Attachment 1

Preliminary Draft Report Staff Recommendations for Agricultural Order

WATER QUALITY CONDITIONS IN THE CENTRAL COAST REGION RELATED TO AGRICULTURAL DISCHARGES

Preliminary Draft Report

CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD

February 1, 2010

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Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Item No. 3 Attachment No. 3
Agricultural Order Renewal
Public Workshop
May 12-13, 2010 Meeting

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Section I - Surface Water Quality

The Central Coast Region includes a diverse landscape of agricultural crops, orchards, and vineyards, rapidly expanding urban areas, and many miles of paved roadways. Chemicals applied to the land (including nutrients, pathogens, metals, pesticides, herbicides, petroleum products and others) make their way into drainages, creeks and rivers, and ultimately the ocean. Pesticides and nutrients that are applied to the land are causing serious damage to our Central Coast water resources. Not all pesticide and nutrient pollution originates from agricultural land. However, numerous research projects and monitoring programs have shown high levels of chemicals leaving agricultural land and entering the waterways of our Region. Our Region's Central Coast Ambient Monitoring Program (CCAMP) data provided evidence of this problem during development of the existing and first Regulatory Order for irrigated agricultural discharges in 2004, the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Agriculture Order). The Order specified monitoring requirements that led to development of the Cooperative Monitoring Program for Agriculture (CMP).

The CMP has now collected over five years of baseline data from 50 long-term trend monitoring sites in agricultural areas, as well as additional data from a number of follow-up monitoring studies. The CMP has developed several summary reports, summarizing the findings of the baseline monitoring program, as well as of follow-up activities. Some of those findings are summarized in this staff report. Data, documentation, and references supporting those findings are included as part of the administrative record. The data, documentation and references are also available online through our CCAMP Agricultural Wiki (www.ccamp.net/ag).

CCAMP has been in place since 1998, and has collected data from watersheds throughout the Region. CCAMP has also collected monthly trend monitoring data at coastal confluence sites since 2001. CCAMP findings related to agricultural pollutants are summarized in this staff report. More complete documentation of CCAMP information, including references and access to data, charts, related documents and maps, can be reached through the CCAMP Ag wiki or at www.ccamp.org.

In this staff report we combine data from the CMP and CCAMP to develop a comprehensive assessment of water quality in agricultural areas throughout the Region, and are evaluating data relative to associated agricultural land use. The CMP data focused monitoring in problem areas and CCAMP data focuses monitoring in all areas of the Region. We also are evaluating both sets of data for evidence of trends. Finally, we have completed an assessment of potential risk to Marine Protected Areas in the nearshore marine environment.

1.0 Overall Water Quality Status

We have summarized overall water quality status of all sites monitored through the CCAMP and CMP programs using a multi-metric approach that combines and scores several parameters into a water quality index. The water quality index includes water temperature, unionized ammonia, water column chlorophyll a, total dissolved solids (TDS), nitrate-nitrite, orthophosphorus, turbidity, and dissolved oxygen. We scored each parameter into one of four categories (good condition (light gray), slightly impacted (medium gray), impacted (dark gray) and very impacted (black). White areas are unscored. Sites which have naturally elevated salt concentrations were removed from consideration for TDS. We have created a separate index for toxicity. The rules for scoring are based on percentile ranking relative to water quality criteria or guideline values, and are described in the CCAMP Ag wiki (www.ccamp.net/ag). We have used the same rules to score sites, water bodies, and watersheds. Map of the water quality index results (scored for small watersheds (HUC12) using federally defined boundaries) is shown in Figure 1.

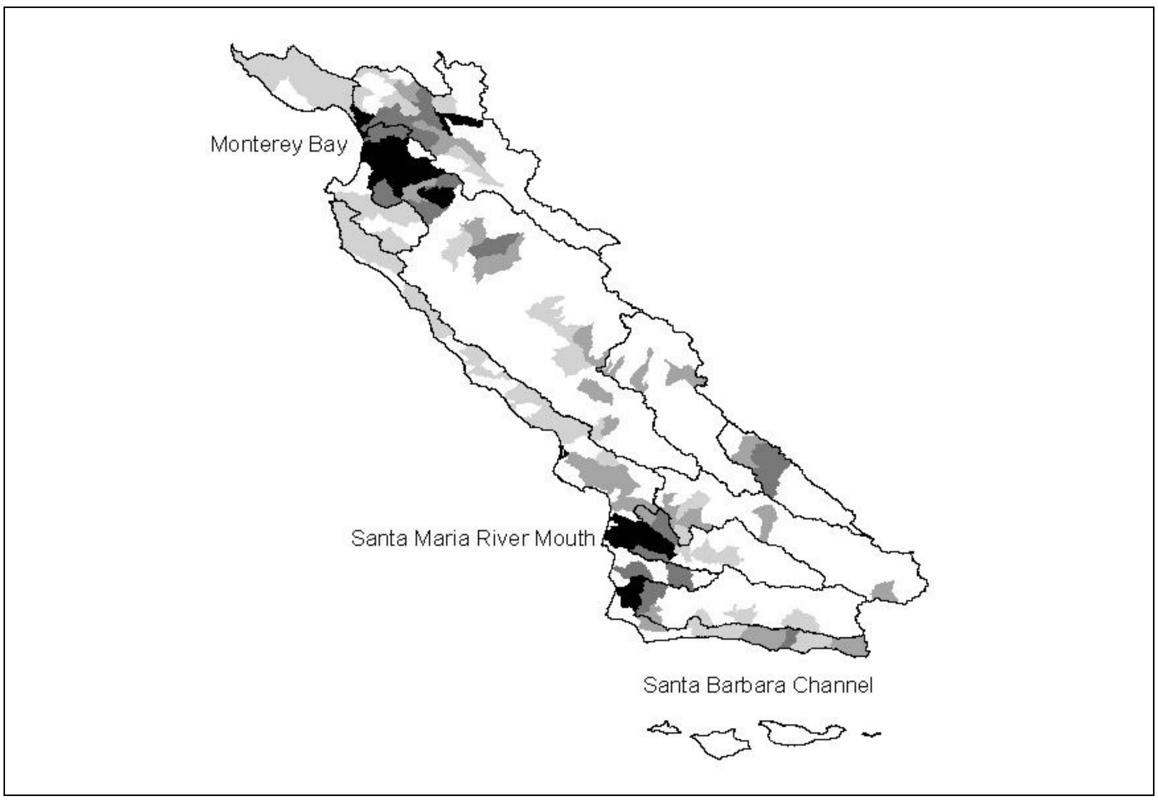

Figure 1 - CCAMP Water Quality Index (scored for HUC12 watersheds)

These summary indices confirm that two areas of our region stand out in terms of severity of impact. These are the lower Salinas and Santa Maria watersheds, both areas of intensive agricultural activity. We have evaluated the water quality index at 250 individual sites. Of the 51 sites that score worst (less than 40 out of 100 possible points), 82 percent are in these two areas. Similar results are seen for the toxicity index, where all of the worst scoring sites (less than 40 out of 100 points) fall in the Santa Maria and Salinas watersheds. Some of the worst quality sites in the Region, Orcutt-Solomon Creek and the Salinas Reclamation Canal, drain directly to sensitive estuarine habitat. In flow and source area follow-up studies by CMP, Orcutt Creek was shown to flow at high volumes at the lower end of the watershed, with agricultural discharges being the primary source of elevated flow, nitrate, toxicity and sediment. Agricultural discharges contribute significantly to Salinas Reclamation Canal water quality problems both above and below the City of Salinas, though urban loading of nitrate and sediment can be important during winter months. The source areas study identifies several other locations where dominant discharges are from agriculture, but it also identifies other areas where urban discharges and surfacing groundwater are dominant influences.

Several other areas in the Region are also in very poor condition. These include the lower Santa Ynez River (heavily influenced by a point source discharge), and the San Juan Creek and Watsonville Slough area in the Pajaro River watershed (heavily influenced by agricultural activities).

Our proposed 2010 List of Impaired Waters recommends 704 listings. This is the list of water bodies not meeting water quality standards developed every two years pursuant to Section 303(d) of the Clean Water Act. The List has been approved by the Central Coast Water Board, but not yet by the State Water Resources Control Board or the US Environmental Protection Agency, as required by law. The List is based on a uniform assessment of all data collected through 2006, including data from CMP, CCAMP, and other sources and is the most comprehensive evaluation of data conducted in the State for this purpose. Of the 704 impaired waterbody listings in the Central Coast Region, 83 are in the lower Santa Maria area, and include fifteen different pollutants and fifteen water bodies; Orcutt Creek and the Santa Maria River have the most listings. One-hundred and seventeen are in the Salinas watershed area, with 11 different pollutants and 16 water bodies; the lower Salinas River, the Salinas Reclamation Canal, and Quail Creek have the most listings.

