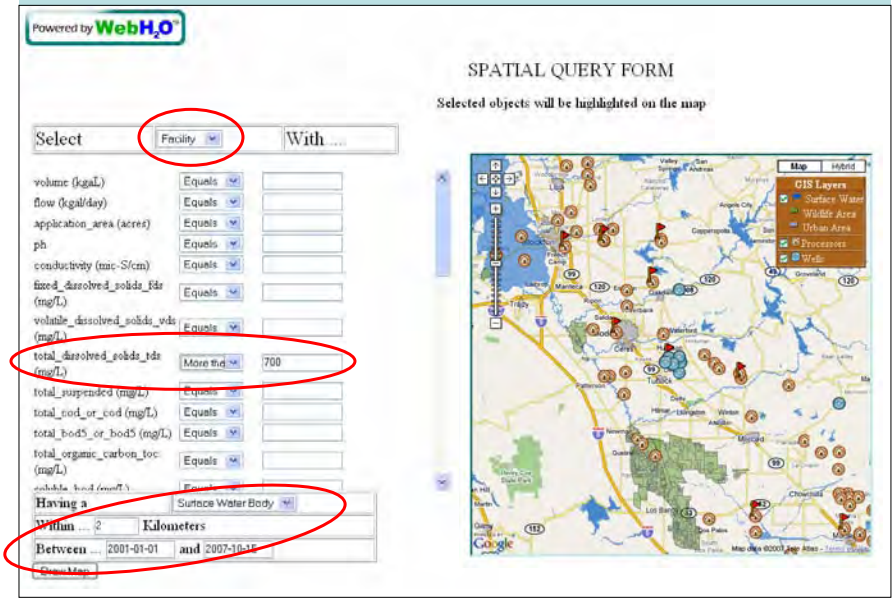
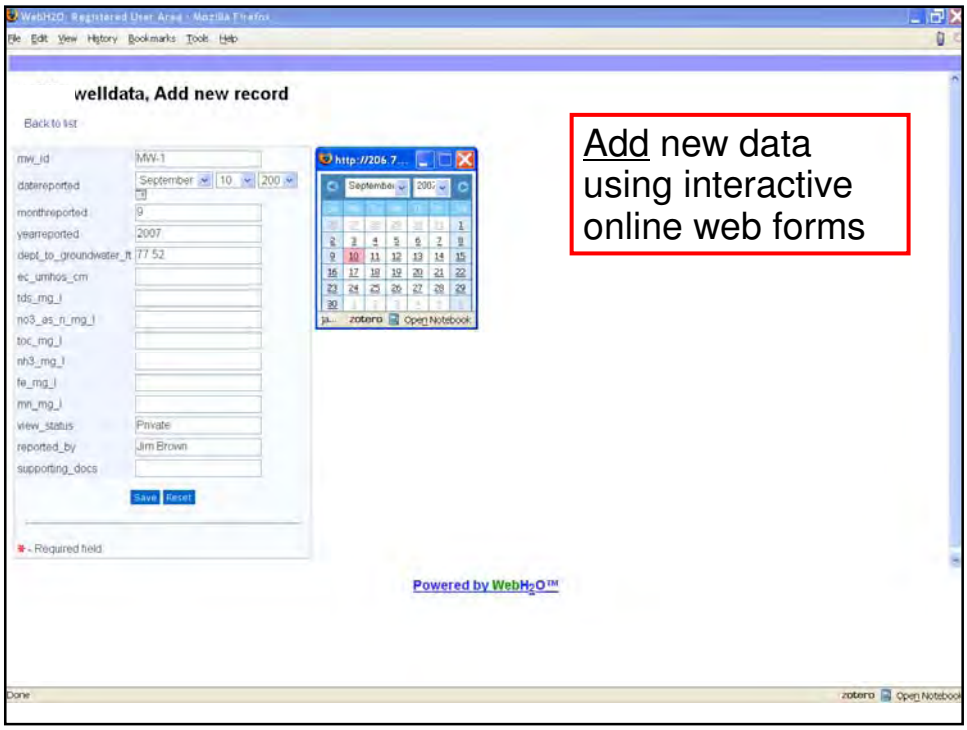
GIS Map Server

- **WebH$_2$O™ is compatible with existing GIS files and data (shape files, DEM, ortho-photos, etc…).**
- **GIS Layers can be added and accessed from internet browser.**

