CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

Environmental Services Department
SAN JOSE/SANTA CLARA WATER POLLUTION CONTROL PLANT

January 30, 2012

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

SUBJECT: Pond A18 Annual Report 2011

Dear Mr. Wolfe:

The Annual Self-Monitoring Report (SMR) is submitted in fulfillment of the Waste Discharge Requirements for Pond A18 described in Order Number R2-2005-0003. This SMR includes a summary of data and studies conducted in 2011 for Pond A18.

Our monitoring data continues to demonstrate Pond A18 discharge has no measurable effect on the water quality of the receiving water.

As requested by Water Board Staff, the City collaborated with USGS and conducted mercury and methyl mercury sediment monitoring in Artesian Slough in lieu of Pond A18. The City found working with USGS to be productive and informative. The USGS Sediment Mercury Report is attached as an appendix to the SMR.

If you have questions or comments regarding this monitoring report, please contact Jim Ervin, our Regulatory Compliance Manager, at 408-945-5124.

Sincerely,

Jon Newby

Jon Newby, P.E.
Deputy Director, Water Pollution Control

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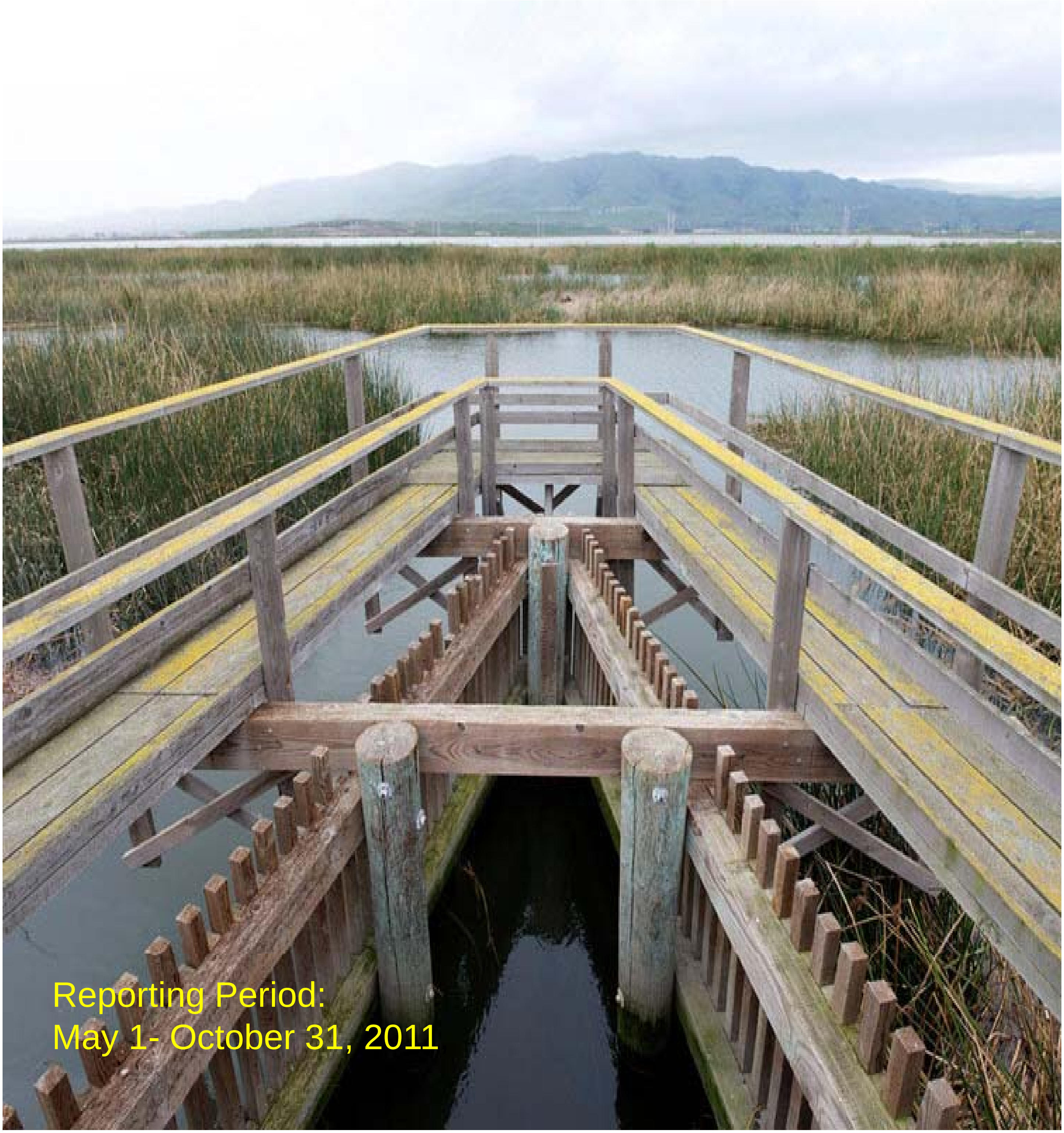
Pond A18 Annual Report
2011



Pond A18 Annual Report 2011

Order No. R2-2005-0003

Prepared for:

California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94560

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I. Introduction

This report summarizes 2011 water quality monitoring for Pond A18 in Santa Clara County. Monitoring was conducted from May 1st through October 31st in accordance with Waste Discharge Requirements (WDR) Order No. R2-2005-0003 (Order) issued February 16, 2005 by the San Francisco Bay Regional Water Quality Control Board (Regional Water Board).

This was the seventh year of monitoring following the initial release of water and commencement of Continuous Discharge Operations from former Salt Pond A18. The City of San Jose (City) continues to collaborate with the Regional Water Board and U.S. Fish and Wildlife Service (USFWS) by sharing weekly data and management strategies. Ponds A16 and A17 are managed by USFWS and are located on the opposite side of Artesian Slough from Pond A18. Pond A16 also discharges into Artesian Slough. Figure 1 shows the location of Pond A18 intake and discharge structures, including sampling sites located in the pond and receiving water.

A. Waste Discharge Requirements

The WDR requires the following three discharge limitations for Pond A18:

1. Salinity, DO, and pH requirements as shown in Table 1.

Table 1. Pond A18 Discharge Requirements

Constituent	Instantaneous Maximum	Instantaneous Minimum	Units
Salinity for continuous circulation	44		ppt
DO[1]		5.0	mg/L
pH[2]	8.5	6.5	

[1] The Discharger may select discharge station A-A18-D, or receiving water station A-A18-5 to evaluate compliance with the DO limitation. In cases where receiving waters do not meet the Basin Plan objective, the Discharger must show, as described in its Operations Plan, that pond discharges do not further depress the DO level in the receiving water.

[2] The Discharger may select discharge station A-A18-D, or receiving water monitoring A-A18-5 to evaluate compliance with the pH limitation.

2. Pond waters discharging to Artesian Slough shall not exceed the natural temperature of the receiving waters by 20°F, or more.

3. DO Trigger. The Discharger shall monitor, report, and take corrective action measures in accordance with the Operations Plan required by Provision D.2, if DO levels in Pond A18 at station A-A18-M fall below 1.0 mg/L during the continuous circulation period [note: the Regional Water Board has allowed the City to monitor A-A18-M at the discharge (D in Figure 1)].

B. Monitoring Requirements

Monitoring requirements for the continuous circulation period are described in Table 2:

Table 2. Continuous Circulation Monitoring for Pond A18

Sampling Station:	D.O.	pH	Temp	Salinity	Turbidity	Chlorophyll *a*	Metals/Water Column	Sample Function
A-A18-M	A	A	A	A		A		Management
A-A18-D	B	B	B	B			C [Eliminated in 2006]	Discharge
A-A18-1	D	D	D	D	D			Receiving Water
A-A18-2	D	D	D	D	D			Receiving Water
A-A18-3	D	D	D	D	D			Receiving Water
A-A18-4	D	D	D	D	D			Receiving Water
A-A18-5	E	E	E	E				Receiving Water

<u>**LEGEND FOR TABLE 2**</u>

A = Monitoring shall be conducted within Pond A18 monthly from May through October. DO monitoring shall be conducted between 0800 and 1000 hours. Time of monitoring shall be reported. [Note: this can be taken at D].

B = Discharge monitoring shall be conducted before pond water mixes with receiving water using a continuous monitoring device from May through October. Downtime of continuous monitoring devices shall be minimized to the maximum extent feasible, and addressed annually in the Discharger's Operations Plan.

C = Water column samples for total and dissolved arsenic, chromium, nickel, copper, zinc, selenium, silver, cadmium, lead, and mercury shall be collected annually in August or September. When collecting metals samples, the Discharger shall also monitor for salinity, and total suspended solids. **[Note: This requirement was eliminated by the Regional Water Board in 2006 in a revision to the SMP included in a letter to the City dated May 9, 2006.].**

D = Receiving water monitoring shall be conducted at discrete locations from downstream to upstream monthly from May through October. The positions indicated on Figure 1 should be considered approximate. For days it monitors receiving water, the Discharger shall also (1) document if it monitors at flood tide, ebb tide, or slack tide (samples shall be collected as close to low tide as practicable), (2) monitor receiving water for DO, pH, temperature, salinity, and turbidity near the water surface and bottom, and (3) report standard observations, as described in Section D of the SMP.

E = Receiving water continuous monitoring for the purposes of determining compliance with the DO and pH limits shall be conducted from May through October at a location selected by the Discharger and approved by the Executive Officer at a point downstream of the discharge. Downtime of continuous monitoring devices shall be minimized to the maximum extent feasible, and addressed annually in the Discharger's Operations Plan.

In addition to the monitoring requirements listed in Table 2, annual sampling for receiving water (Artesian Slough) sediment mercury and methyl mercury is required in August or September of each year per Regional Board order revision letter dated 15 September 2010.

II. Methods and Results

A. Quality Assurance/Quality Control

Sampling instruments were calibrated and maintained to ensure accurate data prior to deployment. Continuous sondes were cleaned and calibrated weekly. The discrete sondes were cleaned and calibrated prior to each use. Post-deployment calibration verification was performed on all sondes after each use.

Data Validation
DO was calibrated using percent saturation in water-saturated air (theoretical reading of 100% saturation). Weekly data with post-deployment readings within ±10% of the theoretical saturation level were accepted. Data with readings between 10 -15% of theoretical were accepted or rejected based on best professional judgment. If an instrument had a post-deployment DO reading exceeding 15% of theoretical, all DO data since the instrument's last calibration were rejected as invalid and the cause of the QA/QC failure was investigated.

For pH, a 2-point calibration (pH 7 and pH 10) was used to establish a slope. Calibrations for conductivity were performed using either a 10,000 or 50,000 micro Sieman standard, depending on the pond salinity. Post-deployment instrument accuracy checks were performed using the same standards. Data outside ±5% of the theoretical value were considered invalid for pH or Conductivity and are not reported. The cause of any failure was investigated and steps to correct the error were taken including troubleshooting, probe replacement and sonde unit repair.

The following post-deployment QA/QC failures occurred: 2 for conductivity and 3 for pH. Two of these failures were considered invalid and are not reported: 1 conductivity failure and 1 pH failure; both of which were due to faulty probes. Other periods of invalid data occurred when sondes in Pond A18 did not function properly (6/18- 6/22 and 7/1- 7/13) due to dead batteries.

For the 2011 monitoring season, post-deployment error was in the following ranges:

1. pH: –2.9% to +5.6% (median 0.41%)
2. Conductivity: –6.7% to – 3.4% (median –1.1%)
3. DO: –7.3 to 2.7 (median 0.45)

B. Continuous Monitoring

Receiving water in Artesian Slough (Station 5) and Pond A18 discharge (Station D) were monitored continuously for temperature, salinity, pH, and DO from May 1, 2011 to October 31, 2011 (Figure 1). YSI model 6600 sonde units were used for this monitoring.

Sonde units were cleaned, serviced, calibrated, deployed, and retrieved weekly. Water quality was recorded every 15 minutes. Following retrieval from the field, data were downloaded to a computer, validated, summarized, and evaluated with respect to discharge requirements and action triggers. Adaptive management actions such as additional receiving water monitoring or discharge gate opening and closing times for the upcoming week were determined using best professional judgment based on evaluation of weekly 10th percentile DO readings for the pond discharge. Data summaries were reported to Regional Water Board staff on a weekly basis.

Temperature

Water temperature in the receiving water (Station 5; Figure 1) and at the Pond A18 discharge gate (Station D), under both discharge and non-discharge conditions, are shown in Table 3.

Table 3. 2011 Continuous Temperature Monitoring Results (ºC)

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
Artesian Slough	18.8	28.4	24.3	24.6	17657
A18 Discharge	13.3	27.9	22.1	22.8	14685
A18 Non-Discharge	9.71	27.9	22.8	23.8	1459

The WDR requires that discharges comply with the State's Thermal Plan. The Plan specifies that discharges shall not exceed the natural temperature of receiving waters by 20°F (~ 11ºC) and shall not cause temperatures to rise greater than 4°F above the natural temperature of the receiving water at any one time or place. To evaluate compliance, receiving water temperatures were compared to Pond A18 temperatures during pond discharges (non-discharge periods were excluded from this comparison). Overall, pond temperatures were lower than receiving water (Figure 3). Differences for each concurrent 15-minute monitoring interval were determined by subtracting each discharge temperature from the corresponding receiving water temperature. Positive results indicate that receiving water temperature was higher (Figure 4). Temperature differences ranged from -1.8 to 7.6ºC and averaged 2.1ºC over 4,416 hours of monitored discharge. At no time was temperature of discharge greater than 11ºC above the corresponding receiving water temperature. Pond temperatures at the discharge gate varied little between discharge and non-discharge periods (Table3; Figure 3).

Salinity

Salinity of the receiving water (Station 5; Figure 1) and of water at Pond A18 discharge gate (Station D), under both discharge and non-discharge conditions, are shown in Table 4. Discharge salinity was the lowest since 2006, remaining below 40 ppt at all times during the 2011 monitoring period (Table 4).

Table 4. 2011 Continuous Salinity Monitoring Results (PSU[1])

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
Artesian Slough	0.2	14.5	3.4	2.7	16455
A18 Discharge	9.7	20.6	16.1	17.4	14348
A18 Non-Discharge	9.7	20.5	15.6	16.5	1414

[1] Practical Salinity Units (PSU) are a measurement of salinity from the specific conductance measured in water. An algorithm based on the ion composition of natural sea water converts specific conductance into PSU. One PSU is approximately equivalent to one part-per-thousand salinity.

Salinity of Pond A18 gradually increased with little variation until late-September (Figure 5), followed by a slight decrease. Receiving water salinity varied greatly due to tidal influence. Compared to most prior years, salinity in both the Pond and receiving water was lower in 2011. This was due to a combination of late season storms, milder temperatures leading to lower evaporation rates, and dam releases that fed large freshwater tributary flows.

pH

The pH of the receiving water (Station 5; Figure 1) and A18 discharge gate (Station D), under discharge and non-discharge conditions are shown in Table 5. Pond pH levels were consistently higher and more variable compared to receiving water (Figure 6). Shorter-term diurnal fluctuations of pH were greater in the receiving water as a result of daily salinity changes from the tides (Figure 7), altering the buffering capacity for pH.

Table 5. 2011 Continuous pH Monitoring Results

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
Artesian Slough	6.7	9.0	7.5	7.4	17657
A18 Discharge	8.3	10.3	9.5	9.7	13741
A18 Non-Discharge	8.4	10.3	9.5	9.6	1345

The WDR requires that receiving water pH remain between 6.5 to 8.5. Receiving water pH this season exceeded the upper threshold 31 times for brief (15-min) to moderate (4 hours 30-min) intervals. These exceedances corresponded to low tides. The greater frequency of exceedances this year is likely due to a weaker buffering capacity brought on by the lower salinity explained above. The in-slough conditions during these events can be characterized as very low volume, shallow fresh water. The elevated pH may be due to the low volume fresh water being more influenced by bottom slough water, which tends to have a higher pH than the surface at all times, regardless of tide or pond discharge.

The higher pH levels in the pond did not appear to influence the receiving water pH (Figure 6). Early this season, pond pH levels were between 9 and 10 followed by a decline in September, which is 1-2 months later than declines typically measured in previous years.

As mentioned above, there were two post-deployment sonde QA/QC failure for pH in Pond A18. One of the failures was high by 6%, which is outside the ± 5% acceptance criteria. After further review, the data showed no major deviations or unusual patterns and are reported after using best professional judgment. The other failure was low by 24.7%, which is well outside acceptance criteria. After further review of those data, they were omitted because they are invalid.

Dissolved Oxygen

DO concentrations in the receiving water (Station 5; Figure 1) and in pond water at the discharge gate (Station D), under both discharge and non-discharge conditions, are summarized in Table 6. DO levels in the receiving water fell below the Basin Plan objective of 5.0 mg/L on 33 occasions (Figure 8). The majority of these incidents were minor (4.3 – 4.9 mg/L), lasting for brief (15-30 min.) to moderate (4.5 hours) periods of time. All incidents were reported to the Regional Water

Board. Discrete trigger monitoring did not correlate the low DO receiving water with A18 discharges.

Table 6. 2011 Continuous DO Monitoring Results

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
Artesian Slough	3.2	12.6	7.0	6.9	17657
A18 Discharge	0.0	18.5	9.2	9.4	14672
A18 Non-Discharge	0.0	15.1	9.5	9.7	1425

The receiving water DO reflects diurnal and tidal patterns (Figure 8). For example, DO in Artesian Slough tends to be low at night and higher during the day when photosynthesis is occurring. DO was also low during very high tides when Bay water dominates Artesian Slough. The lowest DO values were at night during high tides. Based on the full-season comparison between pond and slough DO, pond discharge does not appear to depress receiving water DO.

Weekly 10th percentile DO values were calculated for the pond's discharge and reported to the Regional Water Board. The WDR requires corrective action whenever the weekly 10th percentile for DO falls below 3.3 mg/L. There were 3 different weeks when the 10th percentile fell below the trigger. This is the least number of trigger events since 2005. These events began in late October. This is later than prior years when trigger events have generally occurred in July or August when temperatures are highest. As in recent years, the initial corrective action was to continue pond discharges while monitoring the receiving water more frequently. If the enhanced receiving water monitoring detects negative effects to receiving water, gate closures are then initiated. Since the enhanced receiving water monitoring did not measure clear effects to receiving water from pond discharges, valve closures were not initiated in 2011.

Low DO in Receiving Water

In 2011, there were 5 incidents in which receiving water DO was below 5.0 mg/L for a longer duration (2.5 hours – 4.0 hours). These episodes occurred between mid-June to early July during high tides at night. During these higher tides, pond discharge was minimal and even reaching zero discharge. For these reasons, the low DO incidents were attributed to high tides combined the normal diurnal DO cycle. No pond management changes were implemented as the episodes did not appear to be caused by pond discharges.

General Observations

Overall pond DO was higher than most other seasons (Figure 9) while salinity was lower (Figure 10). Pond water color and clarity changed throughout the monitoring season as observed in prior years, but there was a two-month delay in this succession. Initially the pond was moderately clear with a brownish-green color. This was followed by opaque dark-green to opaque brown blueish-green. Finally, the pond water color changed rapidly from green to opaque brown, which has been accompanied by low DO values in the past. Fouling of continuous sondes in the pond also occurred at this time. This fouling consisted of a dark brown mud-like film covering the entire unit that appeared to be diatoms. Beginning in mid-July and lasting for about 30 days, there were algal mats that formed approximately 50 yards away from the discharge point in the pond. There did not appear to be any water-quality effects related to this growth. The algal mats that typically cover the northern edge of the pond formed later in the season and only covered part of their normal range.

C. Discrete Monitoring

In addition to continuous monitoring of pond discharge and receiving water, the WDR requires discrete monthly sampling of water quality at four receiving water locations (Figure 1) during the monitoring season (Table 2). These surface and bottom measurements (Table 7) help describe the mixing of fresh slough water with Bay salt water during tidal exchange and the extent that Pond A18 discharges may affect either bottom or surface general water quality. Measurements were taken while Pond A18 was discharging, as required by the WDR. The City times this monitoring in an effort to document the effects of both ebbing and flooding tides.

Discrete trigger monitoring

Discrete trigger is in addition to the discrete monitoring required in Table 2, and is only conducted following a DO trigger event. Discrete trigger monitoring occurred only on 10/28/11 (Table 8), which was prompted by the previous weekly 10^{th} percentile DO value, falling below the trigger (3.3 mg/L). This additional monitoring helps detect possible negative impacts of pond discharge to determine if additional actions are necessary.

Table 7. Artesian Slough Monthly Surface and Bottom Water Quality Measurements

Date/ Time	Site	Tide	Depth	Temp (C)	Salinity (PSU)	pH	DO (mg/)	Turbidity (NTU)	(cfs)
5/24/2011 9:49	1	Ebb	Top	22.45	0.54	7.02	7.15	1.4	30.9
5/24/2011 9:50	1	Ebb	Bottom	20.29	6.11	8.1	8.34	3.9	30.9
6/30/2011 14:45	1	Ebb	Top	25.12	0.75	7.55	7.82	1.3	15.2
6/30/2011 14:45	1	Ebb	Bottom	23.61	4.39	7.9	5.59	3.9	15.2
7/26/2011 10:44	1	Flood	Top	25.41	0.71	7.35	6.79	1.3	24.6
7/26/2011 10:43	1	Flood	Bottom	23.76	6.38	8.37	5.69	5.2	24.6
8/23/2011 10:11	1	Hi Slack	Top	25.7	0.62	7.39	6.78	0.8	15.7
8/23/2011 10:09	1	Flood	Bottom	24.36	8.25	8.53	5.37	6.2	15.7
9/22/2011 13:58	1	Ebb	Top	No data	No data	No data	No data	1.2	15.5
9/22/2011 13:58	1	Ebb	Bottom	25.16	11.16	8.71	6.5	7.3	15.5
10/28/2011 10:53	1	Flood	Top	24.16	0.57	7.19	7.31	1.2	21.5
10/28/2011 10:52	1	Flood	Bottom	23.52	2.88	7.16	6.87	3.5	21.5
5/24/2011 9:55	2	Ebb	Top	22.02	1.24	7.4	6.54	2.1	32.2
5/24/2011 9:57	2	Ebb	Bottom	20.87	3.4	7.6	6.98	3.1	32.2
6/30/2011 14:42	2	Ebb	Top	No data	No data	No data	No data	1.9	15.2
6/30/2011 14:40	2	Ebb	Bottom	22.87	6.29	8.55	5.8	9.6	15.2
7/26/2011 10:51	2	Flood	Top	25.32	1.34	7.54	6.65	1.4	24.6
7/26/2011 10:50	2	Flood	Bottom	23.16	11.67	8.89	6.17	10.5	24.6
8/23/2011 10:17	2	Flood	Top	25.53	1.22	7.41	6.29	2.6	15.2
8/23/2011 10:16	2	Flood	Bottom	23.56	7.55	7.8	2.99	7.3	15.2
9/22/2011 14:05	2	Ebb	Top	26.52	1.24	7.53	7.39	2.3	15.5
9/22/2011 14:04	2	Ebb	Bottom	24.94	13.45	8.79	6.68	5.5	15.5
10/28/2011 11:02	2	Flood	Top	22.65	2.16	7.19	6.54	14.7	20
10/28/2011 11:01	2	Flood	Bottom	21.4	4.01	7.18	5.3	18.7	20
5/24/2011 10:13	3	Ebb	Top	21.85	1.31	7.39	5.9	3.4	34
5/24/2011 10:12	3	Ebb	Bottom	21.26	3.05	7.4	5.21	5.7	34
6/30/2011 14:34	3	Ebb	Top	22.24	6.41	7.68	2.35	19.7	18.6
6/30/2011 14:33	3	Ebb	Bottom	21.68	6.6	7.69	2.28	24.4	18.6
7/26/2011 11:06	3	Flood	Top	23.82	5.88	7.99	3.52	11.5	23.4
7/26/2011 11:04	3	Flood	Bottom	22.74	7.5	7.83	2.22	19.8	23.4
8/23/2011 10:33	3	Flood	Top	24.57	2.58	7.54	6.05	4.3	15.2
8/23/2011 10:32	3	Flood	Bottom	22.7	10.16	7.82	2.9	19.3	15.2
9/22/2011 14:20	3	Ebb	Top	26.2	2.44	7.51	6.53	4.9	12.0
9/22/2011 14:19	3	Ebb	Bottom	24.06	10.56	8.19	3.16	14.3	12.0
10/28/2011 11:20	3	Flood	Top	18.88	9.56	7.43	4.77	30.4	12.5
10/28/2011 11:18	3	Flood	Bottom	17.81	11.49	7.51	4.81	96.3	12.5
5/24/2011 10:20	4	Ebb	Top	20.81	2.28	7.34	5.11	13	35.2
5/24/2011 10:19	4	Ebb	Bottom	20.61	2.66	7.35	5.28	14.4	35.2
6/30/2011 14:27	4	Hi Slack	Top	21.35	10.14	7.76	3.51	35.8	14.2
6/30/2011 14:26	4	Hi Slack	Bottom	21.2	10.44	7.75	3.52	47.5	14.2
7/26/2011 11:13	4	Flood	Top	22.7	10.96	8.03	4.57	18.7	22.2
7/26/2011 11:12	4	Flood	Bottom	22.13	12.18	8.09	4.55	23	22.2
8/23/2010 10:41	4	Flood	Top	23.89	5.47	7.65	4.66	16.8	15.2
8/23/2011 10:41	4	Flood	Bottom	22.47	12.29	7.86	4.06	15.5	15.2
9/22/2011 14:28	4	Ebb	Top	25.29	5.08	7.59	5.18	16.7	6.9
9/22/2011 14:27	4	Ebb	Bottom	24.09	7.95	7.74	3.59	23.4	6.9
10/28/2011 11:34	4	Flood	Top	17.41	14.76	7.61	4.75	37.6	11.5
10/28/2011 11:32	4	Flood	Bottom	17.23	15.04	7.61	4.8	67.5	11.5

Under the revised management plan described in the City's Supplemental Report to the 2007 Pond A18 Annual Self-Monitoring Report, discharge valve timing or other adaptive management actions are only implemented if surface receiving water is measured at less than 5.0 mg/L or bottom DO is less than 3.3 mg/L during a period when pond DO was below the 10th percentile trigger value and the low DO in the receiving water was due to discharge of low DO water from Pond A18. These conditions were not met at any time during 2011 monitoring season.

Table 8. Discrete Receiving Water Trigger Monitoring at Station Artesian-02.

Date and Time	Site	Tide	Depth	Temp (˚C)	Salinity (PSU)	pH	DO (mg/L)	A18 Flow (cfs)
10/28/2011 11:02	2	Flood	Top	22.7	2.2	7.2	6.5	21.5
10/28/2011 11:01	2	Flood	Bottom	21.4	4.0	8.2	5.3	21.5

Temperature, salinity, pH, DO, and chlorophyll *a* were measured monthly in Pond A18 discharge, as required by the WDR (indicated by "A" in Table 2). The WDR requires discrete DO measurements to be taken between 0800 and 1000 hours. The results below (Table 9) were taken from the continuous discharge monitor for the date and time of the Pond A18 chlorophyll *a* sample collection, which also occurred between 0800 and 1000 hours.

Table 9. Monthly Water Quality Measurements at A18 Discharge

Date and Time	Temperature (C)	Salinity (PSU)	pH	DO (mg/L)
5/24/2011 08:05	18.9	11.2	9.9	10.0
6/30/2011 08:40	21.0	10.7	9.6	7.8
7/26/2011 08:38	22.3	16.0	9.7	7.1
8/24/2011 08:25	24.8	19.0	9.7	11.9
9/22/2011 08:22	23.9	20.0	9.4	7.3
10/31/2011 08:15	18.9	19.2	8.6	4.3

Temperature

Receiving water temperature decreased in a downstream direction and with depth (Tables 7 and 8). Pond temperature is influenced by ambient air temperature and varied as expected for a large shallow, limited flow waterbody throughout the monitoring season (Table 9).

Salinity

There was a strong pattern of upstream stratification and downstream mixing in the receiving water (Figure 11). This recurring pattern has been observed over the past six years during flooding tides regardless of whether Pond A18 was discharging (Tables 7 and 8). The overall in pond salinity was the lowest in years, gradually increasing from 11 to 19 PSU (Table 9).

pH

Receiving water pH tended to be stratified at the upstream Stations 1 and 2, with bottom pH higher than surface pH regardless of tidal stage or pond discharge status (Tables 7 and 8, Figure 12). Downstream Stations 3 and 4 were less stratified, similar to salinity patterns, and appeared more uniform and well-mixed throughout the water column.

Pond pH was markedly higher than that of the receiving water until mid-September when it began a steady decline (Figure 6). This decline may indicate a transition in the phytoplankton community characterized by increased decomposition rates. The higher pH of the pond does not appear to affect slough pH. It is noteworthy that the pond pH remained consistently high (approx. 10) for most of the season (Figure 13), whereas typically pH drops by mid-season due to a phytoplankton shift. This year, the drop came 2-3 months later than usual. Also, the slough pH variability associated with the tides was not as pronounced this year.