1.1 Nitrate Pollution

Nitrate is arguably the most serious and widespread of all pollution problems in the Central Coast Region. The proposed 2010 List of Impaired Water bodies includes forty-seven Central Coast water bodies that have drinking water beneficial uses impaired by nitrate pollution. Sixty-eight percent of these nitrate listings occur in our three major agricultural watersheds: Salinas River (15 water bodies), Pajaro River (5 water bodies) and Santa Maria River (12 water bodies). Other notable listings fall in small drainages in areas of intensive agriculture or greenhouse activity along the south coast, including Arroyo Paredon, Franklin Creek, Bell Creek, Los Carneros and Glen Annie creeks. Water bodies that are proposed to be listed for nitrate pollution for the 2010 List are shown in Figure 2.

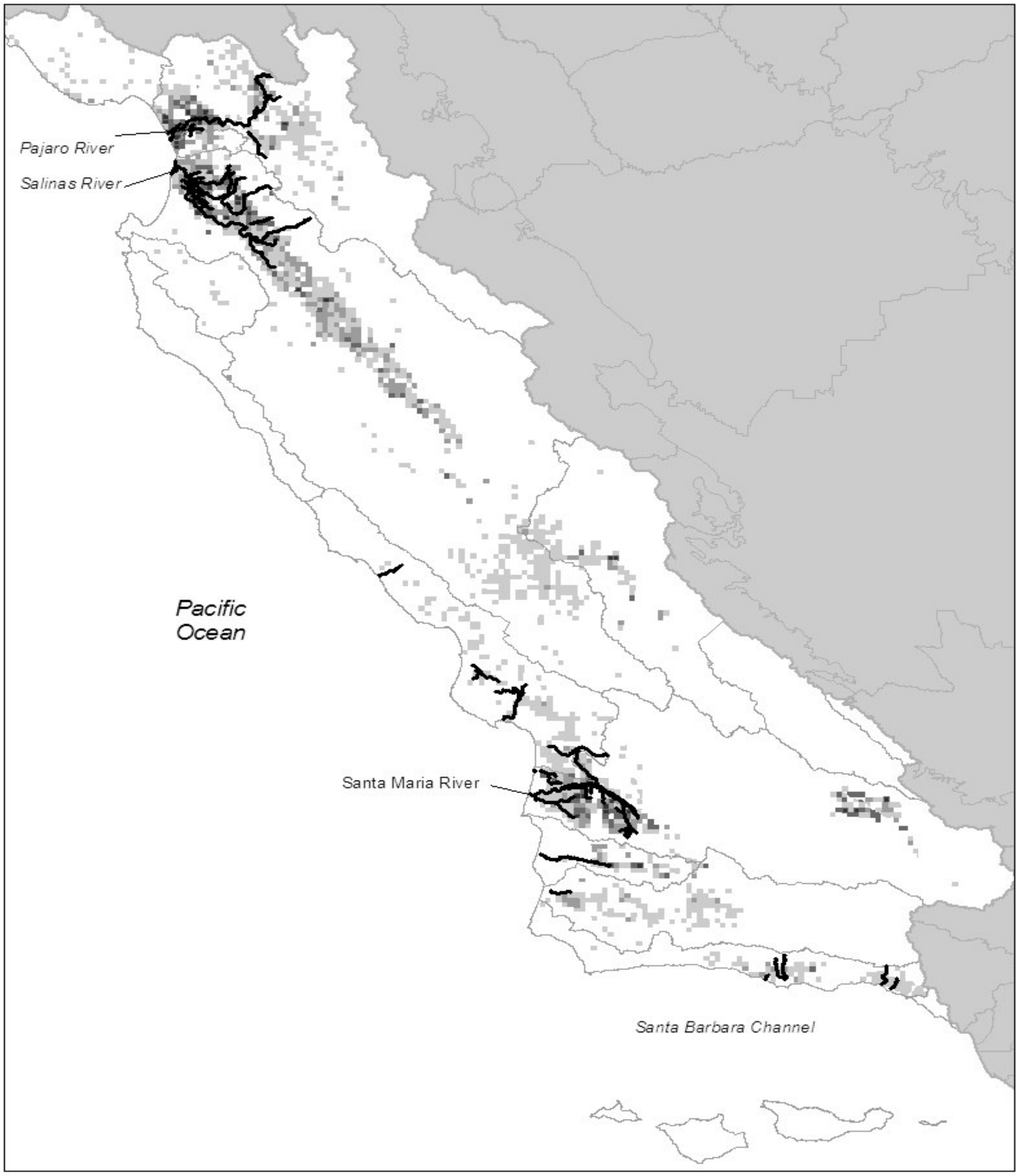

Figure 2 - Proposed 2010 Nitrate Listings in Region 3. Listed water bodies are shown as darkened lines, irrigated agriculture is shown in gray tones.

Of the 250 sites evaluated for the CCAMP and CMP monitoring programs, fully 30 percent have nitrate-N concentrations that exceed the drinking water standard on average. Several of these water bodies have average nitrate that exceed the standard by five-fold or more. The top twenty worst sites from the standpoint of nitrate concentrations have mean concentrations that range from 32.6 to 93.7 mg/L. Staff has determined the acres of row crop agriculture associated with these sites, both in the immediate catchment and in the upstream watershed, based on the National Land Cover Database, 2001. Row crop acreage ranges from 16.1 to 89.1 percent of the immediate catchment area and from 4.7 to 73.3 percent of the total upstream watershed area. Other land uses can contribute to nitrate concentrations, including orchards and vineyards, greenhouses and nurseries and urban landscapes. However, many of the worst quality sites are in areas dominated by row crop agriculture, either in the near vicinity or in the upstream watershed area.

Though overall acreage of irrigated agriculture can serve as an indicator of risk for nitrate pollution, it can't predict locally-scaled impacts. We have observed that even relatively small agricultural operations can greatly influence in-stream nitrate concentrations. In one example, the single intensively irrigated row crop operation on a small watershed was taken out of production in 2006. Nitrate concentrations on the creek were typically around 30 mg/L when first sampled by CCAMP in 2002, and have since declined to under the drinking water standard of 10 mg/L.

With a few exceptions, most high quality sites (where mean nitrate is less than 1.0 mg/L- N) have wet season nitrate averages that are higher than dry season averages. Increased concentrations in winter may result when rain water moves nutrients off of the land into surface waters. Of the 81 higher quality sites evaluated, 80 percent have average dry weather nitrate concentrations that are lower than average wet weather nitrate concentrations. Conversely, most sites with elevated nitrate concentrations (mean nitrate concentration greater than 1.0 mg/L- N) have dry season averages that are higher than their wet season averages. This can result when agricultural discharges are the primary source of water in the dry season and rain acts to dilute instream concentrations in the wet season. Of the 133 sites with elevated nitrate concentrations, 79 percent have average dry weather nitrate concentrations that are higher than average wet weather nitrate concentrations. Where average concentrations exceed 30 mg/L, 89 percent of sites have dry weather concentrations that are higher than wet weather concentrations.

We also have evidence that urban land uses are contributing less significantly to nitrate concentrations than are surrounding agricultural lands. The City of Salinas is a major urban area permitted for stormwater discharges with a Phase 1 National Pollutant Discharge Elimination System Municipal Permit. The City drains to several water bodies that are tributary to Tembladero Slough. The Salinas Reclamation Canal travels from agricultural land through the City of Salinas and then back through agricultural land to Tembladero Slough. Concentrations at the lower end of the City are significantly lower than concentrations entering the City, and than those farther downstream once the drainage travels back through agricultural land. The City does not appear to be significantly contributing to the nitrate problem on this system, and in fact there appears to be a dilution effect across the reach of stream that passes through the City.

1.2 Toxicity and Pesticides

The levels of toxicity found in ambient waters of the Central Coast far exceed anything allowed in permitted point sources discharges. The California Toxics Rule allows only one acute and one chronic toxic test every three years on average for permitted discharges to surface waters. We have drainages in agricultural areas of the Region that are toxic virtually every time they are measured.

CCAMP does not sample for toxicity at all sites, but rather at sites in areas of most intensive land use. Region wide, CCAMP and the CMP have conducted toxicity monitoring in 80 streams and rivers in the Region. In 16 percent of these, no toxic effects were observed. Some measure of lethal effect (as opposed to growth or reproduction) has been observed at 65 percent of the water bodies monitored.

