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USGS Water Quality Monitoring and Studies in the San Joaquin Valley

San Joaquin River Management Program Advisory Council Meeting; Modesto, CA September 10, 2003

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http://ca.water.usgs.gov -- "California Online Reports"
http://ca.water.usgs.gov/sanj

U.S. Department of the Interior
U.S. Geological Survey

Ongoing USGS Water Quality Projects in SJV

- San Joaquin-Tulare Basins study unit (SANJ) of National Water-Quality Assessment program (NAWQA) (http://ca.water.usgs.gov/sanj_nawqa)

  - federally funded

- Wet/Dry Deposition Study of Pesticides

  - funded by SWRCB

- Hydrogeologic Characterization and Quantification of the Modesto area Ground-water Basin

  - funded by Modesto ID

- Evaluation of groundwater nitrate inputs to the lower SJR and their sources

  - proposal to SWRCB (Prop 50 CALFED DWQP)

USGS

Recent USGS Publications on WQ Projects in SJV

- **Panoche Creek Selenium Loads (USBR)**

  Kratzer, C.R., Saleh, D.K., and Zamora, C., 2003, Selenium and sediment loads in storm runoff in Panoche Creek, California, February 1998, USGS WRIR 02-4286, 38 p.

- **Transport of Diazinon and Chlorpyrifos (CDPR)**

  Kratzer, C.R., Zamora, C., and Knifong, D.L., 2002, Diazinon and chlorpyrifos loads in the San Joaquin River Basin, California, January and February, 2000, USGS WRIR 02-4103, 38 p.

  Zamora, C., Kratzer, C.R., Majewski, M.S., and Knifong, D.L., 2003, Diazinon and chlorpyrifos in precipitation and urban and agricultural storm runoff during January and February 2001 in the San Joaquin River Basin, California: USGS WRIR 03-4091, 56 p.

  Domagalski, J.L., and Munday, C., (in press), Evaluation of diazinon and chlorpyrifos concentrations and loads and other pesticide concentrations at select sites of the San Joaquin Valley, California, April to August 2001: USGS WRIR 03-4088, xx p.

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Recent USGS Publs. on WQ Projects in SJV (cont.)

- **Pesticide Distribution in Summer (SWRCB)**

  Brown, L.R., Panshin, S.Y., Kratzer, C.R., Zamora, C., and Gronberg, J.M., (in review), Occurrence, distribution, and loads of dissolved pesticides in the San Joaquin River Basin, California, during summer conditions, 1994 and 2001: USGS WRIR 03-xxxx, xx p.

- **Organic Carbon Loads to the Delta, 1980-99 (CALFED)**

  Saleh, D.K., Domagalski, J.L., Kratzer, C.R., and Knifong, D.L., 2003, Organic carbon trends, loads, and yields to the Sacramento-San Joaquin Delta, California, water years 1980 to 2000: USGS WRIR 03-4070, 77 p.

- **Nutrients and Oxygen-Demanding Substances (CALFED)**

  Kratzer, C.R., Dileanis, P.D., Zamora, C., and Silva, S.R., (in press), Sources and transport of nutrients, organic carbon, and chlorophyll-a in the San Joaquin River upstream of Vernalis, California, during summer and fall, 2000-2001: USGS WRIR 03-4127, xx p.

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NAWQA long-term goal

- To assess the status of and trends in the quality of freshwater streams and aquifers, and to provide a sound understanding of the natural and human factors that affect the quality of these resources.

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SANJ FY03/04 Activities

Status and Trends

- Surface Water – 4 trend sites
- Ground Water – Major Aquifer Survey (MAS), 3 Land Use Studies (LUS); Source Water Assessment (SWA); Flow System Study (FSS)

Topical Teams

- Agricultural Chemicals: Sources, Transport, and Fate (ACT)
- Transport of Anthropogenic and Natural Contaminants to Community Supply Wells (TANC)

Reports

- ACT fact sheet – Domagalski
- SANJ fact sheet – Gronberg and Kratzer
- TANC anthropogenic contaminants report – Burow and others
- TANC hydrogeologic and geochemical characterization report – Others and Phillips

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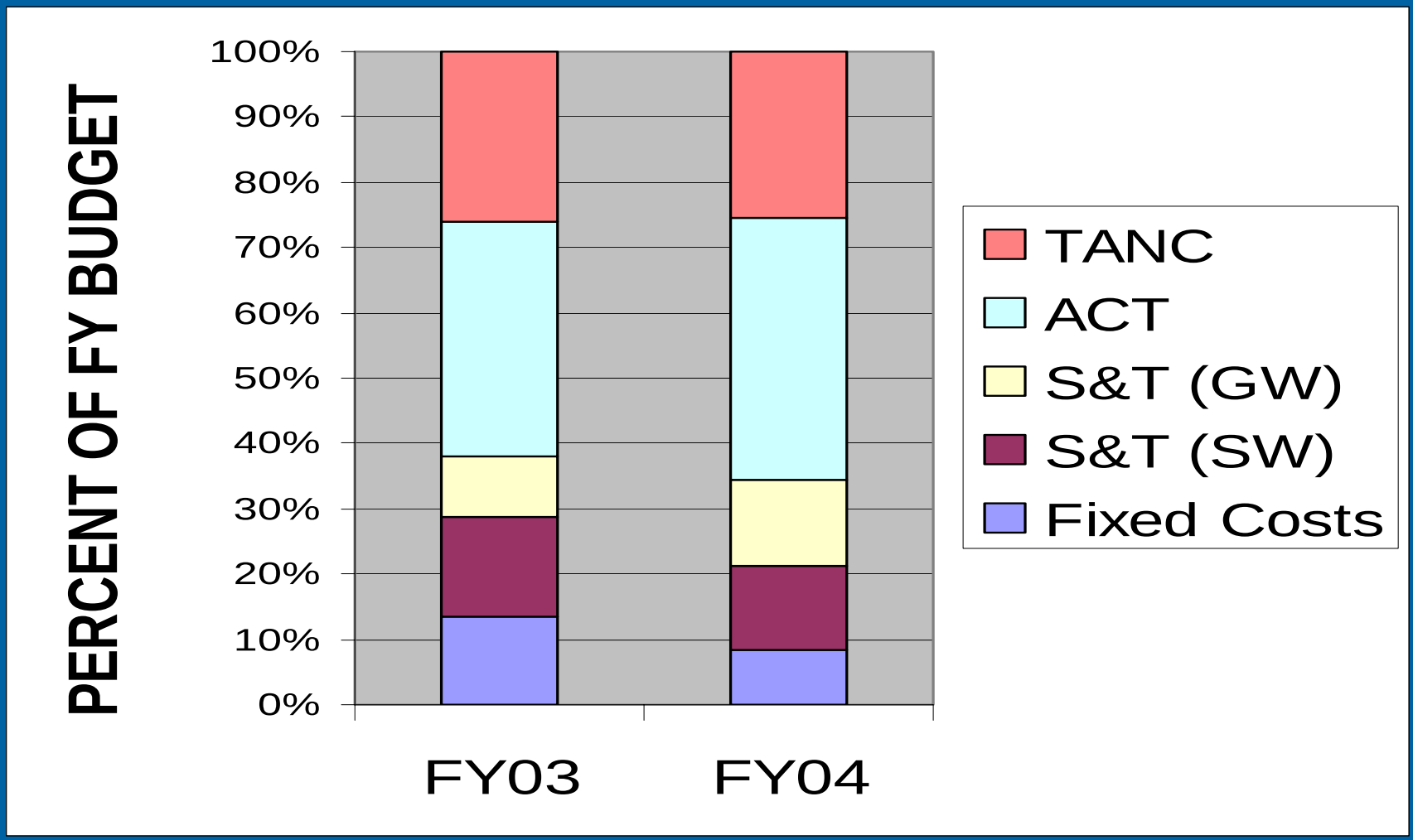
SANJ Cycle II FY03/04 Budgets
(FY03 = $1.6M; FY04 = $1.6M gross)



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SANJ Staffing (FY03/FY04) – 11.6/10.1 FTE

- Charlie Kratzer (75; 75)
- Karen Burow (70; 90)
- Larry Brown (20; 5)
- Joe Domagalski (60; 60)
- JoAnn Gronberg (65; 65)
- Peter Dileanis (55; 65)
- Steve Phillips (95; 85)
- Jennifer Shelton (60; 75)
- Dina Saleh (45; 30)
- Jason May (35; 10)
- Bryant Jurgens (100; 95)
- Diane Rewis (85; 45)
- Celia Zamora (40; 40)
- Willie Kinsey (95; 75)
- Mark Johnson (60; 40)
- Rob Sheipline (100; 100)
- Patricia Von Phul (50; 60)

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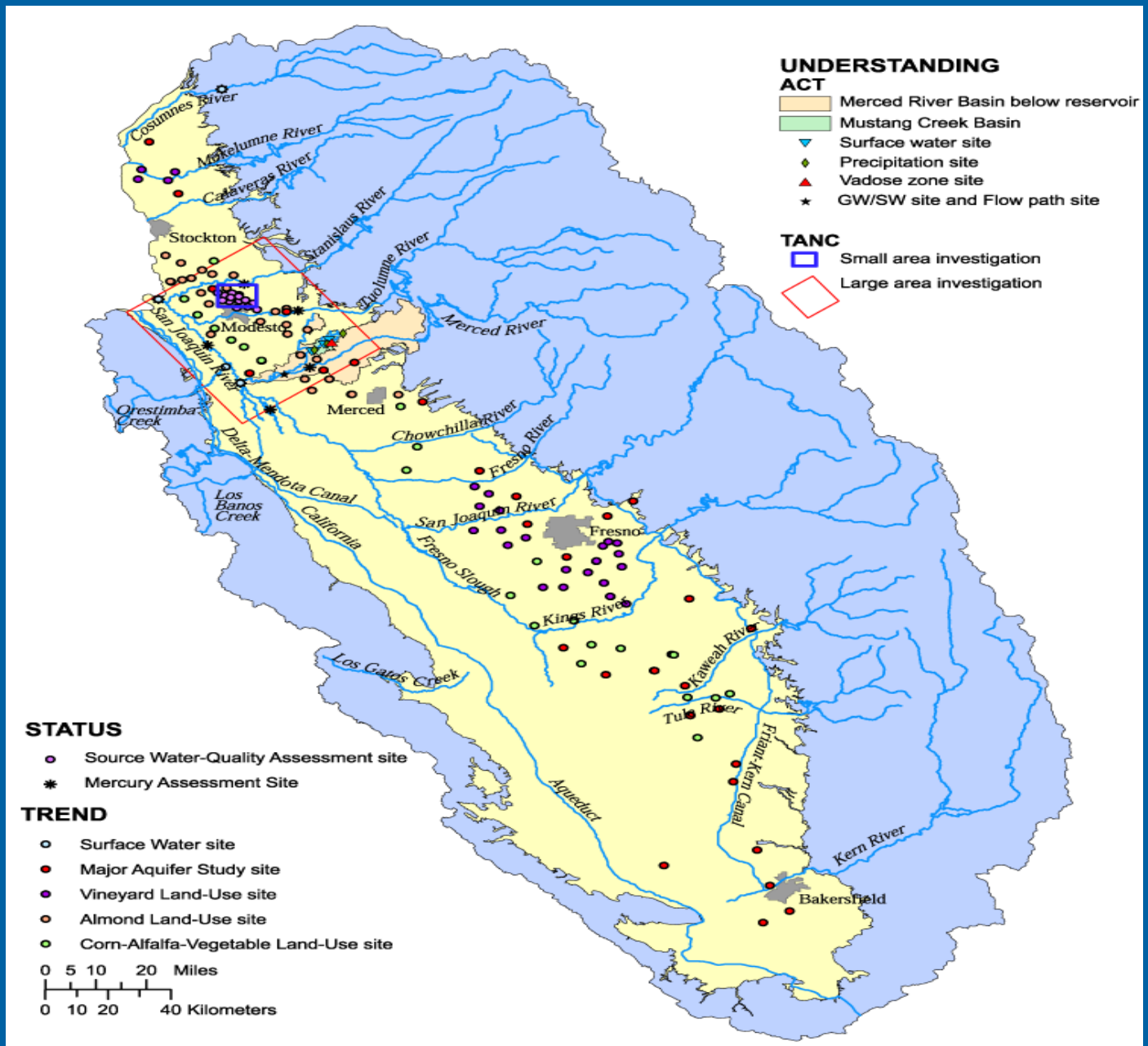
SANJ – S&T, ACT, and TANC sites