Dissolved Oxygen
Monthly DO measurements at the four Artesian Slough stations (Table 7 and Figure 14) show that on average, surface DO was higher than bottom DO along the length of the slough. The decrease in DO further downstream is due to lower oxygen solubility with increasing salinity. The differences between upstream to downstream DO are also amplified by the oxygen-rich effluent that comes from the Plant.

The WDR requires the Discharger to monitor, report, and take corrective action if monthly discrete DO levels in Pond A18, taken between the 0800 and 1000 hours at station A-A18-M [can be taken at station D], fall below 1.0 mg/L. This condition did not occur in 2011 (Table 9).

Weekly "trigger" water column profiles for temperature, salinity, pH and DO at Station Artesian-02 began on October 28 when pond DO levels fell below the 3.3 mg/L trigger as a 10^{th} percentile weekly value the week before. This monitoring (Table 8) occurred once and revealed that the surface DO was not below 5.0 mg/L and the bottom DO was not below 3.3 mg/L.

Turbidity
Monthly turbidity measurements at four stations in Artesian Slough showed that turbidity increased in a downstream direction from Station 1 to Station 4 (Figure 15). As expected, turbidity was greater at the bottom than at the surface at each station. Greater downstream turbidity is due to lower TSS in Plant discharge, the greater effect of flooding tides on turbidity in the lower segments of Artesian Slough, and stream beds in the downstream locations composed primarily of silt rather than cobbles in the upstream portions.

D. Sediment Monitoring

The WDR specifies annual monitoring for mercury and methyl mercury from in-pond sediments to be performed in August or September of each year. Per Regional Water Board letter dated 15 September 2010, the 2011 mercury sediment monitoring was conducted in the receiving waters (Artesian Slough) rather than in Pond A18. This monitoring occurred on 9/13/2011.

Mercury/Methyl Mercury
Artesian Slough sediment was sampled for concentrations of total mercury and methyl mercury at six locations (Figure 1) by the United States Geological Survey (USGS). Sediment mercury analyses are summarized in Table 10. Total mercury in sediment samples ranged from 131 to 310 ng/g dry weight (Table 10), which is well below USEPA criteria for total mercury in

sediment (1000 ng/g dry weight). Methyl mercury concentrations in sediment ranged from 1.3 to 13.1 ng/g.

Table 10. 2011 Sediment mercury & Methyl mercury results for Artesian Slough. Station s-3 is the most upriver station and s-6 is the most down river station.

Analyte	s-3	s-4	s-5	s-6
Total Hg (ng/g)	131	310	329	232
Me Hg (ng/g)	2.0	13.1	1.6	1.5
Percent Fines (%)	33	92	92	68

E. Chlorophyll *a*

Chlorophyll *a* was measured at the Pond A18 discharge point once per month by taking a grab sample in a 1-liter amber glass jar. The sample was kept cool and out of direct light and was transferred (within 24 hours) to Basic Laboratory services in Redding, CA.

Chlorophyll *a* levels in Pond A18 were typical of the past few seasons beginning with marginal values and ending with a peak (Table 11). By September, the water was more turbid and changed from green to brown, followed by a change back to green in October.

Table 11. Monthly chlorophyll *a* measurements at A18 discharge.
Salinity measurements are included for context as general changes in pond characteristics.

Month	Date sampled	Salinity (PSU)	Chlorophyll *a* (µg/L)
May	5/24/11	11.2	ND
June	6/30/11	10.7	13
July	7/26/11	16.0	2
August	8/24/11	19.0	2
September	9/22/11	20.0	8
October	10/31/11	19.2	68

*ND indicates a non-detect reading.

F. Irradiance Measurements and Relationship to Dissolved Oxygen

Measurements for irradiance as solar radiation were obtained from the Union City CIMIS[2] station. Fluctuations in irradiance affect pond community structure, the rate of photosynthesis, and DO concentrations. As daily solar radiation decreases during late summer and early fall, the decrease can cause shifts in pond phytoplankton communities by favoring shade-tolerant phytoplankton species. As less shade-tolerant species die-off, their decomposition consumes oxygen and produces carbonic acid leading to a lower DO and pH.

[2] California Irrigation Management Information Systems (CIMIS) at wwwcimis.water.ca.gov/cimis/data.jsp

Each monitoring season, DO levels are typically stable, followed by a substantial decrease. Not long after this decrease, DO levels increase and decrease sharply, which is indicative of boom and bust cycles in the phytoplankton community similar to what would occur in late-summer eutrophic conditions.

For most of the 2011 season, DO levels were stable and actually increased (Figures 8 and 16) during August, followed by a drop in September. It was after this decrease where DO levels became unstable, which has been the case for all monitoring seasons in the past. This pattern occurred again in 2011, but did so 2-3 months later than usual. The result was an overall higher DO for most of the season than compared to other seasons (Figure 6).

Short Duration Changes in Daily Irradiance
Short-term fluctuations can be caused by overcast skies, storms, or wildfires (Figure 17). Daily average irradiance decreased from early July to mid August, whereas daily average pond DO increased.

III. Exceedances and Triggered Actions

A. Summary of Exceedances and Triggers

Figures 18 and 19 illustrate the exceedances and triggers for DO and pH for 2011. These mostly brief events coincided with tidal cycles and were reported to the Regional Water Board. In late October, the 10^{th} percentile DO value went below the trigger value.

B. Summary of Corrective Action

On seventeen different occasions, receiving water DO fell below the 5.0 mg/L Basin Plan Objective for periods of 1.0- 2.5 hours (Figure 18). These episodes occurred at night during high tide. Neither incident was attributable to Pond A18 discharge.

There were twenty-one incidents where receiving water pH rose above 8.5 (maximum of 9.0). These events were mostly brief and minor and were associated with early morning extreme spring tides rather than Pond A18 discharges (Figure 19).

There were three weeks in which the weekly 10^{th} percentile DO level in the discharge fell below the established trigger of 3.3 mg/L. Despite this decrease in pond DO, no negative effects were detected in the receiving water that could be attributed to Pond A18 discharge, hence gate closures were not implemented in 2011.

IV. Discussion and Interpretation of 2011 Results

Temperature
Pond and receiving water temperatures in 2011 (Table 3; Figures 3 and 4) were similar to 2010.

This was the result of another mild summer with relatively lower temperatures. Prolonged hot weather, such as the heat wave in 2006, can depress DO levels due to increased respiration.

Salinity

Salinity is the most variable parameter in the pond both within and between years. During 2011, overall salinity was the lowest since 2006 (Figure 10). The amount of precipitation in the preceding wet season affects the pond's salinity during the early parts of each dry season. For example, 2008 and 2009 had high salinities in May (18 PSU), which continued through the end (29 PSU) of the monitoring season. Last year (2010) had moderate rainfall and pond salinity in early May was 11 PSU and by end of October, was 25 PSU. This year (2011) was a "wet year" and pond salinity was at 10 PSU in May and reached its maximum (19 PSU) in late September. The lower salinity for this season is due to a number of factors, such as a mild summer with unusual summer rains and lower evaporation rates, preceding wet season precipitation, and dam releases by the Santa Clara Valley Water District (District), which resulted in lower salinity in Artesian Slough (Figure 5).

Since late summer of 2005, there has been no observed vertical stratification of receiving waters as a result of Pond A18 discharge (Table 8). The differences between surface and bottom salinity at downstream stations are explained by tidal action in Artesian Slough (Figure 7) and fresh water flows from the San Jose/Santa Clara Water Pollution Control Plant (Plant). Fresh water from the Plant is less dense and tends to float on top of saline Bay water being pushed into the slough by the flooding tide.

pH

Pond pH increases as a result of photosynthesis when irradiance and temperatures are high. Increases in pH are limited due to the buffering capacity of salt water. Pond pH was high (approx. 10) for most the season due to low salinity (Figure 6). By early September, pH decreased at a typical rate and magnitude; however, this decrease occurred 2-3 months later than previous seasons. These decreases in pH have occurred every monitoring season to date and reflect a change in the algal community. This is evident in observed water color, water clarity changes, and chlorophyll *a* measurements.

Although high pH could cause osmotic stress to aquatic life, the slow rate of pH change in well-buffered pond water likely allows organisms to adjust. The low salinity this season lowered the pond's buffering capacity, keeping pH levels high for a prolonged period. With such high pH levels, there was no apparent effect in the receiving water from Pond A18 discharge. Rather, the regular fluctuations of receiving water pH are strongly associated with the tidal cycle (Figure 7) and show a diurnal pattern likely due to changes in rates of photosynthesis.

Adaptive Management of Pond DO Levels

Years of monitoring have shown it is unnecessary to close the discharge gate when pond DO falls below the trigger. In 2008, a revised management strategy that helps maintain a more consistent circulation pattern in the pond throughout the dry season replaced the previous strategy of initiating timed discharges after a DO trigger event. Instead of discharge valve closures, increased "trigger" monitoring takes place weekly at the nearest downstream station (Table 8) if the weekly 10^{th} percentile DO value goes below the threshold value (3.3 mg/L). This monitoring continues until DO levels rise above the trigger. Gate closures are only implemented if the receiving water DO at the surface is less than 5.0 mg/L or less than 3.3 mg/L at the bottom. By following this revised management strategy, there have not been any observations of stressed fish since 2008. It is noteworthy to point out that receiving water DO was relatively higher during the end of the season when the pond DO began to decrease below the trigger value (Figure 18). This gives further evidence of the tidal influence on water quality of Artesian Slough versus the pond effluent.

There were no timed gate closures in 2011. Also, there were no observations of stressed fish and no negative effects to the receiving water as a result of discharges from the pond during low-DO periods.

Average discharge flow volume from Pond A18
Artesian Slough is dominated by tidal influence and continuous freshwater flows from the Plant (100 MGD). During high tides, salt water from San Francisco Bay provides most of the water volume in Artesian Slough as shown by the discrete transect receiving water monitoring (Table 7). The average pond flow is only ~ 18% of the Plant's continuous daily freshwater flow. The average discharge volume from Pond A18 during the 2011 monitoring season was 17.2 MGD, which is slightly lower than 2010 (21.6 MGD). The slight inter-annual variations in flow are due to modifications to discharge valve settings in order to maintain a consistent pond water depth. There appears to be rapid mixing of pond discharge with receiving waters. These two factors likely account for the negligible effect of pond discharge on receiving water quality even at Artesian Slough Station 2 (Table 7) immediately downstream of the pond discharge point.

Mercury and Methyl Mercury Analysis of Receiving Water Sediment.
Mercury and methyl mercury concentrations in A18 sediments have been measured annually since 2005. At the request of the Regional Water Board, sediment of the receiving water (Artesian Slough) was sampled and analyzed for mercury and methyl mercury.

The previous years of pond data did not show any clear spatial patterns however, a slight temporal trend can be seen with an overall increase in total mercury, peaking in 2009, followed by a substantial decrease in 2010. There are no clear spatial or temporal patterns for methyl mercury in the pond.

Mean (± SE) sediment mercury and methyl mercury concentrations in Artesian Slough are 349 ± 48 ng/g and 7.31 ± 1.74 ng/g, respectively. The total mercury concentration in Artesian Slough is lower than Alviso Slough, however, the methyl mercury concentration is higher (Table 12). This may suggest a higher methylation rate is occurring in Artesian Slough.

Table 12. Comparison of Sediment Mercury (Mean ± SE) in Receving water and an Adjacent Slough[3].

Data Source	Total Mercury (ng/g)	n	Methyl Mercury (ng/g)	n
Artesian Slough	349 ± 48	6	7.31 ± 1.74	6
Alviso Slough	595 ± 75	24	2.25 ± 0.23	24

[3] Unpublished Data, M. Marvin-DiPasquale, USGS. Used by permission.

Pond Primary Production
Due to shallow depths in Pond A18 (average of approximately 2 feet), high summer irradiance, low flow-through rates, and nutrient availability, phytoplankton blooms were common in 2005 and 2006. However, there have not been such dramatic phytoplankton blooms in subsequent seasons in 2007-2011. Chlorophyll *a* levels for 2011 were typical of non-bloom years (Table 11). Although a dramatic bloom did not occur in 2011, observed water color changes and various fouling situations in the pond are indicative of a transition in pond community structure.

While extreme variations in chlorophyll *a* were not observed in 2011, the physical properties of the pond, high irradiance and low flow through rates result in a highly productive system that can become unstable in response to environmental variations such as temperature, precipitation, or irradiance. Based on high resolution continuous DO data collected in Pond A18 for 2006, mean Gross Primary Production (GPP) is estimated to be 8.2 g O_2 /m^2/day. This rate of photosynthesis is double the rate of some of the world's most productive estuaries, such as the Chesapeake Bay[4]. DO data from 2011 is similar to that of 2006. Therefore, 2006 estimates of GPP are a likely approximation for those of 2011.

High rates of photosynthesis, which cause extremely high DO levels measured in the pond (max of 18.5 mg/L, Table 6), are balanced by high rates of ecosystem respiration (ER) by pond algae, zooplankton, benthic invertebrates, and fish. At night when photosynthesis ceases, respiration can cause extremely low DO levels (minimum of 0.0 mg/L, Table 6). The extremes of GPP and ER in Pond A18 provide a beneficial food supply function. However, the extreme levels and apparent tight coupling of GPP and ER also result in a system that is highly susceptible to hypoxic events when irradiance decreases, temperature increases (increases metabolism and respiration) and possibly during seasonal and monthly swings in salinity that may induce changes in phytoplankton species dominance. This year, it may be the low salinity that was responsible for the change in phytoplankton dominance 2-3 months later than normal.

In 2006, Chlorophyll *a* results indicated a rapid decline in pond phytoplankton biomass in July. This corresponded to a prolonged heat wave and a color change in Pond A18. It was suspected that this was due to a die-off of pond phytoplankton. Corresponding declines in pH and DO provided further evidence that a die-off occurred in 2006. Dead algal cells would be expected to decompose and the decomposition process would use up oxygen and release carbonic acid.

To better understand pond phytoplankton dynamics, the City decided to sample periodically for phytoplankton species composition and abundance in 2007 and 2008. This documented a shift in phytoplankton species abundance despite the absence of an apparent phytoplankton die-off in those years. Declines in pond pH levels and more extreme swings in the diurnal DO cycle also coincided with transitions in pond community structure. Each monitoring season, these transitions showed very typical patterns in: water color, clarity, changes in pH, irradiance measurements and changes in DO. The 2011 monitoring season showed similar transitional patterns in water quality and general observations, indicating the pond went through a similar

[4] Kemp, W.M, E.M Smith, M. Marvin-DiPasquale and W.R. Boynton. 1997. Organic carbon balance and net ecosystem metabolism in Chesapeake Bay. Marine Ecology Progress Series 150:229-248.

cycle of succession. The only exception in 2011 was that pond community succession was delayed approximately 2-3 months compared to previous years due to a milder summer.

Nuisance filamentous macro-algae

The presence of filamentous macro-algae in Pond A18 varies from year to year. Filamentous algae consist of macroscopic filaments which are of little value to pond productivity since filter-feeding zooplankton (copepods, cladocerans, rotifers, shrimp, aquatic insects) are not able to utilize them effectively. Filamentous algal mats also block light penetration into the water column, thereby decreasing phytoplankton production and overall pond productivity.

In 2011, there was shift in the amount and distribution of filamentous algae. Typically, there are mats of algae at the north end of the pond. In 2011, those mats were less than half the normal size. Another difference was the presence of algal mats located nearby the discharge structure. If these changes in the abundance of filamentous algae, phytoplankton composition and chlorophyll *a* are due to uncontrollable factors such as variations in irradiance, temperature or increasing pond salinity in a pond designed for high evaporation rates, such changes may be unavoidable.

V. Lessons Learned and Recommendations

1. In 2011, there were no observable effects on receiving water quality from Pond A18 discharge, even when DO levels occasionally fell below the 3.3 mg/L trigger.

Recommendation: Continue to use the DO trigger as an early warning signal to initiate additional weekly receiving water column monitoring at Station Artesian 02. Adaptive management will only be performed when both the receiving water and Pond A18 (measured by discrete monitors or continuous monitors) do not meet the DO water quality standard.

2. The effect of tides and ambient DO concentrations is greater than the effect of Pond A18 discharge on Artesian Slough DO levels. Bottom DO concentrations at Artesian Slough stations nearest the Pond A18 discharge are higher than surface DO concentrations further downstream in Artesian Slough (Figure 8).

Salinity stratification in Artesian Slough occurs during flood tides as a result of freshwater discharge flowing over denser incoming saltwater. During ebb tides near low tide, when Pond A18 has significant discharge, there is less salinity stratification in Artesian Slough, probably due to dilution of pond water with Plant flows.

Recommendation: Continue the current operations and management strategy. This is further evidence of the minimal impact Pond A18 discharge has on Artesian Slough and the greater effect of ambient Bay water entering the slough during flooding tides.

3. Sampling chlorophyll *a* and tracking irradiance provided useful information for characterizing variability of the Pond A18 phytoplankton community and how climatic and

water quality factors affect pond stability. However, DO continued to climb late in the season while irradiance declined.

Recommendation: Continue monitoring chlorophyll *a* and tracking changes in irradiance.

4. Pond A18 has very high primary productivity due to the large biomass of phytoplankton. Because of this high productivity, short-term decreases in irradiance due to cloud cover, rain events or other conditions can temporarily depress DO due to decreased photosynthesis.

Recommendation: The strategy of continuous discharge appears to benefit pond biota. Changes in irradiance are uncontrollable and likely independently affect pond DO and receiving water DO. Shutting the discharge valve as a result of temporary low DO due to decreased irradiance may exacerbate low DO idue to stagnation of pond water. No adverse effects on receiving water DO have been measured in six years of monitoring.

5. Collaborative Artesian Slough sediment sampling of mercury and methylmercury with the United States Geological Survey (USGS) appeared to be productive and cost-effective.

Recommendation: Continue collaborative mercury sediment sampling of Artesian Slough with USGS.

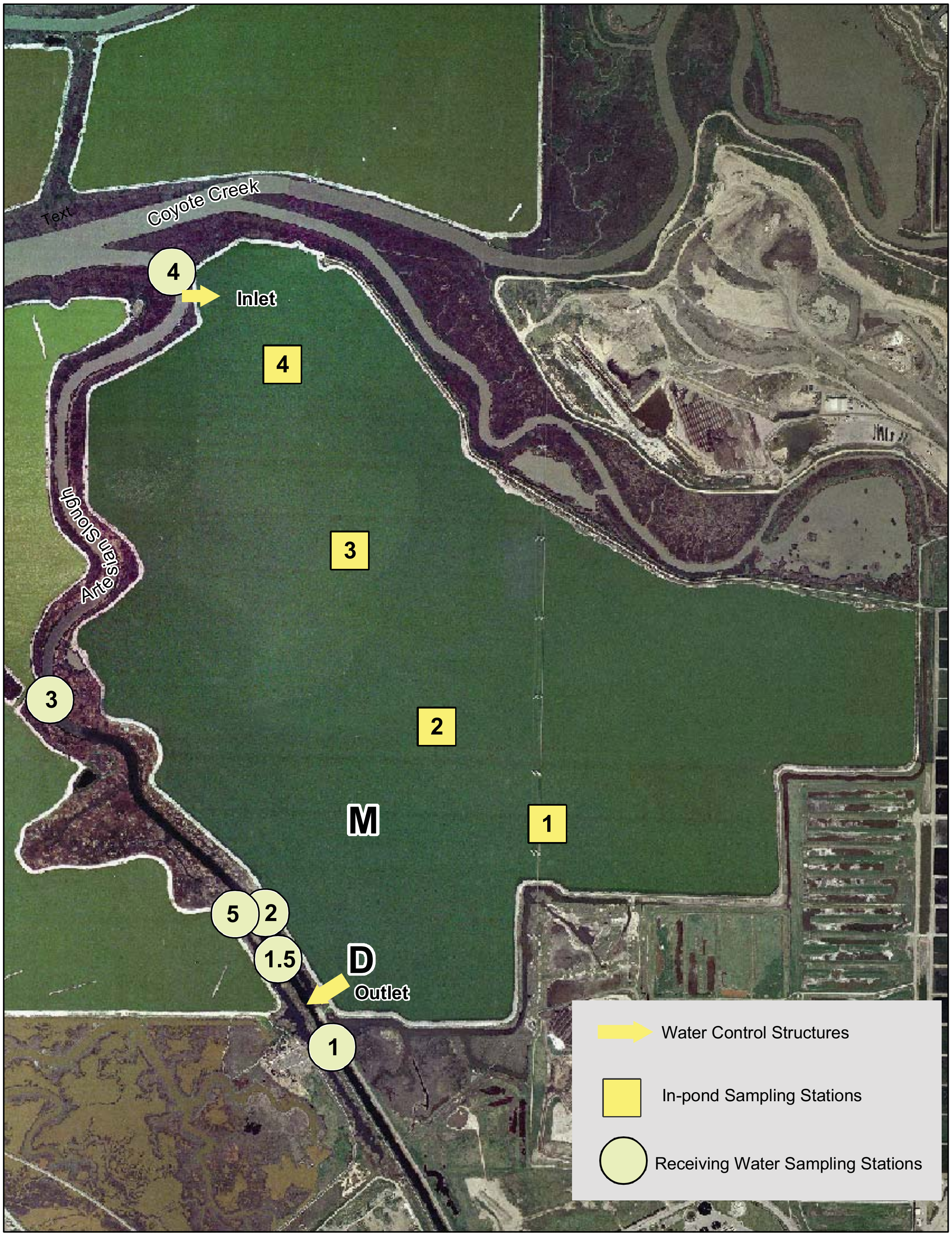


Figure 1. Artesian Slough and Pond A18 Monitoring Stations

Pond stations are referred to in the text as 1,2,3, & 4 (yellow squares). Artesian Slough stations (green circles) and Pond stations D and M are abbreviated in this figure. For example, station A-A18-1 is abbreviated as 1, A-A18-D is abbreviated as D, etc. Stations 2 (for discrete monitoring) and 5 (for continuous monitoring) are located at the same site in Artesian Slough.

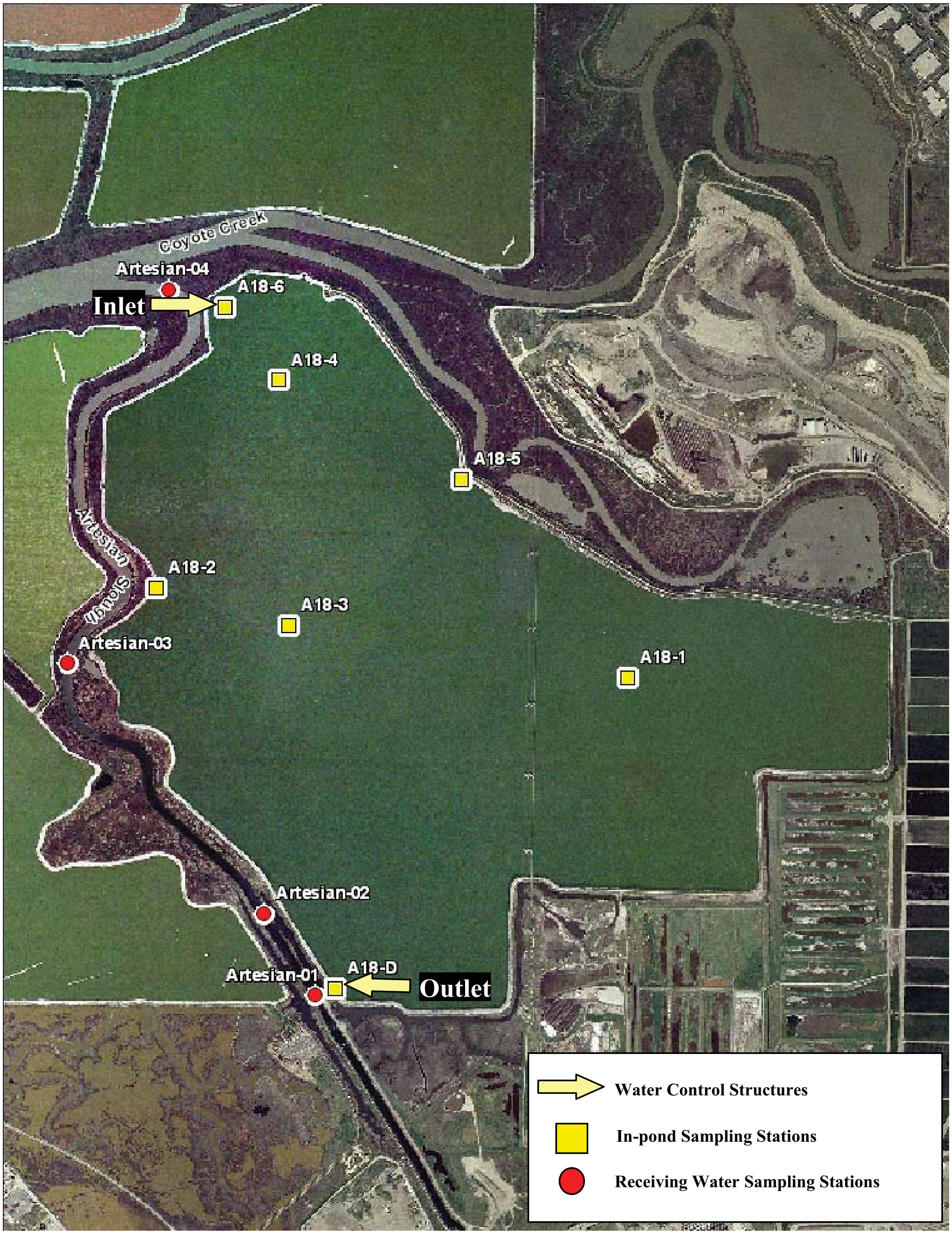


Figure 2. Artesian Slough and Pond A18 Supplemental Monitoring Stations from 2006 Supplemental Monitoring.

Figure 3. 2011 Dry Season Temperature Profiles of Pond A18 and Artesian Slough

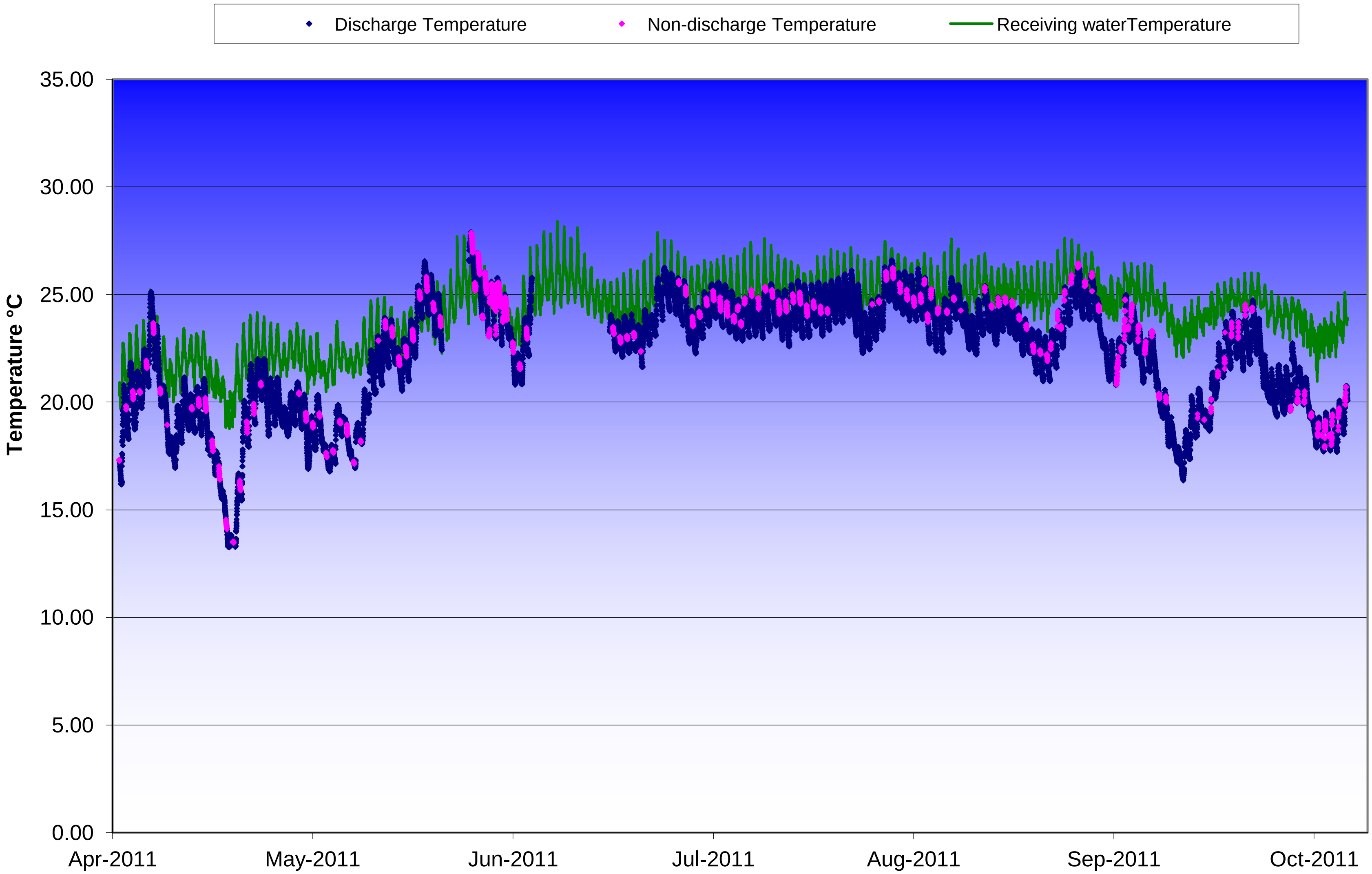


Figure 4. 2011 Temperature Difference between A18 Discharge and Artesian Slough

Positive values indicate that Artesian Slough temperature is greater than Pond A18 discharge.