A number of published studies have already linked invertebrate toxicity in the Central Coast to chlorpyrifos and diazinon in water, and to chlorpyrifos and pyrethroids in sediment. A summary of this work and all references can be accessed through the Ag wiki at http://www.ccamp.net/ag/index.php/Main_Page#Toxicity. Staff has used data collected by these researchers, by CCAMP and by the CMP to evaluate all Central Coast waters for impairment based on toxicity. As a result, 15 water bodies are on the proposed 2010 List of Impaired Waters for both water column and sediment toxicity, and 14 water bodies are on the List for water toxicity alone. The majority of these toxicity listings are in the lower Salinas River (12 listings) and the lower Santa Maria River (10 listings). Seventy-three percent of all toxicity listings and 56 percent of organophosphate pesticide listings are in these two priority areas.

Acute water column toxicity to *Ceriodaphnia* (invertebrate) was found at 50 percent of sites sampled, and 36 percent of all sites were severely toxic. Of these severely toxic sites, 90 percent are in the lower Santa Maria and Salinas watersheds. Fifteen sites have been toxic to invertebrates in water tests virtually every time they are sampled; the vast majority of these (13 sites) are in the lower Salinas/Tembladero watershed.

CMP conducted follow-up studies at agricultural sites in the lower Salinas and Santa Maria watersheds to clarify the sources of the extensive water column invertebrate toxicity identified by the program in those two high priority areas (Central Coast Water Quality Preservation, Inc., 2006).These follow-up studies documented a strong relationship between concentrations of diazinon and chlorpyrifos pesticides and water column toxicity in the lower Salinas and Santa Maria rivers. Diazinon was most commonly elevated in the Salinas watershed, whereas chlorpyrifos was more typically elevated in the Santa Maria watershed. Malathion and methylmyl were also detected at levels sufficient to cause toxicity. In one of the CMP studies, more diazinon was detected during the wet season than in the dry season in the Santa Maria watershed, and more chlorpyrifos was detected during the wet season than in the dry season in the Salinas watershed. According to the Department of Pesticide Regulation 2006 Pesticide Use Report, many more pounds of diazinon are applied in Monterey County than elsewhere in the Region, particularly to leafy vegetable crops. Chlorpyrifos is applied most heavily to broccoli and wine grapes, in both Monterey and Santa Barbara counties.

Sediment toxicity is also prevalent in agricultural areas of the Region, with 64 percent of all sites sampled showing some toxicity (measured as survival), and all but three of the most toxic 23 sites occurring in the lower Salinas and Santa Maria watersheds – these sites are toxic in 75percent or more of samples. Based on several published studies, sediment toxicity appears to be highly related to pyrethroid pesticides and chlorpyrifos, at least in the lower Salinas and Santa Maria rivers. D. Weston et al (2008) describes finding significant toxicity in sediments coming out of agricultural land above the City of Salinas, as well as within the City limits, and shows that urban chemical signatures were somewhat different than those from agricultural areas. In a statewide study of four agricultural areas conducted by the Department of Pesticide Regulation, the Salinas study area had the highest percent of sites with pyrethroid pesticides detected (85 percent), the highest percent of sites that exceeded levels expected to be toxic (42 percent), and the highest rate (by three-fold) of active ingredients applied (113 lbs/acre) (Starner, 2006). More details on this research, as well as access to the technical papers, can be found at http://www.ccamp.net/ag/index.php/Toxicity_Research_Findings.

Toxicity to algae and fish is less commonly encountered in the Central Coast region than toxicity to invertebrates. Overall, lethal effects for fish were the least commonly encountered toxic effect. Acutely toxic effects were found at 28.5 percent of sites sampled, and 6.5 percent of sites were severely toxic. The CMP found repeated toxicity to fish in several tributaries in the Santa Maria watershed and at several sites along the main stem of the Salinas River, from Greenfield to Spreckels. Several other sites had more than one toxic sample, including Prefumo Creek in San Luis Obispo and Tequisquita Slough in the Pajaro watershed. Toxic effects to algae were found at 44 percent of sites, with 11 percent of sites severely toxic. Toxicity to algae shows a different pattern than most other contaminants staff has examined in this report. In addition to toxicity in the lower Salinas and Santa Maria areas, algal toxicity was also prevalent in some of the Santa Barbara area streams (Glenn Annie, Franklin, Bell), the Pajaro watershed (Furlong Creek, San Juan Creek, lower San Benito River, Pajaro River at Murphy's Crossing, and Harkins and Watsonville sloughs), and in the lower Santa Ynez River. This may suggest other sources than runoff from irrigated agricultural fields, such as roadway maintenance, creek channel clearing, or other activities involving herbicides.

1.3 Other Parameters of Concern

Turbidity in a healthy creek system in the Central Coast Region is typically very low during the dry season (under 5 NTU), and though it can be elevated during rain events it typically drops back down to low flow conditions relatively rapidly. Waters that exceed 25 NTUs can reduce feeding ability in trout (Sigler et al., 1984). Elevated turbidity during the dry season is an important measure of discharge across bare soil, and thus can serve as an indicator of systems with heavy tailwater discharge. Many of the sampling sites in areas dominated by agricultural activities have sustained turbidity throughout the dry season, in some cases greatly exceeding 100 NTU as a median.

CCAMP staff evaluated whether sustained problems were present at monitoring sites using median turbidity values. Ninety-three percent of all sites with a median turbidity value exceeding 100 NTUs were in the lower Salinas and Santa Maria watersheds. The worst of these sites, on Chualar Creek (309NOS) had a median value of 3000 NTUs, the upper measurement limit of the turbidity probe. For reference, a majority of CCAMP sites have a median turbidity under 5 NTUs.

Water temperature becomes elevated when creeks are not adequately shaded and solar exposure is high. Low flow and wide sandy stream bottoms contribute to water heating. Twenty-one degrees Celsius is considered at the upper end of a desirable range to support steelhead trout (Moyle, 1976). Though water temperature is problematic in many of the same areas as other parameters examined, there are several other geographic areas of concern. For the 32 sites that most frequently exceed 21^{o}C, less than half are located in the lower Salinas and Santa Maria watershed areas. Other areas that have elevated temperatures include the lower Santa Ynez and tributaries, middle reaches of the Salinas watershed, and several smaller creek systems like Huasna, Jalama and San Lorenzo Creek.

Water quality impairment associated with ammonia is not as widespread in the Central Coast Region as is that associated with nitrate. However, when ammonia is elevated it can be extremely toxic to fish, particularly to salmonids, and thus is of considerable concern. Un-ionized ammonia is the most toxic form of ammonia; it increases in concentration relative to ammonium as pH and temperature increases. The general standard for un-ionized ammonia in the Central Coast Water Quality Control Plan is set at a level that is protective of salmonid populations (EPA, 1999). All but two of the 26 sites most impaired by un-ionized ammonia are in the lower Salinas and Santa Maria watersheds. Nineteen water bodies are listed as impaired because of elevated un-ionized ammonia concentrations; the majority of these sites are located in the lower Santa Maria River (7 listings) and lower Salinas River (8 listings) in areas heavily impacted by agriculture.

1.4 Water Quality Trends

Time is required to show change in environmental data, because of the inherent variability in the environment and because changes in land management do not necessarily result in immediate water quality change. Both CWP and CCAMP are designed to allow for detection of statistical trends over time. Both programs monitor fixed sites on a monthly basis. This design provides sufficient sample size to allow for trend detection, although, it can take five or more years to show change, depending on the variability of the data. However, we have been able to show statistically significant change at a number of sites.

The CCWQP has recently completed an analysis of trends associated with CMP data. They employed a non-parametric approach that evaluates data for overall trends and for trends in dry and wet season data. They found that 18 of 27 sites in the lower Salinas and Santa Maria watersheds showed statistically significant decreases in dry season flow over the first five years of the program. Though flow can be impacted by drought and water diversion, most of these sites are in areas heavily influenced by irrigated agriculture, so it is likely that these trends have been influenced to some degree by changes in agricultural tailwater volume or other discharges. Changes in flow volume need to be taken into consideration when evaluating trends in concentration.

The CMP analysis showed two sites in the lower Santa Maria area with significant improvements in nitrate concentration (Green Valley Creek (312GVS) and Oso Flaco Creek (312OFC). The Oso Flaco trend was confirmed in CCAMP change analysis. Both of these sites also showed declining flow, implying a load reduction has occurred. The CMP analysis also found that concentrations at two sites were getting worse (Natividad Creek (309NAD) in both wet and dry seasons and Salinas River at Chualar (309SAC) during the wet season only).

The CMP analysis also evaluated turbidity for change. In pristine systems, turbidity is typical only during rain events. In some of the sites heavily dominated by tail water, turbidity is elevated throughout the summer. Four sites were identified with significant improving trends in turbidity during the dry season; these were all located on the main stem of the Salinas River from Greenfield to Spreckels. One site had a worsening trend in turbidity – this was on Main Street Canal in the Santa Maria watershed. However, flows declined significantly at this site.