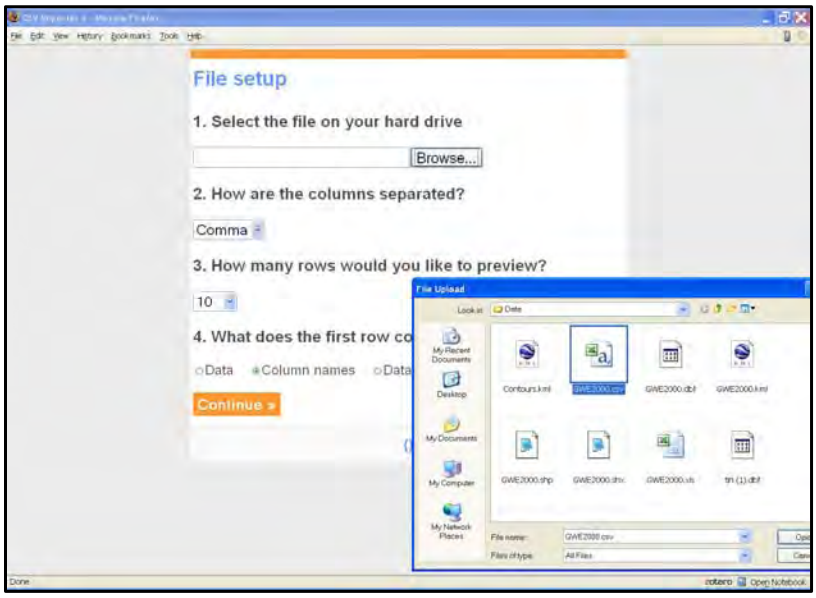
Spatial Query Tools:
Links Database + GIS Info





Add new data using interactive online web forms

…or upload data from a file



Data Validation

Completeness, Consistency, Integrity

- Completeness
  - Required fields for data entry
  - Pre-populated fields
  - Error detection for well names - state plane and USGS well coordinate systems
- QA through Consistency
  - Alerts generated when new data inconsistent with historical records
- Integrity
  - Data capture and storage
  - Unique facility id's, well names, user logins

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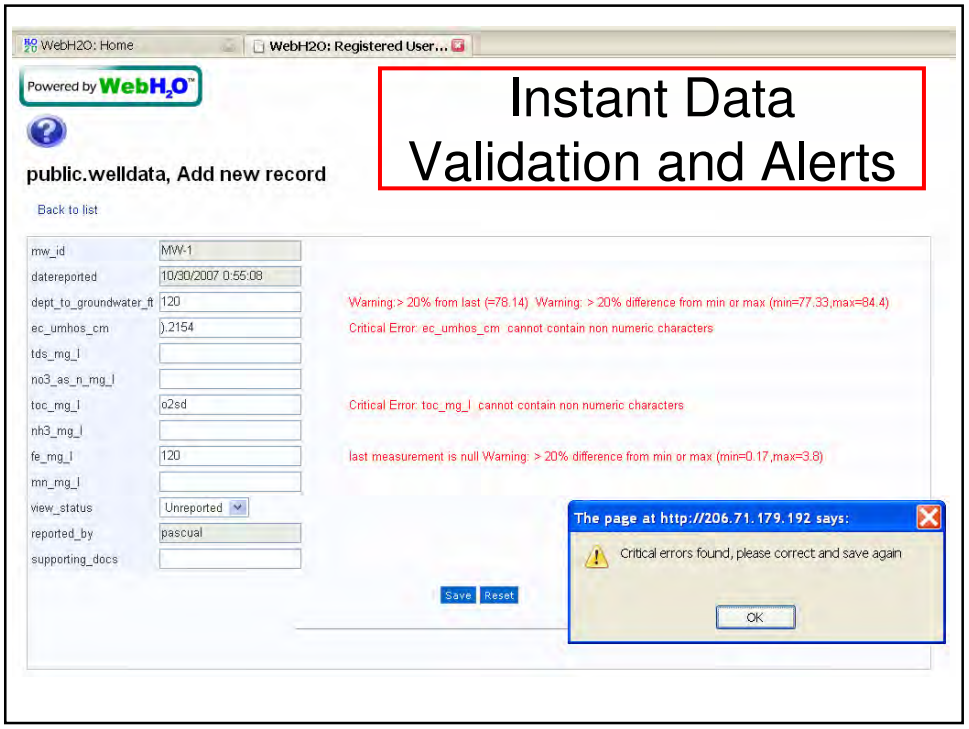