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Status and Trends (SW) – FY03/04

Sites: Merced, Orestimba, SJR nr Vernalis, Cosumnes

Chemical Analyses:

- **Cl, SO4 (12/9, 12/9, 12/8, 12/9)**
- **Organic carbon (12/9, 12/9, 12/8, 12/9)**
- **Suspended sediment (19/9, 19/9, 19/8, 12/9)**
- **Nutrients (19/9, 19/9, 19/8, 12/9)**
- **Pesticides SH2001 (19/8, 19/8, 19/8, 0)**
- **Pesticides SH2002 (19/0, 19/0, 19/0, 0)**
- **Pesticides glyphosate (19/0, 19/0, 19/0, 0)**

Biological Analyses:

- **Invertebrates, algae, fish, habitat (1, 1, 1, 1)**

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Status and Trends (GW) – FY03/04

- Quarterly sampling of 5 wells from existing LUS and MAS networks (20 wells total) FY04
  - Major aquifer survey (MAS)
  - 3 Land-use studies (LUS)
    - almond (ALM)
    - vineyard (VIN)
    - corn, alfalfa, veg (CAV)
- Source-water assessment (SWA)(15 wells) FY03
- Vineyard flow-system study (FSS)(20 wells) FY03

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Status and Trends (GW) - SWA

- Sample area of high use of GW for community water supply (CWS) within 16 Principal Aquifers
- Co-located with TANC study
- Sample 15 large CWS wells for:
  - DOC
  - Pesticides (SH2003 and SH2060)
  - VOCs (SH2020)
  - Wastewater (SH1433)
  - Gasoline oxygenate degradation products
  - Microbes

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Agricultural Chemicals: Sources, Transport, and Fate (ACT)

TOPIC QUESTION

How do environmental processes and agricultural practices interact to affect the transport and fate of agricultural chemicals in the hydrologic system of nationally important agricultural settings, and what are the effects on water quality and implications for management of water resources?

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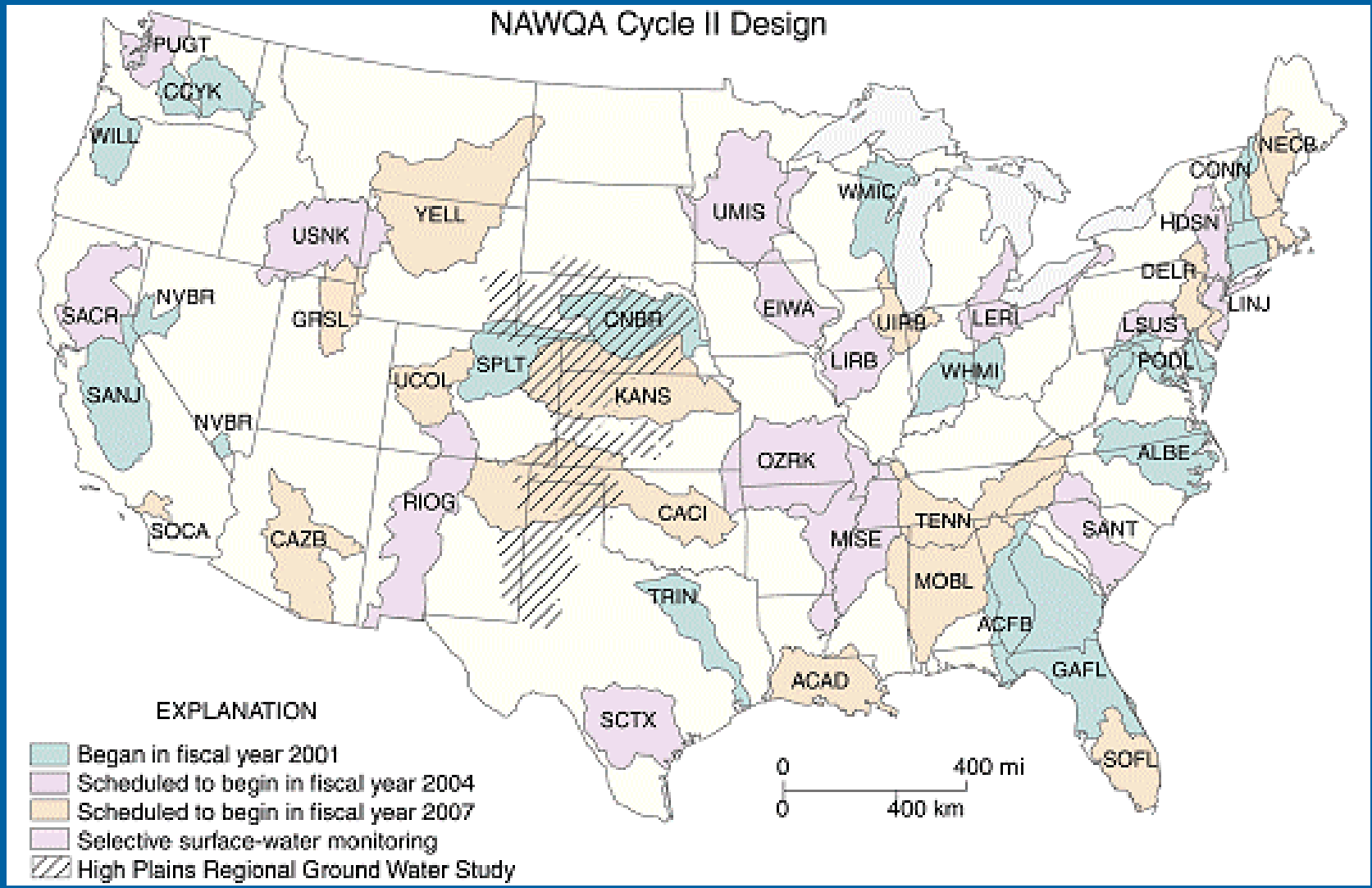
ACT – Study Units involved now are SANJ, CCYK, CNBR, WHMI, and PODL



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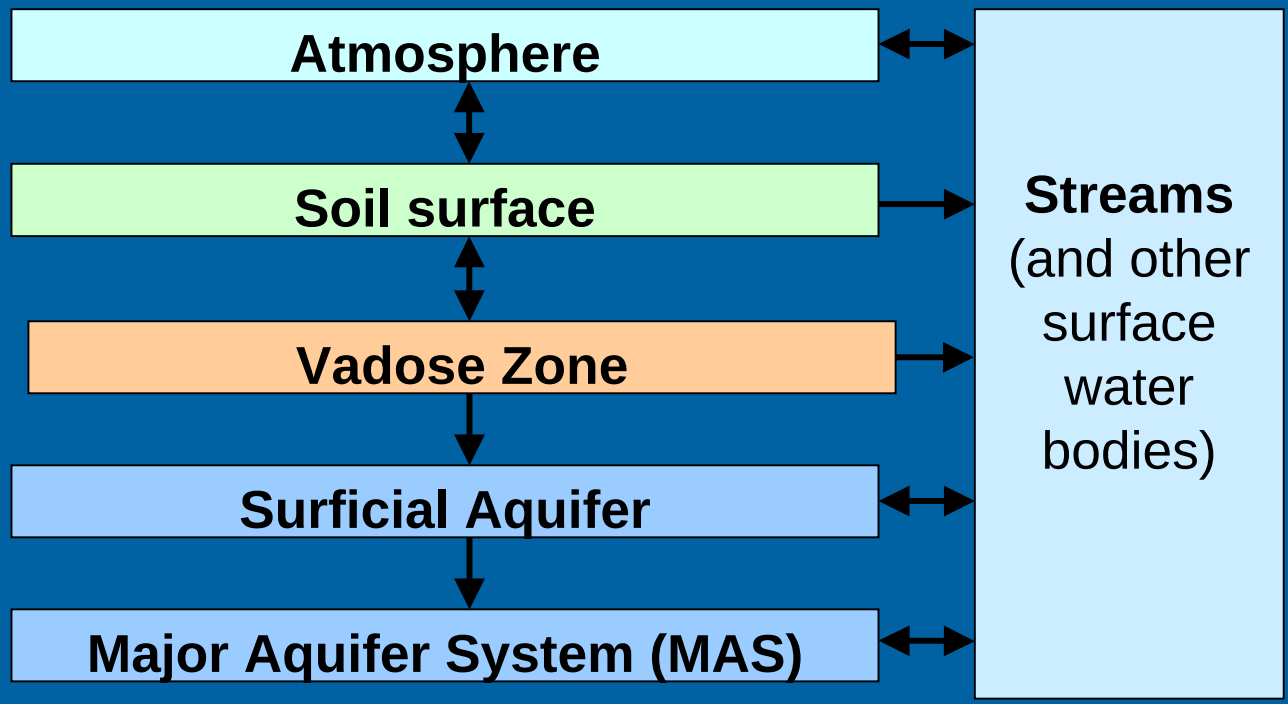
ACT – Hydrologic Compartments

A given agricultural setting contains a combination of row crops, orchards, rangeland, pasture, CAFOs, and ... The hydrologic setting is comprised of a number of important interacting compartments.



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ACT - Specific Objectives

1) Develop an annual, mass budget for water and selected agricultural chemicals.

2) Determine the residence times and rates of water and agricultural chemical transport.

3) Identify the important chemical transformation and transfer processes for selected agricultural chemicals.

4) Use quantitative methods to interpret, extrapolate, and predict the fate and transport of water and selected agricultural chemicals.

5) Interpret study results in terms of water management implications.