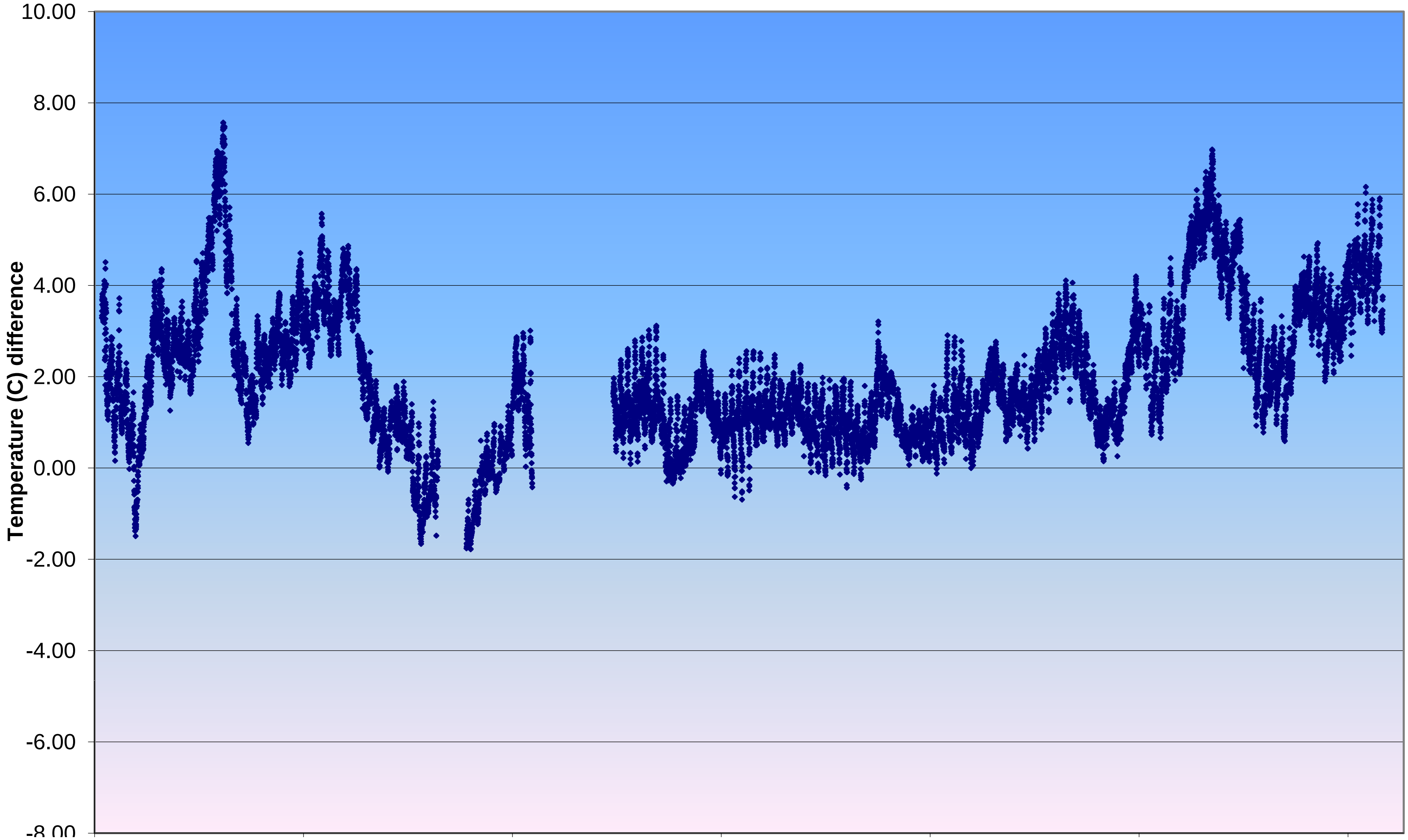
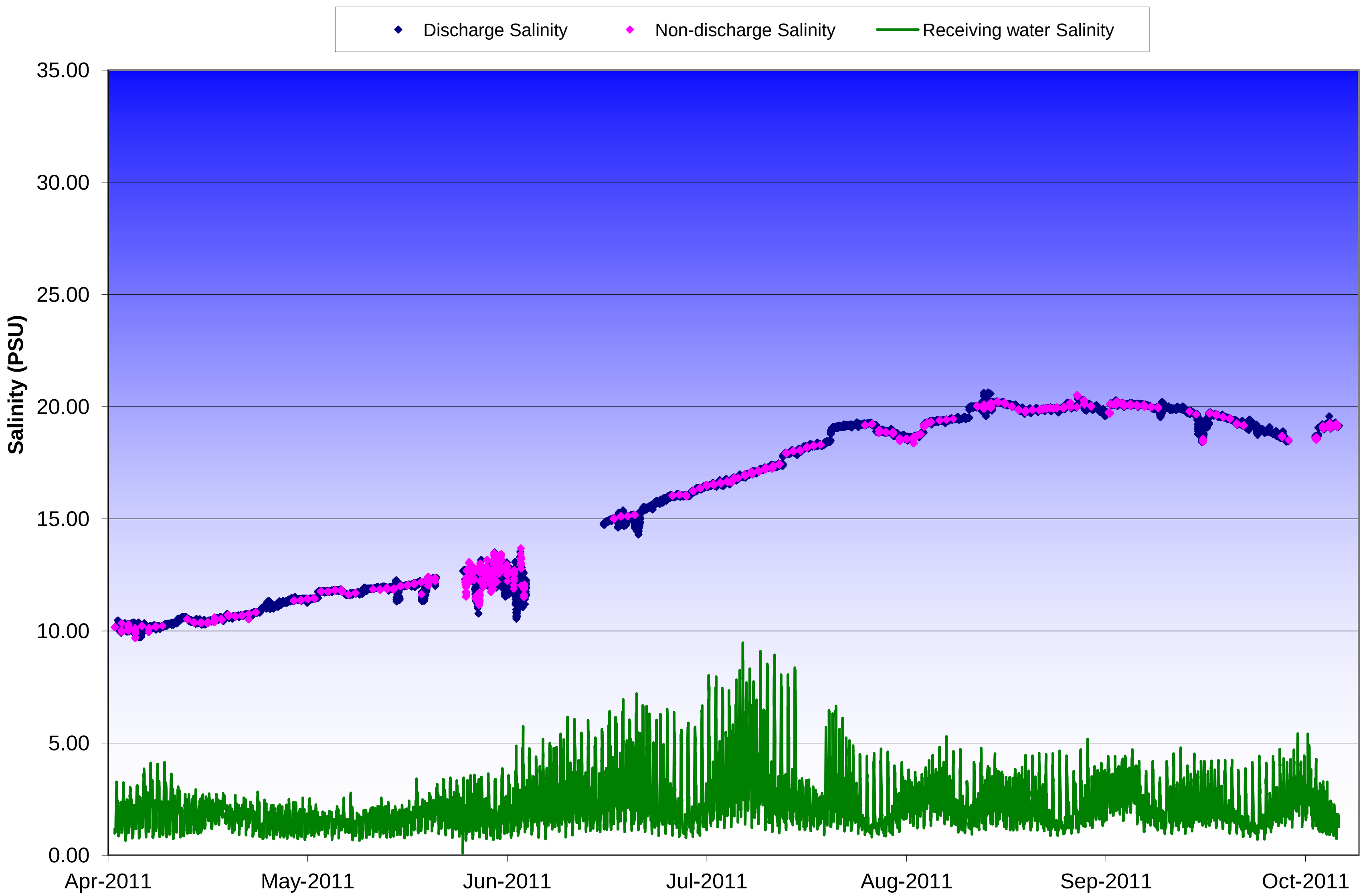


Figure 5. 2011 Dry Season Salinity Profiles of Pond A18 and Artesian Slough



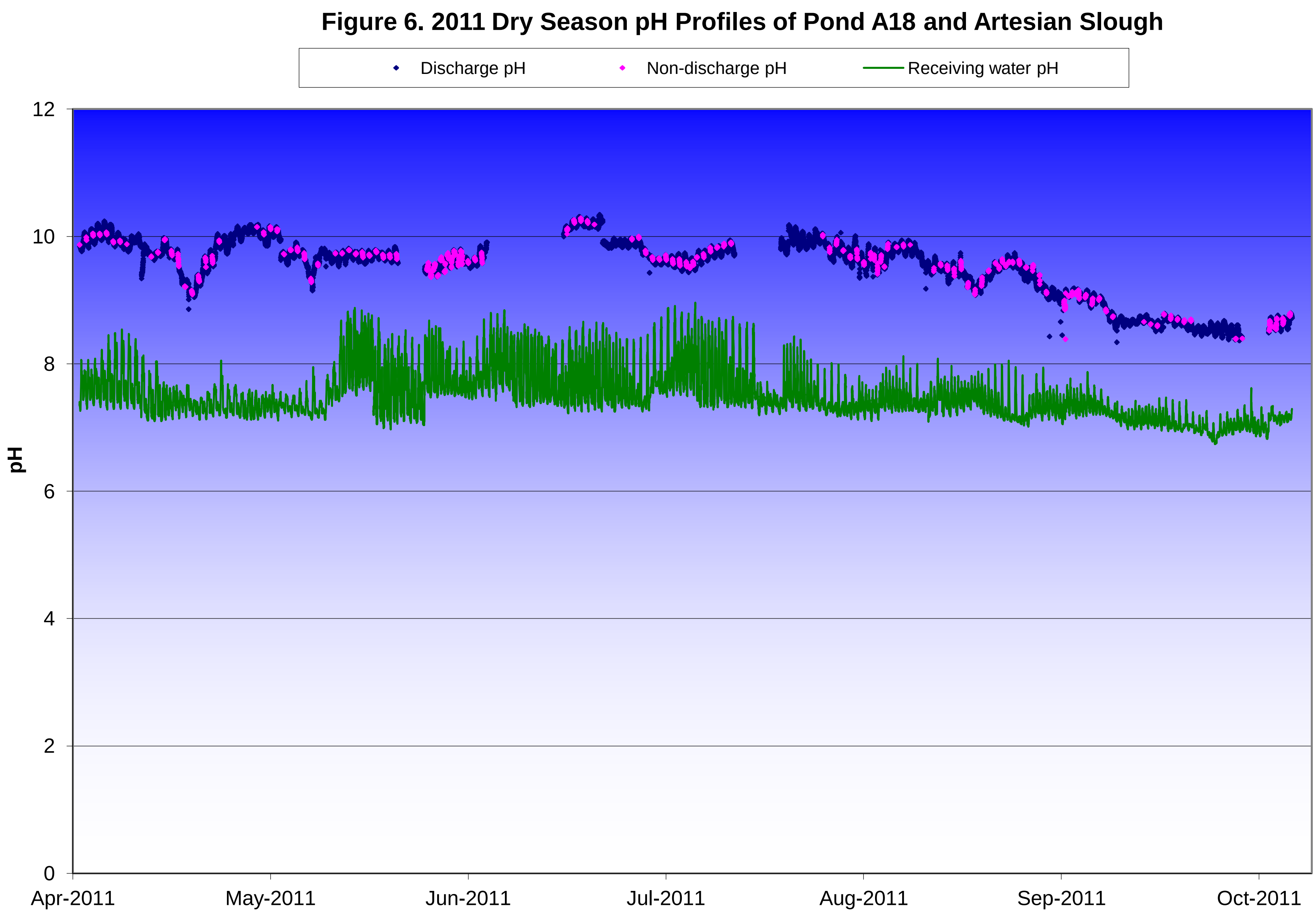


Figure 6. 2011 Dry Season pH Profiles of Pond A18 and Artesian Slough
Discharge pH
Non-discharge pH
Receiving water pH
pH
0
2
4
6
8
10
12
Apr-2011
May-2011
Jun-2011
Jul-2011
Aug-2011
Sep-2011
Oct-2011

Figure 7. Effect of Tidal Cycle on Salinity and pH of Artesian Slough
Example taken from Week 19 of Receiving Water data

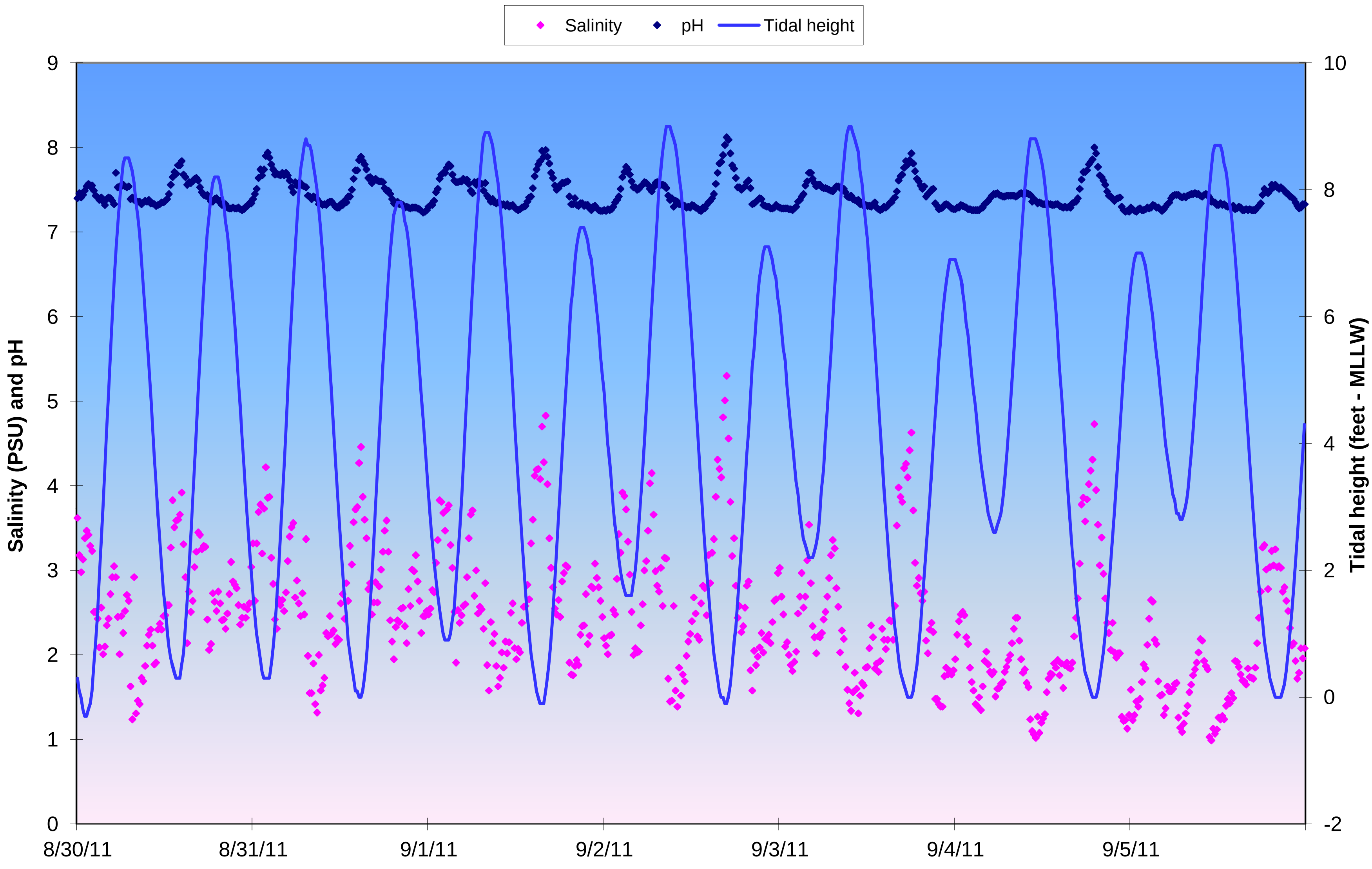
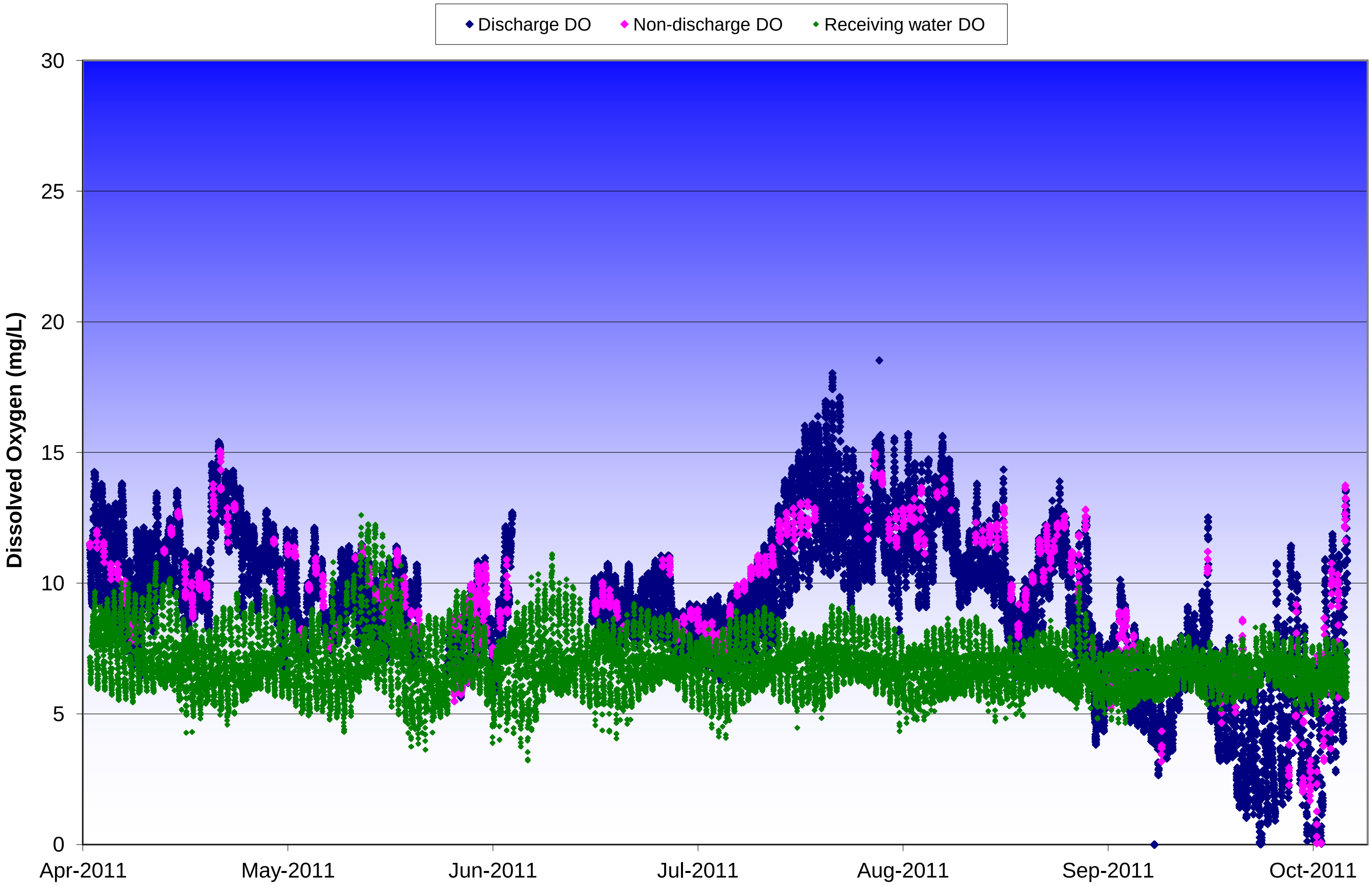


Figure 8. DO Profiles of Pond A18 and Artesian Slough



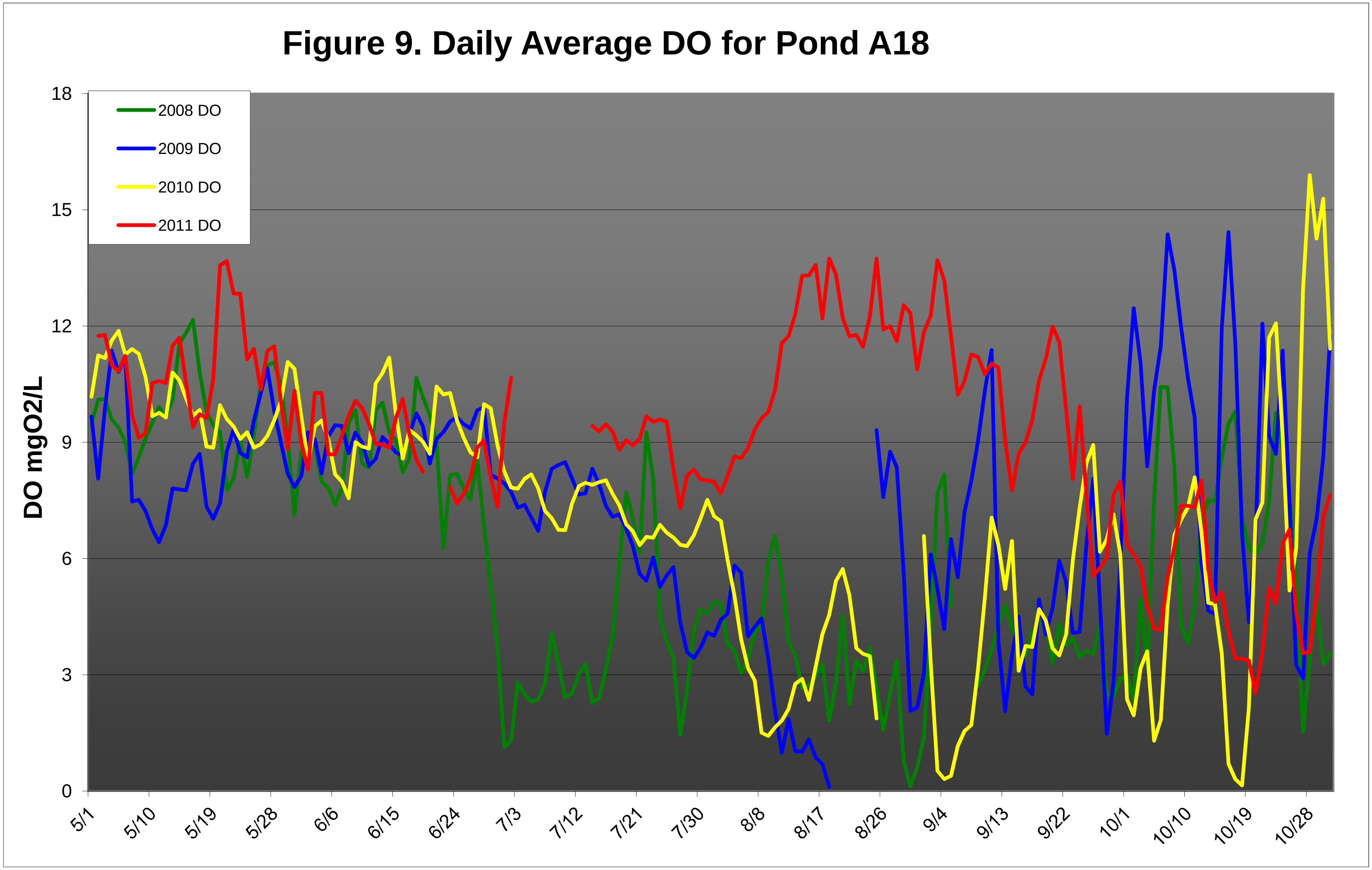


Figure 9. Daily Average DO for Pond A18
DO mgO2/L
2008 DO
2009 DO
2010 DO
2011 DO
0
3
6
9
12
15
18
5/1
5/10
5/19
5/28
6/6
6/15
6/24
7/3
7/12
7/21
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8/17
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10/1
10/10
10/19
10/28

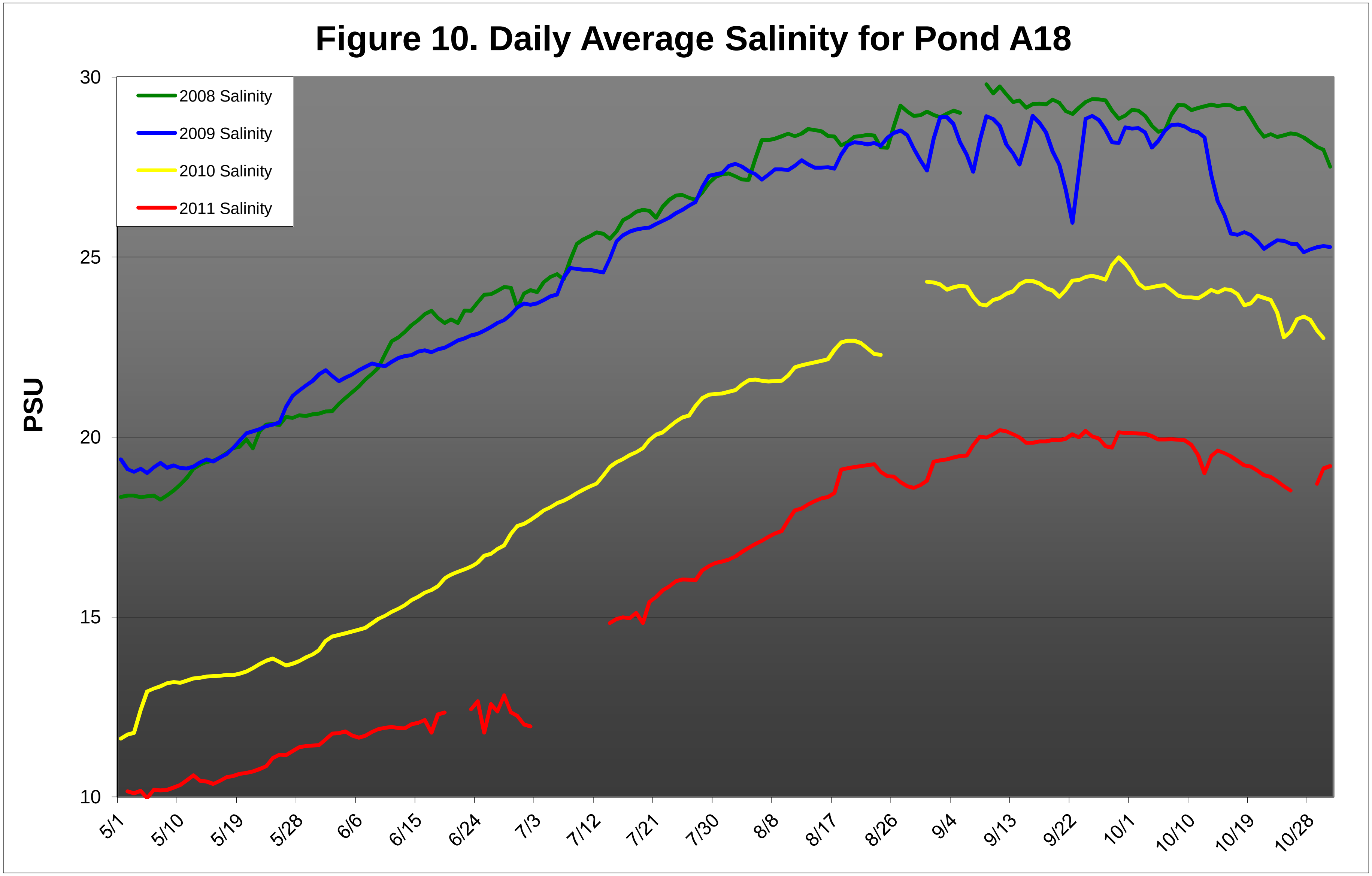


Figure 10. Daily Average Salinity for Pond A18
2008 Salinity
2009 Salinity
2010 Salinity
2011 Salinity
PSU
30
25
20
15
10
5/1
5/10
5/19
5/28
6/6
6/15
6/24
7/3
7/12
7/21
7/30
8/8
8/17
8/26
9/4
9/13
9/22
10/1
10/10
10/19
10/28

