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Agricultural Management Practices and Treatment Wetlands in the Gabilan Watershed:

Monitoring Plan

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Preface

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1 Project Goals & Research Questions

The overall goal of this project is water quality improvement. This will be addressed using both source control and a treatment wetland.

Source control measures will include the implementation of several management practices at agricultural sites in the region. Project actions should result in measured reductions of inputs of excessive sediment, nutrients and pesticides primarily into waterways in the Gabilan Watershed (Fig. 2.1), but also potentially other waterways within the coastal region of the Salinas River, northern Salinas Valley and Monterey County.

The treatment wetland will be located at the base of the Gabilan Watershed, at the confluence of the Tembladero Slough and Old Salinas River Channel (Fig. 2.4). The wetland will demonstrate the potential for and provide valuable data on the use of wetlands for reduction of water quality constituents in local waterways.

The monitoring portion of the project will quantify the effectiveness of both the implemented agricultural management practices and the treatment wetland. The monitoring effort will address the following:

Agricultural Management Practices

1. To what extent is the implemented practice at each agricultural site resulting in a reduction of water quality constituents (sediment, nutrients, pesticides) being exported off-site? This will be answered for storm events and/or irrigation events, as applicable to each specific site.

Wetland treatment

2. To what extent does the wetland remove water quality constituents (sediments, nutrients, pesticides) from the waters passing through it?

3. What are the optimal retention times, inflow-loading rates and depth to achieve maximum removal? How does this vary by season?

4. What is the balance of retention of constituents on site, versus neutralization through transformation or degradation, or volatilization?

5. Using toxicity tests, is the wetland effluent more/less toxic than the influent?

6. Does benthic macroinvertebrate community composition and abundance vary between the wetland and the adjacent Tembladero Slough? Does it vary within the wetland? Do these patterns change over time?

7. What fraction of the annual pollutant loads from the Gabilan Watershed is the wetland able to mitigate? What is the relationship between wetland area and fraction of total watershed load treated?

Questions 1, 2 and 3 are the primary questions of the study. Questions 4 and 5 are more difficult, and will be only qualitatively addressed. Question 6 is exploratory, and serves mainly to build up a general knowledge base on the slough ecology of the region. Question 7 is the ultimate, over-arching question of all water quality remediation work. The study will contribute data toward answering this question, but years of further work will be required to fully answer it.

2 Study Area & Sample Sites

2.1 The Gabilan Watershed

This project addresses water quality concerns in the Gabilan Watershed – also known as the Reclamation Ditch Watershed. The Watershed is defined as the watershed of the Potrero Road Tide Gates, excluding the watershed of the Salinas River (Fig. 2.1). It includes Gabilan Creek, Natividad Creek, Alisal Creek, Alisal Slough, Santa Rita Creek, Merritt Lake, Espinosa Slough, Tembladero Slough, Salinas Reclamation Channel, and the lower part of the Old Salinas River Channel. Agricultural sites on other waterways within the coastal region of the Salinas River, northern Salinas Valley, and Monterey County may also be used if they are considered valuable to the project.

At the receiving end of the Gabilan Watershed is Moss Landing Harbor, a State-listed Toxic Hot Spot that is scheduled for three TMDL action plans. In addition, sixteen total maximum daily load (TMDL) action plans are in development or scheduled for these waterbodies.

Some of the highest levels of surface water pesticide contamination found statewide by the State Mussel Watch and Toxic Substances Monitoring Programs were found in the Gabilan Watershed. Elevated levels of contamination from persistent pesticides such as dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyl (PCB), dieldrin, and endosulfan have been reported from sediment and/or shellfish tissue for the Salinas Reclamation Ditch, Tembladero Slough, Old Salinas River Channel, Espinosa Slough, and Moss Landing Harbor. All of these sites are listed or are candidates for the Toxic Hot Spot List, and all of these waterways drain into the Monterey Bay National Marine Sanctuary.

There are six 303(d) listed waterbodies within the Gabilan Watershed (Casagrande & Watson, in prep.).

1. Gabilan Creek:
   303d list – fecal coliform
2. Salinas Reclamation Canal (Reclamation Ditch):
   303d list – fecal coliform*, low dissolved oxygen*, nitrate*, pesticides, priority organics
3. Alisal Creek:
   303d list – fecal coliform*, nitrate*
4. Espinosa Slough:
   303d list – nutrients, pesticides, and priority organics

5. Tembladero Slough:
   303d list – fecal coliform*, nutrients, pesticides
   State-listed Toxic Hot Spot** – pesticides, PCB's, metals – Ni, Cr
6. Old Salinas River Channel:
   303d list – fecal coliform*, low dissolved oxygen*, nutrients, pesticides
   State-listed Toxic Hot Spot ** – pesticides, PCB's, metals – Ni, Cr

In addition, there are three listed waterbodies downstream of the Gabilan Watershed.

1. Moss Landing Harbor:
   303d list – pathogens, pesticides, sedimentation/siltation
   State-listed Toxic Hot Spot** – pesticides, PCB's, metals – Ni, Cr
2. Elkhorn Slough:
   303d list – pathogens, pesticides, sedimentation/siltation
3. Monterey Bay South (Coastline):
   303d list – metals, pesticides

*added since 1998. http://www.swrcb.ca.gov/tmdl/docs/2002reg3303dlist.pdf
**SWRCB Toxic Hot Spots Clean Up Plan.
http://swrcb2.swrcb.ca.gov/bptcp/docs/dftfedcp.doc