CCAMP has evaluated change using a simple two group comparison (t-test) with transformations to address non-normal data distributions. A number of sites show change over the period of time they have been sampled. It should be noted that with short time frames (less than five years) an apparent change can be very dependent on weather or other localized conditions and we have more confidence in changes when we have more years of data.

The most notable area-wide improvements in nitrate concentrations are occurring along the Santa Barbara coastline. A number of drainages monitored there are showing statistically significant improving trends. Other sites that are improving and that have considerable agricultural influence include Pacheco Creek, Chorro Creek, and Prefumo Creek. It should be noted that discharges to Chorro Creek have changed recently due to upgrade of the California Men's Colony treatment plant that discharges to the creek. Also, the single agricultural operation on the Prefumo Creek drainage was halted awaiting urban development. Changes on these two creeks are likely impacted by these actions.

Currently, not enough toxicity data has been collected for statistical trends analysis. However, staff has evaluated toxicity data for visual signs of improvement. A few sites may show indications of change, including two in the Salinas watershed (309ESP and 309MER) and one in the Santa Maria watershed (312OFN), but more time will be required to confirm these observations.

Our analysis of nitrate data indicates that a number of the sites that are in very poor condition in terms of nitrate concentrations are getting worse, not better. Most of these sites are located in the lower Salinas and Santa Maria watersheds, which are our high priority areas of concern. However, some of these sites have shown statistically significant reductions in flow volumes, which have implications for overall load.

Because toxicity is sampled less frequently than other parameters through the CMP, statistical change in toxicity is less likely to be detected than in conventional parameters. A few sites show indications of improvement in water toxicity to invertebrates, including Espinosa Slough and Salinas Reclamation Canal at Jon Rd. in the Salinas watershed. The Espinosa Slough site has extremely toxic sediment, and diminishing toxicity in water may reflect a change from use of soluble organophosphate pesticides like diazinon to less soluble pesticides like pyrethroids (which are more toxic in sediment). Toxicity to fish appears to be getting worse on the Salinas River at Gonzalez, and improving on the Santa Ynez River above Lompoc. Algal toxicity appears to be improving at a few sites, including the lower San Benito River and lower Orcutt Creek. These changes can be verified as sample count increases.

1.5 Habitat and Stream Biota

State Water Resources Control Board programs are moving aggressively towards adopting biocriteria for regulatory use in permits issued throughout the State. Biocriteria are numeric requirements for maintenance of the invertebrate communities that dwell in stream bottom substrate. Though biocriteria will not be established state-wide until 2013 or later, invertebrate metrics from impacted areas can still be compared to metrics in relatively clean locations to assess overall condition. The species composition within invertebrate communities reflects comprehensive stream health, both in terms of habitat quality and water quality. Both the CCAMP and CMP programs have collected benthic macro-invertebrate data as part of their monitoring programs. As part of this data collection, a detailed analysis of habitat is also conducted at the monitoring site. Because sites are selected for ease of access, habitat scores are not necessarily reflective of all habitats in the sampled area, but can still give an indication of local conditions.

High quality sites monitored by CCAMP (including sites in upper Big Sur River, Big Creek, upper San Simeon Creek and Arroyo de la Cruz) typically have high overall diversity (with more than forty taxa in a sample), and numerous “EPT” taxa (which are considered sensitive to water and habitat quality and include the mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) groups). Additional characteristics of these high quality sites include excellent water quality and stable, diverse habitat (well established and mature riparian corridor and in-stream habitat with a mix of substrates including gravel, cobble and woody debris).

Benthic macro-invertebrate community composition reflects poor water quality and lack of habitat at sites in areas with heavy irrigated agricultural activity. See Table 1 for a comparison of these sites to more normal or “High Quality sites.” In the lower Salinas watershed (downstream of Gonzales) and lower Santa Maria watershed (downstream of the Cuyama/Sisquoc confluence) common measures of benthic macro invertebrate community health and habitat health score low, especially compared to upper watershed monitoring sites and other high quality sites in the Central Coast Region. Overall taxa diversity is much lower, EPA taxa are completely absent from many sites, and substrate is dominated by fines. Canopy cover is low and the riparian habitat typically does not have a diverse structure that includes woody vegetation and understory.

Upper Salinas and Santa Maria watershed sites are more similar to highest quality CCAMP sites, with diverse benthic communities and relatively high numbers of EPT taxa. Habitat at upper watershed sites is also in better condition with a greater diversity of substrates including a mix of sand, gravel and cobbles. The riparian corridor is typically well established, with mature trees and understory vegetation at all sites.

These findings indicate that areas of heavy agricultural use are in very poor condition in terms of benthic community health and that habitat in these areas is often poorly shaded, lacking woody vegetation, and heavily dominated by fine sediment. Invertebrate community composition is sensitive to degradation in both habitat and water quality. In some cases, the heavy sediment cover in stream bottoms is likely the largest influence on benthic community composition, but in areas where sediment and water toxicity is common, chemical impacts to the native communities are also probable. Heavily sedimented stream bottoms can result from the immediate discharge of sediment off of nearby fields, the channelization of streams and consequent loss of floodplain, the loss of stable, vegetated stream bank habitat, as well as from upstream sources.

	Total Taxa Diversity	EPT Taxa Diversity	Instream Substrate	Riparian Canopy
Highest Quality Sites	> 40	> 20	Mixed gravel, cobble, woody debris	Mature trees with understory
Lower Salinas area	3 - 27, with one exception	0 - 6	> 90% sand and fine sediment	Typically (for 8 of 13 sites) < 5% canopy cover, dominated by non-woody plants
Lower Santa Maria watershed	6 - 16, with one exception	0	> 85% sand and fine sediment	Typically < 10 % canopy cover, dominated by non-woody plants
Upper Salinas watershed	26 - 43	6 - 17	Mixed sand, gravel, cobble	Mature trees with understory
Upper Santa Maria watershed	25 - 44	5 - 18	<25% fines, dominated by gravel and cobble	Mature trees with understory

Table 1 - Summary of typical biological and habitat conditions at high quality sites, and at sites in the lower and upper Salinas and Santa Maria watersheds.

1.6 Impacts and Potential Impacts of Agricultural Pollutants on the Marine Environment

A number of monitoring and research efforts over the years have shown that chemicals leaving the land can cause environmental impacts in the marine environment. For example, the Central Coast Long-term Environmental Assessment Network has recently shown that concentrations of dieldrin in the open ocean at times exceed Ocean Plan objectives, dieldrin concentrations in mussels collected along the shoreline can exceed OEHHA Human Health alert levels, concentrations of dieldrin in offshore sediments at times exceed NOAA Effects Range Low concentrations, and concentrations of dieldrin leaving Pajaro and Salinas Rivers can exceed California Toxics Rule criteria (CCLEAN, 2007). Dieldrin was a chemical used widely in agricultural applications from 1950 - 1974, but also in termite and mosquito control up into the early 1980s. It has been banned for many years because of its bioaccumulating properties. Nevertheless, it is clearly still impacting the nearshore ocean environment in measurable ways.

There are other examples of chemicals formerly used in agricultural applications being found in nearshore areas. For example, Dugan (2005) found significant concentrations of DDT in sand crab tissues along the shoreline off of the Santa Maria river mouth, with concentrations declining with distance from the river mouth. Hunt et al found elevated levels of DDT and other more currently applied agricultural chemicals in the Santa Maria lagoon itself, along with significant invertebrate toxicity, and in current work is tracking high levels of agricultural chemicals from stream discharges into the lagoon itself. Moss

Landing Harbor is listed as a Toxic Hot Spot because of high levels of legacy chemicals that have entered from upstream sources. The drainages that enter Moss Landing Harbor are some of the most polluted in our Region, with documented toxicity and chemical pollution from nitrates and pesticides that originate, at least in great extent, from the intensive agricultural activities in the area.

More currently applied chemicals are not known to bioaccumulate in tissue the way that some of the legacy pesticides have. However, some pesticides, such as pyrethroids, are known to attach to sediments and persist in a relatively stable form in the aquatic environment where they can cause sediment toxicity. It is not unreasonable to expect that in some areas, particularly where fine sediments accumulate, they may cause impacts to marine life.

1.7 Risk to Marine Protected Areas

The first Marine Protected Areas designated for the State of California are located along the central coast of California (Figure 3). Many of these are located in relatively remote areas, such as along Big Sur coastline. However, several are located in areas that are more likely to be impacted by sediment and water discharges leaving our river mouths. Three of the MPAs, Elkhorn Slough, Moro Cojo Slough and Morro Bay, are estuaries that receive river runoff into relatively enclosed systems.