Figure 11. Mean (± SE) Monthly Salinity in Artesian Slough for 2011

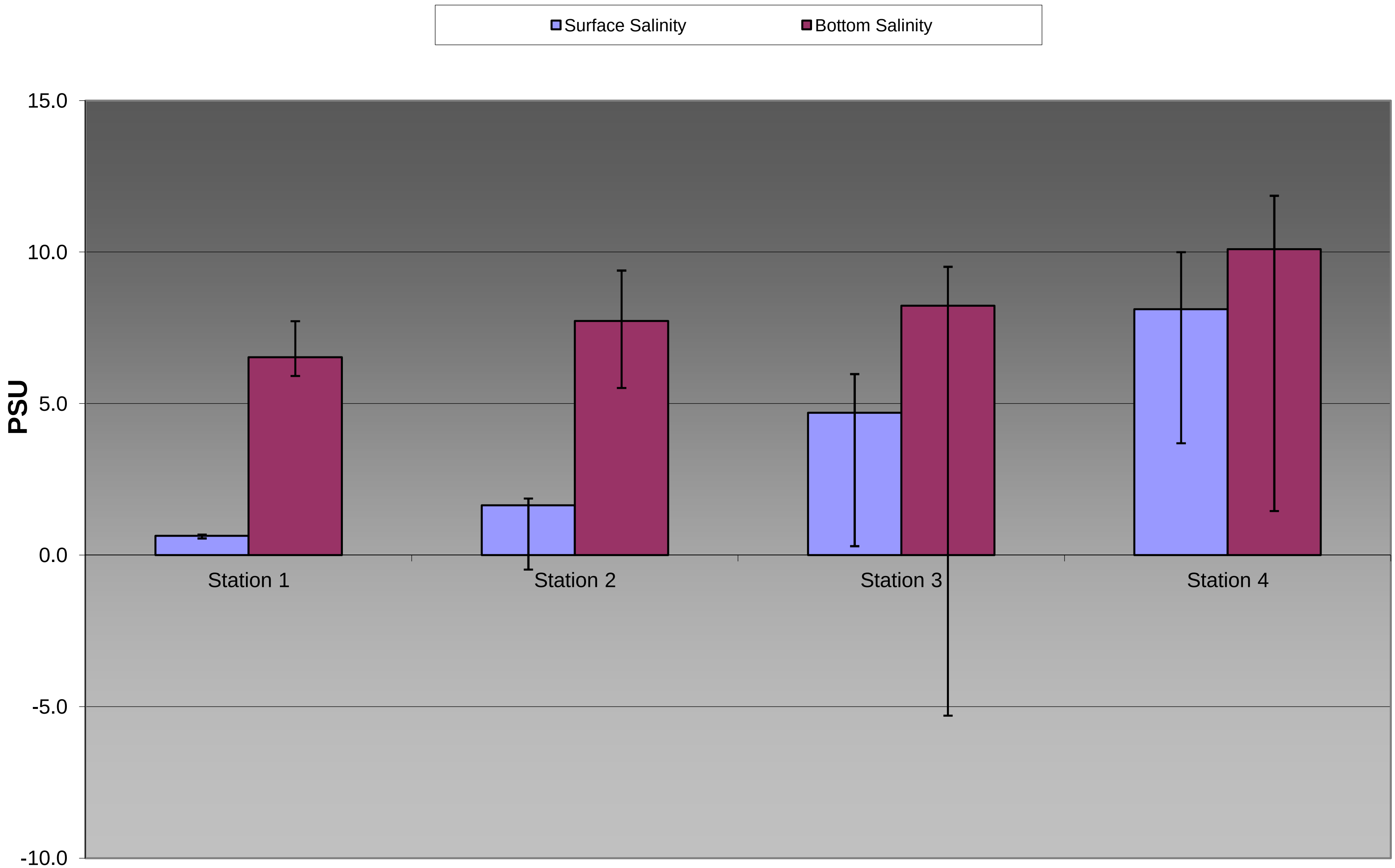
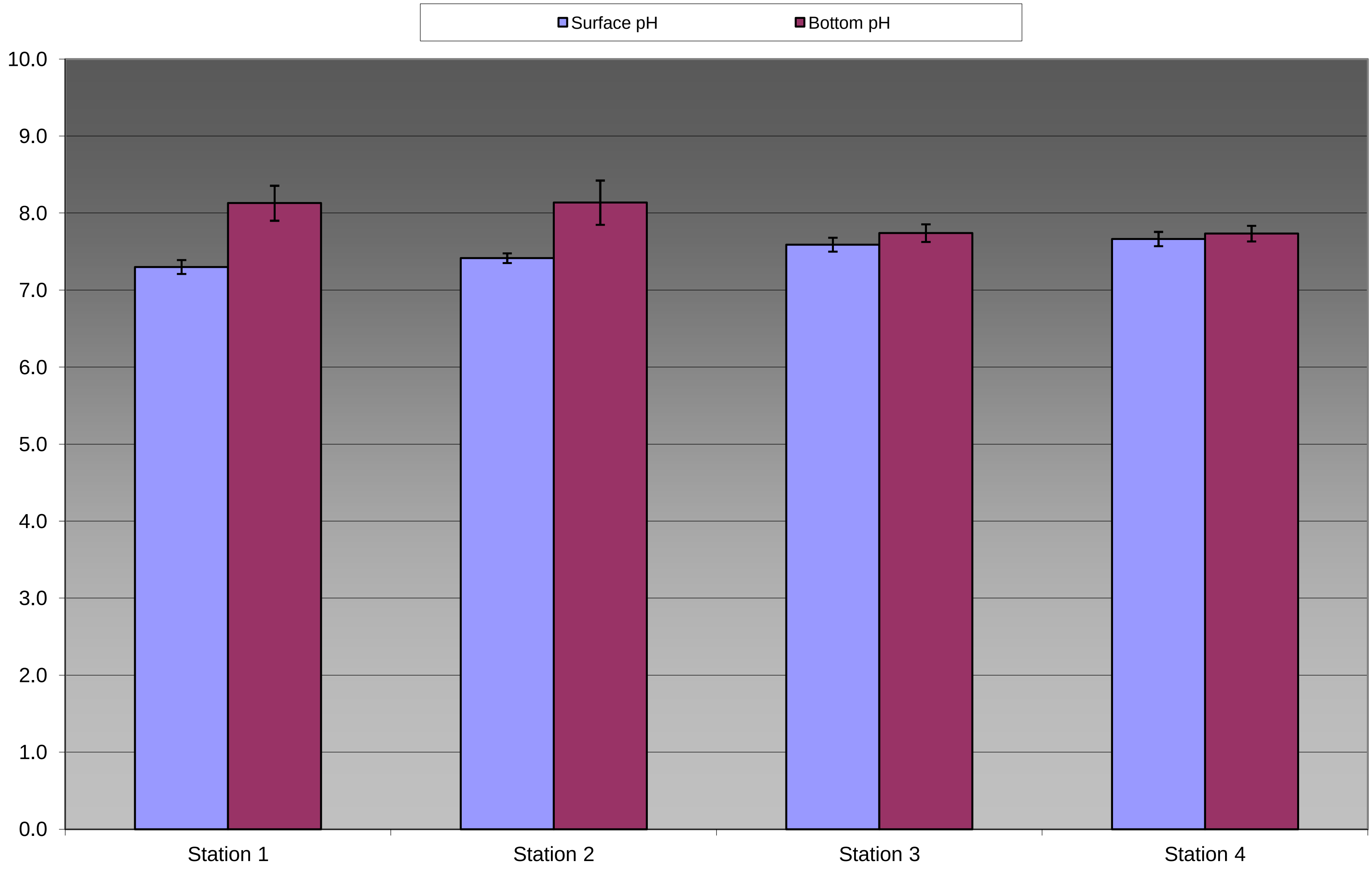


Figure 12. Mean (+ SE) Monthly pH in Artesian Slough for 2011



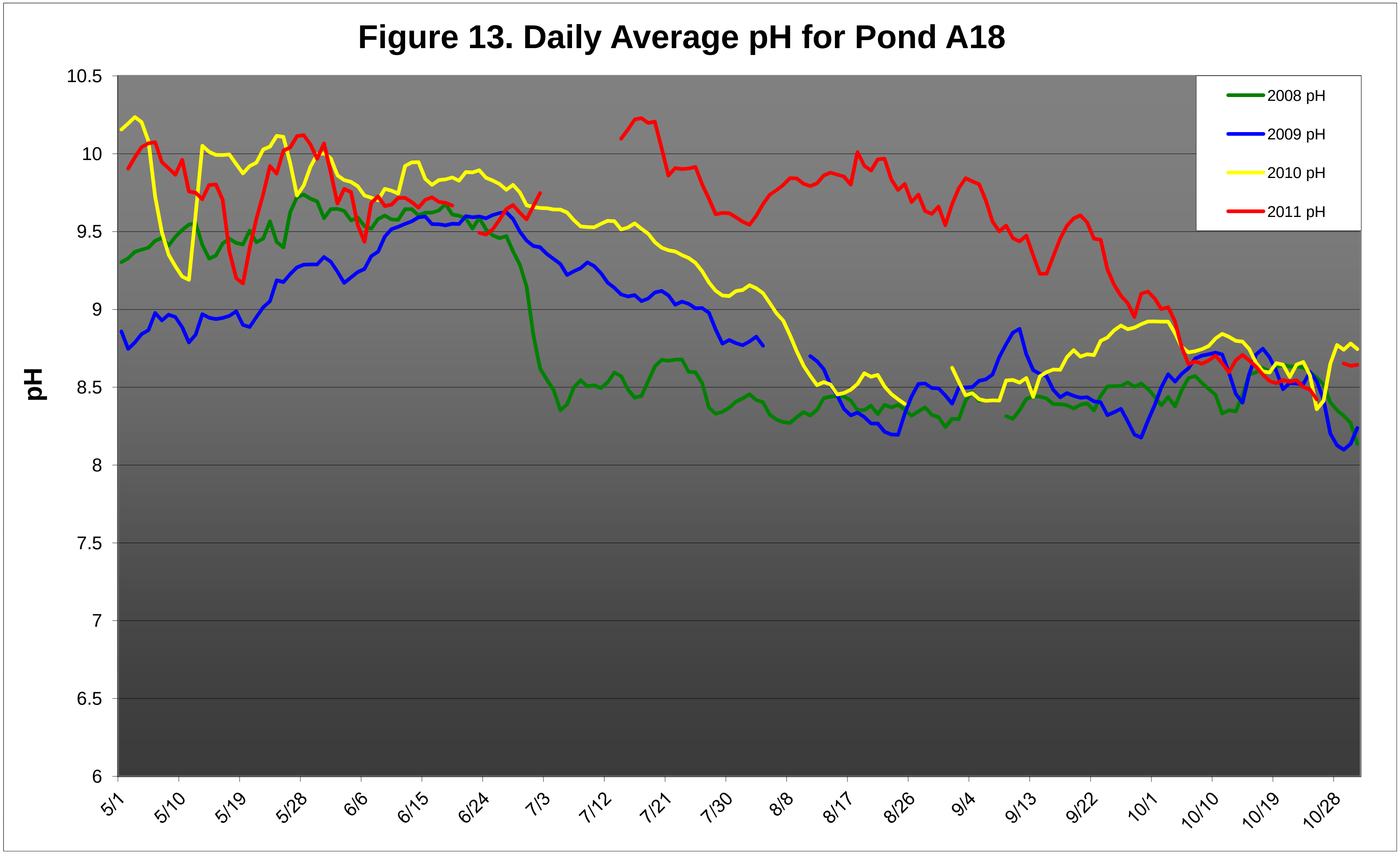


Figure 13. Daily Average pH for Pond A18
pH
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5/1
5/10
5/19
5/28
6/6
6/15
6/24
7/3
7/12
7/21
7/30
8/8
8/17
8/26
9/4
9/13
9/22
10/1
10/10
10/19
10/28
2008 pH
2009 pH
2010 pH
2011 pH

Figure 14. Mean (± SE) Monthly Dissolved Oxygen in Artesian Slough for 2011

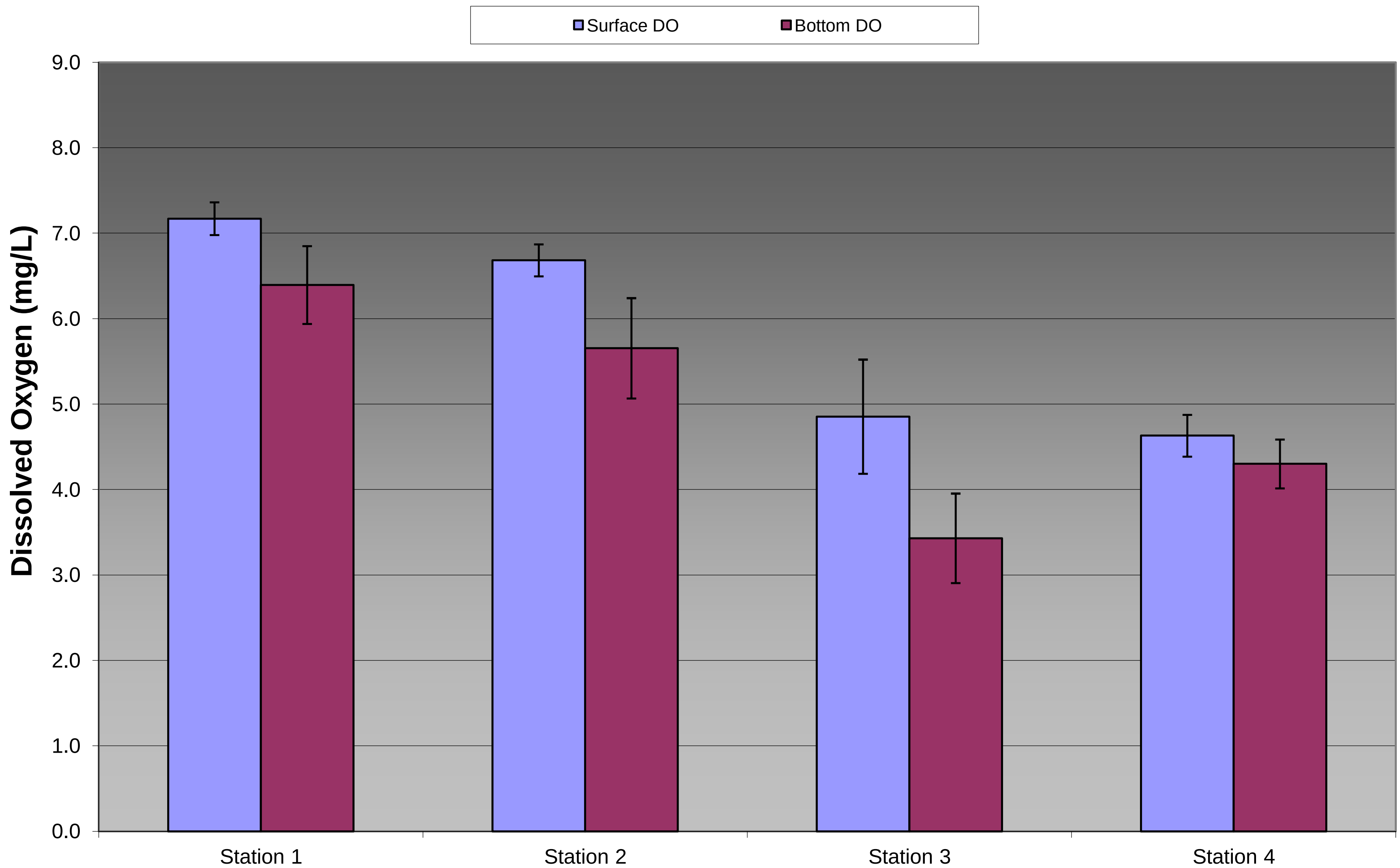
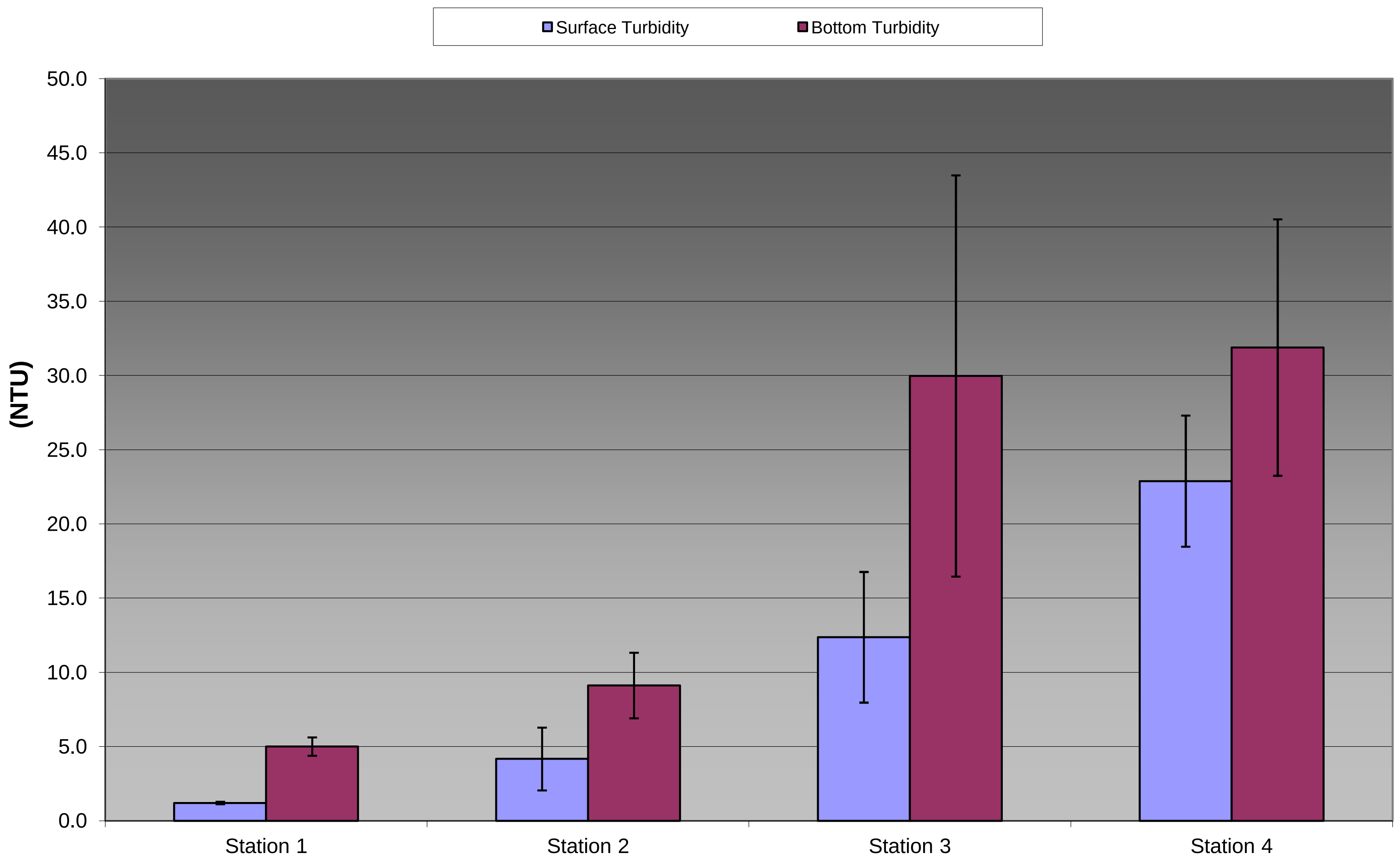


Figure 15. Mean (± SE) Monthly Turbidity in Artesian Slough for 2011



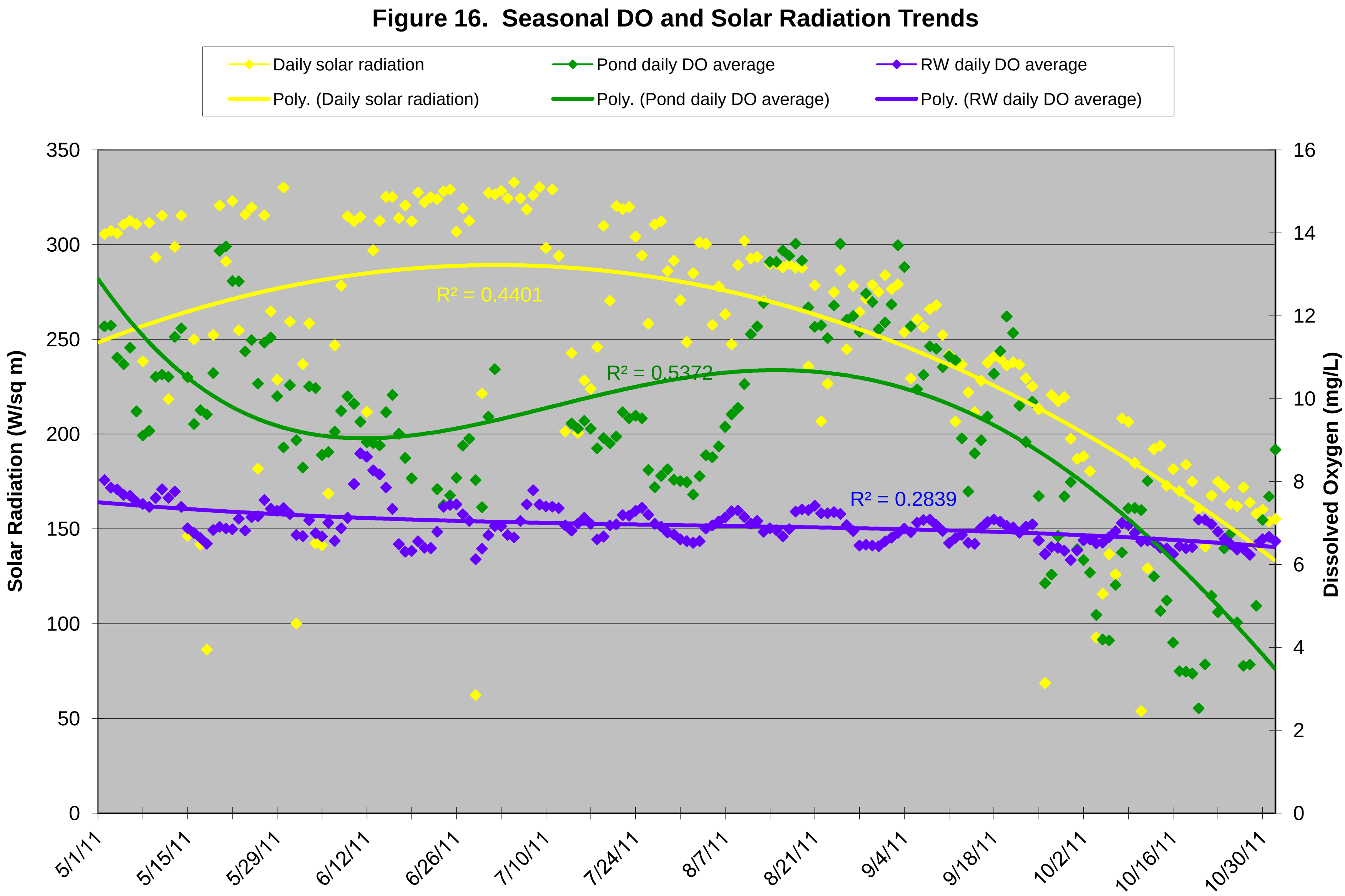


Figure 16. Seasonal DO and Solar Radiation Trends
Daily solar radiation
Pond daily DO average
RW daily DO average
Poly. (Daily solar radiation)
Poly. (Pond daily DO average)
Poly. (RW daily DO average)
Solar Radiation (W/sq m)
Dissolved Oxygen (mg/L)
R² = 0.4401
R² = 0.5372
R² = 0.2839
0
50
100
150
200
250
300
350
0
2
4
6
8
10
12
14
16
5/1/11
5/15/11
5/29/11
6/12/11
6/26/11
7/10/11
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10/2/11
10/16/11
10/30/11

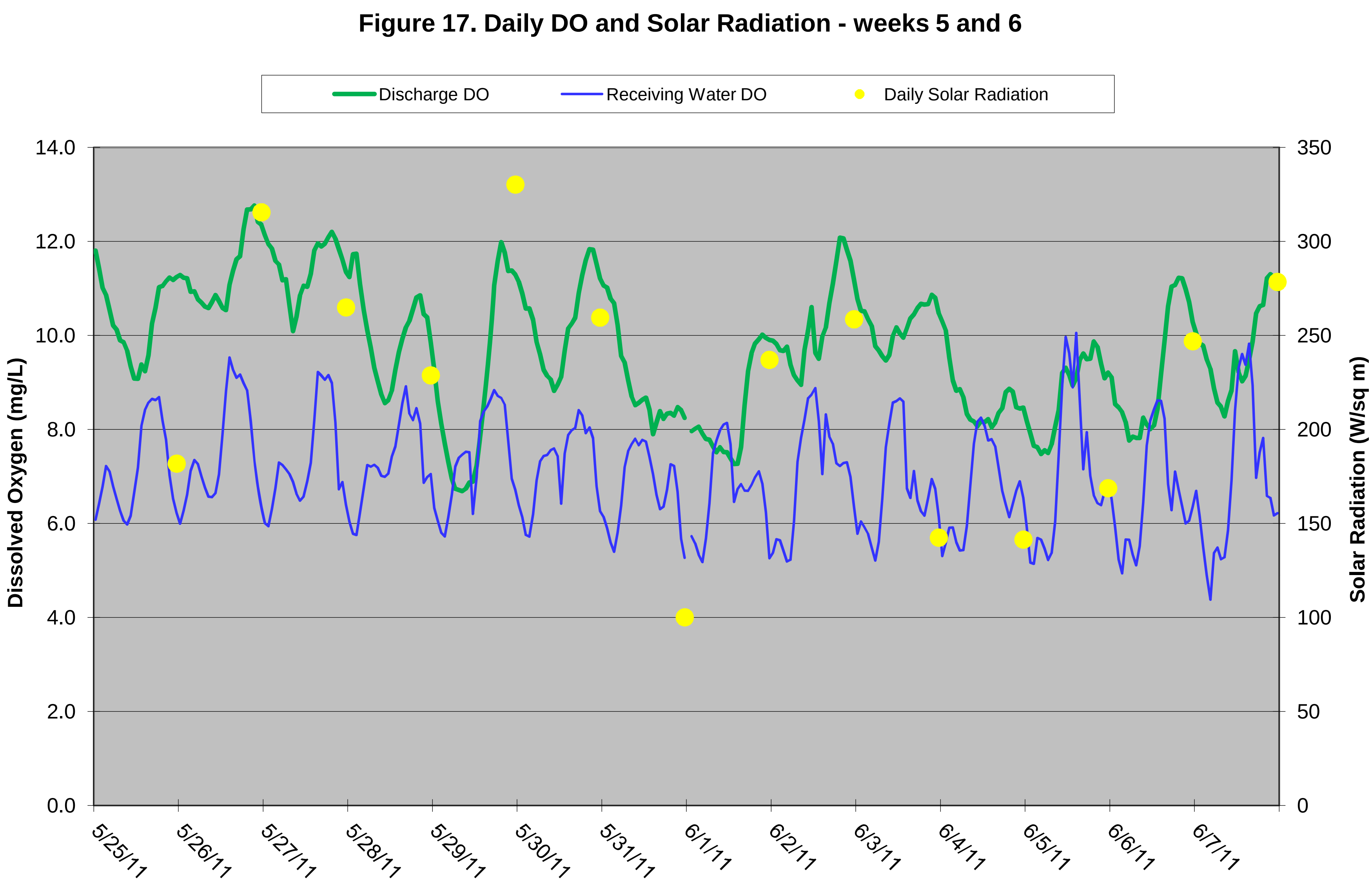
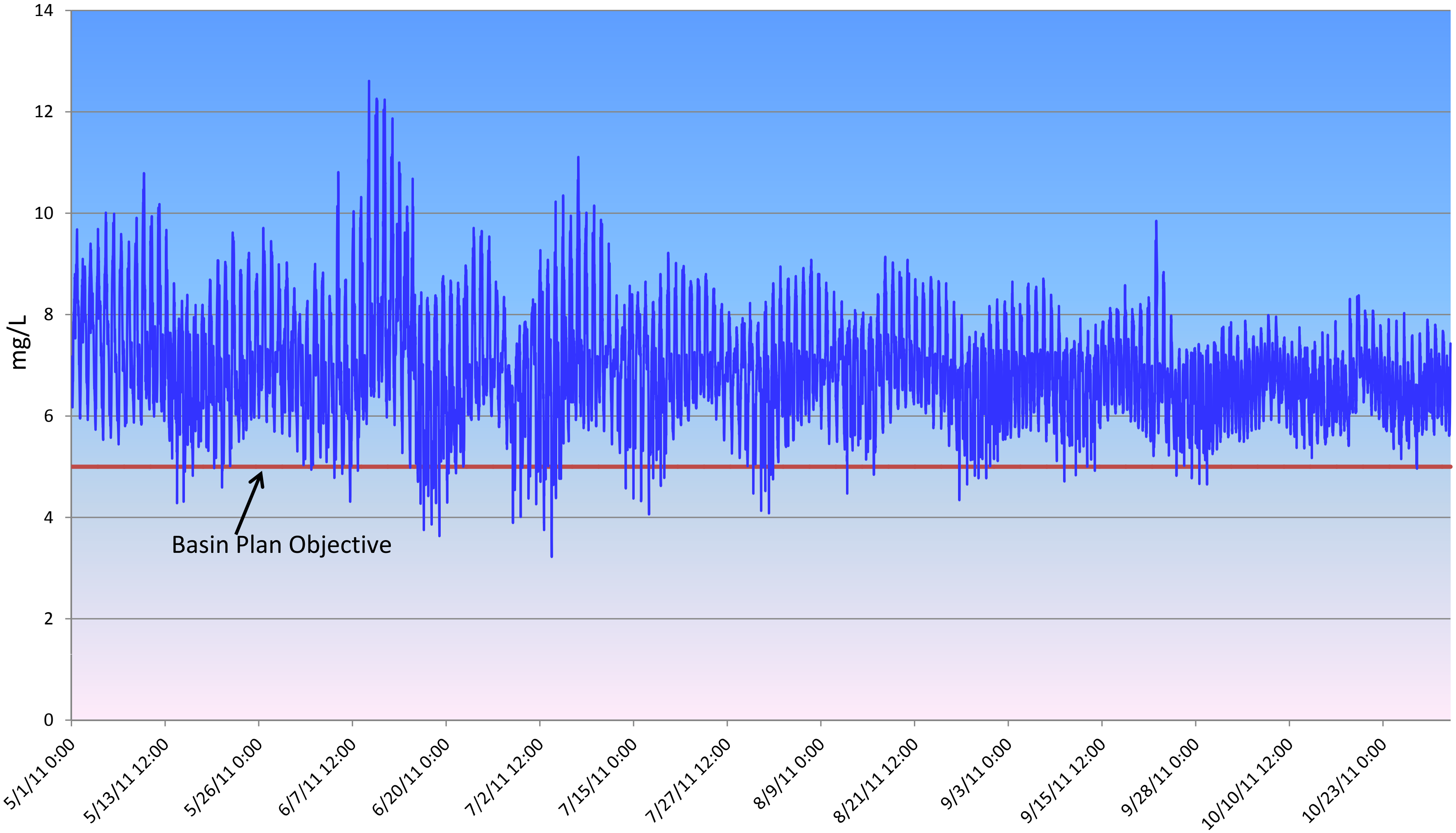


Figure 17. Daily DO and Solar Radiation - weeks 5 and 6
Discharge DO
Receiving Water DO
Daily Solar Radiation
Dissolved Oxygen (mg/L)
Solar Radiation (W/sq m)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
350
300
250
200
150
100
50
0
5/25/11
5/26/11
5/27/11
5/28/11
5/29/11
5/30/11
5/31/11
6/1/11
6/2/11
6/3/11
6/4/11
6/5/11
6/6/11
6/7/11

Figure 18. Receiving Water Quality Deviations from Basin Plan Objective.