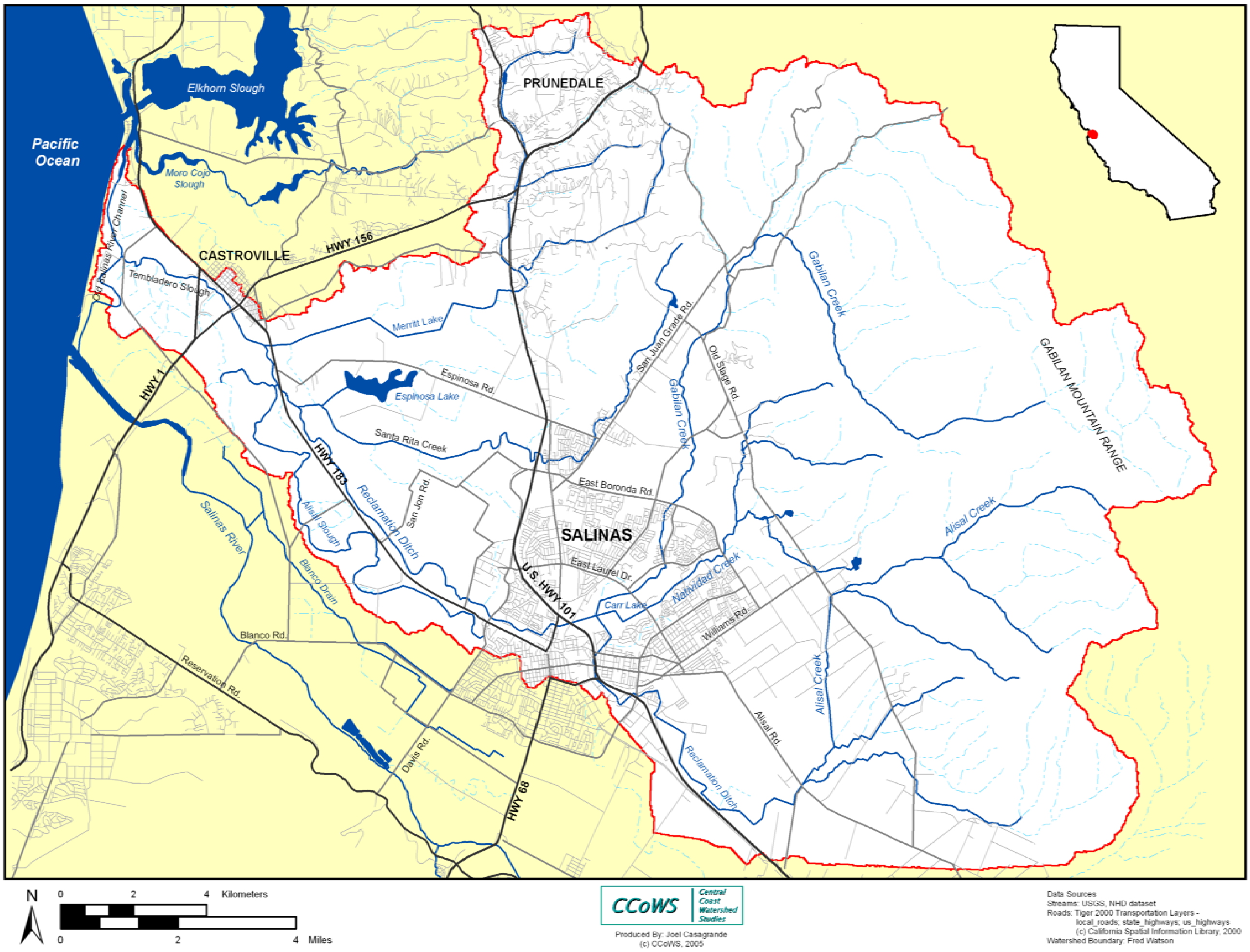

Figure 2.1. The Gabilan Watershed with Watershed boundary shown in red.

2.2 Sampling Site Descriptions

Table 2.1 lists the site codes for the wetland and Tembladero Slough. Figure 2.4 shows the location of these sites within the Gabilan Watershed. Agricultural sites are confidential, and are not included.

Table 2.1. Monitoring Sites and Codes.

Site Code/s	Location	Site type
TEM-HAR	Tembladero Slough at the Haro Rd bridge crossing	Slough / ditch / canal
TEM-MOL	Tembladero Slough at the Molera Rd bridge crossing	Slough / ditch / canal
Wetland (4 sites) DCR-001, DCR-002, DCR-003, DCR-004	Molera Rd and Dunes Colony Rd, at Tembladero Slough and Old Salinas River Channel confluence	Treatment Wetland

2.2.1 Tembladero Slough at Haro Road: TEM-HAR

TEM-HAR (Fig. 2.2) is the Tembladero Slough at Haro Road, located adjacent to Highway 156 on the upstream side of Castroville (Fig. 2.4). It is the farthest downstream location to measure loads delivered from the watershed where access is safe. The channel is wide and too deep for safe wading to take flow measurements and collect samples, so all sampling activity will take place from the bridge. This site will be used to measure loads delivered from the Gabilan Watershed.

Figure 2.2. TEM-HAR - Tembladero Slough at Haro Road. Looking upstream after heavy rains. Photo: Kelleen Harris, March 23, 2005.