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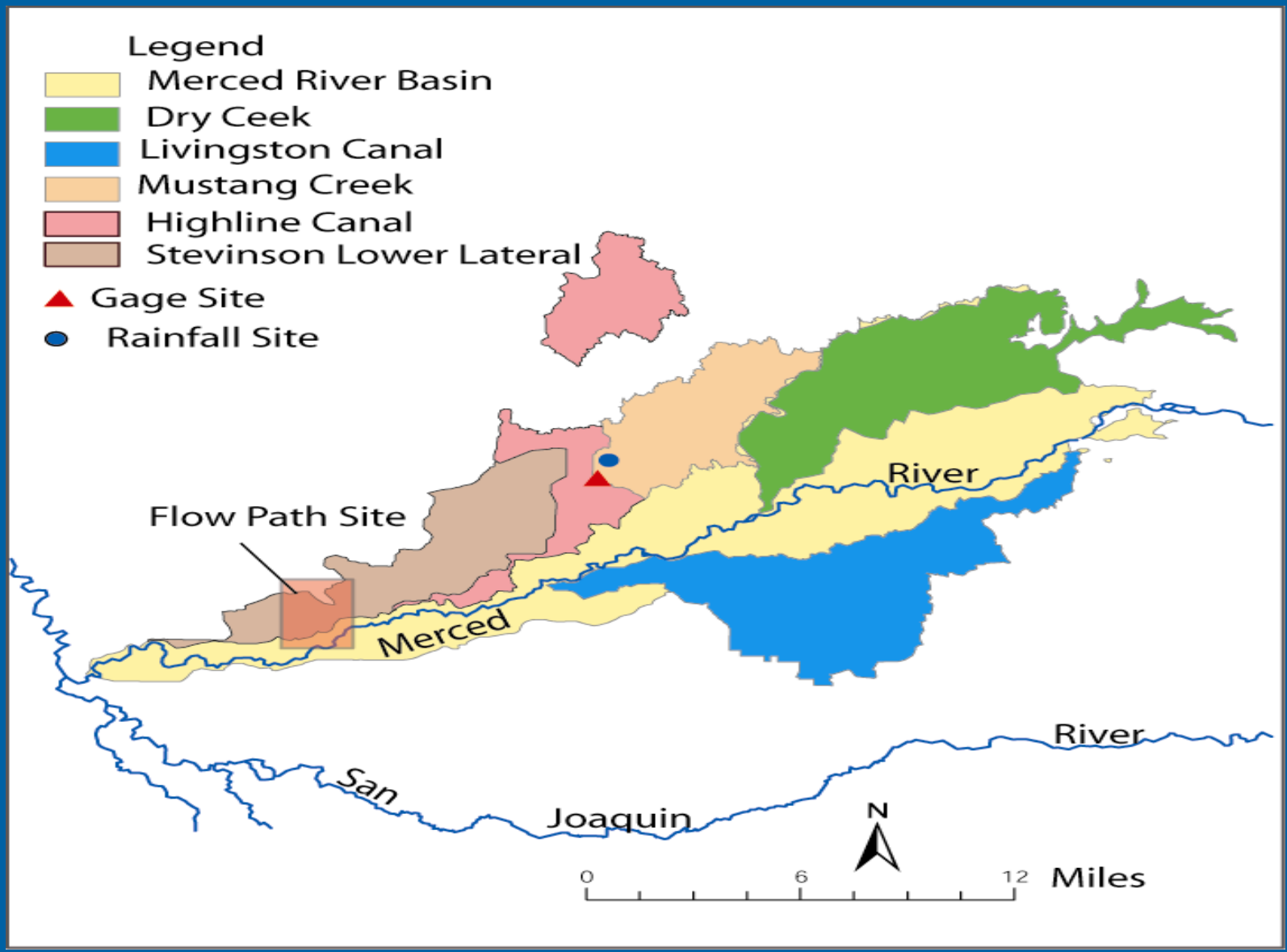
ACT – SANJ site selection



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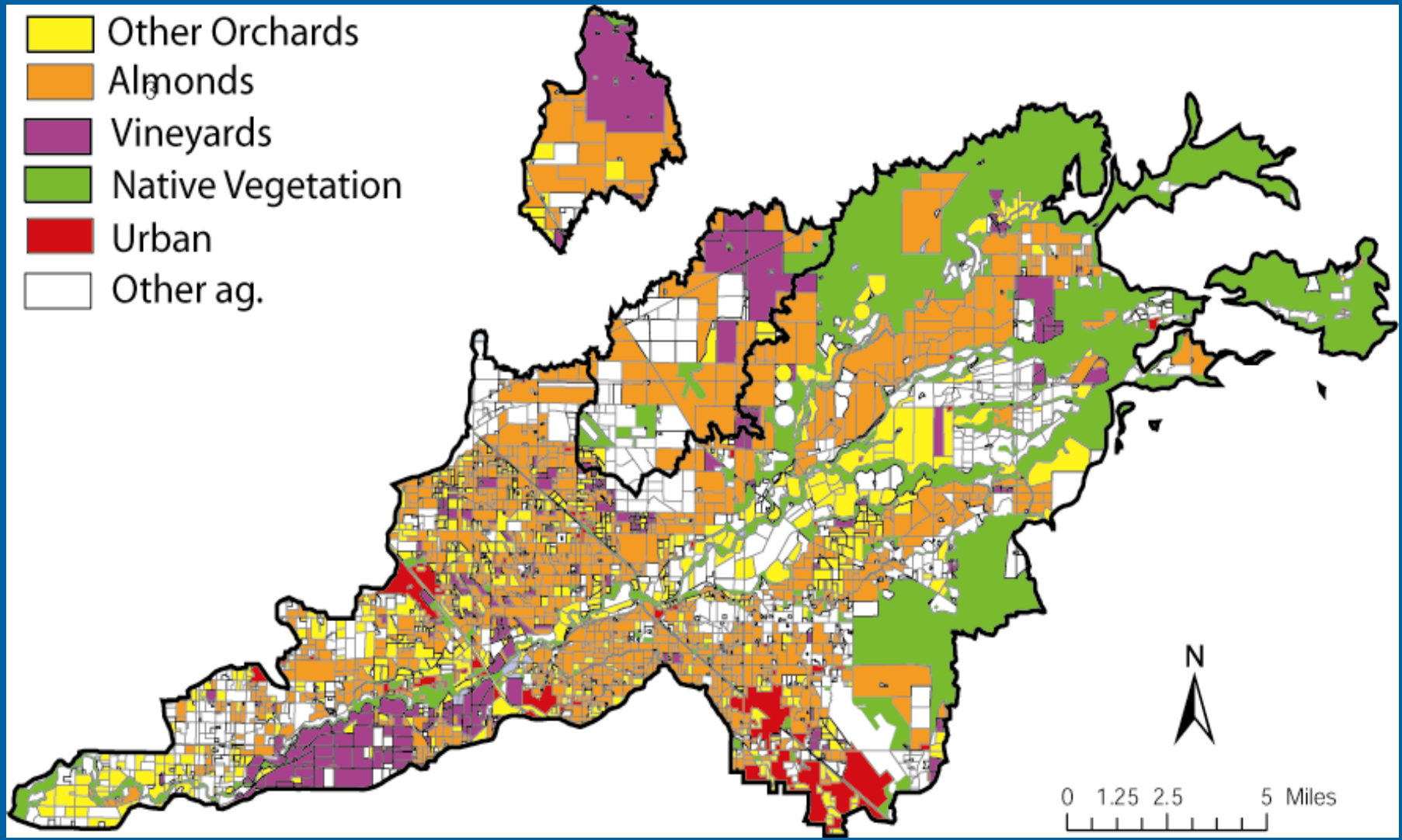
ACT – SANJ site selection



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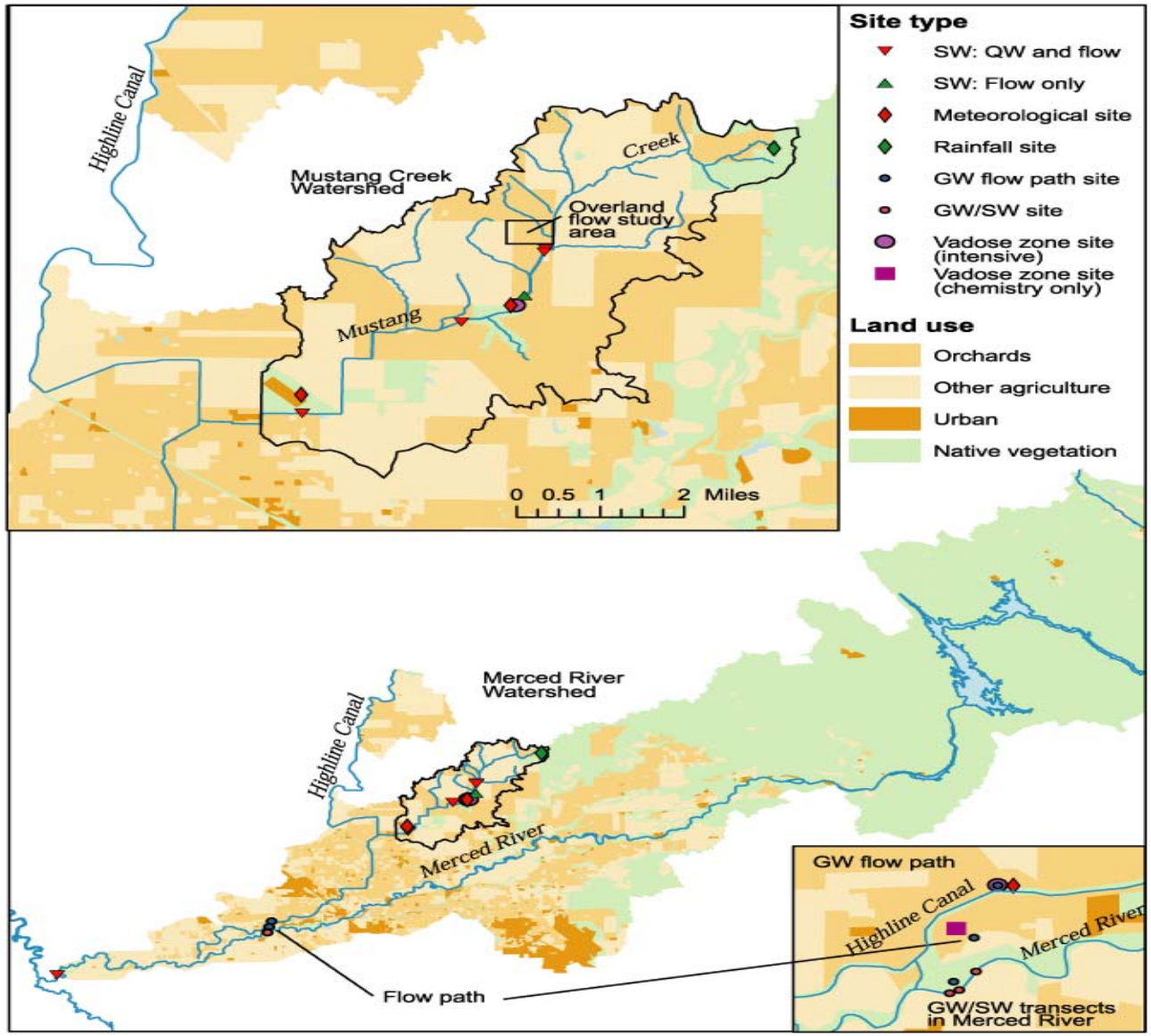
ACT – Mustang Cr and Merced R study areas



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Mustang Creek – Summer conditions

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Mustang Creek – Winter storm flow

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ACT – Surface Water Objectives

- Characterize event-based transport of agricultural chemicals
- Characterize flux of agricultural chemicals from a watershed
- Characterize in-stream transformations of chemicals
- Comparison between scales – small stream and indicator site
- Calibrate models

Sampling SW for the following constituents: pesticides and metabolites (SCH2003, LCAA), nutrients and organic carbon, major ions, and suspended sediment