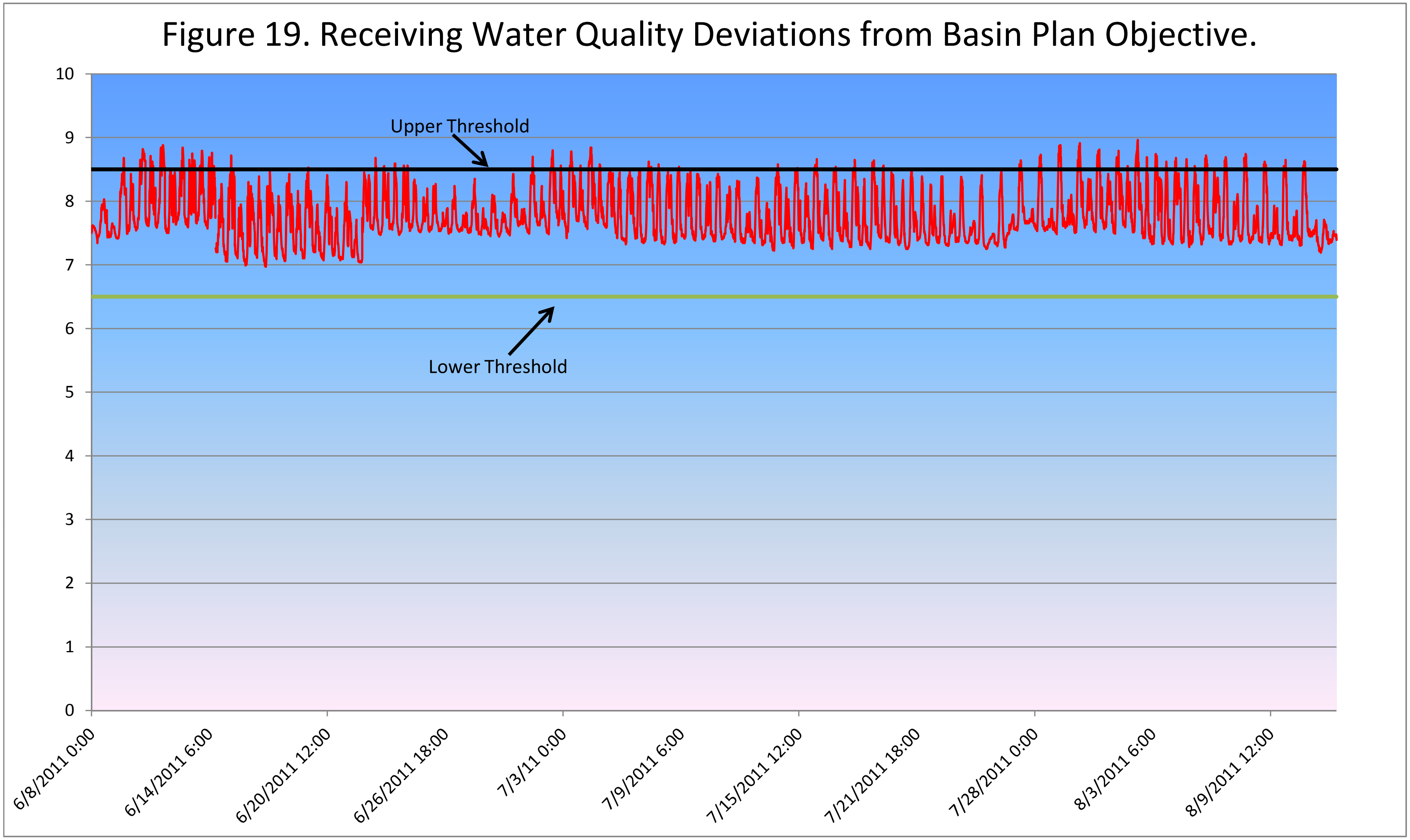


Figure 19. Receiving Water Quality Deviations from Basin Plan Objective.
Upper Threshold
Lower Threshold
10
9
8
7
6
5
4
3
2
1
0
6/8/2011 0:00
6/14/2011 6:00
6/20/2011 12:00
6/26/2011 18:00
7/3/11 0:00
7/9/2011 6:00
7/15/2011 12:00
7/21/2011 18:00
7/28/2011 0:00
8/3/2011 6:00
8/9/2011 12:00

Appendix I. Comparative Profiles of pH, Salinity and Temperature in A18 and Artesian Slough for Each Month of 2011 Monitoring Season.

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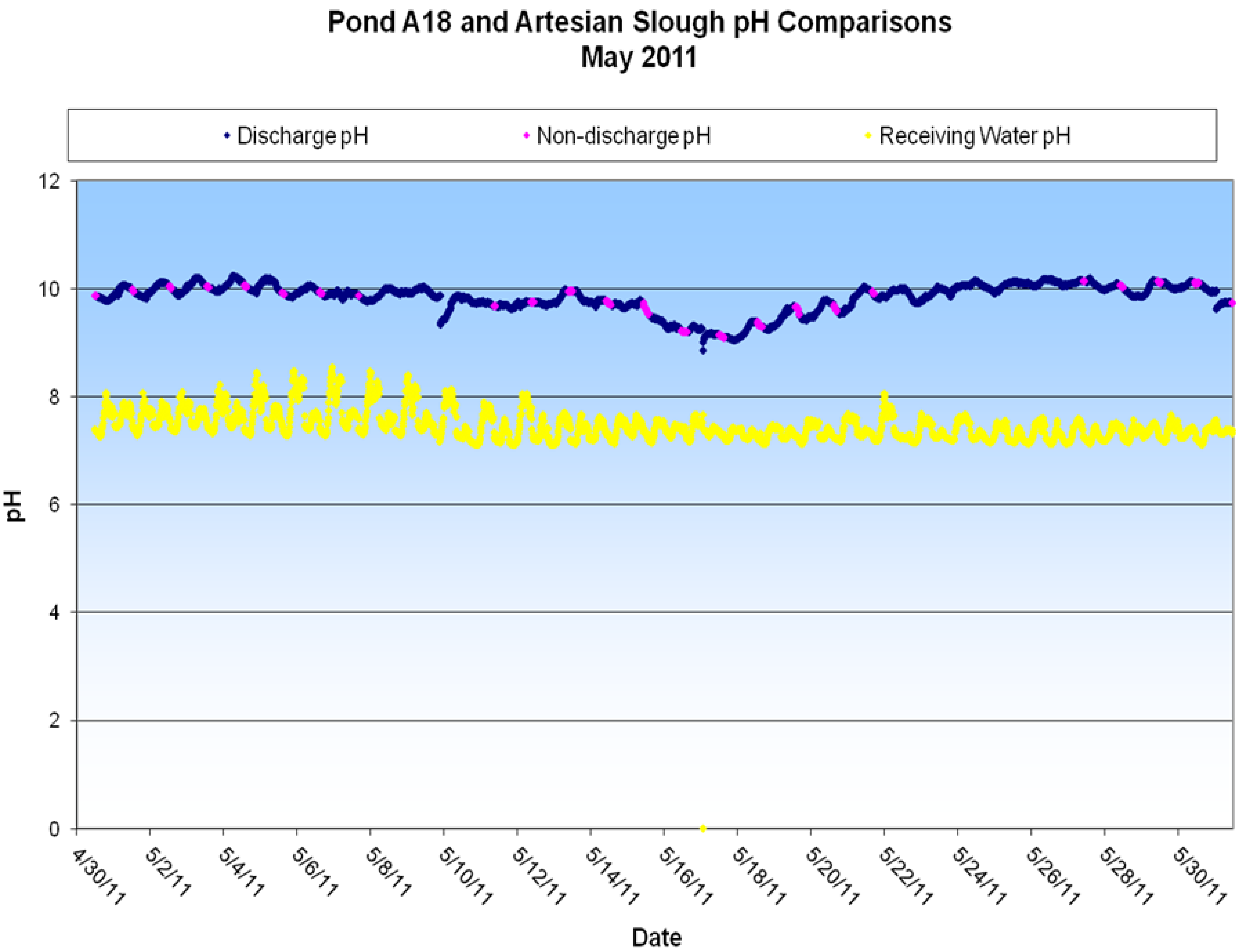
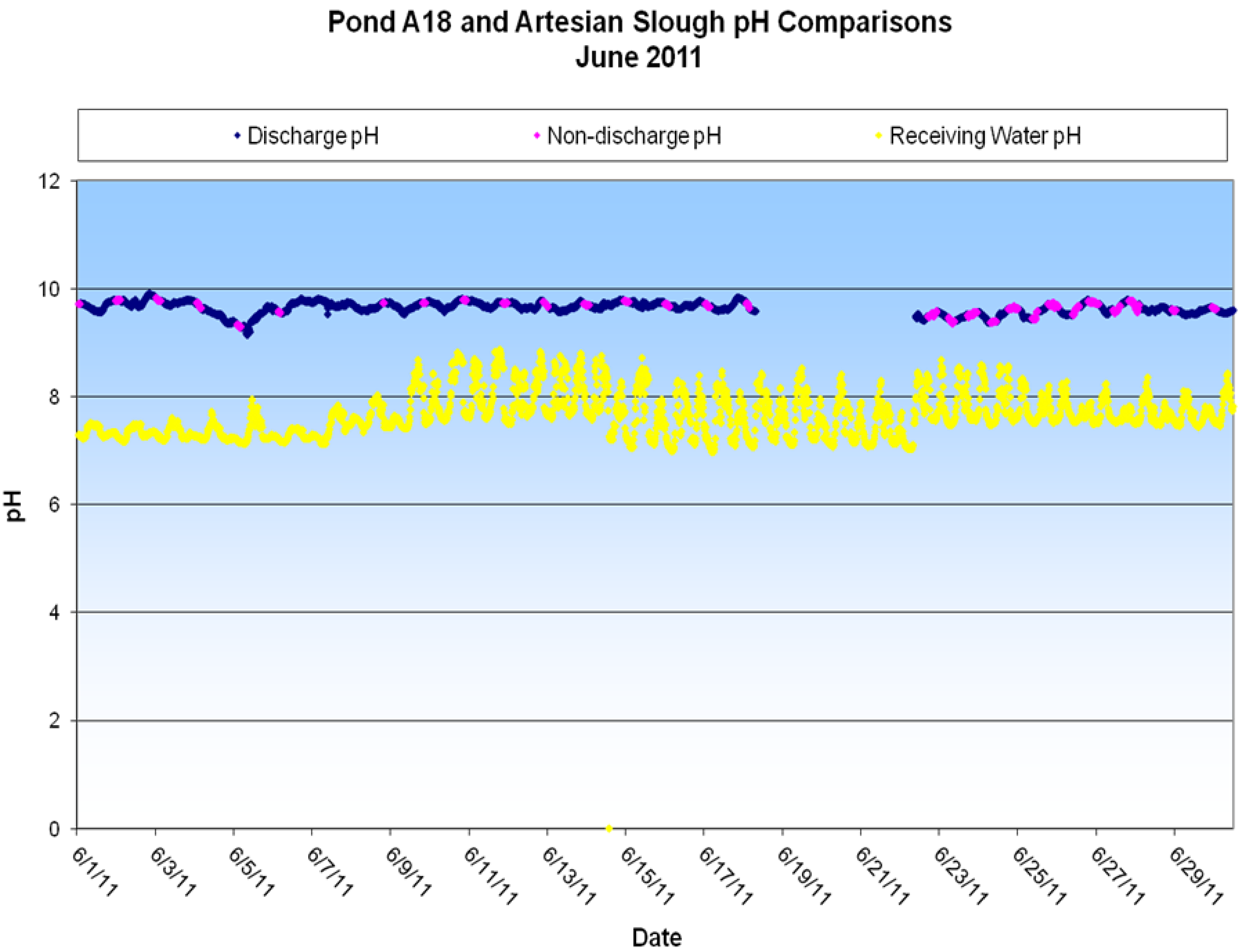
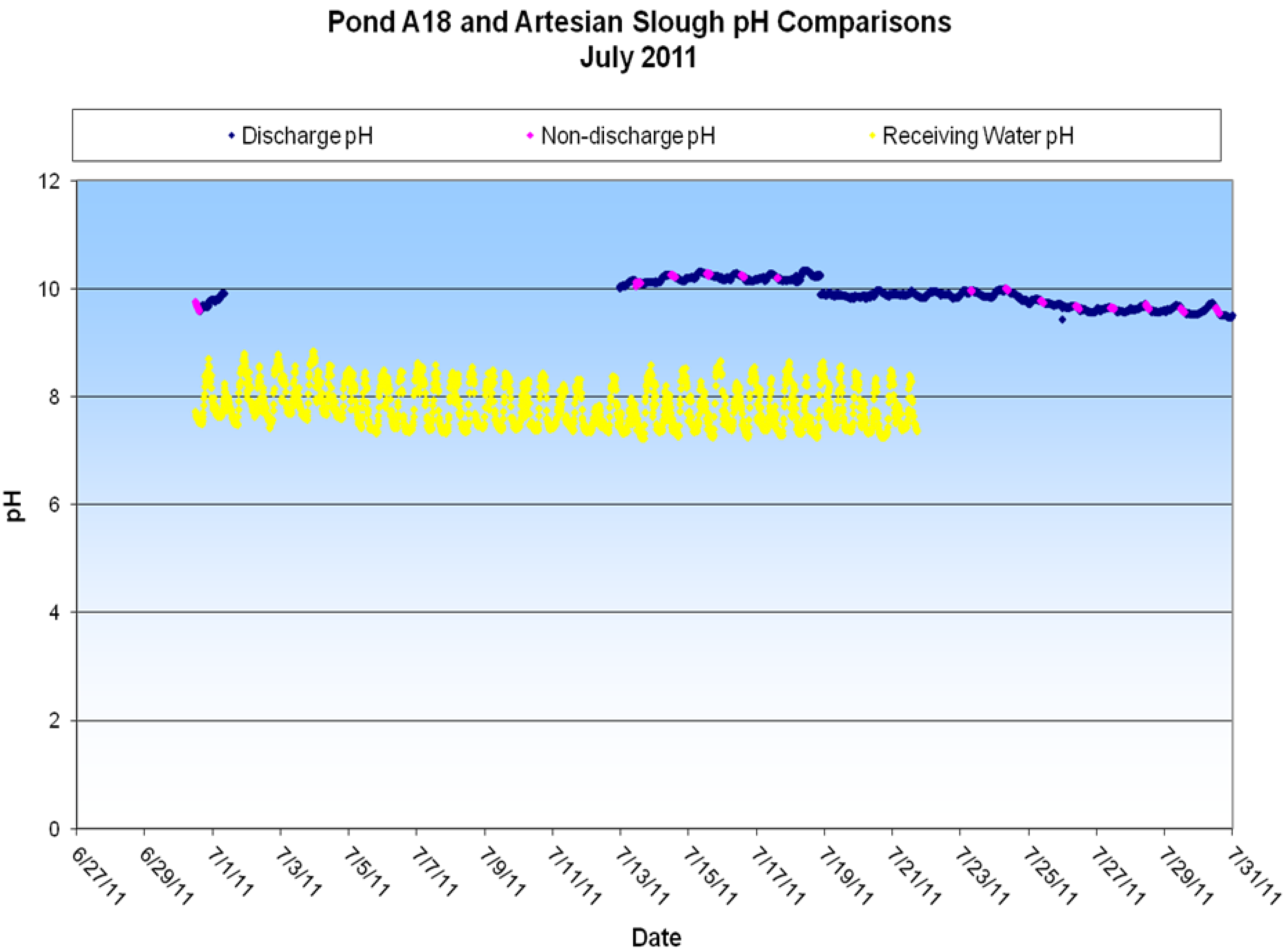
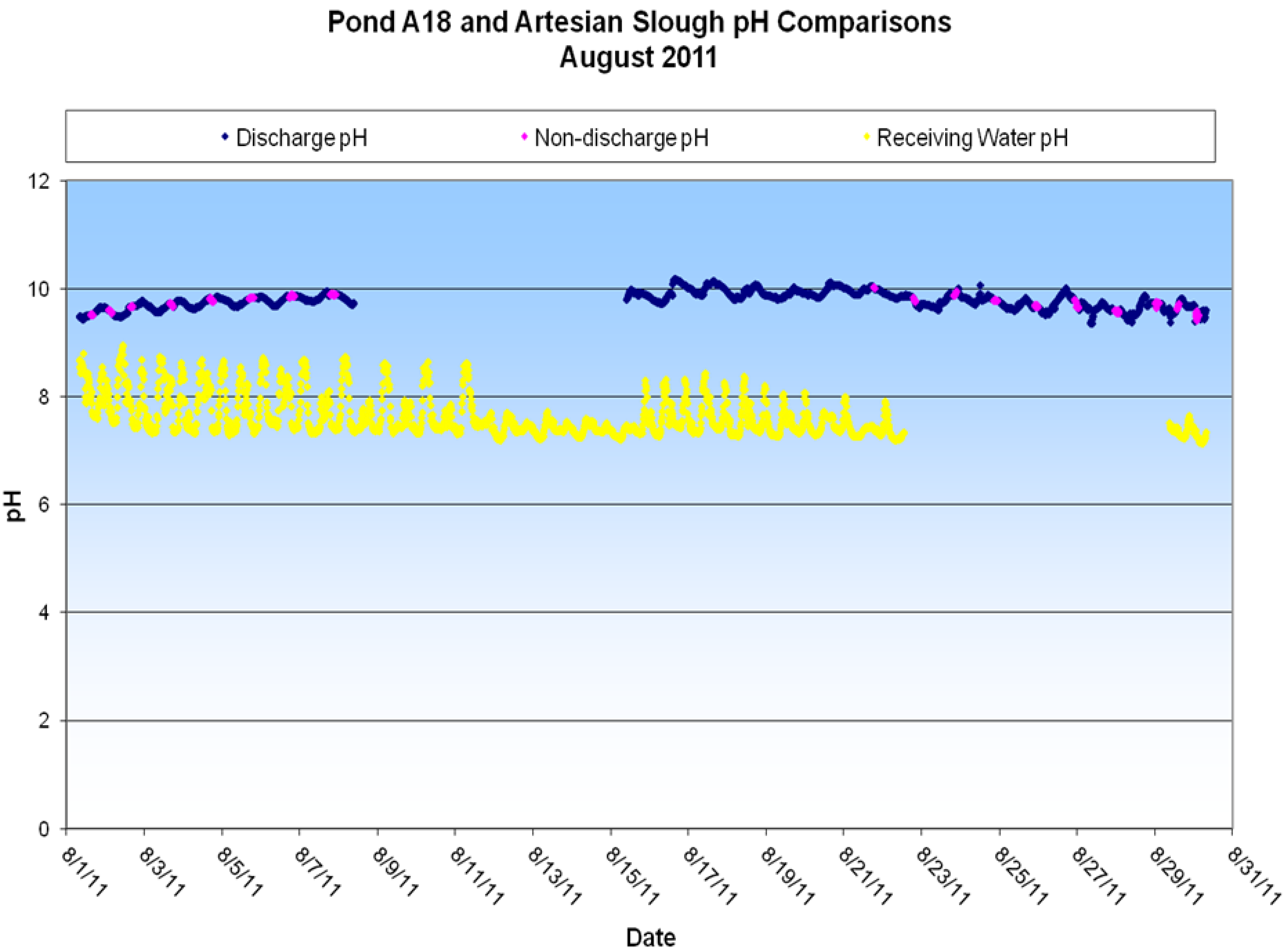
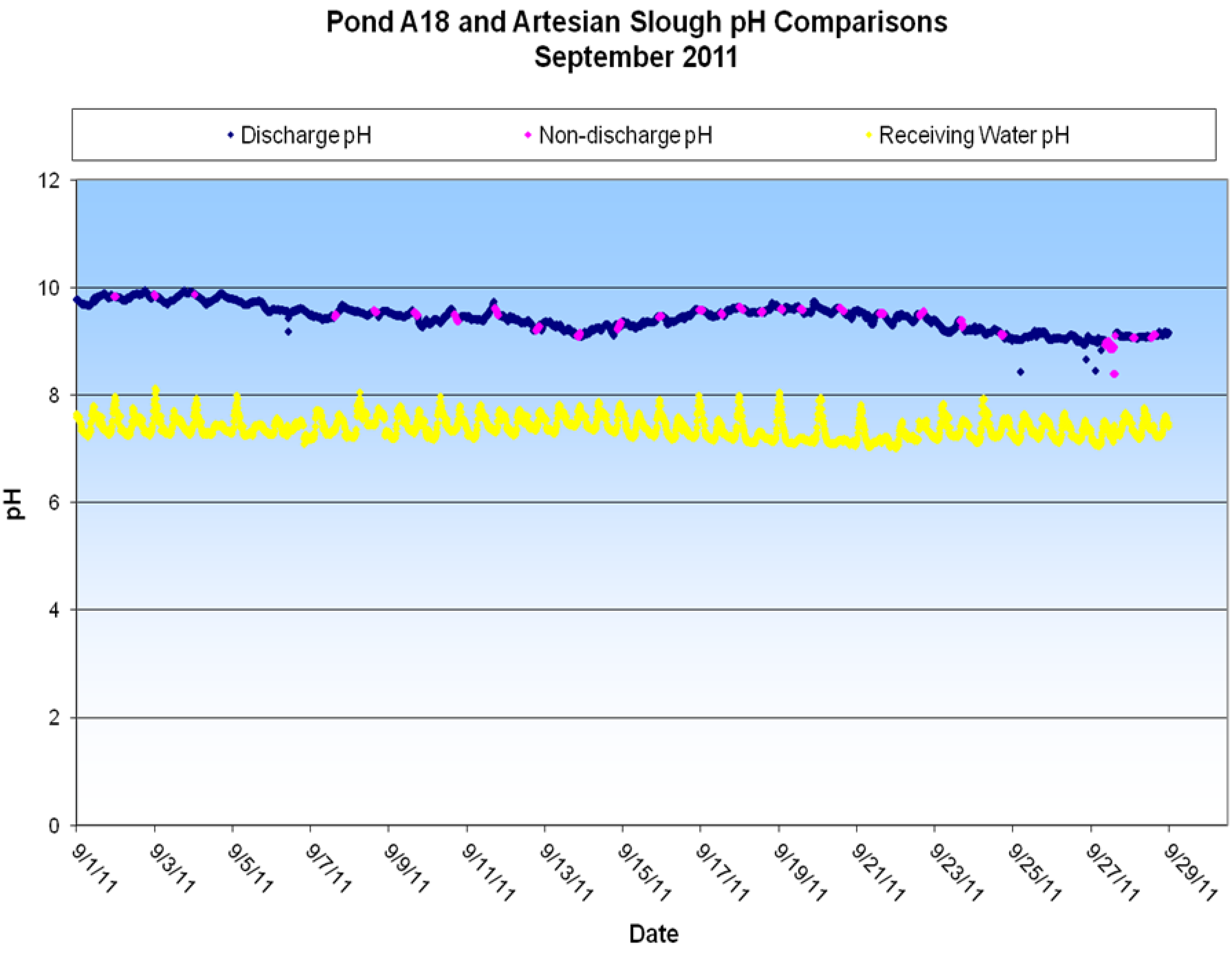


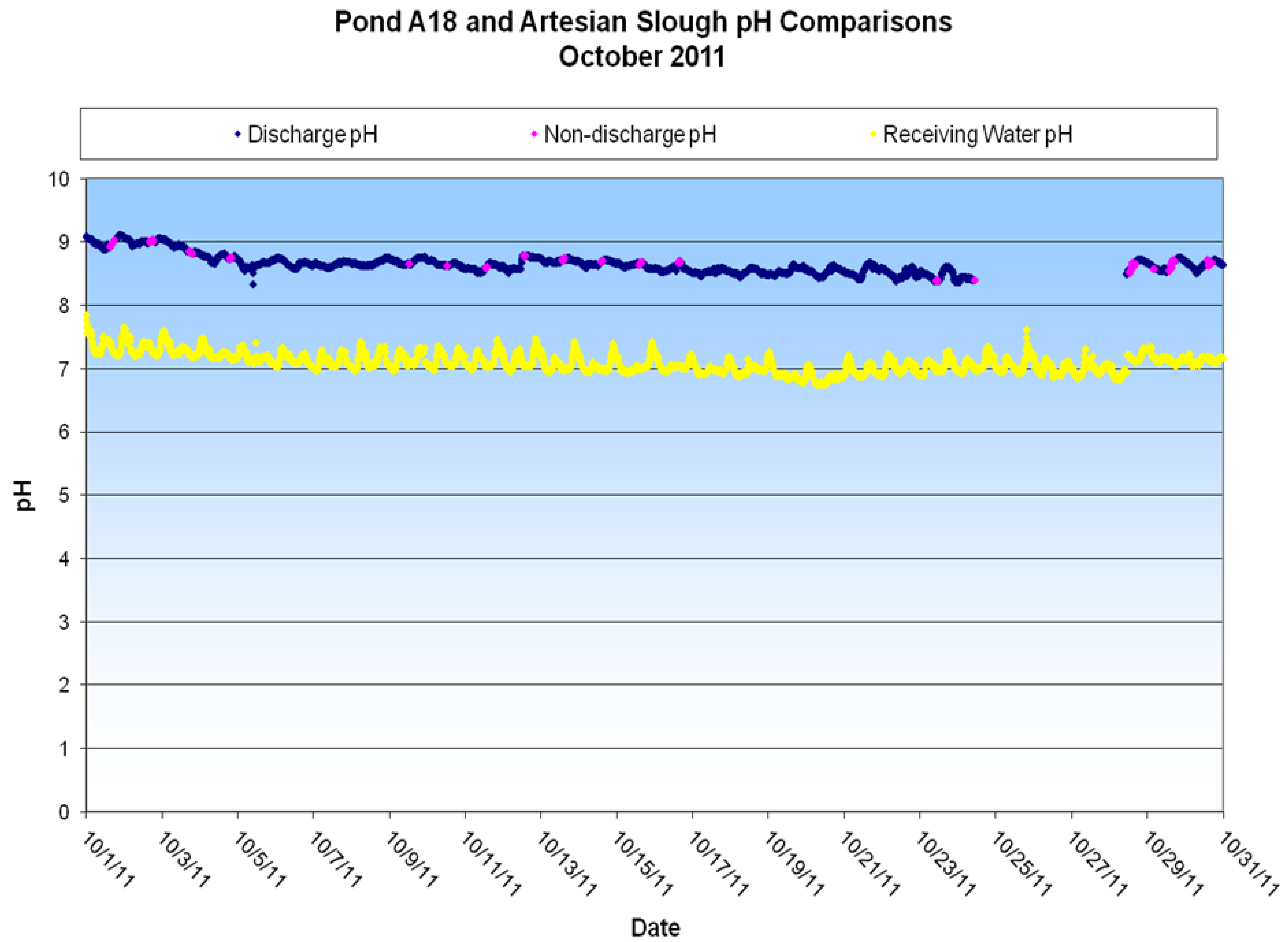
Pond A18 and Artesian Slough pH Comparisons
May 2011
Discharge pH
Non-discharge pH
Receiving Water pH
12
10
8
6
4
2
0
pH
4/30/11
5/2/11
5/4/11
5/6/11
5/8/11
5/10/11
5/12/11
5/14/11
5/16/11
5/18/11
5/20/11
5/22/11
5/24/11
5/26/11
5/28/11
5/30/11
Date


