San José-Santa Clara
Regional Wastewater Facility
Reporting Period June 1 – October 31, 2018

Pond A18

2018 Annual Self-Monitoring Report

Order No. R2-2005-0003

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I. INTRODUCTION

This report summarizes 2018 water quality monitoring for Pond A18. Monitoring began June 1st and ended October 31st as required by the Waste Discharge Requirement (WDR) Order No. R2-2005-0003 (Order) and subsequent modifications to the Order as approved by the Executive Officer of the San Francisco Bay Regional Water Quality Control Board (Water Board).

This was the fourteenth year of continuous discharge monitoring for Pond A18. Figures 1, 2 indicate the location of Pond A18 hydraulic control structures and sampling sites in the receiving water (Artesian Slough and Coyote Creek).

A. Waste Discharge Requirements

Pond A18 circulates San Francisco Bay (Bay) water by means of two water control structures located at the northern and southern ends of the levee bounding the western edge of the pond. Discharge of pond water back into the Bay via Artesian Slough is regulated by the WDR and the water quality of the pond must meet specific general water quality limits (Table 1).

Table 1. Pond A18 discharge requirements for Salinity, Dissolved Oxygen (DO) and pH

Constituent	Instantaneous Maximum	Instantaneous Minimum	Units
Salinity	44		ppt
Dissolved Oxygen		5.0	mg/L
pH	8.5	6.5	standard units

Pond A18 must meet the following water quality requirements:

1. Discharge temperature into Artesian Slough shall not exceed the receiving water temperature by 20°F.
2. If pond dissolved oxygen (DO) levels at station A-A18-D fall below 1.0 mg/L, the discharger shall monitor, report, and take corrective actions required by Provision D.2.

B. Monitoring Requirements

Monitoring in 2018 was conducted in compliance with the Pond A18 WDR monitoring requirements on page 9, Table 2 of the "Self-Monitoring Program" of the Order, and subsequent revisions to the WDR. The City continuously monitored (15-min intervals) pond discharge from 1 June to 31 October 2018 for DO, pH, temperature, and salinity. Additionally, chlorophyll-*a*, DO, pH, temperature, and salinity were measured between 0800 and 1000 once per month in the pond. City staff recorded both surface and bottom DO, pH, temperature, salinity, and turbidity measurements by discrete grab sampling on a monthly interval at four monitoring stations in the receiving water.

Per a modification to the WDR in 2010, the previous requirement for annual sampling of pond sediment mercury and methyl mercury was modified to require monitoring of receiving water sediments in August or September of every other year. This monitoring was last conducted in September 2017.

Following the 2012 annual report, a letter from the Water Board's Executive Officer Bruce Wolfe, dated 9 April 2013, eliminated the requirement of continuous receiving water monitoring. In 2018, receiving water was monitored with weekly discrete water column measurements in response to the pond's weekly 10^{th} percentile DO concentration falling below the 3.3 mg/L trigger threshold. Trigger monitoring is presented on Page 10, Table 6. Weekly 10th percentile DO values for Pond A18 discharge and response in 2018.

C. Pond Operations in 2018

In 2015, the pond's northern gate structure was reconstructed due to deterioration and imminent failure. During the months of dewatering and reconstruction, the southern structure was used to pulse slough water into and out of the pond to maintain pond elevation and water quality. This pulsing of water accelerated bank erosion and active scouring/slumping on the outboard levee proximal to the southern structure.

The extent of the slumping and erosion at the southern structure was substantial, leading City engineering staff and consultant geotechnical engineers to recommend a northern discharge flow regime to reduce risk of levee failure and breach. This flow configuration was maintained while the City prepared to restore the integrity of the southern structure and its levee. A more detailed description of the condition, monitoring and repair of the southern structure and levee can be found later in this report (Page 26, IV. Discussion and Interpretation of 2018 Results). Pond operations in 2018 focused on minimizing further deterioration of the southern hydraulic control structure and its levee.

In advance of the 2018 dry season monitoring, the City contracted with Environmental Science Associates (ESA) to shepherd the regulatory permit process for the Pond A18 South Levee Repair Project. Sweetwater Construction was awarded the build contract based on HydroScience Engineers, Inc. plans and specifications to repair/reinforce the levee embankments surrounding the pond's southern structure to allow for flow in either direction.

Pond A18 was operated in both a northern and a southern discharge flow regime during 2018 dry season monitoring. From June through early October, pond discharge water quality was monitored at the northern structure, and 10th percentile weekly DO values calculated on discharged water through the northern structure. For this time period, monitoring stations in the receiving water for monthly discrete sampling and trigger monitoring locations, were adopted in accordance with the north release scenario detailed in the WDR and Operations Plan (Figure 1). Station 1 was located in Artesian Slough directly upstream of the northern structure, and Station 2 was in Coyote Creek, directly upstream of the confluence with Artesian Slough. Station 3 was located in Coyote Creek directly downstream of the confluence with Artesian Slough, and Station 4 was farther downstream Coyote Creek.

The pond's circulation configuration was reversed on October 9th when the southern hydraulic structure's repairs were completed, and the pursuant monthly discrete monitoring in October was conducted in accordance with stations outlined in the southern release scenario of the WDR and Operations Plan (Figure 2). The four Artesian Slough monitoring stations were renamed 1S, 2S, 3S, and 4S to differentiate the southern discharge configuration from the northern configuration. Trigger monitoring was not required in October as pond DO levels remained above the 3.3 mg/L monthly trigger value.

Figure 1. Pond A18 monitoring stations and hydraulic control structures- Northern Discharge. Arrows indicate the flow of water through the control structures.

Figure 2. Pond A18 monitoring stations and hydraulic control structures- Southern Discharge. Arrows indicate the flow of water through the control structures.

II. MONITORING METHODS AND RESULTS

San José-Santa Clara Regional Wastewater Facility (Facility) staff used water quality monitoring sondes manufactured by YSI, Inc. for general water quality monitoring (DO, pH, temperature, salinity). The 6600 model sonde was deployed for continuous monitoring and recorded water quality measurements every 15 minutes. The 600 XLM sonde was used for discrete monitoring of surface and bottom measurements. All sondes were outfitted with an optical DO probe, a conductivity/temperature probe, and a pH probe.

A. Quality Assurance/Quality Control

Facility staff calibrated and maintained sondes to ensure accuracy before deploying. After each use, staff checked sondes for their accuracy against known standards for conductivity, pH and DO. An unattended 6600 sonde was deployed for 1 or 2 weeks and then replaced with another cleaned and calibrated sonde. This rotation continued throughout the duration of dry season monitoring.

Data Validation

Staff followed established acceptance criteria for sonde data with post-deployment readings within 5% of the theoretical level accepted. Data between 5 - 10% were accepted or rejected based on best professional judgment. Staff rejected data with post deployment measurements exceeding 10% of theoretical and investigated the cause of such failures.

