A Healthy Watershed Report Card Approach

Aquatic Life

Watershed Function

Human Health

Central Coast Regional Water Quality Control Board
Karen Worcester
Dave Paradies
John Hunt

Our Vision for the Central Coast…

Healthy Watersheds

Our project concept:

- Use Cadmus stream health and watershed condition layers as baseline condition
- Create indices of health using our own and other data sources
- Assign our site-scaled data to reaches as appropriate
- Combine our data with Cadmus to create a regionally-scaled assessment
- Score watersheds accordingly
- Do all this in an open-source web environment with connectivity to SWAMP/CEDEN, CA Water Quality Goals, GAMA GeoTracker, and DPR Use databases

Current Data Sources

- CCAMP, SWAMP, Central Coast Ag data, MPSL Grant data
- GAMA/Geotracker
- Pesticide use database
- Cadmus data layers
- National Land Cover Dataset
- USGS Flow gage data
- National Watershed Boundary Dataset
- National Hydrography Dataset

Water quality data types include field data, flow, water and sediment chemistry, pathogen indicators, water and sediment toxicity, bioassessment, NNE model outputs

Threshold Selection

- Assembled thresholds from various sources
- Established criteria for threshold selection
  - Marshack algorithms
  - Health not harm ("threshold" effects)
  - Consistency within chemical group
- Selected thresholds for aquatic life (cold, estuarine, and marine) and human health (drinking water and water body contact) in sediment and water as applicable

Threshold Sources

Aquatic Life

- SWRCB Water Quality Goals database
- U.S EPA Aquatic Life Benchmarks
- Basin Plan standards
- California Toxics Rule
- Various U.S. EPA criteria and guidelines
- Chronic LC50 or 1/10th the acute LC50
- MacDonald (1996, 2000), Stortelder (1989), Persaud (1993), etc.

Threshold Sources, cont.

Human Health

- SWRCB Water Quality Goals database)
- GAMA thresholds
- MCLs
- Public Health Notification Levels and Action Levels
- California Public Health Goals
- California Toxics Rule
- California Ocean Plan
- Various U.S. EPA criteria and guidelines

Develop Scoring Approach

- Select and group indicators
- Transform measured data into unit-less scores using a threshold
- Aggregate scores from multiple indicators into a summary index
- Define breakpoints to bin index scores into descriptors of condition (grades or colors)

Scoring Approach

Magnitude -Exceedance Quotient (MEQ)

Combines two terms that express the number of threshold exceedances and the magnitude relative to standard

Derived from Canadian Council of Ministers for the Environment Water Quality Index method

Canadian CCME WQ Index

Factor 1: Scope

$$F_1 = \left(\frac{\text{Number of failed variables}}{\text{Total number of variables}} \right) \times 100$$

Factor 2: Frequency

(Exceedance)

$$F_2 = \left(\frac{\text{Number of failed tests}}{\text{Total number of tests}} \right) \times 100$$

Factor 3: Amplitude

(Magnitude)

$$excursion_i = \left(\frac{FailedTestValue_i}{Objective_j} \right) - 1$$

MEQ: modifications to CCME

We are scoring all tests, not just failed tests. This provides a “good” end to the scoring tool

We eliminated the scope term (how many analytes fail) because we have inconsistent data availability across sites.

We do the calculations at the level of the analyte so that each analyte can also be given a report card score

Calculating MEQ

Calculate exceedance percentage for each analyte

Calculate magnitude (amplitude) for each individual analyte (from CCME)

Calculate unitless sample magnitudes:

Magnitude = concentration/threshold

Calculate average sum of magnitudes

NSM = Σ magnitudes / sample count

Scale from 0 – 100

= NSM / (0.01*magnitude average+0.01)

Calculating MEQ, cont.