Pond A18 and Artesian Slough pH Comparisons
June 2011
Discharge pH
Non-discharge pH
Receiving Water pH
pH
0
2
4
6
8
10
12
6/1/11
6/3/11
6/5/11
6/7/11
6/9/11
6/11/11
6/13/11
6/15/11
6/17/11
6/19/11
6/21/11
6/23/11
6/25/11
6/27/11
6/29/11
Date

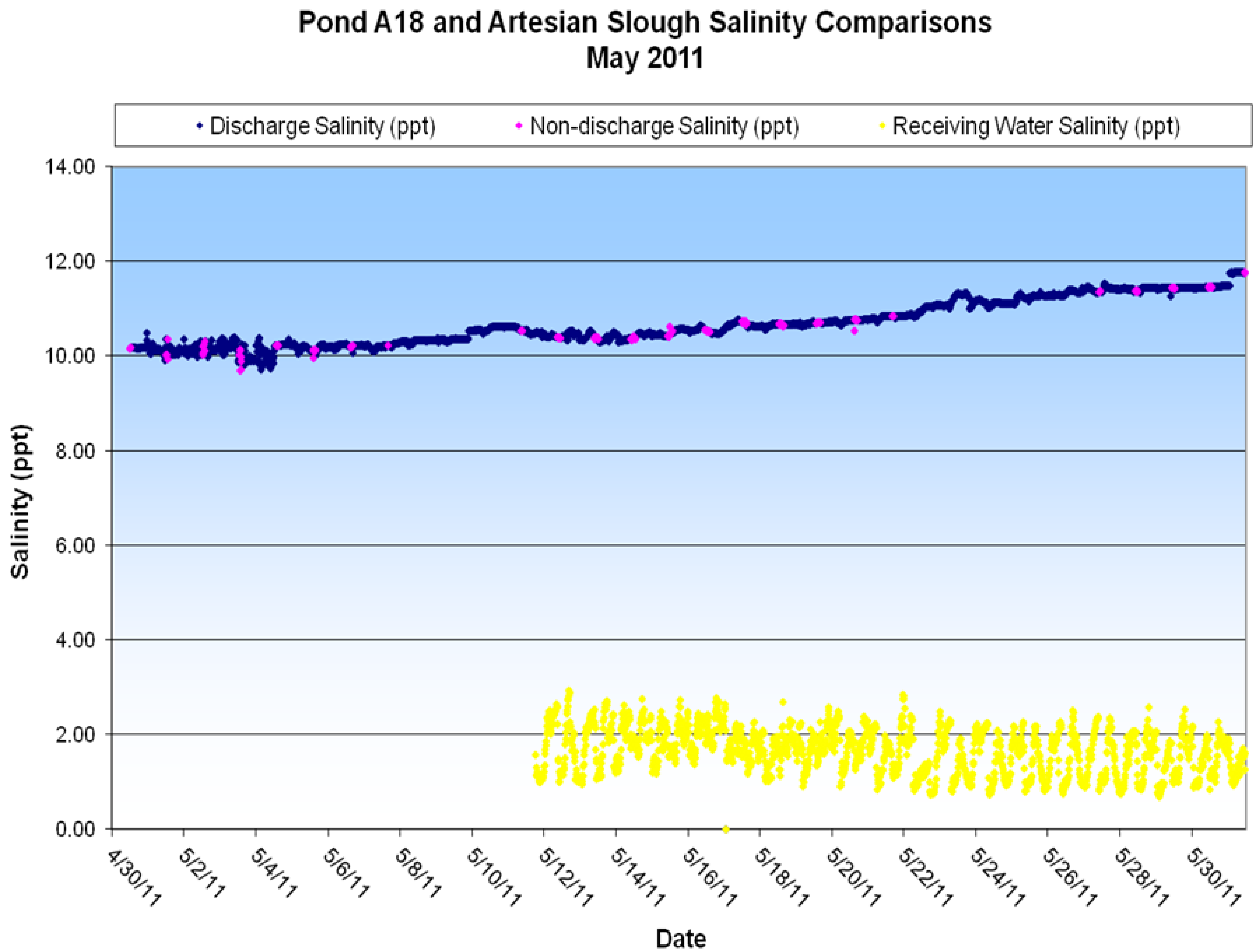

Pond A18 and Artesian Slough pH Comparisons
July 2011
Discharge pH
Non-discharge pH
Receiving Water pH
pH
12
10
8
6
4
2
0
6/27/11
6/29/11
7/1/11
7/3/11
7/5/11
7/7/11
7/9/11
7/11/11
7/13/11
7/15/11
7/17/11
7/19/11
7/21/11
7/23/11
7/25/11
7/27/11
7/29/11
7/31/11
Date


Pond A18 and Artesian Slough pH Comparisons
August 2011
Discharge pH
Non-discharge pH
Receiving Water pH
pH
12
10
8
6
4
2
0
8/1/11
8/3/11
8/5/11
8/7/11
8/9/11
8/11/11
8/13/11
8/15/11
8/17/11
8/19/11
8/21/11
8/23/11
8/25/11
8/27/11
8/29/11
8/31/11
Date

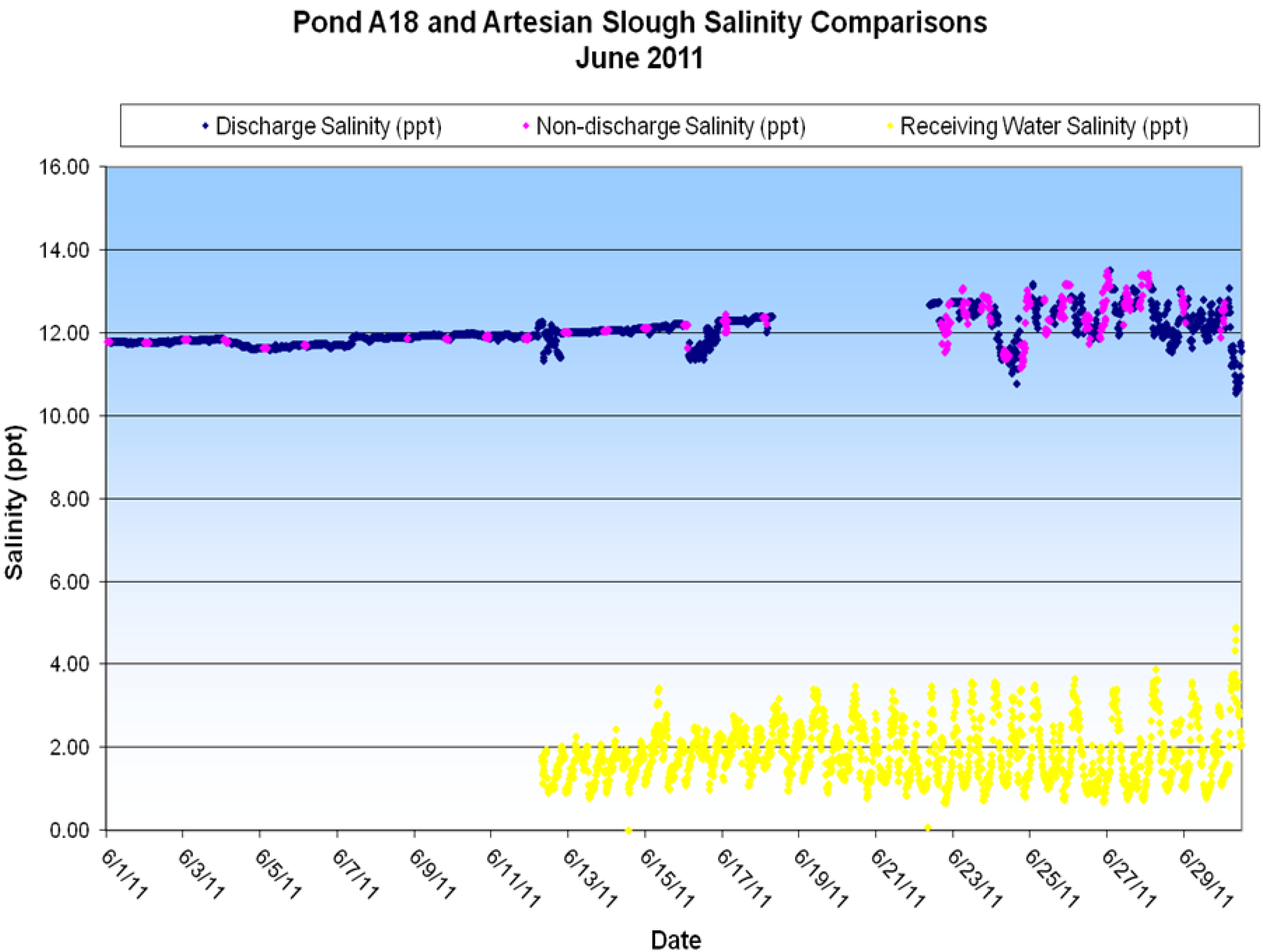

Pond A18 and Artesian Slough pH Comparisons
September 2011
Discharge pH
Non-discharge pH
Receiving Water pH
pH
12
10
8
6
4
2
0
9/1/11
9/3/11
9/5/11
9/7/11
9/9/11
9/11/11
9/13/11
9/15/11
9/17/11
9/19/11
9/21/11
9/23/11
9/25/11
9/27/11
9/29/11
Date

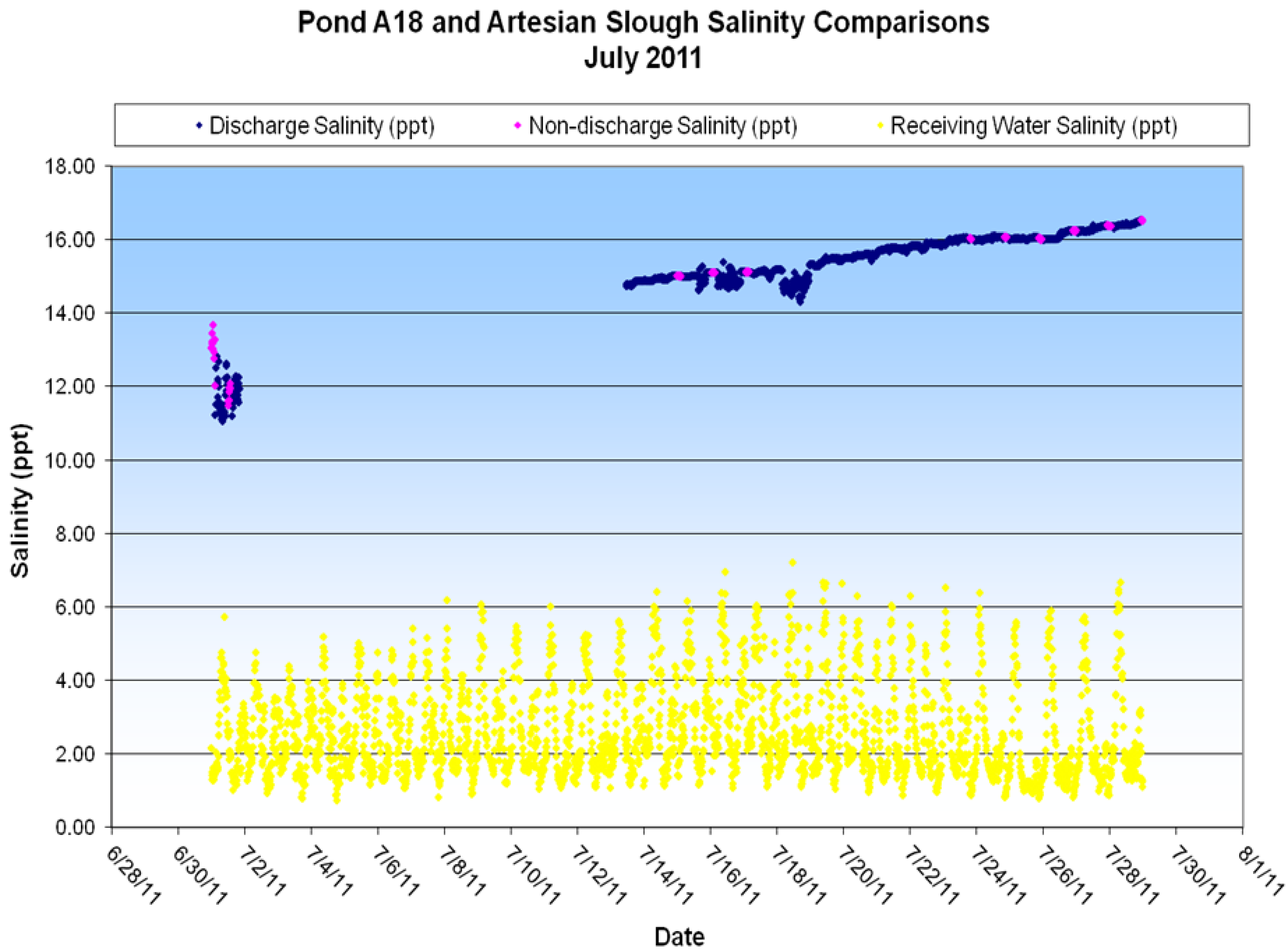


Pond A18 and Artesian Slough pH Comparisons
October 2011
Discharge pH
Non-discharge pH
Receiving Water pH
10
9
8
7
6
5
4
3
2
1
0
pH
10/1/11
10/3/11
10/5/11
10/7/11
10/9/11
10/11/11
10/13/11
10/15/11
10/17/11
10/19/11
10/21/11
10/23/11
10/25/11
10/27/11
10/29/11
10/31/11
Date

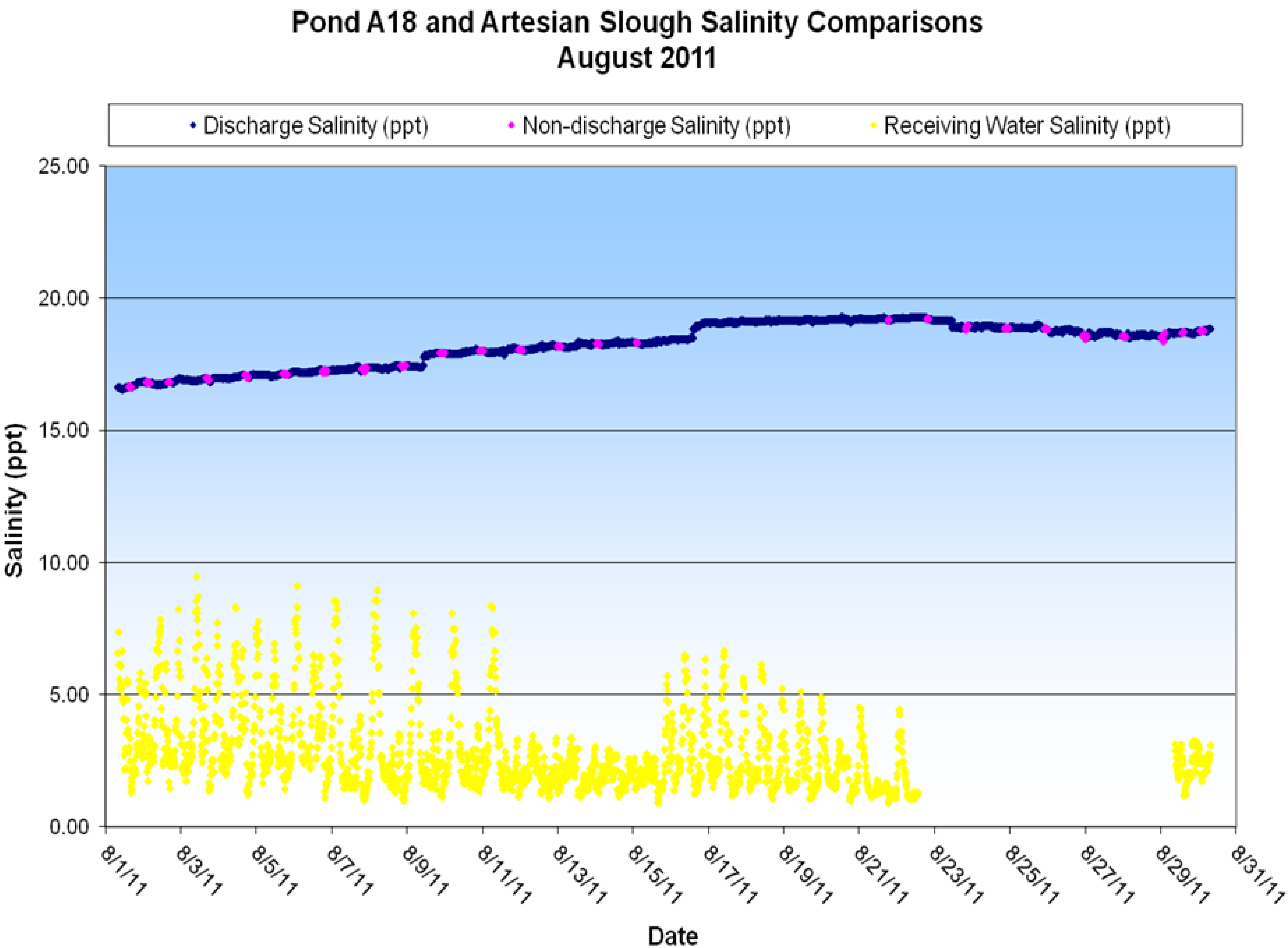


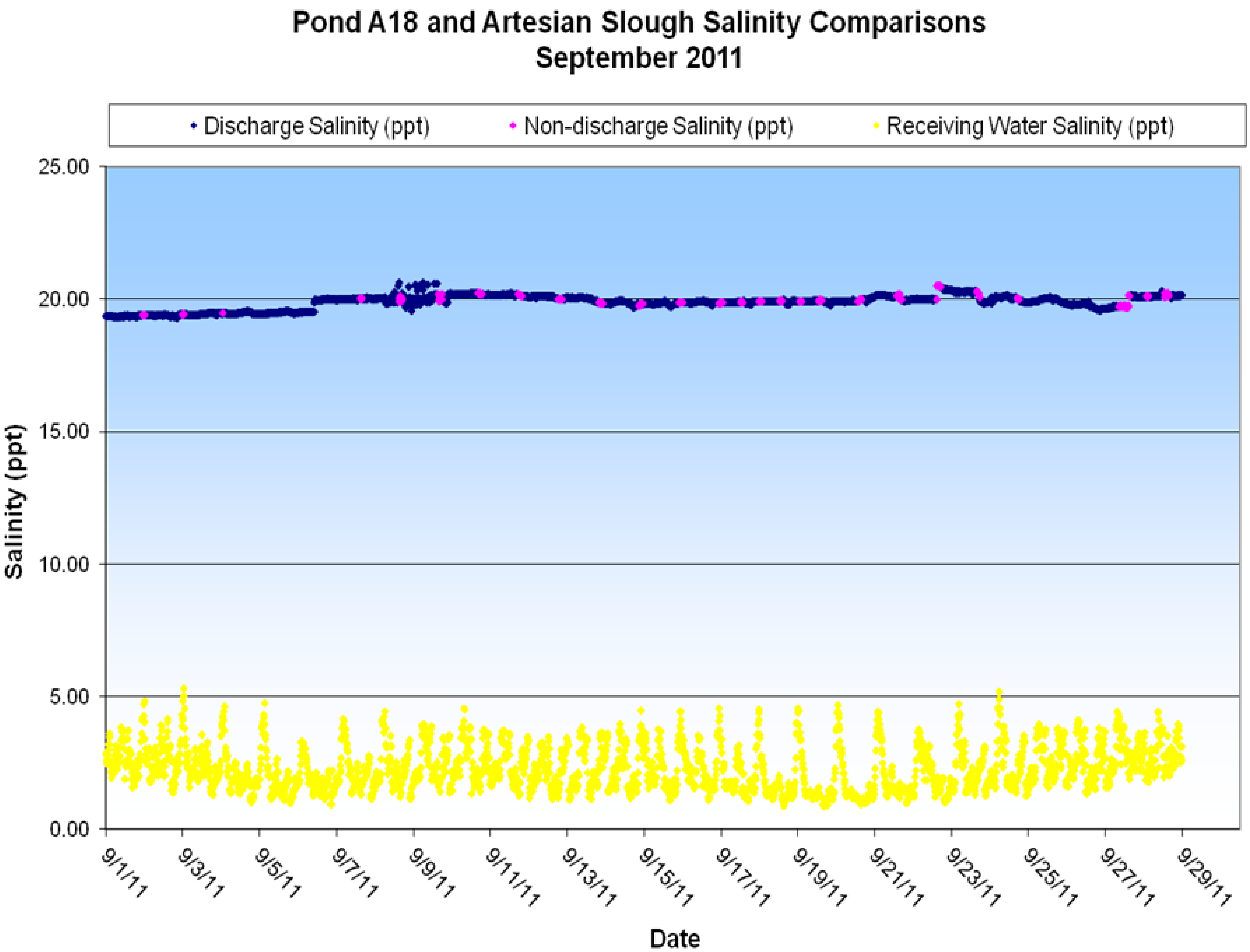
Pond A18 and Artesian Slough Salinity Comparisons
May 2011
Discharge Salinity (ppt)
Non-discharge Salinity (ppt)
Receiving Water Salinity (ppt)
Salinity (ppt)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/30/11
5/2/11
5/4/11
5/6/11
5/8/11
5/10/11
5/12/11
5/14/11
5/16/11
5/18/11
5/20/11
5/22/11
5/24/11
5/26/11
5/28/11
5/30/11
Date


Pond A18 and Artesian Slough Salinity Comparisons
June 2011
Discharge Salinity (ppt)
Non-discharge Salinity (ppt)
Receiving Water Salinity (ppt)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Salinity (ppt)
6/1/11
6/3/11
6/5/11
6/7/11
6/9/11
6/11/11
6/13/11
6/15/11
6/17/11
6/19/11
6/21/11
6/23/11
6/25/11
6/27/11
6/29/11
Date



Pond A18 and Artesian Slough Salinity Comparisons
July 2011
Discharge Salinity (ppt)
Non-discharge Salinity (ppt)
Receiving Water Salinity (ppt)
Salinity (ppt)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
6/28/11
6/30/11
7/2/11
7/4/11
7/6/11
7/8/11
7/10/11
7/12/11
7/14/11
7/16/11
7/18/11
7/20/11
7/22/11
7/24/11
7/26/11
7/28/11
7/30/11
8/1/11
Date


Pond A18 and Artesian Slough Salinity Comparisons
August 2011
Discharge Salinity (ppt)
Non-discharge Salinity (ppt)
Receiving Water Salinity (ppt)
Salinity (ppt)
25.00
20.00
15.00
10.00
5.00
0.00
8/1/11
8/3/11
8/5/11
8/7/11
8/9/11
8/11/11
8/13/11
8/15/11
8/17/11
8/19/11
8/21/11
8/23/11
8/25/11
8/27/11
8/29/11
8/31/11
Date