Calibration standards used for post-deployment accuracy checks to validate sonde data were:

- DO – percent saturation in water-saturated air (theoretical of 100% saturation).
- pH – a 2-point calibration (pH 7 and pH 10) to establish a pH slope.
- Conductivity – 50,000 microSiemens standard.

There were no post-deployment QA/QC failures for any parameter in 2018.

B. Continuous Monitoring

Staff monitored Pond A18 discharge (Station A18-D) for temperature, salinity, pH, and DO from June 1, 2018 to October 31, 2018 (Figure 1 and Figure 2).

Sondes recorded water quality data every 15 minutes. Following deployment, staff uploaded these data to a computer where they were checked for accuracy and completeness, summarized, and evaluated with respect to discharge requirements and action triggers. Weekly 10^{th} percentile DO readings for pond discharge indicated the need for any adaptive management responses during the upcoming week. Such responses included, but are not additional receiving water monitoring, aeration, reversing direction of flow, or strategic timing of pond discharges to limit low DO discharge.

Temperature

Water temperature for Pond A18 discharge is presented in Table 2.

Table 2. Temperature results – 2018 continuous monitoring (℃)

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
A18 Discharge	17.2	27.0	21.5	21.5	13,271
A18 Non-Discharge	17.6	25.9	22.0	21.9	1,402

Compared to 2017, pond minimum temperature increased approximately 2°C while maximum temperature decreased approximately 2°C, with the mean temperature remaining consistent. Unlike prior years, pond temperature between discharge and non-discharge periods varied markedly from mid-August onward to the conclusion of the monitoring season (Table 2; Figure 3).

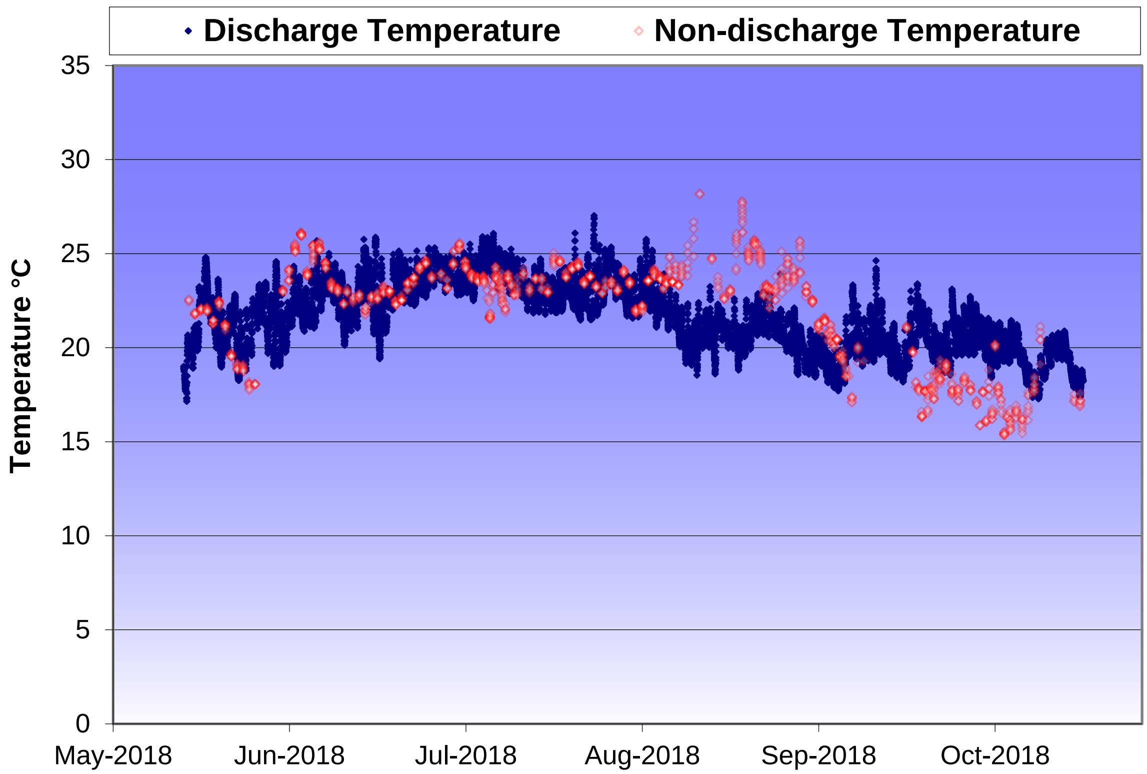

Figure 3. Temperature profile – Pond A18 2018 dry season

Salinity

Pond salinity, under both discharge and non-discharge conditions, is detailed in Table 3.

Table 3. Salinity results - 2018 continuous monitoring (PSU[1])

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
A18 Discharge	6.0	14.5	10.8	11.7	13,263
A18 Non-Discharge	6.4	14.1	10.8	11.7	1,412

[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.

Discharge salinity remained below 44 PSU at all times during the 2018 monitoring period. Pond salinity was consistent with the previous year, albeit slightly higher throughout the entire monitoring season by a margin of 3 PSU. Similar to the pattern observed over the past years, salinity climbed steadily through the dry season monitoring to a peak in late October (Figure *4*).