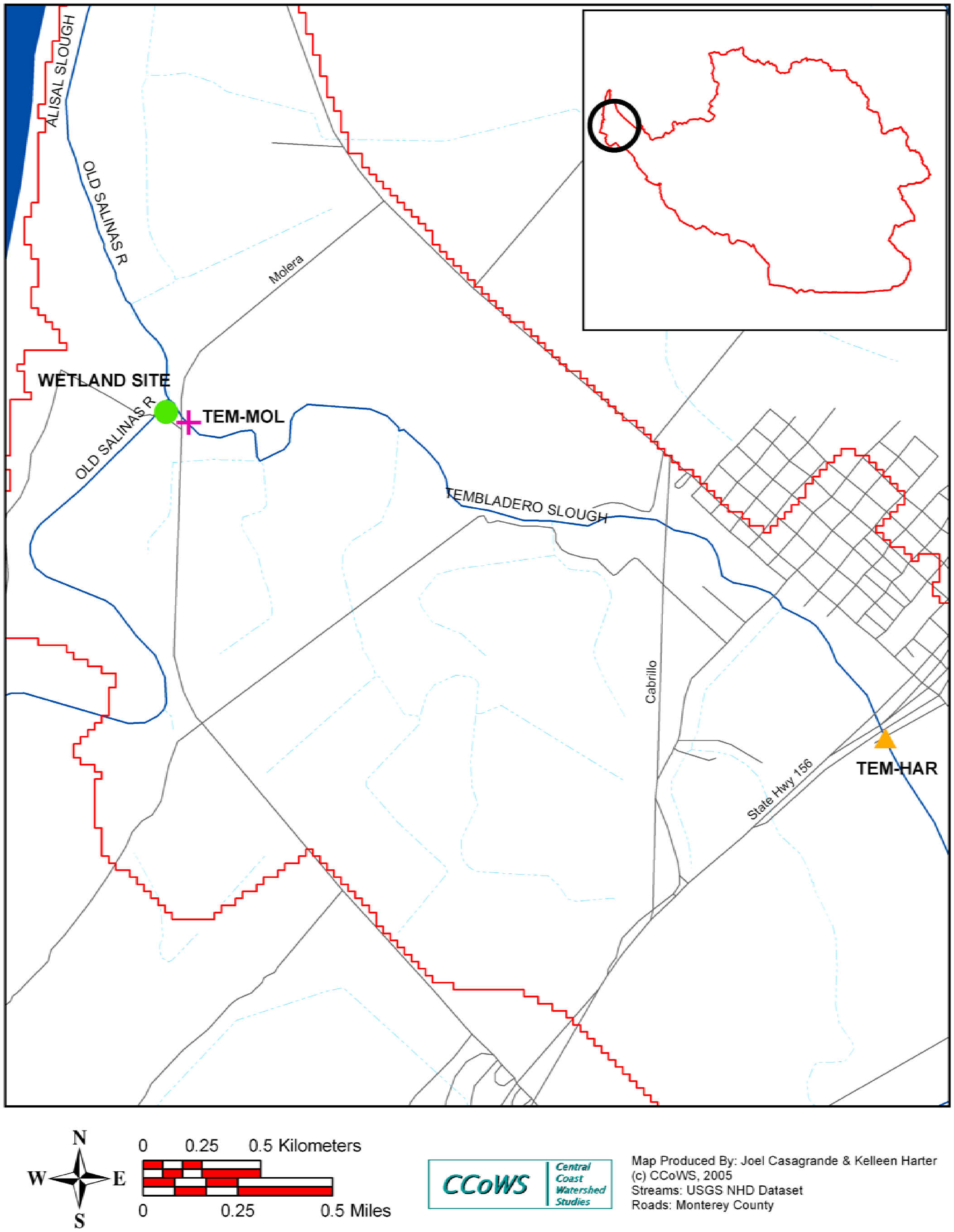

Figure 2.4. Location of established sample sites within the lower portion of the Gabilan Watershed.

2.2.2 Tembladero Slough at Molera Road: TEM-MOL

TEM-MOL (Fig. 2.5) is the Tembladero Slough at Molera Road, where the water intake for the wetland site will be located. The site is just above the slough's confluence with the Old Salinas River Channel. This site was not chosen as the site to characterize loads exiting the Gabilan watershed because of the tidal influence, the mixing with Old Salinas River Channel water, and high speed automobile traffic. Only BMI samples will be collected at this site, within the pictured area up to the Molera Bridge.

Figure 2.5. TEM-MOL - Tembladero Slough at Molera Road looking upstream. The wetland site is on the right edge of the photo. Photo: Fred Watson, October 31, 2004.

2.2.3 Treatment wetland

The site where the wetland will be built is located at the confluence of the Tembladero Slough and the Old Salinas River Channel. The Tembladero Slough is on the Northern border, Molera Road along the eastern border, Dunes Colony Road on the Southern Border and the Old Salinas River Channel on the Western Border (Fig 2.6). These waterways and roads separate it from nearby agricultural fields.

Since the wetland site is perched above the Tembladero Slough water source, it is necessary to pump water into the wetland. This provides a flexible experimental situation because the amount of water flowing into the site can be carefully controlled. Pumping the water in may also lead to optimal removal efficiency, because a larger amount of water can be passed through the wetland.