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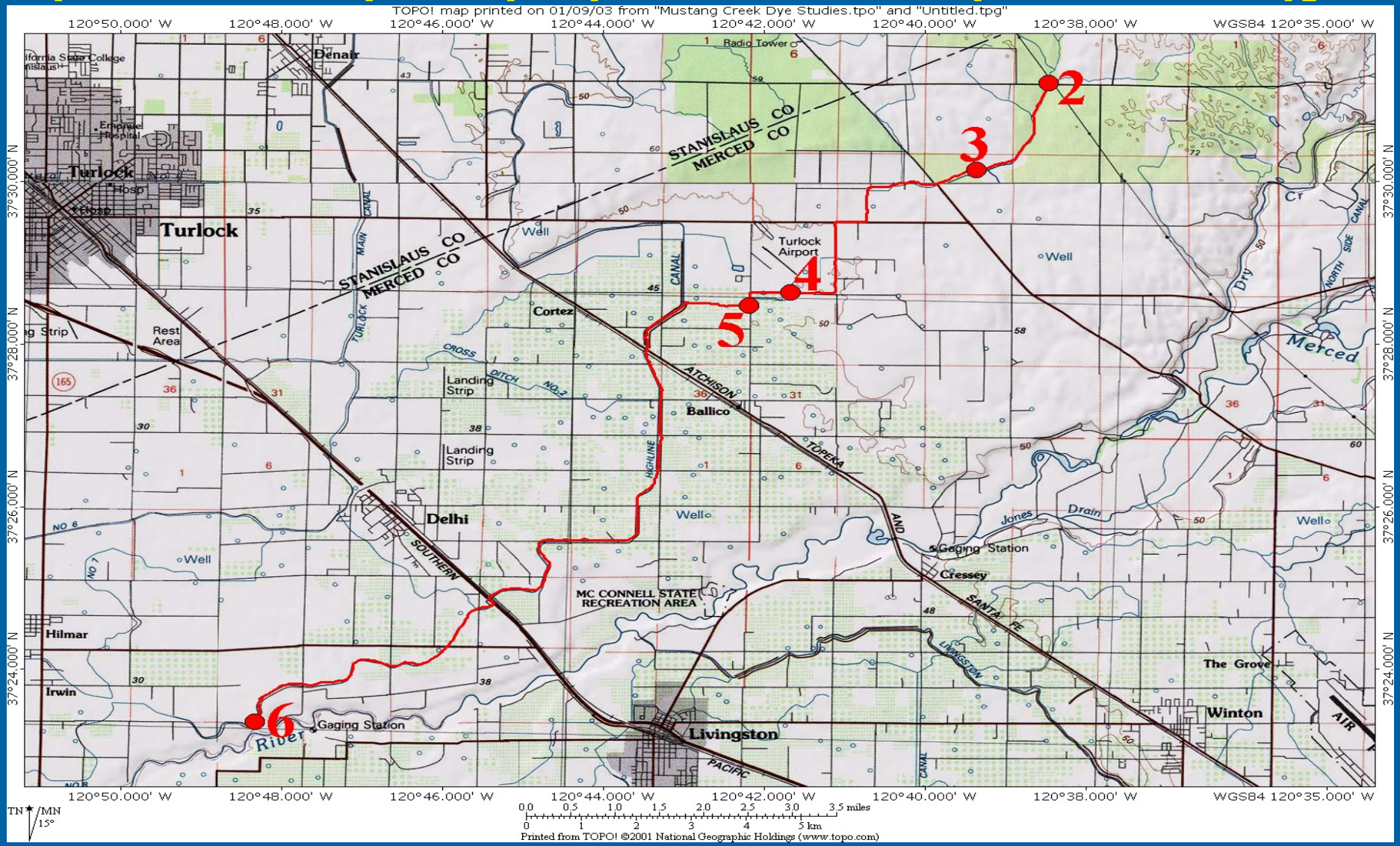
ACT – Mustang Creek dye study, 12/02)

USGS

ACT – Mustang Creek dye studies [completed reaches (3 to 4; 4 to 5) and proposed reaches (2 to 3; 5 to 6)]



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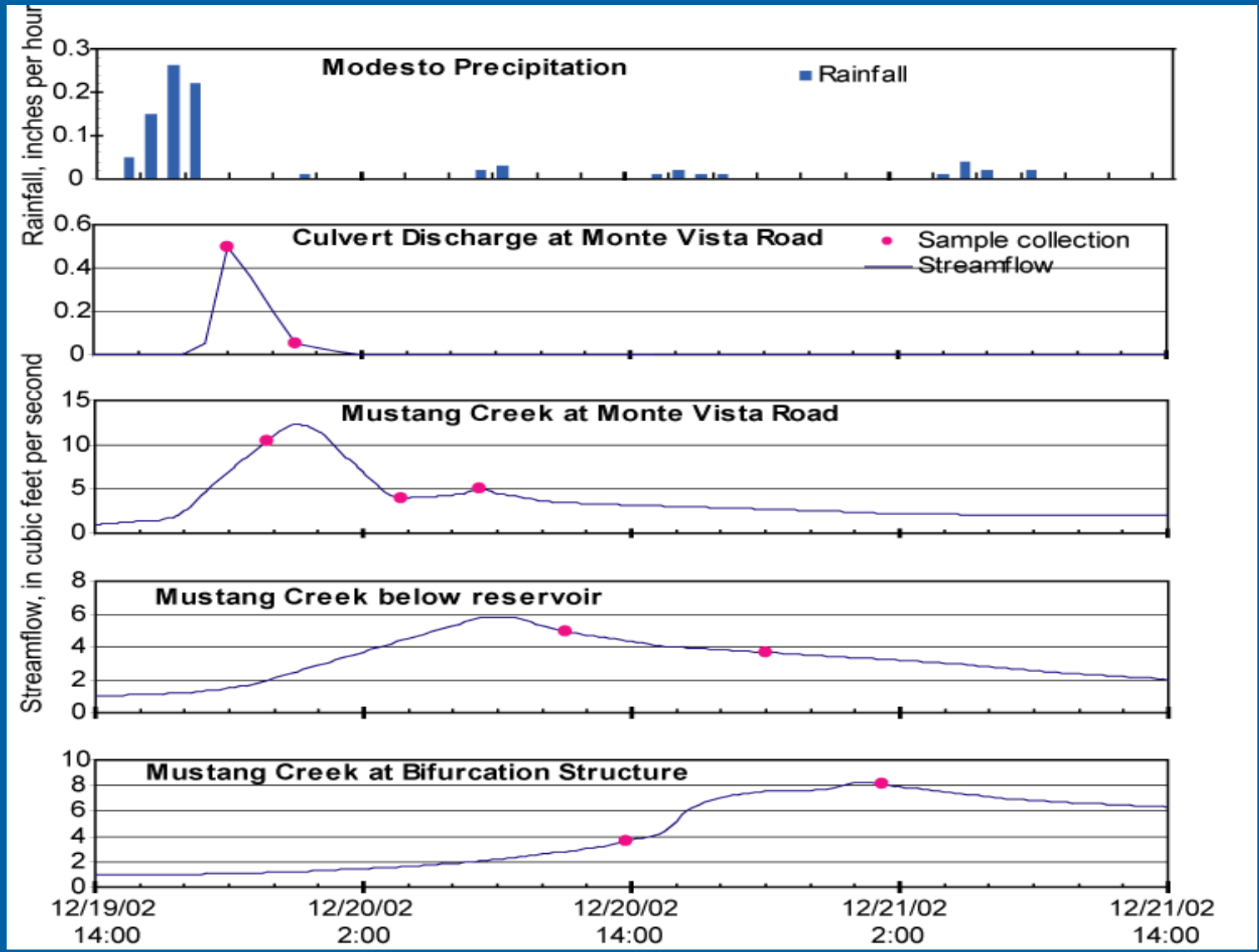
ACT – Estimated Mustang Creek hydrographs for 12/19/02 storm runoff [upstream (culvert) to downstream (Bifurcation)]



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ACT - Vadose Zone Objectives)

- Determine water flux through vadose zone (recharge rate)
- Determine chemical mass in and flux through vadose zone
- Identify important reactions and transformations
- Quantify influence of various factors on water and chemical movement

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ACT - Instrumentation for vadose zone work

	Purpose	Number to be Installed	Sampling Frequency
Weather Station	ET estimates Precipitation	3	Continuous
Suction Lysimeters	Vadose zone water samples	6	4-7/year
Pan Lysimeters	Root-Zone water samples	1	4-7/year
Soil Moisture Sensors	Vadose zone moisture content	2	Continuous
Heat Dissipation Probes	Vadose zone pressure head	4	Continuous
Water-Table Well	GW levels and samples	1	Continuous; 4-7/year

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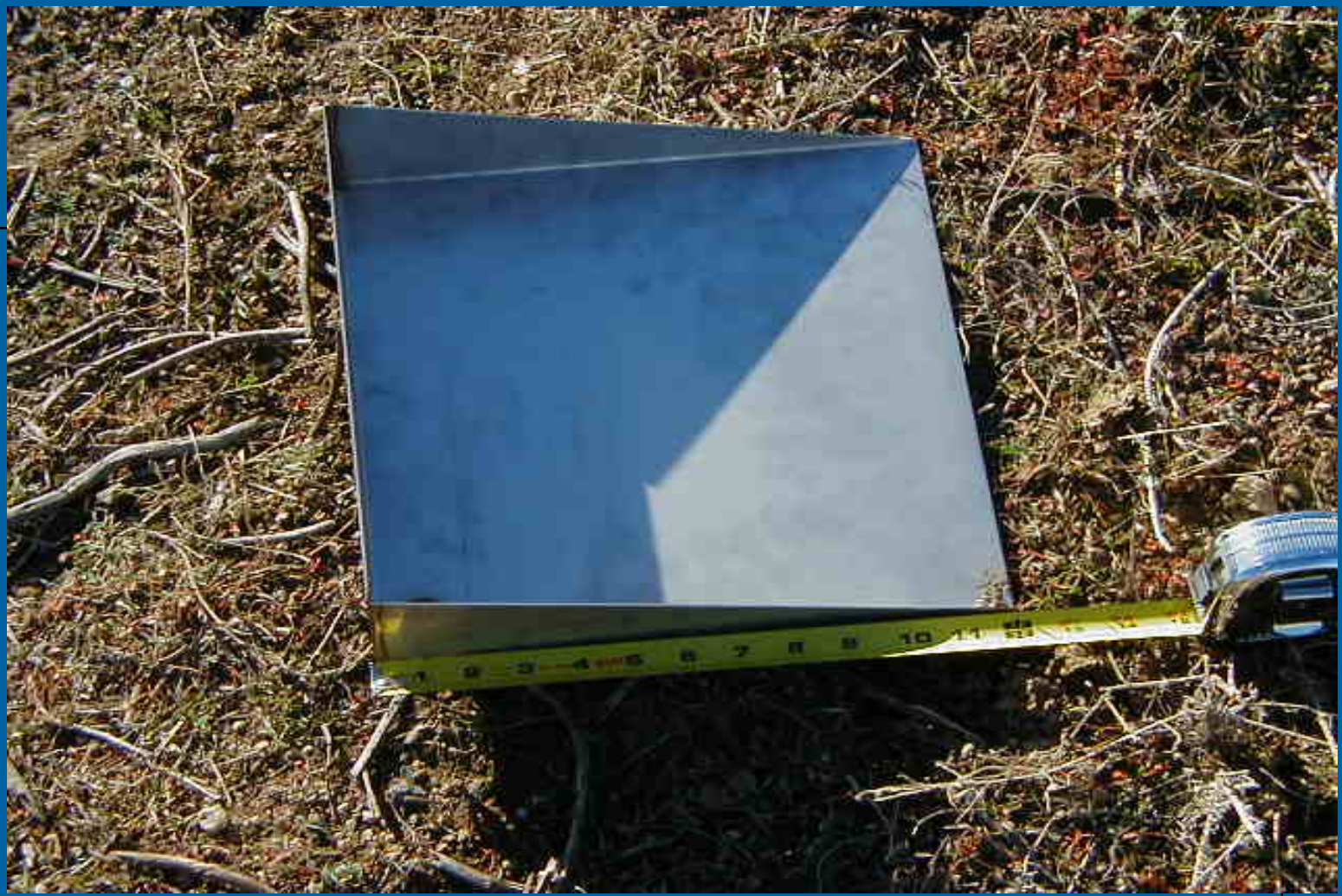
ACT – Pan Lysimeter Installation



Pan Lysimeter 12”x12”

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ACT – Pan Lysimeter Installation

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ACT – Pan Lysimeter Installation

Sample collection vessel. Inlet line is from pan. Outlet line runs to land surface

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ACT - GW/SW (reconnaissance sampling trips in May - July 2003)

- Temperature (about 10 per transect at 2-3 depths below streambed) and head measurements (3 per transect at 2 depths below streambed) at about 20 transects
- Nitrate and dissolved oxygen measured below streambed
- Information used to determine potentially gaining or losing sections and to locate permanent piezometer transects