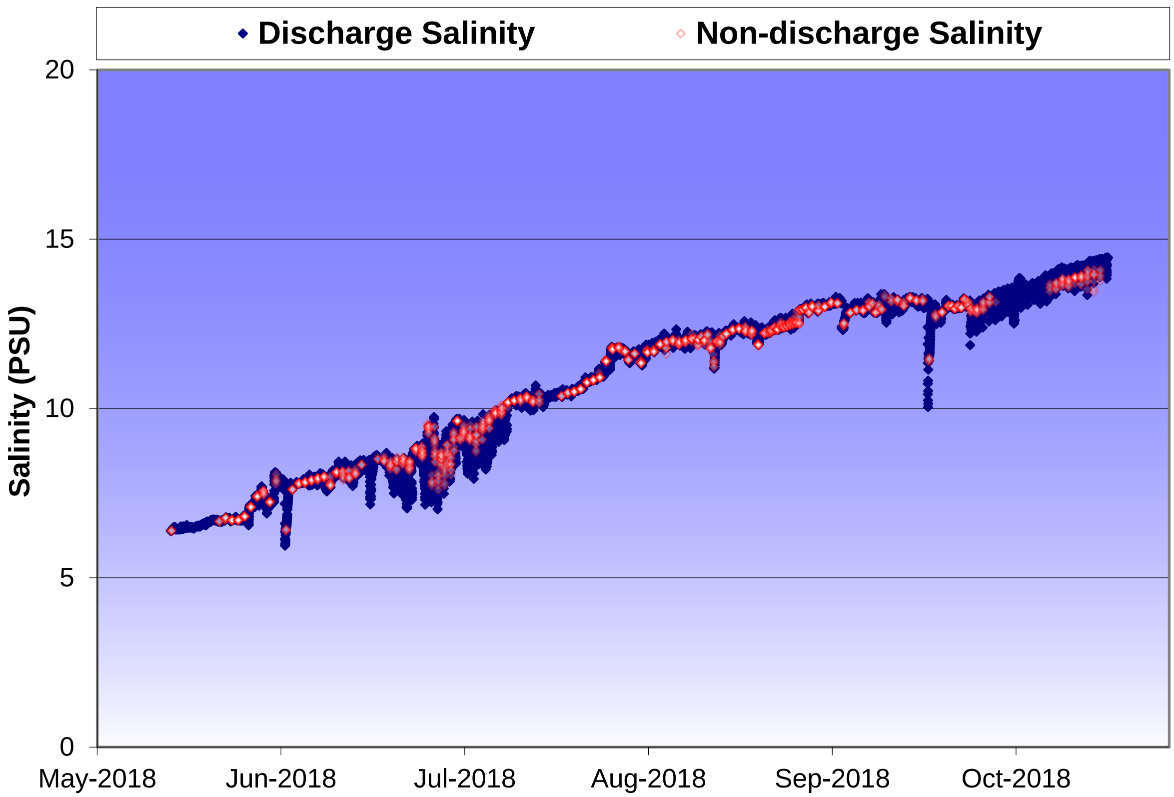

Figure 4. Salinity profile - Pond A18 2018 dry season

pH

The pH of the pond discharge, under discharge and non-discharge conditions, is shown in Table 4.

Table 4. pH results – 2018 continuous monitoring

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
A18 Discharge	8.4	10.6	9.7	9.7	12,743
A18 Non-Discharge	8.2	10.6	9.6	9.5	1,407

The Basin Plan Objective for pH requires that receiving water pH remain between 6.5 and 8.5, and pond pH was consistently above this range for most of 2018. Continuous receiving water data was not collected during 2018 dry season continuous monitoring, but discrete pH monitoring was performed at least monthly and receiving water pH was never measured outside of the range for the pH Objective in the Basin Plan. Furthermore, past years of continuous receiving water monitoring for pH (2005 – 2012) clearly demonstrated no adverse affects to receiving water pH from high pH pond discharges.

Pond pH pattern throughout the 2018 monitoring season remained consistent with previous years. Episodes of intense photosynthesis due to high algal biomass, elevated water temperature and increased solar irradiance coincide with increased pH. This is followed by declines in pH when algae die off and decompose later in the season. These conditions generally coincide with shifts in the phytoplankton species composition as part of a predictable community succession of the pond phytoplankton community.

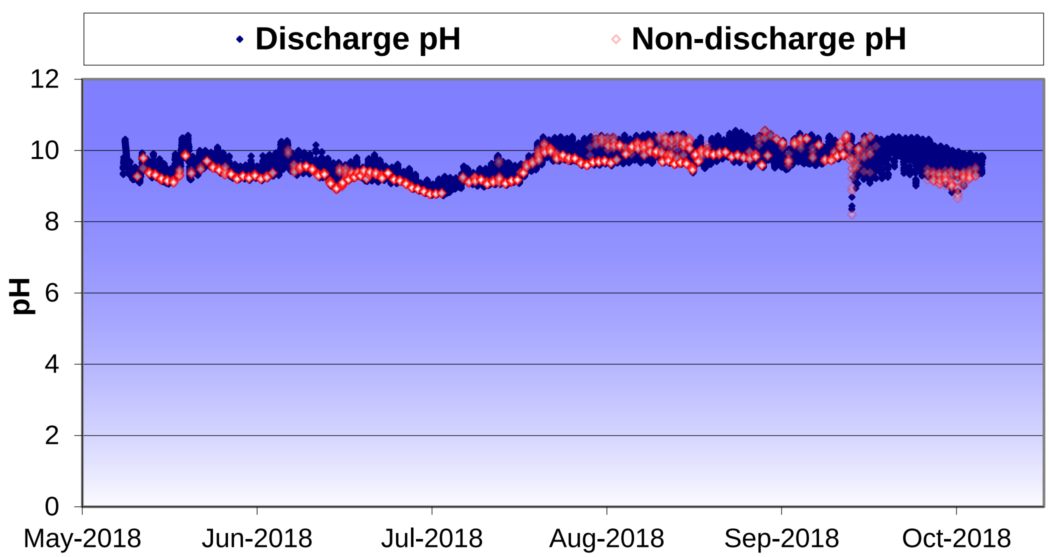

Figure 5. pH profile - Pond A18 2018 dry season

Dissolved Oxygen

DO concentrations in the pond discharge, under both discharge and non-discharge conditions, are summarized in Table 5.

Table 5. DO results - 2018 continuous monitoring (mg/L)

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
A18 Discharge	0.0	22.1	8.2	8.1	13,262
A18 Non-Discharge	0.0	18.3	7.7	7.5	1,412

Pond DO is primarily influenced by a photosynthesis driven diurnal pattern (Figure 6) of high primary productivity by algae during the day and high net ecosystem respiration at night by algae and other organisms residing in the pond. Other factors influencing pond DO to a lesser extent include hydraulic residence time and flushing in the pond, intensity and duration of sunlight/cloud cover, and temperature.

While pond DO concentrations were less variable in 2018 than in years past, with maximum discharge DO approximately 10mg/L less than in 2017, the mean DO concentrations were consistent with prior years.

