Mr. Bruce Wolfe, Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA. 94612

Subject: 2005 Annual Self-Monitoring Report For South San Francisco Bay Low Salinity Salt Ponds Order No. R2-2004-0018, WDID No. 2 019438001.

Dear Mr. Wolfe:

This letter transmits the 2005 Annual Self-Monitoring Report and Revised Operations Plans for the subject project at the U.S. Fish and Wildlife Service's (FWS) Alviso Salt Ponds in Santa Clara County. The California Department of Fish and Game will be submitting a separate report covering the Eden Landing Salt Ponds in Alameda County.

The report provides information on the main parameters of concern including salinity, metals, dissolved oxygen (DO), pH, and temperature. Note that we provided the raw monitoring data to your staff as it became available in order that both our agencies might learn about the operating conditions in these ponds. This report summarizes that data and provides some additional information.

Please contact me or Eric Mruz at (510) 792-0222 if you have questions regarding this report.

"I certify under penalty of law that this document and all attachments have been prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. The information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

Sincerely yours,

Clyde Morris
Don Edwards NWR Manager

Enclosures

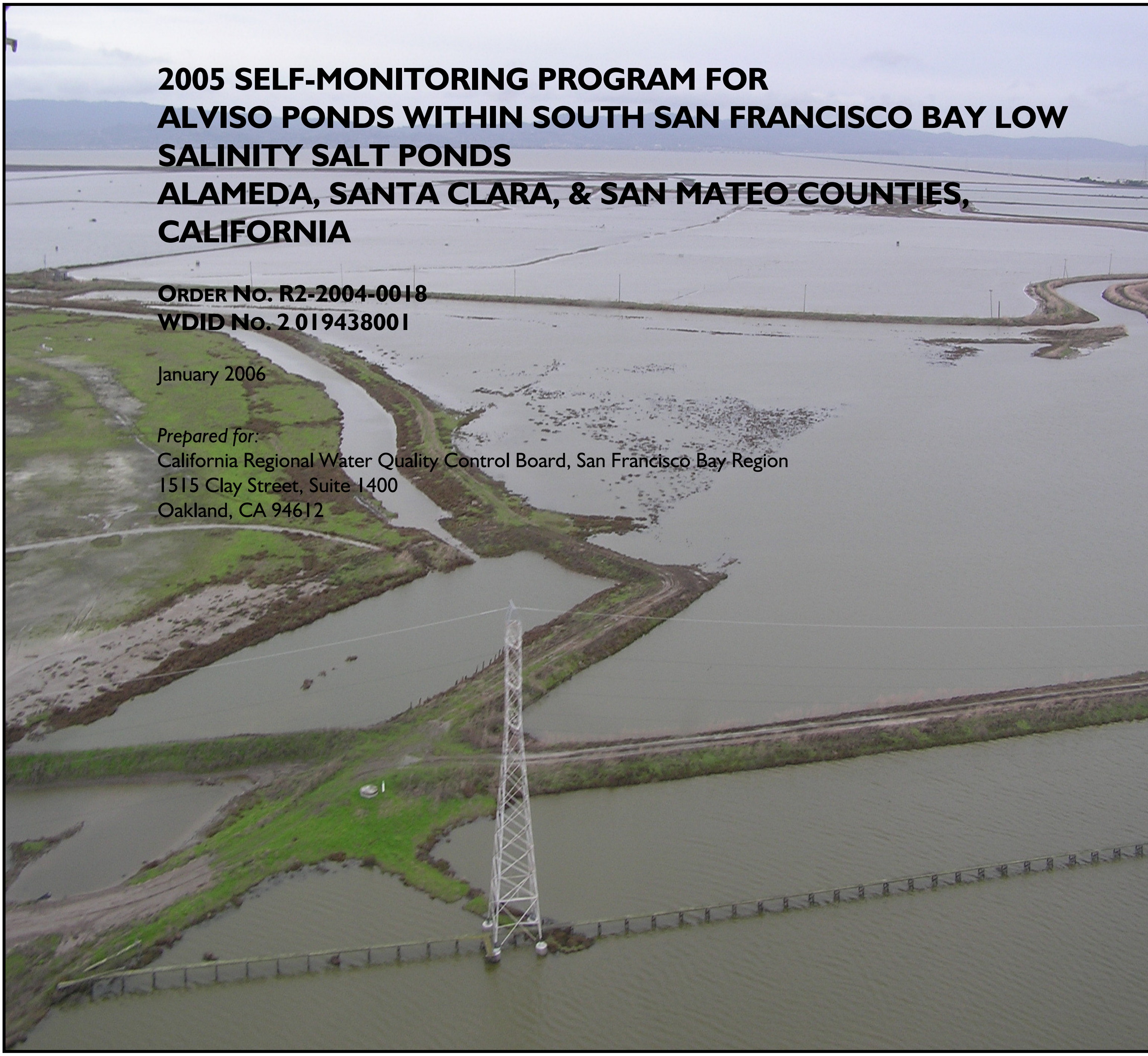
1. Self Monitoring Report

2005 SELF-MONITORING PROGRAM FOR ALVISO PONDS WITHIN SOUTH SAN FRANCISCO BAY LOW SALINITY SALT PONDS ALAMEDA, SANTA CLARA, & SAN MATEO COUNTIES, CALIFORNIA

ORDER NO. R2-2004-0018
WDID NO. 2 019438001

January 2006

Prepared for:
California Regional Water Quality Control Board, San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612



Prepared by:

U.S. Fish and Wildlife Service
San Francisco Bay National Wildlife Refuge Complex
P.O. Box 524
Newark, California 94560

TABLE OF CONTENTS

Section Page

LIST OF APPENDICES

Appendix

LIST OF FIGURES

Figure Page

LIST OF TABLES

Table Page

LIST OF ACRONYMS

Acronym or Abbreviation	Full Phrase
ACOE	Army Corp of Engineers
Bay	South San Francisco Bay
cm	Centimeters
CCM	Continuous Circulation Monitoring
DANR	University of California, Davis Department of Agriculture and Natural Resources laboratory
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
FWS	United States Fish and Wildlife Service
Hg	Mercury
IRM	Initial Release Monitoring
ISP	Initial Stewardship Plan
LDO	Luminescent Dissolved Oxygen
meHg	Methymercury
mg/L	Milligrams per Liter
MLLW	Mean Low Lower Water
NAVD	North American Vertical Datum
NGVD	National Geodetic Vertical Datum
ppt	Parts per Thousand
RW	Receiving Water
RWQCB	California Regional Water Quality Control Board
THg	Total Mercury
TSS	Total Suspended Solids
USGS	United States Geological Survey
WCS	Water Control Structure
WQO	Water Quality Objective

SECTION 1
PROJECT OVERVIEW

This annual report summarizes the results of the 2005 water quality sampling conducted at the Alviso Salt Ponds in Santa Clara County, California, which are part of the South San Francisco Bay Low Salinity Salt Ponds. Operations occurred from May through October 2005. Sampling was performed on a continuous, weekly, monthly, or bi-monthly schedule as required by the California Regional Water Quality Control Board (RWQCB) Final Order (No. R2-2004-0018). Sampling was performed by the United States Geological Survey (USGS) on behalf of the United States Fish and Wildlife Service (FWS) in accordance with the waste discharge requirements.

The Final Order for the South San Francisco Bay Low Salinity Salt Ponds concerned 15,100 acres of ponds in Alameda, Santa Clara, and San Mateo Counties. The area encompasses the Alviso Pond Complex (Figure 1-1). This report covers the following pond systems within the complex: A2W, A3W, A7, A14, and A16. The systems are operated by the Don Edwards San Francisco Bay National Wildlife Refuge in Santa Clara County. The California Department of Fish and Game will submit a report for the Eden Landing (Baumberg) Ponds under a separate cover.

The ponds are generally being operated as flow-through systems with Bay or slough waters entering an intake pond within each pond system at high tides through a tide gate, passing through one or more ponds, and exiting the particular system's discharge pond to either a tidal slough or the Bay at low tides. The ponds only discharge at low tides for about 6 or 8 hours per day. Two ponds in the A3W and A7 systems, Ponds A3N and A8, respectively, were operated as seasonal ponds during 2005 and were not connected to this flow-through system. Also, Ponds A12, A13, and A15, part of the A14 pond system, are designed as batch ponds. Discharge occurs from Pond A15 to Pond A16 when salinity reaches 100-120 ppt, but was not discharged on a batch basis in 2005 due to low target salinities.

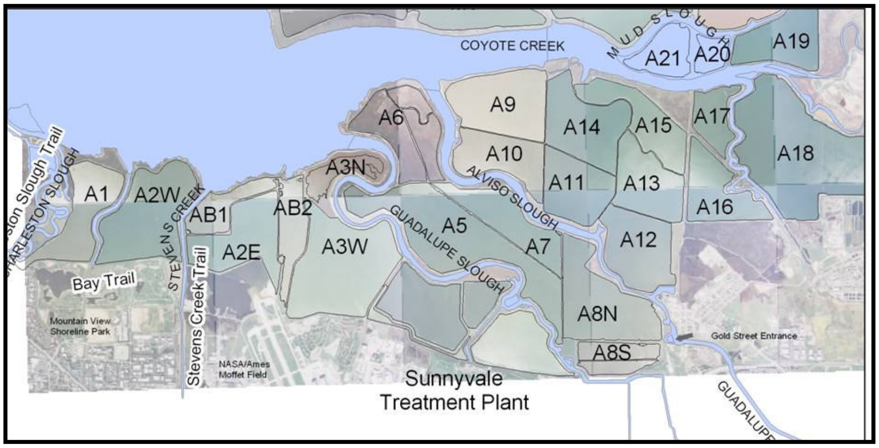


Figure 1-1: Alviso Pond Complex

1.1 FINAL ORDER NUMBER R2-2004-0018

The Final Order recognized two periods of discharges from the ponds. The first covered the Initial Release Period (IRP) when salinity levels would decrease from the initial levels in the ponds. The second period is the Continuous Circulation Monitoring (CCM) period after salinities went below the 44 parts per thousand (ppt) salinity discharge limit. Different monitoring plans were identified in the Final Order by RWQCB and revised in 2005 (March 25, 2005 letter) for each specific period and are reiterated below.

1.1.1 RWQCB Initial Release Period Monitoring Plan

Receiving water samples from the slough and Bay were collected at discrete locations near the water surface and bottom from downstream and upstream of the discharge point. This occurred one week before initiating discharge, one day after the initial discharge, three days later, and then seven days later. Sampling continued on a weekly basis until the FWS was able to document that the discharge salinity levels were below 44 ppt. Once discharge began, discharge pond samples were collected prior to pond water mixing with receiving water using a continuous monitoring device. Dissolved oxygen (DO) levels in the pond water during discharge, calculated on a weekly basis, were required to remain above a 10th percentile of 3.3 mg/L. If the dissolved oxygen levels fell below this requirement, the FWS was required to accelerate receiving water monitoring in the slough and/or Bay to weekly, notify RWQCB Staff, and implement best management practices to increase dissolved oxygen levels in discharged water, including within pond monitoring. For days it collects receiving water samples, the FWS also reported standard observations and documented what tidal phase samples were collected in. Additionally, the FWS made daily estimates of the quantity and time-period of discharge from the ponds and the strength of tides. All notes were recorded on standard monitoring sheets.

Samples for benthos were collected from discrete locations at the convenient stage of the tide at the following frequency: One week before initiating discharge; fourteen days after the initial discharge; 28 days following the second sampling; once in the late summer (August); and finally once in the late summer of the following year. Salinity samples were collected within ponds at least twice per month for at least the previous two months before discharges commenced. Dissolved oxygen samples were collected between 8:00 am and 10:00 am, with the times being recorded on the standard monitoring sheets.

1.1.2 RWQCB Continuous Circulation Period Monitoring Plan

Receiving water samples from the slough and Bay were collected at discrete locations near the water surface and bottom from downstream and upstream of the discharge point. Samples were collected on a monthly basis between May and October 2005 as close to low tide as practicable. Discharge pond samples were collected before pond water mixed with receiving water using a continuous monitoring device. Dissolved oxygen levels in the pond water, calculated on a weekly basis, were required to remain above a 10^{th} percentile of 3.3 mg/L. If the dissolved oxygen levels fell below this requirement, the FWS was required to accelerate receiving water monitoring in the slough and/or Bay to weekly, notify RWQCB Staff, and implement best management practices to increase dissolved oxygen levels in discharged water, including within pond monitoring. For days it collects receiving water samples, the FWS also reported standard observations and documented what tidal phase samples were collected in. Additionally, the FWS made daily estimates of the quantity and time-period of discharge from the ponds and the strength of tides. All notes were recorded on standard monitoring sheets.

Water column samples for total and dissolved arsenic, chromium, nickel, copper, zinc, silver, cadmium, lead, and mercury were collected in September 2005. When collecting metals samples, the FWS also monitored for salinity, and total suspended solids.

SECTION 2
ANNUAL SUMMARY

This section summarizes the monitoring activities conducted by FWS during the 2005 calendar year at the Alviso Pond Complex to comply with the Final Order.

2.1 WATER QUALITY MONITORING METHODOLOGY

Continuous Pond Discharge Sampling (Initial Release and Continuous Circulation Phases):

USGS installed continuous monitoring Datasondes (Hydrolab-Hach Company, Loveland, Colorado) in Alviso ponds A14 and A16 on 24 March 2005, prior to their 31 March release dates. Ponds A2W, A3W, and A7 were initially released during 2004 and were to be monitored under CCM monitoring beginning 1 May 2005; thus, meters were installed and began logging on 27 April 2005. Datasondes were installed on the water control structures at the outflow of the discharge into the slough and/or San Francisco Bay using a PVC holder attached to a ground-mounted pole to allow for free water circulation around the sensors. The devices were installed at a depth of at least 25cm to ensure that all sensors were submerged, and these depths were monitored and adjusted to maintain constant submersion as the pond water level fluctuated (Figure 2-1).


Figure 2-1: Datasonde within Weir Structure

Salinity, pH, temperature, and dissolved oxygen were collected at 15-minute intervals with a sensor and circulator warm-up period of 2 minutes. Data were downloaded weekly and sondes were serviced to check battery voltage and data consistency. A recently calibrated Hydrolab Minisonde was placed next to the Datasonde in the pond at the same depth, and readings of the two instruments were compared. Any problems detected with the Datasonde were corrected through calibration or replacement of parts or instruments. The sensors on the Datasonde were calibrated prior to deployment into the salt pond and were calibrated and cleaned on a biweekly schedule unless otherwise noted in service records. During the cleaning and calibration procedure, simultaneous readings were collected with a recently calibrated Hydrolab Minisonde to confirm data consistency throughout the procedure (initial, de-fouled, post cleaned, and post calibration). The initial and de-fouled readings were also used to detect shifts in the data due to accumulation of biomaterials and sediment on the sensors.

Beginning August 2005, discrete water samples were collected concurrent with some meter calibrations to perform Winkler titration samples. Samples were fixed in the field and analyzed at the USGS Menlo Park facility. Results were compared to direct meter readouts of DO to check for meter accuracy.

2.1.1 Alviso Receiving Water (IRP/CCM):

Receiving waters were measured outside pond discharge locations one week prior to discharge, one, three and seven days after initial discharge, and then weekly by USGS at sites along Artesian Slough adjacent to Alviso pond A16 (5 sites). Beginning 1 May 2005, samples were collected at least monthly from A3W receiving water (Guadalupe Slough, 8 sites) and A7 receiving water (Alviso Slough, 7 sites) through November 2005. Samples were collected weekly when water quality objectives in discharge samples were not met. Additionally, water quality measurements were collected monthly in San Francisco Bay outside the water control structure in pond A2W (3 sites) and A14 (3 sites) from May through November 2005. Sampling locations were marked using a GPS waypoint. We accessed slough sampling sites via boat from San Francisco Bay and used a GPS to navigate to sampling locations. When the boat was approximately 50-25 meters from the site, the engine would be cut or reduced to allow for drifting caused by current and wind to the site location. Every effort was made to ensure that the sample reading was collected from the center of the slough. A recently calibrated Hydrolab Minisonde (Hydrolab-Hach Company, Loveland, Colorado) was used to measure salinity, pH, turbidity, temperature, and dissolved oxygen at each location. Samples were collected from the near-bottom of the water column in addition to the near-surface at each sampling location. Depth readings of sample locations were collected at the completion of each Minisonde measurement to account for drift during the reading equilibration period. The specific gravity of each site was additionally measured with a hydrometer (Ertco, West Paterson, New Jersey) scaled for the appropriate range. This sample was collected concurrently with the near-surface Minisonde measurement. The majority of the samples were collected on the rising or high tide in order to gain access to the sampling sites, which were not accessible at tides less than 3.5 ft MLLW. Alviso pond A2W receiving water sites could only be accessed during high tides over 6.0 ft MLLW. Standard observations were collected at each site. These were:

A. Observance of floating and suspended materials of waste origin.

B. Description of water condition including discoloration and turbidity.

C. Odor – presence or absence, characterization, source and wind direction.

D. Evidence of beneficial use, presence of wildlife, fisherpeople and other recreational activities

E. Hydrographic conditions – time and height of tides, and depth of water column and sampling depths.

F. Weather conditions – air temp, wind direction and velocity, and precipitation.

Sections A, B, C, D and E were recorded at each sampling location. Section F was recorded at the beginning and ending of each slough, unless it had changed significantly.

2.1.2 Calibration and Maintenance:

All the instruments used for sampling as part of the South Bay Salt Pond Initial Stewardship Plan's Self-Monitoring Program were calibrated and maintained according to the USGS standard procedures. Datasondes were calibrated pre-deployment and maintained on a biweekly cleaning and calibration schedule unless they required additional maintenance. The problem of algae and other substances interfering with the moving parts such as on the self-cleaning brush and circulator was improved with the use of nylon stockings. This allowed for maximum water flow past the sensor but stopped algae from wrapping around and binding the moving parts. Copper mesh and wire was used to inhibit growth in ponds with high concentrations of barnacles and hard algae, which could interfere with sensor function. We performed a biweekly fouling check to detect shifts in data due to the accumulation of biomaterial and sediment on the sensors. A calibration and maintenance log was maintained for each pond.

Additionally, Winkler titration samples were collected during and after August 2005 to check accuracy of DO readings. The Minisonde, used for receiving water sample measurements, read on average 0.4 mg/L (SD 0.5 mg/L) lower than the Winkler samples (n=159). Despite some variability in readings, the data fit a regression line well ($R2 = 0.9396$, $y = 0.9304x + 0.7933$, $F1,157 = 2441.51$, $P < 0.000$), suggesting that Minisonde DO readings are slightly lower than actual, but very consistent.

Clarke Cell Datasondes overall read DO on average 0.1 mg/L (SD 1.1 mg/L) lower than the Winkler samples (n=58). Despite a relatively high degree of variability in readings, the data fit a regression line reasonably well ($R2 = 0.9074$, $y = 0.7925x + 1.6551$, $F1,56 = 548.82$, $P < 0.000$), suggesting that Clarke Cell DO readings are slightly lower than actual, and consistent overall, but subject to some variability.

Luminescent DO (LDO) sensors were not accurate prior to mid-August 2005 because the associated software did not compensate for pond salinity. After the software was corrected, LDO meters overall read on average 0.4 mg/L (SD 0.4 mg/L) higher than the Winkler samples (n=41). Some initial variability was due to inconsistent meter calibration, but adjustments to the calibration method have resulted in better consistency. Overall data fit a regression line well (R2 = 0.9686, y = 0.924x + 0.1615, F1,39 = 1201.39, P < 0.000).

We estimated times of actual discharge as the period when the water surface elevation in the receiving waters was lower than the water surface elevation of the ponds. We converted NGVD29 pond staff gage readings to NAVD88 using Corpscon program (ACOE), and then converted NAVD88 to MLLW using estimated conversion values for the specific discharge location (G. Hovis, pers. comm.). Slough water surface elevation was estimated using Coyote Creek Station tide estimates, provided as MLLW feet (Tides and Currents Pro software). The pond was assumed to be discharging when the water surface elevation of the slough was less than that of the pond.

2.2 WATER QUALITY MONITORING SUMMARY

Pond systems A2W, A3W, and A7 have been opened to the Bay and slough since 2004 and are being monitored during their Continuous Circulation Phases. Pond Systems A14 and A16 were opened to the sloughs on March 31, 2005 and are in accordance with the Initial Release Monitoring Plan. The results of the 2005 sampling events in the pond systems are documented below.

2.2.1 Salinity

The salinity levels for Pond Systems A2W, A3W, and A7 in 2005 remained well below 44 ppt and the discharge ponds generally reflected slightly higher salinities than the intake waters from the bay and sloughs (Refer to Figures A-1 through 3 in Appendix A).

The salinity in Pond A14 was below 44 ppt during the initial discharge of the system. However, the salinity began to rise on May 22, 2005. The salinity fluctuated periodically above and below 44 ppt throughout the remainder of the year and went as high as 49.8 ppt (June 27, 2005) (Refer to Figure A-4 in Appendix A).

In Pond System A16, the salinity was 70 ppt at the time of opening. By April 25, 2005, the salinity had fallen below 44 ppt and has remained below the limit since then (Refer to Figure A-5 in Appendix A).

Table 2-1
Salinity Ranges

Pond	Salinity Range (ppt)	Salinity Avg. (ppt)	2004 Salinity Avg.
A2W	9.20 to 37.0	28.9	32.0
A3W	3.9 to 34.4	17.3	29.2
A7	7.2 to 28.0	22.2	33.3
A14	19.2 to 49.8	40.8	N/A
A16	1.2 to 70.7	24.5	N/A

2.2.2 Salinity Compliance

Salinity levels in all the Pond Systems were in compliance with the Final Order except for Pond System A14. Pond System A14 salinity was in compliance 90 percent of the 2005 season. The rise in salinity was caused by a long residence time, poor discharge rate, and actions taken with the observance of extremely low dissolved oxygen in Pond A14 discharge Datasonde (see Section 3, Corrective Actions Taken).

2.2.3 Temperature

Temperature levels in the ponds generally matched the temperature levels in the intake and receiving waters and therefore met the discharge requirement of not exceeding natural temperatures of the receiving waters by 20°F (Refer to Figures A-6 through 10 in Appendix A).

Table 2-2
Temperature Ranges

Pond	Temp. Range (°C)	Temp. Avg. (°C)	2004 Temp. Avg. (°C)
A2W	11.7 to 31.3	20.0	20.3
A3W	13.9 to 27.9	20.9	20.0
A7	13.6 to 27.1	20.1	19.6
A14	10.2 to 30.2	19.4	NA
A16	13.3 to 29.6	22.3	NA

2.2.4 Temperature Compliance

The Alviso Complex was in compliance with the Final Order for temperature 100 percent during the 2005 season.

2.2.5 pH Compliance

Levels of pH varied differently in each Pond System, but were generally greater than 8.5.

- In A2W, pH increased to a high of 9.25 for two 15 minute intervals on August 20, 2005, then oscillated throughout the year with an average of 8.4 (Refer to Figure A-11 in Appendix A).

- Pond System A3W followed a similar pattern as Pond System A2W with an average of 8.6 and a high of 9.8. Similar to data from 2004, Pond System A3W stayed above 9.0 for a longer period than A2W (Refer to Figure A-12 in Appendix A).

- Pond System A7 stayed generally between 8.5 and 9.0 throughout the 2005 season and increased to a high of 9.42 on August 15, 2005 with a season average of 8.67 (Refer to Figure A-13 in Appendix A).

- Pond System A14 averaged 8.42 with an initial pH release of 8.79 (Refer to Figure A-14 in Appendix A).

- Pond System A16 had an initial pH of 8.69 upon release. The season's average was 8.73 (Refer to Figure A-15 in Appendix A).

Levels of pH in receiving waters went above the 8.5 discharge limit on only one occasion. On October 9, 2005 a sample was taken near Pond A7 discharge point in Alviso slough which recorded 8.70. This was a bottom sample that was taken on a flood flow tide which had a higher salinity than the surface values. Table 2-3 shows the stratification between the surface and bottom sample taken in the receiving waters, the pH on the surface sample is within the normal levels. The bottom sample shows a higher pH, and salinity, with a lower dissolved oxygen value. The stratified salinity value suggests that the water being discharged from Pond A7 could have caused an elevated pH seen in the receiving waters on this one occasion.

Table 2-3
pH in Receiving Waters

Sample	Date	Time	Sample Level	Temp. (°C)	pH	DO (mg/L)	Salinity (ppt)
A7-1	9/9/05	12:01	Surface	20.42	7.98	5.63	8.68
A7-1	9/9/05	12:03	Bottom	20.52	8.70	4.54	24.05

2.2.6 Dissolved Oxygen

For the 2005 season, the dissolved oxygen was once again problematic for achieving compliance with the Final Order. Dissolved oxygen levels in the pond water, calculated on a weekly basis during discharge, were required to remain above a 10th percentile of 3.3 mg/L. Significant algae growth and decomposition in these ponds appeared to cause fluctuating diurnal oxygen levels throughout the Alviso Ponds Complex during the summer months. The FWS continued to make adjustments and modifications to the Alviso Ponds Complex (see Section 3, Corrective Actions Taken) in order to improve the dissolved oxygen levels.

Pond System A2W in 2005 had a total of 28 recordable sampling weeks, which had a weekly 10th percentile higher then 3.3 mg/l for 10 of the 28 weeks. Monitoring efforts showed that dissolved oxygen levels in Pond A2W exhibited a strong diurnal pattern (low dissolved oxygen near dawn and higher levels at mid-day), but that receiving water monitoring in the Bay did not detect reductions in dissolved oxygen levels from the discharge. The 2004 data (Figure 2-2) shows that for 13 weeks of monitoring, based on a weekly 10th percentile, 10 weeks were above the 3.3 mg/L trigger.

Pond System A3W was monitored for 29 weeks in 2005. It had a weekly 10th percentile higher then 3.3 mg/l for 22 weeks, compared to 2004 data which had 17 weeks of monitoring, and only one week with a higher level than 10th percentile of 3.3 mg/L (Figure 2-3). Since the discharge point for Pond A3W was located near the edge of a large algal mat, water currents caused discharge waters to flow through the area of algae buildup which resulted in consistently depressed dissolved oxygen levels as seen in the 2004 data. The FWS has installed flow diversion baffles (see Section 3, Corrective Actions Taken) in Pond A3W for the 2005 season to move the flow of water away from algae buildup and to increase oxygen uptake.

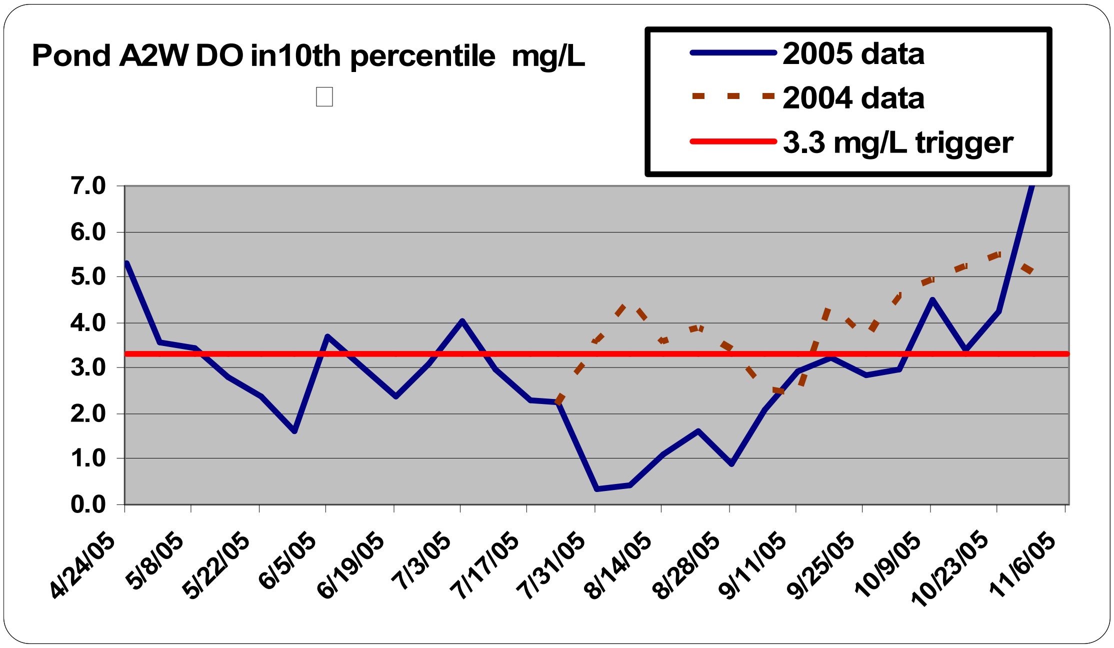


Figure 2-2: Dissolved Oxygen of Pond A2W

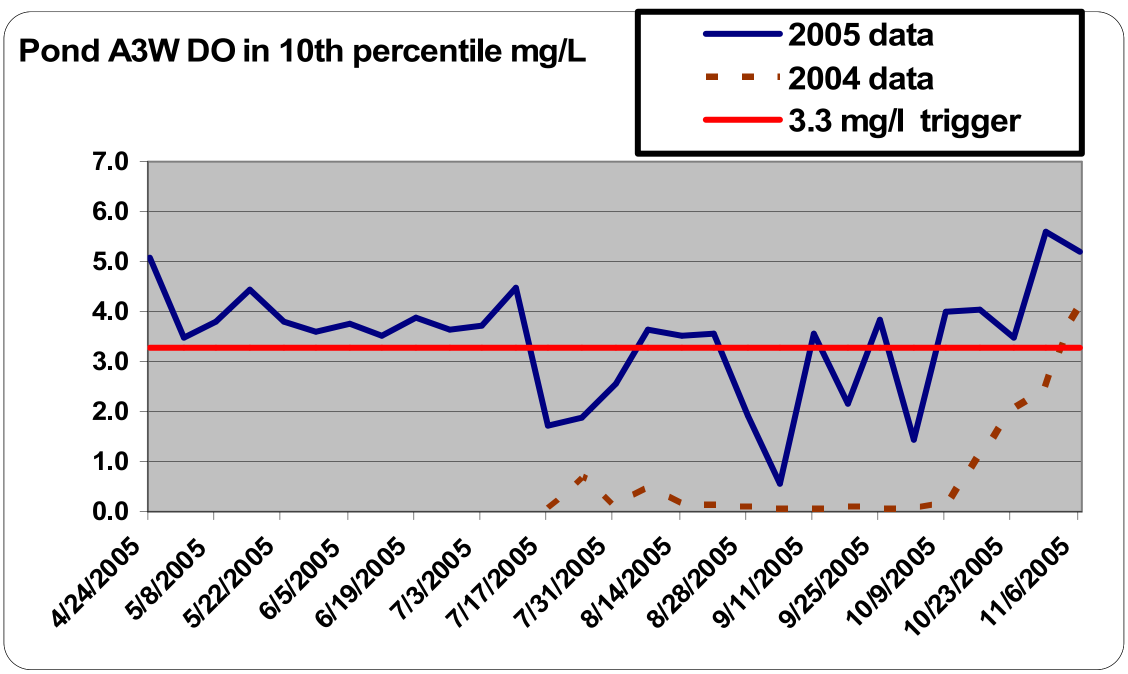


Figure 2-3: Dissolved Oxygen of Pond A3W

Pond System A7 for the 2005 season recorded low levels of dissolved oxygen for approximately half the time, despite changing methods of operation (see Section 3, Corrective Actions Taken). The FWS installed four Solar Aerators on June 24, 2005 into Pond A7 to better help circulate areas of high DO with the lower quality waters. Pond System A7 was monitored for 29 weeks where the weekly 10th percentile was above 3.3 mg/L for 13 weeks (see Figure 2-4). The 2004 data shows 18 weeks of monitoring, with three weekly 10th percentile readings being above 3.3 mg/L.

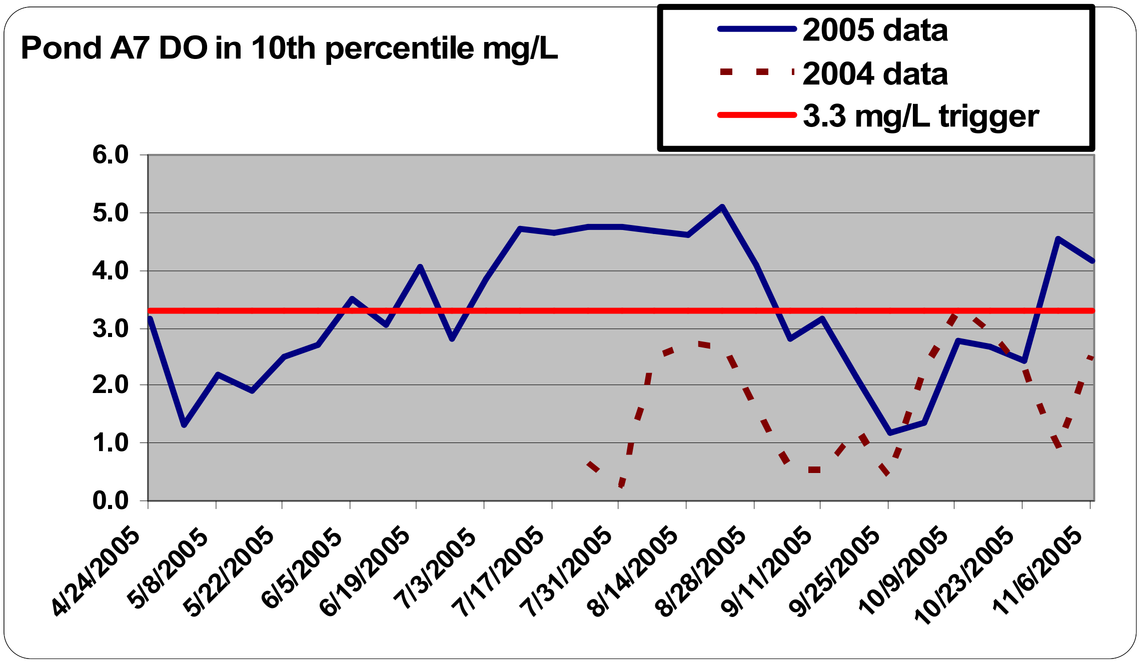


Figure 2-4: Dissolved Oxygen of Pond A7

Pond System A14 had 35 weeks of monitoring (Figure 2-5). There was six weeks which had a 10th percentile value of greater than 3.3 mg/L (this was a 2005 Initial Release Pond, with no 2004 data available). Several Corrective Actions were taken during the season to try and improve the weekly percentile (see Section 3, Corrective Actions Taken). This Pond System has extremely low DO levels that did not respond to any actions taken for its improvement.

Pond System A16 had an Initial Release on March 31, 2005. There was a continuous monitor installed at the discharge point for 32 weeks (Figure 2-6). The dissolved oxygen levels were above the 3.3 mg/L trigger for 22 weeks. The discharge gates were closed from August 1 – August 10, 2005, as part of actions taken to improve water quality in the receiving waters (see Section 3, Corrective Actions Taken).

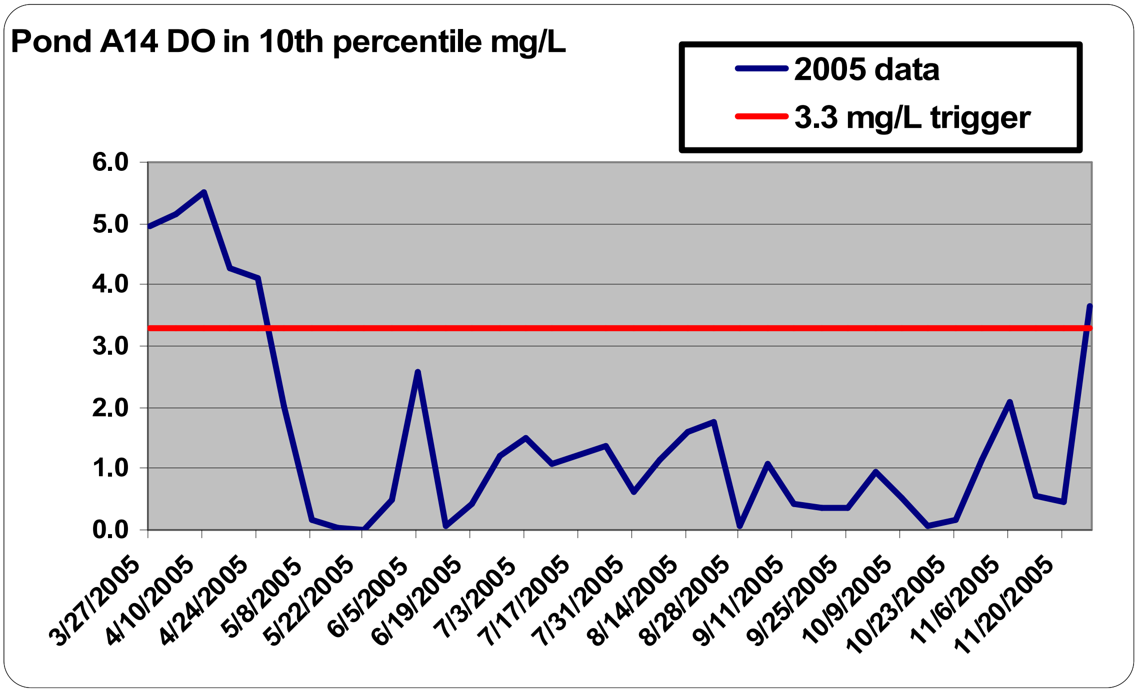


Figure 2-5: Dissolved Oxygen of Pond A14

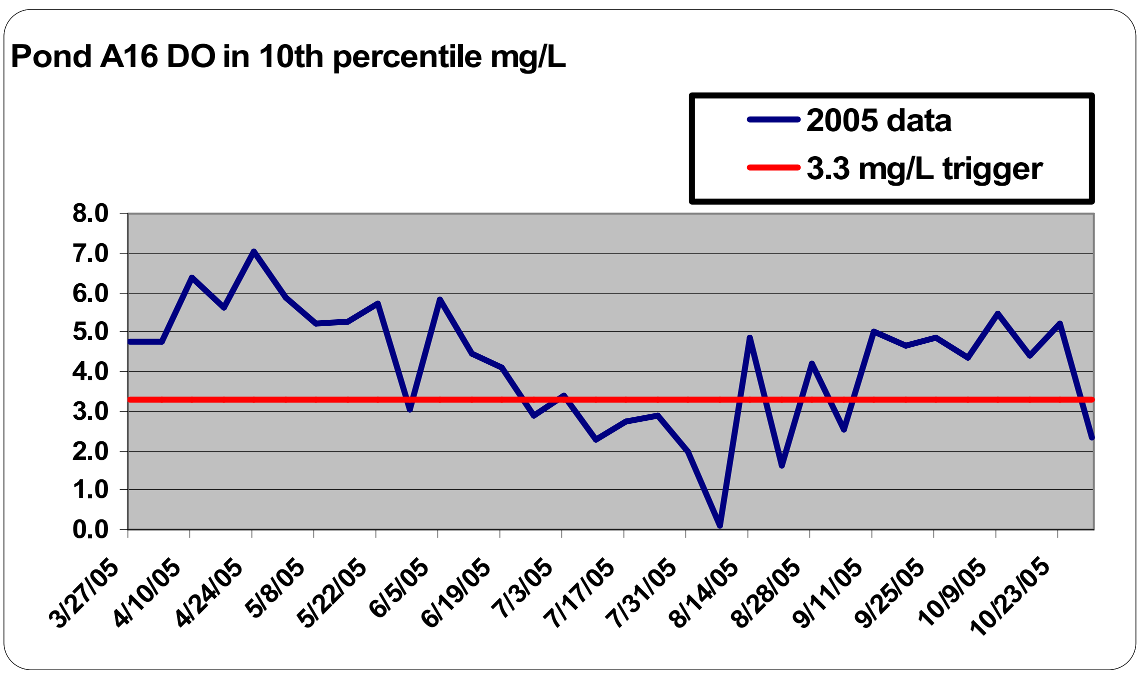


Figure 2-6: Dissolved Oxygen of Pond A16

2.2.7 Dissolved Oxygen Compliance

The FWS has again struggled with DO compliance in the 2005 season. The Pond Systems produced high algal growth (Figure 2-7) that could have caused dissolved oxygen levels to vary significantly over the course of the day. This is because during daylight hours, photosynthesis will produce oxygen and consume dissolved carbon dioxide (which behaves similar to carbonic acid). During nighttime hours, respiration will produce dissolved carbon dioxide and consume oxygen. Therefore, any significant algal growth will cause dissolved oxygen to peak during the late afternoon and to be at their lowest levels in pre-dawn (Final Order). Compliance with the Final Order limits is also dependent on factors beyond the FWS control, such as strength of tides, rainfall, and temperature.

Figure 2-7: Algae Growth near WCS

Table 2-4
Alviso Complex DO Compliance (2005)

Pond System	Total No. of Sampling Weeks	No. of Weeks Below a 10th Percentile of 3.3 mg/L	No. of Weeks Above a 10th Percentile of 3.3 mg/L
A2W	28	18	10
A3W	29	7	22
A7	29	16	13
A14	35	29	6
A16	32	10	22

DO levels in the pond water, calculated on a weekly basis, were required to remain above a 10th percentile of 3.3 mg/L. Calculations were based on discharge times only.

2.2.8 Water Column Sampling for Metals.

Water column samples were collected on September 30, 2005, following Environmental Protection Agency (EPA) method 1669 (Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels). Pre-cleaned sample containers conforming to EPA protocols were provided by Frontier GeoSciences, Inc.. Samples from ponds A2W, A3W, A7, A14, and A16 were sampled approximately 30 meters from the water control structure to minimize the influence of the structure on water column metals concentrations. Salinity, pH, temperature, and dissolved oxygen were measured concurrently with water column sample collection using a Hydrolab Minisonde (Hach Hydrolab Loveland, Colorado). Collected samples were immediately stored on ice in a cooler and shipped overnight to Frontier GeoSciences (Seattle, Washington).