Combine exceedance and magnitude factors and scale to 100

$$MEQ = 100 - \left(\frac{\sqrt{exceedance^2 + magnitude^2}}{1.414} \right)$$

Special Handling

- Some analytes (pH, dissolved oxygen, temperature) are scored as a departure outside a range considered acceptable
- Small sample count handling (under 4)
- Organic carbon normalization
- Hardness adjustments for metals

Preliminary Indices

Human Health Index*

- Nitrogen species
- Salts
- Pathogens
- Metals
- Organic Chemicals
- Hydrocarbons

* Note two beneficial uses are involved

Aquatic Life Index

- Conventional Analytes
- Toxicity
- Bioassessment
- Biostimulatory Risk
- Metals
- Organic Chemicals
- Hydrocarbons

Aquatic Life Index

Conventional water quality

- pH departure
- Water temperature
- Nitrate
- Total and unionized ammonia
- Ortho-phosphate
- Total suspended solids
- Turbidity

Pesticides and other Organics

Hydrocarbons

Metals

Bioassessment (Scores follow IBI or CSCI approach)

Biostimulation

- Oxygen departure
- Chlorophyll a (ug/L)
- % floating mats
- NNE oxygen deficit
- NNE predicted benthic chlorophyll biomass

Toxicity

- Algae Toxicity (cell growth)
- Fish survival
- Fish growth
- Invertebrate survival in water
- Invertebrate reproduction in water
- Invertebrate survival in sediment

Human Health Index
(includes drinking water and water body contact)

Nitrogen Species

- Nitrate
- Ammonia
- Nitrite

Salts

- Boron
- Chloride
- Sodium
- TDS

Pathogens

- *E. Coli*
- Fecal coliform

Pesticides and other Organics

Metals

Hydrocarbons

Aggregating scores into an index

Overall Aquatic Life - Harmonic Mean

- Conventional analytes – Harmonic Mean
- Biostimulation – Harmonic Mean
- Metals – Harmonic Mean
- Toxicity – Worst score
- Organic chemicals, hydrocarbons – Worst score

Overall Human Health – Harmonic mean or worst score of toxic chemicals, whichever is lower

- Pathogens, salts – Harmonic mean
- Nitrogen species, Organic chemicals, metals, hydrocarbons – Worst score

Using Cadmus Healthy Watersheds data

Stream Health

California Stream Condition Index

Habitat Index (PHAB and CRAM)

Water Quality Index (conductivity, nitrate and turbidity medians)

Watershed Condition

Percent Natural Cover

Percent Intact Active River Area

Sedimentation Risk

Percent Artificial Drainage Area

Dam Storage Ratio

Road Crossing Density

Cadmus Stream Health

- Cadmus Stream Health layer serves as baseline condition for Region (aquatic life only)
- Scoring is regionalized (highest score in Region is set at 100)
- Scores are redistributed to 6 categories
- Where measured data is available, measured scores are combined Cadmus scores


www.ccamp.us

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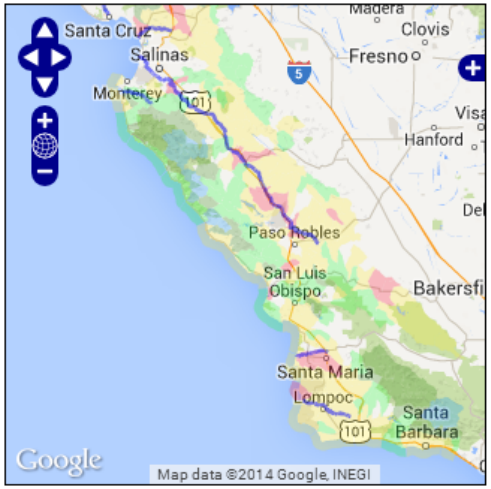
CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD



Aquatic Life | Watershed Function | Human Health

January 13, 2014 Watershed Report for the Central Coast Water Board's Vision of Healthy Watersheds : healthy aquatic habitat, proper land management, and clean groundwater.

Sturgeon Generals Warning: this web app is a very rough work in progress version.

Grades: = **A**+ Outstanding = **A** Excellent = **B** Good = **C** Fair = **D** Impacted = **F** Severely Impacted

A Vision for Healthy Watersheds

Welcome to the Central Coast Water Board's "Healthy Watersheds" Website! This website helps you learn where our Central Coast waters are healthy... and if they're not healthy, why not? [edit]

This website provides an assessment of the Central Coast Water Board's vision of "Healthy Watersheds" and attainment of the Board's three vision goals:

Healthy Aquatic Habitat – By 2025, 80 percent of Aquatic Habitat is healthy, and the remaining 20 percent exhibits positive trends in key parameters.