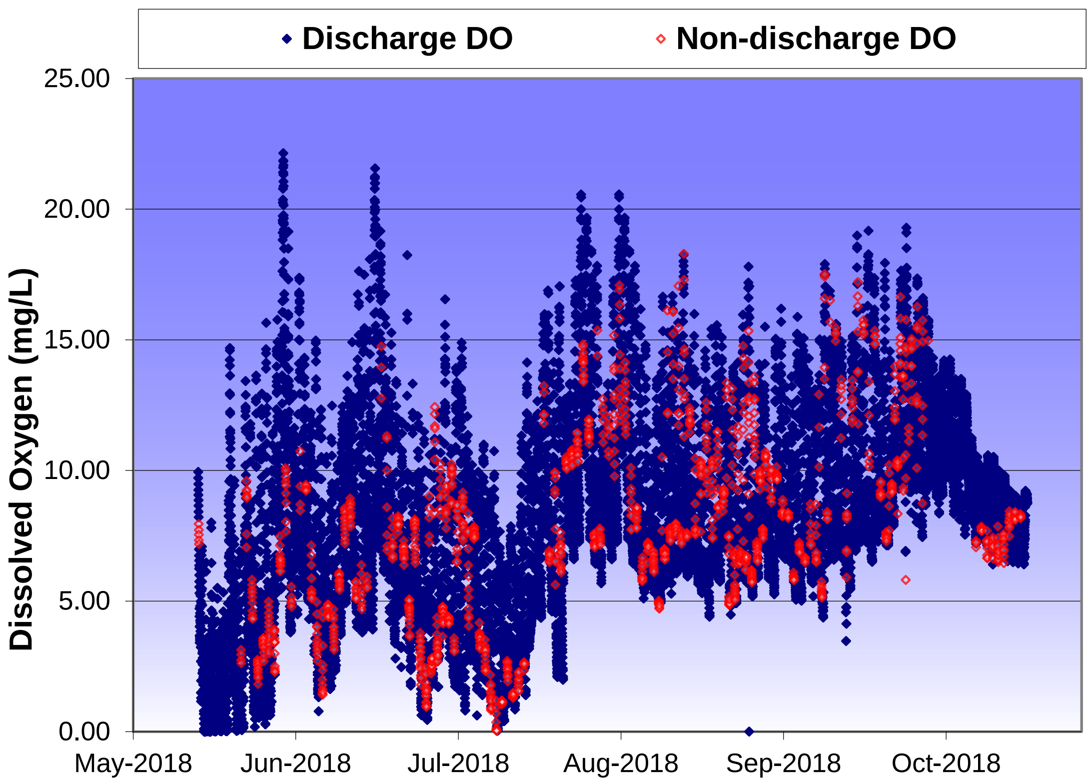

Figure 6. Dissolved Oxygen profile - Pond A18 2018 dry season

The City's trigger response in 2018 consisted of weekly discrete water column measurements at three discrete monitoring stations whenever the pond's weekly 10th percentile DO concentration fell below the 3.3 mg/L threshold. Trigger monitoring consisted of surface and bottom sonde measurements collected at three receiving water stations (Figure1). Under Pond A18's northern release configuration, Station 1 trigger monitoring data was collected in Artesian Slough directly upstream of the pond's discharge from its northern hydraulic structure. Station 2 was located in Coyote Creek, directly upstream of the confluence with Artesian Slough, and Station 3 was positioned in Coyote Creek directly downstream of the confluence with Artesian Slough. Trigger monitoring was not necessary during the time in which the pond was oriented for discharge through the southern structure.

Trigger monitoring occurred seven times in 2018 (Table 6). Trigger data was evaluated by Facility staff and revealed no negative effects from episodic low DO pond discharges, therefore, no additional adaptive management or monitoring actions were implemented.

Table 6. Weekly 10th percentile DO values for Pond A18 discharge and response in 2018

Week and Date Range	10th Percentile Value (mg/L)	Response
1: 6/1/18 – 6/5/18	0.0	Trigger monitoring initiated 6/8- No impacts
2: 6/5/18 – 6/12/18	0.0	Trigger monitoring conducted 6/15- No impacts
3: 6/12/18 – 6/19/18	2.4	Trigger monitoring continued 6/22- No impacts
4: 6/19/18 – 6/26/18	2.9	Trigger monitoring continue 6/26 - No impacts
5: 6/26/18 – 7/3/18	4.5	None Required
6: 7/3/18 – 7/10/18	4.6	None Required
7: 7/10/18 – 7/17/18	2.3	Trigger monitoring initiated 7/19- No impacts
8: 7/17/18 – 7/24/18	2.3	Trigger monitoring continued 7/27- No impacts
9: 7/24/18 – 7/31/18	1.0	Trigger monitoring continued 7/31- No impacts
10: 7/31/18 – 8/7/18	3.5	None Required
11: 8/7/18 – 8/14/18	3.7	None Required
12: 8/14/18 – 8/21/18	7.3	None Required
13: 8/21/18 – 8/28/18	5.7	None Required
14: 8/28/18 – 9/4/18	5.8	None Required
15: 9/4/18 – 9/11/18	5.6	None Required
16: 9/11/18 – 9/18/18	6.5	None Required
17: 9/18/18 – 9/25/18	5.7	None Required
18: 9/25/18 – 10/2/18	6.8	None Required
19: 10/2/18 – 10/9/18	7.6	None Required
20: 10/9/18 - 10/16/18	9.5	None Required
21: 10/16/18 - 10/23/18	8.4	None Required
22: 10/23/17 - 10/31/18	7.0	None Required

General Observations

Figure 9. Pond A18 water color observations. Opaque brownish-green waters, 13 June 2018

Pond water color and clarity at the beginning of the 2018 monitoring season was similar to the previous year, likely due to the same southern intake configuration. This flow orientation allows for higher nitrogen concentrations in the water entering the pond due to the southern structure's proximity to the Facility final effluent discharge point. Pond water in early June was an opaque brownish-green (Figure 7) which brightened to a vibrant green by mid-July (Figure 8), indicating higher concentration of phytoplankton. Secchi values diminished gradually during this time (Table 7), and chlorophyll samples collected in June-July measured approximately 50-65% of those collected in 2017. With the exception of weeks 4 and 5 (June 26- July 10), the pond's weekly 10th percentile DO concentration fell below the 3.3 mg/L threshold throughout June and July. Filamentous algae sparsely populated the pond's margins throughout the majority of the monitoring season, while floating clumps of benthic algae released from the substrate were observed on the pond's surface briefly in late July (Figure 9).

Figure 8. Pond A18 water color observations. High primary productivity waters- 10 July 2018

Figure 7. Pond A18 water color observations. Floating clumps of benthic algae, 26 July 2018

Figure 11. Pond A18 water color observations. Deeper green waters, 28 August 2018

Figure 10. Pond A18 water color observations. Murkier waters, 25 September 2018

The pond's water color darkened to deeper shades of green in August (Figure 10) while secchi measurements dipped, likely due to shifts in phytoplankton species composition. Chlorophyll values decreased considerably in September and remained low through the remainder of the season, indicating diminishing concentration of phytoplankton. Pond water became increasingly turbid (Figure 11) as secchi measurements crept upwards into October.

Figure 12. Pond A18 water color observations. Greenish-brown waters after flow regime reversal, 16 October 2018

On October 9, 2018, the pond's flow regime was reversed, with inflow through the northern hydraulic structure and discharge from the southern structure, and water color shifted to greenish-brown through the end of October (Figure 12).

Table 7. Secchi measurements in 2018. Water quality measurements included for context to illustrate general changes in pond characteristics

Date and Time	Secchi Depth (cm)	Temp (°C)	Salinity (PSU)	DO (mg/L)	pH
6/6/2018 12:00	22	20.7	6.6	4.9	9.5
6/13/2018 11:00	26	21.7	6.8	1.1	9.2
6/19/2018 14:30	18	23.7	7.6	15.0	9.9
6/26/2018 9:30	16	23.4	7.8	3.1	9.2
7/3/2018 10:20	15	21.1	8.5	11.2	9.9
7/10/2018 10:30	19	22.6	7.5	5.9	9.4

Date and Time	Secchi Depth (cm)	Temp (°C)	Salinity (PSU)	DO (mg/L)	pH
7/17/2018 12:00	23	23.1	8.7	4.3	9.3
7/24/2018 8:15	26	24.0	9.5	3.0	9.2
7/31/2018 10:30	29	21.9	10.4	1.4	8.7
8/23/2018 12:00	18	21.7	11.9	9.2	10.0
8/28/2018 12:00	19	20.6	12.2	11.5	10.0
9/4/2018 12:00	19	20.7	12.4	14.8	10.4
9/11/2018 15:30	20	20.5	13.0	9.6	9.9
9/20/2018 09:30	22	17.9	12.9	7.8	10.0
9/25/2018 11:45	24	19.4	13.4	12.0	10.2
10/2/2018 13:00	31	21.6	13.2	17.2	10.4
10/9/2018 13:00	38	20.8	13.1	5.8	8.2
10/16/2018 11:15	32	19.6	13.5	12.4	10.3
10/23/2018 11:30	36	17.8	13.4	7.4	9.6

C. Discrete Monitoring

The WDR requires discrete water quality monitoring in both the pond and receiving water at monthly intervals.