Upon receipt, bottles submitted for dissolved metals analysis were immediately filtered through an acid-rinsed 0.45um disposable filtration unit. Total and dissolved Hg was determined by cold vapor atomic fluorescence spectrometry; total and dissolved Cr, Ni, Cu, Zn, Ag, Cd, and Pb were determined by reductive precipitation preparation and inductively coupled plasma mass spectrometry; and total and dissolved As and Se were determined by hybride generation atomic fluorescence spectrometry. Total Suspended Solids (TSS) samples were sent separately to the University of California, Davis Department of Agriculture and Natural Resources laboratory (DANR) for analysis. All labs reported that the samples arrived intact and were handled with proper chain-of-custody procedures, and that appropriate QA/QC guidelines were employed during the analysis on a minimum five percent basis.

2.2.9 Water Column Sampling for Metals Compliance

Annual water column sampling data indicated that levels of metals in discharge waters for all Alviso ponds met water quality objectives for San Francisco Bay receiving waters. (Table 2-5).

Table 2-5
Water Column for Metals

	Ag		Cd		Cr		Cu		Ni	
WQO[1]	2.2		0.27		11.4		13		27	
Pond	**Salinity (ppt)**	**2005 (µg/L)**	**Salinity (ppt)**	**2005 (µg/L)**	**Salinity (ppt)**	**2005 (µg/L)**	**Salinity (ppt)**	**2005 (µg/L)**	**Salinity (ppt)**	**2005 (µg/L)**
A2W	33.3	<0.4	33.3	0.022	33.3	0.4	33.3	0.83	33.3	4.7
A3W	25.6	<0.4	25.6	<0.02	25.6	<0.4	25.6	0.52	25.6	2.89
A7	18.0	<0.4	18.0	<0.02	18.0	<0.4	18.0	0.57	18.0	4.11
A16	9.9	<0.2	9.9	0.048	9.9	1.7	9.9	2.53	9.9	8.27
A14	41.4	<0.2	41.4	0.032	41.4	0.4	41.4	0.9	41.4	6.64
	Pb		**Zn**		**As**		**Hg**		**Se**	
WQO[1]	3.2		86		36		50		5.0	
Pond	**Salinity (ppt)**	**2005 (µg/L)**	**Salinity (ppt)**	**2005 (µg/L)**	**Salinity (ppt)**	**2005 (µg/L)**	**Salinity (ppt)**	**2005 (µg/L)**	**Salinity (ppt)**	**2005 (µg/L)**
A2W	33.3	<0.20	33.3	2.16	33.3	7.68	33.3	15.9	33.3	0.194
A3W	25.6	<0.20	25.6	0.6	25.6	6.9	25.6	5.51	25.6	0.188
A7	18.0	<0.20	18.0	2.02	18.0	10.1	18.0	19.8	18.0	0.206
A16	9.9	1.24	9.9	26.2	9.9	7.67	9.9	16.1	9.9	0.476
A14	41.4	0.243	41.4	5.62	41.4	11.7	41.4	14.9	41.4	0.283

[1]The Basin Plan only specifies water quality objectives south of Dumbarton Bridge for copper and nickel. For the other inorganics, water quality objectives are from the California Toxics Rule. Since the Board must express limits for metals in the total recoverable form, Board staff used default translators to convert dissolved water quality objectives to total. The water quality objectives for chromium, cadmium, and lead are freshwater driven and based on a hardness of 100 mg/L as $CaCO_3$, which is the lowest value found in sloughs (in this case Guadalupe Slough) monitored near the discharge in the Regional Monitoring Program.

2.2.10 Invertebrates

Ecological monitoring of benthic invertebrates can be a useful tool for detecting the impacts of water quality changes over time, as they can provide consistent responses to environmental stressors. The results for benthic invertebrates are listed in Appendix H.

2.2.11 Receiving Water Sampling

Receiving water analyses

We calculated the proportion of receiving water DO values below 3.3 mg/L and 5.0 mg/L and the 10th percentile DO value for each pond (Table 2-6). For ponds that discharged into sloughs (A16, A3W, and A7), we divided samples into ebb and flood tide samples to test for effect of tide stage and sample location relative to pond discharge (Figure 2-8). No distinction was made among sample dates or time of day. Samples were ranked by distance and direction from the discharge point, and then we compared sample locations among all ebb tide and flood tide sampling events with univariate analysis of variance (ANOVA) tests (SAS Institute, 1990). We tested for equal variances using Levene's test and then used the multiple variance mixed procedure (SAS Institute, 1990) if data violated the equal variance assumption. Because sample sizes often differed among ponds, significant ANOVA results were investigated with the Tukey-Kramer procedure (SAS Institute, 1990) to make multiple comparisons among pairs of means (Sokal & Rohlf, 1995) and determine with sample locations differed from the others Receiving Water Sampling (Initial Release and Continuous Circulation).[1]

Receiving water samples for Pond System A16 showed that during a flood tide, DO value differed significantly by sample location, with upstream samples significantly higher than downstream samples (Table 2-6). The upstream samples (7.1 % of the samples were less than 5.0 mg/L) were low less often than downstream samples (60.9% of the samples were less than 5.0 mg/L (Table 2-6). At the discharge point for Pond A16, the samples that were less than 5.0mg/L for a flood tide were 28.6 %. During an ebb tide, the upstream samples were significantly higher than downstream samples (Table 2-6), with 5.3% of upstream samples lower than 5.0 mg/L compared to 41.7% of downstream samples.

These data suggest that the discharge from Pond A16 may have influenced DO values near the discharge location during a flood tide but showed little effect during an ebb tide. Nearly 61% of downstream samples were < 5.0 mg/L during flood tides, which suggests that the low DO water may have moved into the slough from the bay rather than from the pond discharge into the bay. Discharges from Pond A18 and the San Jose Sewage treatment plant were upstream from Pond A16 which could have influenced Pond A16 receiving waters during an ebb tide (Refer to Figure A-20 in Appendix A).

---

[1] SAS Institute, 1990. SAS procedure guide, Release 6.04 Edition. SAS Institute, Cary, NC.
Sokal, R. R., & F. J. Rohlf, 1995. Biometry, 3rd edition. W.H. Freeman and Co., New York, 887 pp.

Pond System A3W receiving water DO values had a total 10th percentile values for all samples taken of 3.5mg/L. The lowest recordings were found near the discharge where 100 % of the DO readings during flood tide (but only 37.5% during ebb tide) were less than 5.0 mg/L. However, during ebb tide, 100% of upstream samples had DO < 5.0 mg/L, an unexpected result if pond discharges were causing all low DO values in the sloughs. The highest values were found downstream with lower DO recordings upstream, regardless of tide stage. (Refer to Figure A-17 in Appendix A). This is an unclear indication of effects the discharge waters from Pond System A3W are on the DO values in the receiving waters, suggesting that while the pond discharge may have affected slough DO readings immediately adjacent to the discharge location, other factors are possibly causing low DO values in the sloughs.

Pond System A7 showed no differences between receiving water sample locations during a flood or ebb tide. The total 10th percentile for all samples was 3.5 mg/L.

Table 2-6
Receiving Water Samples

Pond			n	% < 3.3 mg/L	% < 5.0 mg/L	10th %ile DO	location difference
A14	Total		197	3.6%	43.1%	4.2 mg/L	-
A16	Total		244	10.7%	35.7%	3.3 mg/L	-
	flood*	upstream	14	0.0%	7.1%		$F_{4,69}$ = 8.64, P<0.0001, highest DO upstream
		discharge	14	7.1%	28.6%		
		downstream	46	19.6%	60.9%		
	ebb*	upstream	38	0.0%	5.3%		$F_{4,165}$ = 13.37, P<0.0001, highest DO upstream
		discharge	36	11.1%	33.3%		
		downstream	96	12.5%	41.7%		
A2W	Total		84	0.0%	1.2%	5.5 mg/L	$F_{4,79}$ = 0.78, P<0.5424
A3W	Total		192	7.3%	65.6%	3.5 mg/L	-
	flood*	upstream	34	8.8%	85.3%		$F_{6,137}$ = 20.23, P<0.0001, lowest DO @ discharge, highest DO downstream
		discharge	36	13.9%	100.0%		
		downstream	74	5.4%	43.2%		
	ebb*	upstream	14	14.3%	100.0%		$F_{5,24}$ = 4.72, P<0.0038, highest DO downstream
		discharge	8	0.0%	37.5%		
		downstream	8	0.0%	75.0%		
A7	Total		424	6.4%	50.5%	3.5 mg/L	-
	flood	upstream	114	14.0%	69.3%		$F_{5,288}$ = 1.86, P<0.1014
		discharge	86	2.3%	60.5%		
		downstream	96	1.0%	30.2%		
	ebb	upstream	66	7.6%	56.1%		$F_{5,110}$ = 0.60, P<0.6965
		discharge	32	6.3%	31.3%		
		downstream	18	5.6%	38.9%		

Table does not include slack tide values. * indicates significance at $\alpha = 0.05$

n refers to number of sampling sites

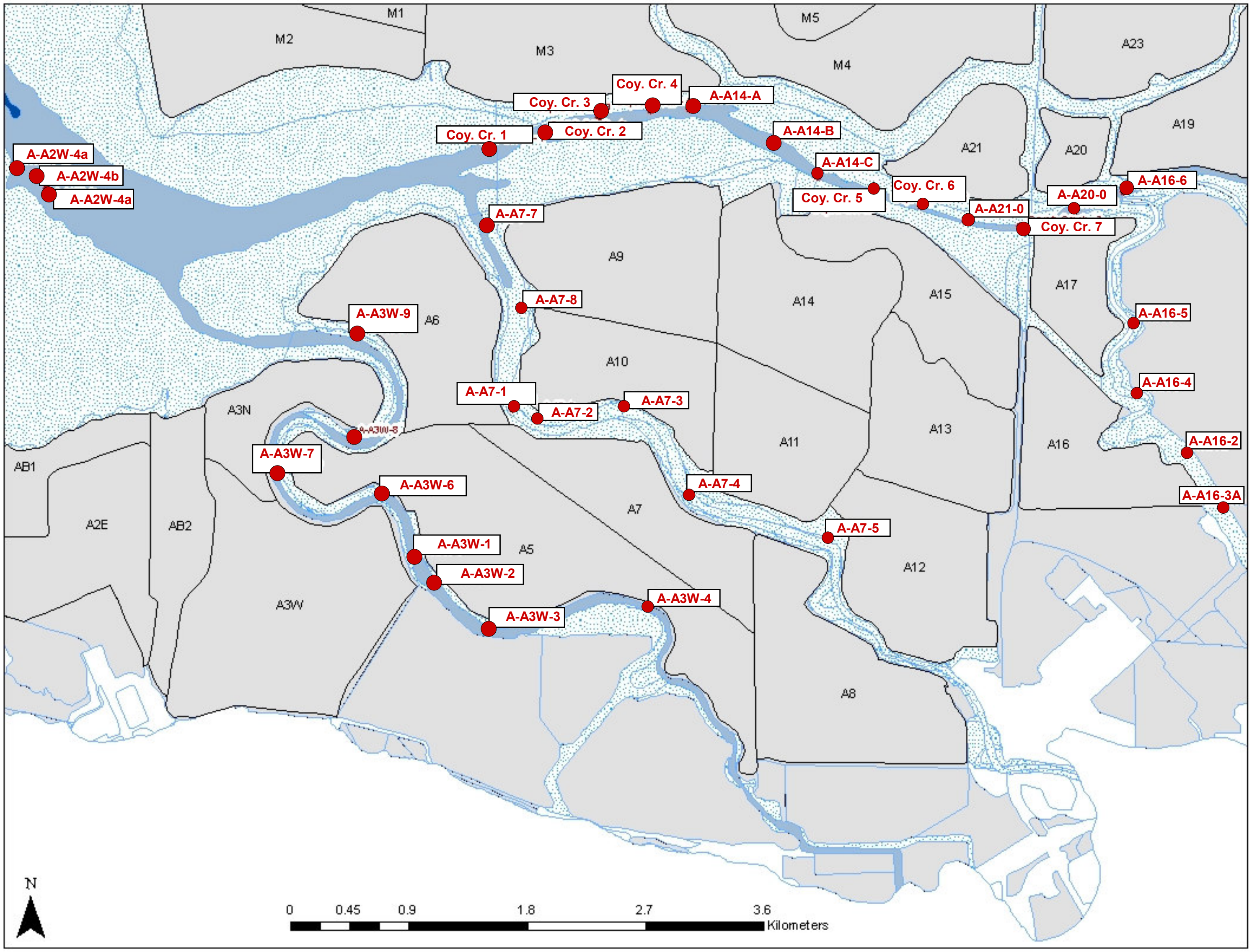


Figure 2-8: Receiving Water Sampling Locations

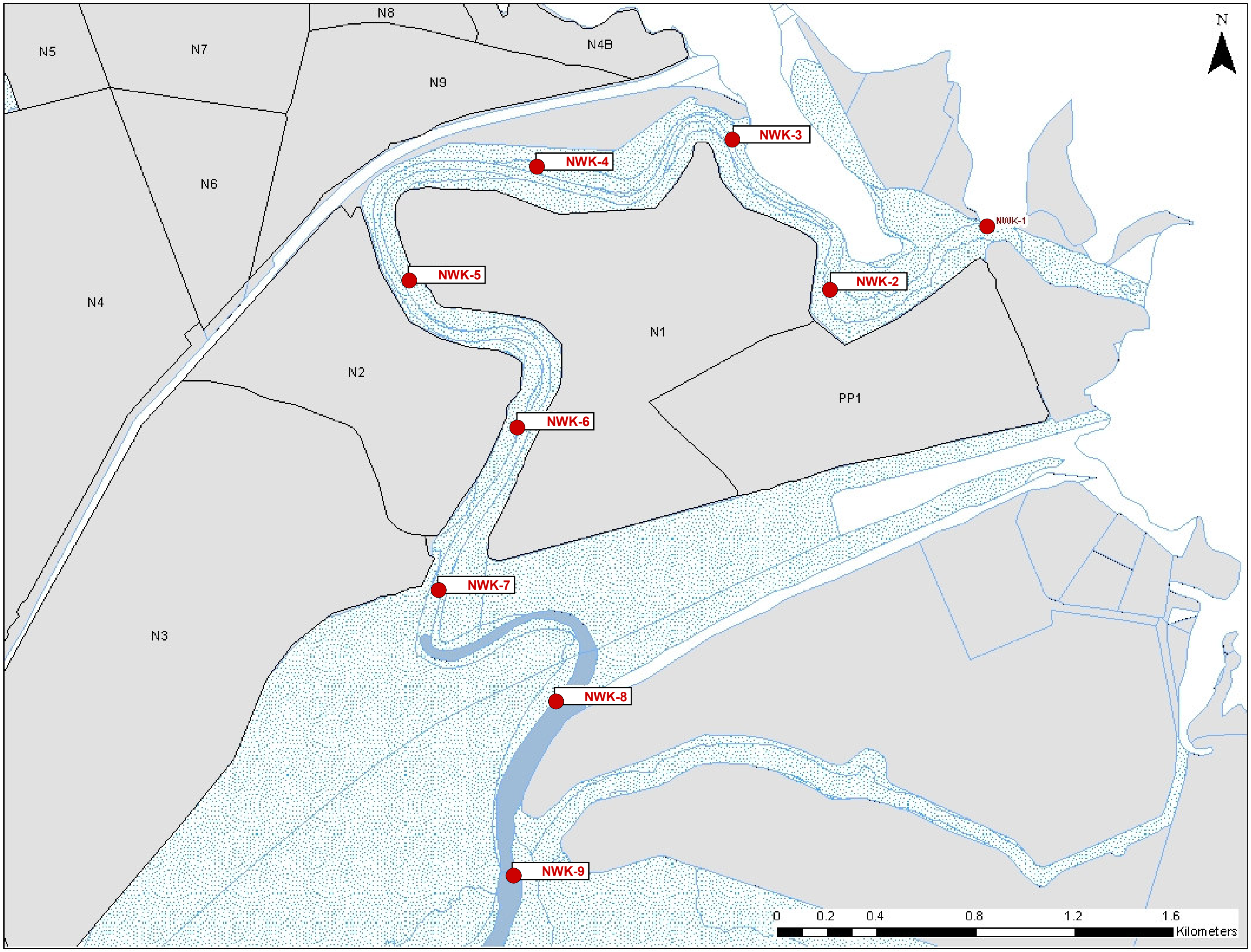


Figure 2-9: Newark Sampling Locations

2.2.12 Additional Water Quality Sampling

To better help understand the water quality in and around the South Bay Salt Ponds, additional sampling was done by the FWS. On August 2, 2005, 18 samples were collected at nine different sites in Newark slough (Figure 2-9). Newark slough is independent of any discharge coming from the Salt Ponds. At the Newark slough sampling locations, seven of the 18 recorded samples had instantaneous values of less

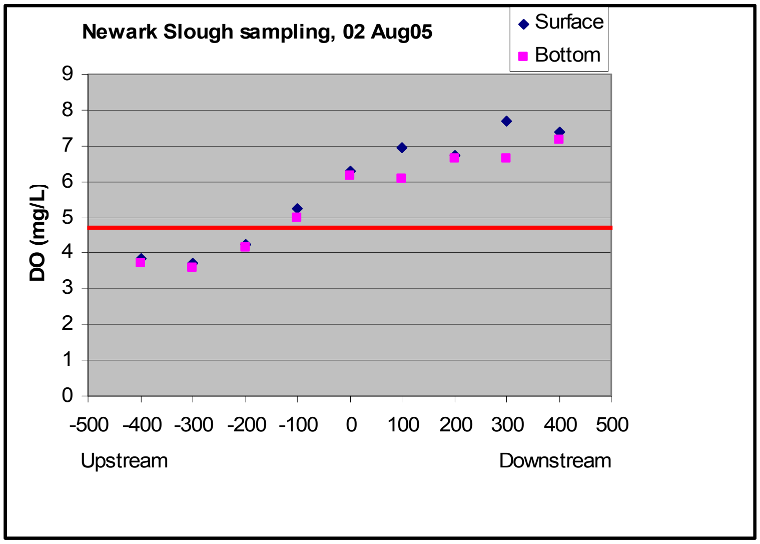


Figure 2-10: Newark slough DO

than 5.0 mg/L (Figure 2-10). The sampling in Newark slough shows that DO in areas completely unaffected by Salt Ponds discharge can have dissolved oxygen values of less than 5.0 mg/L.

The FWS also installed continuous datasonde monitor's with-in three different ponds at the intake gate. The RWQCB states in the Final Order that continuous monitors are only required at the discharge points, so to install datasondes at the intake was an attempt to better understand the water quality coming in to the Alviso Pond Complex.

For Pond System A3W, a datasonde was installed at the intake located in Pond AB1 from May 13 – May 23, 2005. The 10th percentile readings for the entire period recorded 4.9 mg/L. The discharge point at Pond A3W had a 10th percentile reading of 3.5 mg/L for the same time period.

For Pond System A7, a datasonde was installed at the intake in Pond A5 from May 3 – May 13, 2005. The 10th percentile readings for the entire period recorded 3.2 mg/L. The discharge point at Pond A7 had a 10th percentile reading of 1.4 mg/L for the same time period.

For Pond System A3W, a datasonde was installed at the intake located in Pond AB1 from May 13 – May 23, 2005. The 10th percentile readings for the entire period recorded 4.9 mg/L. The discharge point at Pond A3W had a 10th percentile reading of 3.5 mg/L for the same time period

2.3 SEDIMENT MONITORING SUMMARY

Sediment cores were collected for analysis of total mercury (THg) and methyl mercury (meHg) during winter 2005 from the Alviso salt ponds as part of continuing monitoring to establish baseline concentrations in the sediments of the ponds comprising the South Bay Salt Pond Restoration Project. Results reported were summarized from winter 2005 and are presented with summaries from previous sampling conducted during late summer-early fall 2003 and 2004 (see Appendix B).

SECTION 3
CORRECTIVE ACTIONS TAKEN

This section summarizes and analyzes the effectiveness of corrective methods that were taken by the FWS in an attempt to improve water quality within each pond system, as well as when the receiving waters approached limits stated by the Final Order were appearing to be reached. The Final Order states that if summer monitoring shows that DO levels at the discharges fall below a 10^{th} percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will accelerate receiving water monitoring to weekly, conduct within pond monitoring, and consult with the RWQCB as to which Best Management Practices described below for increasing dissolved oxygen levels will be implemented (see Operations Plans Appendix C through G):

- Increase the flows in the system by opening the inlet further. If increased flows are not possible, fully open the discharge gate to allow the pond to become a muted tidal system until pond DO levels revert to levels at or above conditions in the Bay or slough (see Section 3.1 - Pond System A2W).

- Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake (see Section 3.2 - Pond System A3W).

- Install Solar aerators used to circulate waters (see Section 3.3 – Pond System A7).

- Close discharge gates completely until DO levels meet standards (see Section 3.4 - Pond system A14).

- Close discharge gates completely for a period of time each month when low tides occur primarily at night when DO levels are typically at their lowest (see Section 3.5 - Pond System A16).

- Cease nighttime discharges due to diurnal pattern. This is a daily operation of discharge gates, closing the discharge gates at night (when the DO is typically at the lowest) and then opening them in the morning when the DO levels have reverted to higher levels (Table 3-1). However, this is not a long term solution for resolving DO issues and the FWS will continue to consult with the RWQCB on best management practices.

Table 3-1
Ceasing of nighttime discharge

Pond	Total No. of Sampling Weeks	No. of Weeks Above a 10^{th} Percentile of 3.3 mg/L	No. of Weeks Above a 10^{th} Percentile of 3.3 mg/L if discharge gates closed from 10 p.m. to 10 a.m.
A2W	28	10	21
A3W	29	22	25
A7	29	13	15
A14	35	6	7
A16	32	22	28

Dissolved oxygen levels in the pond water, calculated on a weekly basis, were required to remain above a 10^{th} percentile of 3.3 mg/L. Calculations are based on discharge times only

- Mechanically harvest dead algae. Mechanically harvesting algae would be very difficult and expensive considering how large the ponds are. This might work on a very limited basis such as removing the dead algae from around the discharge structure, but it is difficult to find a place to dry and dispose of the harvested algae in our highly urban environment. The algae would smell and the local landfills do not want us to bring our salt laden dead algae into their green waste disposal systems.

3.1 Pond System A2W

This pond system discharges directly into the Bay over an exposed mud-flat at low tide that is approximately 1 1/2 kilometers before it reaches the receiving waters. Most of the discharge water is dissipated into the mud-flat before it reaches the receiving waters. For this reason, the FWS used Pond System A2W as a control pond with few corrective actions taken. The discharge from Pond A2W would have minimal if any effect on its water quality. One action that was taken to improve the dissolved oxygen at the discharge point was to make Pond A2W muted tidal on November 1, 2005. It is unclear if making Pond A2W muted tidal directly affected the dissolved oxygen results (see Figure 3-1). The daily 10^{th} percentile for all times went from 1.5 on October 30, to 7.3 on October 31, with no corrective actions taken, weather pattern changes, or mis-calibrations to data sets or the datasonde. The daily averages also show a rising trend in the pond during the time period it was made muted tidal. Although making systems muted tidal will generally improve water quality, it remains unclear if making Pond A2W muted tidal was a direct cause in raising the dissolved oxygen. There are two islands within this Pond system that have nesting birds during the breeding season. The FWS did not make Pond A2W muted tidal earlier when the DO levels were falling below Final Order limits, for fear of disturbing nesting birds with the fluctuating water levels that occur with a muted tidal system.

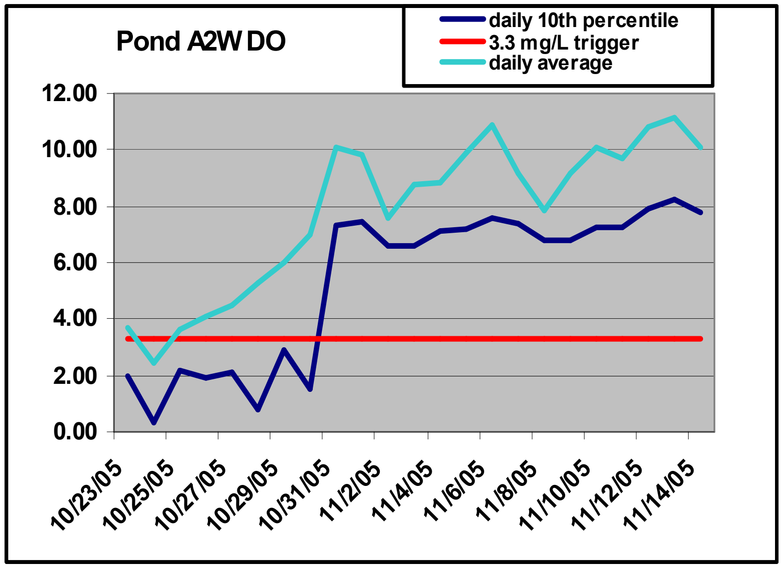


Figure 3-1: DO during muted tidal at A2W

3.2 Pond System A3W

In the 2004 season, Pond A3W discharged dissolved oxygen that was in compliance with the Final Order for only one week (Figure 2-3). To evaluate why dissolved oxygen levels in Pond A3W were severely depressed on a consistent basis (i.e., below 1 mg/L), the FWS performed two surveys and determined the low dissolved oxygen levels in the Pond A3W discharge were the result of a large mat of decaying algae in one area of the pond, and were not representative of the general state of the pond. Since the discharge point for Pond A3W was located near the edge of this algal mat, water currents caused discharge waters to flow through the area of algae buildup which resulted in consistently depressed dissolved oxygen levels. On April 14, 2005 the FWS installed a set of baffles to move the flow of water away from algae buildup to increase oxygen uptake (Figure 3-2). The baffles reach to the pond bottom and extend into the pond 150 feet. While the baffles have not completely solved the dissolved oxygen issues for Pond A3W, they have greatly improved the water quality being discharged into the receiving waters.

Figure 3-2: Baffles at Pond A3W discharge

3.3 POND SYSTEM A7

To help insure that the FWS and the RWQCB are informed on non-compliance issues for the 2005 season, the FWS installed a telemetry system to the Pond A7 datasonde. The datasonde is located inside the weir box at the discharge point that can be monitored via the internet with real time data. The telemetry system was installed on June 21, 2005. Another corrective measure taken at Pond system A7 was to install SolarBee Circulators (Figure 3-3). A total of four circulators were installed on June 22, 2005 into Pond A7 at various points throughout. The SolarBee's are designed to circulate water by bringing water from deeper (low oxygenated areas) and sending it passively across the surface causing a mixing action with generally higher dissolved oxygen values. The 2004 and 2005 data at the discharge point for Pond A7 (Figure 2-4) are found to be closely related with poor dissolved oxygen readings. For the 2005 season the SolarBees were seen to be ineffective in producing higher dissolved oxygen values. As a result of the circulators futility, the FWS opened Pond A7 to partially muted tidal on October 4, 2005 in hopes it would refresh the pond's water quality (see Figure 3-4). Using partially muted tidal as opposed to fully muted tidal which has both tide gates open 100 percent allows more control of water levels within the Pond to assure enough freeboard on the levees. The results of this corrective action raised the DO levels from extremely poor values (a daily 10th percentile of <1.0 mg/L) to daily levels that were closer to the 3.3 mg/L trigger.

Figure 3-3: Installed Solar Circulator

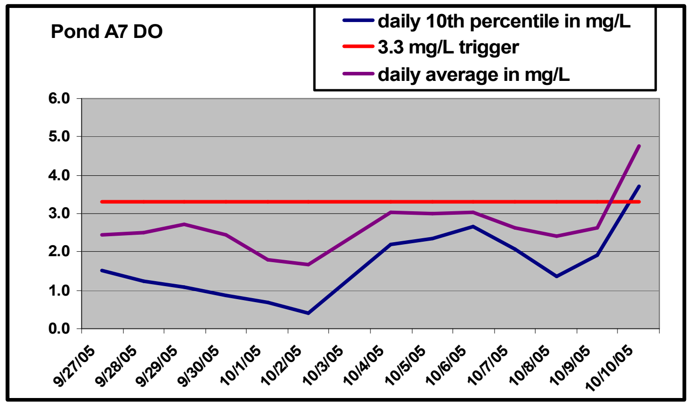


Figure 3-4: Graph showing DO during muted tidal

3.4 POND SYSTEM A14

This is a four pond system that was initially released on April 31, 2005. The salinity was below the 44 ppt. limit at the time of initial discharge. Pond A14's continuous monitor at the discharge had weekly dissolved oxygen readings with a 10th percentile of <2.0 mg/L for the majority of the 2005 season (see Figure 2-5). Many corrective actions were taken to try and improve the DO values; none of them seem to be effective. One action taken was to close the system down to a two pond system (June 27 – July 29, 2005); an intake (Pond A9) and discharge pond (Pond A14). Both of the intake and discharge gates were open 100 percent to allow as much water flow as possible minimizing residence time. The 10th percentile for DO during this time period was 1.2 mg/L. From July 29 – August 30, 2005 a second corrective action taken was to make Pond A14 discharge muted tidal. The 10th percentile for DO during this time period was 1.0 mg/L. A third action was taken on September 6, 2005 to install a set of flow diversion baffles. This action did not show to raise the DO above the 3.3 mg/L trigger. The FWS believes that a limiting factor to increasing the water quality for this system is the channel that discharges water from Pond A14 to Coyote Creek (see Figure 3-5). This channel is approximately 800 feet in length. It was intentionally excavated as narrow as thought possible to reduce impacts to native species with the hopes that it would scour out naturally.

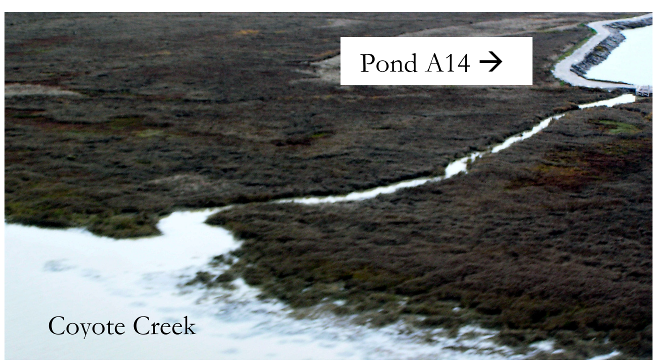


Figure 3-5: Pond A14 discharge channel at high tide

With none of the above corrective actions improving the water quality for Pond System A14, a fourth action was taken to close the discharge gates at Pond A14. This would insure that the receiving waters would not be affected by any poor water quality coming from Pond A14 discharge. However, closing of the discharge gates during the summer can negatively impact other RWQCB parameters stated in the Final Order; such as salinity (see section 2.2.2- Salinity Compliance). On October 4, 2005, both discharge gates were closed and not re-opened until December 7th, 2005 when the weekly 10th percentile DO values were above 3.3 mg/L

3.5 POND SYSTEM A16

This pond system was initially released on April 31, 2005 with a salinity of 70 ppt. There are two ponds in this system with an intake at Pond A17 (coming from Coyote slough) and a discharge at Pond A16 (into Artesian slough). The systems flow is reversed during the winter to prevent entrapment of migrating salmonids coming from Coyote Creek. The intake and discharge gates were open 100 percent for most of the season because of the ability to control water levels with a weir box at both water control structures. Having the gates fully open causes a short residence time for moving water through this system and the dissolved oxygen was in compliance for 22 of the 32 week monitoring period.

As part of our Corrective Actions explained in the Operations Plan, when dissolved oxygen levels fall below a 10th percentile of 3.3 mg/L (based on a calendar week), one option is to close discharge gates completely for a period of time each month when low tides occur primarily at night when DO levels are typically at their lowest. Due to reaching non-compliance concentrations for DO, the FWS closed the intake to 15 percent open and closed the discharge gate completely on August 1, 2005 (see Figure 2-6). As a result of this corrective action, the DO levels within the pond dropped below 1.0 mg/L between one a.m. and 12 p.m. on August 10, 2005 (Figure 3-6). These actions are believed to have caused the pelagic fish to be stressed and were easily preyed upon by gulls and other piscivorous species.

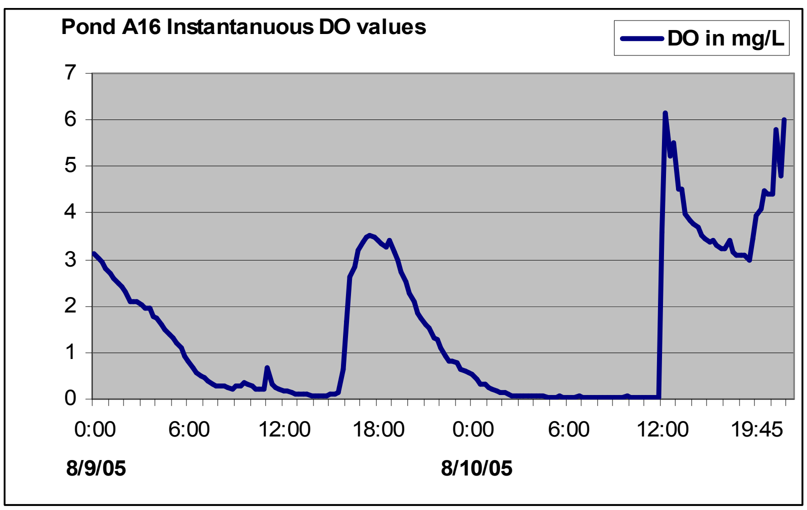


Figure 3-6: DO concentrations every 15 minutes

Several DO concentrations readings were taken throughout Pond A16 on August 10, 2005 which concurred with the continuous monitor data at the discharge. The FWS then notified the RWQCB and opened the intake and discharge for Pond System A16 100 percent on August 10, 2005 at approximately 12 p.m. (Figure 3-6). Receiving water sampling for Pond A16 was done on August 11, 2005 and showed normal water quality readings.

The second corrective action was taken on August 18, 2005. Pond A17 and Pond A16 were made muted tidal to allow water to flow freely from the pond to receiving waters and back depending on the height of the tide. This corrective action showed immediate improvement of DO concentrations from a weekly 10^{th} percentile of 0.1 mg/L (week of August 7 – August 13, 2005) to a weekly 10^{th} percentile of 4.9 mg/L (August 14 – August 20, 2005).

SECTION 4
PLAN TO ACHIEVE COMPLIANCE

Maintaining dissolved oxygen levels in the ponds has been the major water quality challenge for the ISP. A number of corrective actions were implemented in 2005 to raise dissolved oxygen in the ponds. Some of these actions improved DO levels, and some did not. Based on the lessons learned, for the 2006 season, the FWS once again plans on changing methods of operation as the need arises to improve water quality compliance

3.1 POND SYSTEM A2W

Starting in May of 2006, the FWS plan to open Pond A2W discharge to a partially muted tidal system. Having the system partially muted will allow better control of the pond water levels. This will decrease the risk of flooding nesting birds located on several islands within the system during breeding season. With the Bay waters able to enter the discharge pond, it should improve the water quality within the system. Through trial and error, the gates will have to be adjusted to find equilibrium of water in-flow at Pond A1, and the water intake / discharge at Pond A2W and also account for evaporation during the summer.

3.2 POND SYSTEM A3W

Flow diversion baffles will once again remain in place during the 2006 season. These baffles will be extended another 100 feet into the pond to reach across the borrow pits. The baffles have proven to raise the DO concentrations at the discharge in 2005. At the discharge point in Pond A3W, one of the three gates has the ability to allow water in-flow. If the weekly 10th percentile should fall below 3.3 mg/L, the FWS will open this in-flow gate to allow slough waters to enter Pond A3W to better help improve water quality.

3.3 POND SYSTEM A7

For the 2005 season, four solar aerators were installed with hopes to improve the DO for this system. Due to unknown circumstances they were not able to elevate concentrations of DO at the discharge in Pond A7. The aerators will be removed and the system will be set to partially muted tidal. The in-flow gates at Pond A5 will remain partially open to allow a complete system flow. Pond A7 discharge has two 48" gates that allow both in-flow and discharge of slough / pond waters. The gates and weir boards will be adjusted through the season to find the optimum balance of water level and levee freeboard. A set of flow diversion baffles will also be installed at the discharge point in Pond A7. They will extend approximately 150 feet into the pond on either side of the discharge gates, and should provide maximum oxygen discharge from the shallower areas.

3.4 POND SYSTEM A14

Pond A14 system will once again be a challenge to stay in compliance with the Final Order. The FWS believes that the outflow discharge channel is a limiting factor to achieve higher water quality concentrations, and will investigate possible solutions for accomplishing a more productive flow-rate. Several corrective actions were taken at this system last year with no positive results in meeting RQWCB compliance. The FWS will be in communication with the RWQCB as to find the best management practices for this system. Depending on funding, one option may be to install solar aerators into Pond A14 logistics.

3.5 POND SYSTEM A16

Due to observations and corrective actions taken in 2005, it will be recommended to open this system to muted tidal year round. As in Pond system A2W, there is nesting birds using the islands during breeding season and a proper water level will have to be achieved to prevent disturbance of nesting birds. The system will be set with all the gates (both the intake and discharge) open 100 percent. The water levels will be set by adjusting weir boards at the water control structures. Due to fish distress in August at Pond A16 caused by completely closing of intake and outflow gates, it is recommended that the shutting of this system will cause detrimental impact to the pelagic and benthic organisms and the gates should not be completely closed.

SECTION 5
MONITORING PLAN MODIFICATIONS

The FWS recommends that receiving water sampling be stopped for Pond A2W. This pond system discharges directly into the Bay over an exposed mud-flat that is approximately 1 1/2 kilometers before it reaches the receiving waters. Most of the discharge water is dissipated into the mud-flat before it reaches the receiving waters. The 10th percentile for all the receiving waters samples of Pond A2W were 5.5 mg/L. The DO values were below 5.0 mg/l for only 1.2 percent of the total samples taken (Table 2-6). Bay waters quality does not seem to be affected by the discharge of Pond A2W.

Mercury sampling provided by Dr. Keith Miles from USGS for 2004 – 2005 was submitted to you for your comment. Because the purpose of the Hg monitoring in the ponds is to help us better design the long-term restoration project (South Bay Salt Pond Restoration Project), the FWS request that the funds for mercury study be moved to the proposed Hg study centered on Pond A8 and Alviso Slough. Sampling for 2005 – 2006 has been started by Dr. Miles and will be completed and submitted to the RWQCB in early 2006.

The FWS also recommends discontinuing sampling for water column metal concentrations during continuous circulation. The 2004 and 2005 sampling for metals were found to be well below applicable water quality objectives. Since the Final order uses salinity as a surrogate to regulate the concentrations of metals discharged, the data from the past two years has shown that the salinity in the Alviso Ponds Complex discharges has remained fairly constant for the Continuous Monitoring Period. The FWS will continue to adaptively manage the ponds to insure the salinity remains below levels that would cause concentrations of metals which are toxic to aquatic life.

For the 2005 monitoring period the FWS was asked by the RWQCB to provide the time period each day that ponds discharge as well as an estimate for the quantity of discharge into the sloughs. This will provide context of the amount of pond waters entering sloughs and the Bay relative to ambient flows, intermittent nature of the discharges, and to document the effect of manipulating flow rates on receiving water quality. USGS has produced a model for discharge volumes that is still under internal review. This information will be provided to the RWQCB when it becomes available to the FWS in the first half of 2006.

Suggestions that were received from the RWQCB staff for water quality monitoring of the Island Ponds Restoration Project are being incorporated into the final monitoring plan. These will be submitted to the RWQCB for final approval in early February.