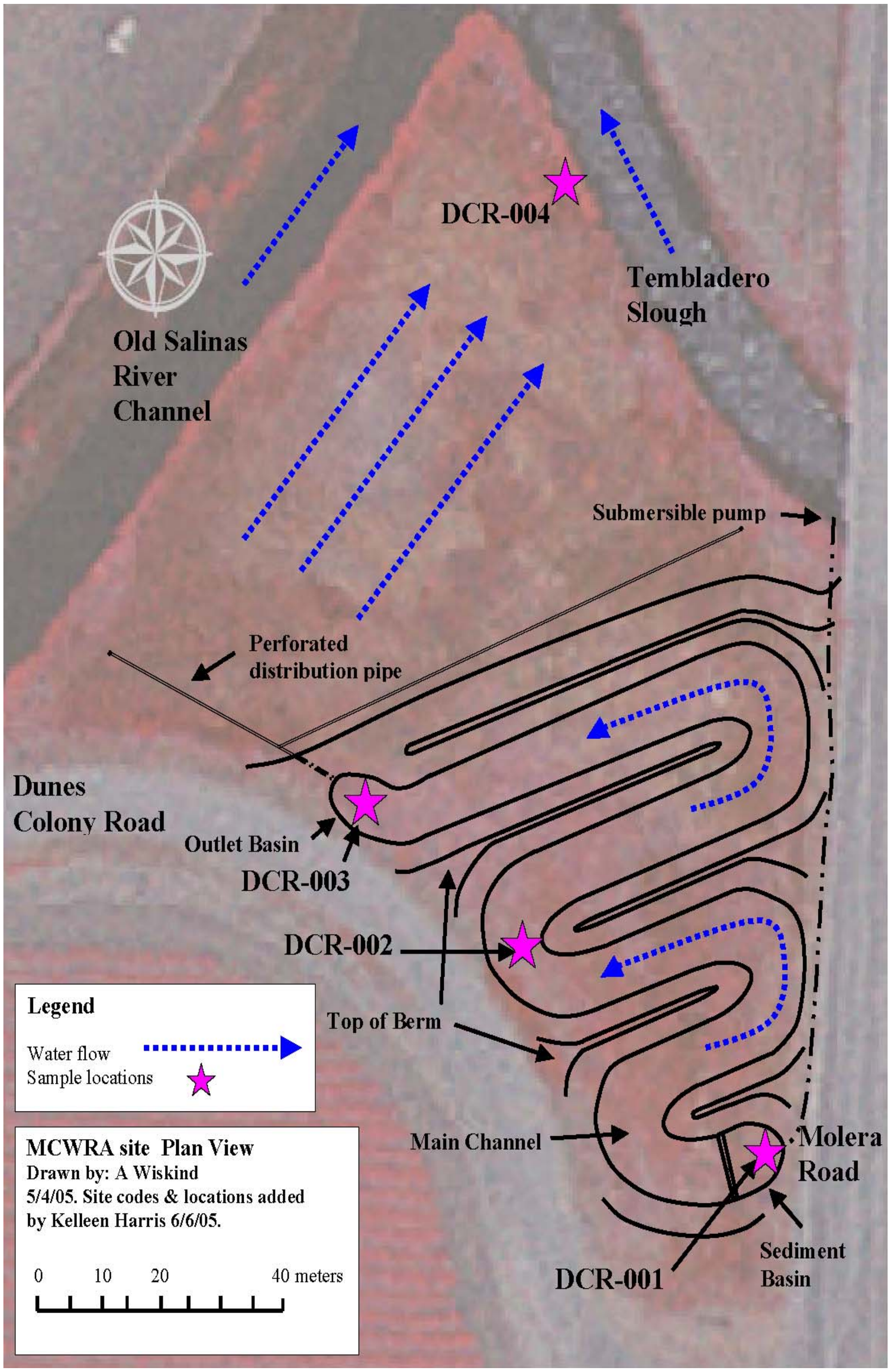

Figure 2.6. Wetland plan and sample locations.

There will be two distinct portions – an upper portion optimized for pesticide removal, and a lower portion optimized for nitrogen removal. The upper portion will be a long sinuous channel, planted on the edges with wetland vegetation and kept open in the center.

A large length to width ratio was chosen to lessen the effects of preferential-flow channels that often develop in treatment wetlands (Crites & Tchobanoglous, 1998). A preferential flow channel develops when water takes the path of least resistance instead of flowing equally through all portions of the wetland. For example, the water on the edges and where vegetation is thicker may be barely flowing, while the water in the center is moving at a good pace. This could interfere with water quality improvements by moving some of the water too quickly through the system before benefits are achieved, and keeping some much longer than is necessary, reducing the total amount that can be effectively treated.

The depth in this portion will be a maximum of 0.46 m (18 in.). This design is based on creating potential for pesticide reduction, such as open water for sunlight exposure (photolysis) and vegetation for sorption. The upper portion may also function to some degree for nitrate and phosphate removal, although it will be on the deeper side of optimal for this purpose. Mitsch and Gosselink (2000) describe that shallow depths (<0.5 m) provide maximum soil-water contact for certain chemical reactions such as denitrification. The fate of phosphorus will be interesting to observe because its' retention in wetlands has been found to be erratic and site specific (Mitsch & Gosselink, 2000). In flow-through wetlands with detention times between 5 and 10 days phosphorus removal will seldom exceed 1 to 3 mg/L (Crites and Tchobanoglous, 1998).

The lower portion is already established with native wetland vegetation. It is already suitable for denitrification, and will be optimized for this purpose. Mechanical disturbance will be minimized in this section. The perimeter berm will be reinforced, and a defined outlet will be installed for flow measurements and sample collection. Areas of low value vegetation may be selectively excavated to maximize the inundated area. The depth will be kept shallow, at approximately 0.15 m (6 in.) deep.

There are four sampling locations (figure 2.6). These sites are located at the beginning, middle, and end of the upper portion (DCR-001, DCR-002 and DCR-003) and at the outlet in the lower portion (DCR-004).

3 Sampling Overview

The following three sections give a very brief overview of the sampling that will occur in the wetland, Tembladero Slough and at agricultural sites. Details are provided in Chapters 4, 5, and 6.

3.1 Wetland

Wetland monitoring will cover a spectrum of water quality and biological measurements, including: various hydrologic components of the site, nutrients (ammonia, nitrate, orthophosphate), suspended sediment concentration, organophosphates, pyrethroids, organochlorines, and toxicity. Benthic macroinvertebrate and bird usage data will also be collected.

The wetland site will be monitored during both storm and ambient conditions in order to assess net gain or loss of pollutants on annual time scales, and build a more complete picture of long-term dynamics. During storms, sampling times will be stratified within events so as to obtain adequate representation of pre-event, peak-flow, and post-event conditions. Although storm events will not cause the flow into the wetland to change (since water is being pumped into it), it is anticipated that constituent loads will be greater. During non-storm conditions, the wetland will be experimentally controlled for investigations of optimal flow through rate and depth.

3.2 Tembladero Slough

The Tembladero Slough (at TEM-HAR) will be monitored during storm and non-storm conditions to estimate the suspended sediment, nutrient, organophosphate, and pyrethroid loads that are being delivered from the Gabilan watershed. During storms, sampling times will be stratified within events so as to obtain adequate representation of pre-event, peak-flow, and post-event conditions.

3.3 Agricultural Sites

Agricultural monitoring will cover a spectrum of water quality measurements, including: any applicable hydrologic components of each site, nutrients (ammonia, nitrate, orthophosphate), suspended sediment concentration, and organophosphates and pyrethroids, if applicable.

The details of measuring load reductions will be defined according to site specifications, and will include storm monitoring as well as irrigation events when possible. Both “above/below” (the practice) and “before/after” (installation) methodologies will be considered. Samples will be collected from sampling locations at defined intervals, such as every 15 or 30 minutes, or using an adaptive scheme that samples more frequently when flow is high or changing rapidly.

Surveying with a digital theodolite may also be an important tool to determine exact drainage areas, slopes, measure suspended sediment volumes captured in basins before and after events, or to assess the success of gully reduction activities.

4 Hydrologic Measurements

4.1 Stage and Discharge

At each visit to a site, the stage (or water level) will be recorded. At most sites the stage is read from staff plates. Discharge is typically/ideally measured using a current meter in a cross-sectional area of a channel, but the exact measurement techniques are site specific. At agricultural sites, there may not be any open channels. The different techniques that may be employed include: a cross section with a current meter in the channel or from a bridge using a USGS Type A Crane (with Four-Wheel Truck, model 4350), an estimation based on surface velocity and depth measurements, a visual estimation, or collection of flow into a calibrated bucket or bin. For detailed descriptions of these techniques, see the project Quality Assurance Project Plan.