Proper Land Management – By 2025, 80 percent of lands within an watershed will be managed to maintain proper watershed functions, and the remaining 20 percent will exhibit positive trends in key watershed parameters.

Clean Groundwater – By 2025, 80 percent of groundwater will be clean, and the remaining 20 percent will exhibit positive trends in key parameters.

In this website we employ data from multiple sources (including our own Central Coast Ambient Monitoring Program) to assess health. We also make use of a statewide "Healthy Watersheds" assessment to draw conclusions about areas where we have no monitoring data available.

CENTRAL COAST AMBIENT MONITORING PROGRAM

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Close

About This Website

This website provides an assessment of the Central Coast Water Board's vision of "Healthy Watersheds" and attainment of the Board's three vision goals: healthy aquatic habitat, proper land management, and clean groundwater.

This website uses a novel technical approach to make a wide array of information available in a user friendly format. We utilize a scoring approach structured around water quality thresholds and indices of health that are protective of sentinel species (including humans!). Tools that support this assessment include:

- a comprehensive scoring approach of water quality indicators into indices of aquatic and human health;
- a report card system to quickly convey detailed status and trends information to decision makers;
- a comprehensive approach that overlays regional indices of health on statewide assessments to enhance and improve the health assessment in the Central Coast;
- a data navigator that provides maps, charts, and tables of data and summary statistics;
- trend and change analysis that uses multiple statistical approaches to assess change over time;
- an evaluation of relationships between numerous watershed attributes and water quality;
- a stream flow and loading model for assessing risk associated with pollutant loading on the nearshore environment.

More detailed information on the technical approach is accessible here:

Technical_Approach

Scoring_Approach

Selecting_Thresholds

Sources_of_Data

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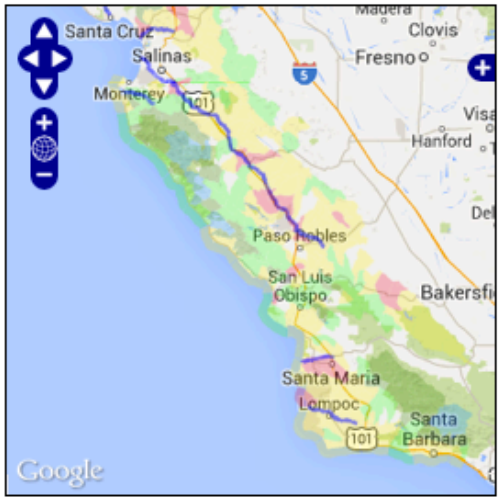

Aquatic Life

Watershed Function

Human Health

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Central Coast Regionwide Watershed Report

Healthy Aquatic Habitat – By 2025, 80 percent of Aquatic Habitat is healthy, and the remaining 20 percent exhibits positive trends in key parameters.

Aquatic Life Grades 

Proper Land Management – By 2025, 80 percent of lands within a watershed will be managed to maintain proper watershed functions, and the remaining 20 percent will exhibit positive trends in key watershed parameters.

Watershed Function Grades 

Clean Drinking Water – By 2025, 80 percent of groundwater will be clean, and the remaining 20 percent will exhibit positive trends in key parameters.

Human Health Grades 

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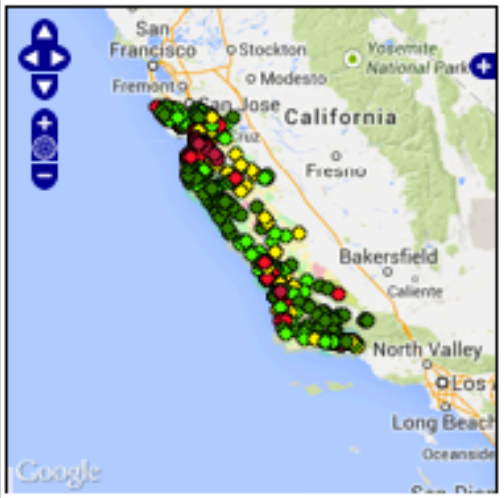