Appendix A
Additional Figures

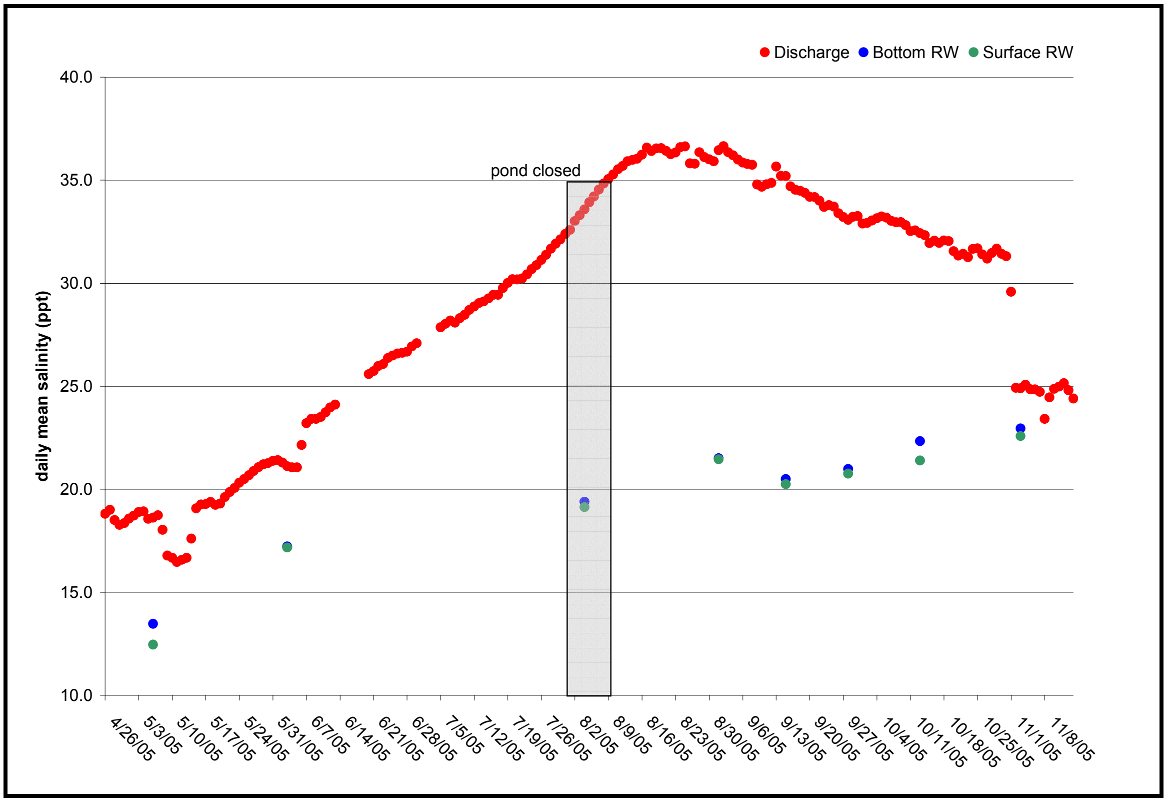


Figure A-1: Salinity of Pond A2W vs. Bay

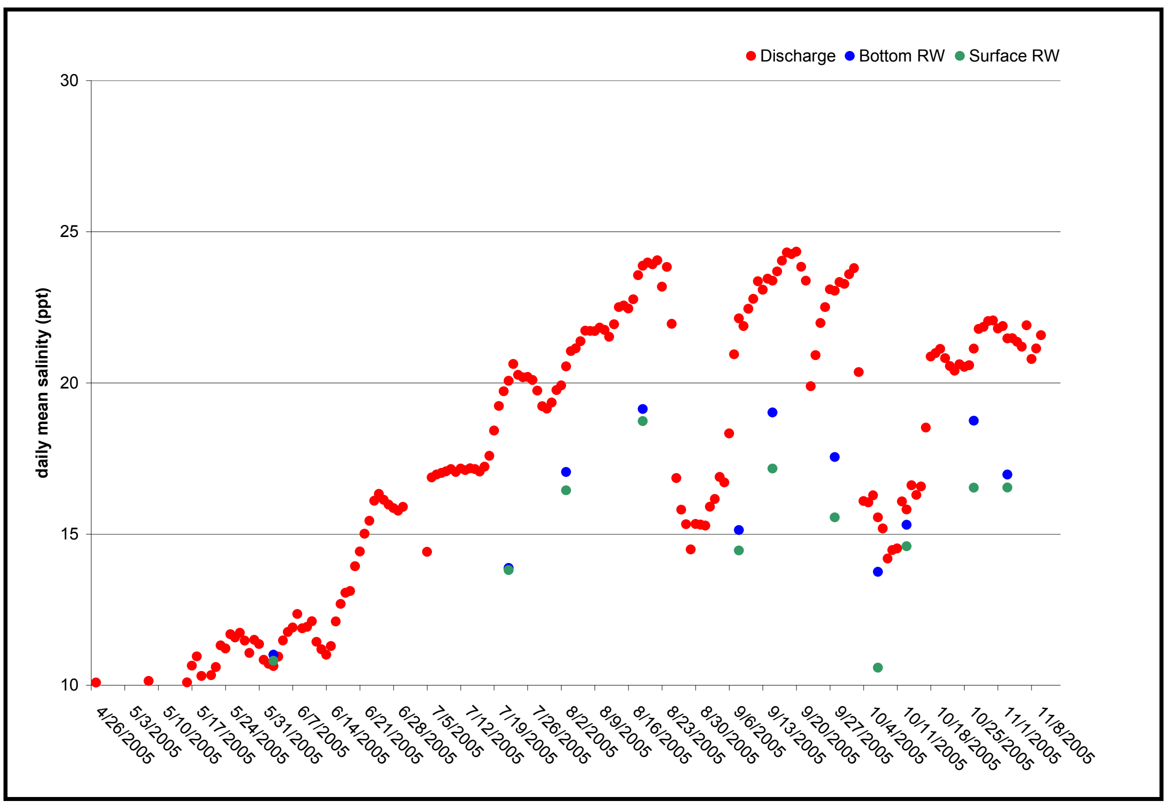


Figure A-2: Salinity of Pond A3W vs. Guadalupe Slough

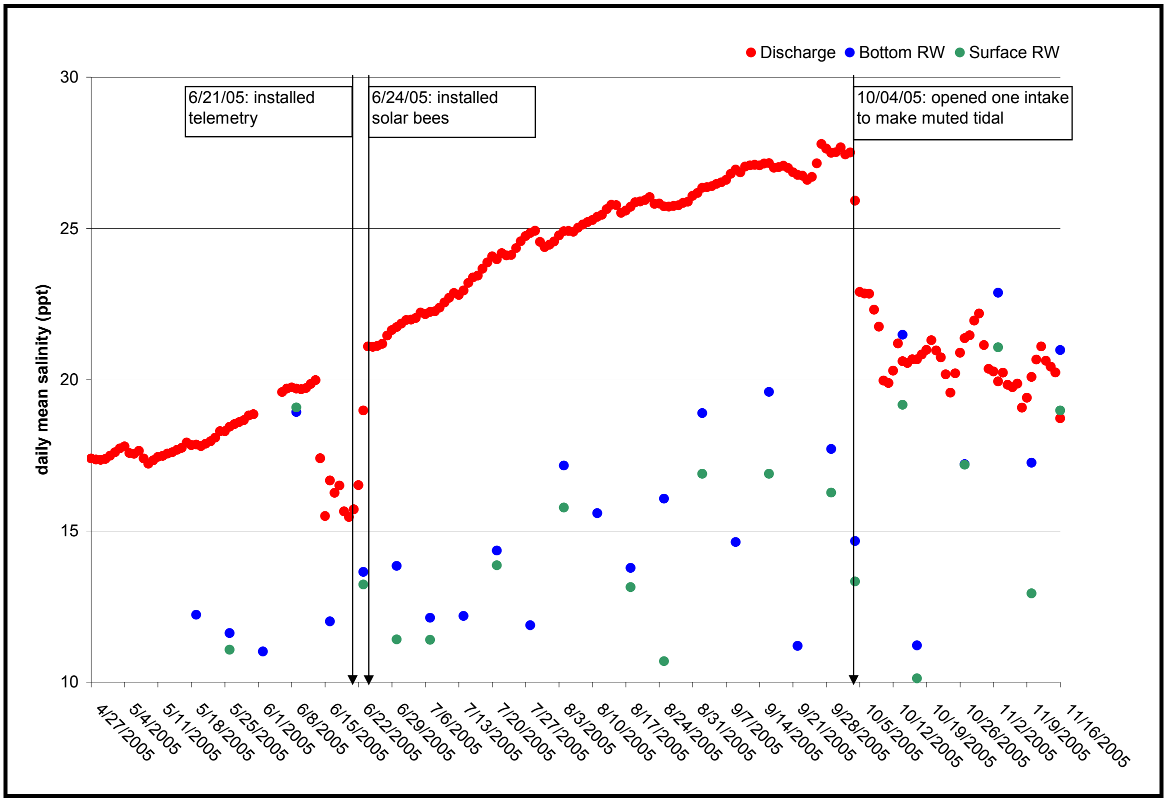


Figure A-3: Salinity of Pond A7 vs. Alviso Slough

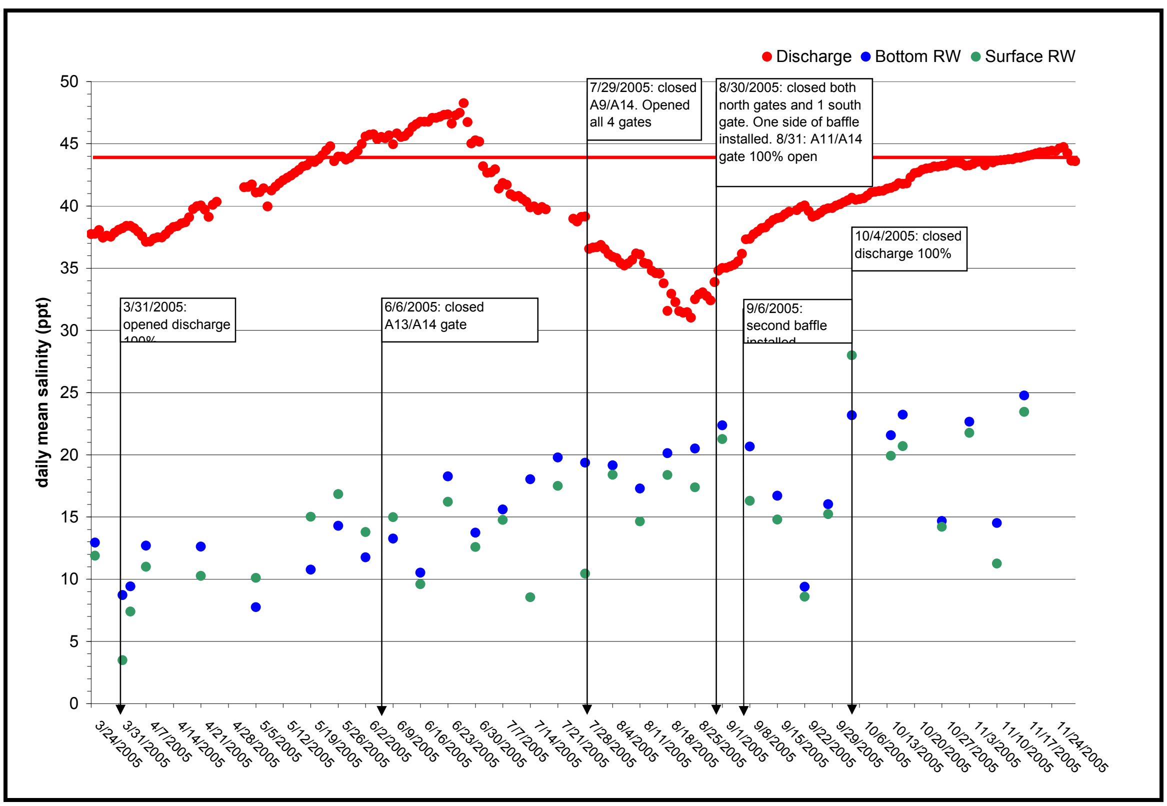


Figure A-4: Salinity of Pond A14 vs. Coyote Creek

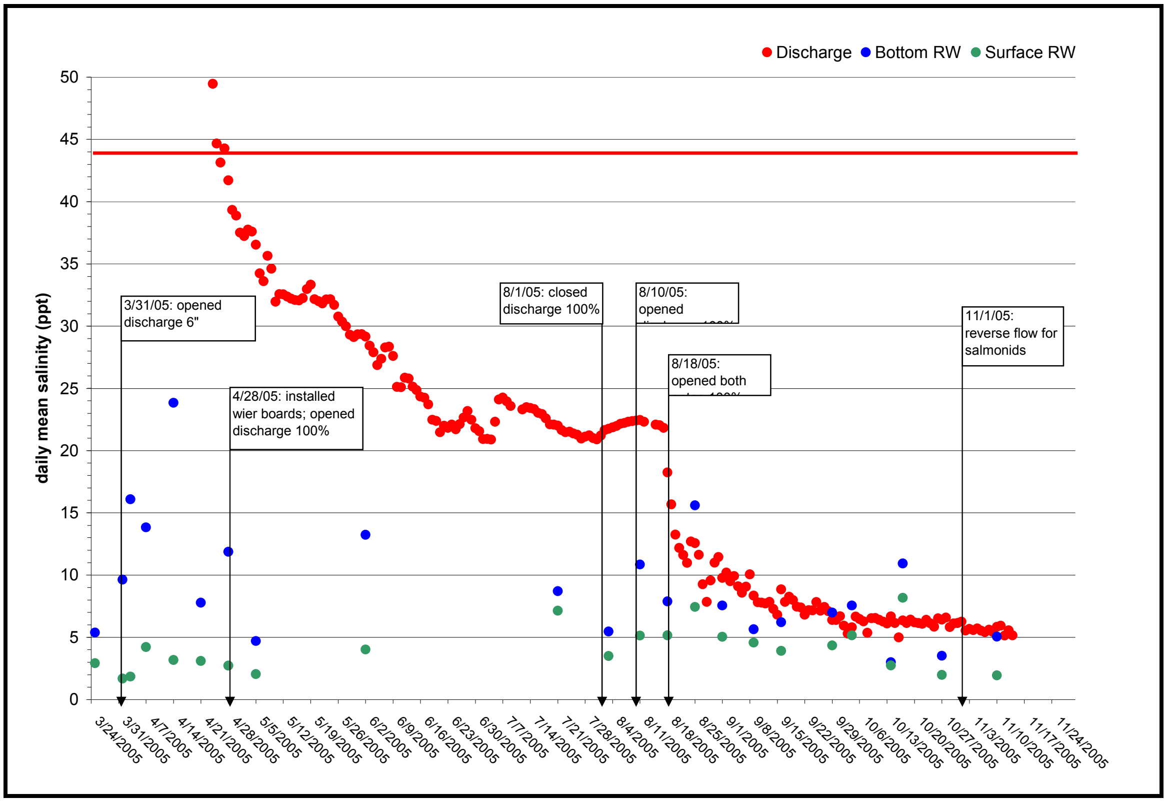


Figure A-5: Salinity of Pond A16 vs. Artesian Slough

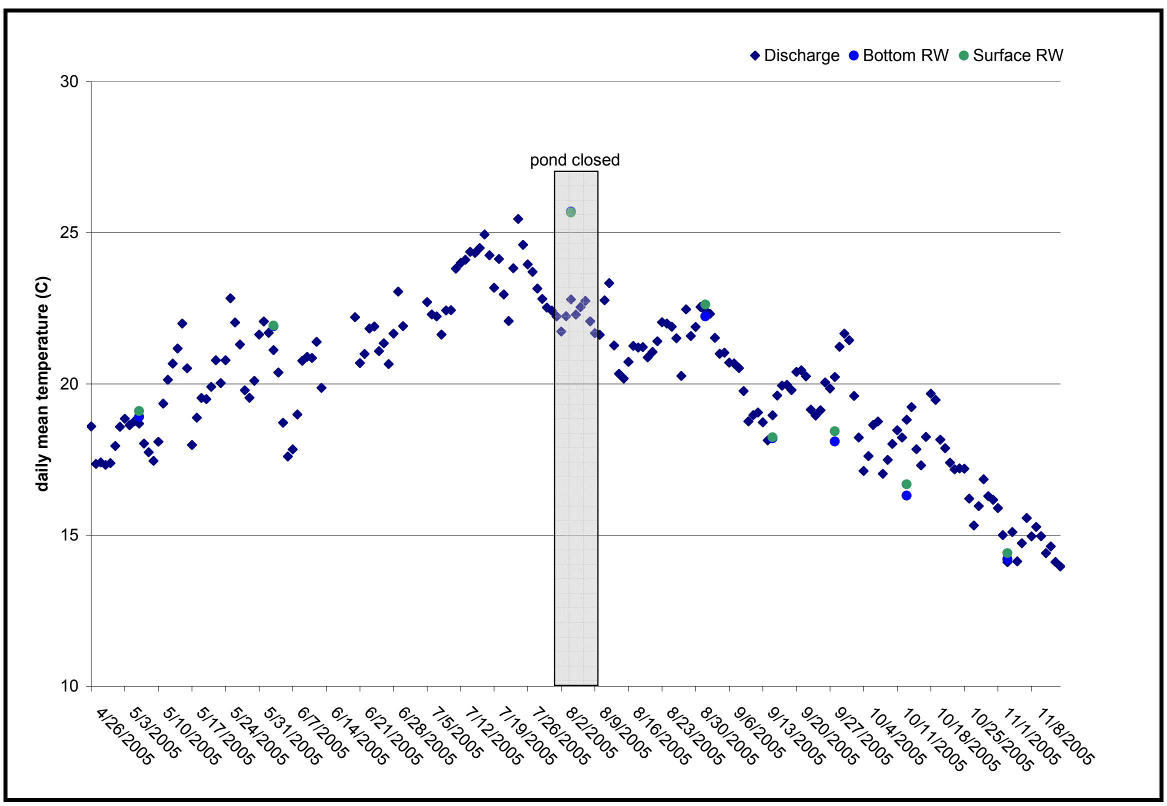


Figure A-6: Temperature of Pond A2W vs. Bay

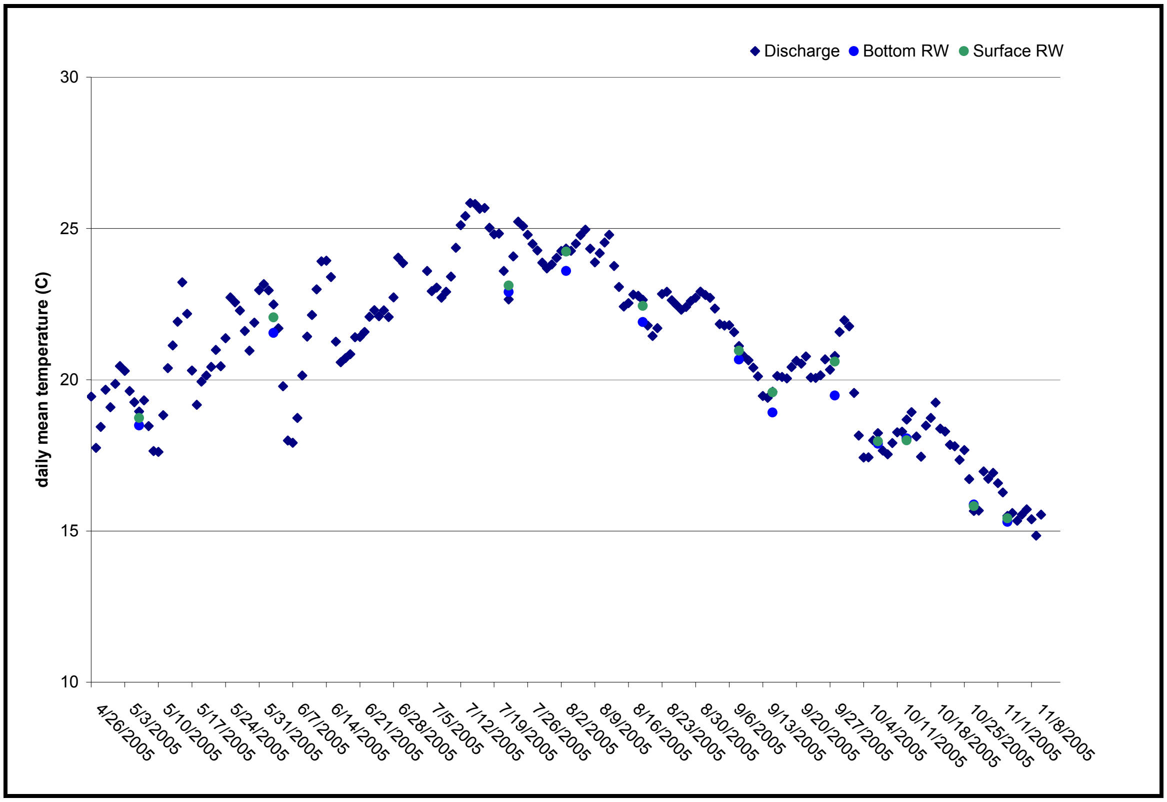


Figure A-7: Temperature of Pond A3W vs. Guadalupe Slough

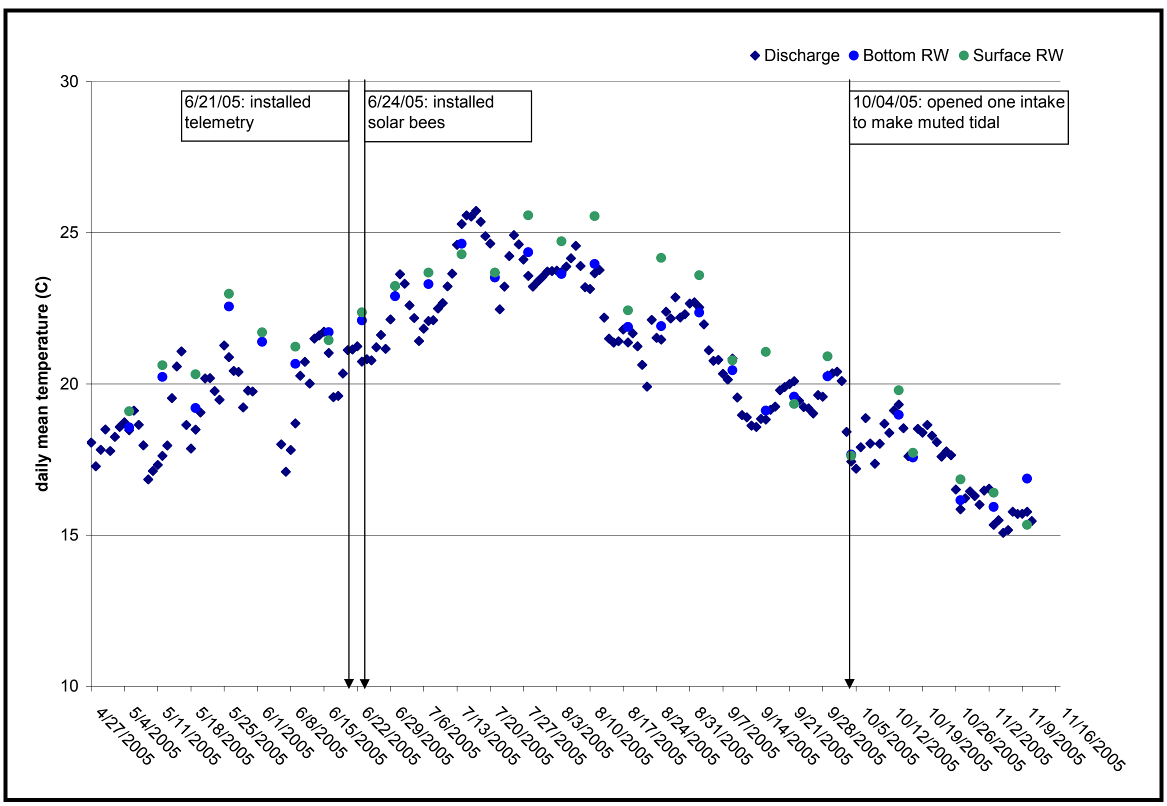


Figure A-8: Temperature of Pond A7 vs. Alviso Slough

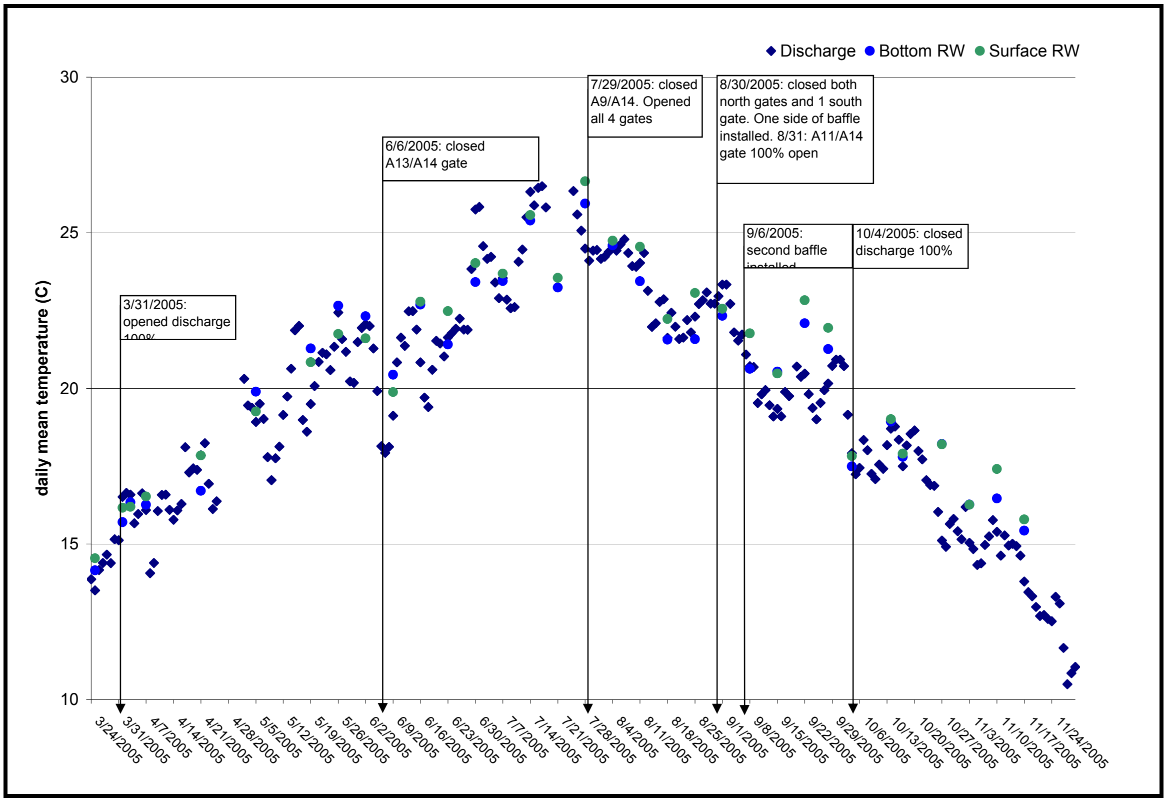


Figure A-9: Temperature of Pond A14 vs. Coyote Creek

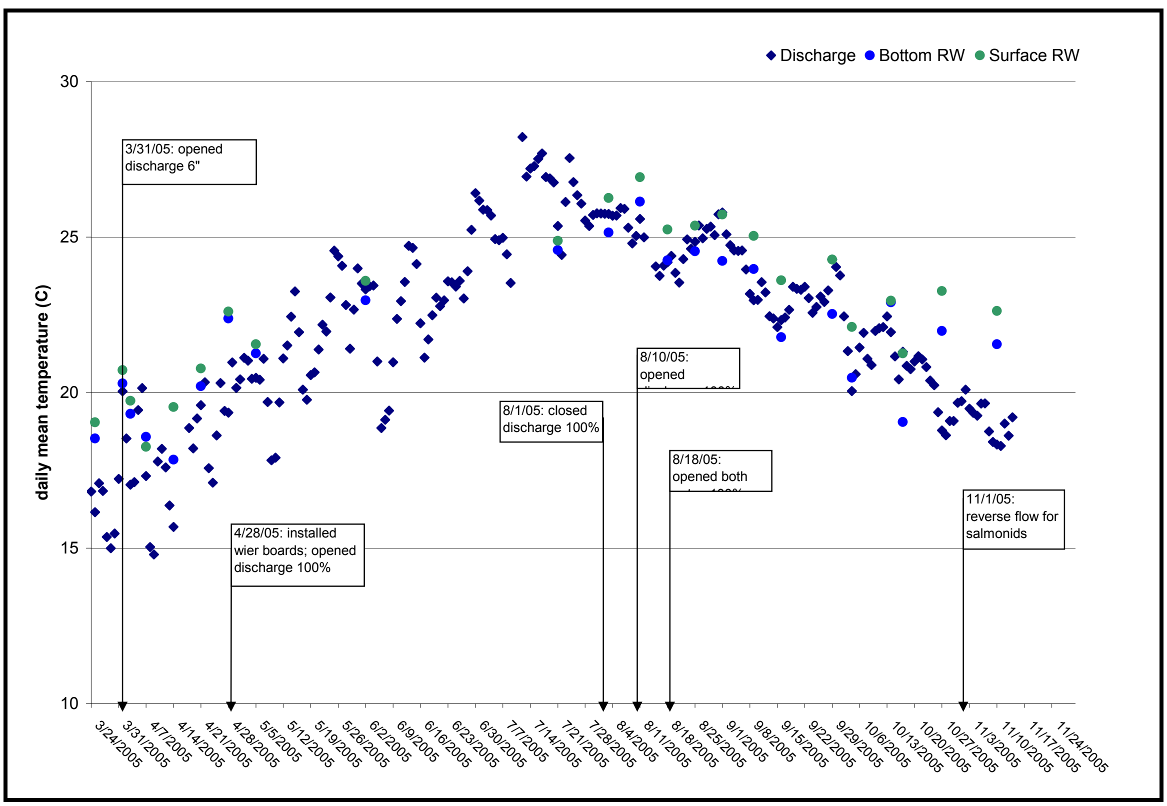


Figure A-10: Temperature of Pond A16 vs. Artesian Slough

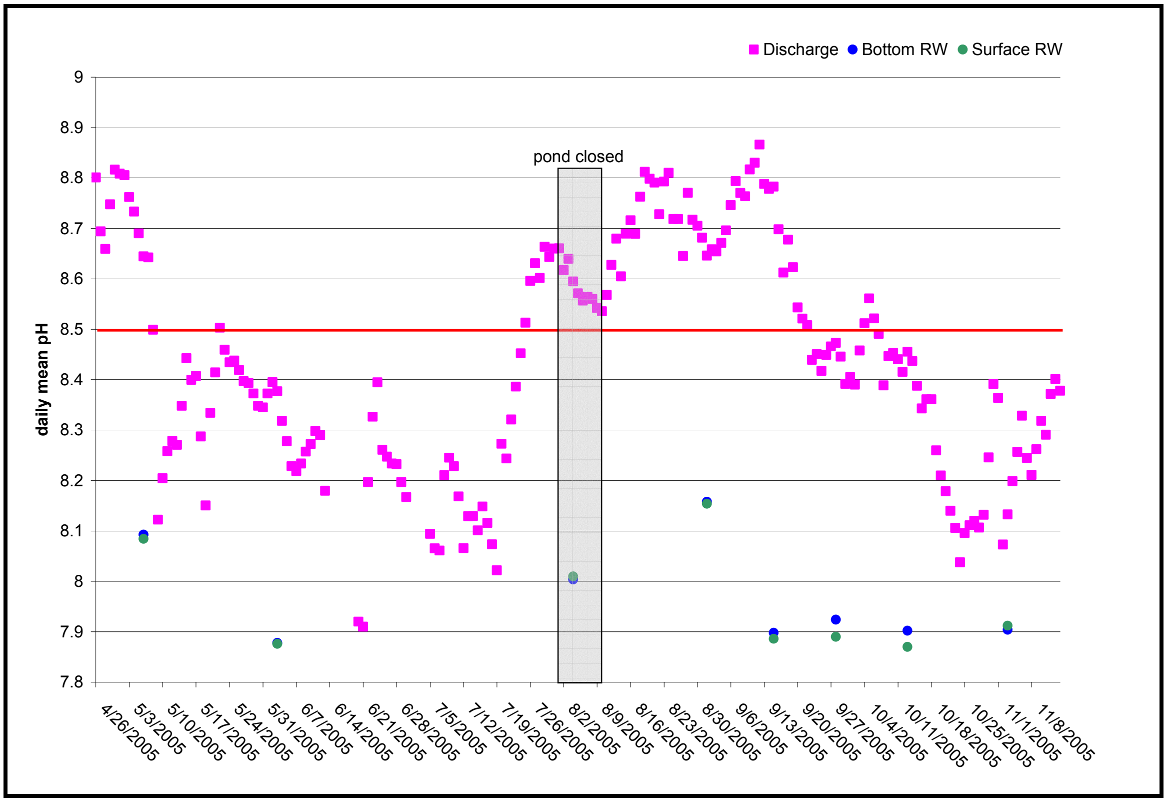


Figure A-11: pH of Pond A2W vs. Bay

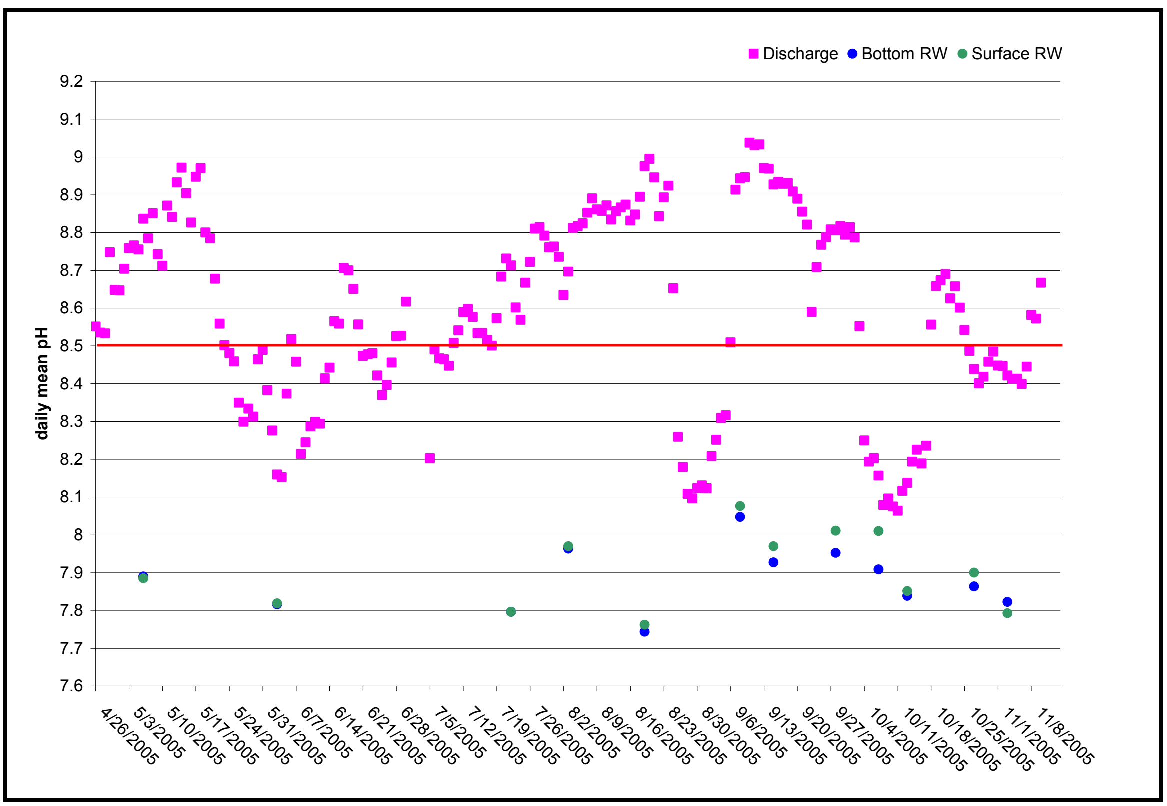


Figure A-12: pH of Pond A3W vs. Guadalupe Slough

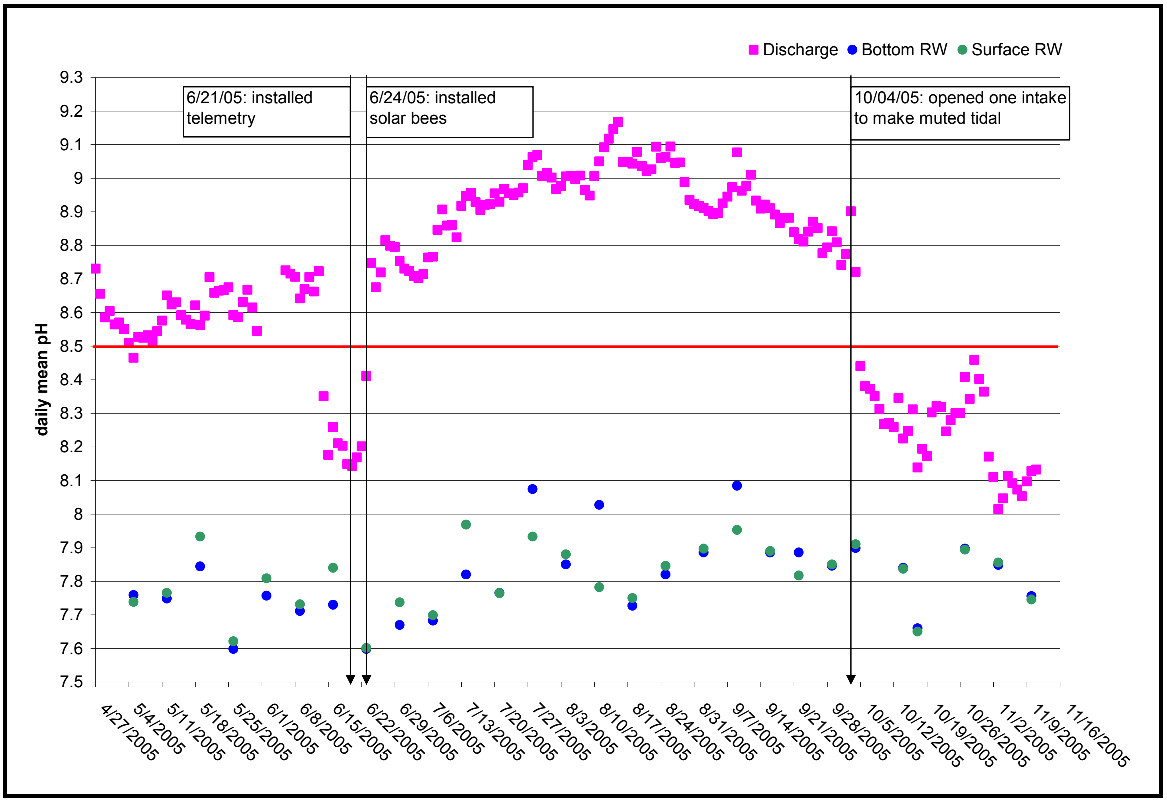


Figure A-13: pH of Pond A7 vs. Alviso Slough

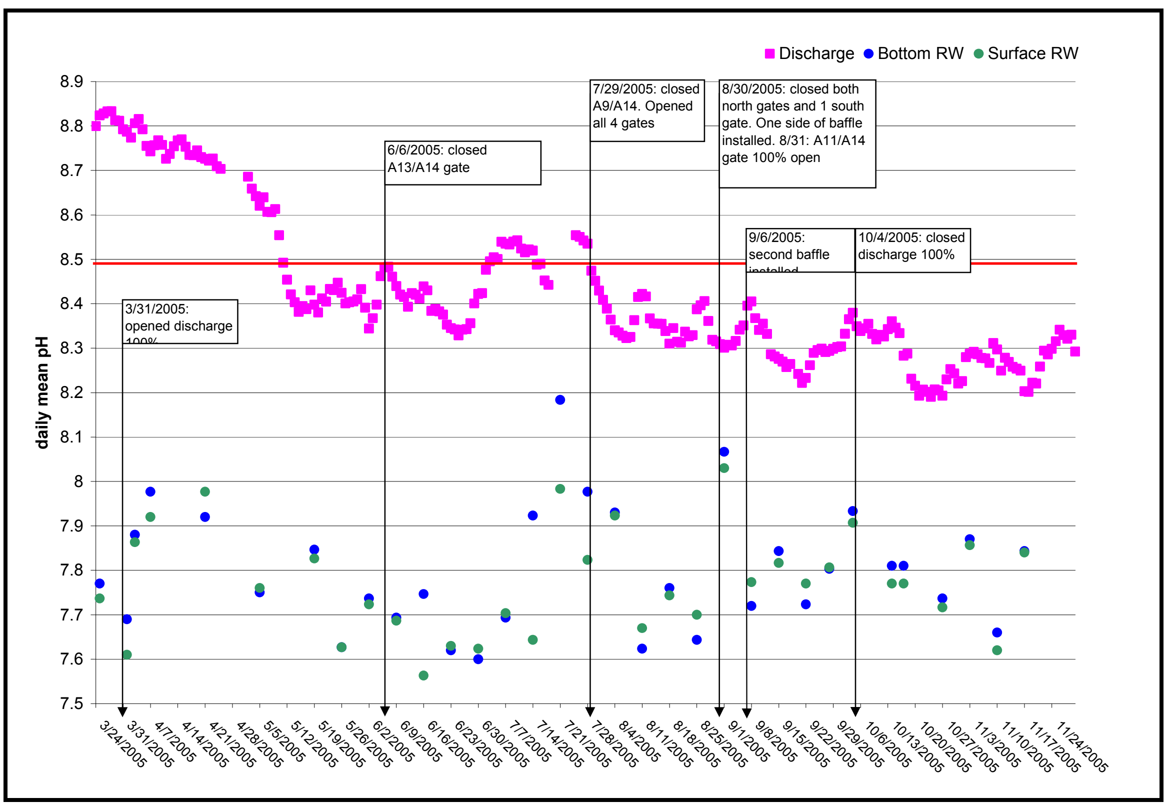


Figure A-14: pH of Pond A14 vs. Coyote Creek

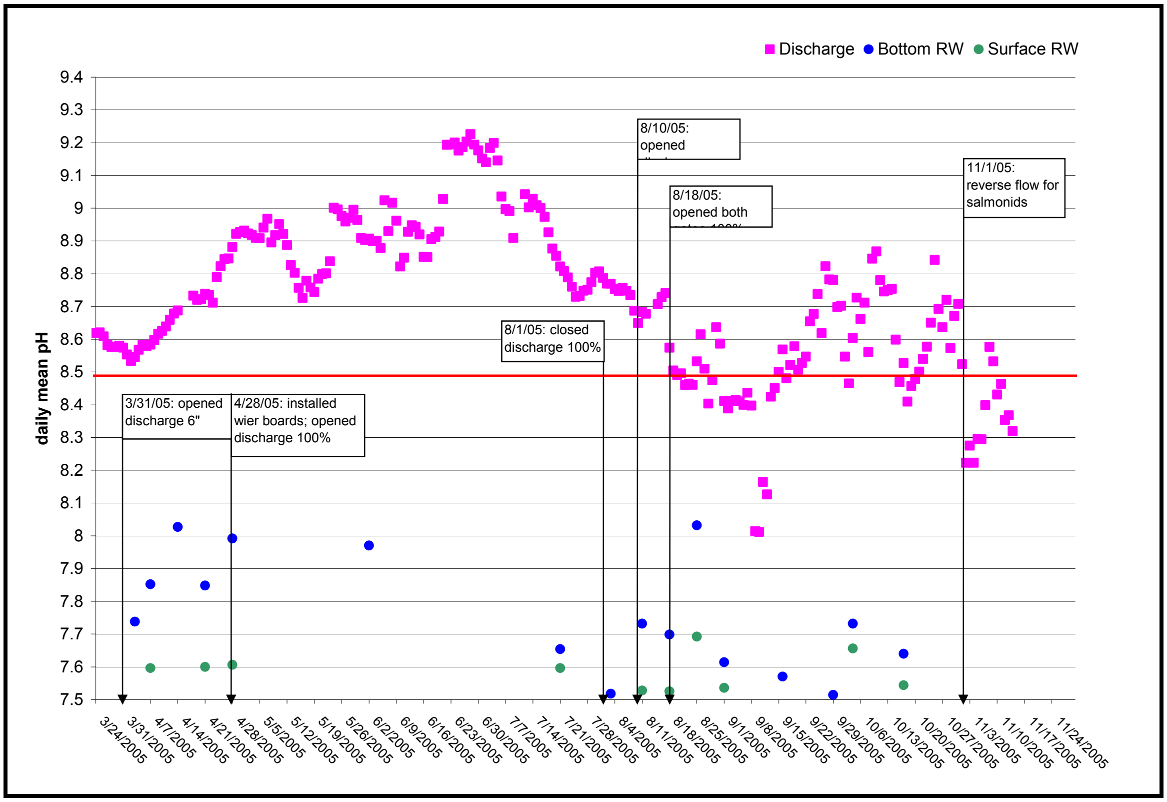


Figure A-15: pH of Pond A16 vs. Artesian Slough

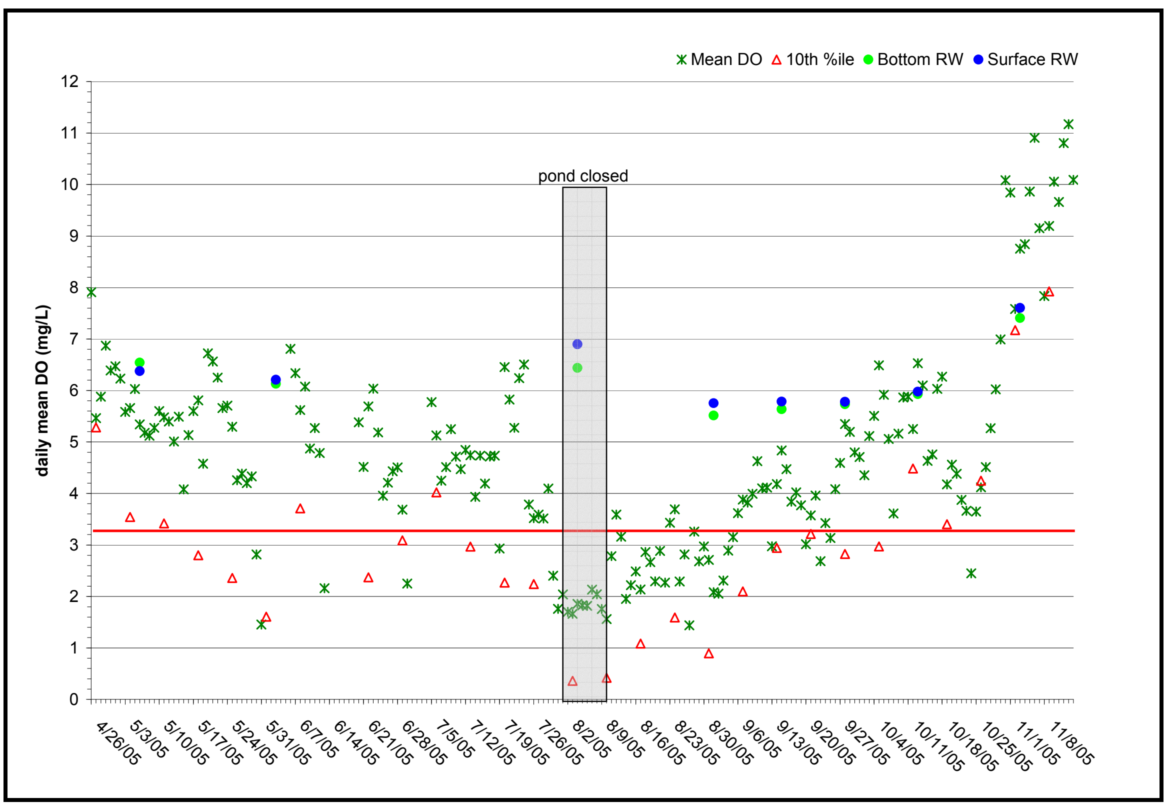


Figure A-16: Dissolved Oxygen of Pond A2W

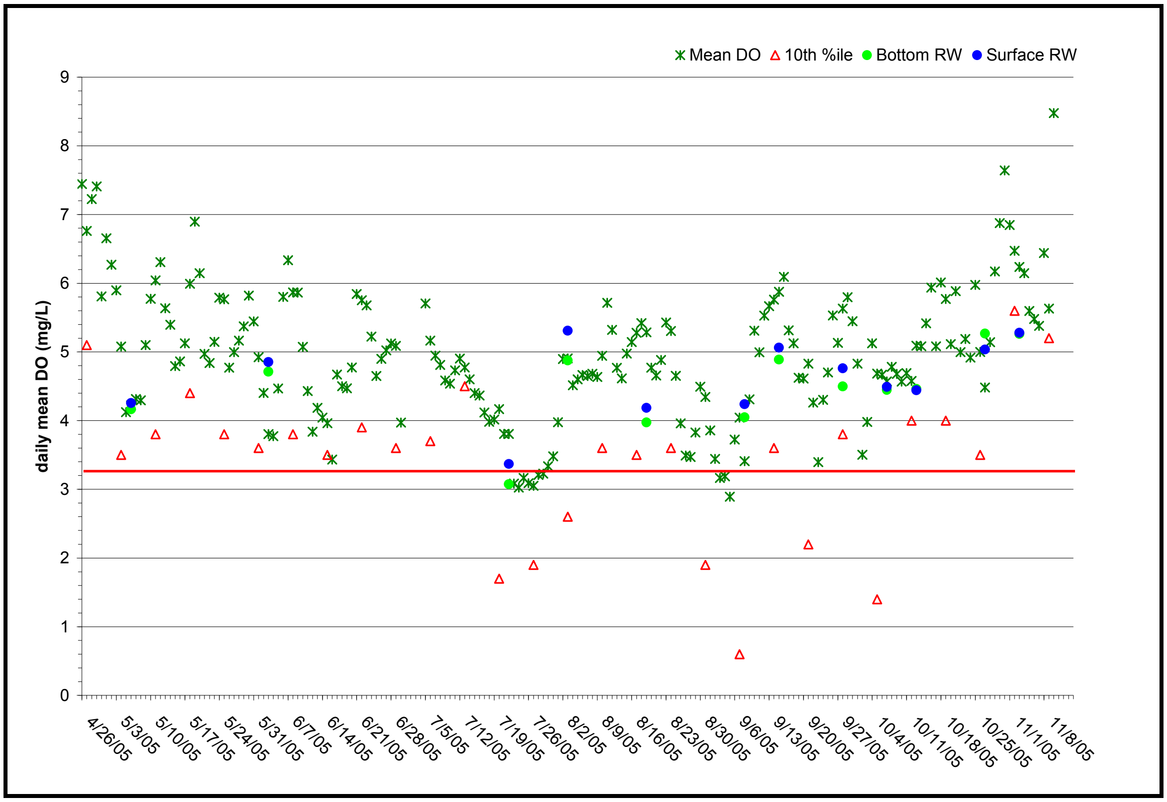


Figure A-17: Dissolved Oxygen of Pond A3W

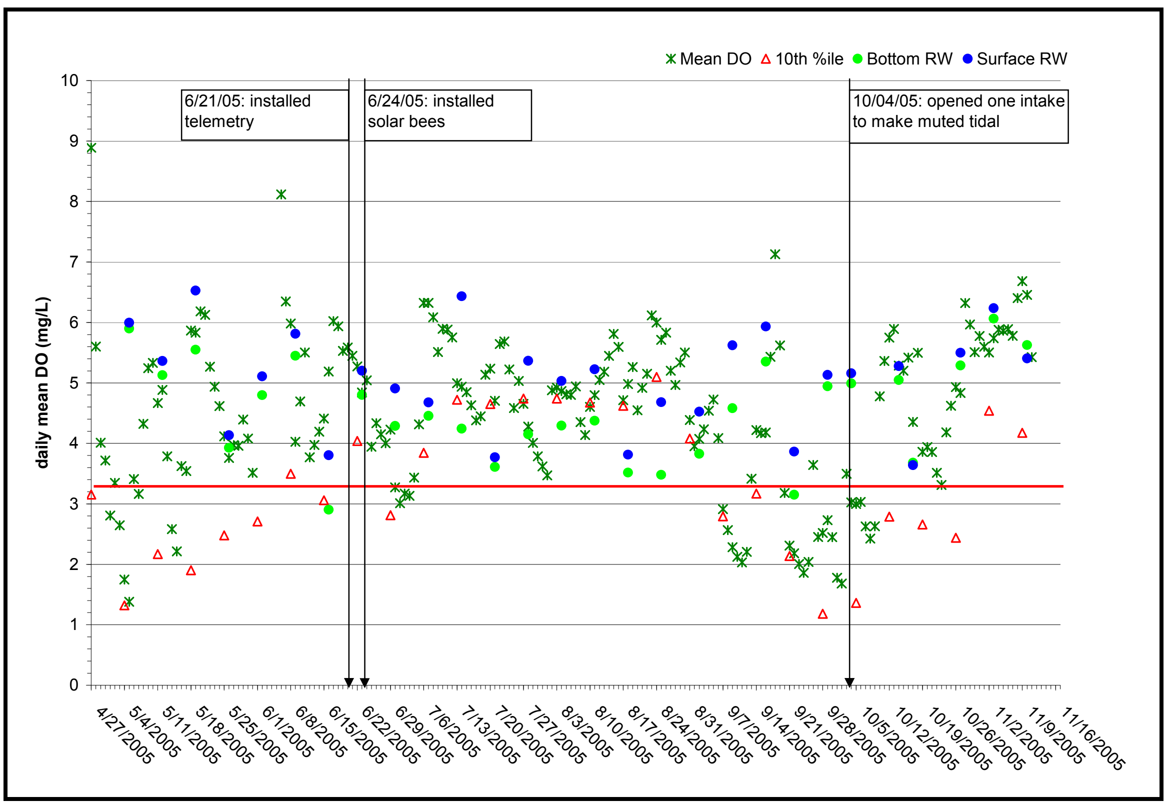


Figure A-17: Dissolved Oxygen of Pond A7

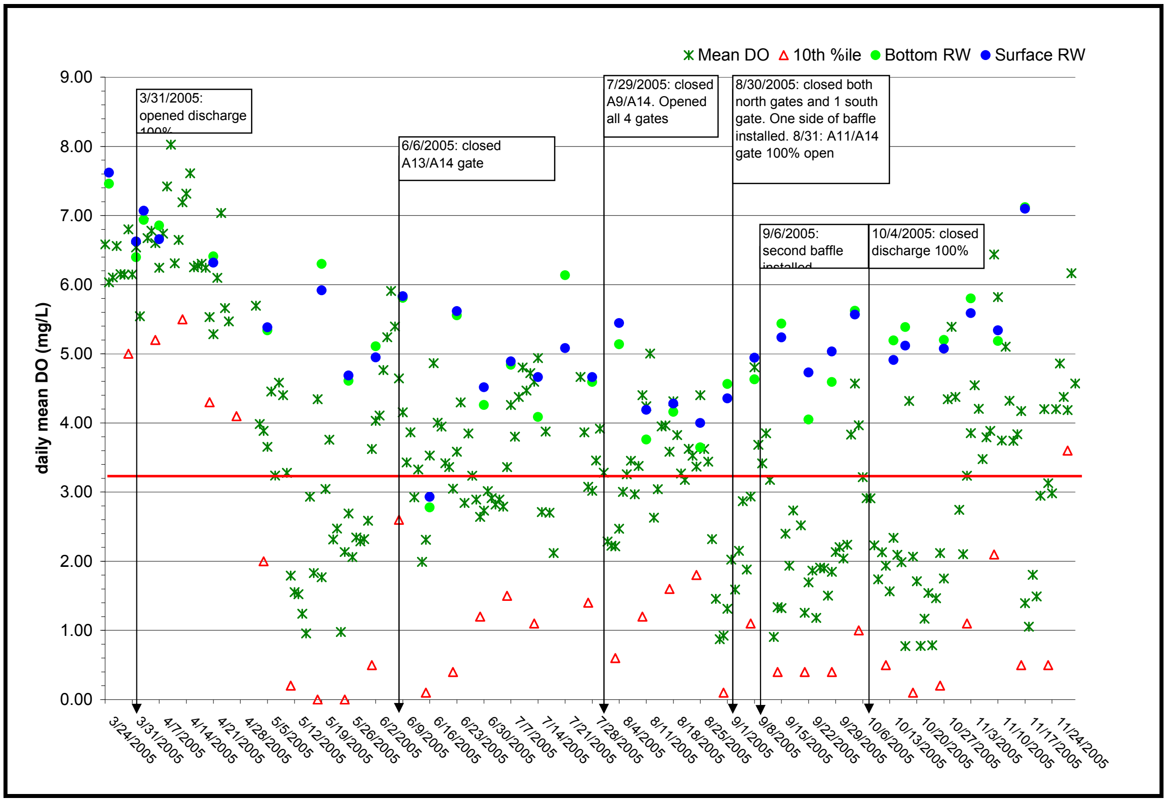


Figure A-18: Dissolved Oxygen of Pond A14

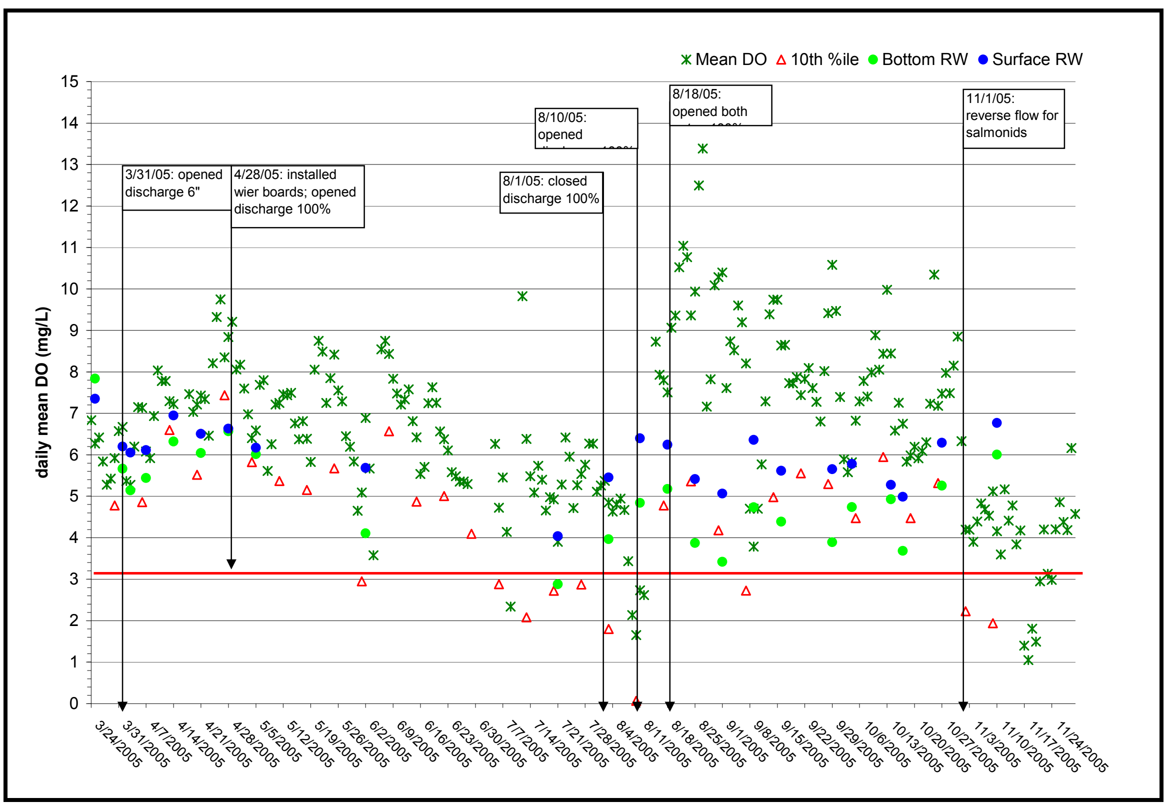


Figure A-20: Dissolved Oxygen of Pond A16

APPENDIX B
USGS MERCURY REPORT

United States Department of the Interior
Western Ecological Research Center
USGS-Davis Field Station
1 Shields Avenue
University of California, Davis
Davis, CA 95616

5 May 2005

Progress Report for Mercury in Sediments of the Alviso and Eden Landing Salt Ponds – Results from Winter 2005 Sampling

A. Keith Miles, Mark A. Ricca, and Sarah E. Spring, U.S. Geological Survey, Western Ecological Research Center

Overview

We collected sediment cores for analysis of total (THg) and methyl (meHg) mercury during winter 2005 from the Alviso and Eden Landing salt ponds as part of continuing monitoring to establish baseline concentrations in the sediments of the ponds comprising the South Bay Salt Pond Restoration Project. Results reported herein summarize efforts from winter 2005 and are presented with summaries from previous sampling conducted during late summer-early fall 2003 and 2004 (Miles et al. 2005).

The protocol set forth in the proposed scope of work for the monitoring study (Miles and Takekawa 2003, Stallings 2003) identified 2 main objectives: 1) establish a set of baseline concentrations of total and meHg in south bay salt ponds, primarily during late summer – early fall or winter, and 2) conduct additional sampling in ponds with highest baseline meHg concentrations, scheduled for changing water and salinity regimes, or characterized by important physical features. Results from ponds sampled during late summer – fall during 2003 and 2004 were reported previously (Miles et al. 2005) and, along with consultation with FWS, were used to determine ponds for sampling during winter 2005. Specifically,

- Ponds A3N, A12, and A13 were re-sampled because they contained surface sediments with the highest geometric mean concentrations of meHg during late summer – early fall.

- AB1, A5, and A7 are characterized by increasing depth associated with increasing distance from the south bay, causing exposed mudflats as water flow changes and higher methylation potential. Thus, we sampled 3 points (near, midway, and farthest from the bay) in order describe potential within pond variation in Hg concentrations associated with depth.

- Alviso ponds A9, A15, A17, A19, A20, and A21 were sampled to establish baseline Hg concentrations during winter. Water regime changes either have been conducted or soon will be conducted on these ponds.

- Finally, we collected sediment samples to obtain winter baseline THg and meHg concentrations in all Eden Landing Ponds (B1, B2, B4, B5, B6, B7, B8, B9, B10, B11, B12, B14, B1C, B2C, B4C, B5C, B6A, B6B, and B6C). In addition, 4 Eden Landing ponds were sampled in late summer – fall (B1, B2, B4, and B7).

- Concentrations of meHg in surface sediments from Alviso ponds A1, A2E, A2W, A3W, A5, A7, AB1, and AB2 sampled during late summer – fall 2004 were not available for inclusion in the January 2005 Progress Report. Results are included in this report which completes the baseline dataset for late summer – early fall.

Methods

Collection protocols and results for sediments collected during 2003 and 2004 were described previously (Miles et al. 2005). Briefly, we sampled 3 sites at each pond using a 2 cm diameter corer made of PVC pipe driven approximately 20 cm into the sediment. GPS coordinates and discrete water quality measurements (e.g. pH, temperature, salinity, Redox potential, dissolved oxygen) were recorded. For ponds sampled in multiple seasons or years, we collected sediment samples at the same sites to control for geographical variation whenever possible. Sites within ponds were generally 1) near an area of water exchange, 2) a distance of about halfway across the pond and 3) a distance at the far end of the pond away from water exchange. At each site, 3 surface sediment (0 – 5 cm) samples were collected approximately 5 – 10 m apart and placed in chemically clean jars (VWR Trace Clean 300 series ©). Previous analyses demonstrated significantly higher concentrations of THg and meHg in surface sediments compared to inner sediments (15 – 20 cm), so we only analyzed surface sediments. Site specific samples from Eden Landing ponds and Alviso ponds A19, A20, and A21 were composited into one sample per pond, while samples from all remaining Alviso ponds were left un-composited to enable examination of within pond Hg variation.

Battelle Marine Sciences Lab (Sequim, WA) conducted all Hg analyses. THg analyses followed EPA guidelines (1996; Method 1631, Appendix A, digestion and cold vapor)) and meHg analyses followed Bloom et al. 1989 and 1997. Limits of detection averaged 0.005 μg/g for THg and 0.014 ng/g for meHg. QA/QC criteria were met for THg and meHg: relative percent difference for duplicate samples ranged from 0 – 11 %, and recovery of matrix spikes ranged from 83 – 125 %. All concentrations reported herein are dry weight.

Preliminary Results

Alviso-winter 2005

We analyzed 31 sediment samples from the Alviso salt ponds collected from 3 February 2005 to 10 March 2005 (Appendix 1).

- Mercury concentrations were highest but also variable within pond A12; THg ranged from 0.27 to 4.2 μg/g, and meHg ranged from 1.8 to 9.0 ng/g (Figure 1). Notably, sample A12-4 was collected from recently dredged sediments and contained the lowest concentrations of THg and meHg.
- Sites A13-1 (1.5 μg/g) and A7-1 (1.7 μg/g) had concentrations of THg exceeding the US EPA criteria for contaminated sediments of 1.0 μg/g (Nichols et al 1991).
- Site A7-2 (0.9 μg/g) exceeded the Effects Range – Median (ERM) of 0.71 ug/g, (Long and Macdonald 1992). The ERM represents the 50^{th} percentile of concentrations from other studies associated with toxic effects, is used as a general, non-absolute baseline.
- Nearly all non-composited sediments had THg concentrations exceeding the Effects Range – Low (ERL) of 0.15 μg/g (Long and Macdonald 1992). The ERL represents the 10^{th} percentile of concentrations from other studies associated with toxic effects, and like the ERM, is used as a general, non-absolute baseline.
- In addition to A12, several sites in ponds A13, A15, A17, A9, A7, and A3N had relatively high meHg (> 2.0 ng/g). Furthermore, within pond concentrations of meHg were more variable than THg concentrations (Figures 2, 3).
- Logarithmic concentrations of THg were significantly correlated with meHg ($P = 0.001$), but similar to previous sampling the relationship was not strong ($R^2 = 0.32$) (Figure 4A).

Sediments from ponds A19, A20, and A21 were composited due to cost constraints. THg concentrations were either slightly above or below the ERL, and meHg did not appear substantially elevated (Figure 1).