Pond A18 and Artesian Slough Salinity Comparisons
September 2011
Discharge Salinity (ppt)
Non-discharge Salinity (ppt)
Receiving Water Salinity (ppt)
Salinity (ppt)
25.00
20.00
15.00
10.00
5.00
0.00
9/1/11
9/3/11
9/5/11
9/7/11
9/9/11
9/11/11
9/13/11
9/15/11
9/17/11
9/19/11
9/21/11
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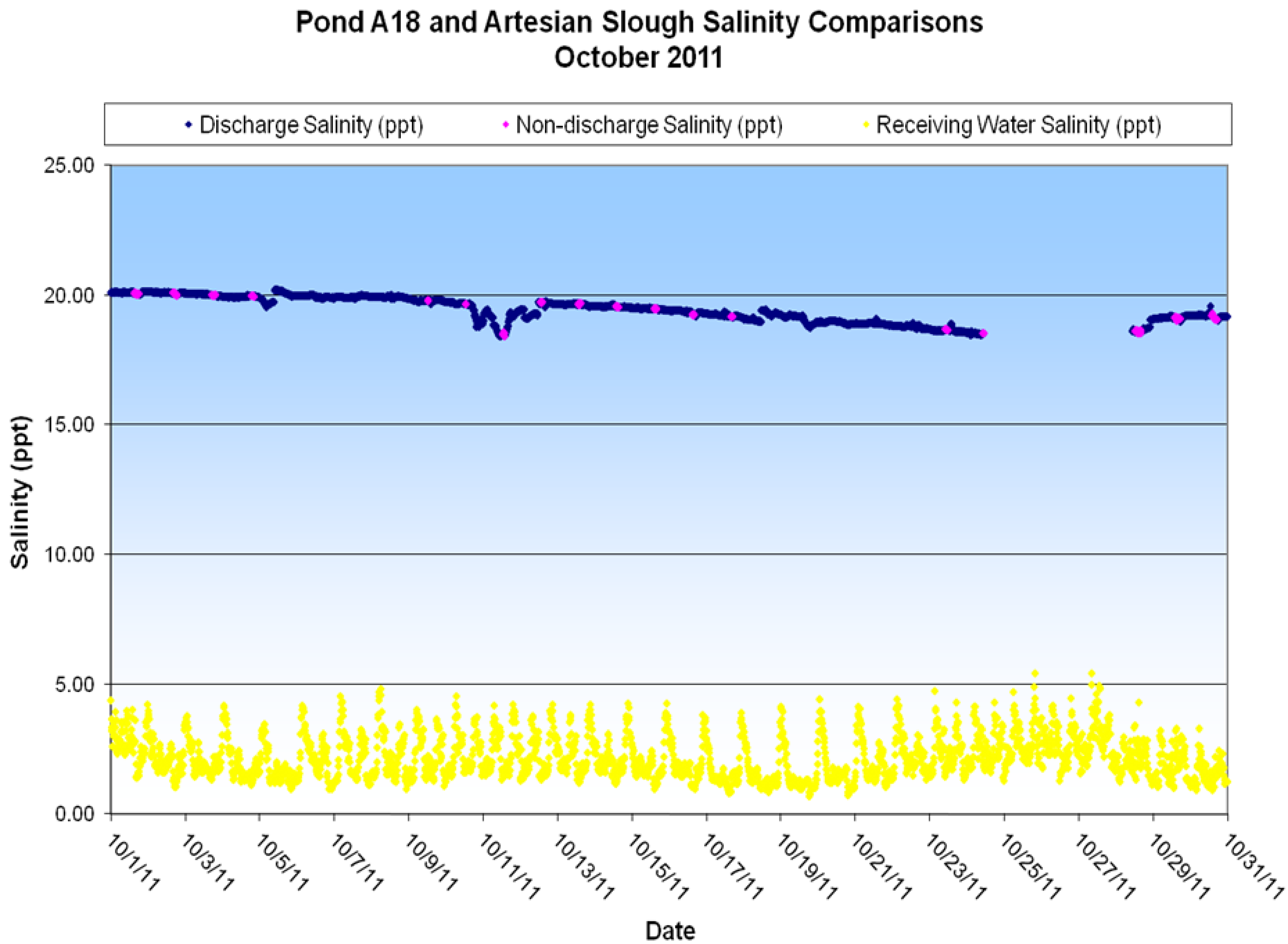
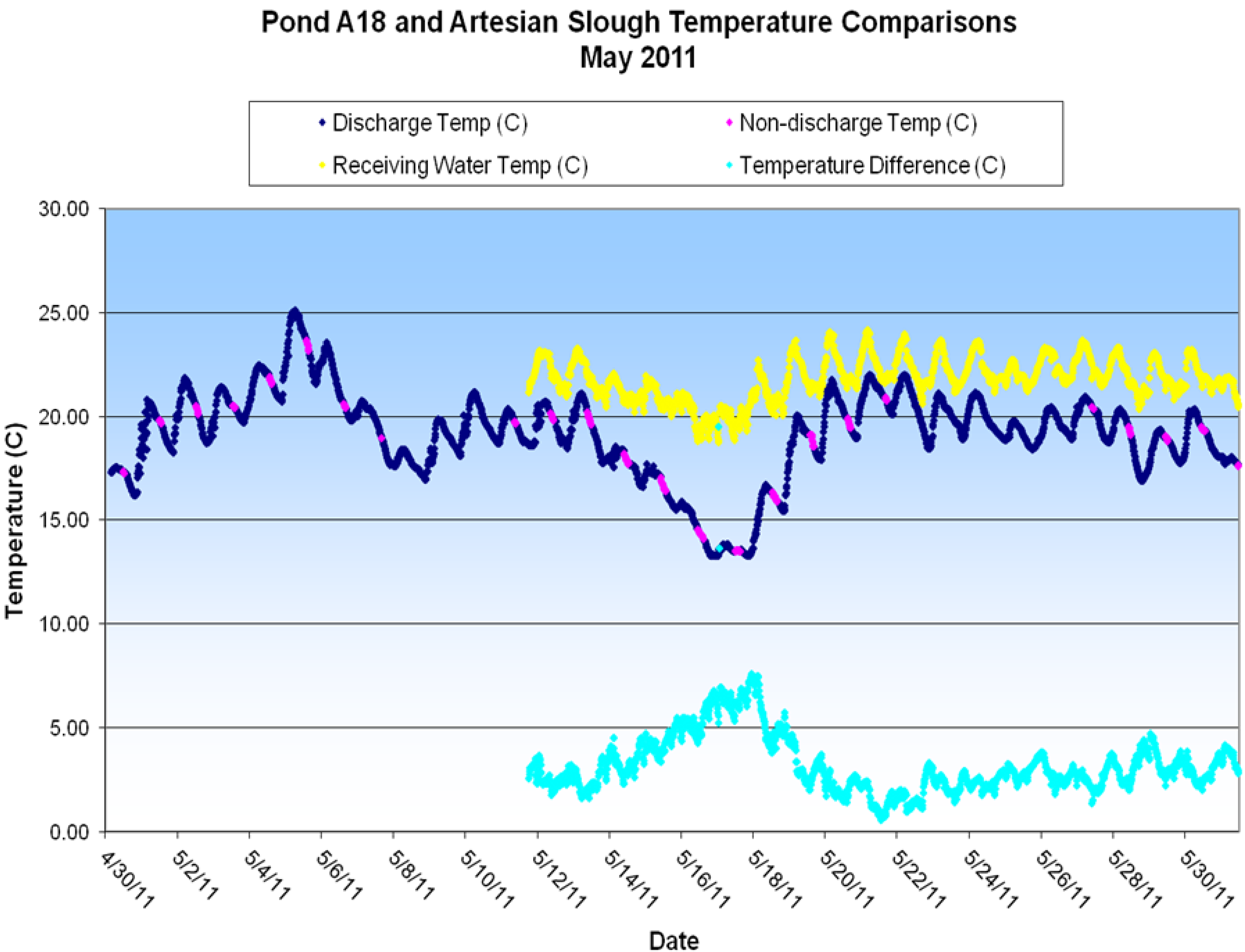
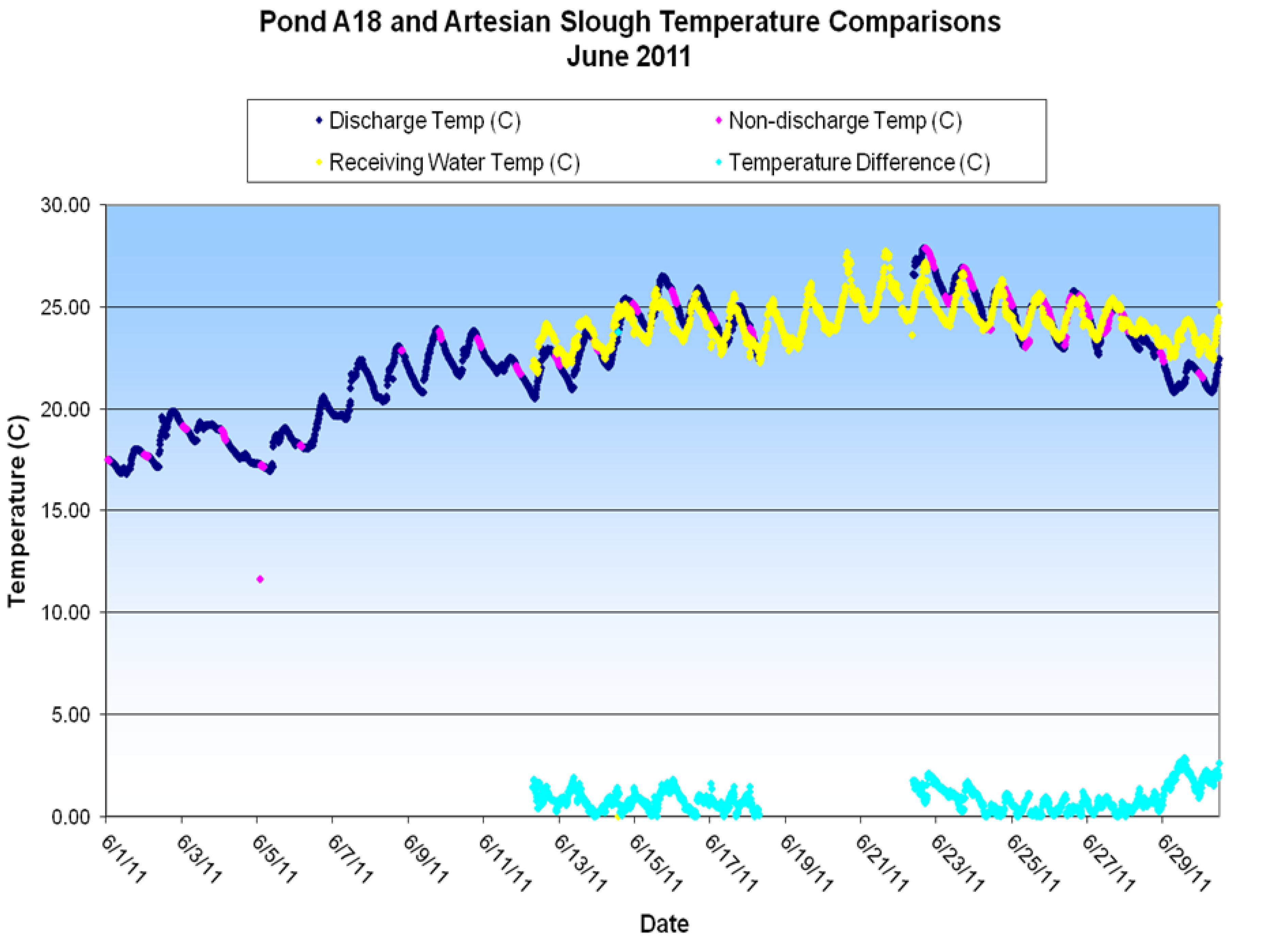
9/25/11
9/27/11
9/29/11
Date



Pond A18 and Artesian Slough Salinity Comparisons
October 2011
Discharge Salinity (ppt)
Non-discharge Salinity (ppt)
Receiving Water Salinity (ppt)
Salinity (ppt)
25.00
20.00
15.00
10.00
5.00
0.00
10/1/11
10/3/11
10/5/11
10/7/11
10/9/11
10/11/11
10/13/11
10/15/11
10/17/11
10/19/11
10/21/11
10/23/11
10/25/11
10/27/11
10/29/11
10/31/11
Date



Pond A18 and Artesian Slough Temperature Comparisons
May 2011
Discharge Temp (C)
Non-discharge Temp (C)
Receiving Water Temp (C)
Temperature Difference (C)
Temperature (C)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
4/30/11
5/2/11
5/4/11
5/6/11
5/8/11
5/10/11
5/12/11
5/14/11
5/16/11
5/18/11
5/20/11
5/22/11
5/24/11
5/26/11
5/28/11
5/30/11
Date


Pond A18 and Artesian Slough Temperature Comparisons
June 2011
Discharge Temp (C)
Non-discharge Temp (C)
Receiving Water Temp (C)
Temperature Difference (C)
Temperature (C)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
6/1/11
6/3/11
6/5/11
6/7/11
6/9/11
6/11/11
6/13/11
6/15/11
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6/19/11
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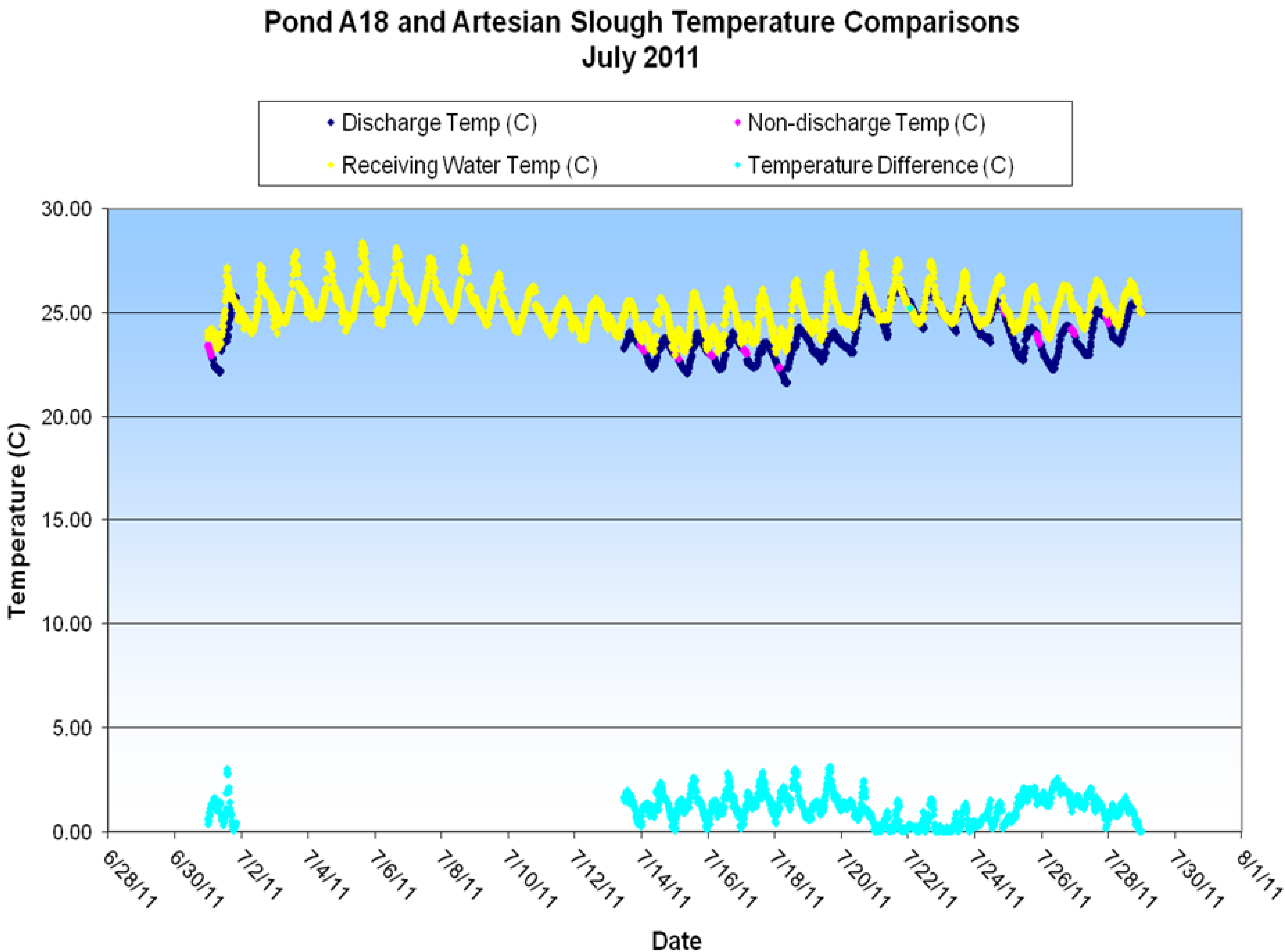
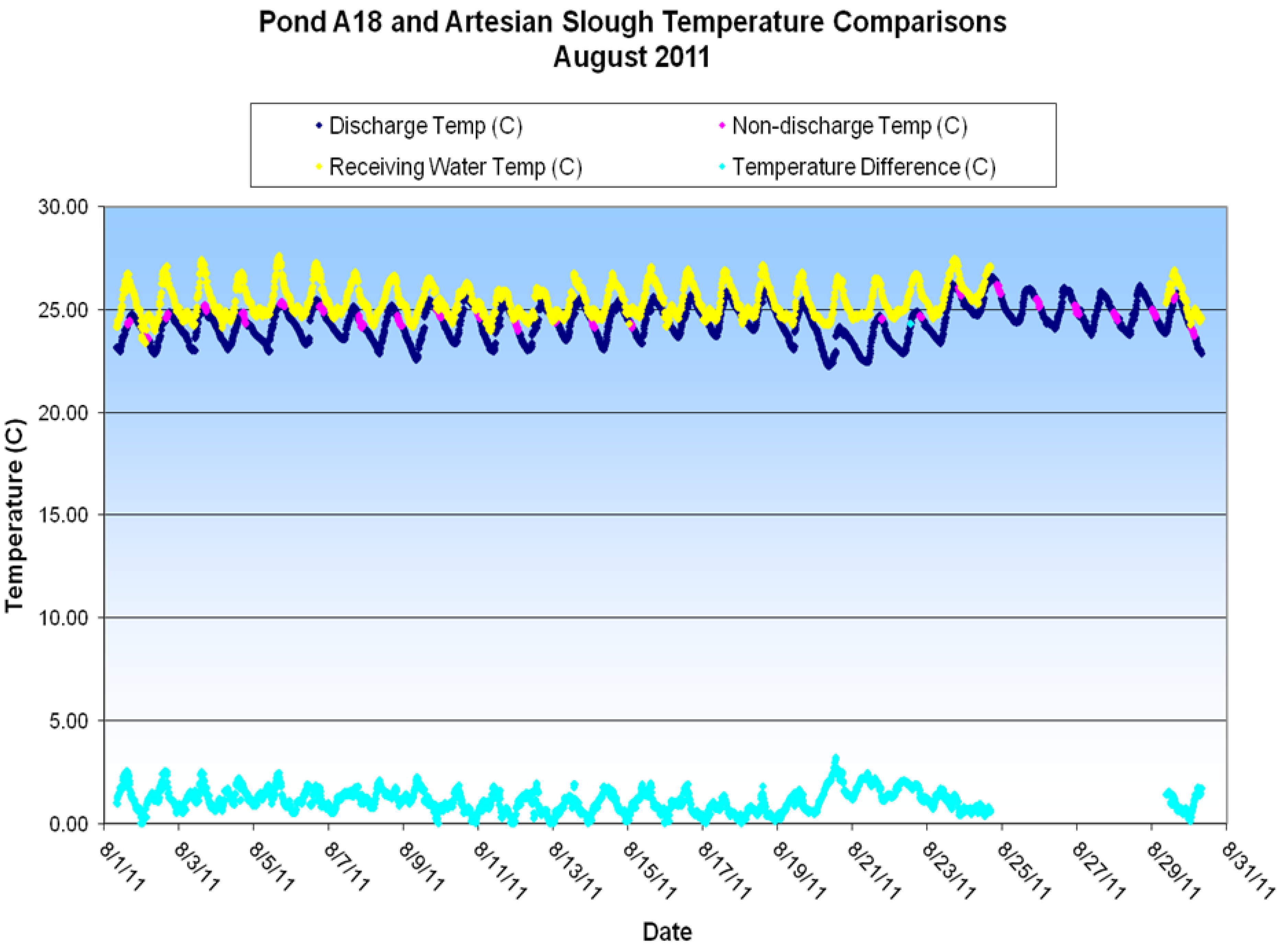
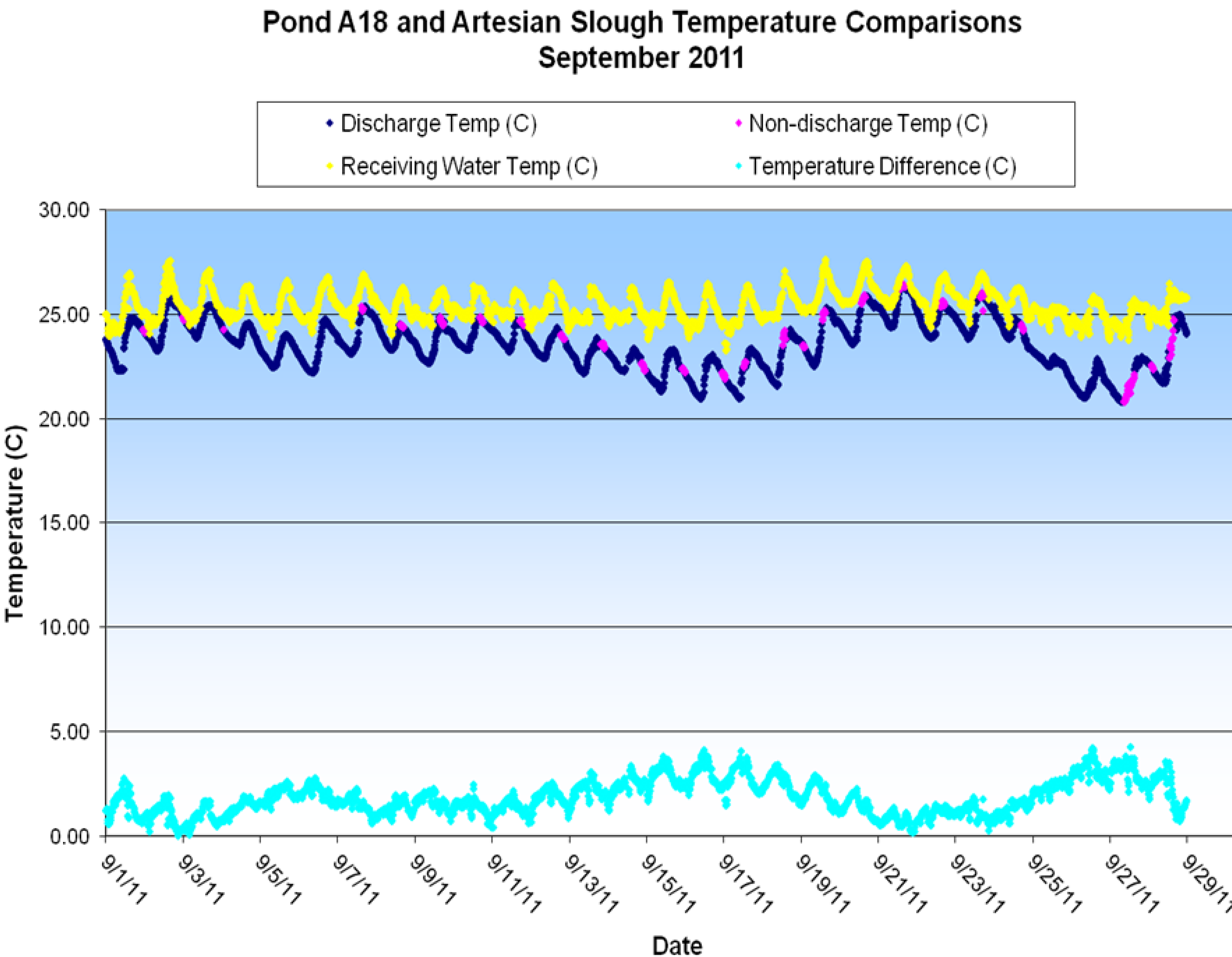
6/23/11
6/25/11
6/27/11
6/29/11
Date



Pond A18 and Artesian Slough Temperature Comparisons
July 2011
Discharge Temp (C)
Non-discharge Temp (C)
Receiving Water Temp (C)
Temperature Difference (C)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Temperature (C)
6/28/11
6/30/11
7/2/11
7/4/11
7/6/11
7/8/11
7/10/11
7/12/11
7/14/11
7/16/11
7/18/11
7/20/11
7/22/11
7/24/11
7/26/11
7/28/11
7/30/11
8/1/11
Date


Pond A18 and Artesian Slough Temperature Comparisons
August 2011
Discharge Temp (C)
Non-discharge Temp (C)
Receiving Water Temp (C)
Temperature Difference (C)
Temperature (C)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
8/1/11
8/3/11
8/5/11
8/7/11
8/9/11
8/11/11
8/13/11
8/15/11
8/17/11
8/19/11
8/21/11
8/23/11
8/25/11
8/27/11
8/29/11
8/31/11
Date


Pond A18 and Artesian Slough Temperature Comparisons
September 2011
Discharge Temp (C)
Non-discharge Temp (C)
Receiving Water Temp (C)
Temperature Difference (C)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Temperature (C)
9/1/11
9/3/11
9/5/11
9/7/11
9/9/11
9/11/11
9/13/11
9/15/11
9/17/11
9/19/11
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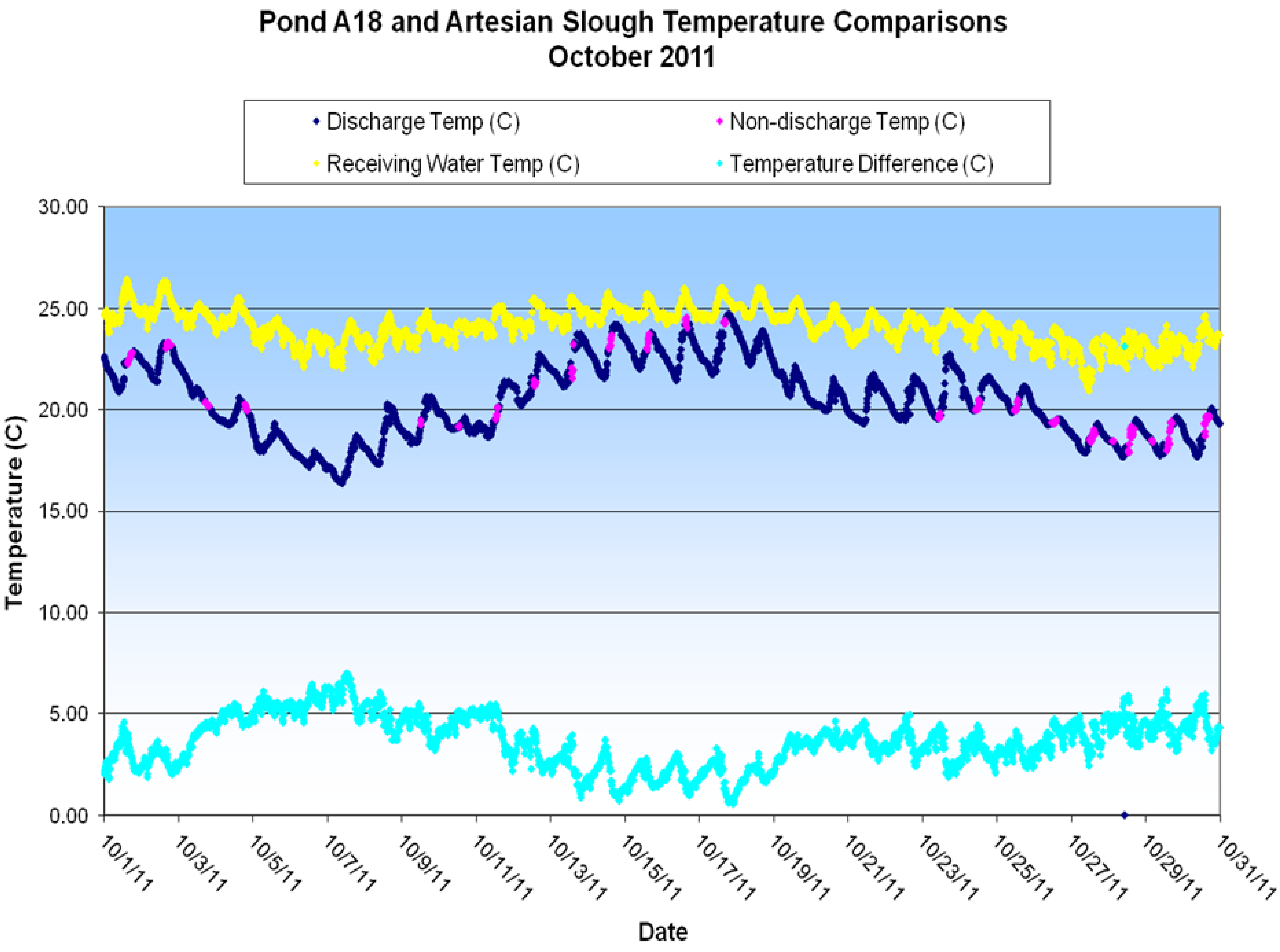
9/27/11
9/29/11
Date



Pond A18 and Artesian Slough Temperature Comparisons
October 2011
Discharge Temp (C)
Non-discharge Temp (C)
Receiving Water Temp (C)
Temperature Difference (C)
Temperature (C)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
10/1/11
10/3/11
10/5/11
10/7/11
10/9/11
10/11/11
10/13/11
10/15/11
10/17/11
10/19/11
10/21/11
10/23/11
10/25/11
10/27/11
10/29/11
10/31/11
Date

Appendix II. Artesian Slough Sediment Mercury Report - 2011

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Artesian Slough Sediment Mercury Report – 2011

Prepared for:
The City of San Jose
Environmental Services Department
700 Los Esteros Road
San Jose, CA 95134

Prepared by:
Mark C Marvin-DiPasquale
U.S. Geological Survey
345 Middlefield Rd. / MS 480
Menlo Park, CA 94025

20 January 2012

Artesian Slough Sediment Mercury Report – 2011

U.S. Geological Survey
20 January 2012

Contents

Artesian Slough Sediment Mercury Report – 2011

U.S. Geological Survey
20 January 2012

1. INTRODUCTION

The City of San Jose, Water Pollution Control Plant (700 Los Esteros Road San Jose, CA 95134) has been directed by the Regional Water Quality Control Board to assess methylmercury (MeHg) concentrations in sediment of Artesian Slough during 2011, as part of the Self-Monitoring Program (SMP) Waste Discharge Requirement associated with Pond A-18,(Order No. R2-2005-0003). Concurrently, the U.S. Geological Survey (USGS) has been conducting a study of mercury cycling in the South San Francisco Bay Alviso Pond and Slough complex, as part of the South Bay Salt Pond Restoration Program (SBSPRP). In addition to sampling a number of former salt ponds, the USGS study has four fixed sampling locations along Alviso Slough and one fixed sampling location in Artesian Slough, which have been sampled six times each (May, June and August of both 2010 and 2011). Results to date suggest that sediment methylmercury concentrations at the single Artesian Slough site (median: 6.2, range: 2.9–14.9, ng/g dry weight; n=6) are higher than in Alviso Slough (median: 2.0, range: 1.0–4.6, ng/g dry weight; n=24). This is surprising given that the sediment total mercury concentrations in the Alviso Slough sites (median: 512, range: 119–1696, ng/g dry weight; n=24) are higher than from the single site in Artesian Slough (median: 348, range: 180–547, ng/g dry weight; n=6). It is unclear why sediment in Artesian Slough might have higher methylmercury concentrations than the heavily mercury contaminated Alviso Slough, and if this trend is consistent along the length of Artesian Slough, or if the one fixed site is an anomaly.

In May 2011, the City of San Jose (the City) entered into a joint agreement with the U.S. Geological Survey (USGS), whereby the USGS would sample surface sediment from six locations along the full length of Artesian Slough, from the waste water plant outfall to the slough mouth at Coyote Creek, and analyze these samples for MeHg. This data thus fulfills two purposes: a) assists the City of San Jose in fulfilling their SMP requirement to analyze Artesian Slough sediment for MeHg concentrations, and b) assists the USGS researchers in their larger SBSPRP study in determining if the higher sediment MeHg concentrations seen thus far at the single Artesian Slough site are an anomaly or represent an overall trend throughout the slough.

In addition to simply documenting the spatial trend of MeHg in Artesian Slough, it is equally important to try to determine why MeHg is high or low at a particular site. To do this, additional parameters were assayed on the same six Artesian Slough sediment samples. These parameters parallel those being measured as part of the USGS SBSPRP study, and included: total mercury (THg), reactive inorganic mercury ($Hg(II)_R$), organic content, grain size, iron (Fe) speciation and total reduced sulfur (TRS).