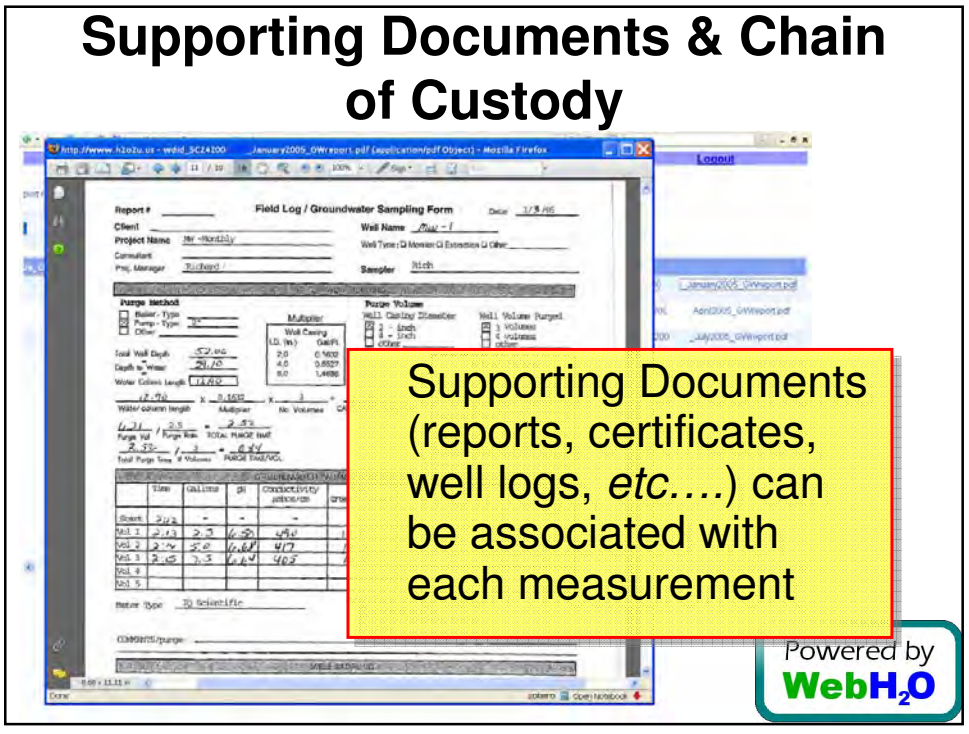

Science Modules

•Can be mounted directly on top of map interface to collected data and GIS Layers

•Can be used for real-time data analysis such as risk assessment, contouring, vector plots, fate & transport models, etc…

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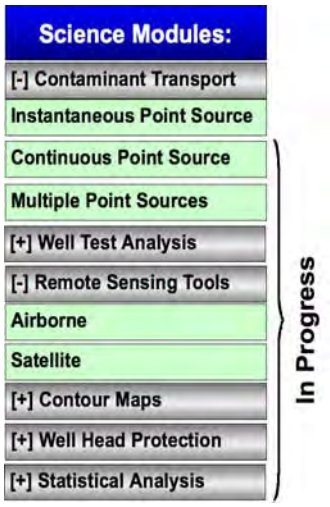
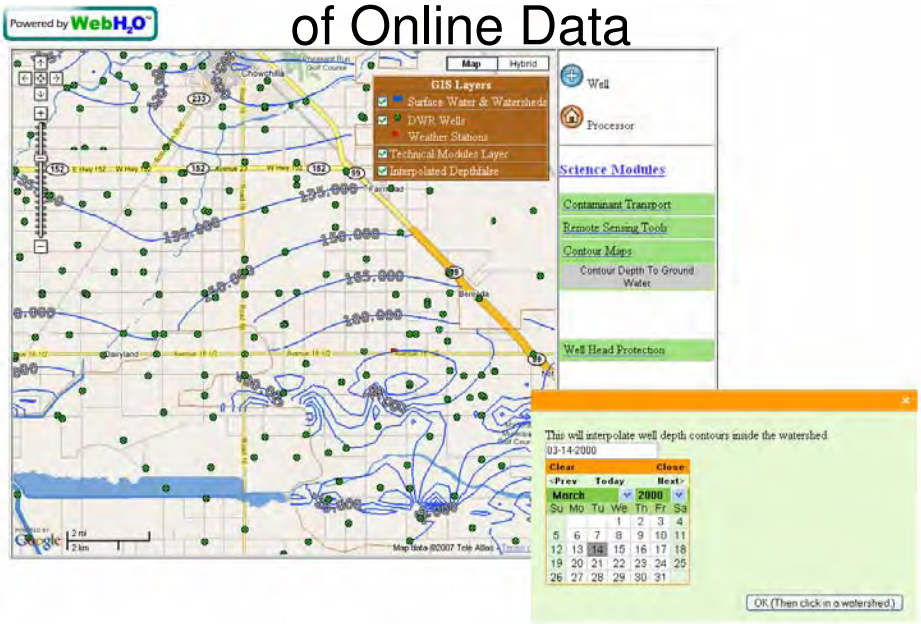
WebH$_2$O™ Science Modules

- WebH$_2$O™ combines Engineering and Science Expertise with enterprise quality IT.
- Integrated Science Modules can be applied to your data to make preliminary assessments of field conditions and risks.