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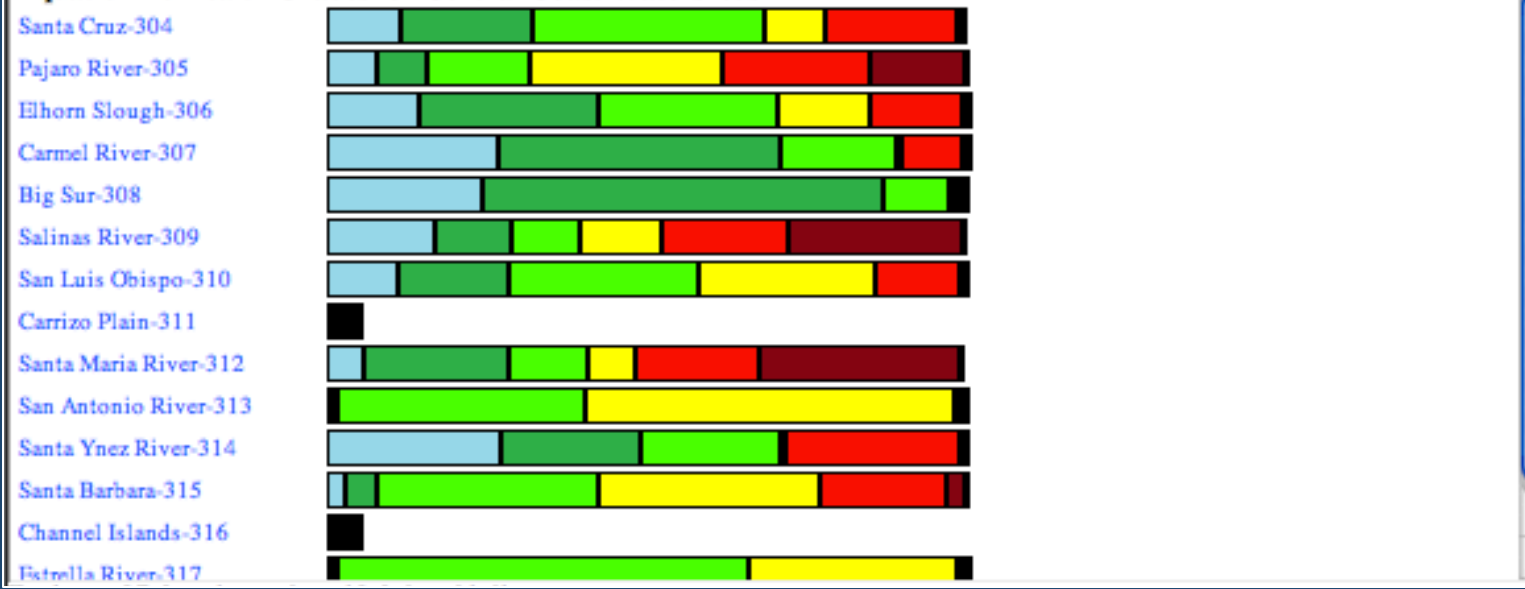
Aquatic Life Health Grades for Central Coast Watersheds



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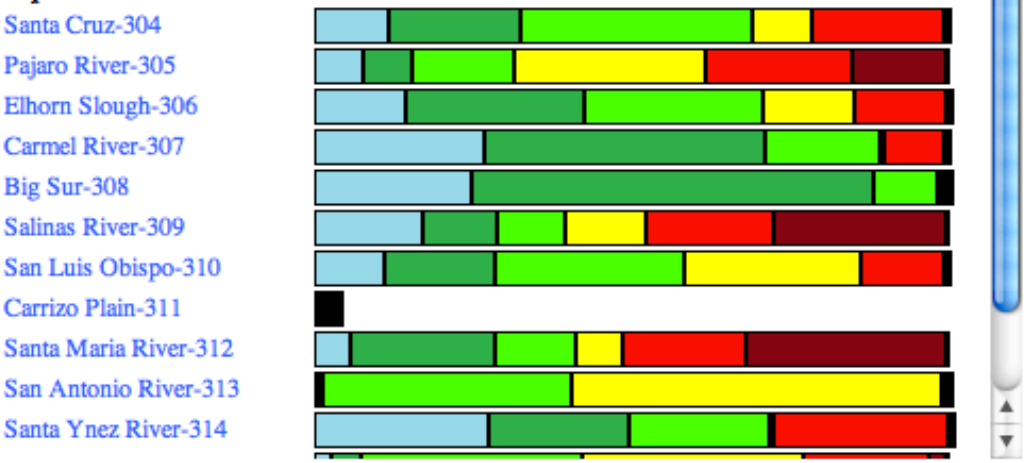