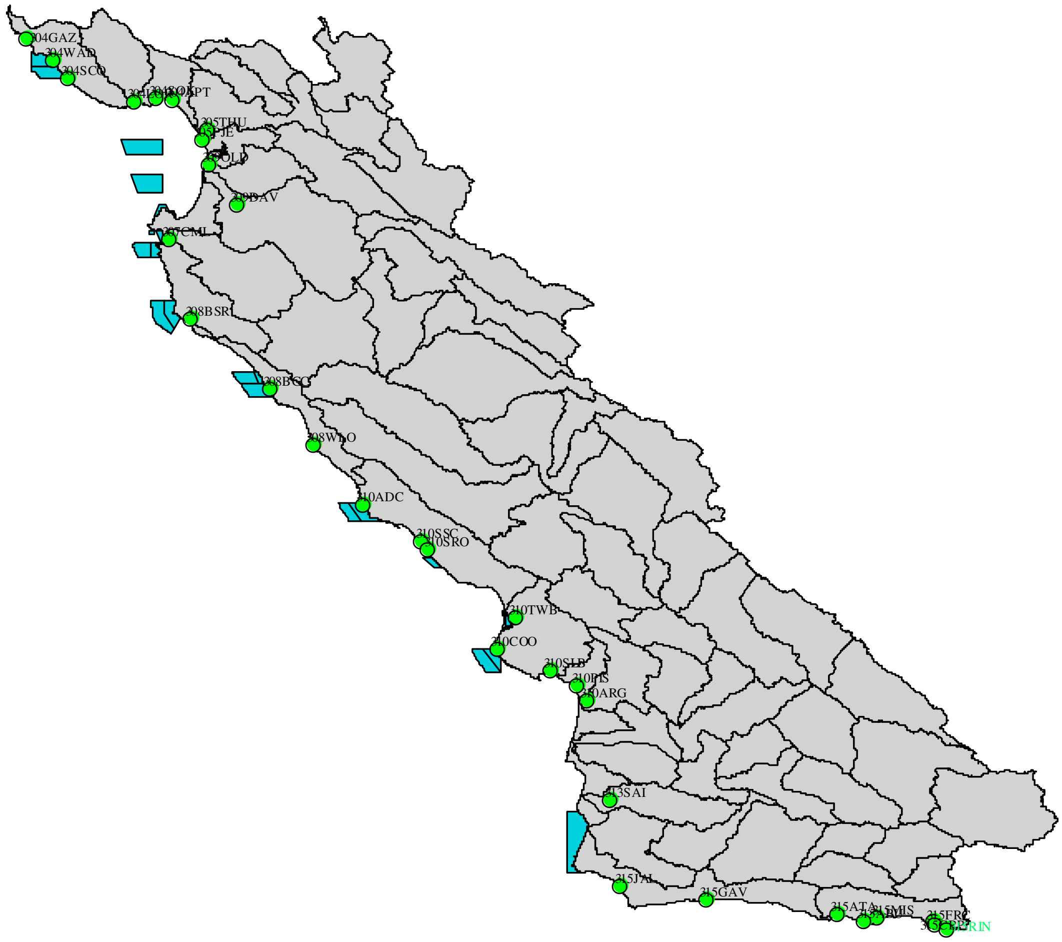

Figure 3 - Marine Protected Areas and CCAMP coastal trend monitoring sites in the Central Coast Region

Staff has identified and ranked the eight MPA areas most likely to be impacted by agricultural chemicals in Table 2. This ranking, although qualitative, is based on technical data and associated models related to MPA proximity to polluted discharges and size of discharge. Other MPAs, because of their locations offshore of smaller, more remote watersheds, are all considered to be at low risk for impacts from agriculture. Staff has described some of the risks for individual MPAs in more detail on the CCAMP Ag wiki. For example, for Moro Cojo Slough and Elkhorn Slough, nitrate, pesticides and toxicity are documented problems. These two MPAs are already included as part of the Moss Landing Toxic Hot Spot (BPTCP, 1998).

<u>Nutrients</u> - Current research indicates that nutrient discharges from rivers may be important drivers of toxic plankton blooms during periods when ocean upwelling is not dominant. Toxic phytoplankton blooms, particularly those from *Pseudo-nitzschia*, appear to be increasing in frequency and possibly in toxicity over the years, and researchers are evaluating whether anthropogenic sources of nutrients from rivers and

wastewater could be contributing to this increase. Recent research shows that *Pseudo-nitzschia* blooms and the toxicity of those blooms can vary according to nitrogen availability.

CCAMP staff has developed a flow discharge model of all of the coastal confluence sites in the Central Coast Region. We have developed gross estimates of loading to the ocean using monthly nitrate concentrations along with modeled flow discharges from coastal confluences. We have provided CCAMP discharge and loading data to U.C. Santa Cruz researchers, who are evaluating the seasonal effects of river and wastewater sources relative to upwelling in the Monterey Bay area. The preliminary UCSC research shows that the ratios of nitrate to other nutrients coming from the Pajaro and Salinas rivers are extreme when compared to other sources (other streams and rivers, upwelling, and wastewater), and that river nitrate loading exceeded that of wind-driven upwelling in 27% of daily load estimates within the preliminary study period (2005 – 2007). Further research will be necessary to understand the realized significance of this statistic within the context of bloom dynamics in local waters.

The Moro Cojo and Elkhorn Slough MPAs are directly impacted by nitrate, which in Moro Cojo Slough in particular is present at levels far above those that are protective of aquatic life. Other MPAs are likely to be impacted by nitrate indirectly, for example by increased frequency of toxic algal blooms.

<u>Pesticides</u> - Any pesticide that enters the marine environment is capable of having an effect on some aspect of the environment. However, pesticides that attach to sediments (such as pyrethroids and chlorpyrifos) represent the highest risk for impact, because fine-grained sediments can accumulate in specific areas as a result of current and wave patterns. The intense mixing that occurs in the marine environment will quickly dilute more soluble chemicals and greatly reduce their concentrations once they leave the vicinity of the shoreline. U.C. Berkeley scientists conducted a screening evaluation of CCLEAN sediment samples for pyrethroid pesticides. These samples are located along the 80-meter contour in the Bay where fine sediments tend to accumulate. No pyrethroids were detected in these samples, implying that these chemicals may not impact Monterey area MPAs that are located farther from the shoreline.

Pesticides directly impact the Moro Cojo and Elkhorn Slough MPAs. Moro Cojo Slough sediment has been toxic to test organisms on more than one occasion, and Elkhorn Slough receives daily tidal inputs from the Old Salinas River, which has been toxic to invertebrates at least 50% of the time it is sampled. The highest pounds of some pyrethroid chemicals in the State are applied in Monterey County (Starner, et al., 2006). Toxicity testing and Toxicity Identification Evaluations conducted in this area have shown that pyrethroids are causing sediment toxicity. We have ranked MPAs in the vicinity of the Salinas River mouth at a high level of risk compared to MPAs in more pristine areas.

MPA	Severity of agricultural discharge	Proximity of MPA to discharge plume(s)	Size of discharge	Overall Risk from Agriculture
1. Moro Cojo Slough	Extremely High	Extremely High	Low	Extremely High
2. Elkhorn Slough	Very High	Extremely High	Medium	Very high
3. South Santa Ynez River mouth	Medium	High	Medium	Medium
4. Monterey Bay	Very High	Very Low	Very High	Medium
5. Monterey Bay	Very High	Very Low	Very High	Medium
6. Morro Bay	Low	Very High	Low-Medium	Low-Medium
7. Carmel River	Low	High	Medium	Low-medium
8. Pacific Grove	Low	Low	Low	Low

Table 2 - Marine Protected Areas most likely to be impacted by agricultural discharges

1.8 Conclusions

Staff has examined a large amount of data from both CCAMP and the CMP. We have found that many of the same areas that showed serious contamination from agricultural pollutants five years ago are still seriously contaminated. We have seen evidence of improving trends in some parameters in some areas. Dry season flow volume appears to be declining in many areas of intensive agriculture. Dry season turbidity is improving along the main stem of the Salinas River. However, we are not seeing widespread improvements in nitrate concentrations in areas that are most heavily impacted, and in fact a number of sites in the lower Salinas and Santa Maria watersheds appear to be getting worse. Invertebrate toxicity remains common in both water and sediment. Statistical trends in toxicity are not yet apparent, in part because of smaller sample sizes, but a few sites may show indications of improvement. Persistent summer turbidity in many agricultural areas implies that water is being discharged over bare soil and is moving that soil into creek systems. High turbidity limits the ability of fish to feed. Bioassessment data shows that creeks in areas of intensive agricultural activity have impaired benthic communities, with reduced diversity and few sensitive species. Associated habitat is often poorly shaded and has in-stream substrate heavily covered with sediment. In general, staff finds poor water quality, biological and physical conditions in many water bodies located in, or affected by, agricultural areas in the Central Coast Region.