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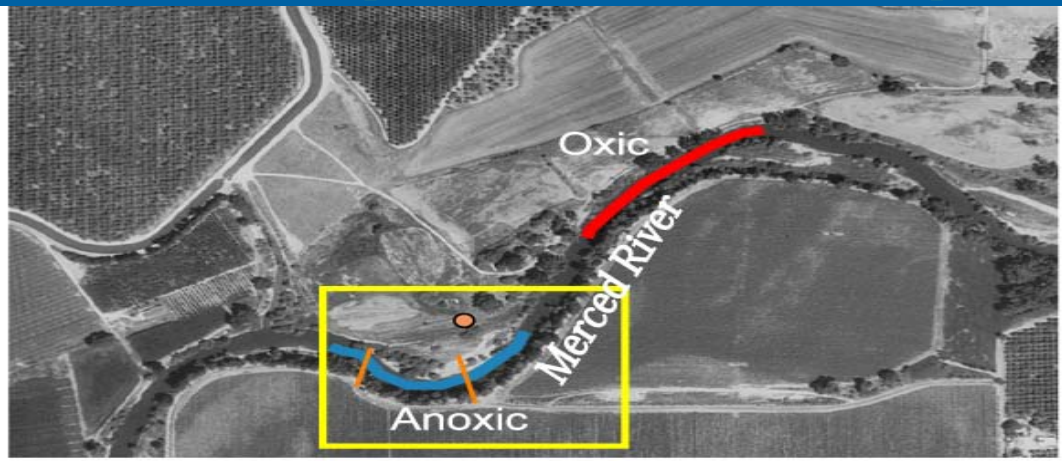
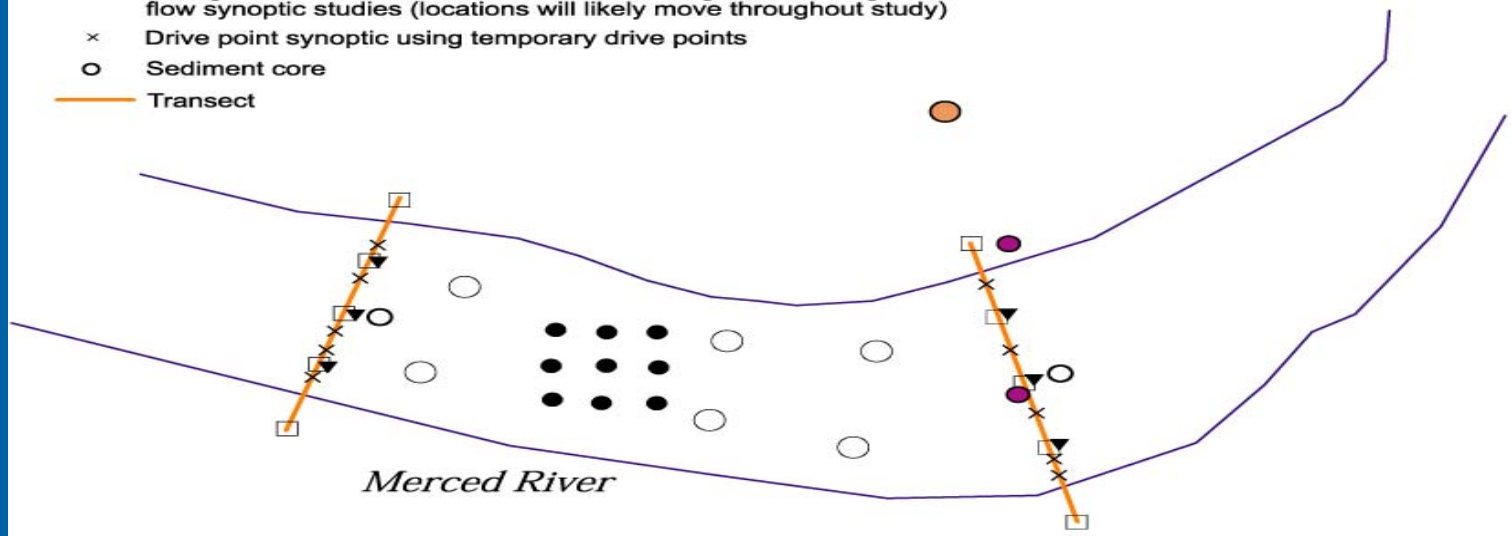
ACT – GW/SW reconnaissance (Merced R site)

USGS

ACT – GW/SW (Merced R site)



- Flow path well
- AMS tip @ three depths (0.5m, 1m, and 2-3m)
- 2" PVC piezometer @ two depths (0.5m and 2-3m, some outfitted with a pressure transducer; all deep ones outfitted with termperature tidbits @ three depths) (located next to AMS tips)
- 2" PVC piezometer with YSI WQ monitors (one in river and two in bed sediment @ two depths (0.5m and 2-3m))
- Push/pull study - done during seasonal low flow and seasonal higher flow (24-48 hr test)
- Seepage meter (24 hr tests) - will be conducted at least two times during seasonal low flow and two times during seasonal higher flow synoptic studies (locations will likely move throughout study)
- Drive point synoptic using temporary drive points
- Sediment core
- Transect



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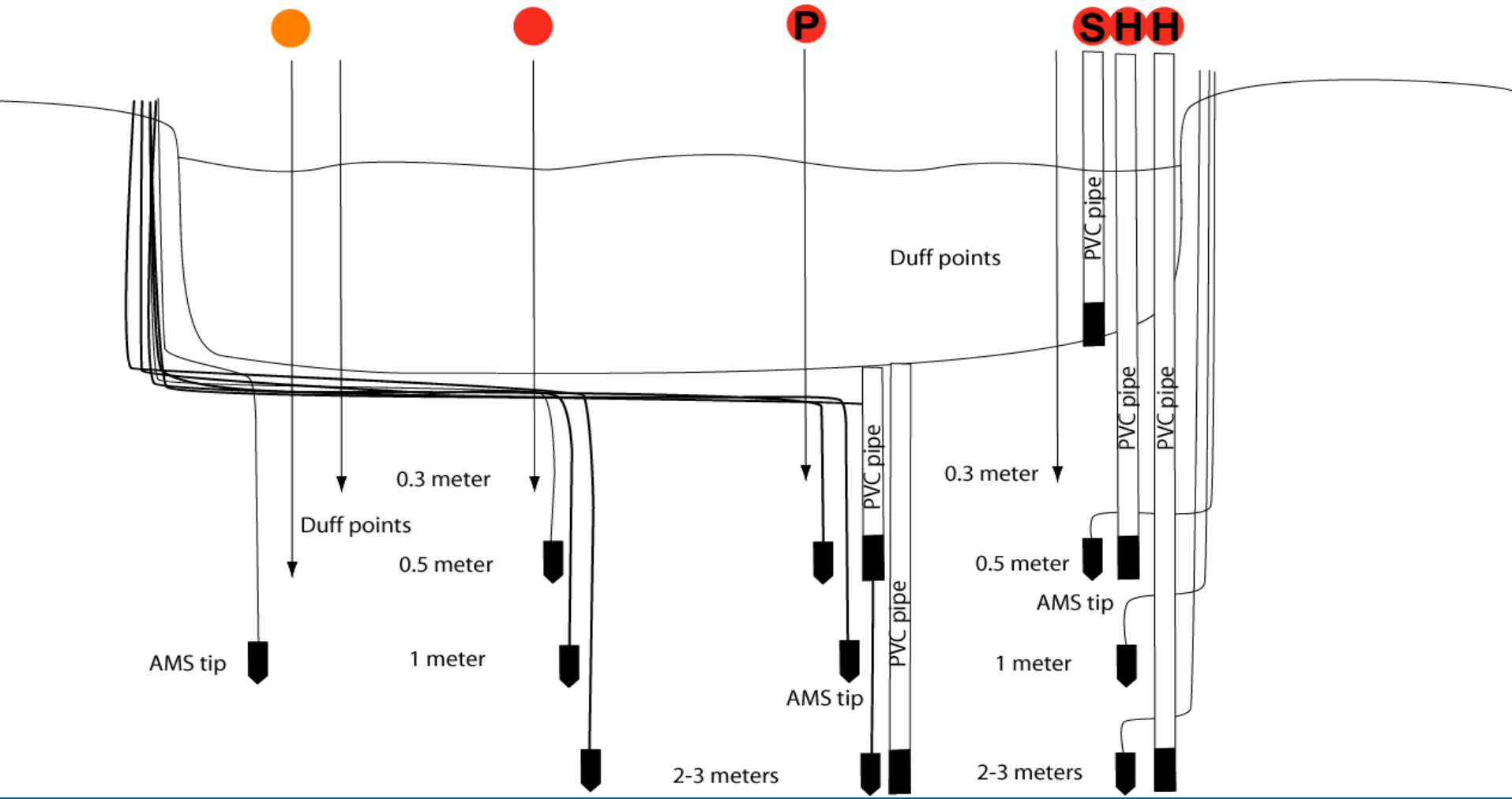
ACT – GW/SW instrumentation



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ACT – GW/SW piezometer installation, Aug. 2003

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ACT - GW/SW (analytical plan for samples)

- Solid Phase—3 sites, once
  - Particle size, bulk density, organic carbon
  - Pesticides, C & N isotopes
  - Mineralogy, iron, sulfide
- Aqueous Phase—all permanent sites, quarterly, CY04
  - DO, temperature, pH, EC, HCO_3^-
  - Pesticides, metabolites, nutrients, cations, anions, S^{2-}
  - Ar, N_2, O_2, CO_2, CH_4 age dates
- Aqueous Phase—high/low flow synoptics
  - DO, temperature, pH, EC
  - Selected redox parameters (NO_3^-, NH_4^+, Fe^{2+}, S^{2-})

USGS

ACT - GW/SW (seepage meters)

Uses design of D. R. Lee (1977)

- Samples collected in sterile, vinyl sample bag (urine bag)

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ACT - GW/SW (seepage meters)

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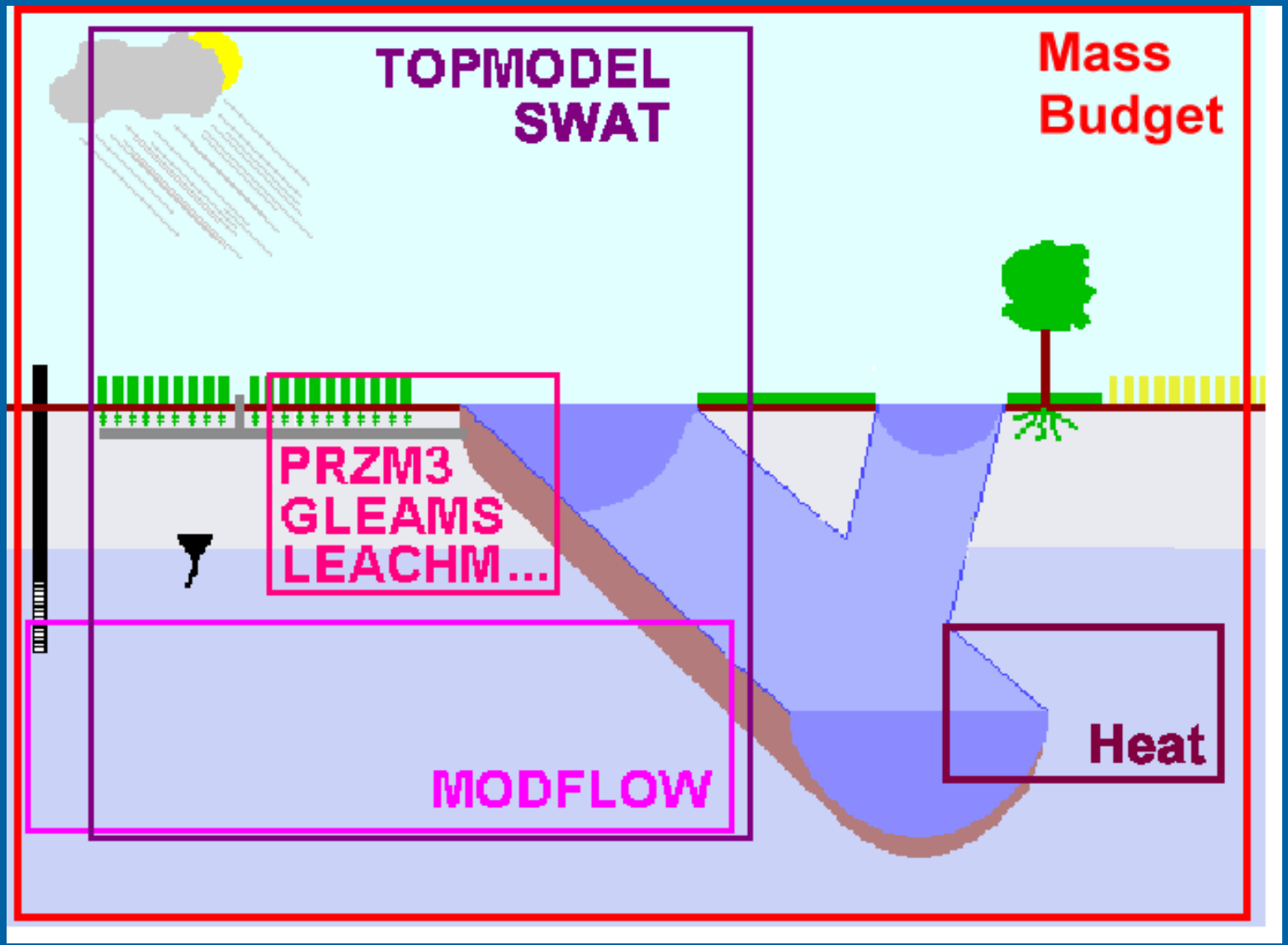
ACT - Modeling overview