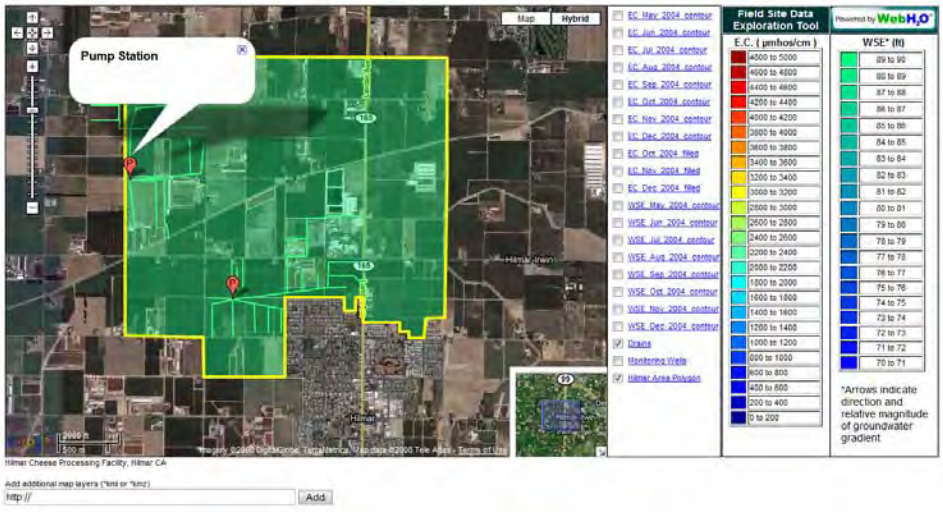
Create Contour Maps of Online Data



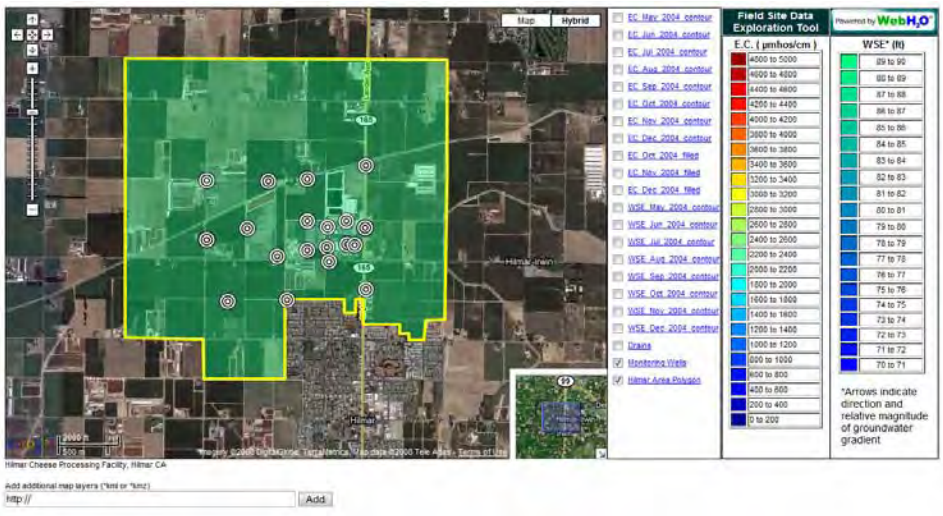
Example: Instantaneous Point Source Release