Overall, water quality measurements (i.e., dissolved oxygen, pH, Redox potential) were not significantly correlated ($R^2 < 0.06$, $P \geq 0.27$) with either THg or meHg concentrations in non–composited samples from Alviso ponds. Water depth was positively (but not strongly) correlated with THg ($R^2 = 0.25$, $P = 0.02$), but not correlated with meHg ($R^2 = 0.09$, $P = 0.17$) (Figure 5). Within ponds AB1, A5, and A7 (the ponds hypothesized to have a strong depth – Hg association), no relation was apparent between depth and THg (Figure 6). However, meHg appeared to increase with depth in ponds AB1 and A5.

Eden Landing winter 2005

We analyzed 20 composite sediment samples from Eden Landing salt ponds collected from 11 January 2005 to 28 January 2005 (Appendix 2).

- Overall, THg concentrations were low (Figure 7).

- Pond B1C had the highest THg concentration (0.16 μg/g) followed by B1 and B11 (0.13 μg/g), while the concentration in B4C was lowest (0.05 μg/g).
- Concentrations of meHg were highest in B11 (3.1 ng/g) followed by B12 (2.8 ng/g) and B6B (2.3 ng/g), while B6C and B7 had lowest concentrations (0.3 ng/g).
- Similar to Alviso ponds, logarithmic concentrations of THg were significantly correlated with meHg (P = 0.008), but predictability the relationship was not strong (R^2 = 0.33) (Figure 4B).

Comparison among all seasons and ponds: 2003 – 2005.

For THg across all years and seasons:

- Alviso ponds A12, A13 (except winter), and A8 had concentrations above 1.0 μg/g in most seasons (Table 1, Figure 8).
- Alviso ponds A7 (late summer – fall 2004 and winter 2005), A10, A11, and A2W had concentrations at or exceeding the ERM.
- All years and seasons had concentrations at or exceeding the ERL except A21.
- In contrast, no Eden Landing pond contained THg concentrations exceeding 1.0 μg/g, and only B11 during late summer – fall 2004 and B1C during winter 2004 had concentrations exceeding the ERL (Table 2, Figure 8).
- THg concentrations did not differ significantly between seasons (paired t-test: t = 1.2, P = 0.24) among ponds sampled in both seasons (n = 12).

For meHg across all years and seasons:

- Alviso ponds A3N, A7 (except fall 2004), A12, A13, A11, A2W, and A9 had concentrations above the average meHg concentration for all Alviso samples ($\overline{x}$ = 2.6 ng/g) (Table 1, Figure 9).
- A3N had the highest elevated concentration (6.8 ng/g) in fall 2003, while samples from A1, A3W, and A5 had very low concentrations ($\leq$ 0.32 ng/g) in late summer-fall 2004.
- Notably, mean meHg concentrations in A5 were 9–fold higher in winter 2005 compared to late-summer – fall 2004, when methylation was expected to be higher.
- Eden Landing ponds B11, B12, B6B, B1, B1C, B14, and B4 had concentrations above the average concentration for all Eden Landing samples ($\overline{x}$ = 1.7 ng/g), and were generally lower than those in the Alviso ponds (Table 2, Figure 9).
- Pond B11 contained very elevated concentrations in late summer – fall 2003 ($\overline{x}$ = 10.7), but declined over 3–fold in winter 2005 ($\overline{x}$ = 3.1 ng/g).
- On average, however, meHg concentrations did not differ significantly between seasons (paired t-test: t = 0.81, P = 0.43) among ponds sampled in both seasons (n = 12).

- Percentages of THg comprised of meHg ranged from 0.03% to 1.5% in Alviso ponds (Table 1), and 0.2% to 6.9% in Eden Landing ponds (Table 2).

References

Bloom, N.J. Colman, and L. Barber. 1997. Artifact formation of methylmercury during aqueous distillation and alternative techniques for the extraction of methylmercury from environmental samples. Fresenius Journal of Analytical Chemistry. 358:371-377.

Bloom, N.S. 1989. Determination of picogram levels of methylmercury by aqueous phase ethylation, followed by cryogenic gas chromatography with cold vapor atomic fluorescence detection. Canadian Journal of Fisheries and Aquatic Science. 46.

EPA 1996. Test Methods for Evaluating Solid Waste. EPA, Office of Solid Waste and Emergency Response, Washington, D.C. (SW846).

Long, E.R., and D.D. MacDonald. 1992. National Status and Trends Program Approach *In*: Sediment Classification Methods Compendium. EPA 823-R-92-006. EPA Office of Water (WH-556). Washington D.C.: U.S. Environmental Protection Agency.

Miles, A.K., M.A. Ricca, S. E. Spring, and L. Stallings. 2005. Progress report for mercury in sediments of the Alviso, Eden Landing, and Ravenswood salt ponds. USGS progress report to USFWS.

Miles, A.K., and J. Takekawa. Proposed Scope of Work, ISP monitoring protocol for mercury in sediments of Alviso and some Baumberg salt ponds, July 2004.

Nichols, S.J., B.A. many, D. W. Schloesser, and T. A. Edsall. 1991. Heavy metal contamination of sediment in the upper connecting channels of the Great Lakes. Hydrobiologia. 219:307-315.

Stallings, L. Additional sediment sampling and analysis plan, south bay salt ponds ISP. August 2003.

Table 1. Summary results for concentrations (dry weight) of total Hg (THg) and methyl Hg (meHg) in surface sediments from salt ponds in the Alviso Salt Pond Complexes. Arithmetic (and geometric) means are calculated for non composited samples (*n* > 1).

Pond Complex	Year	season	Pond	*n*	THg (µg/g)	meHg (ng/g)	% meHg [a]
Alviso	2003	late summer - fall	A2E	3	0.487 (0.486)	0.788 (0.724)	0.15%
			A3N	3	0.438 (0.380)	6.793 (5.772)	1.52%
			A7	5	0.855 (0.810)	4.808 (2.825)	0.35%
			A8	3	1.362 (0.695)	2.063 (1.449)	0.21%
			A10	3	0.723 (0.722)	1.451 (1.425)	0.20%
			A11	3	0.690 (0.649)	2.834 (2.308)	0.36%
			A12	3	2.200 (1.697)	3.909 (3.344)	0.20%
			A13	3	1.454 (1.068)	3.299 (3.027)	0.28%
			A14	3	0.303 (0.276)	1.509 (1.435)	0.52%
			A16	3	0.441 (0.411)	1.382 (1.209)	0.29%
			Mean		*0.925 (0.635)*	*2.833 (1.954)*	0.32%
Alviso	2004	late summer - fall	A1	1	0.301	0.322	0.11%
			A2E	1	0.436	1.190	0.27%
			A2W	1	0.307	2.540	0.83%
			A3W	1	0.181	0.271	0.15%
			A5	1	0.736	0.233	0.03%
			A7	1	0.554	2.150	0.39%
			AB1	1	0.390	1.910	0.49%
			AB2	1	0.387	0.731	0.19%
			Mean	*1.168*	*0.412 (0.382)*	*1.168 (0.810)*	0.22%
Alviso	2004	winter	A12	4	1.594 (0.948)	4.525 (3.817)	0.40%
			A13	3	0.919 (0.832)	3.086 (3.075)	0.37%
			A15	3	0.533 (0.491)	2.237 (2.217)	0.45%
			A17	3	0.210 (0.204)	2.208 (1.939)	0.95%
			A19	1	0.1373	0.6828	0.50%
			A20	1	0.2539	1.6928	0.67%
			A21	1	0.1100	1.2175	1.11%
			A3N	3	0.295 (0.256)	3.286 (3.030)	1.18%
			A5	3	0.419 (0.407)	2.293 (2.115)	0.52%
			A7	3	0.960 (0.769)	3.230 (2.040)	0.27%
			A9	3	0.564 (0.560)	3.044 (2.585)	0.46%
			AB1	3	0.382 (0.380)	1.178 (0.989)	0.26%
			Mean		0.532 (0.363)	2.391 (1.911)	0.59%
Alviso - USFWS [b]	2002	late summer - fall	A1	3	0.313	na	
			AB1	3	0.563	na	
			A5	3	0.372	na	
			A9	3	0.479	na	
			A10	3	0.919	na	
			A16	3	0.533	na	

[a] based on geometric means for non-composited samples

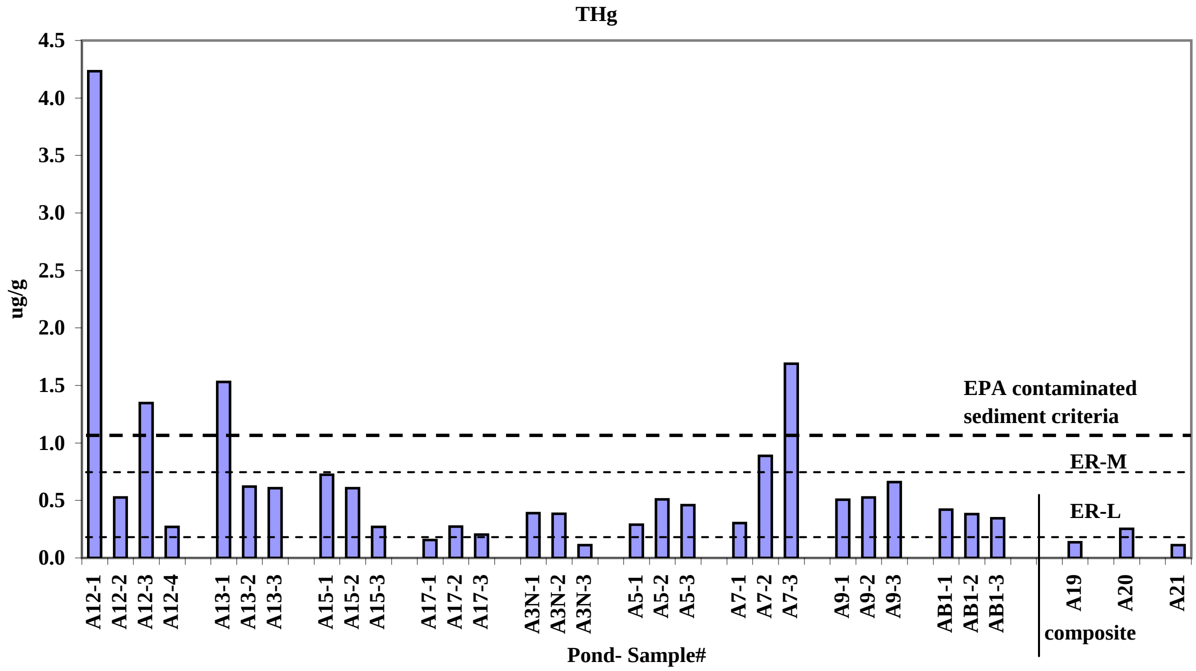
[b] data from Maurer and Adelsbach (Phase 2 Environmental Site Assessment, USFW Environmental Contaminants Division, Sacramento CA). Samples collected in top 10-15 cm

na = not analyzed

Table 2. Summary results for concentrations (dry weight) of total Hg (THg) and methyl Hg (meHg) in surface sediments from salt ponds in the Eden Landing and Ravenswood Salt Pond Complexes. Arithmetic (and geometric) means are calculated for non composited samples (*n* > 1).

Pond Complex	Year	Season [a]	Pond	*n*	THg (µg/g)	meHg (ng/g)	% meHg [a]
Eden Landing	2003	late summer - fall	B2	3	0.136 (0.134)	0.751 (0.655)	0.5%
			B6A	3	0.070 (0.070)	0.128 (0.121)	0.2%
			B11	2	0.156 (0.156)	10.71 (10.71)	6.9%
			B12	2	0.067 (0.064)	2.083 (2.073)	3.2%
			Mean		*0.107 (0.098)*	*3.419 (1.150)*	*1.2%*
	2004	late summer - fall	B1	1	0.145	1.710	1.2%
			B2	1	0.142	0.616	0.4%
			B4	1	0.103	2.170	2.1%
			B7	1	0.080	0.467	0.6%
			Mean		*0.177 (0.114)*	*1.241 (1.016)*	*0.9%*
	2005	winter	B1	1	0.134	2.160	1.6%
			B1C	1	0.161	1.790	1.1%
			B2	1	0.118	1.240	1.1%
			B2C	1	0.070	0.535	0.8%
			B4	1	0.121	1.480	1.2%
			B4C	1	0.054	0.484	0.9%
			B5	1	0.091	0.819	0.9%
			B5C	1	0.116	0.413	0.4%
			B6	1	0.066	0.484	0.7%
			B6A	1	0.076	1.600	2.1%
			B6B	1	0.092	2.330	2.5%
			B6C	1	0.070	0.325	0.5%
			B7	1	0.090	0.256	0.3%
			B8	1	0.075	0.663	0.9%
			B8A	1	0.130	0.983	0.8%
			B9	1	0.091	2.240	2.5%
			B10	1	0.088	0.986	1.1%
			B11	1	0.128	3.070	2.4%
			B12	1	0.125	2.760	2.2%
			B14	1	0.091	1.680	1.9%
			Mean		*0.099 (0.096)*	*1.315 (1.033)*	*1.1%*
Ravenswood	2003	late summer - fall	R2	3	0.048 (0.044)	1.413 (0.882)	2.0%
			R4	3	0.041 (0.039)	0.368 (0.295)	0.8%
			Mean		*0.045 (0.041)*	*0.891 (0.510)*	*1.2%*

[a] based on geometric means for non-composited samples



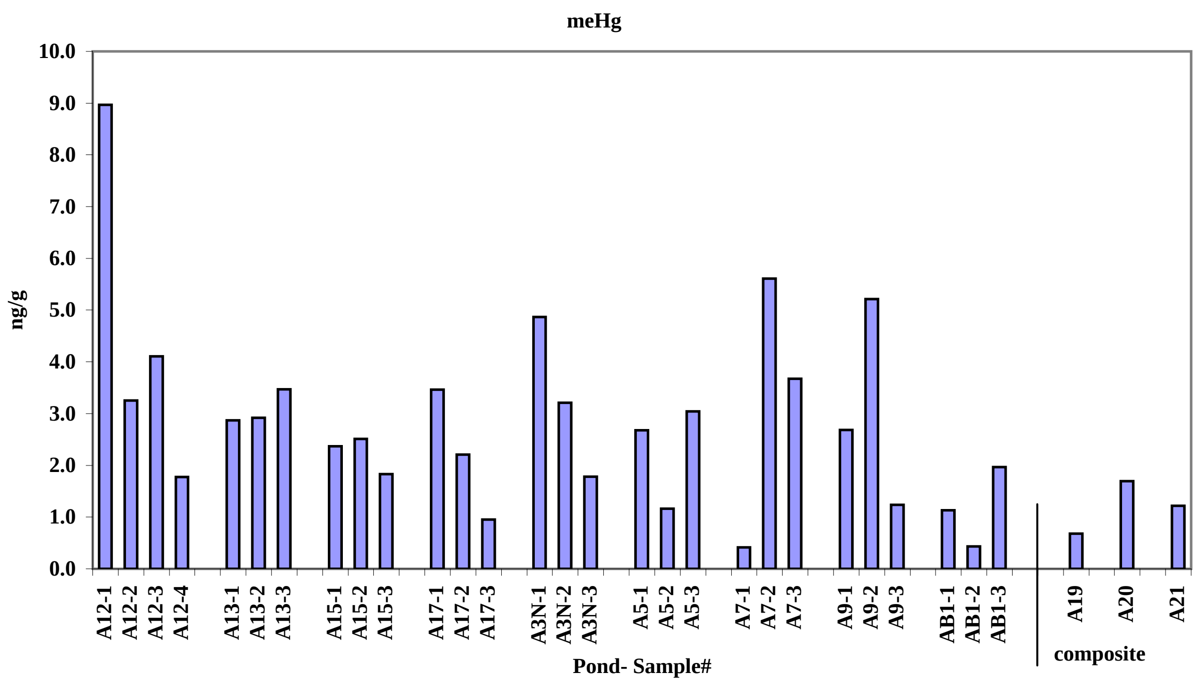


Figure 1. Concentrations of THg and meHg from site specific and composite sediment samples from Aviso salt ponds, winter 2005. Baseline biological effect levels for THg are indicated by doted lines: 1.0 ng/g = US EPA criteria for contaminated sediment, 0.71 µg/g = Effects Range-Median (ER-M), 0.15 µg/g = Effects Range-Low (ER-L).