Section II - Groundwater Quality

In the Central Coast Region, groundwater accounts for greater than 80 percent of the water supply used for agricultural, industrial, and urban purposes, and in some groundwater basins in the Region, groundwater accounts for nearly all of the water supply. As such, groundwater is an extremely important resource within the Region. Moreover, as we have learned from numerous cleanup sites, once groundwater is impaired, it takes a very long time (decades to centuries) to clean up. Therefore, source control of pollutants is essential for preserving future beneficial uses of groundwater, minimizing the societal burden due to cleanup, and maintaining the economic viability of the region.

Central Coast Region's groundwater basins have localized and generally well-known groundwater impacts caused by point sources such as leaking underground storage tanks and chemical spills located primarily around urban and commercial land use areas. However, the largest groundwater impacts to the Central Coast groundwater basins are from widespread salt and nutrient (nitrate) discharges. Salt impacts are primarily a result of:

1) Seawater intrusion within the coastal basins (e.g., Salinas and Pajaro groundwater basins) caused by excessive groundwater pumping,
2) Historical agricultural pumping/recycling of groundwater that concentrates salts in the aquifers,
3) The importation of salts into the basin from agricultural soil amendments and domestic/municipal wastewater discharges.

On a regional basis, agricultural crop production provides the major source of nitrate waste to water resources, including groundwater.[1] A study of the Salinas Basin suggests that agricultural crop production is also the leading source of salt loading to that basin.[2] If left unmitigated, salts and nitrates accumulate in the basin and threaten the beneficial uses of groundwater. As presented below, beneficial uses of groundwater are already impaired by salts and nitrates in many areas of our groundwater basins.

Some principal aquifers (strata used for water supply) in the Central Coast Region's groundwater basins are vulnerable to pollutant migration from the surface because of their geological characteristics such as overlying permeable soils and unconfined

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[1] DeSimone, L.A., 2009, Quality of water from domestic wells in principal aquifers of the United States, 1991–2004: U.S. Geological Survey Scientific Investigations Report 2008–5227, 139 p., available online at http://pubs.usgs.gov/sir/2008/5227

[2] Monterey County Flood Control and Water Conservation District, November 1990. "Report of the Ad Hoc Salinas Valley Nitrate Advisory Committee." Zidar, Snow, and Mills.

conditions (lack of clay layers above the aquifer). Aquifers considered as vulnerable include large portions of the Santa Maria, Salinas, and Gilroy-Hollister basins. However, both unconfined and confined (pressured) aquifers are susceptible to downward pollutant migration through improperly constructed, operated (e.g., fertigation or chemigation without backflow prevention), or abandoned wells. Additionally, land with shallow groundwater and permeable soil is susceptible to downward pollutant migration. Areas with these physical features often coincide with aquifer recharge areas. Geographical areas recognized as important recharge areas should be protected from pollution, including pollution from agricultural activities, because they are direct conduits for replenishment of our potable water supply. Land with deeper groundwater can also be susceptible to pollution but it may take tens of years for pollution to migrate through the unsaturated zone before reaching the water table. Therefore, pollution introduced from historical activities might take years to manifest itself in deeper groundwater.

2.1 Groundwater Overdraft and Saltwater Intrusion

Groundwater overdraft in a basin is a decrease in groundwater storage that results in a significant prolonged period of groundwater level declines. Along the Central Coast, prolonged periods of groundwater level decline are causing saltwater intrusion into aquifers that are hydraulically connected to the ocean. Overdraft can also cause upward or downward migration of poor-quality groundwater, loss of surface water flows, and land subsidence with corresponding permanent loss of aquifer storage capacity. Portions of the Gilroy-Hollister and Santa Maria basins have been in overdraft but basin management appears to have stabilized or caused a rebound in groundwater levels within these basins.

Agriculture accounts for approximately 80 to 90 percent of groundwater pumping from the Salinas, Pajaro, and Santa Maria groundwater basins. The Gilroy-Hollister, Salinas, and Santa Maria groundwater basins are actively managed to enhance groundwater recharge from streams in order to meet pumping demand but excessive pumping (primarily related to agriculture) continues to cause saltwater intrusion into the Salinas and Pajaro groundwater basins, with increasing portions of the basins unusable for agriculture and municipal supply as a result. Therefore, maximizing irrigation efficiency is essential to minimize saltwater intrusion and other problems associated with overdraft.

2.1 Nitrate Loading

Agriculture comprises the largest proportion of land use over many of the Central Coast Region’s groundwater basins. Agricultural land use is most intense over portions of the Salinas groundwater basin, with up to 70 percent of the land used for farmland/agriculture. This is important information to consider when estimating sources and loading of nitrates to groundwater.

Nitrate loading studies conducted in the Llagas subbasin and Salinas groundwater basin conclude that out of various sources that are responsible for nitrogen loading to groundwater, including septic tanks, sewage treatment facilities, agricultural fertilizers, animal feeding operations, and greenhouse operations, the highest loading comes from the application and associated discharge of agricultural fertilizers. In the Llagas subbasin (a portion of the Gilroy-Hollister groundwater basin), a 2005 study that used multiple analytical and isotopic techniques concluded that inorganic fertilizer is the main source of nitrate to shallow groundwater.[3] The study recommended that continued efforts to minimize over-application of fertilizer (that which is not taken up by plants but rather leached to groundwater or runs off in surface water) is critical. The chemical form of nitrogen in fertilizer, the timing of application, and the method and timing of irrigation are important factors in the propensity for leaching of nitrate from soils. In particular, more efficient irrigation will minimize significant return flow of high nitrate groundwater; this return flow often infiltrates and leads to ongoing groundwater pollution. A study of sources of nitrates and salts to the soil and potentially groundwater in Santa Cruz and Monterey Counties indicated that irrigated agriculture contributes approximately 78 percent of the loading.[4]

According to the California Department of Food and Agriculture (CDFA), about 90 percent of the fertilizer distribution in California is for agricultural farm use while 10 percent is for home and garden use. Annual CDFA Fertilizing Materials Tonnage Reports include total pounds of nutrients sold within each county in California by license fertilizer distributors, including type of fertilizer and mineral additives. Water Board staff was able to obtain the CDFA tonnage reports for the period between 1997 and 2007. These reports are useful for estimating historic nitrogen loading and tracking future nitrogen loading to irrigated agricultural basins. As an example of nutrient loading estimates for Monterey County, the tons of nitrogen within fertilizer sold rose steadily between 1997 and 2003, from approximately 21 thousand tons in 1997 and peaking at approximately 37 thousand tons in 2003. Between 2004 and 2007, nitrogen sold stabilized at approximately 30 thousand tons., Based on the most recent data, Given the documented amount of nitrogen contained within fertilizer sold in Monterey County, up to approximately 56 million pounds of nitrogen was applied as fertilizer in the Salinas Valley in 2007;up to 37.5 percent[5] of the applied nitrogen may be leached to groundwater in the form of nitrate, for a total estimated nitrate loading to groundwater of approximately 93 million pounds in 2007. This results in approximately 100 pounds of nitrate per farmed acre leaching to groundwater. Since nutrients are transported to the groundwater via percolating surface water, both nutrient application and irrigation efficiency are essential for reducing nitrate loading to groundwater. Given the recent historical data described above, groundwater impacts resulting from the elevated

[3] State Water Resources Control Board, 2005. California GAMA Program: Sources and Transport of nitrate in shallow groundwater in the Llagas Basin of Santa Clara County, California.
[4] Monterey County Flood Control and Water Conservation District, November 1990. "Report of the Ad Hoc Salinas Valley Nitrate Advisory Committee." Zidar, Snow, and Mills.
[5] Thomas Harter, 2003. Agricultural Impacts on Groundwater Nitrate, Southwest Hydrology, Vol 8/No.4, July/August.

nitrogen loading between 1997 and 2003 in Monterey County may not yet be realized because of the slow movement of leachate through the unsaturated zone.

Probable mechanisms for nitrate loading to groundwater from agriculture practices include:

1) Fertilizer applications on permeable soils;
2) High-concentration nitrate tailwater discharges from farming operations and greenhouse;
3) Liquid fertilizer hookups on well pump discharge lines lacking back flow prevention devices;
4) Wells with screened intervals spanning multi-aquifer;
5) Spills and/or uncontrolled wash water or runoff from fertilizer handling and storage operations;
6) Infiltration from leaky holding ponds.

Responsible parties and Water Board staff will identify and prioritize these mechanisms in terms of relative nitrate loading on the farm plot and groundwater basin scale.