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Aquatic Life Grades for Waterbodies in the Santa Cruz Watershed

Watersheds

Waterbody	Aquatic Life Grade	Aquatic Life Score
Aptos Creek	B	89
Arana Gulch Creek	B	85
Bear Creek(Santa Cruz County)	B	83
Boulder Creek	B	85
Branciforte Creek	A	92
Gazos Creek	D	61
Kings Creek	not yet	
Lompico Creek	B	86
Majors Creek (Santa Cruz County)	not yet	
San Lorenzo Estuary	B	84
San Lorenzo River	A	91

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San Lorenzo River	A	91
San Vicente Creek	A	92
Santa Cruz Harbor	D	60

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Aquatic Life Health Grades for Sites in the wb_id_280

Watersheds Waterbodies

Site	Site Name	Aquatic Life Grade	Aquatic Life Score
304GAZ	Gazos Creek Lagoon at Hwy 1	not yet	61

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Gazos Creek Lagoon at Hwy 1 (304GAZ)

Watersheds | Waterbodies | Sites

Aquatic Life	Conventional Analytes	Biostimulation	Benthics	Toxicity	Metals	Organic Chemicals	Hydrocarbons
D (61)	95	88			79	23	96

Human Health	Nitrogen Species	Salts	Pathogens	Metals	Organic Chemicals	Hydrocarbons	Groundwater
A (96)	98		85	100	100	100	

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The Aquatic Health Grade of **D** (61) was based on scoring of ***n_analytes_aquatic_life analytes and ***n_samples individual tests. 0 conventional analytes were in poor or very poor condition. Other conventional analytes scored fair or better, with 9 in excellent or good condition. Of ***25 organic chemicals tested in water or sediment, ***5 were detected and ***2 scored poor or very poor; these were diazinon in water (2 samples) and chlorpyrifos in sediment (3 samples). No samples were collected for hydrocarbons. Of ***6 metals tested in water or sediment, ***6 were detected and ***2 scored poor or very poor; these were copper (5 total samples) and arsenic (3 samples). Benthic invertebrates scored ***D, and toxicity scored C overall, with ***invertebrates in sediment scoring lowest .

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Trichlorfon	ug/l	water	0.03	0.03	0.03	2	A
Trichloronate	ug/l	water	0.03	0.03	0.03	2	A
Chlorpyrifos	ug/l	water	0.005	0.01	0.02	4	A
Chlorpyrifos	ug/kg dw	sediment	5.32	5.32	5.32	1	A
DDT, total	ug/kg dw	sediment	160	160	160	1	F
Dieldrin	ug/kg dw	sediment	0.64	0.64	0.64	1	A
Endrin	ug/kg dw	sediment	1.43	1.43	1.43	1	A
HCH,gamma(Lindane)	ug/kg dw	sediment	0.52	0.52	0.52	1	A
Heptachlor	ug/kg dw	sediment	0.78	0.78	0.78	1	A
Heptachlor Epoxide	ug/kg dw	sediment	0.77	0.77	0.77	1	A
Mirex	ug/kg dw	sediment	1.43	1.43	1.43	1	A
Methyl Parathion	ug/l	water	0.01	0.01	0.01	2	A

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Gazos Creek Lagoon at Hwy 1 (304GAZ)

Watersheds Waterbodies Sites

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Bell Creek (Santa Barbara Co)	C	73
Canada de la Gaviota	B	86
Canada Del Refugio	C	70
Canada Honda Creek	A	94
Carpinteria Creek	C	71
Devereux Slough	not yet	
Dos Pueblos Canyon Creek	A	90
El Capitan Creek	B	82
Franklin Creek	D	62
Glenn Annie Creek	C	76
Goleta Slough	B	82
Jalama Creek	B	87
Los Carneros Creek	C	76
Maria Ygnacio Creek	B	80
Mission Creek	C	73

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Franklin Creek at Carpenteria Avenue (315FRC)

Watersheds Waterbodies Sites

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D (63)	71	45		76	84	54	46

Human Health	Nitrogen Species	Salts	Pathogens	Metals	Organic Chemicals	Hydrocarbons	Groundwater
F (18)	18		27	100	96	100	