Field Site Exploration Tool

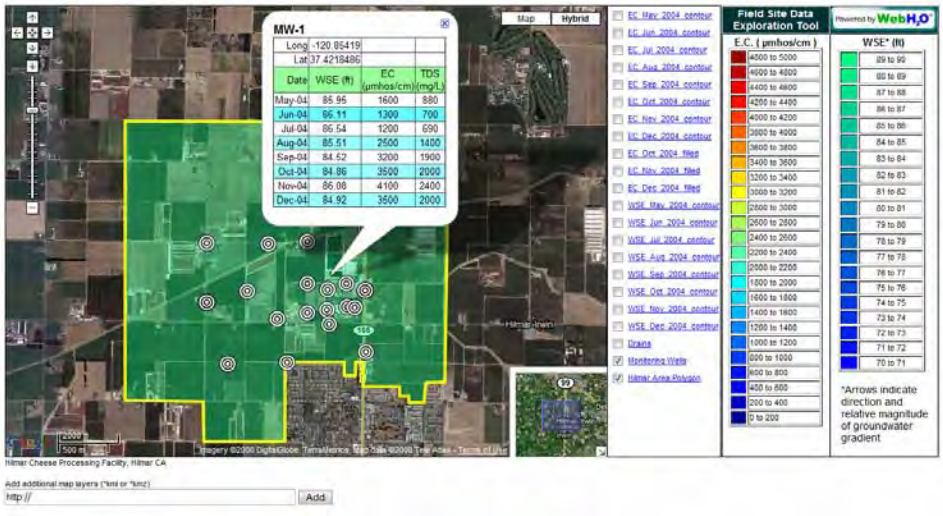
Site Infrastructure: Drains + Pumps



Monitoring Wells

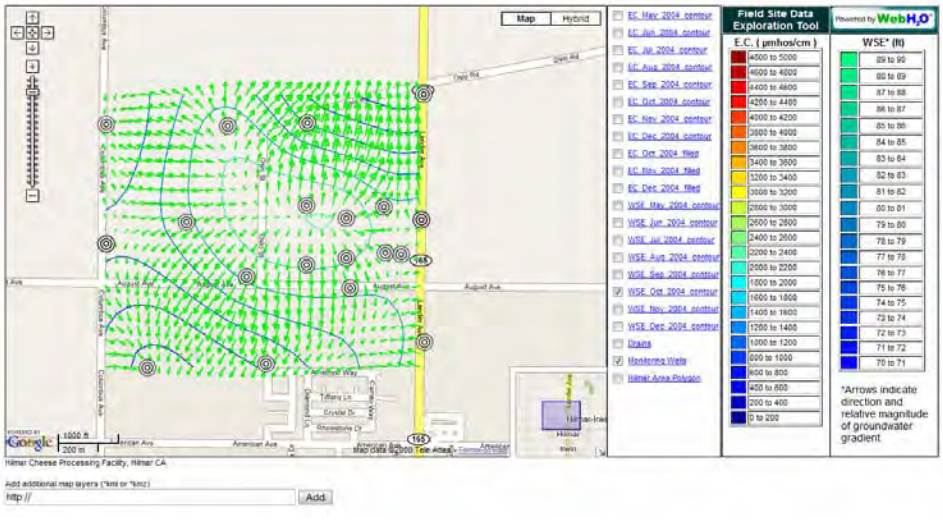


Monitoring Wells: Data View

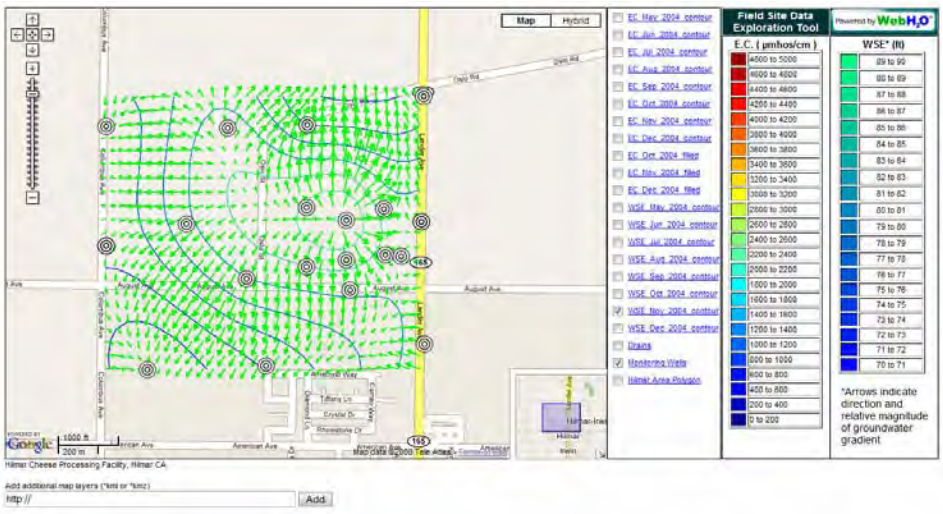


Monitoring Wells: MW-1 Chart View

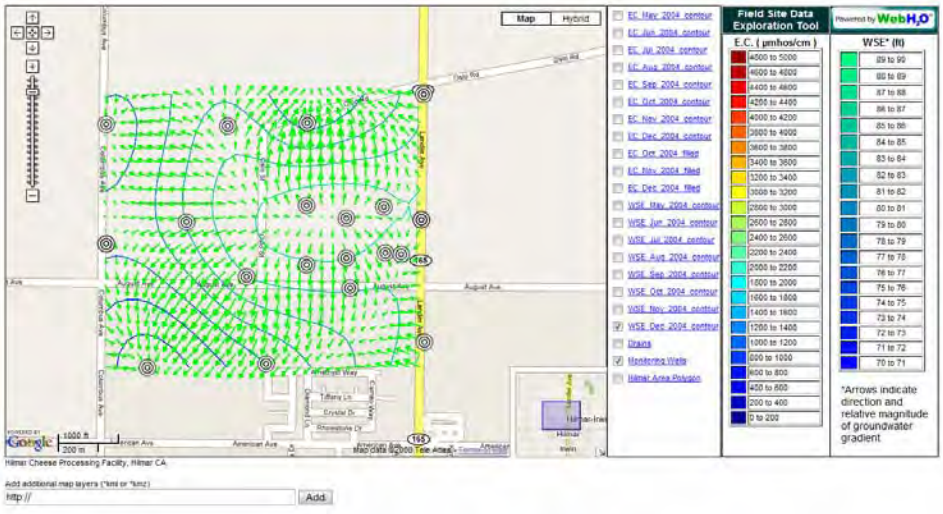
WSE: Oct 2004



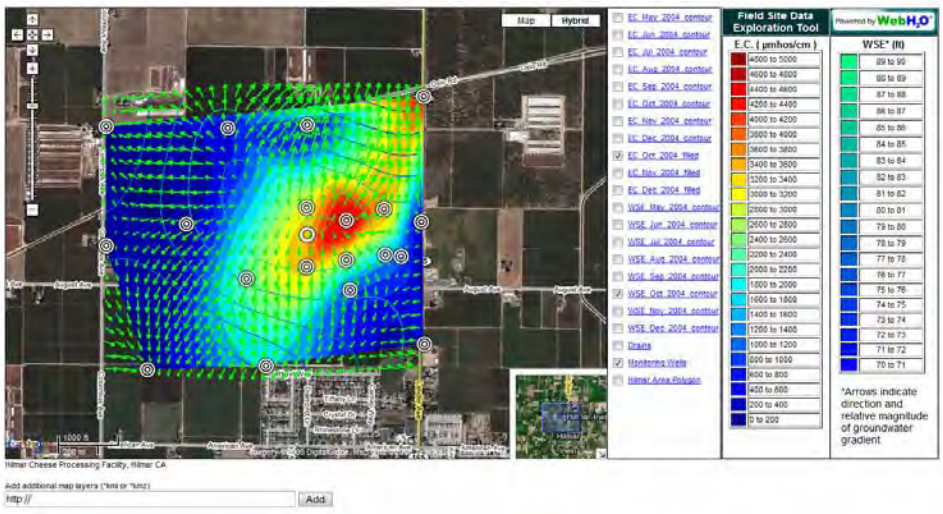
WSE: Nov 2004



WSE: Dec 2004



EC + WSE: Oct 2004



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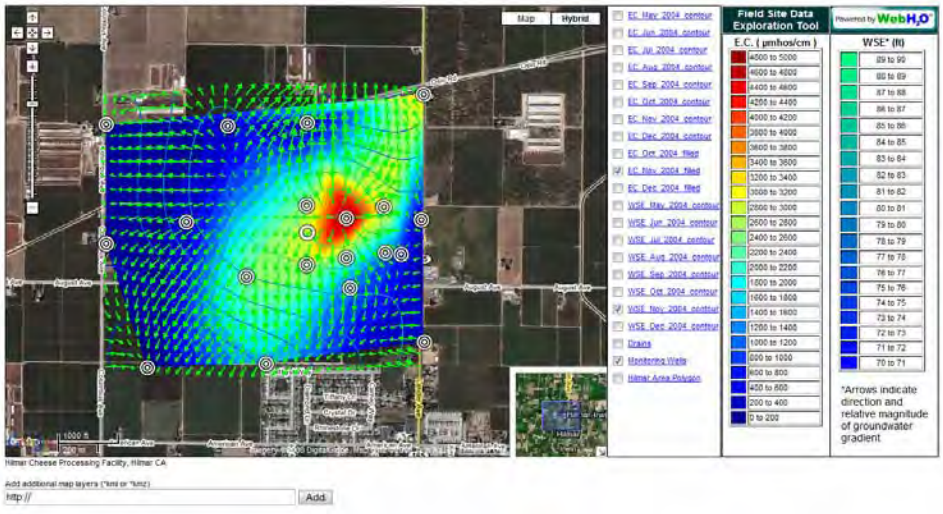

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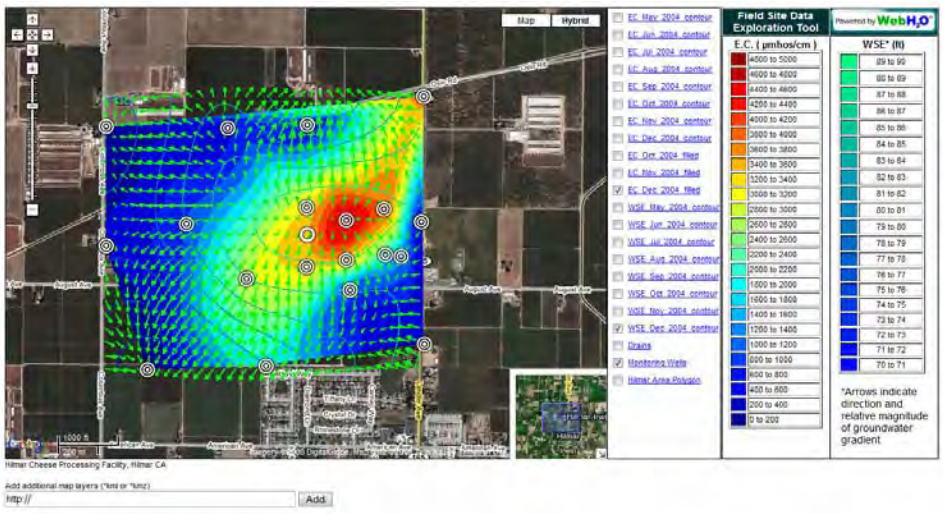

Sonoma Hydrological Information Portal

SHIP 1.0 Beta 1 Release

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SONOMA COUNTY WATER AGENCY

SHIP Goals

- SCWA-led multi-stakeholders groups collaborating on developing the Sonoma Valley' groundwater basin plan
- Data needs include groundwater elevations, groundwater quality, well construction data and well logs
- Goals:
  - Management of groundwater resources
  - Development of groundwater numerical model
- Provide added value to stakeholders as an incentive to participate

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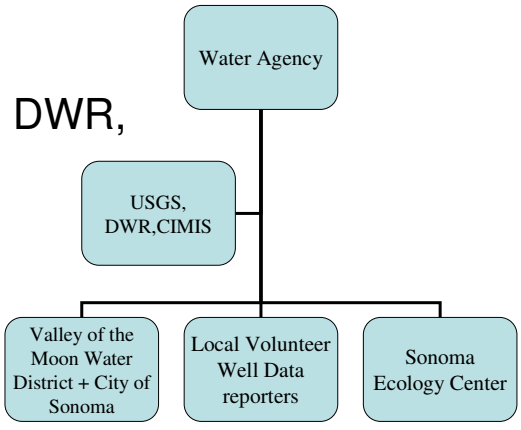
Sources of Data