2. METHODS

2.1.Field Sampling

A single sampling event was conducted on Sept. 13, 2011 by the USGS and City of San Jose biologist Ryan Mayfield. Sediment was collected from six locations (S1 thru S6) along the full length of Artesian Slough, from the waste water plant outfall to the slough mouth at Coyote Creek (Fig. 1). One field replicate was collected at site S2 (immediately upstream of the weir) and treated as a uniquely individual sample to provide some assessment of within-site variability. Surface sediment (top 10–20 cm, approximately) was initially collected from a boat using an Ekman style box core (16 x 16 x 30 cm) and trace metal clean sampling techniques (USEPA, 1996) as appropriate. The top 0-2 cm of the sediment surface was then sub-sampled using a 2 cm high polycarbonate core ring (acid cleaned), and transferred into an acid-cleaned glass mason jar, which was stored chilled until returned to the USGS laboratory the same day. Sediment was subsequently sub-sampled for the suite of sediment parameters listed below in an anaerobic (N_2 flushed) glove bag, as previously described (Marvin-DiPasquale and others, 2009). One field replicate was collected at site S2 (immediately upstream of the weir) and treated as a uniquely individual sample to provide some assessment of with-site variability. Surface water (approximately 20-50 cm below the air/water interface) and surface sediment (top 0-2 cm interval) temperature was measured at the time of sample collection using a digital thermometer equipped with a thermocouple probe.

Figure 1. Sediment sampling locations along Artesian Slough on Sept. 13, 2011.

2.2. Total Mercury (THg)

Sediment sub-samples for THg were stored frozen until analysis. After thawing, sediment THg was first extracted overnight in concentrated acid (HNO_3 plus HCl), followed by the addition of the oxidant BrCl and overnight heating at 60°C to ensure all of the mercury is in the divalent inorganic form (i.e. Hg(II)), as per standard USGS protocol (Olund and others, 2004). Quantification of Hg(II) in the extract was then carried out on an automated total mercury analyzer (Tekran 2600) according to EPA method 1631 (USEPA, 2001, 2002). Each batch of analytical samples was accompanied by the analysis of the following minimum number of quality assurance (QA) samples: 1 certified reference material sample, 1 matrix spike sample, 1 analytical duplicate, 1 field duplicate, 1 method blank, and calibration standards prepared from commercially certified $HgCl_2$ solution. The detection limit for the THg assay is approximately 0.5 ng/L at the level of the autoanalyzer.

2.3. Methylmercury (MeHg)

Sediment sub-samples for MeHg were stored frozen until analysis. After thawing, sediment MeHg was first extracted with a solution of 25% KOH in methanol at 60°C for four hours (Xianchao and others, 2005). Quantification of MeHg in the extract was then carried out after ethylation of the analyte using an automated MeHg analyzer (MERX, Brooks Rand, Seattle WA). Further method details are given elsewhere (Marvin-DiPasquale and others, 2011). Each batch of analytical samples was accompanied by the analysis of the following minimum number of QA samples: 1 certified reference material sample, 1 matrix spike sample, 1 analytical duplicate, 1 field duplicate, 1 method blank, and calibration standards prepared from commercial crystalline MeHgCl and compared to a separate, commercially available MeHg standard solution. The detection limit for the MeHg assay is approximately 0.5 pg (absolute mass as Hg).

2.4. Reactive Inorganic Mercury ($Hg(II)_R$)

Sediment "reactive" mercury ($Hg(II)_R$) is methodologically defined as the fraction of total Hg(II), which has not been chemically altered (for example, digested, oxidized, or chemically preserved apart from freezing), that is readily reduced to elemental Hg^0 by an excess of $SnCl_2$ over an exposure time of 15 minutes. Further method details are given elsewhere (Marvin-DiPasquale and Cox, 2007). Sediment sub-samples for $Hg(II)_R$ were stored frozen until analysis. Each batch of analytical samples was accompanied by the analysis of the following minimum number of QA samples: 1 analytical duplicate, 1 field duplicate, 4 bubbler blanks, and calibration standards prepared from a commercial $HgCl_2$ stock solution. No commercially available certified reference material exists for $Hg(II)_R$ in sediment. The detection limit for the $Hg(II)_R$ assay is approximately 40 pg (absolute mass).

2.5. Iron Speciation

Sediment sub-samples for iron (Fe) speciation were stored frozen until analysis. Three forms of sediment iron were assayed: acid extractable ferrous iron ($Fe(II)_{AE}$), amorphous (poorly crystalline) ferric iron ($Fe(III)_a$) and crystalline ferric iron ($Fe(III)_c$). Method details are given elsewhere (Marvin-DiPasquale and others, 2008). The typical detection limit for each Fe-fraction is approximately 0.02 µg/mL at the level of the spectrophotometric analysis. Each batch of analytical samples was accompanied by the analysis of the following minimum number of QA samples: 1 analytical duplicate, 1 field duplicate, 1 matrix spike for $Fe(II)_{AE}$ and $Fe(III)_{c}$ fractions only, 1 method blank, and $FeSO_4$ calibration standards prepared from analytical grade crystalline reagents. No certified reference material is commercially available for these method-defined iron species.

2.6.Total Reduced Sulfur

Sediment sub-samples for TRS were stored frozen until analysis. After thawing, sediment TRS was extracted by a single-step hot acid chromium reduction approach and quantified spectrophotometrically (Marvin-DiPasquale and others, 2008). Each batch of analytical samples was accompanied by the analysis of the following minimum number of QA samples: 1 analytical duplicate, 1 field duplicate, 1 method blank, and ZnS calibration standards. No certified reference material is commercially available for the TRS assay. The detection limit for this assay is approximately 1 nmol/mL at the level of the colorimetric analysis.

2.7.Grain Size (sand/silt break)

Sediment sub-samples for grain size were stored refrigerated until analysis. Sediment grain size was assayed as the weight percentage of dry sediment less than 63 micrometers (the sand/silt split), and was conducted via wet sieving (Matthes and others, 1992). Each batch of analytical samples was accompanied by the analysis of the following minimum number of QA samples: 1 analytical duplicate and 1 field duplicate. No certified reference material is commercially available for the grain size analysis.

2.8. Dry weight / Bulk Density / Porosity / Organic Content

Sediment sub-samples for general sediment characterization were stored refrigerated until analysis. Sediment bulk density, dry weight, porosity, and organic content (as percent loss on ignition; %LOI) were analyzed consecutively from single sediment sub-samples, as previously detailed (Marvin-DiPasquale and others, 2008). Each batch of analytical samples was accompanied by the analysis of the following minimum number of QA samples: Analytical duplicate at all sites and 1 field duplicate. No certified reference material is commercially available for this suite of sediment analyses.

2.9. Redox and pH

Sediment reduction-oxidation measurements were made with a platinum band ORP electrode (Model EW05990-55, Cole Parmer®, Vernon Hills, Ill.) used in conjunction with a hand-held pH/mV multi-meter (Model 59002-00, Cole Parmer®, Vernon Hills, IL) after verifying probe response with pH adjusted quinhydrone solutions. Similarly, sediment pH measurements were made with a pH electrode used in conjunction with the same hand-held pH/mV multimeter after probe calibration with two commercial pH buffers. Both measurements were made immediately after sediment sub-sampling. Further details on approach and probe calibration are published elsewhere (Marvin-DiPasquale and others, 2009). Each batch of analytical samples was accompanied by the analysis of the following minimum number of QA samples: 1 analytical duplicate and 1 field duplicate. No certified reference material is commercially available for these two sediment analyses.

3. RESULTS

The site specific descriptions, coordinates, sampling times and in-situ temperature data are given in **Table 1**. Parameter results are summarized in **Table 2**.

Table 1. Artesian Slough sites sampled during September 13, 2011

Site	Description	Latitude (degrees, decimal minutes)	Longitude (degrees, decimal minutes)	Sampling Time (hr:min)	Temperature Water / sediment (°C)
S1	below outfall	37 26.081	121 57.243	10:24	25.3 / n.r.
S2	upstream of weir	37 26.375	121 57.459	11:30	25.4 / n.r.
S3	downstream of weir	37 26.421	121 57.511	12:17	25.6 / 24.8
S4	near fixed continuous monitoring buoy	37 26.585	121 57.642	12:20	24.3 / 23.3
S5	mid-slough	37 27.054	121 58.066	12:45	22.8 / 23.2
S6	near mouth / Coyote Cr.	37 27.675	121 57.856	13:00	21.7 / 22.0

n.r. = not recorded

Table 2. Parameter Results for Artesian Slough sites sampled during September 13, 2011

[Values less than the reporting limit are preceded by '<' and the reporting limit is given. Notation: THg, total mercury; MeHg, methylmercury; $Hg(II)_R$, inorganic reactive mercury; $Fe(II)_{AE}$, acid extractable ferrous iron; $Fe(III)_a$, amorphous (poorly crystalline) ferric iron; $Fe(III)_c$, crystalline ferric iron; $Fe(II)_{AE}/Fe_T$, the ratio of $Fe(II)_{AE}$ to total-iron (Fe_T), where FeT = $Fe(II)_{AE}$ + $Fe(III)_a$ + $Fe(III)_c$; TRS, total reduced sulfur; E_h, oxidation-reduction potential corrected for the hydrogen half-cell reaction; LOI, loss on ignition at 500°C, a measure of organic content; ng/g, nanogram per gram; d.w., dry weight; %, percentage, mg/g, milligram per gram; µmol/g, micromole per gram; mV, millivolt; g/cm^3, gram per cubic centimeter; ml PW/cm^3, milliliters of pore water per cubic centimeter; % < 64 µm, percent less than 64 micrometers]

Parameter	Units	Site					
		S1	S2 [a]	S3	S4	S5	S6
THg	(ng/g) d.w.	333	151	131	310	329	232
MeHg	(ng/g) d.w.	4.3	2.4	2.0 [c]	13.1	1.6	1.5
MeHg	(% of THg)	1.30	1.75	1.50	4.23	0.48	0.63
$Hg(II)_R$	(ng/g) d.w.	0.82	0.04	<0.02	0.17	0.06 [c]	2.97
$Hg(II)_R$	(% of THg)	0.25	0.03	<0.02	0.06	0.02	1.28
$Fe(II)_{AE}$	(mg/g) d.w.	3.2 [c]	4.8	3.4	9.3	8.6	1.1
$Fe(III)_a$	(mg/g) d.w.	<0.1 [c]	<0.1	0.1	0.1	0.3	0.9
$Fe(III)_c$	(mg/g) d.w.	<0.2 [c]	3.5	3.1	1.4	5.7	9.6
$Fe(II)/Fe_T$	(%)	93	60	51	86	59	9
TRS	(µmol/g) d.w.	33	33	32	210	125	43 [c]
E_h	(mV)	-39	-99	-31	-115	-3	125
pH	pH Units	7.14	7.08	7.40	7.22	7.33	7.49
dry weight [b]	(% of wet weight)	51.4	36.2	25.4	21.2	29.6	41.1
LOI [b]	(% of d.w.)	4.2	6.4	8.4	11.3	8.3	6.5

Parameter	Units	Site S1	S2 [a]	S3	S4	S5	S6
Bulk density [b]	(g/cm^3)	1.39	1.24	1.14	1.11	1.18	1.30
Porosity [b]	(ml PW/cm^3)	0.68	0.78	0.85	0.87	0.83	0.77
Grain Size	(% < 64 µm)	8	30	33 [c]	92	92 [c]	68

[a] For site S2, the average of both the primary sample and the field replicate sample is given. The individual measurements for both field replicates, along with the error, are given for each parameter in **Table 5**.

[b] Analytical duplicates (n=2) were assayed for all sites and the average is reported. The error associated with analytical duplicates for each parameter is given in **Table 6**.

[c] The value represents the average of analytical duplicates (n=2) assayed for a single site. The error associated with analytical duplicates for each parameter is given in **Table 6**.

4. QUALITY ASSURANCE/QUALITY CONTROL

4.1. Holding Times

All assays were conducted within the prescribed holding times, as established by either USGS or USEPA (**Table 3**).

Table 3. Holding Times and preservation used for Artesian Slough sediment samples collected on September 13, 2011

[Parameter notation as given **Table 2**. Maximum holding times 'authority' as established by either the U.S. Environmental Protection Agency (EPA) where indicated. Where no EPA guidance exists, holding times are given as established by our laboratory (USGS).]

Parameter	Authority	Preservation prior to assay	Maximum Prescribed Holding Time	Actual Holding Time
THg	EPA	Frozen	1 year	71 days
MeHg	EPA	Frozen	28 days [a]	10 days
$Hg(II)_R$	USGS	Frozen	90 days	31 days
$Fe(II)_{AE}$	USGS	Frozen	90 days	66 days
$Fe(III)_a$	USGS	Frozen	90 days	66 days
$Fe(III)_c$	USGS	Frozen	90 days	66 days
TRS	USGS	Frozen	90 days	69 days
E_h	USGS	Refrigerated	< 24 hrs	< 24 hrs
pH	USGS	Refrigerated	< 24 hrs	< 24 hrs
dry weight	USGS	Refrigerated	undetermined [b]	21 days
LOI	USGS	Refrigerated	undetermined [b]	21 days
Bulk density	USGS	Refrigerated	undetermined [b]	21 days
Porosity	USGS	Refrigerated	undetermined [b]	21 days
Grain Size	USGS	Refrigerated	Indefinite	32 days

[a] Prescribed for MeHg in acid preserved water samples, although no holding time guidance exists for frozen sediment samples, which are presumably much more stable when frozen than water samples are refrigerated and acidified.

[b] A holding time for this parameter has not been explicitly determined, but based upon many years of experience samples held refrigerated in tightly sealed containers are stable for this parameter for at least 30 days and likely for months.

4.2. Blanks

Method blanks were run to assess contamination introduced in the laboratory for the following parameters: THg, MeHg, $Hg(II)_R$, Fe-species, and TRS. In all cases, method blanks were below our method detection limit (**Table 4**) indicating that the methods and equipment used were free of (or did not introduce) contamination.

Table 4. Method blanks and Method Detection Limits.

[Parameter notation as given **Table 2**.]

Parameter	Method Detection Limit	Method Blank
THg	0.5 ng/L at the level of the Tekran 2600 autoanalyzer	<0.5 ng/L
MeHg	0.5 pg (absolute mass as Hg) at the level of the MERX autoanalyzer	< 0.5 pg
$Hg(II)_R$	0.05 ng (absolute mass as Hg) at the level of the fluorescence detector.	< 0.05 ng
$Fe(II)_{AE}$	0.01 mg/ml at the level of the spectrophotometric analysis	< 0.01 mg/ml
$Fe(III)_a$	0.01 mg/ml at the level of the spectrophotometric analysis	< 0.01 mg/ml
$Fe(III)_c$	0.01 mg/ml at the level of the spectrophotometric analysis	< 0.01 mg/ml
TRS	0.2 nmol/ml at the level of the spectrophotometric analysis	< 0.2 nmol/ml

4.3. Field Replicates

One field replicate was collected at site S2 (immediately upstream of the weir) and treated as a uniquely individual sample to provide some assessment of with-site variability for all parameters (**Table 5**). The two samples (S2 and S2-FDUP) were collected approximately 5–10 meters apart. A number of parameters exhibited ≤ 10% deviation between the two adjacent sites (i.e. $Fe(II)_{AE}$, pH, bulk density, porosity), while a few slightly exceeded 50% (i.e. %MeHg, $Fe(III)_c$ and grain size), suggesting a moderate degree of spatial variability within Artesian Slough at the scale of meters.

Table 5. Field Replicate Results for Artesian Slough sediment parameters

[Parameter and unit notation as given **Table 2**. The mean value for the n=2 sites is given (as presented in **Table 2**), along with the deviation (DEV), calculated as: DEV = ABS($X_1 - X_2$)/2, where X_1 = S2 data and X_2 = S2-FDUP data. The percent deviation (%DEV) is than calculated as: %DEV = DEV/mean x 100.]

Parameter	Units	Sampling Site S2	S2-FDUP	Mean	DEV	%DEV
THg	(ng/g) d.w.	180	122	151	29	19
MeHg	(ng/g) d.w.	1.3	3.4	2.4	1.0	43
MeHg	(% of THg)	0.74	2.77	1.75	1.01	58
$Hg(II)_R$	(ng/g) d.w.	0.03	0.05	0.04	0.01	28
$Hg(II)_R$	(% of THg)	0.02	0.04	0.03	0.01	44
$Fe(II)_{AE}$	(mg/g) d.w.	4.6	4.9	4.8	0.1	3
$Fe(III)_a$	(mg/g) d.w.	<0.08	0.14	<0.11	0.03	30
$Fe(III)_c$	(mg/g) d.w.	5.3	1.6	3.5	1.9	55
$Fe(II)/Fe_T$	(%)	46	74	60	14	23
TRS	(µmol/g) d.w.	27	39	33	6	18
E_h	(mV)	-110	-88	-99	11	11
pH	pH Units	7.04	7.11	7.08	0.04	0.5
dry weight	(% of wet weight)	48.8	23.6	36.2	12.6	35
LOI	(% of d.w.)	4.3	8.6	6.4	2.1	33
Bulk density	(g/cm^3)	1.37	1.12	1.24	0.13	10
Porosity	(ml PW/cm^3)	0.70	0.85	0.78	0.08	10
Grain Size	(% < 64 µm)	14	45	30	15	51

4.4. Laboratory Replicates

Laboratory analytical replicates represent multiple samples taken from the same container of site specific sediment, as a measure of both sample homogeneity and laboratory reproducibility. At least one analytical replicate was run for each sediment parameter, with the results given in **Table 6**.

Table 6. Laboratory Analytical Replicate Results for Artesian Slough sediment parameters

[Parameter and unit notation as given **Table 2**. The percent deviation (%DEV) between n=2 analytical duplicates is calculated as described for **Table 5**. The number of analytical duplicates analyzed for a given parameter is defined as 'N', and the specific sites used for analytical replicate analyses are indicated. If more than one pair of analytical duplicates were run (N>1), the mean %DEV is given, along with the error associated with those multiple assessments. Field duplicates, as given in **Table 5**, are not reflected in the data below. n.d., not determined.]

Parameter	Units	Site(s)	%DEV	N
THg [a]	(ng/g) d.w.	Pond A7, ALSL-2	3.5 ± 0.2	2
MeHg	(ng/g) d.w.	S3	6.5	1
$Hg(II)_R$	(ng/g) d.w.	S5	31	1
$Fe(II)_{AE}$	(mg/g) d.w.	S1	5.9	1
$Fe(III)_a$	(mg/g) d.w.	S1	n.d. [b]	1
$Fe(III)_c$	(mg/g) d.w.	S1	n.d. [c]	1
TRS	(µmol/g) d.w.	S6	4.1	1
E_h	(mV)		n.d.	0
pH	pH Units		n.d.	0
dry weight	(% of wet weight)	all	0.7 ± 0.3	7
LOI	(% of d.w.)	all	3.2 ± 2.5	7

Parameter	Units	Site(s)	%DEV	N
Bulk density	(g/cm^3)	All	0.7 ± 0.5	7
Porosity	$(ml\ PW/cm^3)$	All	0.5 ± 0.3	7
Grain Size	(% < 64 µm)	S2, S3, S5	3.6 ± 2.2	3

[a] For the THg assay, no samples from Artesian Slough were run in duplicate, however two samples (Pond A7 and Alviso Slough site 2 [ALSL-2]), collected during August 2011 as part of our SBSPRP study were run as part of the same analytical batch. As such, those results are given above.

[b] The %DEV could not be calculated in this case because both replicates were below our analytical reporting limit of 0.1 mg/g for $Fe(III)_a$.

[c] The %DEV could not be calculated in this case because one of the two replicates was just above (0.3 mg/g) and the other below our analytical reporting limit of 0.1 mg/g for $Fe(III)_c$.

4.5. Matrix Spike Samples

Matrix spike percent recoveries were evaluated to determine acceptable accuracy based on method-specific percent recoveries, which are generally set at 75–125% recovery for our laboratory's control limit. Typically when spikes are reported below this accepted range they indicate a low bias, and when reported above this range they indicate a high bias. However, if the spike concentration was low in comparison with the sample concentration, a poor recovery is not in itself indicative of a QC problem. Further, not all sediment parameters are amenable to matrix spikes. For example, the addition of $HgCl_2$ to sediment quickly partitions itself between Sn-reducible and non-reducible pools, and thus cannot be used as a reliable matrix spike for the $Hg(II)_R$ assay. Similarly, there is no commercially available material that can mimic the operationally defined amorphous Fe(III) sediment pool, and thus the $Fe(III)_a$ assay is not subject to a matrix spike assay. Matrix spike additions were applied to THg, MeHg (x2), $Fe(II)_{AE}$, and $Fe(III)_c$, with the results given in **Table 7**. The matrix spike % recovery for the Fe(III)c assay (73%) was just a little lower than our standard low-end control limit of 75%.

Table 7. Matrix Spike Results for Artesian Slough sediment samples

[Parameter and unit notation as given **Table 2**.]

Parameter	Units	Sample amended	Sample Value (non-spiked)	Theoretical Spiked Value	Measured value	Recovery (%)
THg [a]	(ng/g) d.w.	S4	310	889	850	96
MeHg	(ng/g) wet wt.	S1	2.22	2.92	3.12	107
MeHg	(ng/g) wet wt.	S1	2.22	2.92	3.13	108
$Fe(II)_{AE}$	(mg/g) d.w.	S5 [a]	8.6	27.6	27.1	98
$Fe(III)_c$	(mg/g) d.w.	S5 [b]	5.7	43.2	31.7	73

[a] Spike consisted of $FeSO_4$ solution.

[b] Spike consisted of commercial solid phase powdered magnetite (Fe_2O_3)

4.6. Certified Reference Material

Certified reference material (CRM) is available for only a limited number of the analytes assayed in the current study, specifically for sediment THg and MeHg. Like matrix spike's, CRM recoveries were evaluated to determine acceptable accuracy based on method-specific percent recoveries, which are generally set at 75–125% for our laboratory's control limit. CRM recovery results for THg and MeHg given in **Table 8.**

Table 8. Certified Reference Material Recovery Results

[Parameter and unit notation as given **Table 2**.]

Parameter	Units	CRM Used	Certified Value	Measured value	Recovery (%)
THg	(µg/g) d.w.	PACS-2 marine sediment	3.04	2.64	87
MeHg	(ng/g) d.w.	IAEA 405 estuarine sediment	5.49	5.06	92
MeHg	(ng/g) d.w.	IAEA 405 estuarine sediment	5.49	5.34	97

5. References

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Appendix III. Update on A18 Future Use Planning and Long-term Operations.

Status Report on A18 Planning Process and Long-term Operations

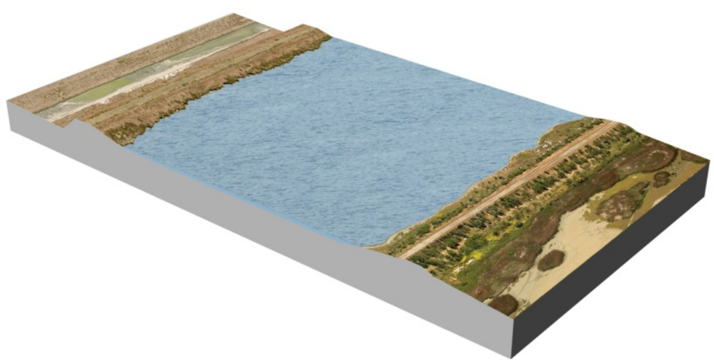
This section provides an update on efforts to determine the future uses of Pond A18 within the context of the Master Planning effort for the San Jose/Santa Clara WPCP (Plant).

Plant Master Plan

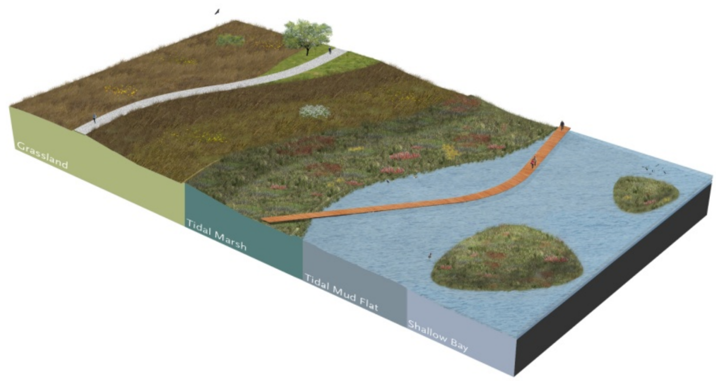
The Plant Master Plan, which includes planning for A18, is now under environmental review and expected to be presented to San Jose City Council for adoption in early 2013. The draft Plan includes a 30-year capital plan for liquids, solids, and energy management. The Plan includes a land use plan for the Plant's 2,684 acres. Developed with robust community engagement process, including public workshop and Community Advisory Group meetings, the Plan outlines a long-range vision for Pond A18 that provides vital flood control for the Plant and neighboring communities while also restoring historic habitats.

The plans for levee alignments along and the "terraced habitat" concept for Pond A18 have been closely coordinated with the South Bay Salt Pond Restoration effort and is included as an integral part of the Shoreline Study to address tidal flooding due to projected sea-level rise. Pond A18 is proposed to include only water-based uses dominated by tidal influence as open bay, mudflats, habitat islands, and salt marsh.

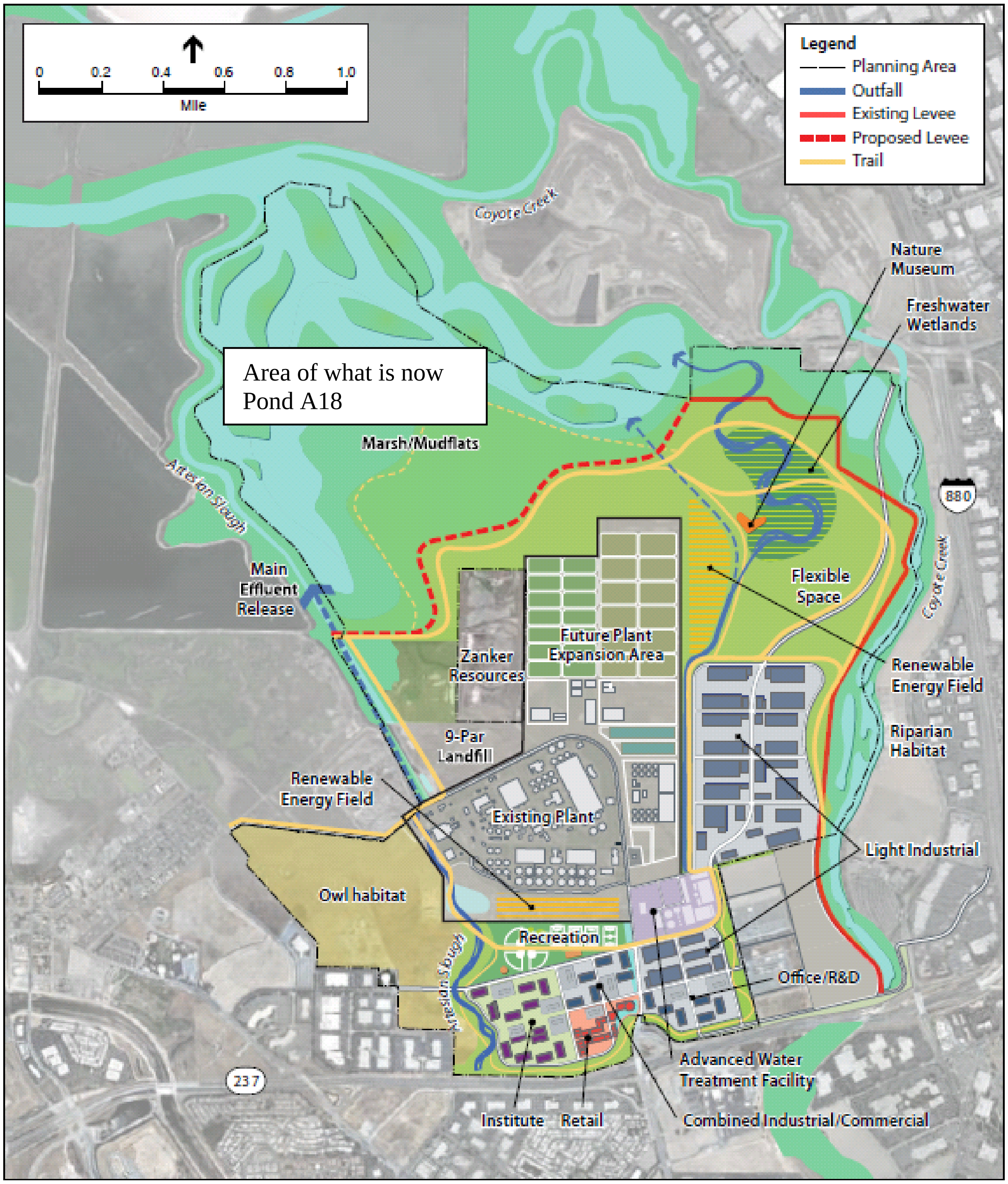
A18 Existing Condition Cross Section



A18 With Terraced Habitat Cross Section



Plant Master Plan Land Use Plan



SOURCE: Skidmore, Owings & Merrill LLP

San Jose/Santa Clara WPCP Master Plan

Figure 3
Site Plan