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ACT - SW modeling (objectives)

1. Understand the process of how water flows through a watershed

2. Understand how land use impacts water quality

3. Extrapolate findings to ungaged watersheds and to different scales

4. Forecast changes in hydrology and water quality under a variety of ‘what if’ scenarios

USGS

ACT - GW modeling (overview)

- MODFLOW models for indicator basins
- Characterize ground-water flow in basin
- Guide data collection/network design
- Provide framework for extrapolation of detailed GW work to entire basin
- More refined models may be used in areas of flow path studies

USGS

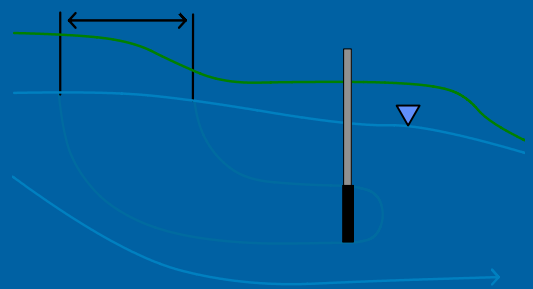
Transport of Anthropogenic and Natural Contaminants to Community Supply Wells (TANC)

TOPIC QUESTION

What are the primary

(1) contaminant sources,
(2) aquifer processes, and
(3) well characteristics

that control the transport and transformation of contaminants from recharge areas to supply wells in representative drinking water aquifers?



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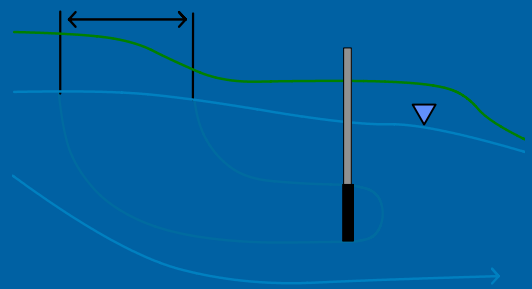
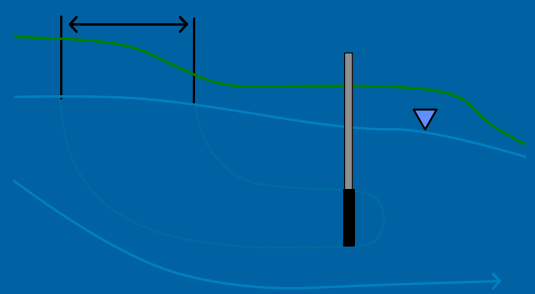
TANC - Specific Objectives

- Assess human activities, and hydrologic and geologic factors that are related to sources
- Determine hydrologic factors that affect transport
- Identify important chemical characteristics and transformation processes
- Evaluate effects of well characteristics and well-field management
- Extrapolate results



TANC - Site Selection Criteria

- Overlies an important regional water-supply aquifer
- Nests within an area scheduled for re-sampling
- Ground-water is a critical source of drinking water
- Ground-water is vulnerable to contamination
- Water quality issues are related to human activities
- Fits into a network that covers a wide range of settings



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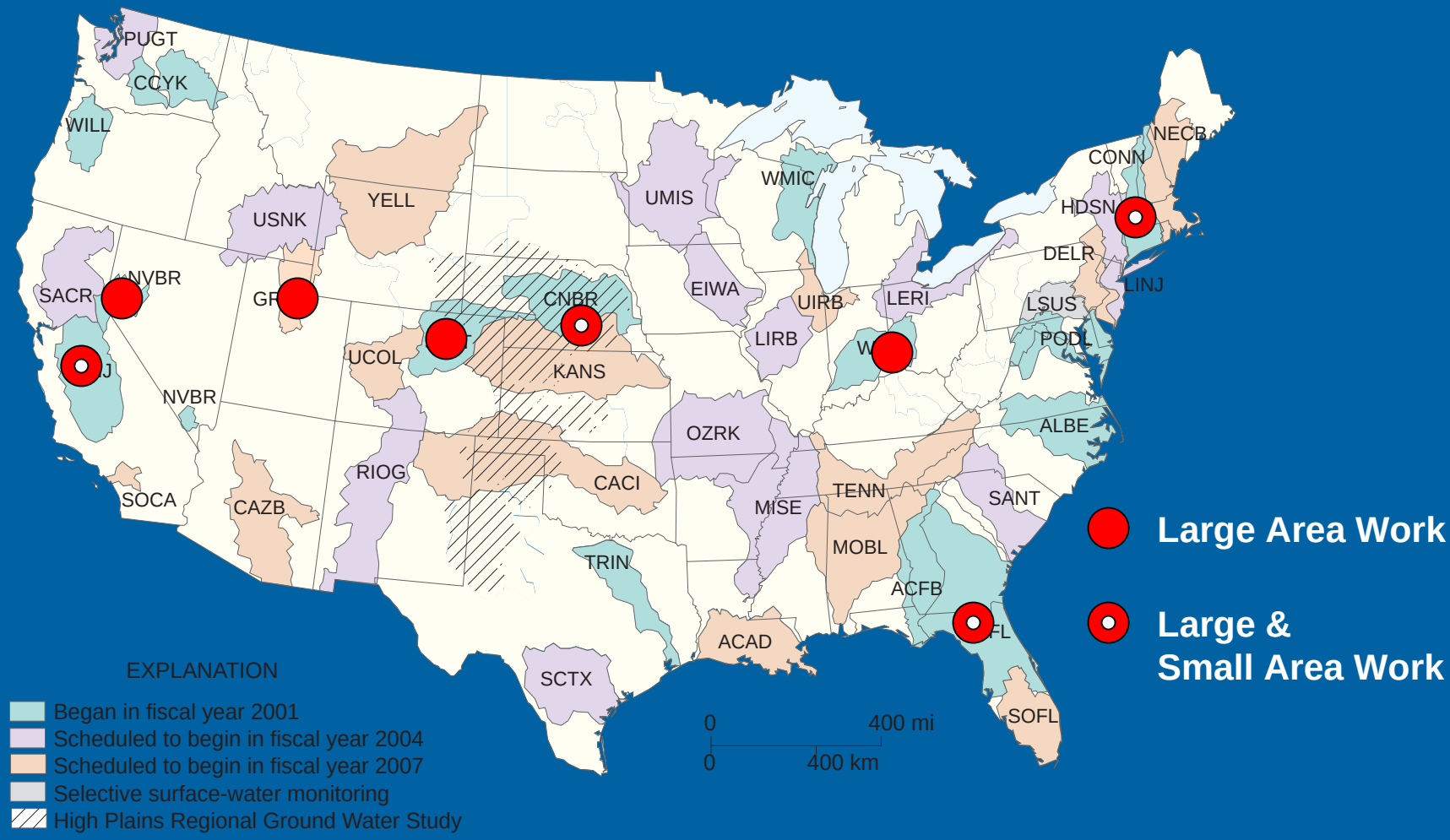
TANC - Study Units involved now



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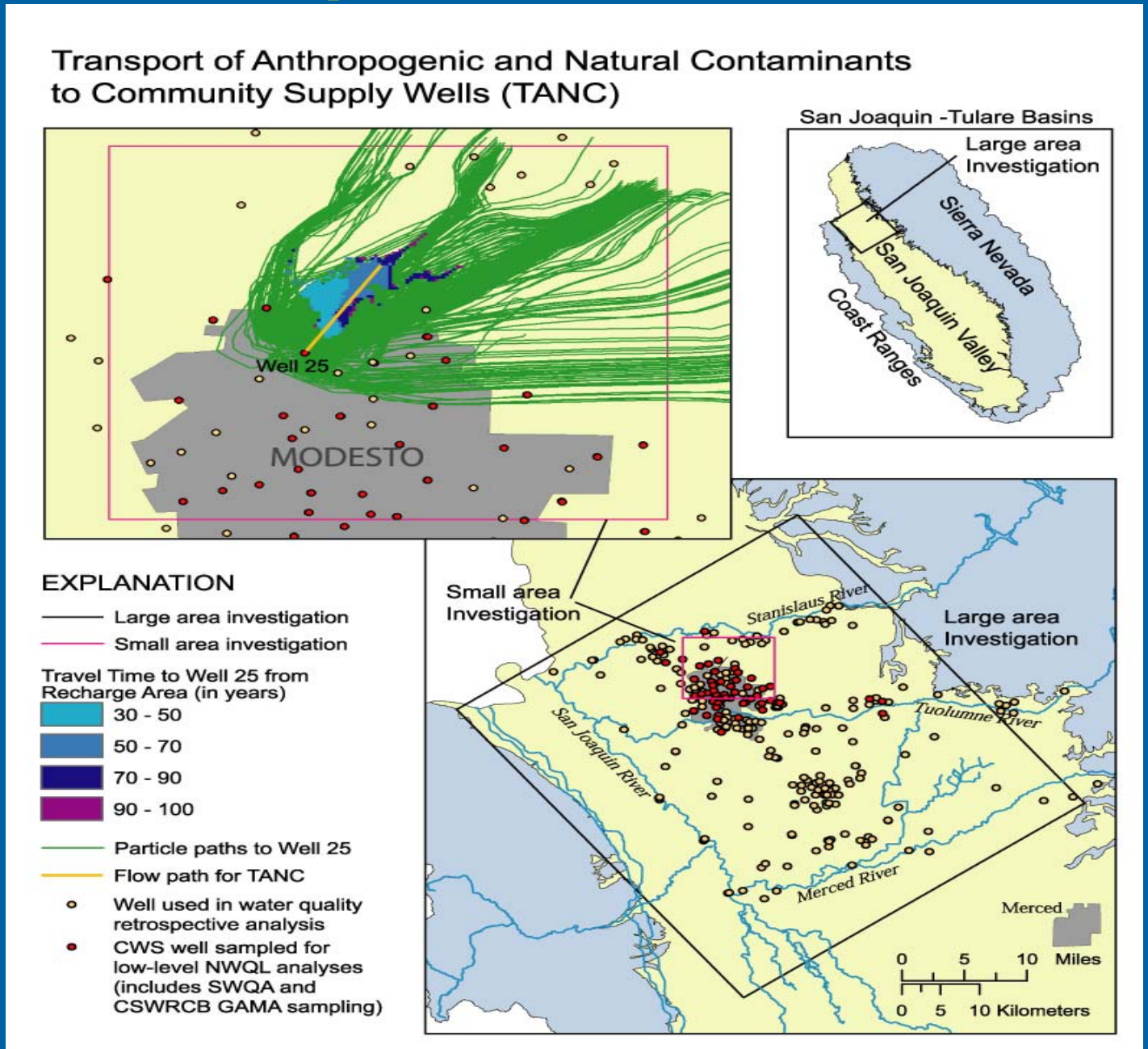
TANC – flowpath in Modesto area