- Local
- Public agencies: DWR, California Water Service, USGS



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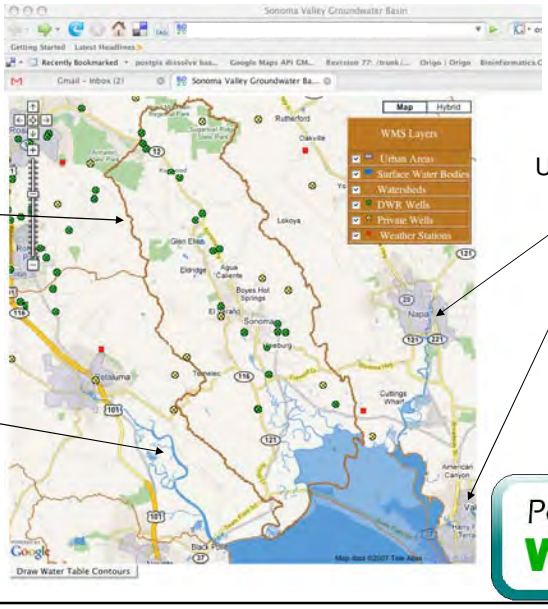
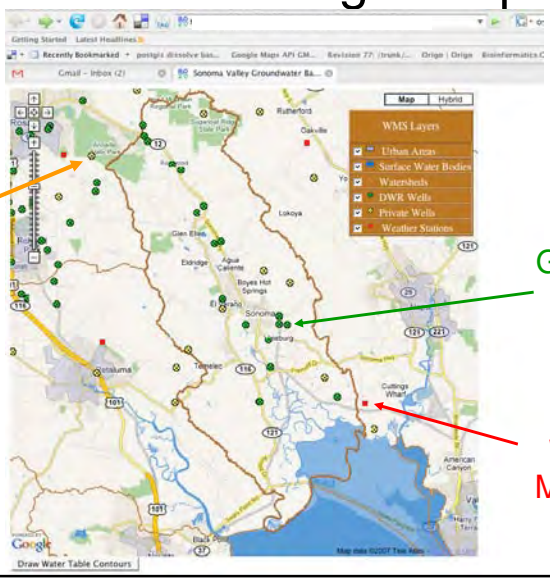
View GIS Layer Overlays



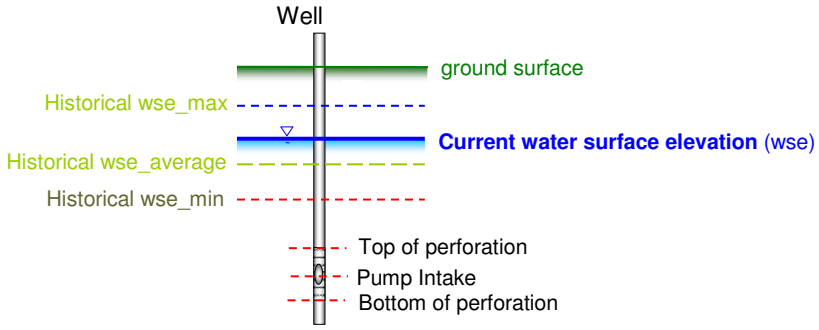
View Collected Data and Public Data on single map



Data Analysis

Statistics, Historical Trends, and Mapping Capabilities

- Automated statistics calculations
  - Well statistics for *wse* - water surface elevation



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Data Analysis

Statistics, Historical Trends, and Mapping Capabilities

- Alerts for water surface elevation
  - *wse* is less than *wse_critical_lower* + 5ft
  - *wse* is less than *wse_min* (the historical minimum)
  - *wse* is less than 0.8 * *wse_avg* (the average *wse*)
  - *wse* is less than the *perforation_elevation_bottom* +3ft
  - See SHIP user guide for additional alerts

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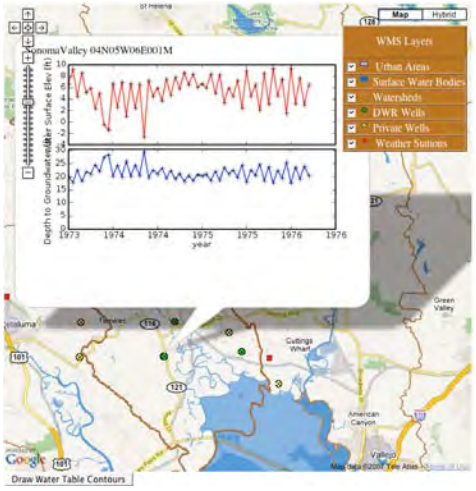
Click Wells to see Public Groundwater Data