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Franklin Creek at Carpenteria Avenue (315FRC)

Watersheds Waterbodies Sites

*	Analyte	Units	Matrix	Min	Mean	Max	# Samples	Grade
●	Oxygen,Dissolved-departure	mg/l	water	0	3.39	15.2	131	F
●	Water Temperature-departure	degrees c	water	0	0.55	8.08	131	B
▼	Ammonia as N,Total	mg/l	water	0.01	0.05	0.31	129	A
▼	Ammonia as N,Unionized	mg/l	water	0	0.003	0.03	230	A
●	Nitrate,Nitrite as N	mg/l	water	1.78	21.3	48.1	128	F
▼	OrthoPhosphate as P	mg/l	water	0.003	0.15	1.9	128	D
●	pH departure	-log[h+]	water	0	0.07	0.87	131	A
●	Suspended Solids,Total	mg/l	water	0.11	19.2	370	254	A
●	Turbidity	ntu	water	0	17.1	818	132	A

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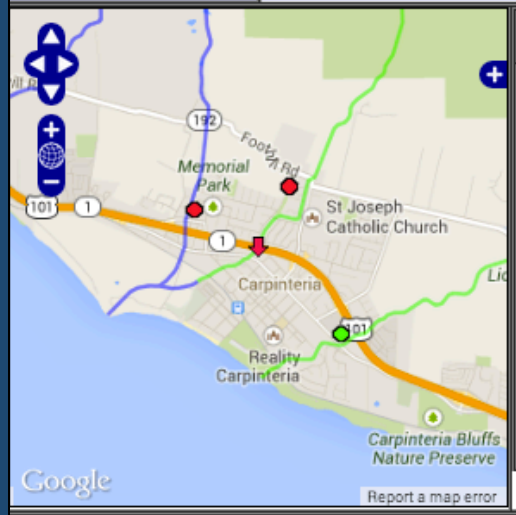
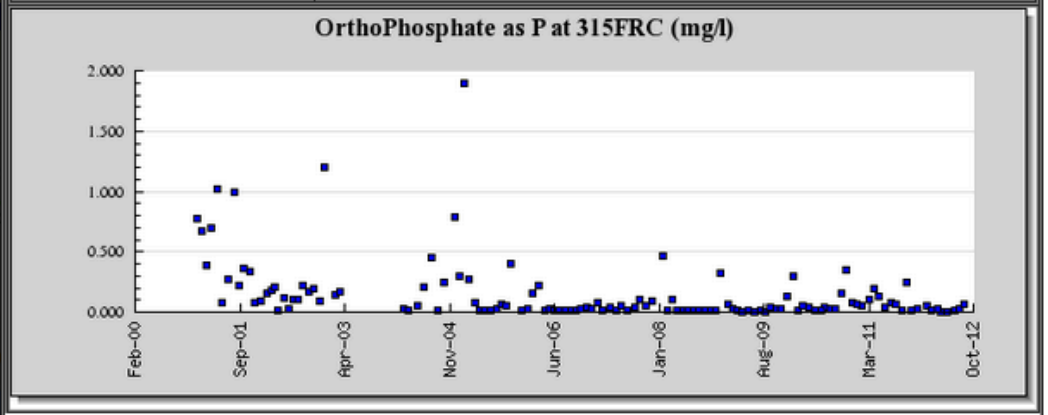
Watersheds | Waterbodies | Monitoring Sites



Basic Water Quality | Analytes



Map Overlays | Chart Options | More Information

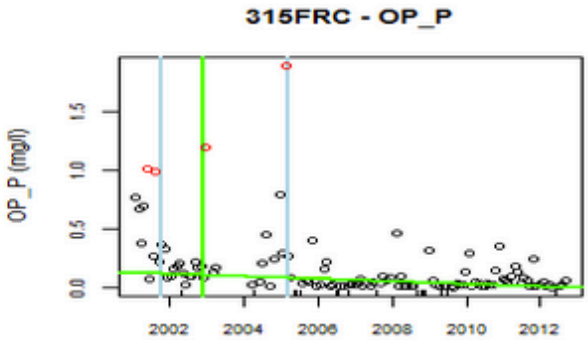
● = Outstanding ● = Excellent ● = Good ● = Fair ● = Impacted ● = Severely Impacted ⇧ = Increasing ⇩ = Decreasing ○ = No change