Receiving Water Discrete Monitoring

Discrete monthly water quality sampling is required at four receiving water locations (Figure 1; Figure 2) during the monitoring season (Figure 13). These surface and bottom measurements of DO, pH, temperature, salinity and turbidity (Table 8; Table 9) characterize the mixing of fresh slough water with Bay salt water during tidal exchange, and illustrate the effects (if any) that Pond A18 discharge may have on water quality. The WDR requires these measurements to be recorded while the pond is discharging. A logging error prevented the surface measurement from being recorded at Station 4 on September 27, 2018.

Figure 13. City of San José biologist, Bryan Frueh collects a discrete water sample from Artesian Slough

Table 8. Receiving water monthly surface and bottom water quality measurements- Northern discharge scenario

Date and Time	Site	Tide	Depth	Temp (°C)	Salinity (PSU)	pH	DO (mg/L)	Turbidity	A18 Flow (cfs)
6/26/2018 11:12	1	Flood	Top	23.2	12.8	8.0	4.2	47.2	48.1
6/26/2018 11:13	1	Flood	Bottom	23.1	13.0	7.9	4.0	59.1	48.1
7/12/2018 11:11	1	Flood	Top	23.6	15.2	7.8	3.3	107.0	36.1
7/12/2018 11:13	1	Flood	Bottom	23.5	15.5	7.7	3.0	132	36.1
8/30/2018 15:08	1	Flood	Top	22.5	17.4	7.8	6.2	42.8	2.8
8/30/2018 15:10	1	Flood	Bottom	22.2	18.4	7.9	4.9	68.7	2.8
9/27/2018 13:23	1	Flood	Top	21.5	18.4	7.7	4.8	65.0	8.4
9/27/2018 13:24	1	Flood	Bottom	21.3	19.2	7.8	4.6	70.0	8.4
6/26/2018 11:07	2	Flood	Top	23.0	13.6	7.9	4.3	42.5	48.1
6/26/2018 11:08	2	Flood	Bottom	23.0	13.6	7.9	4.0	98.2	48.1
7/12/2018 11:16	2	Flood	Top	23.6	16.2	7.7	3.8	70.2	34.1
7/12/2018 11:17	2	Flood	Bottom	23.4	16.3	7.7	3.1	31.6	34.1
8/30/2018 15:15	2	Flood	Top	21.9	20.5	7.8	5.7	100.0	2.0
8/30/2018 15:16	2	Flood	Bottom	22.0	20.9	7.8	5.5	96.5	2.0
9/27/2018 13:28	2	Flood	Top	21.1	21.3	7.8	5.0	60.0	8.4
9/27/2018 13:30	2	Flood	Bottom	21.1	22.0	7.8	4.8	120.0	7.4
6/26/2018 11:02	3	Flood	Top	23.2	13.6	7.8	4.3	73.1	48.1
6/26/2018 11:04	3	Flood	Bottom	22.9	14.1	7.9	4.2	82.3	48.1
7/12/2018 11:23	3	Flood	Top	23.4	16.6	7.8	3.6	98.4	34.1
7/12/2018 11:24	3	Flood	Bottom	23.3	10.3	8.0	4.5	65.2	28.3
8/30/2018 15:21	3	Flood	Top	22.0	22.2	7.8	5.9	87.4	2.0

Date and Time	Site	Tide	Depth	Temp (°C)	Salinity (PSU)	pH	DO (mg/L)	Turbidity	A18 Flow (cfs)
8/30/2018 15:22	3	Flood	Bottom	21.8	19.4	7.8	5.3	141	2.0
9/27/2018 13:34	3	Flood	Top	21.6	22.3	7.8	5.2	60	7.4
9/27/2018 13:37	3	Flood	Bottom	20.8	23.2	7.8	4.7	160	7.4
6/26/2018 11:22	4	Flood	Top	23.2	15.3	8.0	4.6	71.6	45.6
6/26/2018 11:23	4	Flood	Bottom	22.9	15.3	8.0	4.3	87.6	45.6
7/12/2018 11:27	4	Flood	Top	23.4	16.8	7.8	3.6	117	34.1
7/12/2018 11:29	4	Flood	Bottom	23.3	16.7	7.8	3.4	129	34.1
8/30/2018 15:28	4	Flood	Top	21.9	23.2	7.8	5.8	121	2.0
8/30/2018 15:29	4	Flood	Bottom	21.8	22.9	7.8	5.3	161	2.0
9/27/2018 13:44	4	Flood	Top	-	-	-	-	85.0	7.4
9/27/2018 13:45	4	Flood	Bottom	20.9	24.1	7.8	4.9	160.0	5.9

Table 9. Receiving water monthly surface and bottom water quality measurements- Southern discharge scenario

Date and Time	Site	Tide	Depth	Temp (°C)	Salinity (PSU)	pH	DO (mg/L)	Turbidity	A18 Flow (cfs)
10/22/2018 11:07	1S	Flood	Top	24.0	0.94	7.6	6.5	1.7	6.8
10/22/2018 11:08	1S	Flood	Bottom	19.7	12.3	8.1	5.4	14.0	6.8
10/22/2018 11:02	2S	Flood	Top	22.9	2.3	7.6	6.8	3.2	6.8
10/22/2018 11:03	2S	Flood	Bottom	19.1	16.8	8.5	5.0	17.0	6. 8
10/22/2018 10:56	3S	Flood	Top	19.1	13.4	7.7	5.0	32.9	7.9
10/22/2018 10:58	3S	Flood	Bottom	19.1	13.6	7.7	4.3	34.6	7.9
10/22/2018 10:50	4S	Flood	Top	18.4	19.5	7.5	5.3	51.9	7.9
10/22/2018 10:51	4S	Flood	Bottom	18.4	19.9	7.6	5.0	54.1	7.9

Trigger Monitoring and Adaptive Management Actions

In 2018, the response to Pond A18's weekly 10th percentile DO concentration falling below the trigger threshold of 3.3 mg/L consisted of recording additional weekly discrete water column measurements at three stations in Artesian Slough and Coyote Creek to determine if lower DO discharges were adversely affecting receiving water DO (Figure 14). During the pond's northern release configuration, Station 1 trigger monitoring data was collected in Artesian Slough directly upstream of the pond's hydraulic structure. Station 2 was located in Coyote Creek, directly upstream of the confluence with Artesian Slough, and Station 3 was positioned in Coyote Creek directly downstream of the confluence with Artesian Slough (Figure 1).