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TANC - drilling in Modesto, 8/03

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TANC - drilling in Modesto, 8/03

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Wet/dry deposition study - objectives

- To provide a better determination of the contribution of atmospheric deposition, both wet – precipitation, and dry – gaseous and particle, of airborne organophosphorus insecticides and other pesticides to the overall pesticide loading in the San Joaquin and Sacramento basins

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Wet/dry deposition study - data collection

- 6 sites in SJB since January 2002
- 2 sites in Sac Basin since January 2003
- Sampling at 8 sites to continue through March 2004
- SCH 2003 pesticides at all sites
- Data stored in NWIS with appropriate medium codes

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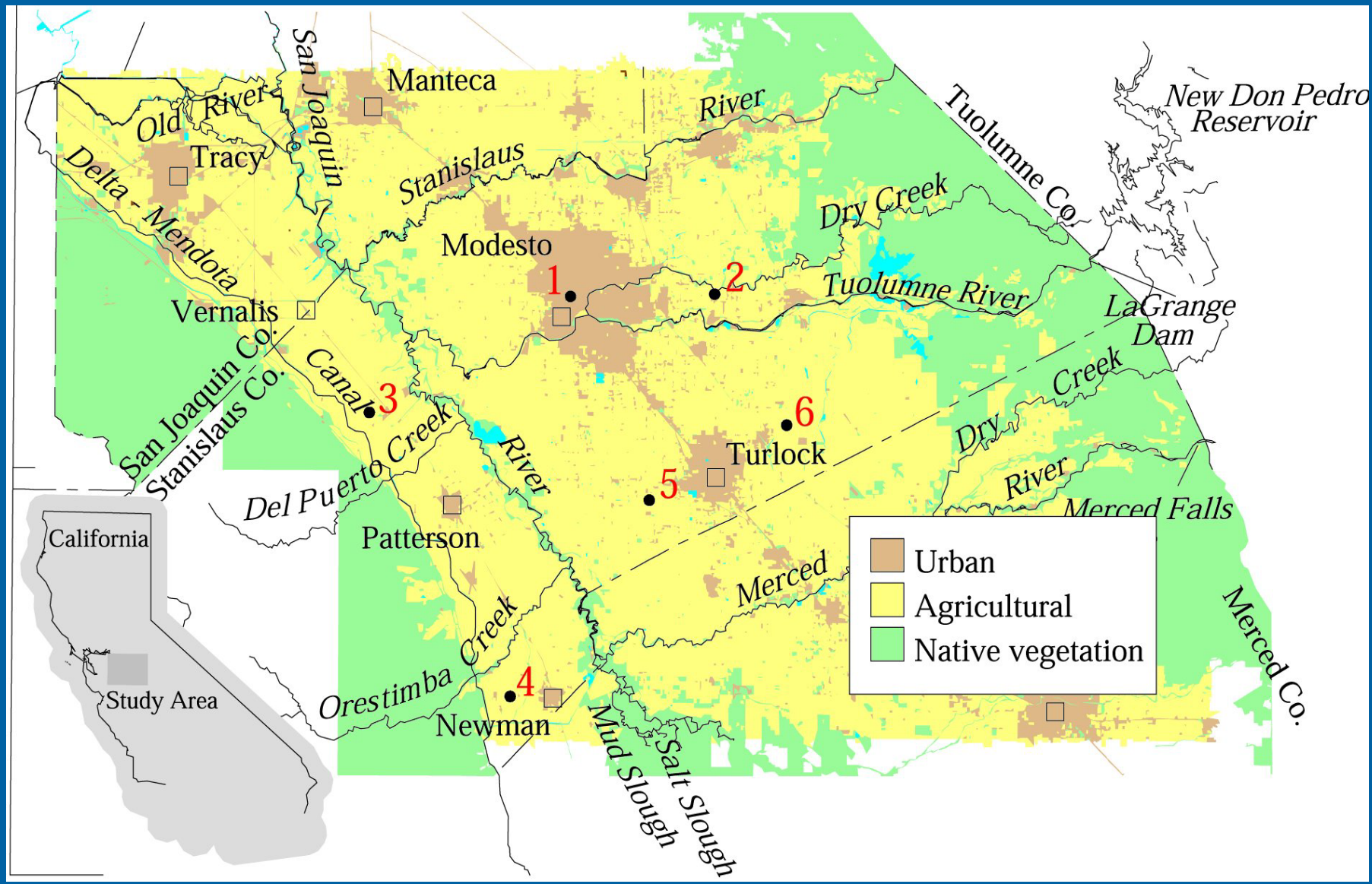
Wet/dry deposition study - 2002/3 SJB sites



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Wet/dry deposition study - samplers (funnels and autosamplers)

- **Wet and dry deposition**
  - 32 cm diam. funnels (8)
  - Automated wet/dry sampler (3)

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Wet/dry deposition study - 2003 sampling additions

- **Additional locations**
  - Gridley HS (Sutterville)
    - autosampler, funnel, soil box
    - funnel
  - At Oroville Dam
    - funnel
- **Additional samples**
  - Funnels added to autosampler sites
  - Soil boxes added at autosampler sites
    - Dry deposition
    - Runoff
    - Suspended sediments in runoff

USGS

Wet/dry deposition study - samplers (soil box)

USGS

Wet/dry deposition study - pesticides detected
(112 Total Samples)

- Dacthal (112)
- Simazine (101)
- Chlorpyrifos (93)
- Metolachlor (83)
- Myclobutanil (59)
- Prometryn (38)
- Azinphos Methyl (22)
- Methyl Parathion (8)
- Diazinon (108)
- Pendimethalin (94)
- Trifluralin (93)
- Carbaryl (69)
- Malathion (58)
- Methidathion (33)
- Phosmet (17)

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Wet/dry deposition study - pesticide concentrations

- **Diazinon (108/112)**
  - Range - 0.003 to 10.3 µg/L
  - Average - 0.30 µg/L (~0.6 in '01; 0.20 in '02)
- **Chlorpyrifos (93/112)**
  - Range - 0.002 to 0.60 µg/L
  - Average - 0.05 µg/L (~0.08 in '01; 0.07 in '02)

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Wet/dry deposition study - pesticide concentrations *(continued)*

- **Dacthal (112/112)**
  - Range - 0.002 to 0.025 µg/L
  - Average - 0.01 µg/L (0.01 in '01, 0.015 in '02)
- **Simazine (101/112)**
  - Range - 0.004 to 15.6 µg/L
  - Average - 0.31 µg/L (0.05 in '01, 0.09 in '02)
- **Pendimethalin (94/112)**
  - Range - 0.010 to 0.269 µg/L
  - Average - 0.046 µg/L (0.02 µg/L in '02)

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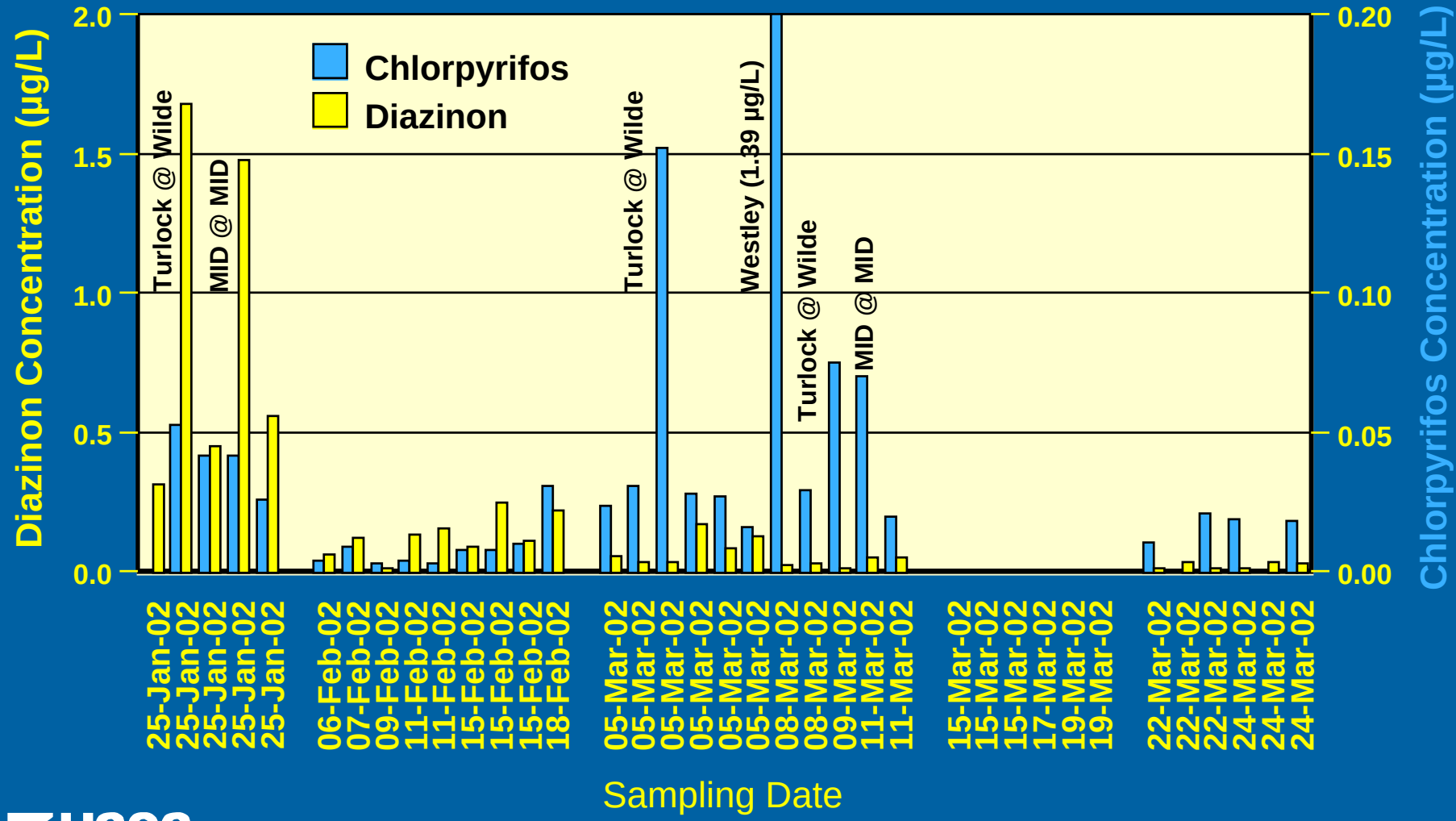
Wet/dry deposition study - OP insecticide trends, 2002