Final discharge estimates may be taken from a stage-discharge ‘rating’ curve hand-fitted to the discharge data where applicable (ie. where enough points have been collected for a reliable curve). This curve is of the form:

$$Discharge = Scale \times (Stage + Offset)^{Power}$$

Where *Scale*, *Offset* and *Power* are parameters that will be fitted for each site (Larson and Watson, 2004).

Because individual measurement errors are likely to be smoothed by the curve it is assumed that discharge estimates based on the curve are more accurate than actual measurements. This practice is also effectively followed by the USGS (although the USGS uses a more complex rating curve). In the case that a discharge-curve is not applicable to a particular monitoring run, then interpolation over time will be used to estimate total discharge based on individual discharge measurements. Discharge estimates (m^3/s) will be multiplied by the concentration of the constituent of interest (mg/L) to calculate the instantaneous constituent load (g/s). These data may then be extrapolated to infer a longer time series (ie. seasonal or annual loads).

4.2 Precipitation

Storm events during the wet season will be anticipated by using satellite images (NOAA), radar images (NOAA, weatherunderground.com, etc), quantitative precipitation forecasts (QPFs, NOAA), and 10-day weather forecasts (weather.com) available online. Storms predicted to have greater than about 13 mm (0.5 inches) of precipitation will be prioritized for monitoring.

Local precipitation will be measured with rain gauges. Precipitation data will also be obtained from weather stations located in close proximity to sampling sites. Examples of places these weather stations may be found are on the California Irrigation Management Information System (CIMIS) website that is maintained by the Department of Water Resources, as well as the National Weather Service website maintained by the National Oceanic and Atmospheric Association (NOAA).

4.3 Wetland Hydrology

Wetland hydrology will be described by measurements and/or calculations of inflow and outflow rates, detention time, hydraulic loading rate, evaporation, and losses to groundwater. Inflow and outflow rates will be controlled at the site, and will be measured using volumetric discharge methods (calibrated bucket or bin) at the inflow and outflow pipes. Relationships will be established between the stage reading and both wetland volume and surface area.

4.3.1 Hydraulic loading rate and detention time

The hydraulic loading rate (HLR) and detention time will be determined for each sampling event. The HLR is the volume of water flowing into the wetland per unit time per unit area (m day^{-1}). HLR will be calculated as (Mitsch & Gosselink, 2000):

$$q = Q / A$$

where $q =$ inflowing hydraulic loading rate
$Q =$ flow rate (m^3 day^{-1} or m^3 yr^{-1})
$A =$ wetland surface area (m^2)

The time that a parcel of water is estimated to remain in the wetland is the detention time. The detention time will be calculated as (Mitsch & Gosselink, 2000):

$$t = Vp / Q$$

where $t =$ theoretical detention time (days)
$V =$ volume of wetland basin (m^3)
$p =$ porosity of medium (~1 for surface flow wetlands)
$Q =$ flow rate through wetland (m^3 day^{-1}) = $(Qi + Qo)/2$,
where Qi is inflow and Qo is outflow

4.3.2 Groundwater Exchange

The extent of groundwater exchange at the site is not known. The lowest part of the site holds standing water for several days after rain events. Since water will be pumped up to the wetland, which will be at a slightly higher elevation than the slough, groundwater loss is not unlikely.

Groundwater loss will be investigated by comparing surface outflow to inflow rates (minus evaporation), and by installing shallow (~1m) manual piezometers along a transect leading away from the location of maximum head in the wetland. Water level fluctuations in the piezometers would be evidence of a hydraulic connection to surrounding groundwater, indicating some degree of groundwater loss. The question of actually quantifying groundwater loss will be addressed only once there is some evidence that it is actually occurring to a significant extent.

4.3.3 Evaporation

Evaporation will be estimated for the wetland site. An evaporation pan will be installed in combination with estimates from the nearest CIMIS site.

5 Water Quality Sampling

The water quality sampling plan is presented in Tables 5.1 and 5.2. This plan was constructed to answer the research questions presented in Chapter 1, and a budget was prepared to determine the maximum allowable monitoring effort. The amount of samples actually collected may change as needed, to be greater or lesser depending on the site-specific situation and the duration of storm events.

Sampling will be conducted as a series of "Sampling Runs" – i.e. a sequence of samples taken at a sequence of sites within a relatively short time frame (say, 2 hours). When reading the tables, a fraction means that a sample will be collected once out of a certain number of 'runs'. For example, 1/3 means that a sample will be taken once per every 3 runs.

5.1 Wetland and Tembladero Slough

This section describes sampling run types (SRTs) that have been designed to address the monitoring questions 2, 3, 4, 5, and 7 (from Chapter 1) for the wetland site and Tembladero Slough. The description is divided into dry and wet events, as they are sampled quite differently. Each SRT is designed to contribute data toward answering one or more of the questions, as follows:

The following three questions will be addressed with SRTs A and D:

> Q2. To what extent does the wetland remove water quality constituents (sediment, nutrients, pesticides) from the waters passing through it?
>
> Q3. What are the optimal retention times, inflow-loading rates and depth to achieve maximum removal? How does this vary by season? (Suspended sediment, nutrient and pesticide samples will be collected)
>
> Q5. Using toxicity tests, is the wetland effluent more/less toxic than the influent?

The following question will be addressed with SRTs B and E:

> Q4. What is the balance of retention of constituents on site, versus neutralization through transformation or degradation, or volatilization?

The following question will be addressed with SRTs A, D, C, and F:

Q7. What fraction of the annual pollutant loads from the Gabilan Watershed is the wetland able to mitigate? What is the relationship between wetland area and fraction of total watershed load treated?

5.1.1 Dry Sampling Events

There are four different SRTs that will occur during dry weather. These are labeled A, B, C, and G in Table 5.1.

Sampling run type A

Suspended sediment, nutrient, pesticide, and toxicity samples will be collected from the wetland. The flow rate into the wetland and the depth of the water will be experimentally controlled for two weeks before each event. These values cannot be pre-determined at this point.