Figure 14. Environmental Services Specialist, Ryan Mayfield, records water quality measurements using a multi-probe YSI

Monitoring was performed in response to the trigger events in weeks 1 through 4, and weeks 7 through 9. Results are detailed in Table 10. Due to a logging error, the bottom measurement was not recorded at Station 1 on June 22, 2018. Trigger monitoring continued through the following week. Trigger monitoring was not required during the period in which the pond's circulation was configured for a southern release scenario because the pond's weekly 10th percentile DO concentration never dipped below the 3.3 mg/L threshold during this period.

Trigger monitoring is designed to detect impacts of pond discharge on receiving water quality. Any confirmed negative impacts trigger additional adaptive management actions (e.g., additional water quality monitoring or valve adjustments). Negative impacts from pond discharges are defined as follows:

- Receiving water DO at Artesian Station 2 is < 5.0 mg/L at surface or < 3.3 mg/L at bottom, and;
- 2-hour average pond DO bracketing the time that receiving water measurements were taken is less than measured receiving water DO.

Low DO conditions in the receiving water must be linked to Pond A18 discharge to necessitate additional adaptive management measures.

In 2018, there were five instances when trigger monitoring measured receiving water DO less than 5.0 mg/L at the surface and/or less than 3.3 mg/L at the bottom at Station 2. These five instances occurred on June 15, June 26, July 19, July 27, and July 31, 2018. Continuous sonde data in the pond was evaluated to determine if pond discharge contributed to these values, and in every case except for one (July 27), the 2-hour average pond DO measured higher than the corresponding receiving water DO, so additional management actions were not implemented. Subsequent to the aforementioned July 27 measurement, trigger monitoring was continued through the following week to better characterize the effects of low DO discharge to receiving water. On July 31, the 2-hour average pond DO measured higher than the receiving water DO, and the weekly 10th percentile DO value of pond discharge was above 3.3 mg/L so trigger monitoring was suspended and was not required for the remainder of 2018.

Table 10. Discrete trigger monitoring results in 2018

Week	Date and Time	Site	Tide	Depth	Temp (°C)	Salinity (PSU)	pH	DO (mg/L)
1	6/8/2018 12:03	1	Ebb	Top	23.4	2.8	7.3	5.2
	6/8/2018 12:04	1	Ebb	Bottom	21.0	7.6	7.6	2.0
	6/8/2018 12:07	2	Ebb	Top	21.9	7.5	7.7	5.3
	6/8/2018 12:08	2	Ebb	Bottom	20.6	11.6	7.8	4.1
	6/8/2018 12:11	3	Ebb	Top	22.5	4.6	7.6	4.6
	6/8/2018 12:12	3	Ebb	Bottom	21.0	9.6	7.7	3.5
2	6/15/2018 11:44	1	Flood	Top	22.5	10.4	7.8	4.2
	6/15/2018 11:46	1	Flood	Bottom	22.4	10.5	7.9	3.5
	6/15/2018 11:49	2	Flood	Top	22.3	11.8	7.7	4.1
	6/15/2018 11:50	2	Flood	Bottom	22.1	11.8	7.7	3.3
	6/15/2018 11:53	3	Flood	Top	22.7	12.0	7.7	3.5
	6/15/2018 11:54	3	Flood	Bottom	22.3	12.8	7.7	3.3
3	6/22/2018 12:01	1	Ebb	Top	24.2	4.3	7.8	6.3
	6/22/2018 12:02	1	Ebb	Bottom	-	-	-	-
	6/22/2018 11:57	2	Ebb	Top	22.9	10.8	7.9	5.2
	6/22/2018 11:59	2	Ebb	Bottom	21.3	13.9	7.9	4.0
	6/22/2018 11:54	3	Ebb	Top	23.3	6.9	8.1	5.9
	6/22/2018 11:55	3	Ebb	Bottom	21.1	14.7	7.9	4.2
4	6/26/2018 11:12	1	Flood	Top	23.2	12.8	8.0	4.2
	6/26/2018 11:13	1	Flood	Bottom	23.1	13.0	7.9	4.0
	6/26/2018 11:07	2	Flood	Top	23.0	13.6	7.9	4.3
	6/26/2018 11:08	2	Flood	Bottom	23.0	13.6	7.9	4.0
	6/26/2018 11:02	3	Flood	Top	23.2	13.6	7.8	4.3
	6/26/2018 11:04	3	Flood	Bottom	23.0	14.1	7.9	4.2
7	7/19/2018 11:35	1	Ebb	Top	25.6	5.6	7.5	5.1
	7/19/2018 11:36	1	Ebb	Bottom	25.1	6.5	7.5	4.1
	7/19/2018 11:38	2	Ebb	Top	23.5	13.8	7.7	3.4
	7/19/2018 11:38	2	Ebb	Bottom	24.1	12.5	7.7	3.2
	7/19/2018 11:41	3	Ebb	Top	23.7	13.4	7.7	3.0
	7/19/2018 11:42	3	Ebb	Bottom	25.0	8.0	7.7	3.3

Week	Date and Time	Site	Tide	Depth	Temp (°C)	Salinity (PSU)	pH	DO (mg/L)
8	7/27/2018 11:40	1	Flood	Top	23.8	13.6	7.6	5.1
	7/27/2018 11:42	1	Flood	Bottom	23.8	13.6	7.7	4.0
	7/27/2018 11:46	2	Flood	Top	23.6	14.9	7.8	4.3
	7/27/2018 11:47	2	Flood	Bottom	23.6	14.9	7.8	4.0
	7/27/2018 11:51	3	Flood	Top	23.7	15.4	7.8	4.1
	7/27/2018 11:52	3	Flood	Bottom	23.5	15.5	7.8	4.0
9	7/31/2018 12:13	1	Flood	Top	24.3	10.0	7.7	5.5
	7/31/2018 12:14	1	Flood	Bottom	22.7	11.9	7.7	3.5
	7/31/2018 12:17	2	Flood	Top	24.1	10.5	7.7	4.7
	7/31/2018 12:18	2	Flood	Bottom	23.0	11.3	7.7	3.7
	7/31/2018 12:19	3	Flood	Top	24.0	11.0	7.7	5.5
	7/31/2018 12:20	3	Flood	Bottom	23.5	11.6	7.7	4.2

Pond Discrete Monitoring

The WDR requires the collection of discrete water quality measurements in Pond A18 once per month. Monthly discrete DO and chlorophyll *a* readings for the pond need to be taken between 0800 and 1000 hours per the A18 WDR Monitoring Provisions. Staff measured the discrete pond water quality using temperature, salinity, pH, and DO from the continuous discharge monitoring sonde to fulfill these discrete monitoring requirements (Table 12). These measurements were recorded on the same date and time as the required monthly chlorophyll *a* sampling, which is detailed below in the section "Chlorophyll-*a* Monitoring."