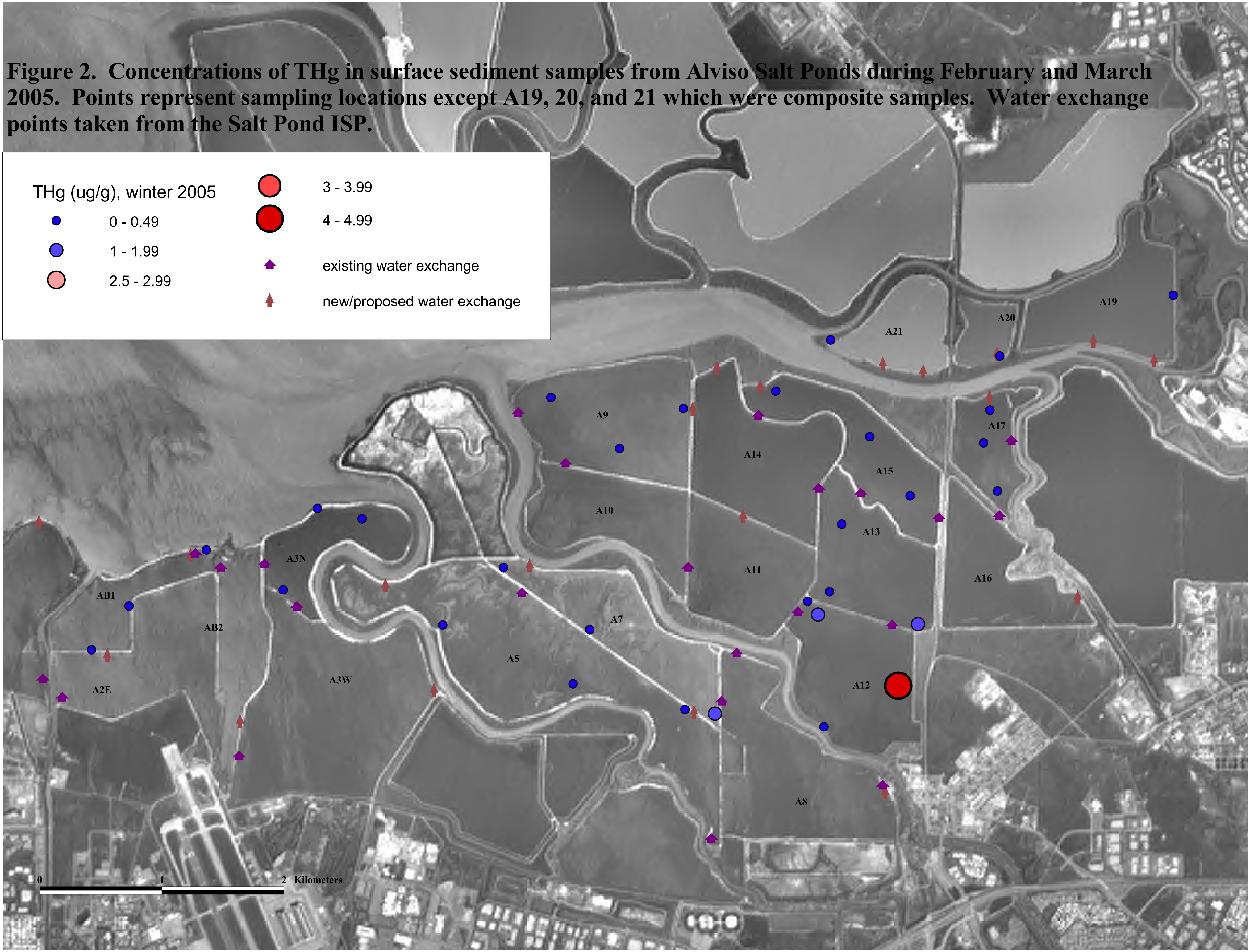
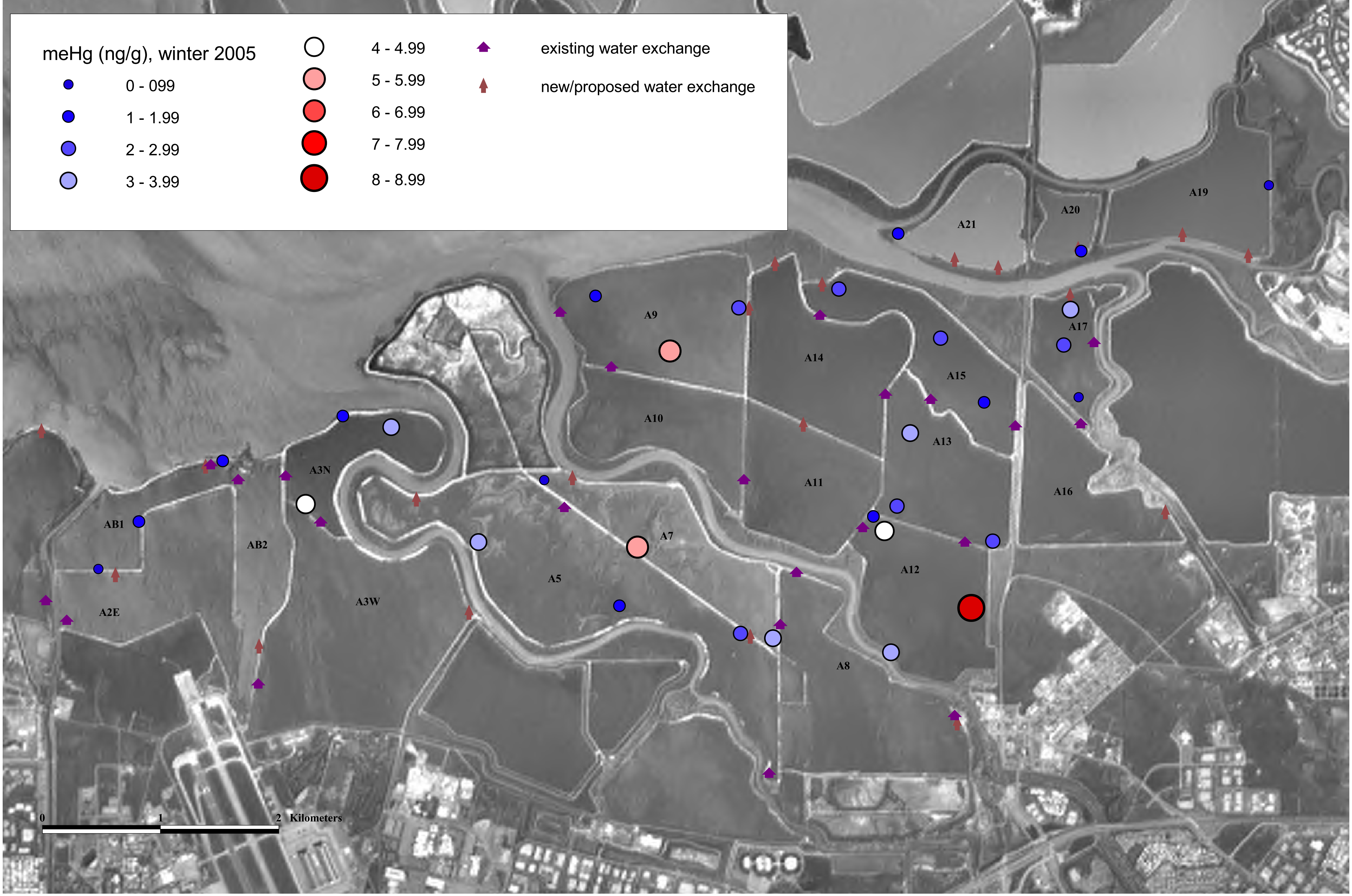
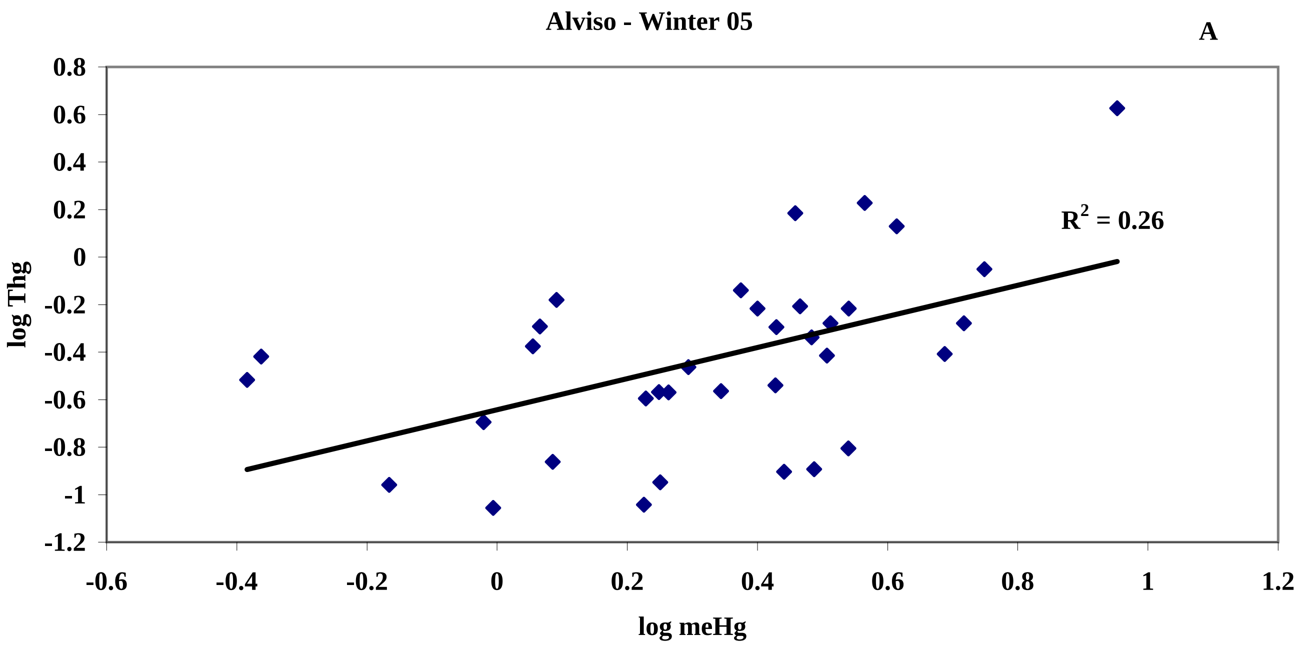


Figure 2. Concentrations of THg in surface sediment samples from Alviso Salt Ponds during February and March 2005. Points represent sampling locations except A19, 20, and 21 which were composite samples. Water exchange points taken from the Salt Pond ISP.

Figure 3. Concentrations of meHg in surface sediment samples from Alviso Salt Ponds during February and March 2005. Points represent sampling locations except A19, 20, and 21 which were composite samples. Water exchange points taken from the Salt Pond ISP.





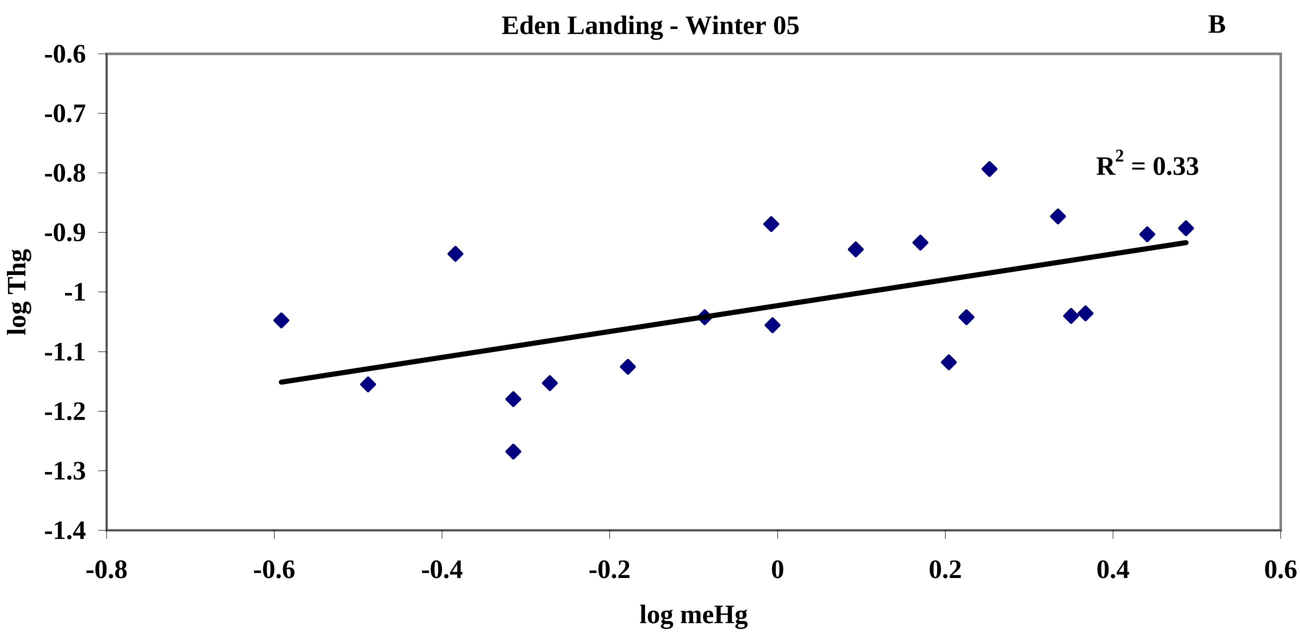


Figure 4. Correlations between log transformed concentrations of THg and meHg in Alviso (A) and Eden Landing (B) salt ponds sampled during winter 2005.

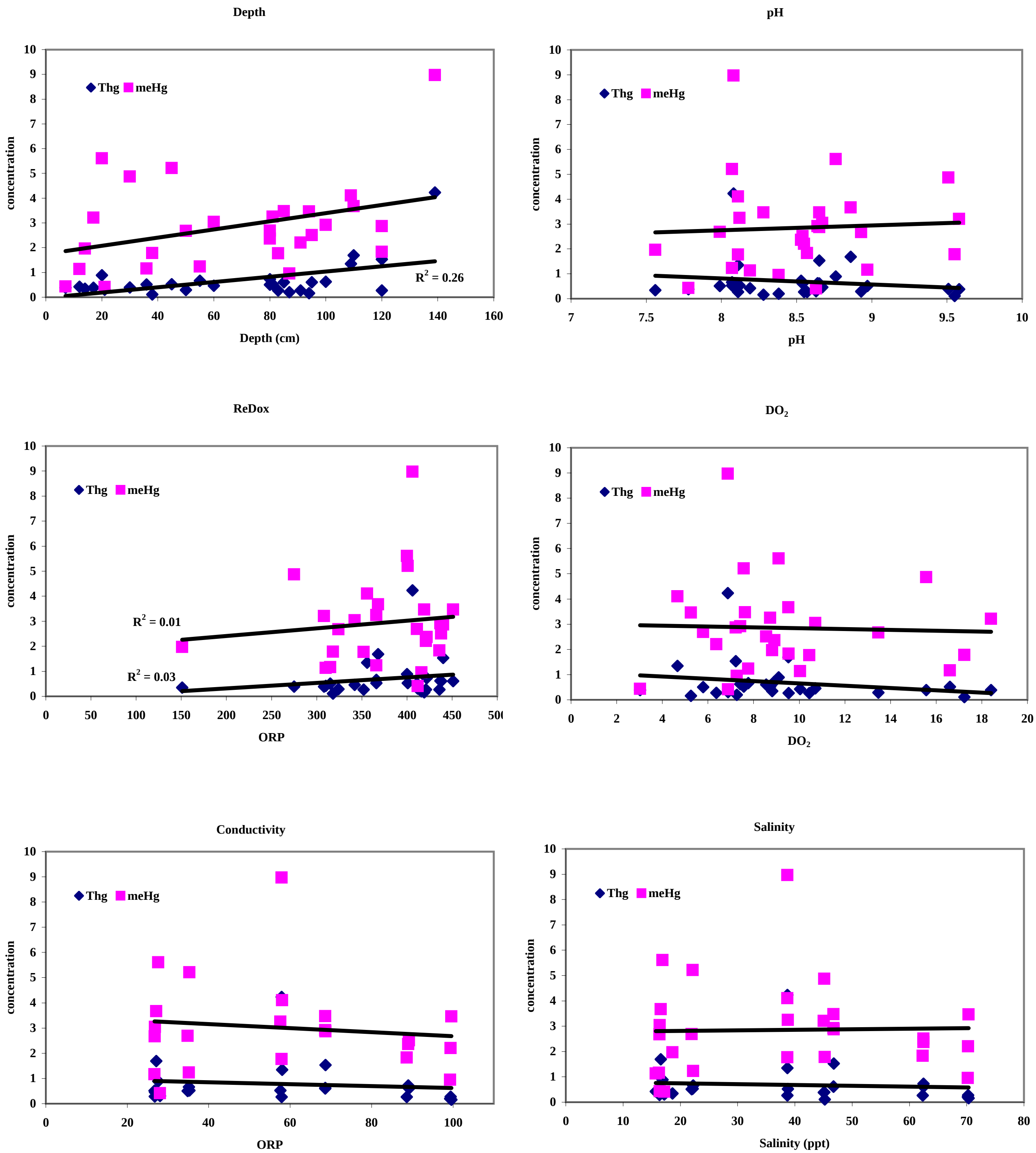


Figure 5. Correlations between water chemistry and concentrations of THg and meHg in site specific (non composited) sediment samples from Alviso salt ponds, winter 2005. Only depth vs. THg was significant ($P < 0.001$).

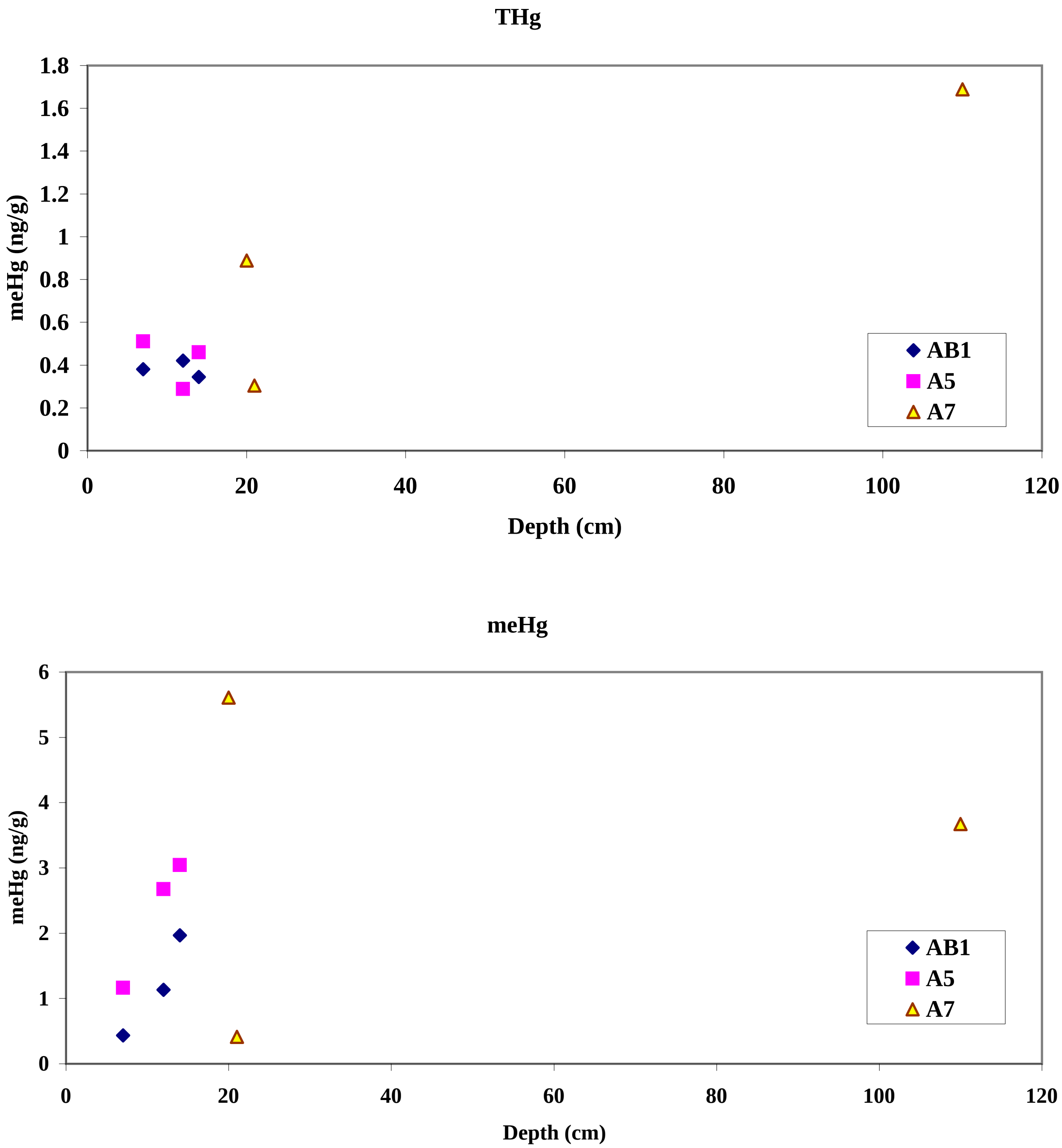
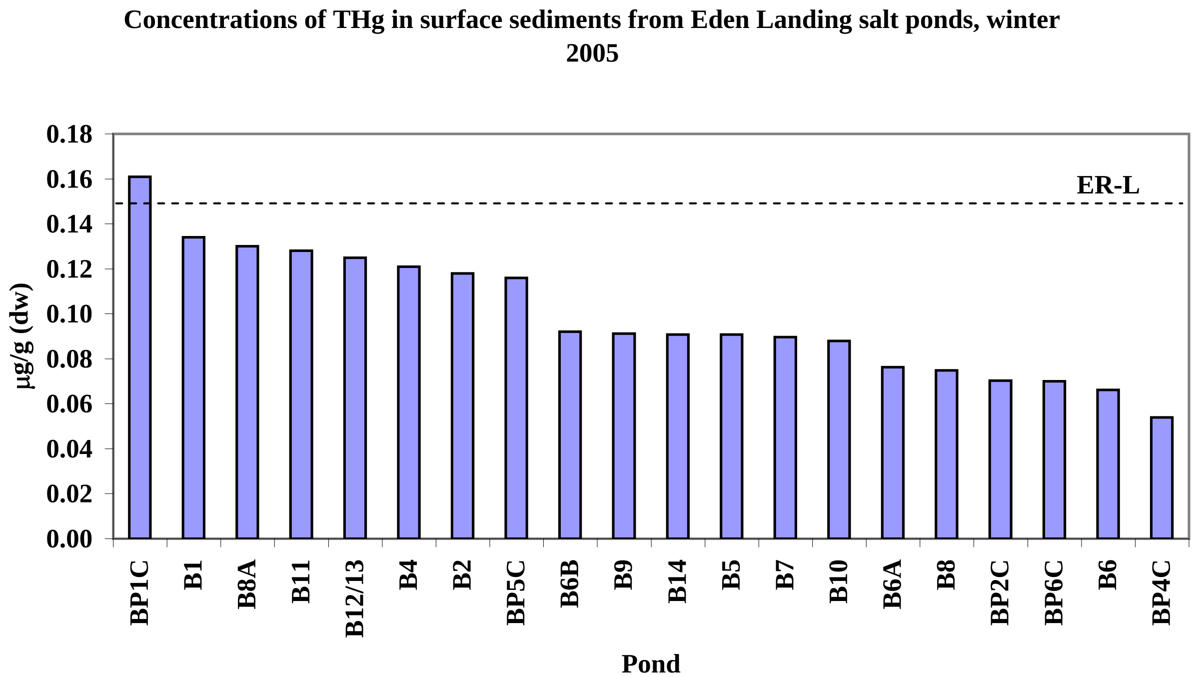


Figure 6: Simple graphical relations between water depth and concentrations of THg and meHg in Alviso ponds AB1 A5, and A7.



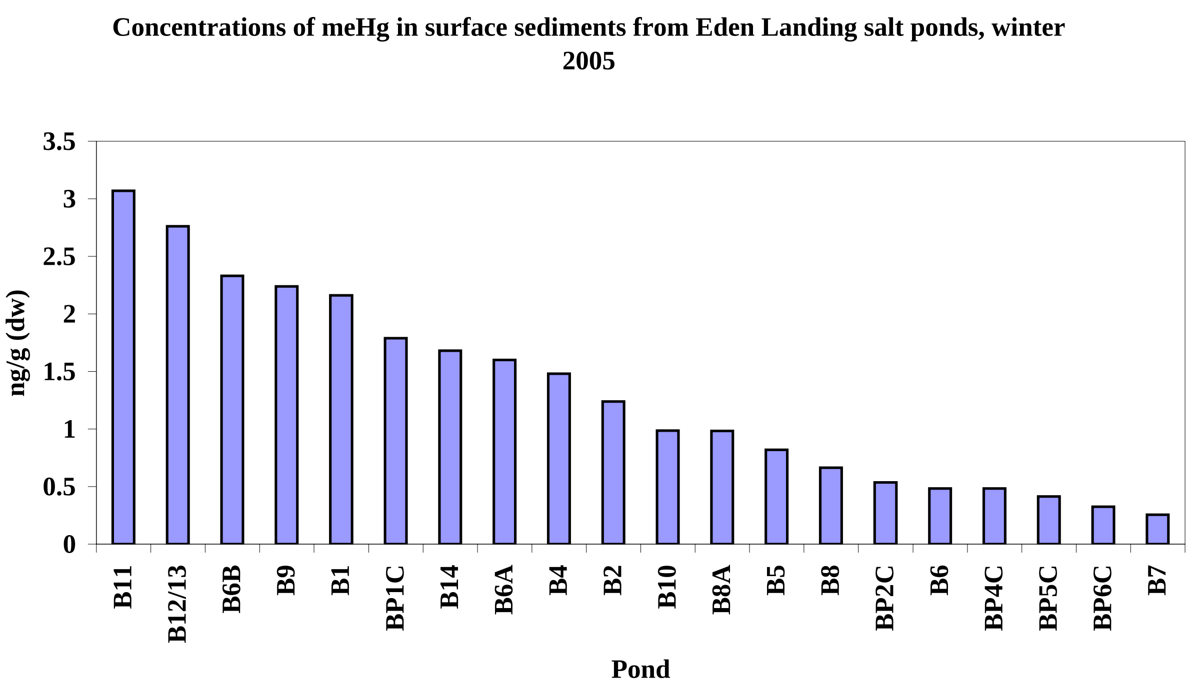
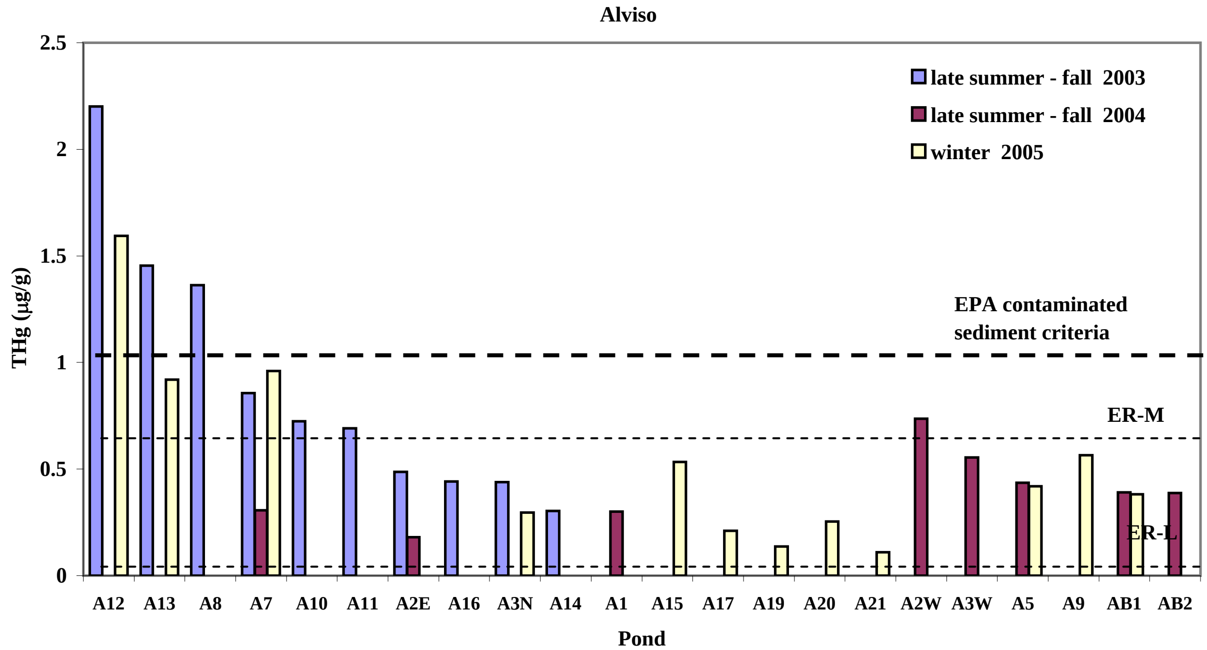


Figure 7. Concentrations of THg and meHg in composite surface sediment samples collected from Eden Landing salt ponds, winter 2005. ER-L = Effects Range-Low.



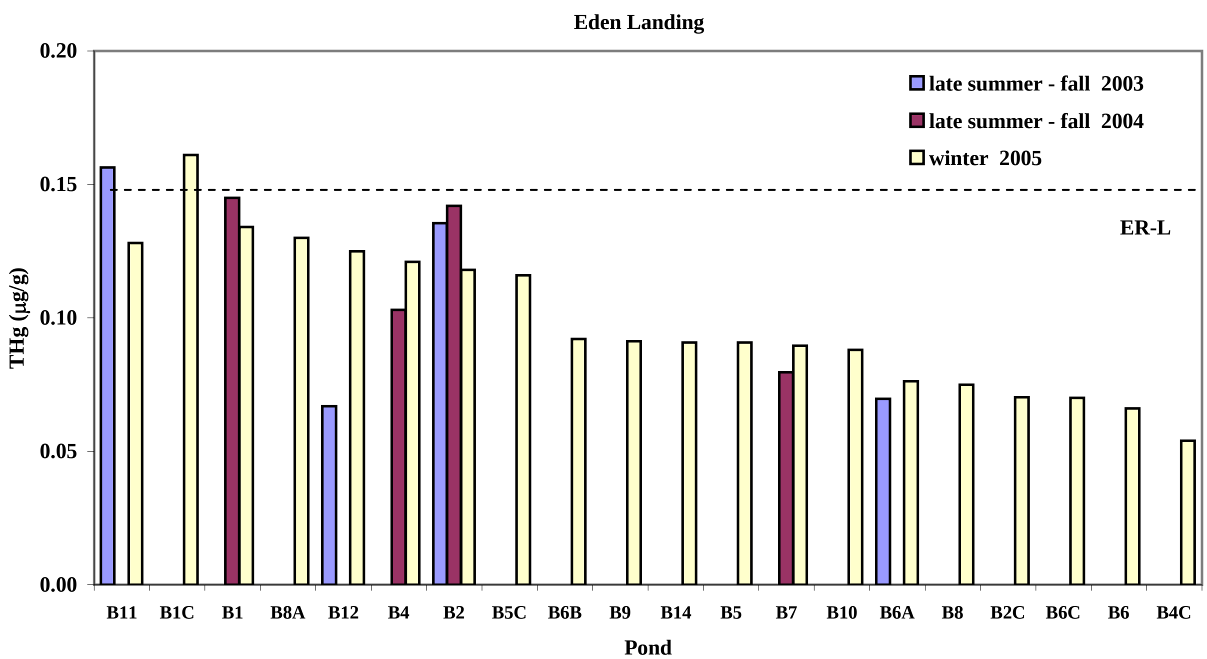
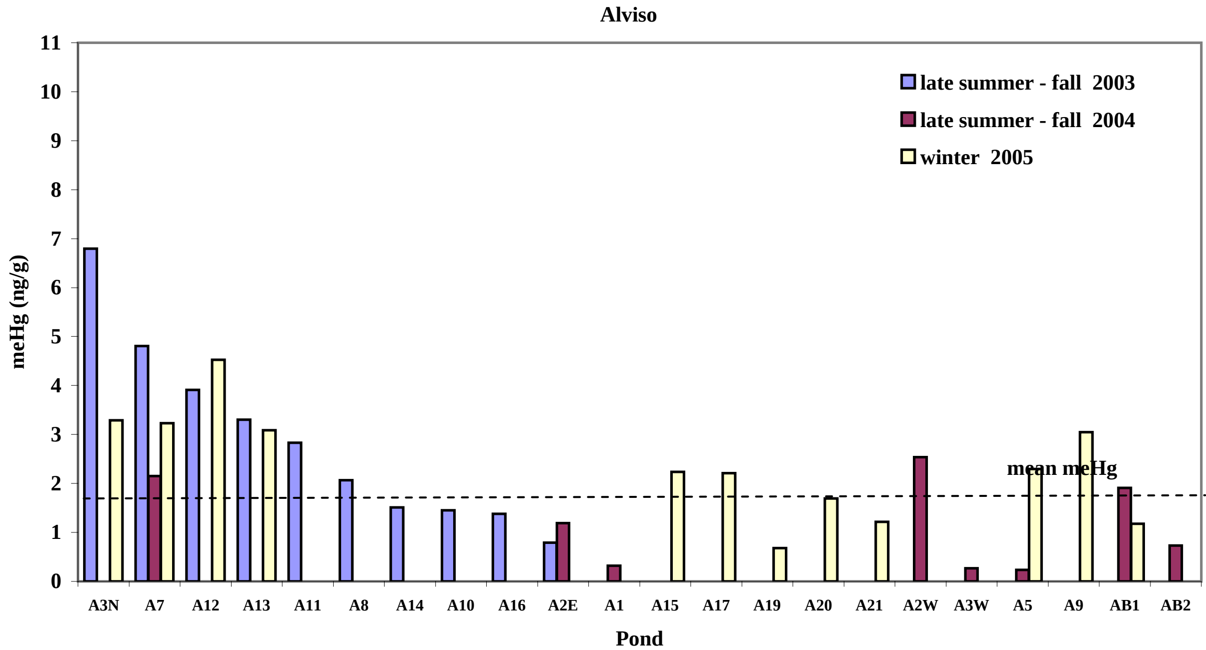


Figure 8. THg concentrations (mean or single composite value) in Alviso and Eden Landing pond surface sediments, fall 2003 - winter 2005. Note y-axis varies between pond complexes. Baseline biological effect levels for THg are indicated by doted lines: 1.0 ng/g = US EPA criteria for contaminated sediment, 0.71 mg/g = Effects Range-Median (ER-M), 0.15 mg/g = Effects Range-Low (ER-L).



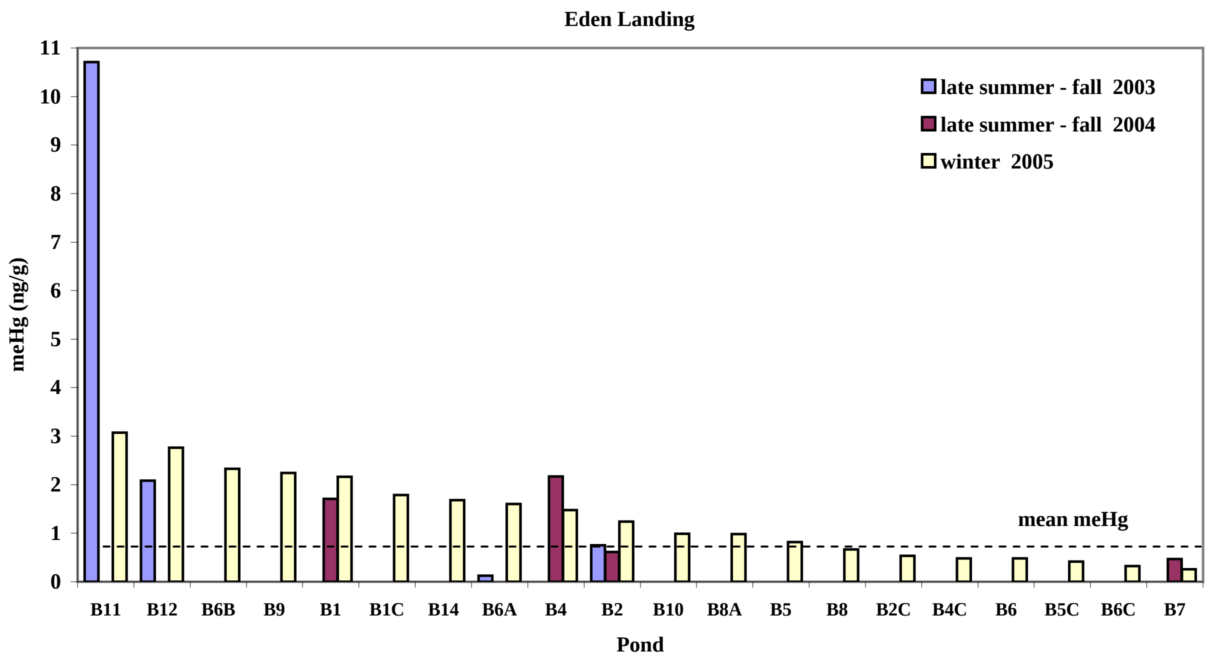
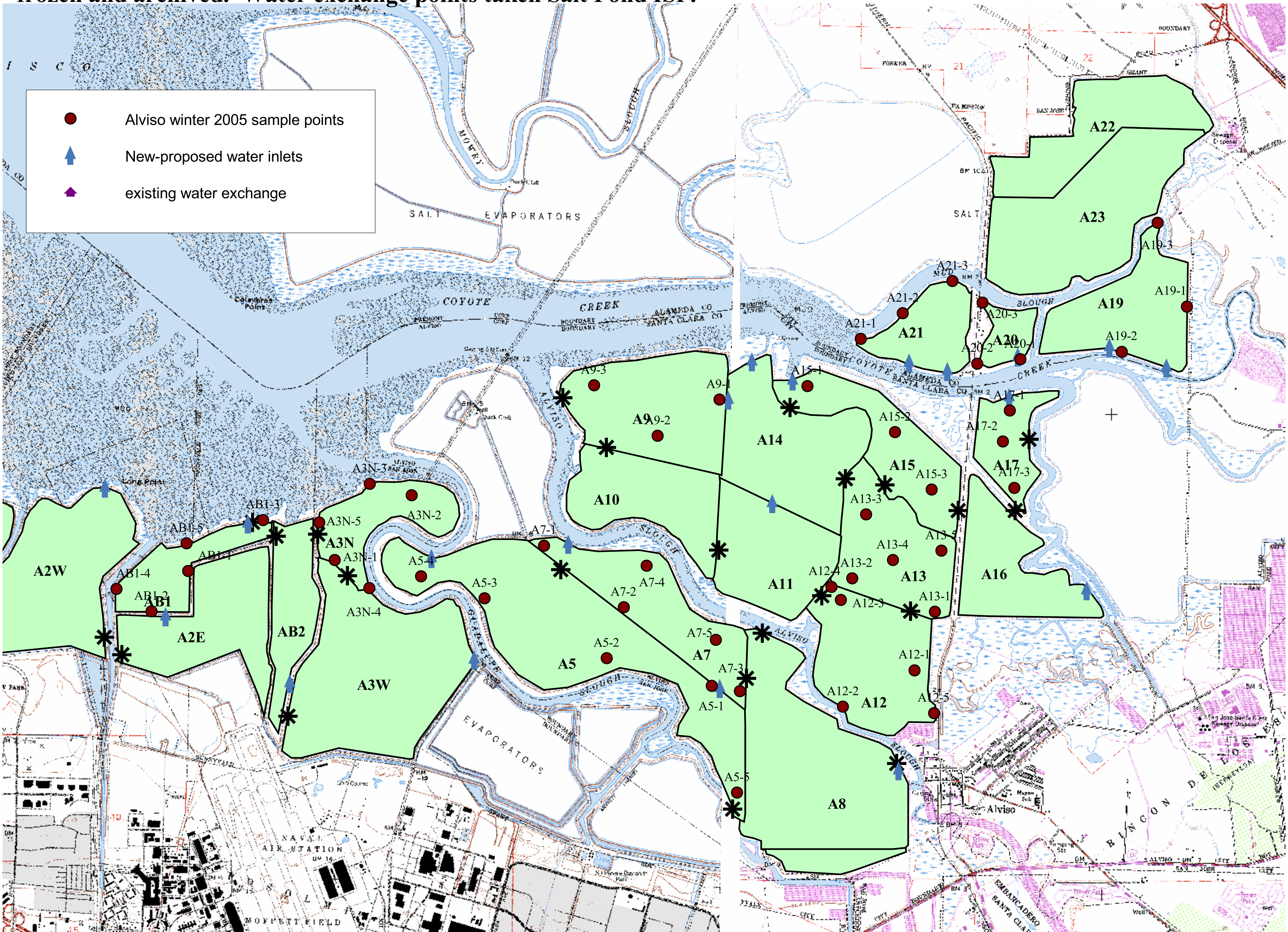
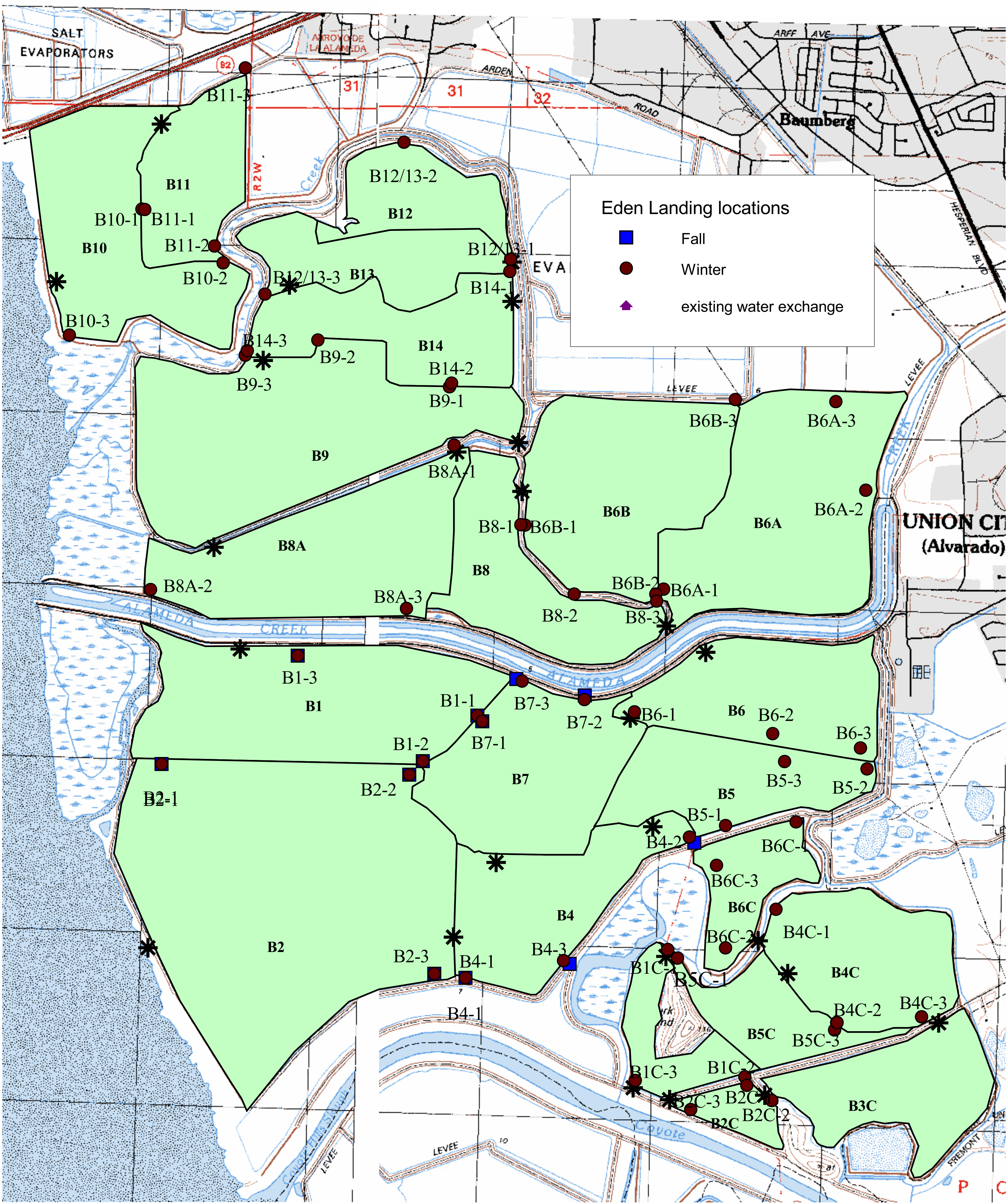


Figure 9. MeHg concentrations (mean or single composite value) in Alviso and Eden Landing pond surface sediments, fall 2003 - winter 2005. Baseline biological effect levels for THg are indicated by doted lines: 1.0 ng/g = US EPA criteria for contaminated sediment, 0.71 mg/g = Effects Range-Median (ER-M), 0.15 mg/g = Effects Range-Low (ER-L).

Appendix 1. Sediment sampling locations for Hg analysis in Alviso sat ponds, winter 2005. Note 1-2 additional samples in ponds AB1, A3N, A13, A5, and A7 were collected which were not analyzed for Hg but were frozen and archived. Water exchange points taken Salt Pond ISP.



Appendix 2. Sediment sampling locations for Hg analysis in Eden Landing salt ponds, late summer-fall 2004 and winter 2005. Water exchange points taken from Salt Pond ISP.