Each type A event will consist of 3 runs, one occurring every other day until completed, for a total time span of 5 days. During each run, 1 suspended sediment and 1 nutrient sample will be collected at each of the 4 wetland locations (DCR-001, -002, -003, -004). These are the upper inlet, the middle of the upper section, the upper outlet, and the lower outlet (figure 2.6). A QC sample will be taken during 1 of the 3 runs (shown as 1/3 in Table 5.1), for a rate of 5%. Organophosphate and pyrethroid samples will be collected only on the last run (due to analysis cost and a need for immediate shipping). The sites are the same, except that no sample will be taken at DCR-002.

Toxicity samples will also be collected during one of the sampling run type A dry events, most likely the last one near the end of the project. The purpose of this is to gain a qualitative idea of how much the effluent is improved from the influent. One toxicity sample will be taken at each of 3 wetland locations (DCR-001, -003, -004). These are the upper inlet, the upper outlet, and the lower outlet (figure 2.6).

Sampling run type C

This sampling run type occurs in the Tembladero Slough. It will, along with SRT F, determine the loads of suspended sediment, nutrients and organophosphates and pyrethroid pesticides exiting the Gabilan watershed on an annual basis.

The timing of sample collection will be like SRT A. Each event will consist of 3 runs, one occurring every other day until completed, for a total time span of 5 days. During each run, 1 suspended sediment and 3 nutrient samples will be collected at the TEM-HAR site (figure 2.4). Organophosphate and pyrethroid samples will be collected only on the last run (due to analysis cost and a need for immediate shipping).

Sampling run type G

This SRT will occur in the wetland. It has not been designed to answer a research question, however, it may give some indication of if there is an accumulation of Organochlorine pesticides (OCs) occurring in the wetland. This is a concern because of the wildlife a wetland attracts. Although Organochlorines such as DDT are no longer applied, they can still be present in soils, sediments, and runoff (Kozlowski et al., 2004b).

Soil samples will be collected once following construction and once near the end of the project timeframe. During each of these events, three samples will be taken clustered around the sampling point DCR-002 in the upper section, and three around DCR-004 in the lower wetland, for a total of 6 samples per event.

Sampling run type B

This SRT will occur in the wetland. Water from the pore spaces in the sediment will be sampled and analyzed for nutrients, and organophosphate and pyrethroid pesticides.

The nutrient samples will be collected in the upper wetland clustered around DCR-002, and in the lower wetland clustered around DCR-004. Pesticide samples will be collected in the upper wetland only at DCR-002.

5.1.2 Storm Sampling Events

There are three different types of sampling events that will occur during storms. These are sampling run types D, E, and F (Table 5.1).

A storm event is sampled quite differently from a dry event. There are 6 runs per event instead of 3 (as in SRT A), and they are spaced by hours instead of days. The amount of spacing will depend on how quickly the storm reaches its' peak, and how long it lasts. The first run is completed just prior to the storm, the second during the climb in the hydrograph, twice around the peak, once as the hydrograph is falling, and the last run is immediately post-storm. This avoids a bias in the estimation of loads from the storm.

Sampling run type D

This SRT occurs in the wetland. The sampling locations are the same as for the dry events (DCR-001, -002, -003, -004). Suspended sediment and nutrient samples will be collected during every run, with a QC sample taken during 1 out of every 3 runs (shown as 1/3 in the table), for a total of 2 per event at a rate of 5%. Organophosphate and pyrethroid samples will be collected once at all wetland sites except DCR-002.

Sampling run type E

This SRT will occur in the wetland and is the same as SRT B, except that it is completed just after a major storm event.

Sampling run type F

This SRT will occur in the Tembladero Slough and is the same as SRT C except that the samples will be collected during storms. There are six runs to follow the rising and falling of the hydrograph, as described for SRT D. Like the collection at TEM-HAR during dry weather (SRT C), pesticides will be collected only once per event. The data from SRTs C and F will be combined.

Table 5.1. Planned water quality monitoring events in the wetland and Tembladero Slough.

WETLAND AND TEMBLADERO SLOUGH						Samples per run									
						Water samples					Benthos samples				
Sampling run type	# of events	System	Runs per event	Sites	Flow measurement (Q)	Suspended sediment	Nutrients	Organophosphates	Pyrethroids	Toxicity	Nutrients	Organochlorines	Organophosphates	Pyrethroids	Total samples per site
A - Dry	3	Wetland	3	DCR-001	1	1	1	1/3	1/3	1/9	0	0	0	0	25
				DCR-002	0	1	1	0	0	0	0	0	0	0	18
				DCR-003	1	1	1	1/3	1/3	1/9	0	0	0	0	25
				DCR-004	1	1	1	1/3	1/3	1/9	0	0	0	0	25
				QC	0	1/3	1/3	1/3	1/3	0	0	0	0	0	12
B - Dry	3	Wetland	1	DCR-002a	0	0	0	0	0	0	1	0	1	1	9
				DCR-002b	0	0	0	0	0	0	1	0	1	1	9
				DCR-002c	0	0	0	0	0	0	1	0	1	1	9
				DCR-004a	0	0	0	0	0	0	1	0	0	0	3
				DCR-004b	0	0	0	0	0	0	1	0	0	0	3
				DCR-004c	0	0	0	0	0	0	1	0	0	0	3
C - Dry	3	Slough	3	TEM-HAR	1	1	2	1/3	1/3	0	0	0	0	0	33
				QC	0	1/3	1	1/3	1/3	0	1	0	0	0	27
D - Storm	3	Wetland	6	DCR-001	1	1	1	1/6	1/6	1/18	0	0	0	0	43
				DCR-002	0	1	1	0	0	0	0	0	0	0	36
				DCR-003	1	1	1	1/6	1/6	1/18	0	0	0	0	43
				DCR-004	1	1	1	1/6	1/6	1/18	0	0	0	0	43
				QC	0	1/3	1/3	1/6	1/6	1/18	0	0	0	0	19
E - Storm	3	Wetland	1	DCR-002a	0	0	0	0	0	0	1	0	1	1	9
				DCR-002b	0	0	0	0	0	0	1	0	1	1	9
				DCR-002c	0	0	0	0	0	0	1	0	1	1	9
				DCR-004a	0	0	0	0	0	0	1	0	0	0	3
				DCR-004b	0	0	0	0	0	0	1	0	0	0	3
				DCR-004c	0	0	0	0	0	0	1	0	0	0	3
F- Storm	3	Slough	6	TEM-HAR	1	1	2	1/6	1/6	0	0	0	0	0	60
				QC	0	1/6	1	1/6	1/6	0	1	0	0	0	45
G - Start	2	Wetland	1	DCR-002a	0	0	0	0	0	0	0	1	0	0	2
and end of				DCR-002b	0	0	0	0	0	0	0	1	0	0	2
project				DCR-002c	0	0	0	0	0	0	0	1	0	0	2
(Dry)				DCR-004a	0	0	0	0	0	0	0	1	0	0	2
				DCR-004b	0	0	0	0	0	0	0	1	0	0	2
				DCR-004c	0	0	0	0	0	0	0	1	0	0	2
				Total samples	108	150	198	36	36	7	63	12	18	18	538