Table 11. Discrete monthly water quality measurements at Pond A18 discharge

Date and Time	Temperature (C)	Salinity (PSU)	pH	DO (mg/L)
6/21/2018 09:45	21.2	7.7	9.6	6.0
7/20/2018 09:15	22.7	8.8	9.2	4.3
8/22/2018 09:00	21.2	12.1	9.8	6.2
9/20/2018 09:15	17.9	12.9	9.9	7.0
10/19/2018 09:45	19.2	13.5	9.9	9.4

Temperature

Receiving water temperature was relatively consistent across the stations, regardless of flow regime (Table 8; Table 9). Similar to previous years, temperature decreased with depth. The pond is large and shallow with a limited flow, so pond water temperature is highly influenced by ambient air temperature.

Salinity

In years prior to the northern release discharge configuration initiated in 2016, the salinity profile for receiving water has been dictated by upstream stratification and downstream mixing in Artesian Slough. This pattern, caused by interactions between saltier tidal influence and fresher Facility effluent, was observed regardless of pond discharge or tides. With the exception of the most Bay-ward Station 4, salinity stratification was less pronounced in 2018, indicative of more mixing since all stations are much further downstream from the Facility freshwater effluent discharge. Bottom salinity measured higher than surface salinity at all stations, with the exception of Station 3.

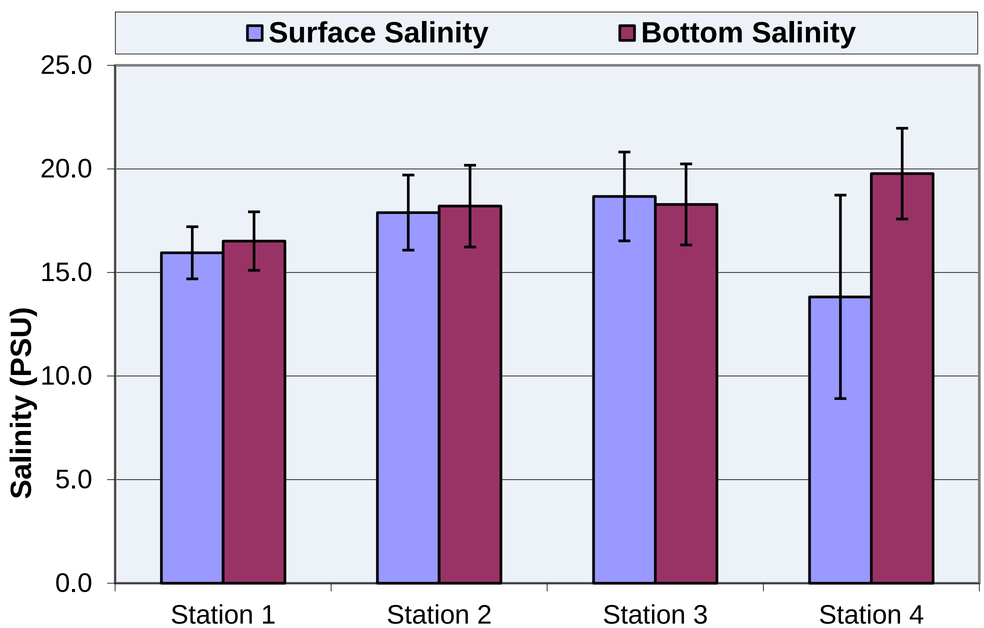

Figure 15. Mean (+ SE) monthly Salinity in receiving water for 2018- Northern discharge

Monitoring stations in the receiving water were relocated in October in accordance with the southern discharge scenario. As expected, salinity profiles revealed pronounced upstream stratification and downstream mixing in Artesian Slough, with surface salinities dropping at Stations 1S and 2S nearest Facility freshwater effluent discharge (Figure 16).

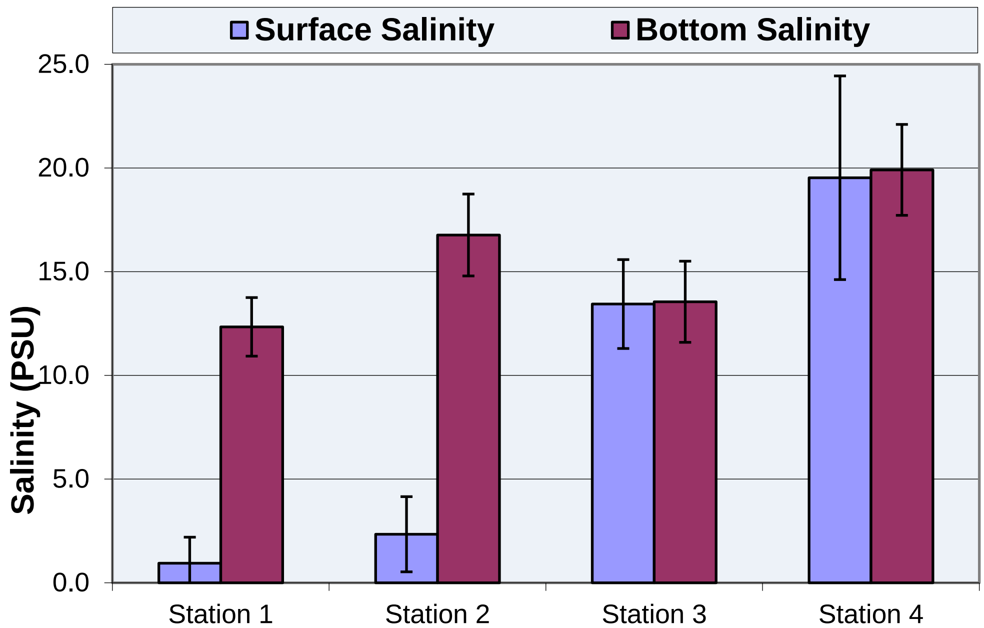

Figure 16. Mean (+ SE) monthly Salinity in receiving water for 2018- Southern discharge

pH

Pond pH was higher (8.4 – 10.6; Table 4) than the surface and bottom measurements of the receiving water (7.5 – 7.9; Figure 17). Despite this, pH in receiving waters remained within the Basin Plan Objective.

When stations were relcated in October, pH values shifted (Figure 18). Stations 1S and 2S showed strong stratification, an indication that receiving water conditions are driven by localized conditions and broader, more significant hydraulic inputs from the Bay, tributaries and the RWF discharge rather than being strongly influenced by Pond A18 discharge. Surface pH at the southern receiving water stations were lower and bottom pH was considerably higher, indicating localized stratification due to RWF freshwater effluent, which is less dense than Bay water. pH at Stations 3S and 4S indicated more mixing with values more consistent with years past.