2.2 Nitrate Impacts

Data from public supply wells in the Central Coast Region suggest that the municipal beneficial use of groundwater is impaired or threatened by nitrates in several areas of Central Coast region basins. A Department of Water Resources (DWR) survey of groundwater quality data collected between 1994 and 2000 from 711 public supply wells in the Central Coast found that 17 percent of the wells (121 municipal supply wells) detected a constituent exceeding one or more primary MCL[6]. Nitrate exceeded the MCL (45 mg/L nitrate as nitrate) the most, with approximately 9 percent of the wells (64 wells) exceeding the MCL for nitrate. Research shows that nitrate concentrations found in groundwater above 14 mg/L (as nitrate) are likely from anthropogenic activity such as agriculture, so concentrations above 45 mg/L indicate a significant anthropogenic impact.[7] According to the GAMA Geotracker website, recent impacts to public supply wells are greatest in portions of the Salinas Valley (up to 20 percent of wells impacted) and the Santa Maria (approximately 17 percent) groundwater basins. In the Gilroy-Hollister groundwater basin, 11 percent are impacted but the California Department of Health (CDPH) identified over half of the drinking water supply wells as vulnerable to agricultural related activities. Due to the elevated concentrations of nitrate in groundwater, many public water supply systems have to incorporate wellhead treatment or blending to address elevated nitrate concentrations before delivery to the consumer. Water Board staff will identify and prioritize nitrate sources within "zones of contribution"

[6] Department of Water Resources, 2003. California's Groundwater Update, Central Coast Hydrologic Region
[7] W.M. Alley, 1993. Regional Ground-Water Quality. Van Nostrand Reinhold, New York NY

to nitrate impacted public supply wells, and prioritize implementation of source control in those vulnerable areas.

The above discussion details current impacts to drinking water supplies regulated by CDPH; these are readily tracked and evaluated data because data from supply wells is collected on a regular frequency and made publicly available as required by California law. With respect to nutrients and salts, there is more difficulty assessing the overall quality of groundwater and protection of future beneficial uses in the Central Coast Region's groundwater basins because robust monitoring systems and/or consistent monitoring frequencies do not exist. Thus, a thorough statistical evaluation of nitrate/salt distribution (vertical and horizontal) and corresponding trend analysis cannot be performed. However, some County and water district monitoring programs use available agricultural, domestic, municipal, and cleanup site dedicated monitoring wells to provide some indication of the horizontal nitrate distribution and trends. These data indicate a greater percentage of nitrate exceedences than indicated by CDPH data.

According to Monterey County reports, 25 percent of 352 wells (88 wells) sampled had concentrations above the MCL for nitrate in the northern Salinas Valley. In portions of the Salinas Valley, up to approximately 50 percent of the wells surveyed had concentrations above the nitrate MCL, with average concentrations nearly double the MCL and the highest concentration of nitrate approximately 9 times the MCL (approximately 400 mg/L).

Municipal supply wells, including those detailed above, are typically screened in deeper portions of groundwater basins, where nitrate concentrations tend to be lower than overlying portions of the aquifer. Domestic wells (wells supplying one to a handful of households) are typically screened in shallower zones, and typically have higher nitrate concentrations as a result. Water quality information on domestic wells is not readily as available as from municipal wells, however based on the limited data available, the number of residential wells in the Central Coast Region that exceed the nitrate MCL is likely several hundred.

Agencies/districts report that nitrate concentration trends vary by area and time, with some areas showing increases over the last decade, and others showing decreases.

2.3 Health Impacts From Nitrate

Nitrogen is essential for all living things as it is a component of protein. Nitrogen exists in the environment in many forms and changes forms as it moves through the nitrate cycle. For most people, consuming small amounts of nitrate is not harmful. However, excessive concentrations of nitrate-nitrogen or nitrite-nitrogen in drinking water can be hazardous to health, especially for infants and pregnant women. For this reason, the U.S. Environmental Protection Agency (U.S. EPA) has established a maximum contaminant level (MCL) of 45 mg/L nitrate as NO_3 [10 mg/L nitrate as nitrogen].

The nitrite oxidizes iron in the hemoglobin of the red blood cells to form methemoglobin, which lacks the oxygen-carrying ability of hemoglobin. This creates the condition known as methemoglobinemia (sometimes referred to as "blue baby syndrome"), in which blood lacks the ability to carry sufficient oxygen to the individual body cells causing the veins and skin to appear blue. While acute health effects from excessive nitrate levels in drinking water are primarily limited to infants (methemoglobinemia or "blue baby syndrome"), evidence suggests there may also be adverse health effects among adults as a result of long-term ingestion exposure, and in older individuals who have genetically impaired enzyme systems for metabolizing methemoglobin. Generally, families drawing their water supply from farm areas experience the greatest exposure to elevated nitrate concentrations in drinking water[8].

A recent study[9] suggests that low doses of nitrate can also have serious effects on the brain. Nitrate as nitrogen concentrations of 4 mg/L or more in rural drinking-water supplies have been associated with increased risk of non-Hodgkin's lymphoma. Additionally, researches from the University of Iowa found that up to 20 percent of ingested nitrate is transformed in the body to nitrite, which can then undergo transformation in the stomach, colon, and bladder to form N-nitroso compounds[10]. These compounds are known to cause cancer in a variety of organs in more than 40 animal species, including higher primates.

Section III - AQUATIC HABITAT

3.0 Importance of wetland and riparian areas

Wetland and riparian areas are some of the most important ecosystems in a watershed. Ecologically intact riparian and wetland areas play important roles in protecting the Region's beneficial uses designated in the Basin Plan. These beneficial uses include Ground Water Recharge; Fresh Water Replenishment; Warm Fresh Water Habitat; Cold Fresh Water Habitat; Inland Saline Water Habitat; Estuarine Habitat; Marine Habitat; Wildlife Habitat; Preservation of Biological Habitats of Special Significance; Rare, Threatened or Endangered Species; Migration of Aquatic Organisms; Spawning, Reproduction and/or Early Development; and Areas of Special Biological Significance.

The Central Coast Water Board's actions should be focused on achieving our highest priority, the measurable goals of our Vision. The Healthy Aquatic Habitat Measurable

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[8] R. B. Brinsfield and K. W. Staver, *Addressing groundwater quality in the 1990 farm bill: Nitrate contamination in the Atlantic Coastal Plain*, Journal of Soil and Water Conservation, March 1990, vol 45., no. 2, 285-286.

[9] M.H. Ward, Mark S.D., Cantor K.P., et al., *Drinking Water Nitrate and the Risk of Non-Hodgkin's Lymphoma*, Journal of Epidemiology and Community Health, 1996, Vol. 7, pgs 465-471.

[10] Peter Weyer, *Nitrate in Drinking Water and Human Health*, 2001, http://www.agsafetyandhealthnet.org/Nitrate.PDF

Goal reads: By 2025, 80 percent of Aquatic Habitat is healthy, and the remaining 20 percent exhibits positive trends in key parameters. In order to meet this goal, the Central Coast Water Board must take comprehensive action to protect and restore riparian and wetland areas, which necessitates action through agricultural regulatory programs. This Order includes requirements to protect and restore wetlands and riparian areas.

3.1 Wetland Definition

In 2008, the State Water Resources Control Board (SWRCB) passed Resolution 2008-0026 for "development of a policy to protect wetlands and riparian areas in order to restore and maintain the water quality and beneficial uses of the waters of the State." The resolution was needed to foster greater efficiency, effectiveness, and consistency among SWRCB programs, to reverse the trend in wetland loss revealed by recent scientific studies, and to counter a series of U.S. Supreme Court decisions that have destabilized federal wetland jurisdiction, resulting in less protection for California wetlands.

Staff working on developing the policy has produced a wetland definition. The definition is as follows and is recommended for use in this Order:

> An area is wetland if, under normal circumstances, it (1) is saturated by groundwater or inundated by shallow surface water for a duration sufficient to cause anaerobic conditions within the upper substrate; (2) exhibits hydric substrate conditions indicative of such hydrology; and (3) either lacks vegetation or the vegetation is dominated by hydrophytes. (TAT 2009)

3.2 Current conditions

California has lost an estimated 91 percent of its historic wetland acreage, the highest loss rate of any state. Similarly, California has lost between 85 and 98 percent of its historic riparian areas (State Water Resources Control Board, 2008).

Agricultural areas often border and encroach upon riparian and wetland areas. In addition to the historical clearing of riparian and wetland habitat to allow for cultivation and staging areas at field perimeters, some growers have scraped 30-foot wide borders to create bare soil around field edges, have cleared trees, plants and brush from creeks and ditches, and have applied poison into and along surface waters to kill wildlife, all in an effort to keep wildlife from coming near their agricultural fields (Estabrook, 2008; Slater, 2009). Staff expects that growers will continue to alter riparian and wetland areas due to food safety pressures, unless regulatory agencies successfully apply sufficient pressure in the opposite direction.