5.2 Agricultural Sites

This section describes SRTs that have been designed to address the research question (from Ch. 1) for agricultural sites:

> Q1. To what extent is the implemented practice at each agricultural site resulting in a reduction of water quality constituents (sediment, nutrients, pesticides) being exported off-site?

There are a total of 32 events in the plan (Table 5.2), but monitoring will not occur on 32 separate days. If there are three practices at a site, for example, then coordination will occur so that all three are monitored on a rotating basis during a single event. This is important when looking at the schedule for storm events. The 25 events that are scheduled will be completed within a few major storms.

5.2.1 Dry Sampling Events

Table 5.2. Planned water quality monitoring events at agricultural sites.

AGRICULTURAL SITES						Samples per run Water samples				
Sampling run type	**# of events**	**System**	**Runs per event**	**Sites**	**Flow measurement (Q)**	**Suspended sediment**	**Nutrients**	**Organophosphates**	**Pyrethroids**	**Total samples per site**
H - Dry	7	Ag	1	CONFIDENTIAL	10	20	20	0	0	280
				QC	0	1	1	0	0	14
I - Storm	21	Ag	1	CONFIDENTIAL	20	60	20	0	0	1680
				QC	0	3	1	0	0	84
J - Storm	4	Ag	1	CONFIDENTIAL	6	0	0	6	6	48
				QC	0	0	0	1	1	8
				Total samples	514	1470	588	28	28	2114

Sampling run type H

To test the effectiveness of management practices on tail water, irrigation events will be monitored. The number of samples cannot be pre-determined as with the sampling plan for the wetland because each site will be different, and the amount of runoff will vary. However, it is estimated based on previous monitoring experience, that 20 suspended sediment and nutrient samples will be collected per practice. One QC sample will be collected per 20 samples, for a rate of 5%.

5.2.2 Storm Sampling Events

Sampling run type I

This is the same as SRT H, except that samples of storm runoff will be collected. Since more sediment is liberated during storms, it is estimated that 60 suspended sediment samples will be collected. The amount of nutrient samples will stay around the same, 20 samples, unless a storm is very long in duration, and then more will be collected. Every storm is different in intensity and duration, so sample numbers will vary up or down based on conditions.

Sampling run type J

This SRT is for organophosphates and pyrethroids. An estimated 6 samples will be collected per event, with one QC, for a total of 7 samples. For example, during one event on a vegetated ditch, 3 samples would be collected above the practice and 3 below, throughout the course of a storm.

The amount of pesticide samples has been limited more so than for nutrients and sediment due to the cost of sample analysis. If it turns out that there are not 4 separate opportunities to monitor management practices for pesticides, then more samples will be taken per practice.

6 Biological Monitoring

The biological monitoring plan is summarized below in table 6.1. It illustrates the quantities of monitoring events, and the number of samples or surveys that will be completed. Biological monitoring will occur only at the wetland and Tembladero Slough. All biological monitoring will occur during dry conditions.

Table 6.1. Planned biological monitoring events in the wetland and Tembladero Slough.

WETLAND & TEMBLADERO BIOLOGICAL MONITORING					Samples or surveys per run			
Event type (weather)	# of events	System	Runs per event	Sites	BMIs	Bird usage surveys	Photo documentation	Total per site
Dry	6	Wetland	1	randomly select transect	1			6
				randomly select transect	1			6
				randomly select transect	1			6
		Tembladero, below TEM-MOL	1	randomly select transect	1			6
				randomly select transect	1			6
				randomly select transect	1			6
Dry	38	Wetland	1	1		1		38
				2		1		38
				3		1		38
Dry	8	Wetland	1	1			1	8
				2			1	8
				3			1	8
				4			1	8
				Total samples or surveys	36	114	32	182

The BMI monitoring has been designed to answer the following question presented in Chapter 1:

> Q6. Does benthic macroinvertebrate community composition and abundance vary between the wetland and the adjacent Tembladero Slough? Does it vary within the wetland? Do these patterns change over time?

Bird usage data will be collected to determine if usage increases or decreases after the installation of the wetland.

Photo monitoring will be conducted to illustrate changes at the wetland site. At agricultural sites it will document the practices where effectiveness is being measured.

6.1 BMI Monitoring

Water quality samples provide strategic snapshots at discrete points in time. Aquatic organisms, on the other hand, live in the water for more just a moment, and thus their presence or absence provides information about the longer-term biological integrity of the water. Surveying aquatic organisms for this purpose is called rapid bioassessment, and normally involves sampling for benthic macroinvertebrates (BMIs). BMI communities are very sensitive to stress, and thus serve as a tool for detecting and assessing environmental perturbation resulting from introduced point and non-point sources of pollution (Klemm et al., 1990).

BMI samples will be collected from the Tembladero Slough (TEM-MOL) and within the wetland. Besides answering Q6, the purpose is mainly to provide a general characterization of the ecology of the wetland versus that of the slough. Differences between the wetland and the Tembladero Slough could be attributable to a number of factors, including: substrate, depth, vegetation, inter-specific competition, salinity, dispersal, succession, and water quality. The time limitations of the study may also be a factor. A more abundant and diverse BMI community in the wetland may be a general indication of better ecological health - perhaps leading to improved habitat for higher organisms such as birds.