APPENDIX C
WATER MANAGEMENT OPERATION PLAN
POND SYSTEM A2W

Pond System A2W Water Management Operation Plan – Alviso System 2006

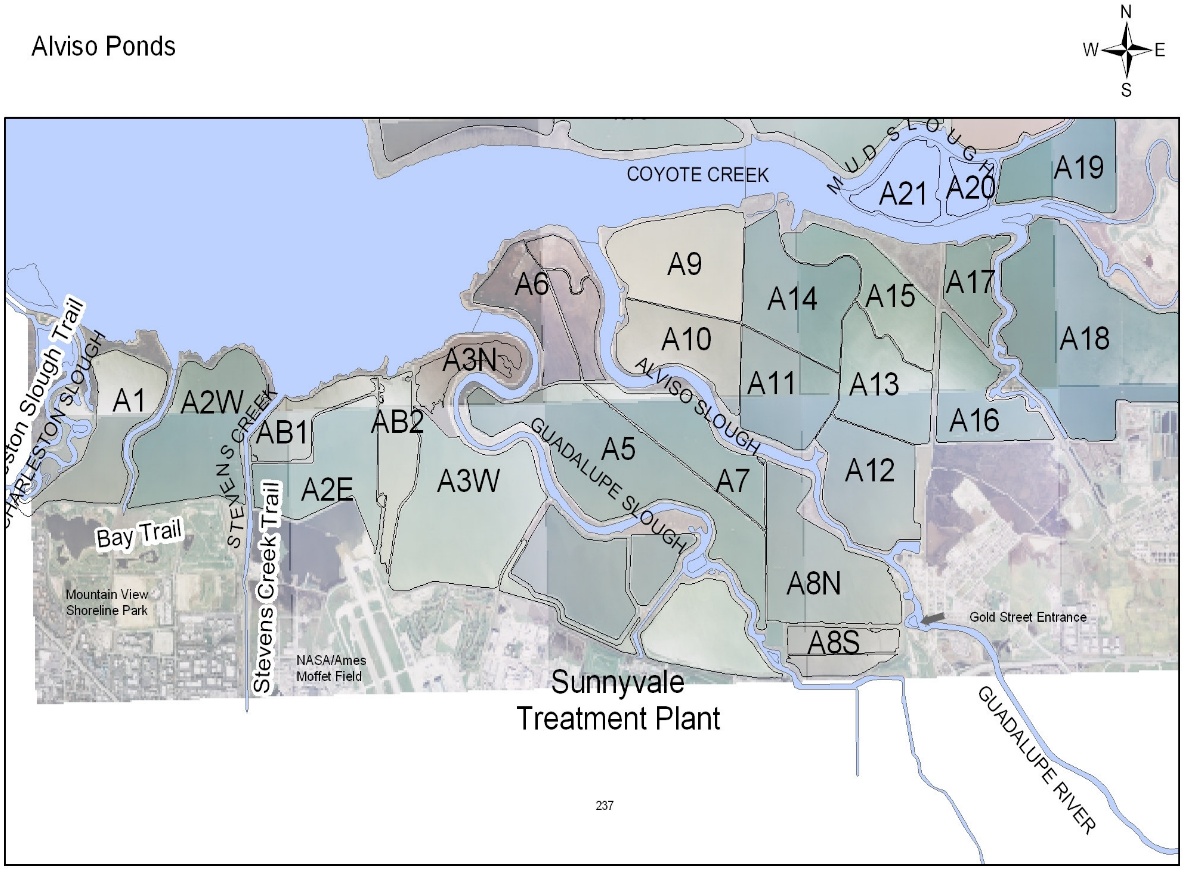
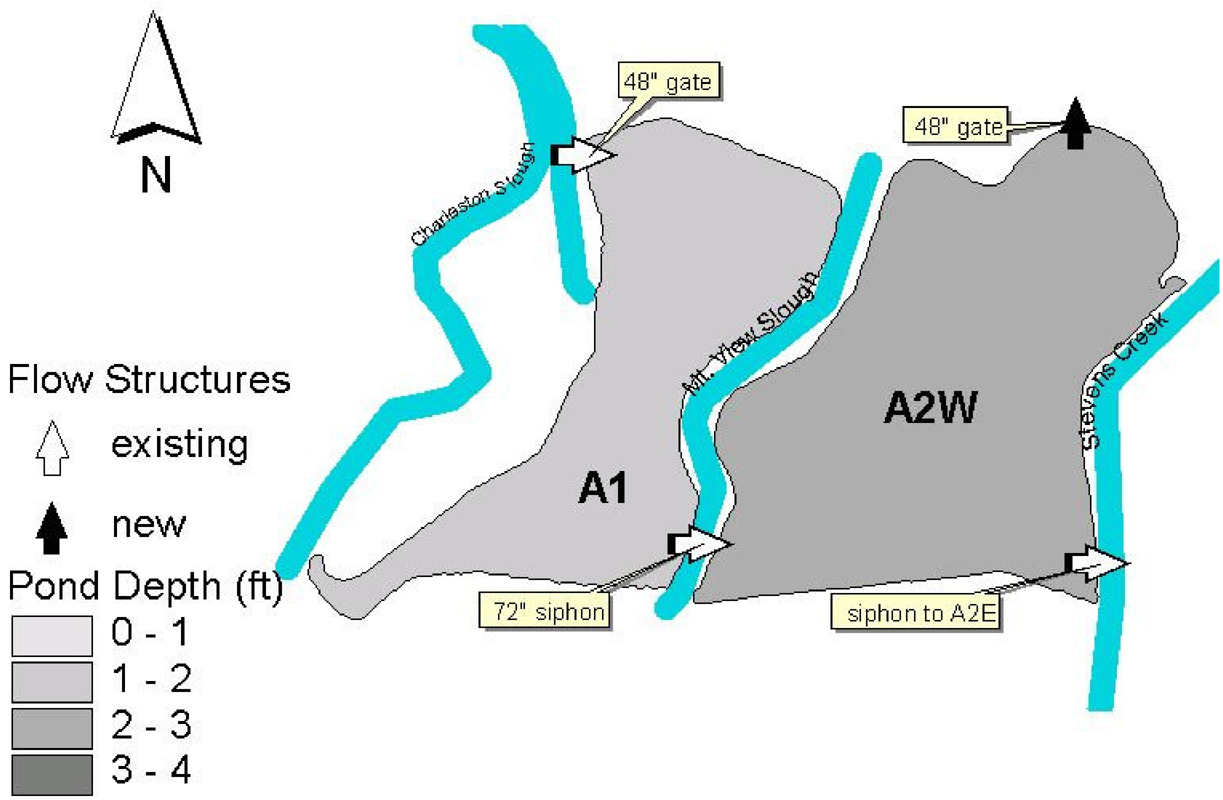


Table of Contents



Objectives

Maintain full tidal circulation through ponds A1 and A2W while maintaining discharge salinities to the Bay at less than 40 ppt and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen, temperature, avian botulism, and potential for inorganic mobilization.

Structures

The A2W system includes the following structures needed for water circulation in the ponds:

- Existing 48" gate intake at A1 from lower Charleston Slough
- New NGVD gauge at A1
- Existing 72" siphon under Mountain View Slough between A1 and A2W
- Existing staff gauge (no datum) at A1
- New 48" gate outlet structure with 24' weir box at A2W to the Bay
- New NGVD gauge at A2W
- Note that existing siphon to A2E should be closed

System Description

The intake for the A2W system is located at the northwest end of pond A1 and includes one 48" gate from lower Charleston Slough near the Bay. The system outlet is located at the north end of pond A2W, with one 48" gate to the Bay. The flow through the system proceeds from the intake at A1 though the 72" siphon under Mountain View Slough to A2W. An existing siphon under Stevens Creek to Pond A2E was used for salt pond operations. It should remain closed for normal operations, though it is available for unforeseen circumstances.

Operations of the A2W system should require little active management of gate openings to maintain appropriate flows. Summer and winter operations are described below to indicate predicted operating levels during the dry and wet seasons. The system will discharge when the tide is below 3.6 ft. MLLW.

Summer Operation

The summer operation is intended to provide circulation flow to makeup for evaporation during the summer season. The average total circulation inflow is approximately 19 cfs, or 38 acre-feet/day, with an outlet flow of about 14 cfs (28 acre-feet/day). The summer operation would normally extend from May through October.

Summer Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A1	277	-1.8	-0.4	2.0
A2W	429	-2.4	-0.5	NA

Summer Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A1 intakes	50	19
A2W	100	48
Weir	-1.2 ft NGVD	6 boards

Water Level Control

The water level in A2W is the primary control for the pond system. The outlet at A2W includes both a control gate and control weir. Either may be used to limit flow through the system. The system flow is limited by the outlet capacity. Normal operation would have the outlet gates fully open, and the weir set at elevation -1.2 ft NGVD, approximately 0.7 feet below the normal water level. The normal water level in A2W should be at -0.5 ft NGVD in summer. The level may vary by 0.2 due to the influence of weak and strong tides.

The A1 intake gate can be adjusted to control the overall flow though the system. The maximum water level in either A1 or A2W should generally be less than 1.2 ft NGVD. This is to maintain freeboard on the internal levees, limit wind wave erosion, and to preserve existing islands within the system used by nesting birds.

Design Water Level Ranges

Pond	Design Water Level Elev. (ft, NGVD)	Maximum Water Elev. (ft, NGVD)	Maximum Water Level (ft, Staff Gage)	Minimum Water Elev. (ft, NGVD)	Minimum Water Level (ft, Staff Gage)
A1	-0.4	1.2	3.6	-0.6	1.8
A2W	-0.5	1.1	NA	-0.7	NA

The minimum and maximum water levels are based on our observations in the ponds for the period 2005.

There is no existing staff gage in pond A2W. Therefore, there is no record of existing minimums and maximums. Based on system hydraulics, pond A2W would typically be about 0.1 feet below pond A1.

100 Percent Coverage Water Level

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
A1	-0.4	-0.7	1.7
A2W	-0.5	NA	NA

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems.

Salinity Control

The summer salinity in the system will increase from the intake at A1 to the outlet at A2W, due to evaporation within the system. The design maximum salinity for the discharge at A2W is 40 ppt. The intake flow at A1 should be increased when the salinity in A2W is close to 35 ppt. If the gate at A1 is fully open, the flow can be increased by lowering the weir elevation at the A2W outlet structure. Increased flow will increase the water level in A2W. Water levels above elevation 1.1 ft NGVD should be avoided as they may increase wave erosion of the levees.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A2W fall below a 10th percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will conduct within-pond monitoring and notify and consult with the Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the A1 inlet further. If increased flows are not possible, open the A2W gate to allow the pond to become fully muted or partially muted tidal system until pond DO levels revert to levels at or above conditions in the Creek.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.

To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.
2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.
3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks).

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on Dissolved Oxygen and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

The winter operation is intended to provide less circulation flow than the summer operation. Evaporation is normally minimal during the winter. The winter operation is intended to limit large inflows during storm tide periods and to allow rain water to drain from the system.

The average total circulation inflow is approximately 9 cfs, or 18 acre-feet/day, with an outlet flow of about 9 cfs (18 acre-feet/day). The winter operation period would normally extend from November through April. The proposed gate settings are intended to limit the intake flow, and flow within the system.

<u>Winter Pond Water Levels</u>

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A1	277	-1.8	-0.6	1.8
A2W	429	-2.4	-0.6	NA

<u>Winter Gate Settings</u>

Gate	Setting (% open)	Setting (in, gate open)
A1 intakes	30	12
A2W	100	48
Weir	-1.2 ft NGVD	6 boards

Water Level Control

The water level in A2W is the primary control for the pond system. The system flow is limited by the both the intake and outlet capacities. Normal winter operation would have the intake gate partially open to reduce inflow during extreme storm tides. Water levels in the ponds are controlled by the outlet weir setting. The normal winter water level in A2W should be at -0.6 ft NGVD, approximately 0.6 ft above the outlet weir. The pond water level may vary by 0.2 ft due to the influence of weak and strong tides, and over 0.5 ft due to storms

During winter operations, the water levels should not fall below the outlet weir elevation. If the elevation does decrease in April, it may be necessary to begin summer operation in April instead of May.

During winter operations, if the water levels exceed approximately 1.2 ft NGVD, the A1 intake should be closed to allow the excess water to drain. Note that without rainfall or inflow, it will take approximately 3 weeks to drain 1.0 ft from the ponds.

Salinity Control

The winter salinity in the system may decrease from the intake at A1 to the outlet at A2W, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease to as low as 11 ppt.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings. The monitoring parameters are listed below.

Weekly Monitoring Program

Location	Parameter
A1 intakes	Salinity
A1	Depth, Salinity, Observations
A2W	Depth, Salinity, Observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

.

Additional monitoring required by the RWQCB discharge permit includes the following:

Location	**Frequency**	**Parameters**
A2W(discharge)	Continuous (May-Oct)	DO, pH, Temp., Salinity

Appendix D
Water Management Operation Plan
Pond System A3W

Pond System A3W Water Management Operation Plan – Alviso System 2006

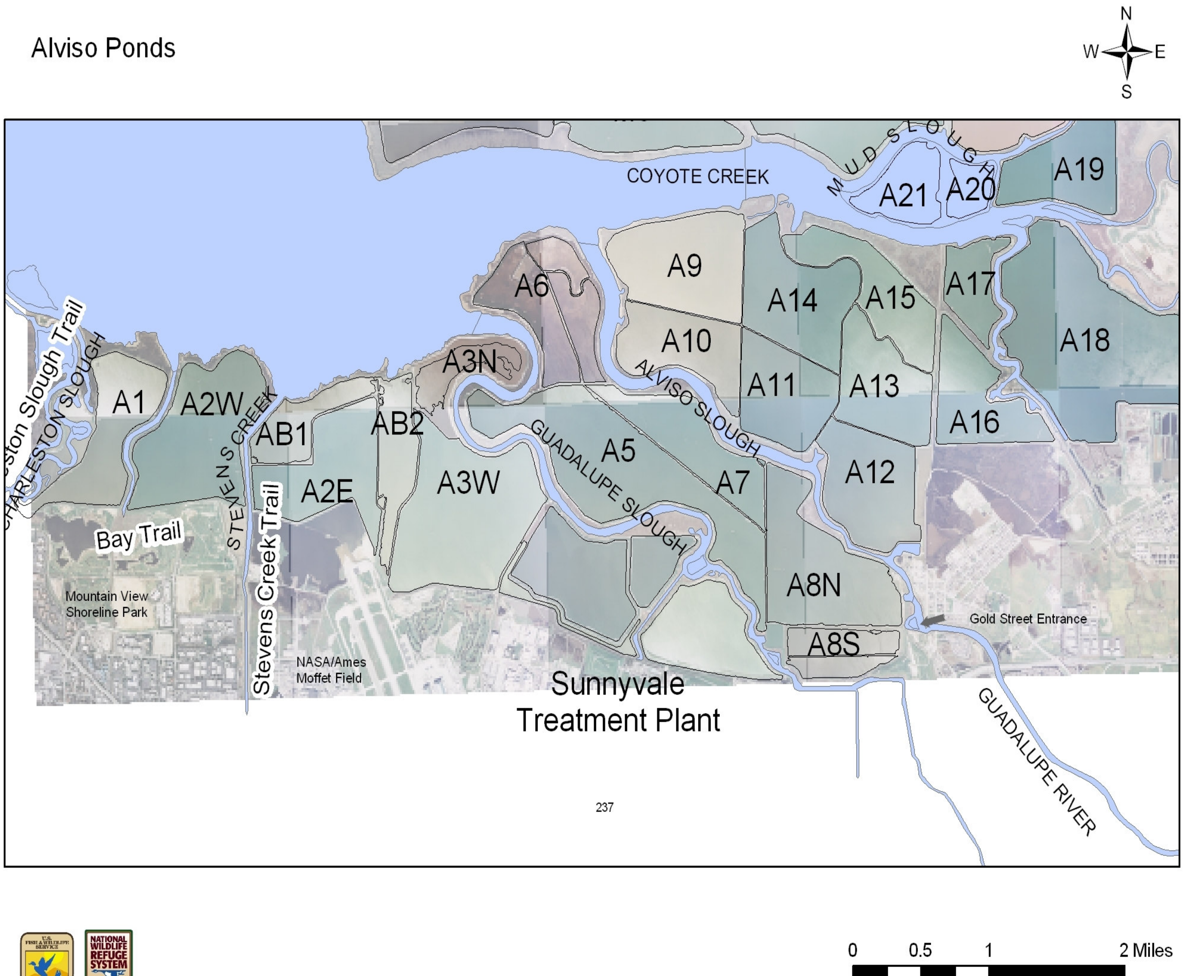
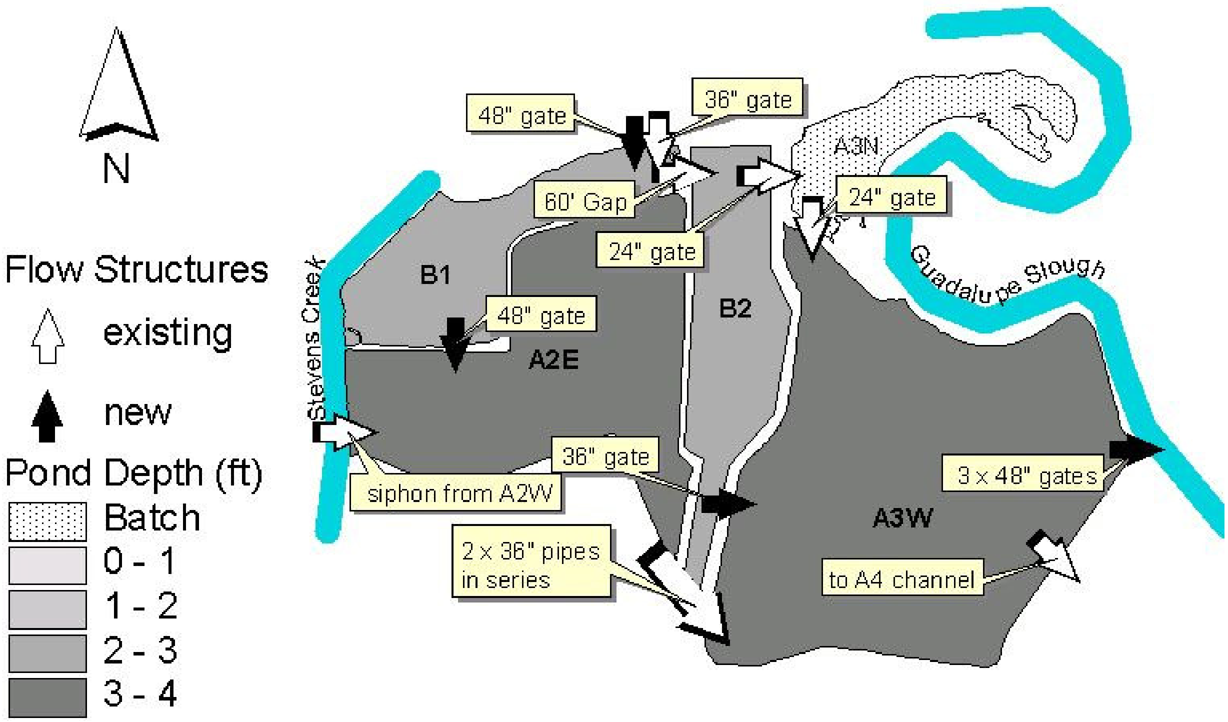


Table of Contents



Objectives

Maintain full tidal circulation through ponds B1, B2, A2E, and A3W while maintaining discharge salinities to Guadalupe Slough at less than 40 ppt and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen, temperature, avian botulism, and potential for inorganic mobilization.

Maintain pond A3N as a seasonal pond. If results of wildlife population monitoring indicate the need, operate pond A3N as a batch pond (i.e., at higher salinities).

Maintain water surface levels lower in winter to reduce potential overtopping of A3W levee adjacent to Moffett Field.

Structures

The A3W system includes the following structures needed for water circulation in the ponds:

- Existing 36" gate intake structure from the Bay at B1
- New 48" gate intake from the Bay at B1
- New 48" gate between B1 and A2E
- Existing 2x36" pipes in series between A2E and A3W (no gates).
- New 36" gate between B2 and A3W

- Existing gap between B1 and B2
- Existing 24" gate between B2 and A3N
- Existing 24" gate between A3N and A3W
- New 3x48" gate outlet at A3W to Guadalupe Slough. Two are outlet only, and one allows both inflow and outflow, no weir.
- Existing staff gauges at all ponds and new NGVD gauges at all ponds
- Existing siphon from A2W is closed, but available if needed

System Description

The intake for the A3W system is located at the northeast end of pond B1 and includes one 48" gate and one 36" gate from the bay. The system outlet is located at the eastern end of pond A3W, with three 48" gates into Guadalupe Slough. The normal flow through the system follows two parallel routes. One route is from B1 to A2E and then to A3W. The second route is from B1 to B2 and then to A3W. Flow through the two routes is controlled by gates from B1 to A2E, and from B2 to A3W. There is an uncontrolled gap between ponds B1 and B2. Due to the size of pond A2E, the majority of the flow should be through A2E, with only minimal circulation flow through B2. Because of the flap gates and the relative elevation of the tides and pond levels, all gravity intake flow would occur at high tide, and all outflows would occur when the tide is below 3.1 ft. MLLW.

Pond A3N is a seasonal pond. Therefore, for the ISP period, the pond will be drained, and left to partially fill with rain water during the winter and to evaporate completely during the summer. However, if wildlife population monitoring during this period indicates the need for additional higher salinity habitats or if mercury monitoring indicates an increase in methylation due to reduction in water levels, Pond A3N could be operated as a batch pond.

Summer Operation

The summer operation is intended to provide circulation flow to makeup for evaporation during the summer season. The average total circulation inflow is approximately 35 cfs, or 70 acre-feet/day. The summer operation would normally extend from May through October.

Summer Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
B1	142	-0.8	0.4	1.3
B2	170	-0.6	0.4	1.3
A2E	310	-3.1	-0.5	3.0
A3W	560	-3.2	-1.4	2.1
A3N	163	-1.4	NA	NA

Summer Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
B1 west intake	100	36
B1 east intake	90	39
B1 – A2E	38	14
A2E – A3W	NA	NA
B2 – A3W	41	12
A3W outlets	100	48
A3W intake	0	0
B2 – A3N	0	0
A3N – A3W	0	0

Water Level Control

The water level in A3W is the primary control for the pond system. The system flow is limited by the outlet capacity. Normal operation would have the outlet gates fully open. Water levels are controlled by the intake gate settings. The normal water level in A3W should be at -1.4 ft NGVD (2.1 ft gage). The level may vary by 0.2 due to the influence of weak and strong tides.

The flow through B2 to A3W is only required to maintain circulation through B2. This circulation prevents local stagnant areas which may create areas of higher salinity or algal blooms. The gate can be set to a standard opening and would not require frequent adjustment.

The flow through A2E is controlled by the gates from B1 to A2E. The partial gate opening is to maintain the water level differences between A2E and B1. Again, the setting should not require frequent adjustment. There are no gates on the culverts between A2E and A3W, therefore the water levels in those two ponds should be similar.

The B1 intake gates should be adjusted to control the overall flow though the system. The water levels in B1 (and therefore B2) will change due to the change in inflow. The maximum water level should be less than 1.6 ft NGVD (2.5 ft gage). This is to maintain freeboard on the internal levees and limit wind wave erosion.

Design Water Level Ranges

Pond	Design Water Level Elev. (ft, NGVD)	Maximum Water Elev. (ft, NGVD)	Maximum Water Level (ft, Staff Gage)	Minimum Water Elev. (ft, NGVD)	Minimum Water Level (ft, Staff Gage)
B1	0.4	1.6	2.5	-0.2	0.7
B2	0.4	1.6	2.5	-0.2	0.7
A2E	-0.5	-0.2	3.3	-2.0	1.5
A3W	-1.4	-0.2	3.3	-2.0	1.5
A3N	NA	NA	2.6	NA	NA

The minimum and maximum water levels are based on our observations in the ponds for the period 2005.

100 Percent Coverage Water Level

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
B1	0.4	-0.8	0.1
B2	0.4	-0.8	0.1
A2E	-0.5	-2.2	1.3
A3W	-1.4	-2.7	0.8
A3N	NA	NA	NA

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems.

Salinity Control

The summer salinity in the system will increase from the intake at B1 to the outlet at A3W, due to evaporation within the system. The design maximum salinity for the discharge at A3W is 40 ppt. The intake flow at B1 should be increased when the salinity in A3W is close to 35 ppt. Increased flow will increase the water level in A3W. Water levels in pond A3W above elevation -0.2 ft NGVD (3.3 ft gauge) should be avoided as they may increase wave erosion of the levees.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A3W fall below a 10th percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will accelerate receiving water monitoring to weekly, conduct within-pond monitoring and notify and consult with the Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the B1 inlet further. If increased flows are not possible, open A3W gate to allow the pond to become fully muted tidal or partially muted tidal system until pond DO levels revert to levels at or above conditions in the slough.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.

.

The pH of the discharge is related to the DO of the discharge. If the pH of the discharge falls outside the range of 6.5 – 8.5, an analysis of the impact of discharging pH on the receiving waters will be performed. If it is determined that discharge is impacting receiving water pH outside the range of 6.5 – 8.5, ammonia monitoring in the receiving water will be done to document potential toxicity affects associated with unionized ammonia.

To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.
2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.
3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks).

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on Dissolved Oxygen and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early

September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

The winter operation is intended to provide less circulation flow than the summer operation. Evaporation is normally minimal during the winter. The winter operation is intended to limit large inflows during storm tide periods and to allow rain water to drain from the system.

The average total circulation inflow is approximately 16 cfs, or 32 acre-feet/day, with an average outflow of approximately 18 cfs (36 acre-feet per day). The winter operation period would normally extend from November through April. The proposed gate settings are intended to limit the intake flow, and flow within the system.

Winter Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
B1	142	-0.8	0.9	1.8
B2	170	-0.6	0.9	1.8
A2E	310	-3.1	-1.8	1.7
A3W	560	-3.2	-1.8	1.7
A3N	163	-1.4	NA	NA

Winter Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
B1 west intake	34	10
B1 east intake	25	10
B1 – A2E	16	6
A2E – A3W	NA	NA
B2 – A3W	21	6
A3W outlets	100	48
A3W intake	0	0
B2 – A3N	0	0
A3N – A3W	0	0

Water Level Control

The water level in A3W is the primary control for the pond system. The system flow is limited by the outlet capacity. Normal winter operation would have the A3W outlet gates fully open. Water levels are controlled by the intake gate settings. The normal water level in A3W should be near -1.8 ft NGVD (1.7 ft gage). The level may vary by 0.2 due to the influence of weak and strong tides, storm tides, and rainfall inflows.

The water levels in A3W are important to prevent levee overtopping. The south levee separates the pond from the Moffit Field drainage ditch. The levee is low, and subject to erosion with high water levels. If the water level in A3W exceeds -0.6 ft NGVD (2.9 ft gage), the intake gate openings at B1 should be reduced or closed. The internal gates from B1 and B2 would also require adjustment. If the water level in A3W exceeds -0.2 ft NGVD (3.3 ft gauge), the intake gates and all internal gates should be closed until the water level in A3W is back to normal. This may take one to two weeks depending on the weather. The water levels in the upper ponds (B1, B2, and A2E) may increase due to rainfall during this period, but are less sensitive to higher water levels. The historic high elevation in pond A3W has been -0.2 ft NGVD (3.3 ft gauge).

Whenever possible, the system intake at B1 should be closed in anticipation of heavy winter rains and high tides. When the system intake gates are closed, the internal gates from B1 to A2E and from B2 to A3W should also be closed to keep water in the upper ponds (B1 and B2).

There is no gate between A2E and A3W. During winter operations with reduced flows through the system, the A2E water level will be similar to the A3W water level. During the summer, the higher flows will establish approximately 0.9 ft difference due to the head loss through the two pipes in series which connect the ponds.

Salinity Control

The winter salinity in the system may decrease from the intake at B1 to the outlet at A3W, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease to as low as 10 ppt.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings, as well as to inspect water control structures, siphons and levees. The monitoring parameters are listed below.

Weekly Monitoring Program

Location	Parameter
B1 intakes	Salinity
B1	Depth, Salinity, Observations
B2	Depth, Salinity, Observations
A2E	Depth, Salinity, Observations
A3W	Depth, Salinity, Observations
A3N	Depth, Salinity, Observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

Location	**Frequency**	**Parameters**
A3W(discharge)	Continuous (May-Oct)	DO, pH, Temp., Salinity
Guadalupe.Sl.	Monthly (May –Oct)	DO, pH, Temp., Salinity

APPENDIX E
WATER MANAGEMENT OPERATION PLAN
POND SYSTEM A7

Pond System A7 Water Management Operation Plan – Alviso System 2006

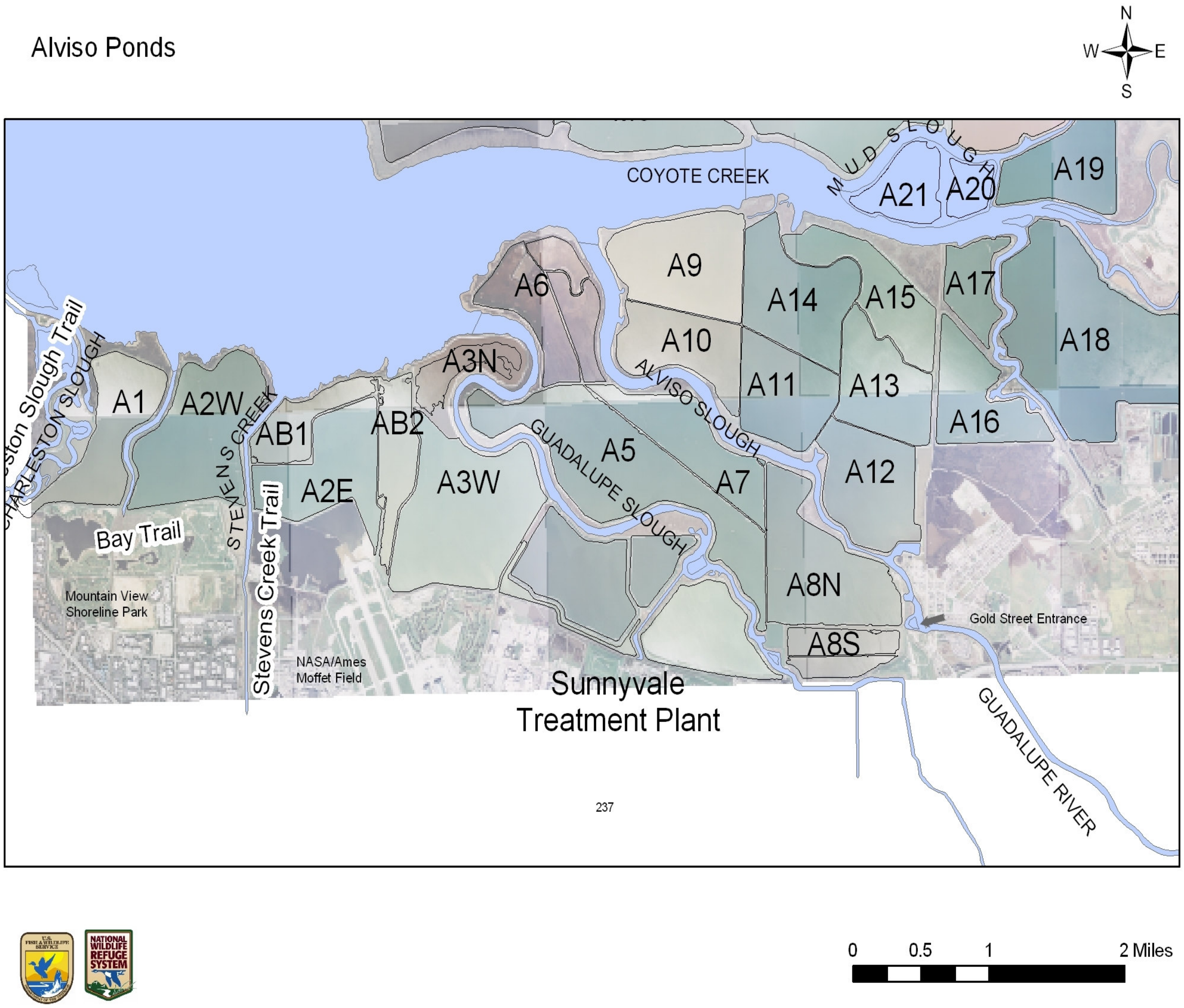
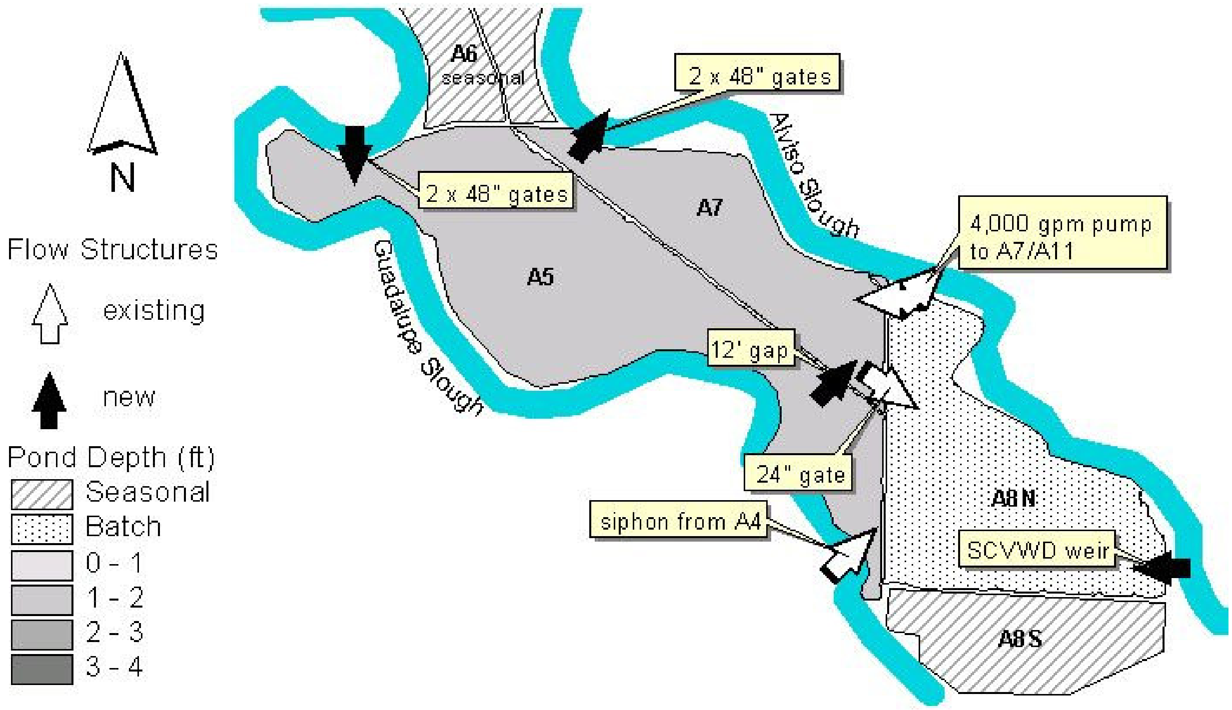


Table of Contents



Objectives

Maintain full tidal circulation through ponds A5 and A7 while maintaining discharge salinities to the Bay at less than 40 ppt. and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen, temperature, avian botulism, and potential for inorganic mobilization.

Maintain pond A8 as a seasonal pond. If results of wildlife population monitoring indicate the need, operate pond A8 as a batch pond.

Maintain option to reverse flows if needed.

Structures

The A7 system includes the following structures needed for water circulation in the ponds:

- New 2x48" gate intake at A5 from Guadalupe Slough.
- New cut at the internal levee between A5 and A7.
- Existing 24" control gate from A7 to A8.
- Existing 4,000 gpm pump from A8 to A11. Outlet piping modified to allow discharge to A7 in addition to A11.
- New 2x48" gate outlet with two 24' weir boxes at A7 into Alviso Slough.
- Existing staff gages in both ponds; New NGVD gages at both new structures
- Existing siphon from A4 should generally be closed.

System Description

The intake for the A7 system is located at the northwest end of pond A5 and includes two 48-inch gates from lower Guadalupe Slough. The system outlet is located at the northeast end of pond A7, with two 48-inch gates to Alviso Slough. In normal operations, the flow through the system starts at the intake at A5 though a cut at the southern end of the levee between A5 and A7, and flows out to Alviso Slough through two 48-inch outlet gates. Both sections of Pond A8 (A8N and A8S) will be operated as seasonal ponds filling with winter rains and generally drying during the summer, though some makeup water can be added A8N through a 24-inch gate from pond A7. If necessary in the future, following bird monitoring studies, A8N may be operated as a batch pond with higher salinities. Because of the flap gates and the relative elevation of the tides and pond levels, all gravity intake flow would occur at high tide, and all outflows would occur when the tide is below 4.8 ft. MLLW.

The Santa Clara Valley Water District has built a weir at Pond A8 to allow flood overflow waters from Alviso Slough to enter the pond during 10-year storm events, or greater. Some flood waters may overtop the levees and enter Ponds A5 and A7 as well. When the ponds fill with floodwaters, the District is responsible for pumping the pond waters back to Alviso Slough or Guadalupe Slough and monitoring for increased mercury levels in sediments/pond waters.

The A7 system can be reversed by changing the control gate settings to intake water from Alviso Slough and release water to Guadalupe Slough. However, the reversed flow circulation does not have an outlet weir at the A5 structure. Therefore, the A5 gates must be set to maintain minimum water levels in the ponds. The reverse flow condition may conflict with the seasonal intake limitations from Alviso Slough for salmonid protection. The A7 structure should not be used as an intake during the winter (December to April) to avoid entrainment of migrating juvenile salmonids. The only reason to use the reversed flow circulation is to avoid potential poor water quality conditions in Guadalupe Slough, if necessary.

The A7 system would require very limited management, unless Pond A8 is operated as a batch pond. Note that for a period of time, the SCVWD may request to continue pumping waters from Pond A4 into Pond A5. At that time, they will provide data analyses and operations plans to assure that A7 discharges will remain below our RWQCB permit limits.

Summer Operation

The summer operation is intended to provide circulation flow to makeup for evaporation during the summer season. The average total circulation inflow is approximately 22 cfs, or 44 acre-feet/day, with an outlet flow of about 16 cfs (32 acre-feet/day). The summer operation would normally extend from May through October.

Summer Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A5	615	-0.6	0.4	1.9
A7	256	-0.5	0.4	1.8
A8N	406	-3.4	NA	NA

Summer Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A5 intakes	30	12
A7 outlet	100	48
A7/A8	0	0
Weir	0.0 ft NGVD	6 boards

Water Level Control

The bottom elevations in both Ponds A5 and A7 are similar and inlet/outlet capacities are the same. Due to the levee cut to connect the ponds, the water levels are similar in both ponds. Flows will occur in either direction based on inlet and outlet gate settings

The A5 intake gate should be adjusted to control the overall flow though the system. The maximum water level in either A5 or A7 should be less than 0.6 ft NGVD (2.1 ft gage). This is to maintain freeboard on the internal levees and limit wind wave erosion. The maximum water level is also intended to preserve the existing islands within the ponds used by nesting birds.

If a significant volume of water is to be diverted into Pond A8, the A5 inlet structure may need to be open further to bring in additional water. Diversions to A8 are controlled by the A7 to A8 gate. One foot of water in A8 (400 acre-feet) represents approximately 0.5 ft in A5/A7, or the net inflow to the system over approximately 10 days.

Design Water Level Ranges

Pond	Design Water Level Elev. (ft, NGVD)	Maximum Water Elev. (ft, NGVD)	Maximum Water Level (ft, Staff Gage)	Minimum Water Elev. (ft, NGVD)	Minimum Water Level (ft, Staff Gage)
A5	0.4	0.6	2.1	-0.3	1.2
A7	0.4	0.6	2.0	-0.3	1.1
A8N	NA	-1.0	0.5	-2.5	-1.0

The minimum and maximum water levels are based on our observations in the ponds for the period 2004.

100 Percent Coverage Water Level

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
A5	0.4	0.2	1.4
A7	0.4	0.2	1.4
A8N	NA	-2.5	-1.0

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems.

Salinity Control

The summer salinity in the system will increase from the intake at A5 to the outlet at A7 due to evaporation within the system. The design maximum salinity for the discharge at A7W is 40 ppt. The intake flow at A5 should be increased if the salinity in A7 is close to 35 ppt. Increased flow may increase the water level in A7. Water levels above elevation 0.6 ft NGVD (2.1 ft gage) should be avoided as they may increase wave erosion of the levees.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A7 fall below a 10th percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will accelerate receiving water monitoring to weekly, conduct within-pond monitoring and notify and consult with the Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the A5 inlet further. If increased flows are not possible, open both the A5 and A7 gates to allow the ponds to become fully muted tidal or partially muted tidal systems until pond DO levels revert to levels at or above conditions in the Creek.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.

7. Install solar aeration circulators.

The pH of the discharge is related to the DO of the discharge. If the pH of the discharge falls outside the range of 6.5 – 8.5, an analysis of the impact of discharging pH on the receiving waters will be performed. If it is determined that discharge is impacting receiving water pH outside the range of 6.5 – 8.5, ammonia monitoring in the receiving water will be done to document potential toxicity affects associated with unionized ammonia.

To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.
2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.
3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on Dissolved Oxygen and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

The winter operation is intended to provide circulation flow and to allow rain water to drain from the system. The proposed winter operation would be the same as the summer operation.
The average total circulation inflow is approximately 22 cfs, or 44 acre-feet/day, with an outlet flow of about 23 cfs (46 acre-feet/day). The winter operation period would normally extend from November through April. The proposed gate settings are intended to limit the intake flow, and flow within the system.

Winter Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A5	615	-0.6	0.4	1.8
A7	256	-0.5	0.4	1.8
A8N	406	-3.4	NA	NA

Winter Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A5 intakes	30	12
A7 outlet	100	48
A7/A8	0	0
Weir	0.0 NGVD	6 boards

Water Level Control

Consideration may be made to reduce water levels in the ponds prior to winter storm events and high tides by closing or reducing the gate opening at the A5 inlet structure. Approximately three weeks would be needed to reduce pond levels by 0.5 feet. Water levels above elevation 0.6 ft NGVD (2.1 ft gage) should be avoided as they may increase wave erosion of the levees.

Salinity Control

The winter salinity in the system may decrease from the intake at A5 to the outlet at A7, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease below 10 ppt.
If the SCVWD weir has a significant flood spill into pond A8N, the flood water may overflow into A5 and A7. The intake gates and outlet gates can be opened to the maximum after the flood event to aid in lowering the water level in the system. The volume in A8 below the elevation of the cross levee will not drain by gravity, and will need to be pumped from the ponds by the SCVWD.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings. The monitoring parameters are listed below.