In response to the September 2006 outbreak of *E. coli* O157:H7 in spinach, California's agricultural industry developed the California Leafy Greens Marketing Agreement (LGMA) and associated metrics to decrease the risk of such contamination happening again. Unfortunately, alongside the development of the LGMA metrics, a competition has developed among buyers and retailers to lay claim to the "safest" food by calling for increased requirements that go above and beyond what is called for in the LGMA metrics. These market-driven practices (known as "supermetrics") have resulted in large expanses of bare dirt buffers, miles of deer fences along riparian and migration corridors and water conveyance systems void of vegetation where it previously existed.

According to a spring 2007 survey by the Resource Conservation District of Monterey County, 19 percent of 181 respondents said that their buyers or auditors had suggested they remove non-crop vegetation from their ranches. In response to pressures by auditors and/or buyers, approximately 15 percent of all growers surveyed indicated that they had removed or discontinued use of previously adopted environmental practices. Grassed waterways, filter or buffer strips, and trees or shrubs were among the environmental practices removed (RCDMC, 2007). According to a follow-up spring 2009 survey by the Resource Conservation District of Monterey County, growers are being told by their auditors and/or buyers that wetland or riparian plants are a risk to food safety (RCDMC, 2009). As a result farmers are removing wetland and riparian plants in order to be able to sell their food.

A recent aerial survey and comparison was conducted by the Wild Farm Alliance, a non-profit, conservation-based, agriculture group to demonstrate the differences in vegetation before and after the fall 2006 *E. coli* O157:H7 outbreak. Below are two images taken along the same riparian corridor of the Salinas River. The first was taken before the 2006 outbreak and the second was taken in 2008 after buyers and sellers started requiring more stringent buffer requirements.

Picture 1 - Salinas River Riparian Corridor before the 2006 *E. coli* O157:H7 outbreak. 2005 National Agriculture Imagery Program

Picture 2 - Salinas River Riparian Corridor after the 2006 *E. coli* O157:H7 outbreak. 2008 -Jitze Couperus/Lighthawk

According to one farmer, interviewed for the November 2008 issue of Gourmet magazine, “Buyers don’t come right out and order you to do this or that. It’s more subtle: ‘We can’t buy crops that are grown within so many feet of that weedy waterway.’ And because the handler sells to a number of retailers, you have to conform to the strictest common denominator.”

3.3 Functions of wetlands and riparian areas

Wetland areas can protect and improve water quality by reducing pollutant loading (Fisher and Acremen 2004; Mayer 2005; and United States Environmental Protection Agency (USEPA) 2009). Mayer found that water passing through managed wetlands reduced turbidity levels in the Lower Klamath National Wildlife Refuge of southern Oregon and northern California. A 1990 study showed that the Congaree Bottomland Hardwood Swamp in South Carolina removed a quantity of pollutants equivalent to that removed annually by a $5 million wastewater treatment plant. Another study at a 2,500 acre wetland in Georgia indicated that the filtering action of the wetland saved $1 million in water pollution abatement costs annually (USEPA 2009).

Riparian and wetland areas play an important role in achieving several water quality objectives, including those water quality objectives related to natural receiving water temperature, dissolved oxygen, suspended sediment load, settleable material concentrations, chemical constituents, and turbidity. In particular, seasonal and daily water temperatures are strongly influenced by the amount of solar radiation reaching the stream surface, which is influenced by riparian vegetation. Removal of vegetative canopy along surface waters has a negative impact toward achieving temperature water quality objectives, which in turn negatively affects dissolved oxygen related water quality objectives.

Riparian areas can also improve water quality by trapping sediment and other pollutants contained in terrestrial runoff (NRC 2002; Flosi and others 1998; Pierce's Disease/Riparian Habitat Workgroup PDRHW 2000; Palone and Todd 1998). Palone and Todd (1998) also reported that an intact riparian area helps to decrease the effects of downstream floods by decreasing the rate of water flow, storing floodwaters, and dissipating stream energy, that in turn, increases infiltration.

In the absence of human alteration, riparian areas can form dense thickets of vegetation that have deep root systems. This vegetated system serves to stabilize banks from erosion (NRC 2002). Riparian and wetland areas can be an effective tool in improving agricultural land management. Wide riparian areas act as buffers to trees and debris that may wash in during floods, thereby offsetting damage to agricultural fields and improving water quality (Flosi and others 1998; PDRHW 2000). Further, agricultural floodplains are approximately 80 to 150 percent more erodible than riparian forest floodplains (Micheli and others 2004).

Riparian forests also provide as much as 40 times the water storage, relative to a cropped field (Palone and Todd 1998). The water stored in wetland and riparian areas can contribute base flow to a stream during times of the year when surface water would otherwise cease to flow (DWR 2003).

Riparian trees block solar radiation from streams, thereby helping to maintain water temperature. (Naiman 1992; PDRHW 2000; Rose 2006). Naiman (1992) found that lack of riparian canopy can change water temperature in summer by 3 to 10 degrees within a 24-hour period due to increased direct solar radiation. Data collected indicates that peak temperatures in Chorro Creek in California were recorded during mid-day peak solar hours due in part to minimal or absent overhead riparian canopy (Rose 2006). Regulating instream temperature is important to the existence of instream organisms because it affects their metabolism, development and activity (Naiman 1992). Cool water helps to maintain dissolved oxygen levels, high levels of which are critical to the survival of oxygen-consuming organisms (PDRHW 2000).

Conversion from native, multi-layered, riparian vegetation to a non-native species monoculture, such as a grass species, can also result in lack of shade, woody debris, and leaf litter that contribute food and instream habitat complexity for salmonids and other species (California Department of Fish and Game 2003). Leaf litter from riparian vegetation is the primary driver of most stream ecosystems (Palone and Todd 1998). Stream ecosystems in turn support broadly based food webs that support a diverse assemblage of wildlife (NRC 2002).

Palone and Todd (1998) also reported that when riparian trees are removed, populations of aquatic insects decline or disappear, and in turn, wildlife that may depend on them also disappears. Some insects adapted to specific tree species cannot survive when fed the leaves of exotic grasses.

More than 225 species of birds, mammals, reptiles, and amphibians depend on the riparian habitat of California. The most diverse bird communities in the arid and semiarid portions of the western United States are found in riparian ecosystems (RHJV 2004). Approximately 43 percent of federally threatened and endangered species depend directly or indirectly on wetlands for their survival (United States Environmental Protection Agency 2008). Of all the states, California has the greatest number of at-risk animal species (15) and the greatest number of at-risk plant species (104) occurring within isolated wetlands (Comer and others 2005).

Riparian vegetation may play a role in integrated pest management. Cavity-nesting riparian bird species prey on rodents and pest insects in agricultural fields (PDRHW 2000), thereby reducing the need for poison and pesticide use on agricultural lands, and protecting water quality as a result.

Intermittent and ephemeral headwater streams play important roles in protecting water quality. Alterations to headwater streams and wetlands can lead to detrimental changes in habitat features affecting aquatic and terrestrial wildlife. Changes to headwater streams, including from agricultural operations, can lead to downstream eutrophication, coastal hypoxia, and an increase in nutrient loading (Freeman and others 2007).

The main benefits of wetland and riparian areas are:

- Protecting beneficial uses, all of which protect water, a natural resource. In turn, water protects beneficial uses such as Wildlife Habitat and Rare, Threatened or Endangered Species.
- Supporting 43 percent of Federally threatened and endangered species
- Supporting more than 225 species of animals
- Protecting headwater streams that protect the wildlife that depend on them
- Regulating instream and micro-habitat temperature, and instream oxygen.
- Retaining soil due to bank stabilization
- Retaining instream habitat features and complexity
- Reducing turbidity affecting wildlife habitat
- Storing floodwaters that protect downstream natural resources from damage
- Protecting other wetland and riparian areas

The following negative impacts result from disturbing or destroying wetland and riparian areas.

- The quality of habitat that is removed may be lost forever due to complexity of reconstructing natural habitat.

- Many beneficial uses may go unprotected leading to a loss of available water that meets water quality objectives.
- Pollution affecting water quality and wildlife habitat can enter water bodies at an accelerated rate.
- More plant and wildlife species may be endangered or at risk of extinction.
- Temperature and in-stream oxygen regulation will not be moderated.
- Habitat complexity that supports aquatic wildlife will not be maintained.
- Soil will not be protected and more erosion will occur.
- Floods may be more detrimental.
- Wetland and riparian areas adjacent to disturbed areas will be exposed and less protected.

Agricultural activities and other land uses should be conducted to avoid or minimize impacts to wetland and riparian areas.

S:\Agricultural Regulatory Program\Ag. Order 2.0\February 1 2010 Docs\Final Documents\Attachment 1-Preliminary Report on Water Quality Conditions 020210.doc