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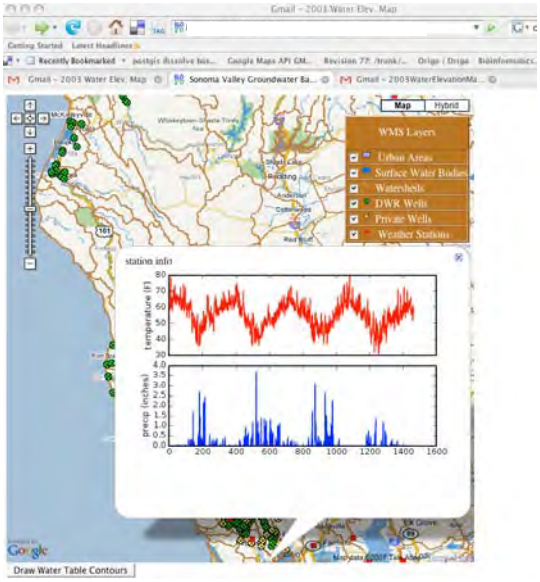
Weather Station Data



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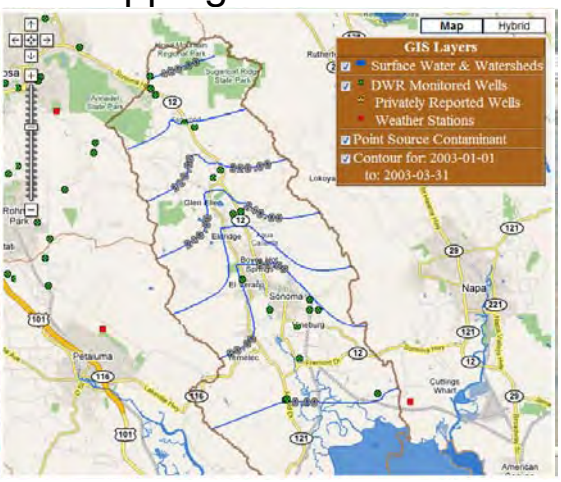
Data Analysis

Statistics, Historical Trends, and Mapping Capabilities

- Contour mapping



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Vision

- Expand integration with science modules
  - EPA's on-line tools such as Domenico Model, BIOSCREEN, BIOCHLOR
  - Water resources management: e.g., conjunctive use of water resources
    - Access to powerful/parallelized computing resources
- Integrate with environmental sensors
- Access on-line data bases for parameter determination (e.g., USDA's Rosetta)

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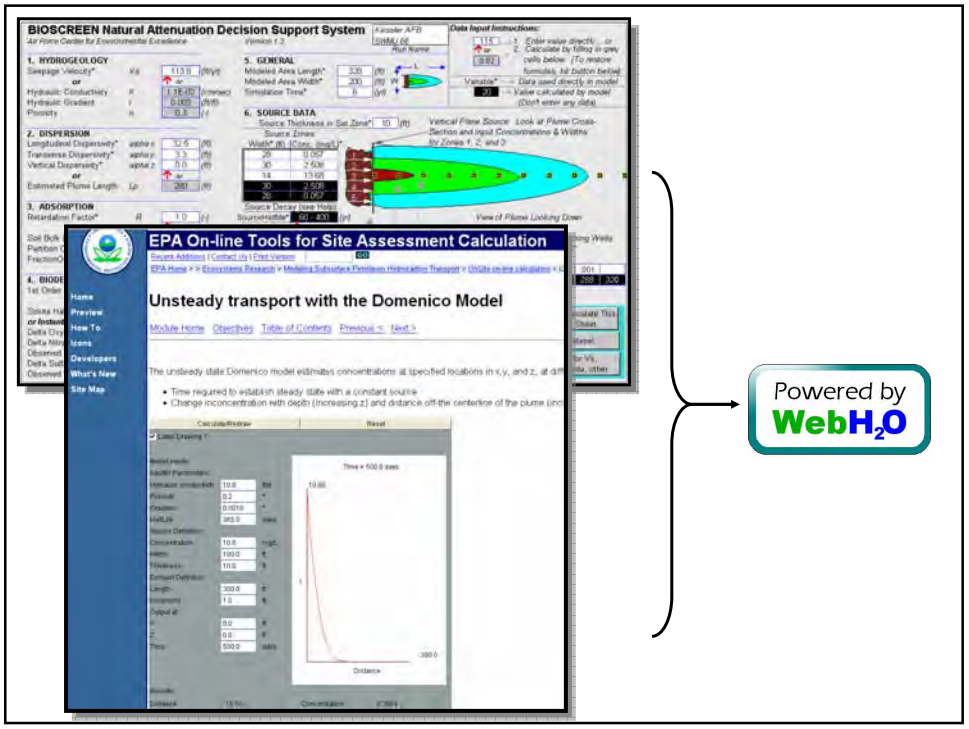

Built Using Open-Source Software Components

- PostgreSQL (database)
- PostGIS (spatial data and queries)
- MapServer (render and serve images over the web)
- Python (programming language for web, science, ...)
  - Scipy/Numpy/Matplotlib (provide Matlab+++ type functionality)
- PHP (scripting language for web development)
  - Excellent support for user administration
- Apache (fast, popular web server)
- **How is this part of our vision?**
  - Making science affordable
  - Get a broad community of developers to share and contribute

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