Weekly Monitoring Program

Location	Parameter
A5 intake	Salinity
A5	Depth, Salinity, Observations
A7	Depth, Salinity, Observations
A8	Depth, salinity, observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

Location	**Frequency**	**Parameters**
A7(discharge)	Continuous (May-Oct)	DO, pH, Temp., Salinity
Alviso Slough	Monthly (May –Oct)	DO, pH, Temp., Salinity

Appendix F
Water Management Operation Plan
Pond System A14

Pond System A14 Water Management Operation Plan – Alviso System 2006

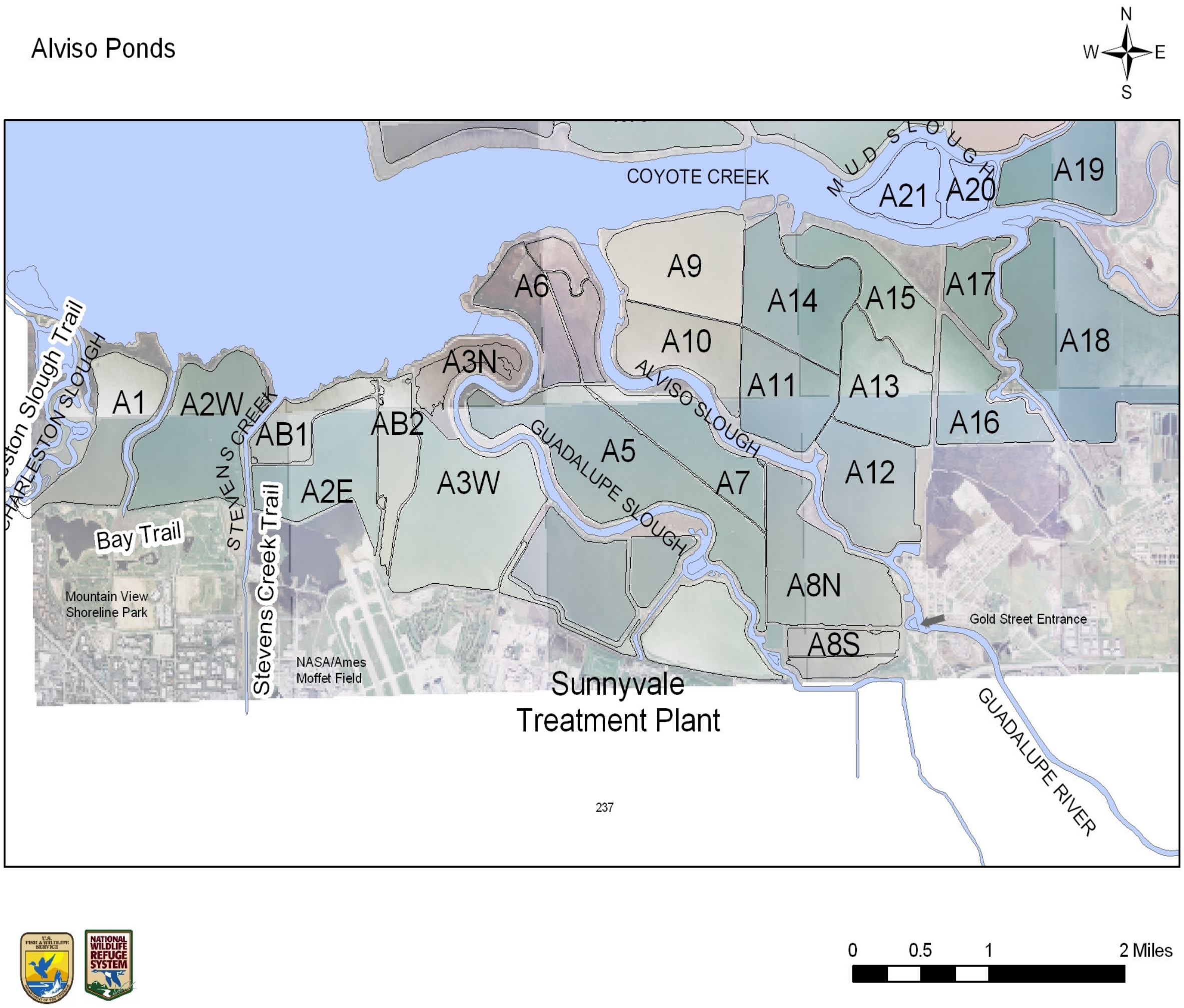
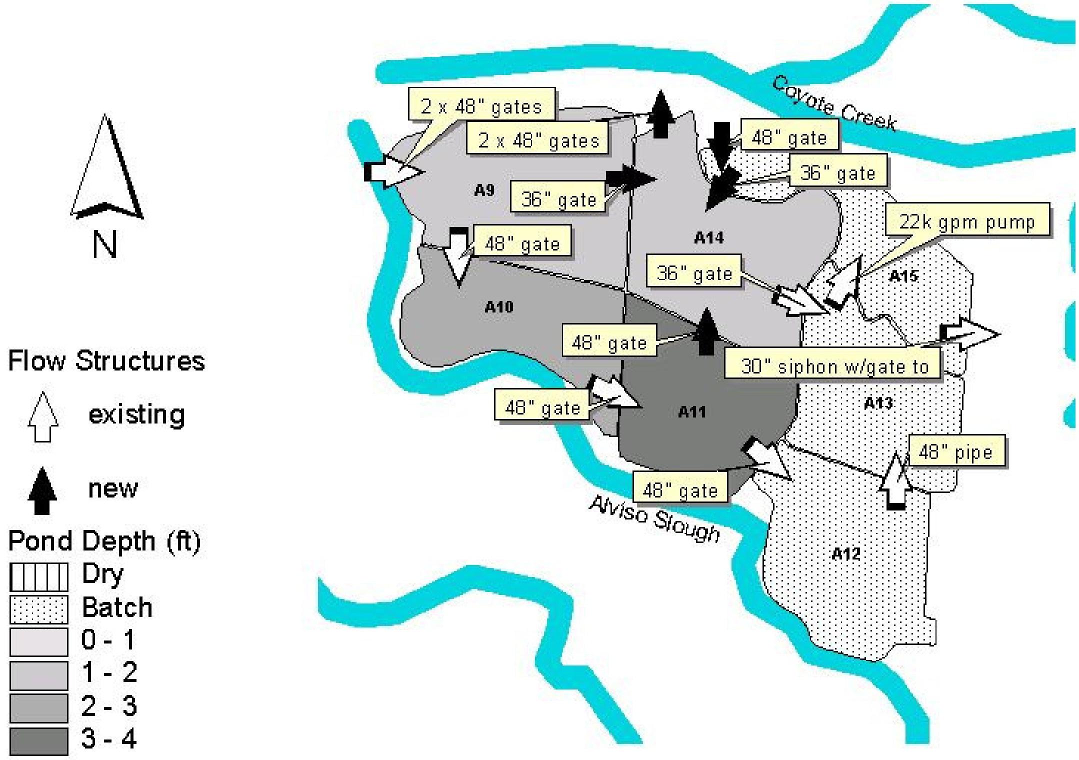


Table of Contents



Objectives

Maintain full tidal circulation through pondsA9, A10, A11 and A14, while maintaining discharge salinities to Coyote Creek at less than 40 ppt. and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen, temperature, avian botulism, and potential for inorganic mobilization.

Maintain pond A12, A13 and A15 as batch ponds. Operate batch ponds at a higher salinity (80 – 120 ppt) during summer to favor brine shrimp.

Minimize entrainment of salmonids by limiting inflows during winter.

Maintain water surface levels lower in winter to reduce potential overtopping.

Structures

The A14 system includes the following structures needed for water circulation in the ponds:

- Existing 2 x 48” gate intake at A9 from Alviso Slough
- Existing 48” gate between A9 and A10
- New 48” gate between A9 and A14
- Existing 48” gate between A10 and A11
- New 48” gate between A11 and A14
- Existing 48” gate between A11 and A12
- Existing 48” gate between A12 and A13
- Existing 36” gate between A14 and A13
- Existing siphon from A15 to A16
- Existing 36” gate between A15 and A14
- Existing 22,000 gpm pump from A13 to A15
- New 48” gate intake at A15 from Coyote Creek
- New 2 x 48” gate outlet at A14 into Coyote Creek
- Existing staff gages at all ponds and new NGVD gages at all pond

System Description

The intake for the A14 system is located at the northwest end of pond A9 and includes two 48” gates from Alviso slough near the Bay. The system outlet is located at the northerly end of A14, with two 48” gates into Coyote Creek. The normal flow through the system proceeds from the intake at A9, then flow through A10 and A11 to the outlet at A14. Because of the flap gates and the relative elevation of the tides and pond levels, all gravity intake flow would occur at high tide, and all outflows would occur when the tide is below 6.2 ft. MLLW.

Ponds A12, A13, and A15 will be operated as batch ponds to control the individual pond volumes and salinities.

Operations of the A14 system should require little active management of gate openings to maintain appropriate circulation flows. Summer and winter operations are described below to indicate predicted operating levels during the dry and wet seasons.

Summer Operation

The summer operation is intended to provide circulation flow to makeup for evaporation during the summer season. The average total circulation inflow is approximately 38 cfs, or 17,000 gpm. The summer operation would normally extend from May through October.

Summer Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A9	385	-0.2	2.0	3.3
A10	249	-0.8	1.8	3.0
A11	263	-1.8	1.3	2.5
A14	341	-0.0	0.9	2.3
A12	309	-2.0	1.2	2.5
A13	269	-1.1	1.1	2.6
A15	249	0.7	2.8	4.1

Summer Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A9 north intake	100	48
A9 south intake	100	48
A9 – A10	100	48
A10 – A11	100	48
A11 – A14	100	48
A14 west outlet	100	48
A14 east outlet	100	48
A9 – A14	0	0
A11 – A12	0	0
A12 – A13	0	0
A13 – A15	0	0
A14 – A13	0	0
A15 – A14	0	0
A15 intake	0	0
A14 weir	0.0 ft NGVD	

Water Level Control

The water level in A14 is the primary control for the pond system. The system flow is limited by the inlet capacity at A9. Normal operation would have the outlet gates fully open. Water levels are controlled by the weir elevation at A14. The A14 weir should be at approximately 0.0 ft NGVD to maintain the summer water level in A14 at 0.9 ft NGVD (2.3ft gage). The level may vary by 0.2 due to the influence of weak and strong tides.

The route of flow through this system will be from A9 to A10 to A11 to A14. The partial gate opening is to maintain the water level differences between the ponds. Again, the setting should not require frequent adjustment.

The A9 intake gates should be adjusted to control the overall flow though the system. The water levels in A9 will change due to the change in inflow. The maximum water level should be less than 2.5 ft NGVD (3.8 ft gage). This is to maintain freeboard on the internal levees and limit wind wave erosion.

<u>100 Percent Coverage Water Level</u>

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
A9	2.0	1.6	3.0
A10	1.8	-0.2	1.0
A11	1.3	-0.2	1.0
A14	0.9	0.8	2.2
A12	NA	-0.3	1.0
A13	NA	-0.3	1.2
A15	NA	0.7	2.0

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems. The 100 percent coverage water levels are intended for information purposes only. Operating the ponds at or near minimum depths will interfere with circulation through the ponds and may cause significant increases in pond salinity during the summer evaporation season.

Pond A14 has an estimated average bottom elevation at 0.0 ft NGVD, but portions of the pond bottom are at 0.8 ft NGVD, very near the design water level. The proposed A14 water level may need to be adjusted to maintain circulation through the pond.

Salinity Control

The summer salinity in the system will increase from the intake at A9 to the outlet at A14, due to evaporation within the system. The design maximum salinity for the discharge at A14 is 40 ppt. The intake flow at A9 should be increased when the salinity in A14 is close to 35 ppt. Increased flow may increase the water level in A14. The inflow at A9 is constrained by the tide level in Alviso Slough since the intake gates would be fully open. The inflow can be increased by partially opening the gate from A9 to A14 to lower the water level in A9 and increase the gravity inflow. This would increase the flow through A9 and A14, but reduce the flow through A10 and A11. Water levels in pond A14 above elevation 2.0 ft NGVD (3.4 ft gage) should be avoided as they may increase wave erosion of the levees.

Batch Ponds A12, A13, and A15 summer salinity levels should be between 80 and 120 ppt, to provide habitat for brine shrimp and wildlife which feeds on brine shrimp. Salinity control for the batch ponds will require both inflows to replace evaporation losses, and outflows to reduce the salt mass in the ponds and create space for lower salinity inflows. Ponds A12 and A13 would operate as a single unit, with inflow from pond A11 and outflows to either A14 or A15. The water levels in A12 and A13 would generally be between the elevations in A11 (higher than A12) and A14 (lower than A13). Therefore inflows from A11 and outflows to A14 would be by gravity. Outflows from A13 can also be pumped to A15. Water can also be pumped from A13 to A14 if the water levels are low in A13. Pond A15 would operate as a separate batch pond at a higher elevation than A13 or A14. Inflows to A15 would be pumped from A13, or by gravity from Coyote Creek with the supplemental intake at A15. Outflows from A15 would be by gravity to either A14 or A16.

The batch pond operation will require the outflow of approximately 0.5 to 0.7 ft of water from the batch ponds each month. This represents approximately 25 percent of the pond volumes. Because the A14 and A17 system have no circulation inflows from Coyote Creek for dilution from December through April, the outflow would normally occur during the evaporation season. The preferred operation would be to maintain the pond salinities near 100 ppt as much as possible, with consistent small outflows during the month from A13 to A14 and from A15 to A16. These gates should only be open approximately 10 percent, depending on the pond water levels. The inflows would be on a batch basis to add approximately 0.5 ft to the batch ponds about every other week.

If the salinity levels are high in A14 or A16, it may be necessary to reduce or suspend outflows from the batch ponds and allow the batch pond salinity to increase until later in the season. The salinity in a batch pond will increase by approximately 10 ppt per month during the peak evaporation months. If the batch pond salinities are high at the end of the circulation season, it may be necessary to continue to operate the A16 system with reverse flow during the winter continue to dilute the batch pond outflows until a reasonable salinity level is reached to start the next evaporation season.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A14 fall below a 10^{th} percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will accelerate receiving water monitoring to weekly, conduct within-pond monitoring and notify and consult with the Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the A9 inlet further. If increased flows are not possible, open A14 gates to allow the ponds to become fully muted tidal or partially muted tidal systems until pond DO levels revert to levels at or above conditions in the Creek.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.

7. Install solar aeration circulators.

The pH of the discharge is related to the DO of the discharge. If the pH of the discharge falls outside the range of 6.5 – 8.5, an analysis of the impact of discharging pH on the receiving waters will be performed. If it is determined that discharge is impacting receiving water pH outside the range of 6.5 – 8.5, ammonia monitoring in the receiving water will be done to document potential toxicity affects associated with unionized ammonia.

To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.
2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.
3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks).

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on Dissolved Oxygen and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

During the winter season, the A9 intake will be closed to prevent entrainment of migrating salmonids. The winter operation period would normally extend from December through May 31. During the winter, rainfall would tend to increase the water levels in the ponds. The water levels in the ponds would be set by a weir at the outfall or adjustment of the control gates to avoid flooding of the existing internal levees or wave damage to the levees. The gates from A9, A10, and A11 will be partially open to allow rainfall to drain to A14. Excess water from rainfall would be drained from the system after larger storms and will require additional active management to adjust the interior control gates.

Winter Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A9 north intake	0	0
A9 south intake	0	0
A9 – A10	100	48
A10 – A11	100	48
A11 – A14	100	48
A14 west outlet	0	0
A14 east outlet	100	48
A9 – A14	0	0
A11 – A12	0	0
A12 – A13	0	0
A13 – A15	0	0
A14 – A13	0	0
A15 – A14	0	0
A15 intake	0	0

Winter Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A9	385	-0.2	1.5	2.8
A10	249	-0.8	1.5	2.7
A11	263	-1.8	1.4	2.6
A14	341	-0.0	1.3	2.7
A12	309	-2.0	1.4	2.7
A13	269	-1.1	1.2	2.7
A15	249	0.7	2.8	4.1

Salinity Control

The winter salinity in the system may decrease from the intake at A9 to the outlet at A14, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease to as low as 11 ppt.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings, as well as to inspect water control structures, siphons and levees. The monitoring parameters are listed below.

Weekly Monitoring Program

Location	Parameter
A9 intakes	Salinity
A10	Depth, Salinity, Observations
A11	Depth, Salinity, Observations
A14	Depth, Salinity, Observations
A12	Depth, Salinity, Observations
A13	Depth, Salinity, Observations
A15	Depth, Salinity, Observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

Location	Frequency	Parameters
A14(discharge)	Continuous (May-Oct)	DO, pH, Temp., Salinity
Coyote Creek	Monthly (May –Oct)	DO, pH, Temp., Salinity

APPENDIX G
WATER MANAGEMENT OPERATION PLAN
POND SYSTEM A16

Pond System A16 Water Management Operation Plan – Alviso System 2006

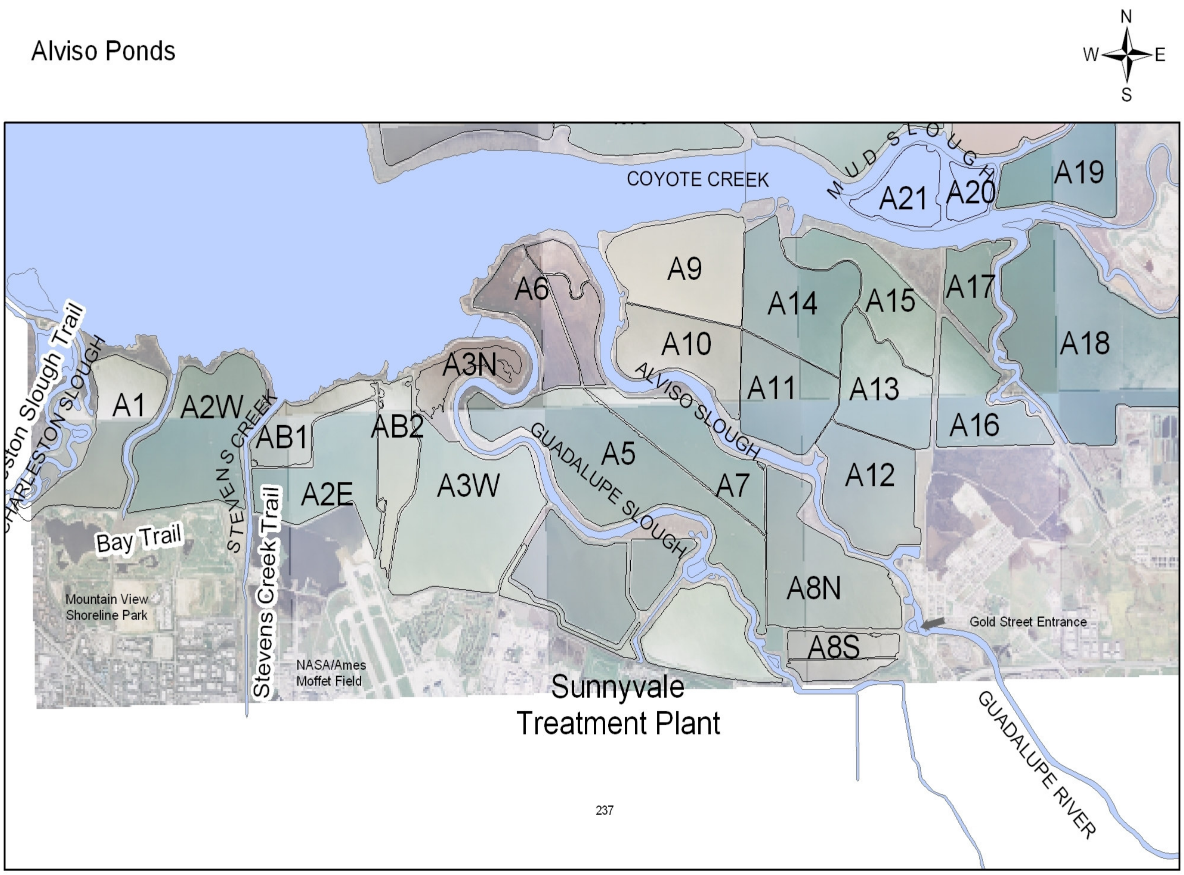
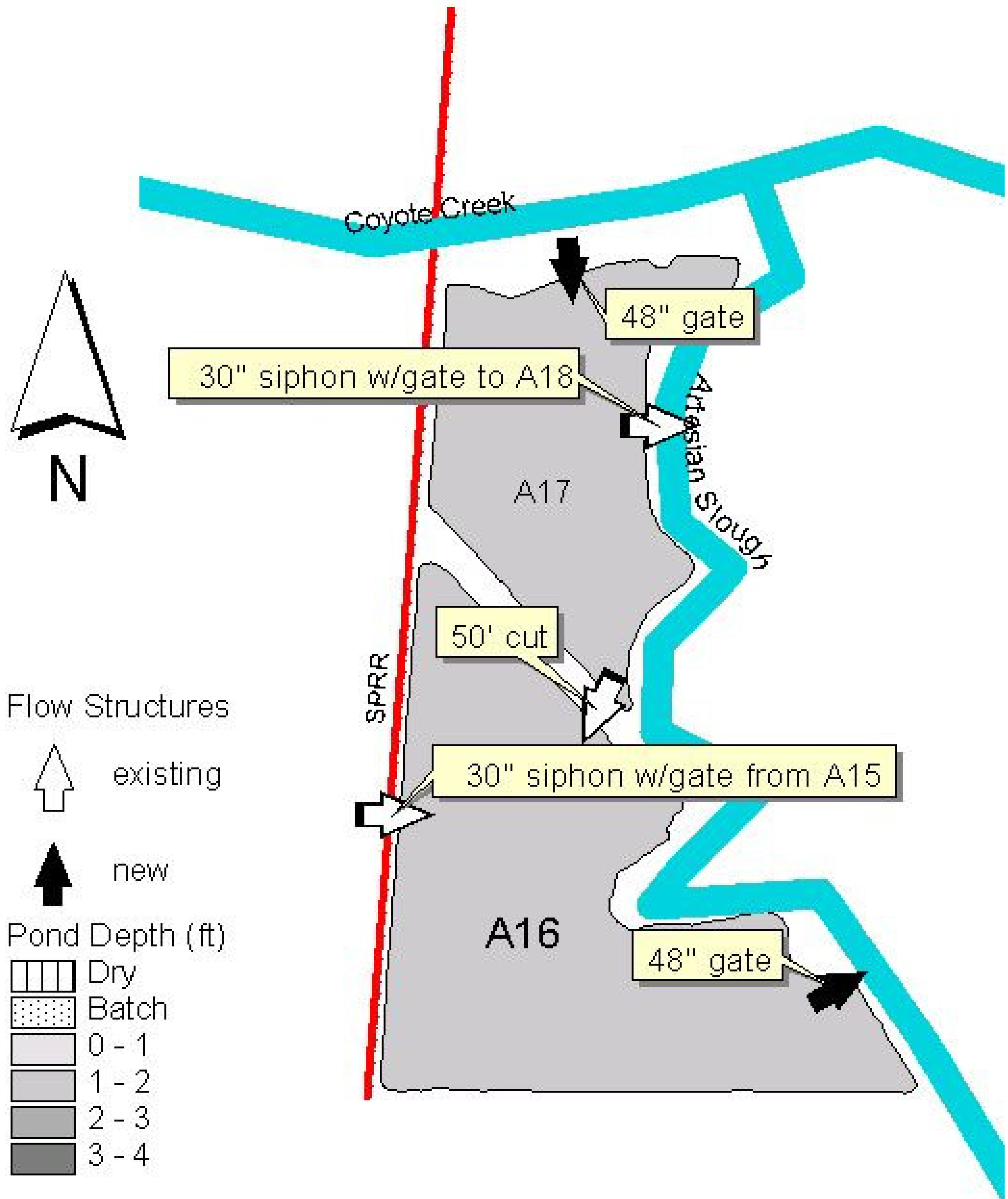


Table of Contents



Objectives

Maintain full tidal circulation through ponds A17 and A16 while maintaining discharge salinities to the Artesian Slough lower than 40 ppt. and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen, temperature, avian botulism, mercury methylation, and potential for inorganic mobilization.

Minimize entrainment of salmonids by:

Close A17 intake during winter, or

Reverse of intake and outlet flow during winter.

Structures

The A16 system includes the following structures needed for water circulation in the ponds:

- New 48" gate intake at A17 from Coyote Creek
- New 48" gate outlet structure at A16 into Artesian Slough
- Existing siphon between A15 (from system A14) to A16
- Existing gap between A17 and A16
- Existing siphon between A17 and A18
- Existing staff gauges (no datum) , plus new NGVD gauges to be installed

System Description

The intake for the A16 system is located at the northern end of pond A17 and includes one 48" gate from lower Coyote Creek. The system outlet is located at the southeast end of pond A16, with one 48" gate to the Artesian Slough. The flow through the system proceeds from the intake at A17 though a 50' cut in the levee between A17 and A16, then through the 48" gate at the outlet A16. An existing siphon from A15 to A16 will be used to release excess water from ponds A12, A13, and A15 on a batch basis. The existing siphon between A17 and A18 will not be used for system circulation, and may be sealed in the future. A18 will be owned and operated by the City of San Jose.

Operations of the A16 system should require limited active management of gate openings to maintain appropriate flows. Because of the flap gates and the relative elevation of the tides and pond levels, all gravity intake flow would occur at high tide, and all outflows would occur when the tide is below 7.2 ft. MLLW. Summer and winter operations are described below to indicate predicted operating levels during the dry and wet seasons.

Summer Operation

The summer operation is intended to provide circulation flow to makeup for evaporation during the summer season. The average total circulation inflow is approximately 15 cfs, or 6,800 gpm, with an outlet flow of about 12 cfs (5,400 gpm). The summer operation would normally extend from May through October.

<u>Summer Pond Water Levels</u>

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A17	131	1.1	2.3	1.3
A16	243	0.6	2.3	0.7

<u>Summer Gate Settings</u>

Gate	Setting (% open)	Setting (in, gate open)
A17 intake	100	48
A16 outlet	100	48
A16 weir	1.9 ft NGVD	

Water Level Control

The water level in A16 is the primary control for the pond system. The system flow is limited by the outlet capacity. Normal operation would have the outlet gates fully open, and the water level in A16 would be controlled by the elevation of the outlet weir at A16. The estimated weir elevation would be 1.9 ft NGVD to maintain the pond water level at 2.3 ft NGVD in summer. The level may vary by 0.2 feet during a month due to the influence of weak and strong tides.

The A17 intake gate can be adjusted to control the overall flow though the system. The maximum water level in either A17 or A16 should generally be less than 3.0 ft NGVD during the summer. This is to maintain freeboard on the internal levees and limit wind wave erosion. The maximum historic water level in A16 and A17 has been 3.8 ft NGVD during the winter.

<u>100 Percent Coverage Water Level</u>

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
A17	2.3	1.1	0.1
A16	2.3	1.6	0.1

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems. The 100 percent coverage water levels are intended for information purposes only. Operating the ponds at or near minimum depths will interfere with circulation through the ponds and may cause significant increases in pond salinity during the summer evaporation season.

Salinity Control

The summer salinity in the system will increase from the intake at A17 to the outlet at A16 due to evaporation within the system. The design maximum salinity for the discharge at A16 is 40 ppt. The discharge permit requires that the discharge salinity not exceed 44 ppt.

The system circulation flow should be increased when the salinity in A16 reaches approximately 35 ppt during the summer. There are two operational measures available to increase the circulation flow. First, the level of the outlet weir can be lowered to lower the pond water level and the gravity inflow to the system. The weir structure includes weir boards on three sides of the structure. In general, the overall weir elevation should not be lowered more than 0.5 ft, but it may be more practical to lower one side by 1.0 ft or less.

The second operational measure to increase the circulation flow would be to adjust the intake gate at the A16 outlet structure to allow inflow from Artesian Slough at high tide. With the A16 intake gate fully open, the overall circulation flow would be approximately double the flow with A17 alone. In addition, the salinity in Artesian Slough at high tide is lower than in Coyote Creek and would directly lower the salinity in A16. The weir level at A16 should be adjusted to increase the outflow from A16 to account for the increased inflow.

The A16 system is intended to be the discharge for flows from pond A15 in the A14 system. A15 is a batch pond with operating salinities in the range of 80 to 120 ppt. Water will be transferred from A15 to A16 to lower the water levels in A15 and provide capacity for lower salinity inflows control the batch pond salinity. The intention is to dilute the higher salinity water with the pond A16 circulation. The siphon from A15 should be approximately 10 to 25 percent open, and the 22,000 gpm pump from A13 to A15 should operate approximately two to 3 days per month. The pump can add approximately 0.4 ft of water to A15 in one day.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A16 fall below a 10th percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will accelerate receiving water monitoring to weekly, conduct within-pond monitoring and notify and consult with the Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the A17 inlet further. If increased flows are not possible, open both the A17 and A16 gates to allow the ponds to become fully

muted tidal or partially muted tidal systems until pond DO levels revert to levels at or above conditions in the Creek.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.

7. Install solar aeration circulators.

The pH of the discharge is related to the DO of the discharge. If the pH of the discharge falls outside the range of 6.5 – 8.5, an analysis of the impact of discharging pH on the receiving waters will be performed. If it is determined that discharge is impacting receiving water pH outside the range of 6.5 – 8.5, ammonia monitoring in the receiving water will be done to document potential toxicity affects associated with unionized ammonia.

To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.
2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.
3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks).

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on Dissolved Oxygen and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

During the winter season, the A17 intake will be closed to prevent entrainment of migrating salmonids in Coyote Creek. The winter operation period would normally extend from November through April. During the winter, rainfall would tend to increase the water levels in the ponds. The inflow and outflow direction of the system will be reversed, where intake at A16 from Artesian Slough during the winter to minimize potential entrapment of migrating salmonids in Coyote Creek. The outlet at A17 includes both a control gate and control weir. Either may be used to limit flow through the system. The water levels in the ponds would be set by a weir at the outfall of A17 or adjustment of the control gates to avoid flooding of the existing internal levees or wave damage to the levees. The winter operation is intended to provide less circulation flow than the summer operation. Evaporation is normally minimal during the winter.

Winter Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A17	131	1.1	2.2	1.2
A16	243	0.6	2.2	0.6

Winter Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A17 intake	0	0
A16	25	12
Weir	2.1 ft NGVD	

Water Level Control

The water level in A17 is the primary control for the pond system. The A17 water level is controlled by the outlet weir structure. Normal winter operation would have the A16 intake gate partially open to reduce inflow during extreme storm tides. Water levels in the ponds are controlled by the outlet weir setting. The normal winter water level in A17 should be at 2.2 ft NGVD, approximately 0.1 ft above the outlet weir. The pond water level may vary by 0.2 ft due to the influence of weak and strong tides, and over 0.5 ft due to storms.
During winter operations, the water levels should not fall below the outlet weir elevation.

During winter operations, if the water levels exceed approximately 3.0ft NGVD, the A16 gate should be closed to allow the excess water to drain. Note that without rainfall or inflow, it will take approximately 3 weeks to drain 1.0 ft from the ponds.

Salinity Control

The winter salinity in the system may decrease from the intake at A16 to the outlet at A17, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease to as low as 5 ppt.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings. The monitoring parameters are listed below.

Weekly Monitoring Program

Location	Parameter
A17 intake	Salinity
A17	Depth, Salinity, Observations
A16	Depth, Salinity, Observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

Location	**Frequency**	**Parameters**
A16(discharge)	Continuous (May-Oct)	DO, pH, Temp., Salinity
Artesian Slough	Monthly (May –Oct)	DO, pH, Temp., Salinity

APPENDIX H
USGS BENTHIC INVERTEBRATE SAMPLING

Benthic Invertebrate Sampling

Methods

USGS collected benthic slough samples at Artesian Slough (A16 receiving water) sampling locations concurrently with receiving water quality samples on four occasions during 2005. The sampling schedule for pond A16 was 7 days prior to the 31 March initial pond release (25 March 2005), 14 days following pond release (14 April 2005), and 28 days following pond release (28 April 2005), followed by a sample during late summer (18 August 2005). Late summer benthic samples were also taken at A3W receiving waters (Guadalupe Slough, 19 August 2005) and A7 receiving waters (Alviso Slough, 2 September 2005) as a follow-up to 2004 benthic sampling.

Benthic macroinvertebrates were sampled from the boat using a standard Eckman grab sampler (15.2 cm x 15.2 cm x 15.2 cm). Samples were collected by lowering the dredge into the water slowly, holding it level on the substrate, and releasing the "jaws." Soft substrates consistently produced samples that filled the dredge, whereas on harder substrates only a portion of the dredge was filled (the dredge cannot as deeply penetrate a hard surface). Sampling locations with vegetative debris on the substrate produced samples with high concentrations of vegetation. Grab samples were washed in the field using a 0.5mm mesh sieve and preserved in 70% ethanol and rose bengal dye.

Samples were sorted and invertebrates enumerated using dissecting microscopes and appropriate taxonomic keys (Usinger 1956, Merritt and Cummins 1996, Pennak 1989, Smith and Johnson 1996). Identifications were confirmed, when necessary, by comparison to confirmed identification voucher specimens at the USGS Davis Field Station, Davis, CA. Sorted samples and associated sample debris were stored at USGS San Francisco Bay Estuary Field Station, Vallejo, CA.

We used the Shannon-Weiner index (Krebs 1999) to assess invertebrate taxa diversity for each sampling event. On all sampling dates, samples were taken with approximately equal frequency along a gradient from the mouth to the upstream portion of the slough. We computed means from repeated invertebrate measurements for each slough and examined differences in *Capitella* sp., *Potamacorbula* sp., Tubificoides, total abundance, and diversity between sample dates with analysis of variance tests (ANOVA; SAS Institute, 1990). Abundance values were log-transformed prior to analysis. We similarly tested for differences in dissolved oxygen, salinity, temperature, and pH measured at the time of sample collection. We tested for equal variances using Levene's test and then used the multiple variance mixed procedure (SAS Institute, 1990) if data violated the equal variance assumption. Significant ANOVA results ($\alpha = 0.05$) were investigated with the Tukey-Kramer procedure (SAS Institute, 1990) to make multiple comparisons among pairs of means (Sokal and Rohlf 1995).

Differences in taxa composition may exist when overall abundance and diversity indices are similar, and these differences may be ecologically important. To examine differences in taxa composition among sample dates, we used CANOCO 4.5 (ter Braak and Smilauer 1998) to perform detrended correspondence analysis (DCA) with downweighting of rare species. DCA is an indirect gradient analysis technique that reveals gradients in taxa composition independent of measured environmental variables. Although water quality was measured at the time of sample collection, point sampling may not account for the extent of variability in those parameters that could have affected the benthic community. The DCA axes are measured in units of constant beta diversity; therefore, it is useful for examining data for potential environmental patterns, regardless of whether the gradient displayed represents a measured environmental variable (Gauch 1982).

Results

Collected data were compiled according to sample date and location within each slough (upstream, midstream near discharge point, and mouth; tables 1-3).

Guadalupe Slough (Pond A3W receiving water)

Water quality parameters differed among sampling dates (Fig. 1). Dissolved oxygen differed among sampling dates ($F_{3,25}$ = 11.68, P < 0.0001), and the 29 July 2004 (first) sample differed from the second (2 August 2004), third (16 August 2004), and fourth (19 August 2005) samples (Tukey-Kramer, P = 0.0018), which did not differ from each other (P = 0.628). Salinity differed among sampling dates ($F_{3,25}$ = 6.94, P = 0.0015), with the second and third samples different from the fourth (Tukey-Kramer, P = 0.035), but from one another or from the first sample. Temperature differed among sampling dates ($F_{4,44}$= 6.82, P < 0.0001), with values increasing through the season. The first and second samples were different from the later samples. pH differed ($F_{3,25}$ = 7.32, P = 0.0011), with the first sample different from the second and fourth (Tukey-Kramer, P = 0.0028), but not the third (P = 0.0975).

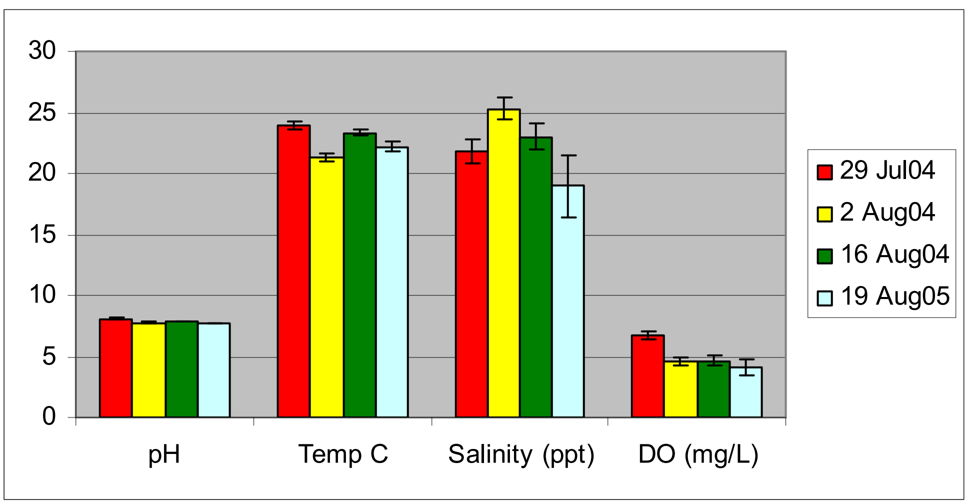


Figure 1. Comparison of pH, temperature, salinity, and dissolved oxygen among three summer 2004 sampling dates and one summer 2005 sampling date when benthic invertebrates were collected in Pond A3W receiving waters, Guadalupe Slough, Alviso, CA.

Taxa diversity did not differ among the four sample dates (Fig. 2, $F_{3,25}$= 2.72, P = 0.40661). Total abundance did not differ ($F_{3,25}$ = 0.53, P = 0.6680), and neither did abundance of *Capitella* sp. ($F_{3,25}$ = 1.81, P = 0.1714). Tubificoides was detected only during 2005 and abundance differed significantly among sample dates ($F_{3,25}$= 15.61, P < 0.0001), with the 2005 sample different from all 2004 samples. *Potamacorbula* sp. abundance did not differ among sampling dates ($F_{3,25}$ = 0.57, P = 0.6377), although it was detected only during 2005 (Figure 2).

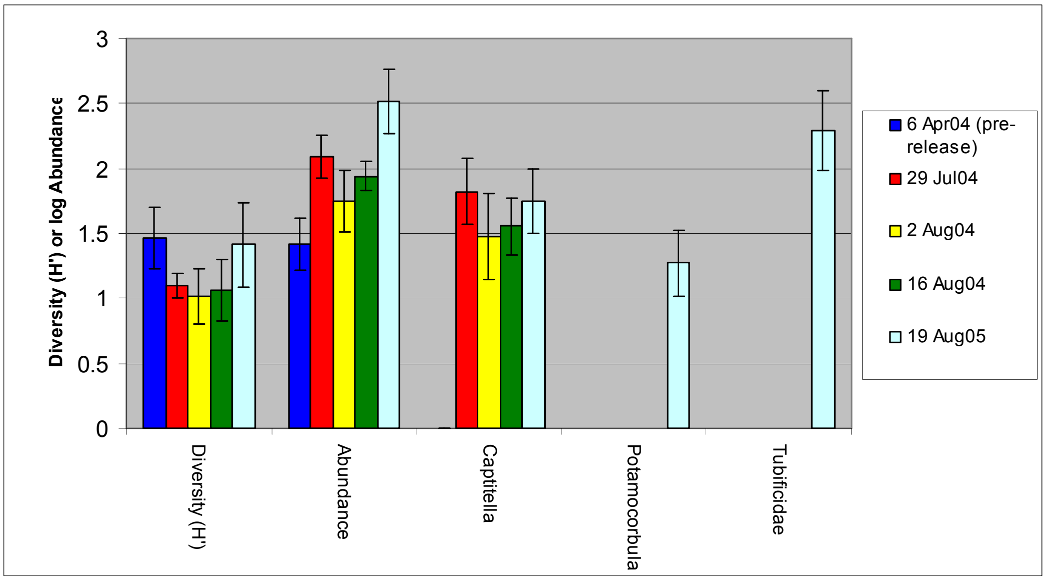


Figure 2. Comparison of taxa diverity, mean (log-transformed) total abundance, *Capitella* sp. abundance, *Streblospio* sp. abundance, *Potamocorbula* sp. abundance, and Tubificade abundance among four 2004 sampling dates and one summer 2005 sampling date in Pond A3W receiving waters, Guadalupe Slough, Alviso, CA.

DCA Axis 1 had an eigenvalue of 0.430 and explained 18.6% of the explainable variance, and DCA Axis 2 had an eigenvalue of 0.270; together, they explain 30.3% of the explainable variance (Fig. 3). The length of DCA Axis 1 was 3.428 and represents constant beta diversity, indicating that a gradient exists relative to taxa composition. It is the perpendicular distance of a sample point relative to an axis that determines its position along that gradient; samples from 2 August and 6 April had the least variability in taxa composition within samples relative to DCA Axis 1, and the 16 August sample had the most. The samples from 6 April were most dissimilar in taxa composition and fall farthest along the gradient; this gradient could be related to seasonal changes or other environmental differences between April and late July-August. These 6 April samples were also those with the least variability in taxa composition relative to DCA Axis 2, which was a 2.902-unit axis with high variability and little differentiation among all July and August samples, but the April samples did not differ from the summer samples relative to DCA Axis 2. The August 2005 samples were most similar to the April 2004 samples relative to DCA Axis 1, but showed a response to DCA Axis 2.