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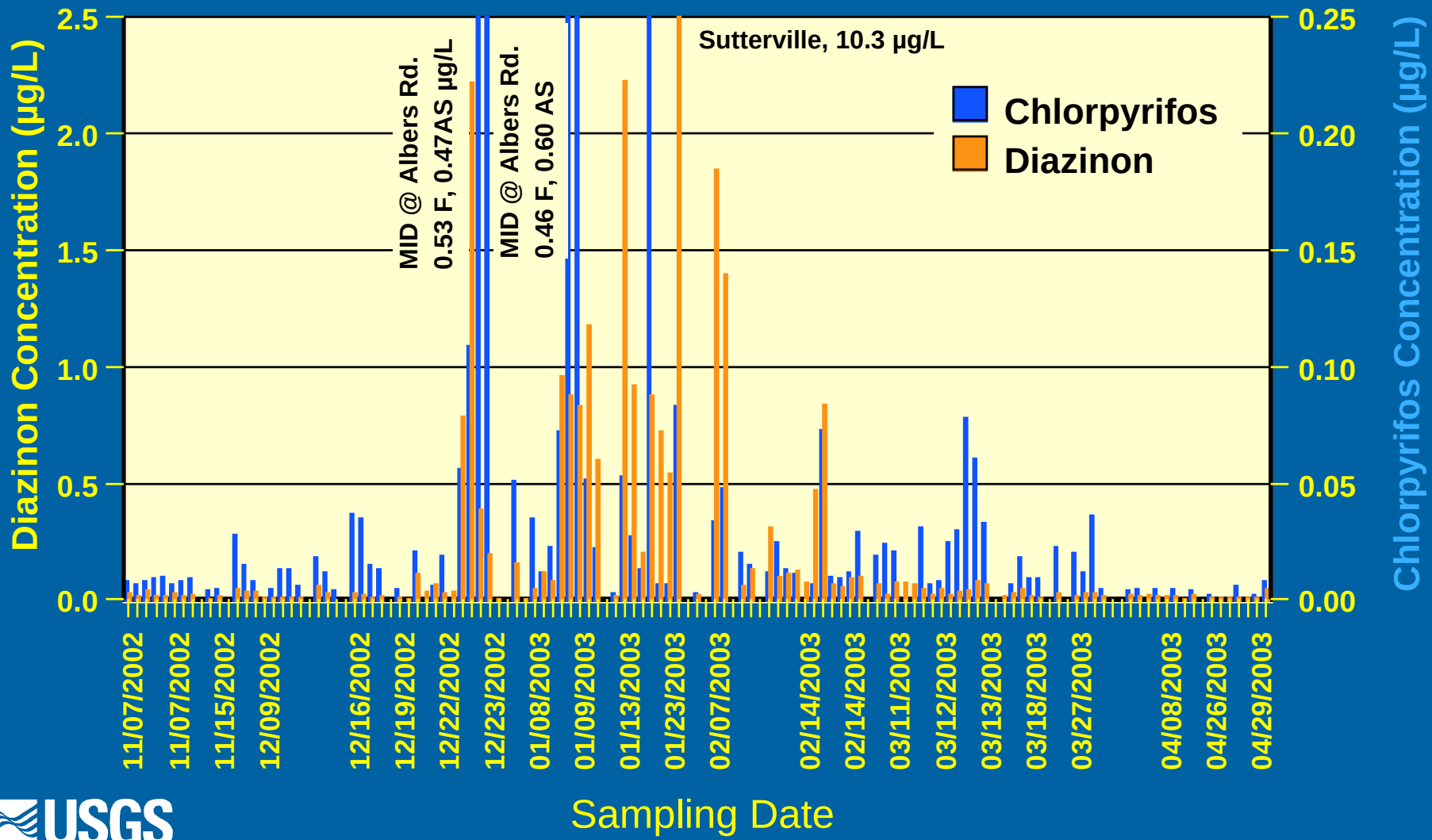
Wet/dry deposition study - OP insecticide trends, 2003



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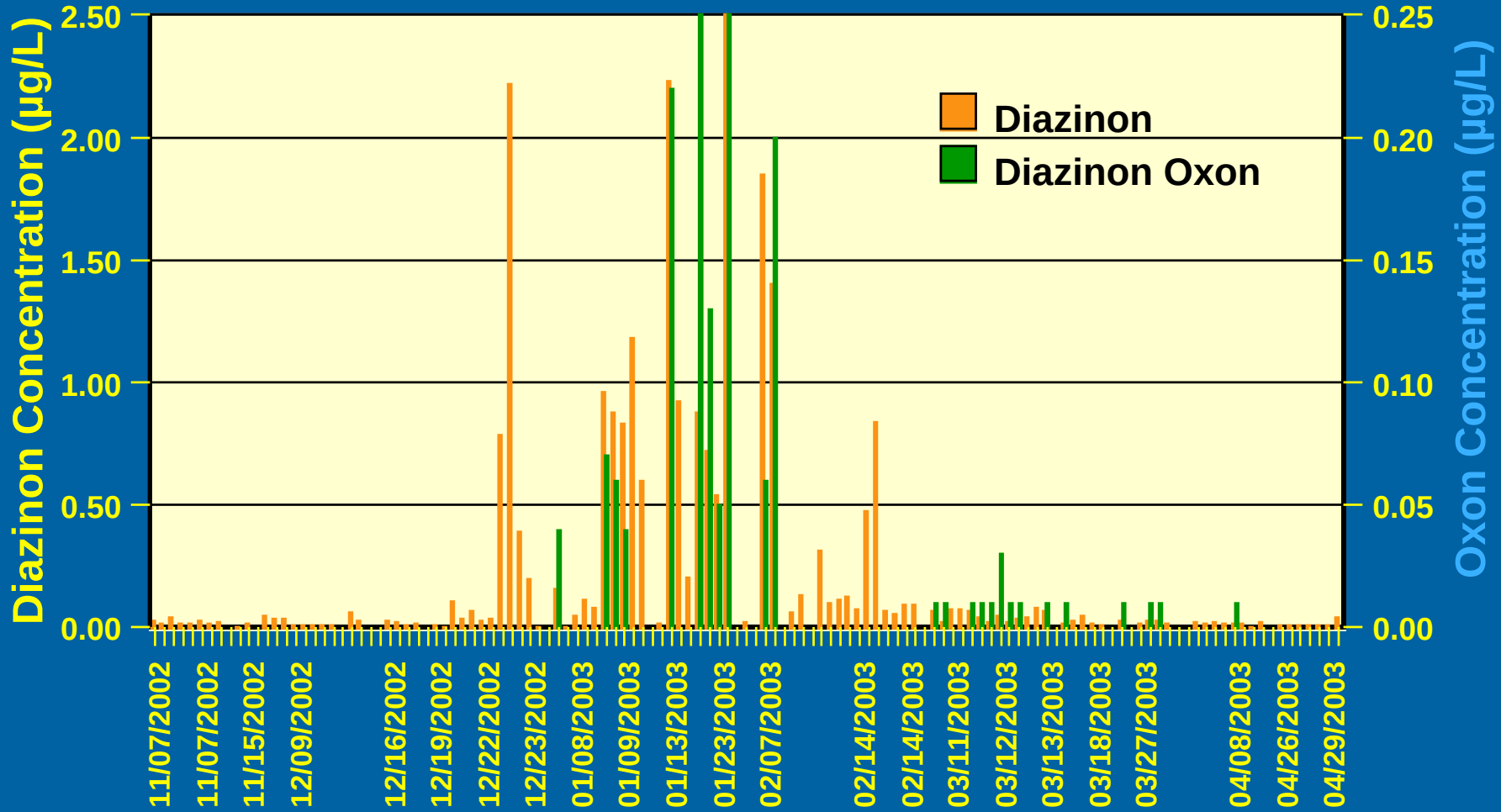
Wet/dry deposition study - OP insecticide trends, 2003



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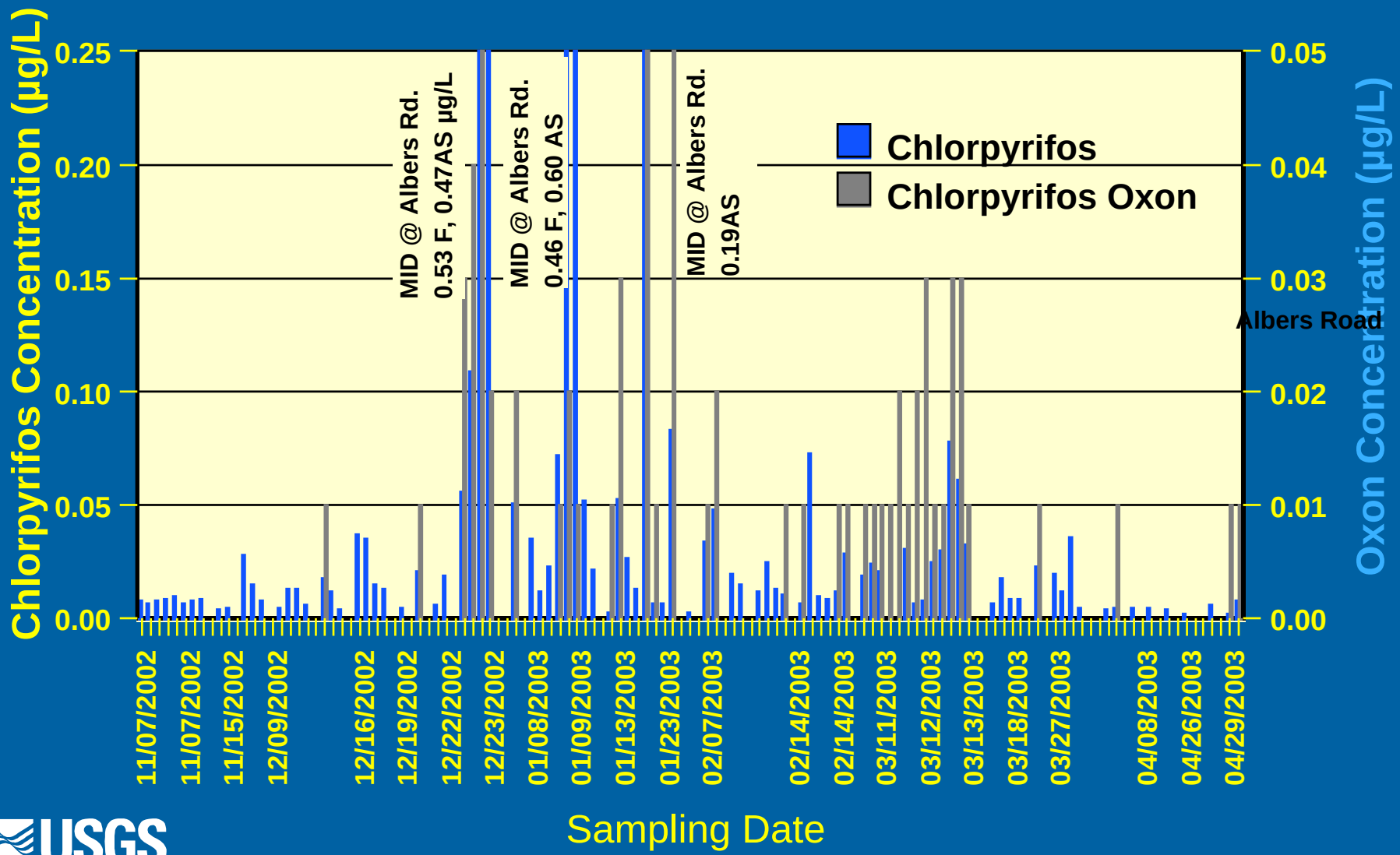
Wet/dry deposition study - OP insecticide trends, 2003



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Evaluation of groundwater nitrate inputs to the lower SJR and their sources (proposal to SWRCB)

3 approaches proposed to define spatial and temporal variability and to quantify nitrate sources and loads:

(1) Boat reconnaissance with continuous measurement of temperature, EC, and optical properties of water just above streambed. Areas with significant changes will have samples collected for C, N, and O isotopes and other tracers. These samples will be compared to samples from source areas.

USGS

Evaluation of GW nitrate inputs to the lower SJR and their sources (proposal to SWRCB) (cont.)

(2) Re-visit 3 sites on SJR (Newman, Crows Landing, and Patterson) with nested piezometers and install 3 more between Patterson and Vernalis. Two years of the following measurements: continuous temperature and water level and monthly nutrients. GW inflow rates will be based on 2 numerical methods: simulation of vertical flow and heat flux beneath the streambed at 6 sites; and simulation of 2-D GW flow at the 3 existing transects.

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Evaluation of GW nitrate inputs to the lower SJR and their sources (proposal to SWRCB) (cont.)

(3) Use SANJ reconnaissance method (used on Merced R) at 30 sites between the 6 permanent piezometer transects twice per year (in Spring and Fall, coordinated with the boat recons). At each site -- measure gradients with a manometer with a drivepoint; measure temperature differences between river and below streambed; measure nitrate in the river and below the streambed.

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