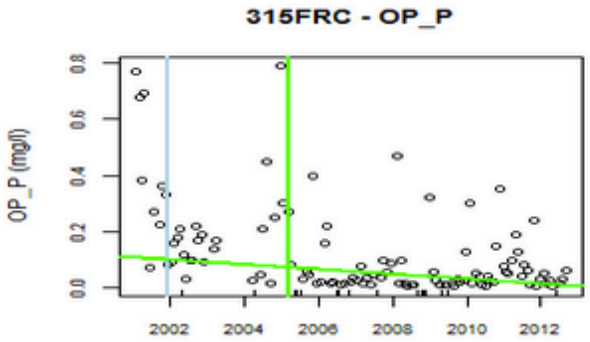
**	Analyte Name	Units	Min	Mean	Geomean	Median	Max	Samples	Dates	Before	After	Year
●	Air Temperature	Degrees C	10.0	19.9	19.5	20.0	30.0	91	2001-2012			
●	algae-attached	%	0.00	77.48	74.98	95.00	100.00	117	2001-2012			
●	algae-filamentous	%	0.00	29.92	14.18	5.00	98.00	26	2001-2003			
●	algae-floating mats	%	0.00	13.37	16.11	0.00	85.00	94	2004-2012			
⇩	Ammonia as N,Total	mg/l	0.010	0.049	0.035	0.031	0.312	129	2001-2012	0.069	0.036	
⇩	Boron,dissolved	mg/l	0.020	0.405	0.384	0.410	0.620	122	2001-2012	0.467	0.383	
●	Calcium	mg/l	13.00	108.02	104.05	110.00	190.00	127	2001-2012			
●	Chloride	mg/l	5	87	83	88	190	122	2001-2012			
●	Chlorophyll a	ug/l	0.000	11.889	4.273	4.170	311.000	131	2001-2012			
●	Coliform, E. coli	MPN/100 ml	30	2,183	546	440	93,000	91	2005-2012			
⇩	Coliform, Fecal	MPN/100 ml	30	2,537	969	900	50,000	128	2001-2012	3,044	1,000	
●	Coliform,Total		240	22,202	10,581	13,000	160,000	135	2001-2012			

Select a Monitoring Site

Franklin Creek at Carpenteria Avenue (315FRC)

Watershed area (1,685 acres)





Outliers (unusual single samples) included | **Outliers excluded**

Change analysis - Concentration | About the site | About Change analysis

Analyte	Change	Trend	Date of Change	Before	After	% Change
Ammonia as N,Total(NH3_N)	Decreasing	No trend	Jan 17 2006	0.056	0.036	-36%
Ammonia as N,Unionized(NH3U_N)	Decreasing	Decreasing	Jan 17 2006	0.0038	0.002	-47%
Boron,dissolved(BORON_DIS)	Decreasing	Decreasing	Jan 06 2005	0.47	0.38	-19%
Calcium(CA)	No change	No trend				0%
Chloride(CHLORIDE)	No change	No trend				0%
Chlorophyll a(CHLORA)	No change	No trend				0%
Coliform,ecoli(ECOLI)	Decreasing	No trend	Jun 18 2009	1700	455	-73%
Coliform,Fecal(FCOLI)	Decreasing	No trend	Jun 18 2009	1842	1051	-43%
Coliform,Total(TCOLI)	No change	No trend				0%
Dissolved Solids,Fixed(FTDS)	No change	Decreasing				0%
Dissolved Solids,Total(TDS)	No change	Decreasing				0%
Dissolved Solids,volatile(VTDS)	No change	No trend				0%

What's Next?

- Peer review by Jon Marshack and others
- Internal testing by agency staff
- Presentation at MCC and State Board (by EO request)
- Potential for use in the Healthy Streams My Water Quality portal
- Publication of methods in peer reviewed journal
- Launch of public website

Technical next steps

- Create Land disturbance index from Cadmus and other data
- Extend site scores upstream (to next site or land disturbance boundary)
- Merge scores with Cadmus stream health layer
- Bring groundwater into Human Health evaluation
- Evaluate index scores for change to assess change component of vision goals