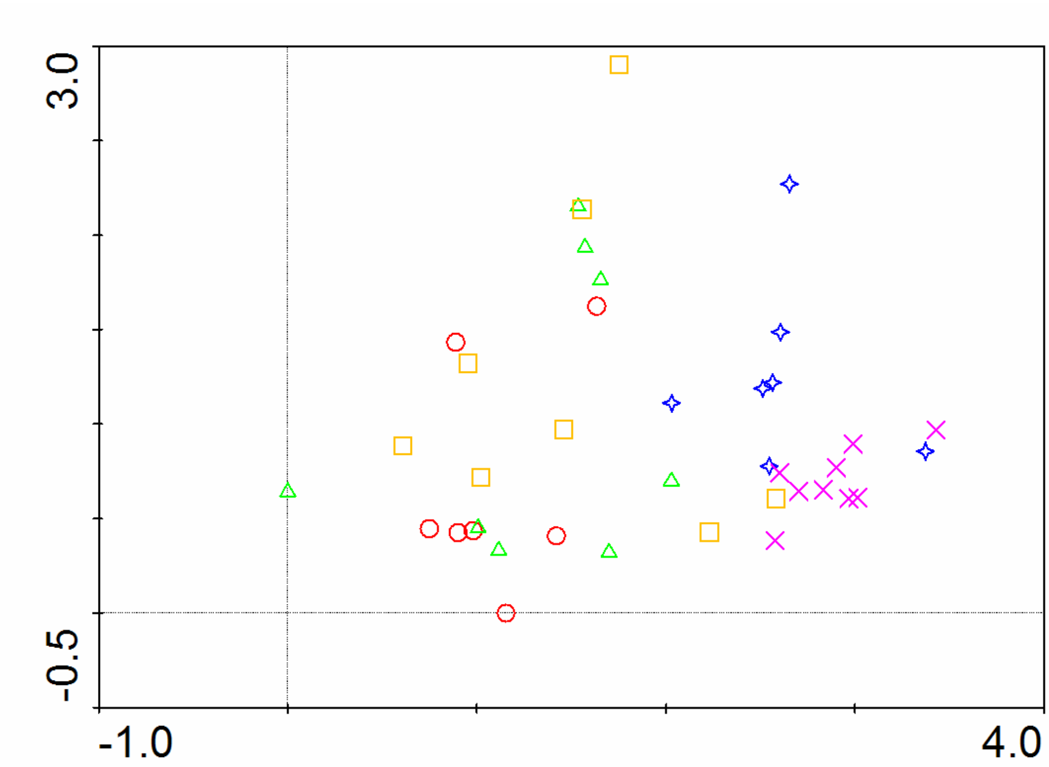


Figure 3. Results of DCA analysis showing 2004 Pond A3W receiving water Guadalupe Slough benthic invertebrate samples in ordination space. Purple X = 6 April 2004, red circles = 29 July 2004, green triangles = 2 August 2004, orange squares = 16 August 2004, and blue stars = 19 August 2005.

Alviso Slough (Pond A7 receiving water)

Some differences were detected in water quality between sample dates (Fig. 4). There was no difference detected in salinity ($F_{3,22} = 1.09$, $P = 0.3749$) in Alviso Slough among sampling dates. DO differed among sampling dates ($F_{3,22} = 3.17$, $P = 0.0444$), with the first sample significantly different from the final sample taken in September 2005. There was a difference in temperature ($F_{3,22} = 17.63$, $P <$

0.0001), and the 29 July (first) sample differed from the later samples, which did not differ from each other. pH differed ($F_{3,22} = 6.02$, $P = 0.0037$), with the third sample different from all other samples.

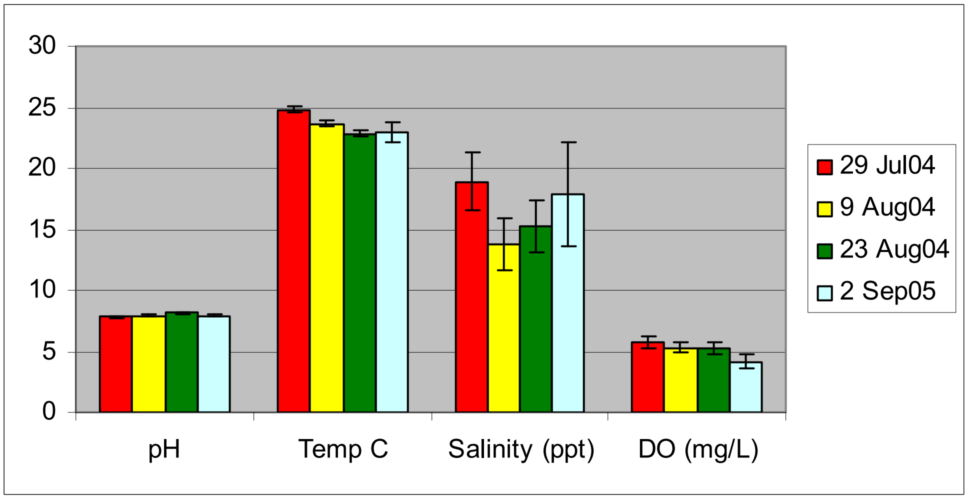


Figure 4. Comparison of pH, temperature, salinity, and dissolved oxygen among three summer 2004 sampling dates and one summer 2005 sampling date when benthic invertebrates were collected in Pond A7 receiving waters, Alviso Slough, Alviso, CA.

Taxa diversity differed among sampling dates ($F_{3,22} = 9.35$, $P = 0.0004$), with significantly lower diversity during the 2005 sample ($P = 0.0026$). Total abundance also differed ($F_{3,22} = 4.91$, $P = 0.0093$), with abundance significantly higher during the 2005 sample. Abundance of *Capitella* sp. did not differ among sampling dates ($F_{3,22} = 0.52$, $P = 0.6698$). Abundance of Tubificoides ($F_{3,22} = 5.83$, $P = 0.0043$) and *Potamocorbula* sp. ($F_{3,22} = 4.23$, $P = 0.0166$) both differed among sample dates, with the final 2005 sampling date significantly different from earlier dates.

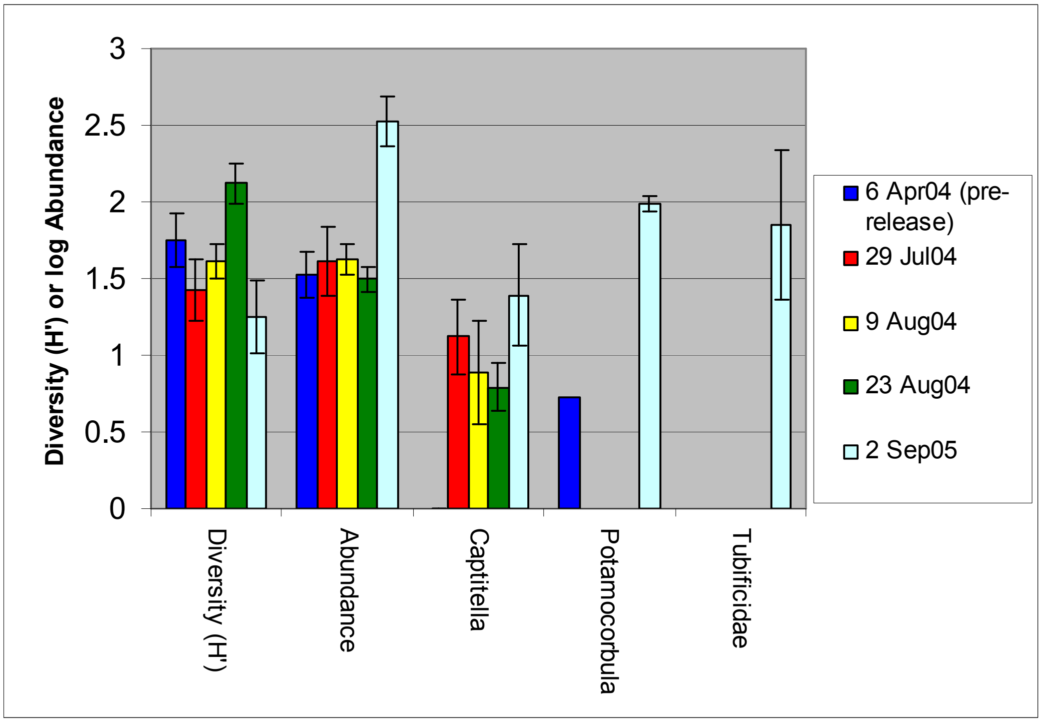


Figure 5. Comparison of taxa diverity, mean (log-transformed) total abundance, *Capitella* sp. abundance, *Potamocorbula* sp. abundance, and Tubificade abundance among four 2004 sampling dates and one summer 2005 sampling date in Pond A7 receiving waters, Alviso Slough, Alviso, CA.

DCA Axis 1 had an eigenvalue of 0.436 and explained 13.9% of the explainable variance, and DCA Axis 2 had an eigenvalue of 0.272; together, they explain 22.5% of the explainable variance (Fig. 6). The length of DCA Axis 1 was 2.819 and represents constant beta diversity, indicating that a gradient exists relative to taxa composition, but the first DCA Axis is not as important for defining taxa composition in Alviso Slough as it was in Guadalupe Slough. It is the perpendicular distance of a sample point relative to an axis that determines its position along that gradient; samples from 29 July had the least variability in taxa composition within samples relative to DCA Axis 1, and the 7 April sample had the most. The samples from 7 April were most dissimilar in taxa composition and fall farthest along the gradient, but were not as distinct in Alviso Slough as in Guadalupe Slough; this could indicate that environmental changes across time were less pronounced in Alviso Slough. The 29 July samples were also those with the least variability in taxa composition relative to DCA Axis 2, which was a

2.303-unit axis with high variability and little differentiation among all samples, including those from April. August 2005 samples were variable relative to DCA Axis 1 and most similar overall to 9 August 2004 samples.

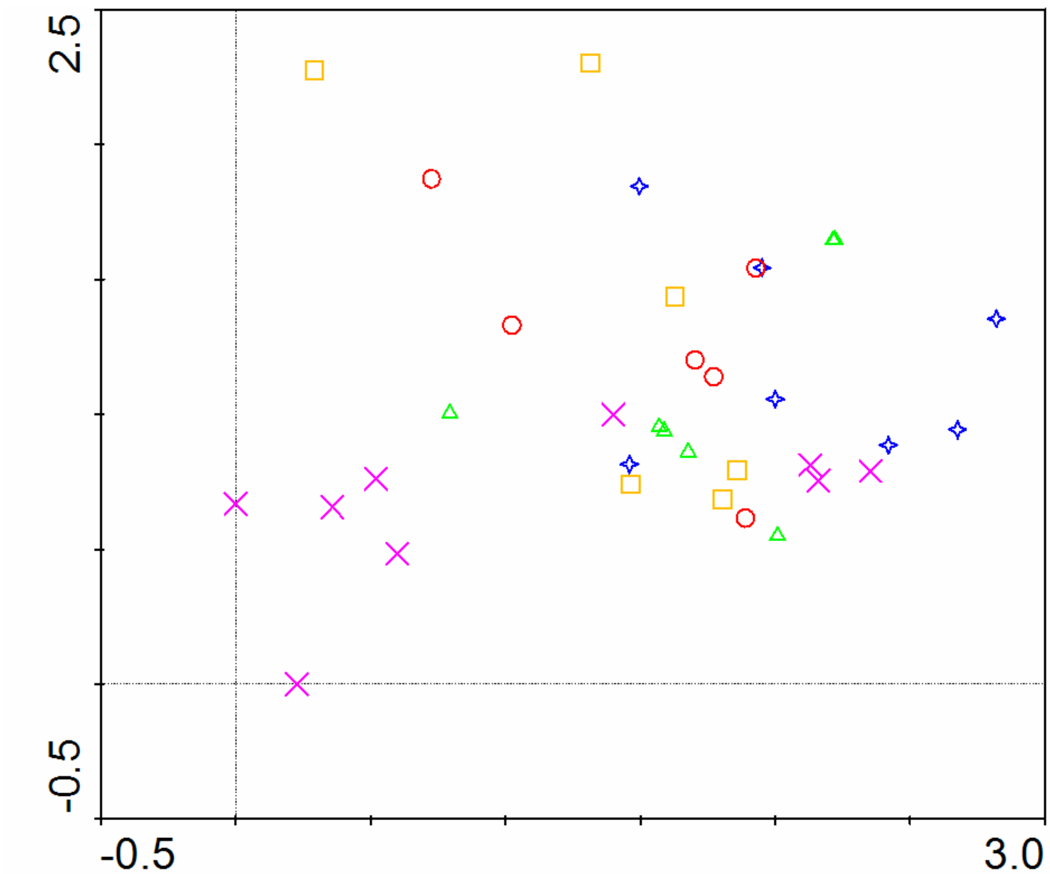


Figure 6. Results of DCA analysis showing 2004 Pond A7 receiving water Alviso Slough benthic invertebrate samples in ordination space. Purple X = 7 April 2004, red circles = 29 July 2004, green triangles = 9 August 2004, orange squares = 23 August 2004, and blue stars = 2 September 2005.

Artesian Slough (Pond A16 receiving water)

Some differences were detected in water quality between sample dates (Fig. 7). There was no difference detected in dissolved oxygen ($F_{3,16}$ = 2.93, P = 0.0656) in Artesian Slough among sampling dates. Salinity differed among samples ($F_{3,16}$ = 5.38, P = 0.0094), with the second sample (first sample taken post-release) differing from the first (pre-release) sample, but no other differences were detected. There was a difference in temperature ($F_{3,16}$ = 18.67, P < 0.0001), with the first two samples significantly different from the last two samples. pH differed

($F_{3,16} = 6.84$, $P = 0.0035$) in that the first sample differed from the second and third samples, but not the fourth.

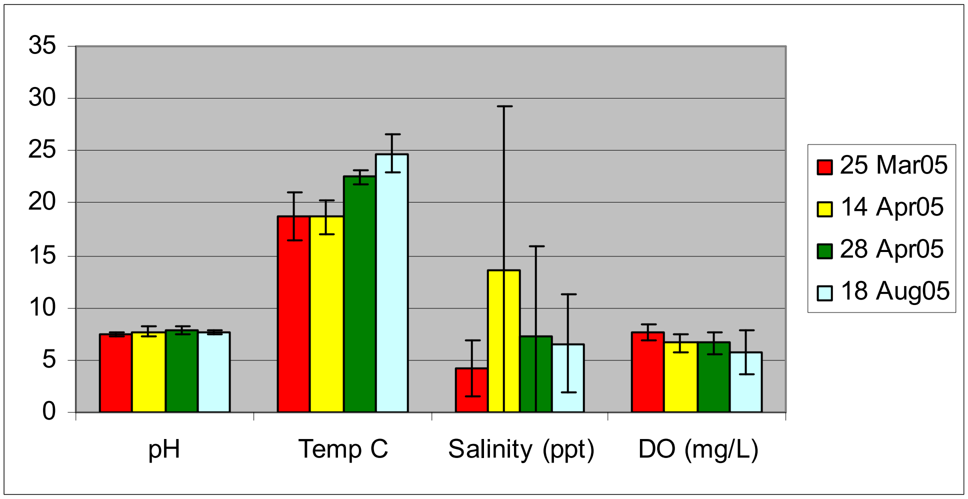


Figure 7. Comparison of pH, temperature, salinity, and dissolved oxygen among four 2005 sampling dates when benthic invertebrates were collected in Pond A16 receiving waters, Artesian Slough, Alviso, CA.

Taxa diversity did not differ among the four sample dates (Figure 8; $F_{3,16} = 0.66$, $P = 0.5873$). Total abundance did not differ ($F_{3,16} = 0.66$, $P = 0.5873$), and neither did abundance of *Capitella* sp. ($F_{3,16} = 0.91$, $P = 0.4575$), Tubificoides ($F_{3,16} = 0.30$, $P = 0.8256$), or *Potamocorbula* sp. ($F_{3,16} = 1.00$, $P = 0.4182$).

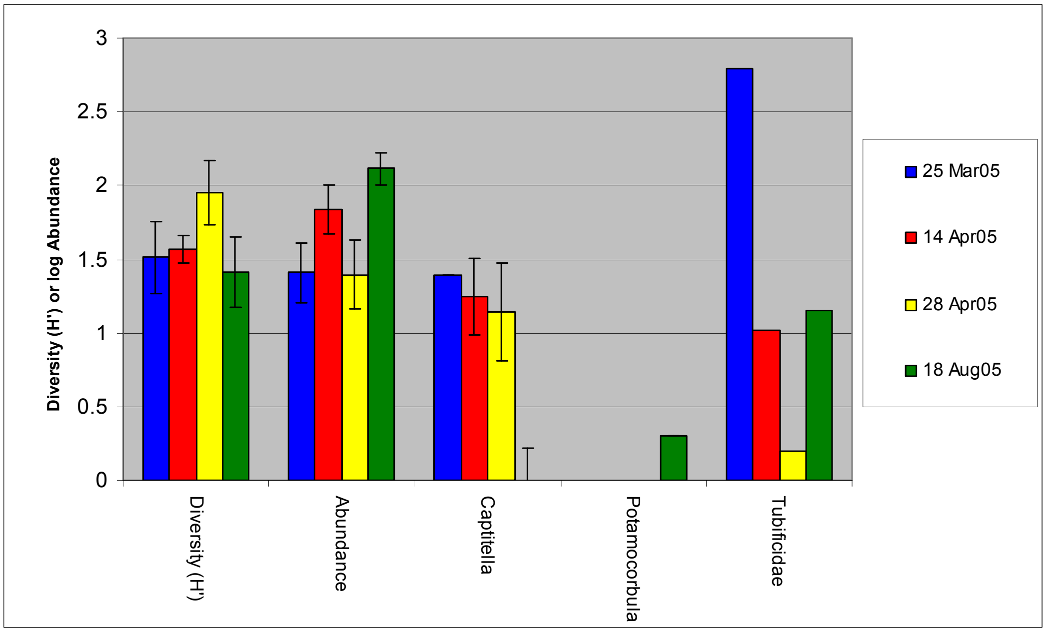


Figure 8. Comparison of taxa diverity, mean (log-transformed) total abundance, *Capitella* sp. abundance, *Potamocorbula* sp. abundance, and Tubificade abundance among four 2005 sampling dates in Pond A16 receiving waters, Artesian Slough, Alviso, CA.

DCA Axis 1 had an eigenvalue of 1.00 and explained 23.8% of the explainable variance, and DCA Axis 2 had an eigenvalue of 0.730; together, they explain 41.1% of the explainable variance (Fig. 9). It is the perpendicular distance of a sample point relative to an axis that determines its position along that gradient; samples from 25 March and 14 April had the least variability in taxa composition within samples relative to either axis and were most similar to one another. 28 April and 18 August samples were similar to the first two samples, but were most dissimilar to one another as the responded to DCA Axis 1.

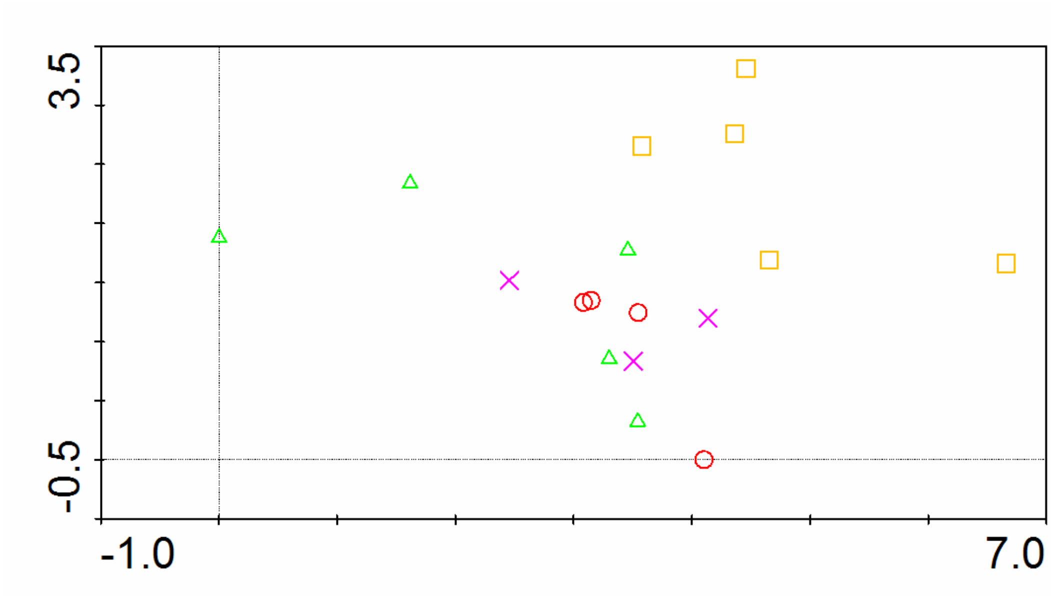


Figure 9. Results of DCA analysis showing 2005 Pond A16 receiving water Alviso Slough benthic invertebrate samples in ordination space. Purple X = 25 March 2005, red circles = 14 April 2005, green triangles = 28 April 2005, and orange squares = 18 August 2005.

Discussion

Ecological monitoring of benthic invertebrates can be a useful tool for detecting the impacts of water quality changes over time (Summers et al. 1991, Christman and Dauer 2003), as they can provide consistent responses to environmental stressors (Weisberg et al. 1997). Benthic samples were taken on four occasions prior to and following the A16 salt pond discharge into Artesian Slough and once during summer 2005 in Guadalupe Slough and Alviso Slough, CA, to assess the effects of pond discharges on the benthic community within the receiving waters. Comparisons were made between all sampling events to assess community changes over time, and to relate them to water quality changes in the sloughs.

In addition to taxa diversity and total abundance, three indicator taxa (*Capitella* sp., *Potamacorbula* sp., and Tubificoides) were chosen for abundance comparison among sampling dates. *Capitella* sp. is recognized as a taxon that is tolerant of stressful environmental conditions, which may include low dissolved oxygen and contaminants (Thompson and Lowe 2004, Thompson and Shouse 2004, Gaston et al. 1998). Higher relative abundances of this taxon could be indicative of degraded conditions. Although no sloughs showed differences in *Capitella* sp. across the sampling dates, high sample variability and low sample size may make differences difficult to detect. *Capitella* sp. was not found during the pre-release sample during April 2004 in A7 or A3W receiving waters. In Guadalupe Slough (A3W receiving waters), *Capitella* sp. was found in the highest number in the second summer sample and slightly lower in the third sample. In Alviso Slough (A7 receiving waters), *Capitella* sp. was found in the highest number in the first summer sample and each subsequent sample contained fewer individuals, although high sample variability made these differences insignificant. These results suggest that more data could show an increase in *Capitella* sp. immediately after pond release, followed by a decline. However, no differences were detected overall in Alviso and Guadalupe Sloughs, where samples were obtained pre-release in April 2004, during the summer 2004 initial release period, and once year later in late summer 2005, suggesting no effect of the initial pond releases at A3W or A7 on the abundance of this taxon in benthic samples. The highest abundance of *Capitella* sp. in Artesian Slough (A16 receiving water) was detected in March 2005 prior to the pond release, and declined through the season, with no individuals detected by August. These results seem more indicative of a seasonal decline in *Capitella* sp. rather than a response to water quality changes.

Potamacorbula sp. was generally found only during August 2005, and at A7 receiving waters during April 2004, but the difference in abundance was only significant at Alviso Slough. This taxon was not found in 2005 prior to August, even in Artesian Slough before the release of pond A16, so the differences are likely an effect of season or other fluctuations rather than changed water quality.

The abundance of Tubificoides, an oligochaete worm, was observed because of its appearance in August 2005 samples at A7 and A3W receiving waters and because of its presence in all A16 receiving water samples. Abundance of this taxon in A7 receiving waters was significantly different by date, with the final 2005 sample significantly higher than the 2004 abundance. In A16 receiving waters, abundance was highest preceding initial pond release, lower in the second and third samples, and higher in the final summer sample, but these differences were not significant by date and may be due to normal sample variation rather than any effect of water quality.

Although abundance and diversity comparisons showed no differences among sample dates, DCA revealed a shift in taxa composition between April samples and summer samples in both sloughs, especially Guadalupe Slough. In Guadalupe Slough, the three summer samples were similar relative to the ecological gradient represented by DCA Axis 1, whereas the April sample was distinct. April samples contained few or no *Capitella* sp., *Potamacorbula* sp., or *Heteromastus* sp., although these genera were abundant in summer samples. In contrast, April samples contained Nematoda, which was not represented in summer samples. August 2005 taxa composition was most similar to the April 2004 pre-release samples, and had higher numbers of some previously unrecorded taxa such as Tubificoides and *Potamacorbula* sp., but were similar to 2004 samples overall. In Alviso Slough, trends were similar but Tubificoides was present in April 2004 and August 2005 samples and not in summer 2004 samples, while Cumacea was more abundant in April samples than in summer samples. In Artesian Slough, where pond A16 was released in early 2005, pre-release samples were very similar to samples collected 14-days after release, suggesting no immediate effect of discharge. Taxa composition changed through the season, but did not exhibit a linear trend that could be related to water quality. Differences in taxa composition may be useful for evaluating water quality changes if evaluated carefully with respect to known environmental tolerances of individual taxa. Although shifts in taxa composition and abundance may be due to water quality changes that are not associated with season, there is no evidence to suggest such an effect. Seasonal shifts in invertebrate taxa have been noted to occur seasonally in Alviso salt ponds (Miles et al. 2004) and should be expected to occur in sloughs, as well.

References

Christman, C.S. and D.M. Dauer. 2003. An approach for identifying the causes of benthic degradation in Chesapeake Bay. Environmental Monitoring and Assessment 81: 187-197.

Gaston, G.R. C. F. Rakocinski, S.S. Brown, and C.M. Cleveland. 1998. Trophic function in estuaries: response of macrobenthos to natural and contaminant gradients. Marine Freshwater Research 49: 833-846.

Gauch, H.G. 1982. Multivariate Analysis in Community Ecology, Cambridge University Press, New York, pp. 152-160.

Krebs, C. J. 1999. Ecological methodology, second edition. Benjamin-Cummings, Menlo Park, 620 pp.

Merritt, R.W. and K.W. Cummins, eds. 1996. An introduction to the aquatic insects of North America, 3rd ed. Kendall Hunt Pub. Co., Dubuque, Iowa, 862 pp.

Miles, A.K., J.Y. Takekawa, D.H. Schoellhamer, S.E. Spring, N.D. Athearn, G.G. Shellenbarger, and D.C. Tsao. 2004. San Francisco Bay Estuary Salt Ponds Progress Report 2001-2003, USGS Priority Ecosystem Science Program, USGS/USFWS (CNO) Science Support.

Pennak, R.W. 1989. Fresh-water invertebrates of the United States : protozoa to mollusca, 3rd ed. Wiley, New York, 628 pp.

SAS Institute, 1990. SAS procedure guide, Release 6.04 Edition. SAS Institute, Cary, NC.

Smith, D.L. and K.B. Johnson. 1996. A guide to marine coastal plankton and marine invertebrate larvae, 2nd ed. Kendall Hunt Pub. Co., Dubuque, Iowa, 221 pp.

Sokal, R. R., and F. J. Rohlf. 1995. Biometry, 3rd edition. W.H. Freeman and Co., New York, 887 pp.

Summers, J. K., Macualey, J. M. and P.T. Heitmuller. 1991. Environmental Monitoring and AssessmentProgram. Implementation Plan for Monitoring the Estuarine Waters of the Louisianian Province-1991 Demonstration, EPA/600/5-91/228. United States Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, Florida.

Thompson, B. and S. Lowe. 2004. Assessment of macrobenthos response to sediment contamination in the San Francisco Estuary, California, USA. Environmental Toxicology and Chemistry 23: 2178-2187.

Thompson, J.K. and M.K. Shouse. 2004 A summary of our knowledge of South San Francisco Bay Infaunal Invertebrate Community. Unpublished Report, U.S. Geological Survey, 36 pp.

ter Braak, C.J.F. and Smilauer, P. 1998. CANOCO Reference Manual and User’s Guide to CANOCO for Windows: Software for Canonical Community Ordination, version 4, Microcomputer Power, Ithaca, NY.

Usinger, R.L. 1956. Aquatic insects of California. University of California Press, Berkeley, CA, 508 pp.

Weisberg, S. B., J.A. Ranasinghe, D.M. Dauer, L.C. Schaffner, R.J. Diaz, and J.B. Frithsen. 1997. An estuarine benthic index of biotic integrity (B-IBI) for Chesapeake Bay. Estuaries 20: 149-158.

		Upstream											
		4/6/2004			7/29/2004		8/2/2004		8/16/2004		8/19/2005	
		GUAB1A	GUAB1B	GUAB1C	A3W-3	A3W-4	A3W-3	A3W-4	A3W-3	A3W-4	A3W-3	A3W-4
Annelida	*Capitella*	0	0	0	40	12	71	4	99	134	12	0
	Cirratulus	0	0	0	0	0	0	0	0	0	0	0
	Eteone	0	0	0	0	0	0	0	0	0	11	1
	Goniadidae	0	0	0	0	0	0	0	0	0	0	0
	Heteromastus	0	0	0	0	0	0	0	0	0	8	0
	Nereis	0	0	0	0	0	0	0	0	0	0	0
	Polydora	0	0	0	4	2	0	1	5	0	0	0
	Sabellidae	0	0	0	0	0	0	0	0	1	0	0
	Spionidae	0	0	3	0	0	0	0	0	1	0	0
	Streblospio	0	0	0	0	0	0	0	0	0	4	0
	Tubificoides	7	2	121	0	0	0	0	0	0	617	639
Nematoda	Nematoda	0	0	2	0	0	0	0	0	0	0	0
Mollusca	*Assiminea*	0	0	0	0	0	0	0	0	0	1	1
	Gemma gemma	0	0	0	0	0	0	0	1	0	0	0
	Macoma balthica	0	0	0	2	0	1	0	0	1	2	0
	Potamacorbula	0	0	0	0	0	1	0	2	3	84	0
Crustacea	*Balanus*	0	0	0	0	0	0	0	0	0	0	0
	Copepoda	0	0	0	0	0	0	0	0	0	0	0
	Corophium	0	0	0	0	0	0	0	1	0	1	0
	Cumacea	0	1	33	52	10	8	0	12	23	0	16
	Ericthonius	0	0	0	0	0	0	0	0	0	2	6
	Melita californica	0	0	0	0	0	0	0	0	0	0	5
	Synidotea	0	0	0	1	0	0	0	0	0	0	0

		Midstream														
		4/6/2004			7/29/2004			8/2/2004			8/16/2004			8/19/2005		
		GUAB2A	GUAB2B	GUAB2C	A3W-1	A3W-2	A3W-6	A3W-1	A3W-2	A3W-6	A3W-1	A3W-2	A3W-6	A3W-1	A3W-2	A3W-6
Annelida	*Capitella*	0	0	0	263	151	410	93	220	41	0	0	5	0	322	0
	Cirratulus	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0
	Eteone	0	0	1	0	0	0	0	0	1	1	0	0	0	0	4
	Goniadidae	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Heteromastus	0	0	0	5	0	0	0	0	86	64	73	0	0	0	0
	Nereis	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0
	Polydora	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Sabellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Spionidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streblospio	4	0	20	0	0	0	0	0	0	0	0	0	0	5	0
	Tubificoides	3	5	82	0	0	0	33	0	36	210	0	0	0	1392	621
Nematoda	Nematoda	4	4	0	0	0	8	0	0	0	2	0	0	0	0	0
Mollusca	*Assiminea*	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0
	Gemma gemma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Macoma balthica	3	3	0	0	16	15	9	8	5	5	4	6	0	5	7
	Potamacorbula	0	1	0	0	0	3	1	0	13	1	1	6	0	93	45
Crustacea	*Balanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Copepoda	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Corophium	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
	Cumacea	13	5	105	45	2	66	15	33	5	6	1	27	0	10	17
	Ericthonius	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Melita californica	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Synidotea	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0

		Downstream														
		4/6/2004			7/29/2004			8/2/2004			8/16/2004			8/19/2005		
		GUAB3A	GUAB3B	GUAB3C	A3W-7	A3W-8	A3W-9	A3W-7	A3W-8	A3W-9	A3W-7	A3W-8	A3W-9	A3W-7	A3W-8	A3W-9
Annelida	*Capitella*	0	0	0	11	0	0	0	0	0	7	0	0	0	0	15
	Cirratulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Eteone	0	0	4	0	0	0	0	0	0	0	0	0	0	0	16
	Goniadidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Heteromastus	1	0	1	0	0	0	0	1	0	0	0	0	0	0	12
	Nereis	0	0	0	0	0	2	0	2	0	1	0	1	0	1	0
	Polydora	0	0	0	3	0	0	0	0	0	7	0	0	0	0	0
	Sabellidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Spionidae	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0
	Streblospio	20	1	21	0	0	0	0	0	0	0	0	0	3	5	49
	Tubificoides	12	7	449	0	0	0	0	0	0	0	0	0	48	7	97
Nematoda	Nematoda	3	3	89	0	0	0	0	0	0	0	0	0	0	0	6
Mollusca	*Assiminea*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Gemma gemma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Macoma balthica	2	1	7	0	0	23	2	6	4	16	0	3	7	0	5
	Potamacorbula	0	0	0	53	0	63	4	49	84	17	29	83	10	4	3
Crustacea	*Balanus*	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0
	Copepoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Corophium	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
	Cumacea	11	1	52	3	0	6	0	1	0	8	0	0	0	0	129
	Ericthonius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Melita californica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Synidotea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		Upstream										
		4/7/2004			7/29/2004		8/9/2004		8/23/2004		9/2/2005	
		ALVB1A	ALVB1B	ALVB1C	A7-4	A7-5	A7-4	A7-5	A7-4	A7-5	A7-4	A7-5
Annelida	*Capitella*	0	0	1	0	19	0	60	0	20	0	4
	Cirratulus	0	0	0	0	0	0	0	0	25	0	0
	Eteone	0	0	1	0	0	0	1	0	0	0	4
	Fabricia berkeleyi	0	0	0	0	27	0	0	0	0	0	0
	Heteromastus	1	0	1	0	0	0	0	9	1	0	0
	Mediomastus	0	0	0	0	0	0	0	0	0	0	0
	Nereis	5	1	1	0	1	3	0	0	0	0	0
	Phyllodocidae	0	0	0	0	0	0	0	1	0	0	0
	Polydora	0	0	1	0	135	0	0	0	5	0	0
	Pseudopolydora	0	0	0	0	0	0	0	0	0	0	0
	Sabellidae	0	0	0	0	0	2	0	0	4	0	0
	Spionidae	0	0	0	0	0	3	0	0	0	0	0
	Streblospio	16	3	14	1	67	0	0	0	0	0	0
	Tubificoides	0	0	0	0	0	0	0	0	0	486	34
Mollusca	*Assiminea*	0	0	0	0	0	0	0	0	0	8	0
	Gemma gemma	0	0	0	0	0	0	0	0	0	0	0
	Macoma balthica	2	0	2	5	0	1	12	3	0	20	4
	Mya arenaria	0	0	0	0	0	0	0	0	0	0	0
	Potamacorbula	0	1	1	0	0	1	5	4	2	85	0
Crustacea	*Balanus*	0	0	0	0	0	0	0	0	0	0	0
	Cirripedia	0	0	0	0	0	0	0	0	0	0	0
	Corophium	0	2	0	0	1	0	0	0	0	0	0
	Cumacea	0	1	391	0	5	9	4	13	21	50	48
	Ericthonius	1	0	0	0	0	0	0	0	0	0	0
	Melita californica	0	0	0	0	0	0	0	0	0	0	0
	Synidotea	0	0	0	0	0	0	0	0	0	0	0

		Midstream														
		4/7/2004			7/29/2004			8/9/2004			8/23/2004			9/2/2005		
		ALVB2A	ALVB2B	ALVB2C	A7-1	A7-2	A7-3	A7-1	A7-2	A7-3	A7-1	A7-2	A7-3	A7-1	A7-2	A7-3
Annelida	*Capitella*	0	0	0	0	11	70	0	0	64	2	0	0		164	0
	Cirratulus	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Eteone	0	0	0	0	0	0	0	0	1	0	0	0		7	0
	Fabricia berkeleyi	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Heteromastus	0	0	0	0	0	3	0	1	0	0	0	0		0	0
	Mediomastus	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Nereis	3	7	6	0	4	2	1	1	0	1	1	2		0	0
	Phyllodocidae	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Polydora	0	1	2	0	0	0	0	0	0	0	0	0		0	0
	Pseudopolydora	0	0	0	0	0	0	3	0	0	0	0	0		0	0
	Sabellidae	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Spionidae	0	0	0	0	2	0	0	0	1	0	0	0		0	0
	Streblospio	0	1	40	0	0	0	0	0	0	0	0	0		19	16
	Tubificoides	0	0	0	0	0	0	0	0	0	0	0	0		2	760
Mollusca	*Assiminea*	0	0	0	0	0	0	0	0	0	0	0	0		2	0
	Gemma gemma	0	0	0	0	0	0	0	0	0	0	0	0		2	0
	Macoma balthica	2	0	0	0	16	14	18	7	14	6	8	9		25	41
	Mya arenaria	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Potamacorbula	2	4	7	0	8	0	15	12	6	13	7	2		84	73
Crustacea	*Balanus*	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Cirripedia	4	0	0	0	0	0	0	0	0	0	0	0		0	0
	Corophium	2	11	5	0	0	0	0	0	0	0	0	0		0	0
	Cumacea	1	0	8	0	0	36	2	0	3	8	5	5		1	33
	Ericthonius	10	13	0	0	0	0	0	0	0	0	0	0		0	0
	Melita californica	0	0	0	0	0	0	0	0	0	0	0	0		0	0
	Synidotea	0	0	0	0	0	0	0	0	0	2	0	0		0	0

		Downstream											
		4/7/2004			7/29/2004		8/9/2004		8/23/2004		9/2/2005	
		ALVB3A	ALVB3B	ALVB3C	A7-7	A7-8	A7-7	A7-8	A7-7	A7-8	A7-7	A7-8
Annelida	*Capitella*	0	0	0	0	0	0	0	0	0	0	23
	Cirratulus	0	0	0	0	0	0	0	0	0	0	0
	Eteone	0	0	0	0	0	0	0	0	0	0	6
	Fabricia berkeleyi	0	0	0	0	0	0	0	0	0	0	0
	Heteromastus	0	0	0	0	2	1	4	0	8	0	0
	Mediomastus	0	0	0	0	0	0	3	3	0	0	0
	Nereis	0	0	1	0	1	1	1	5	2	2	0
	Phyllodocidae	0	0	0	0	0	0	0	0	0	0	0
	Polydora	0	0	0	0	5	0	0	0	0	0	3
	Pseudopolydora	0	0	0	0	0	0	0	0	0	0	0
	Sabellidae	0	0	0	0	0	0	0	0	0	0	0
	Spionidae	0	1	0	0	0	3	0	10	0	0	0
	Streblospio	0	2	58	0	2	0	0	0	0	0	4
	Tubificoides	0	1	60	0	0	0	0	0	0	0	0
Mollusca	*Assiminea*	0	0	0	0	0	0	0	0	0	0	4
	Gemma gemma	0	0	0	1	0	0	0	2	4	0	348
	Macoma balthica	1	1	2	3	2	8	6	3	0	2	3
	Mya arenaria	1	0	0	0	0	0	0	0	0	0	0
	Potamacorbula	1	1	0	9	34	23	38	8	4	132	125
Crustacea	*Balanus*	0	0	0	0	0	1	0	0	0	0	0
	Cirripedia	0	0	0	0	0	0	0	0	0	0	0
	Corophium	0	0	0	0	0	0	0	0	5	0	1
	Cumacea	12	10	124	0	0	1	6	6	0	0	36
	Ericthonius	0	0	0	0	0	0	0	0	0	0	0
	Melita californica	0	0	0	0	0	0	0	0	5	0	0
	Synidotea	0	0	0	0	0	0	0	0	0	0	0

		Upstream				Midstream			
		3/25/2005	4/14/2005	4/28/2005	8/18/2005	3/25/2005	4/14/2005	4/28/2005	8/18/2005
		A16-3	A16-3	A16-3	A16-3	A16-2	A16-2	A16-2	A16-2
Annelida	*Capitella*	0	0	0	0	0	0	0	0
	Cirratulus	0	0	0	0	0	0	0	0
	Eteone	0	0	0	0	0	0	0	0
	Fabricia berkeleyi	0	0	0	2	0	0	0	2
	Heteromastus	0	0	0	0	0	0	0	0
	Polydora	0	0	0	0	0	0	0	0
	Pseudopolydora	0	0	0	0	0	0	0	0
	Spionidae	0	0	0	0	0	0	0	0
	Streblospio	0	0	0	0	0	1	0	0
	Tubificoides	0	0	1	0	0	0	1	0
Malacostraca	*Pancolus californiensis*	0	0	0	33	0	0	0	0
Hexapoda	Corixidae	0	0	2	0	0	0	0	0
Mollusca	*Assiminea*	0	0	1	0	0	0	0	8
	Cerithidea californica	0	0	0	0	0	0	0	1
	Macoma balthica	0	0	0	0	0	0	0	0
	Potamacorbula	0	0	0	0	0	0	0	0
Crustacea	*Artemia*	0	3	0	0	0	0	0	0
	Corophium	0	0	0	0	0	0	0	18
	Cumacea	0	0	0	0	0	4	0	19
	Ericthonius	0	0	0	0	0	0	0	35
	Ostracoda	0	0	0	0	0	3	0	30
	Gammaridae	0	0	0	0	0	0	0	339
	Melita californica	0	0	0	1	0	0	0	4

		Downstream											
		3/25/2005			4/14/2005			4/28/2005			8/18/2005		
		A16-4	A16-5	A16-6	A16-4	A16-5	A16-6	A16-4	A16-5	A16-6	A16-4	A16-5	A16-6
Annelida	*Capitella*	1	24	633	0	15	17	29	1	90	1	0	1
	Cirratulus	0	0	0	0	0	0	0	4	0	1	0	0
	Eteone	0	0	0	0	1	0	0	0	0	0	0	0
	Fabricia berkeleyi	0	1	0	0	0	0	0	0	0	1	0	0
	Heteromastus	0	0	5	0	3	0	0	0	3	0	0	0
	Polydora	0	0	1	0	0	0	0	0	0	0	0	0
	Pseudopolydora	0	0	7	0	0	0	0	0	0	0	0	0
	Spionidae	0	1	0	0	0	0	0	0	0	0	0	0
	Streblospio	0	4	0	0	0	0	5	0	2	0	0	0
	Tubificoides	0	0	618	21	4	13	0	3	2	102	2	0
Malacostraca	*Pancolus californiensis*	0	1	0	0	0	0	0	0	0	0	1	0
Hexapoda	Corixidae	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	*Assiminea*	0	8	0	0	4	0	0	0	1	6	15	0
	Cerithidea californica	0	0	0	0	0	0	0	0	0	0	0	0
	Macoma balthica	0	0	0	1	23	0	0	0	0	0	0	2
	Potamacorbula	0	0	0	0	0	0	0	0	0	0	0	2
Crustacea	*Artemia*	0	0	0	0	0	0	0	0	0	0	0	0
	Corophium	0	0	0	0	0	1	0	3	0	36	8	185
	Cumacea	2	63	0	159	515	255	9	439	21	1	0	0
	Ericthonius	0	0	0	0	4	0	0	0	0	0	0	0
	Ostracoda	0	0	0	1	0	0	0	0	0	0	0	0
	Gammaridae	0	13	0	0	0	0	0	0	0	19	23	85
	Melita californica	0	0	0	0	0	0	0	0	0	0	0	0