Sampling for BMIs will occur during low flow conditions, at least 6 weeks following any major storm event. Typically, sampling will occur during the Spring and Fall because this corresponds to the life cycle of BMIs (Harrington and Born, 2000). This is the reason that BMI sampling is condensed in the calendar at these times (Table 7.1).

Six samples will be collected each time - 3 in the wetland and 3 in the Tembladero Slough below the TEM-MOL bridge (Figure 2.5), alongside the wetland.

6.2 Bird Monitoring

Staff from Moss Landing Marine Laboratories will be conducting the bird surveys at the wetland site. Three fixed monitoring plots have been established. The observer drives to the site and begins surveying from their vehicle. After all birds that are seen from the vehicle are counted, the observer steps out of the vehicle to complete the count. Birds that fly over the site without stopping are noted as “flyovers”. Surveys are completed within an hour. The surveys will be conducted twice monthly for the duration of the project.

Figure 6.1. Blue Heron standing on the bank of the wetland site. There is also a Mallard duck at the upper left in the Old Salinas River Channel. Snowy White Egrets have also been seen in the waterways adjacent to the site. Photo: Kelleen Harris, 2004.

Bird usage of the wetland site is not directly linked with water quality. However, wildlife habitat is an additional benefit that a constructed wetland can provide. An increase in bird usage would suggest that the habitat has been enhanced.

6.3 Photo Monitoring

Photo monitoring will be conducted using the State Water Resources Control Board protocols for stream photo documentation (CARCD, 2001).

In the wetland, photos will be taken from 3 established photo points (Figure 6.2), with consideration given to similar lighting conditions and the landscape scale. Each photograph will be taken in a designated direction. Points 1 and 2 are taken while standing on guardrail posts. Point 3 photos are taken at ground height. Points 2 and 3 use multiple photos to create one merged image for each point. A separate photo-monitoring log will be kept.

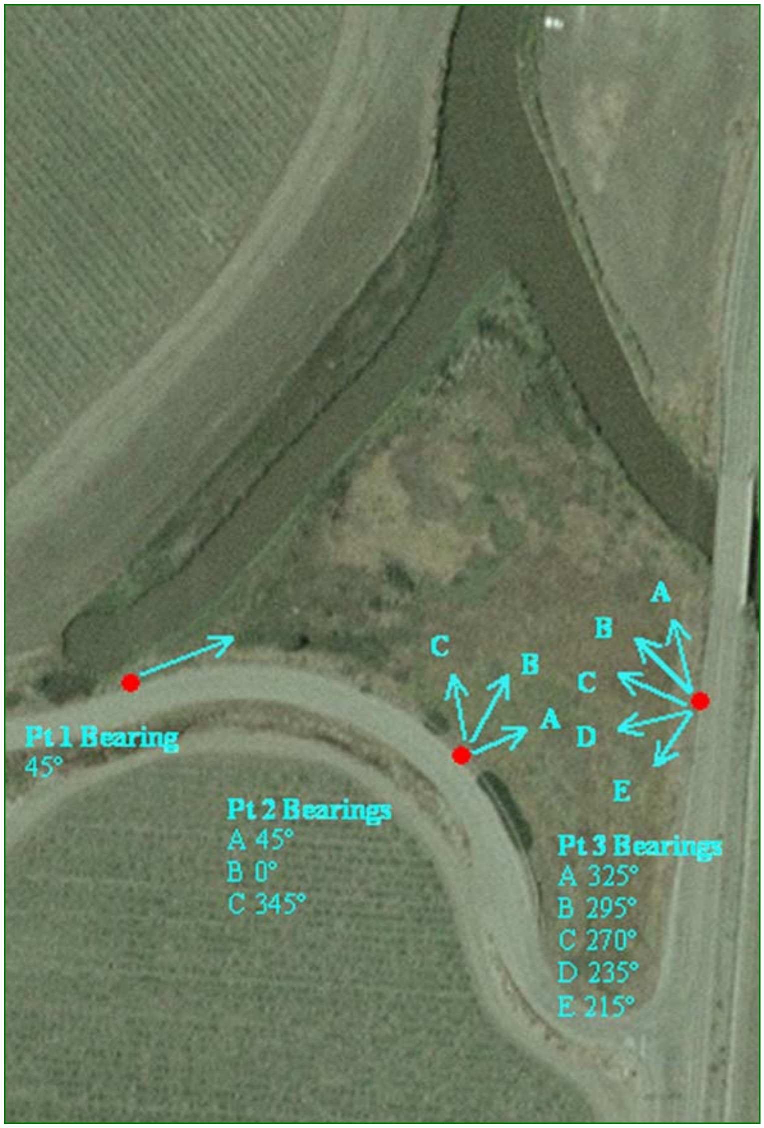

Figure 6.2. Map of wetland site designating photo points. All compass bearings are magnetic N.

Photo monitoring at agricultural sites will include "before" and "after" the instillation of management practices, whenever possible. If no before is available, then the practice in its' current state will be documented. Photo surveys will be conducted quarterly at the wetland and as needed at agricultural sites.

7 Monitoring Calendar

Monitoring events will be carried out through December of 2006. A project calendar has been created (Table 7.1). Please refer back to Chapter 5, *Water Quality Sampling*, for a detailed description of each letter coded sampling run type.

Table 7.1. Monitoring Calendar.

2005	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Wetland And Tembladero	Set up photo points	Photo	—	—	Photo BMI technique	—	—	Photo	—	BMI	Photo BMI C	F G
Ag Sites	—	—	—	—	—	—	—	—	—	—	I	I(x3)
2006	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Wetland And Tembladero	F D E	Photo	BMI D E	BMI F	Photo C	A B	C	Photo BMI A B	BMI	A with toxicity B G	Photo D with toxicity E	—
Ag Sites	I(x5) J(x2)	I(x6) J(x2)	I(x4)	I(x2)	—	H(x2)	H(x2)	H(x2)	H	—	—	—

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