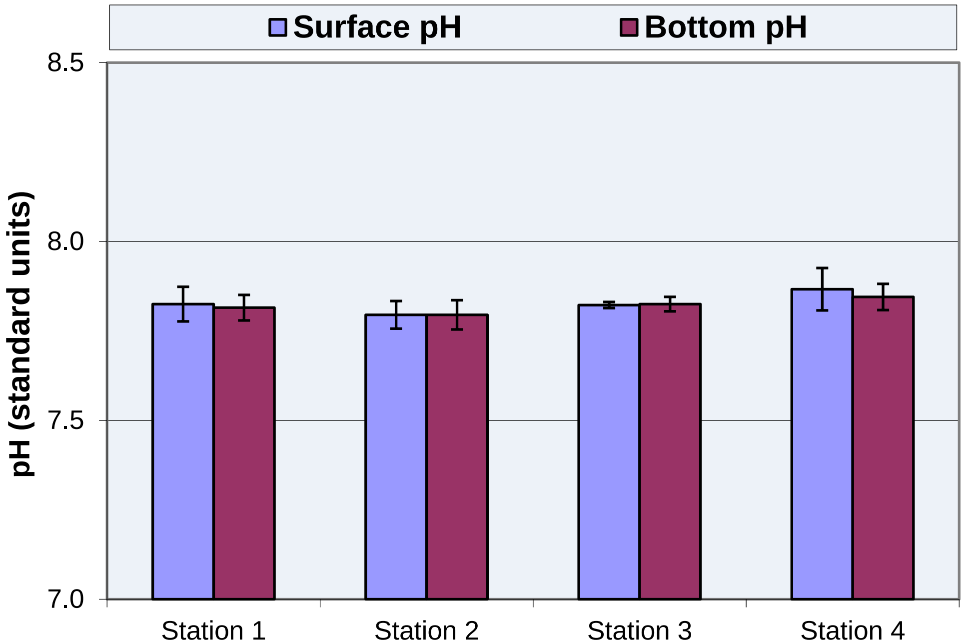

Figure 17. Mean (+ SE) monthly pH in receiving water for 2018- Northern discharge

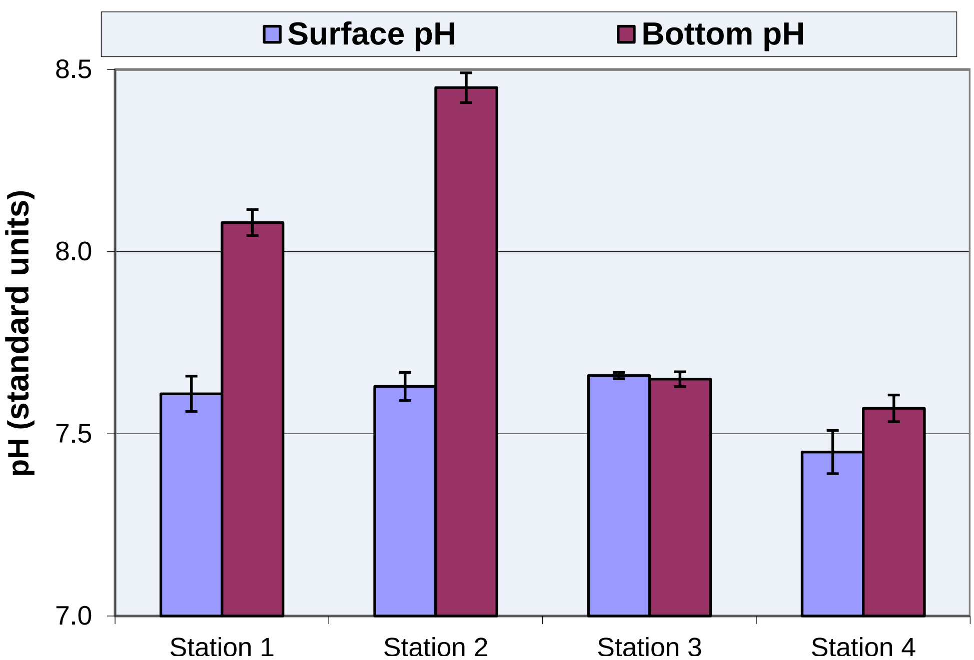

Figure 18. Mean (+ SE) monthly pH in receiving water for 2018- Southern discharge

Dissolved Oxygen

For the Northern discharge flow regime, monthly DO measurements at the four monitoring stations (Table 8) reveal surface DO was higher than bottom DO at every station (Figure 19).

The WDR requires the Discharger to monitor, report, and take corrective action if monthly discrete DO levels in Pond A18 fall below 1.0 mg/L. This scenario did not occur during the 2018 season (Table 10). Trigger monitoring for temperature, salinity, pH and DO was initiated on June 8 (Table 6) when pond DO levels fell below the 10th percentile weekly trigger of 3.3 mg/l.

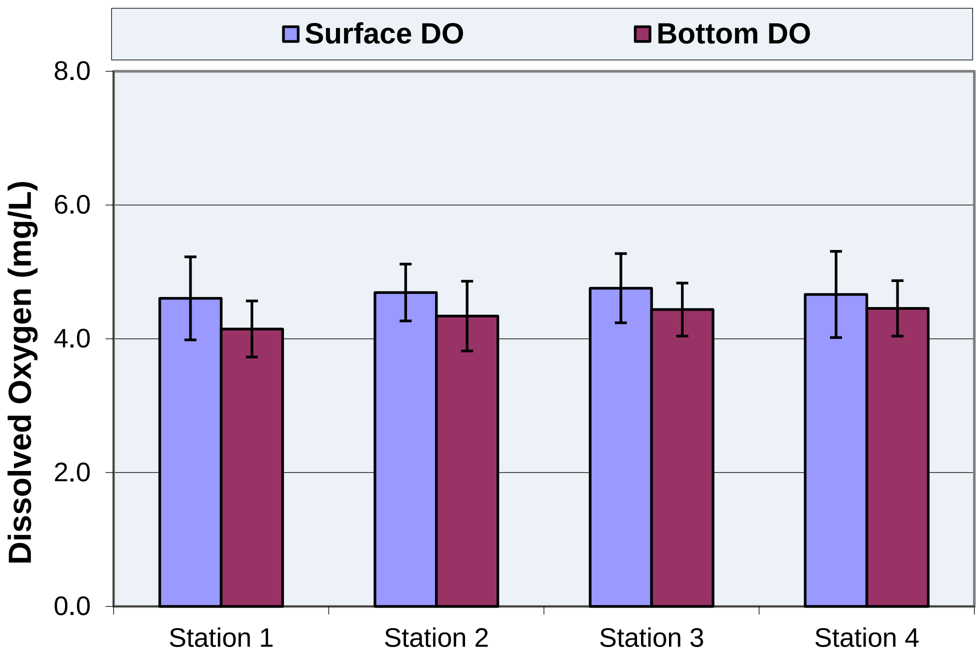

Figure 19. Mean (+ SE) monthly Dissolved Oxygen in receiving water for 2018- Northern discharge

Once relocated nearer the Facility discharge in the Southern discharge flow regime, DO at Stations 1S and 2S increased (Figure *20*), reflective of the oxygen-rich effect of the RWF effluent on both surface and bottom DO. Stratification diminished along the length of the slough at Stations 3S and 4S as surface DO declined.

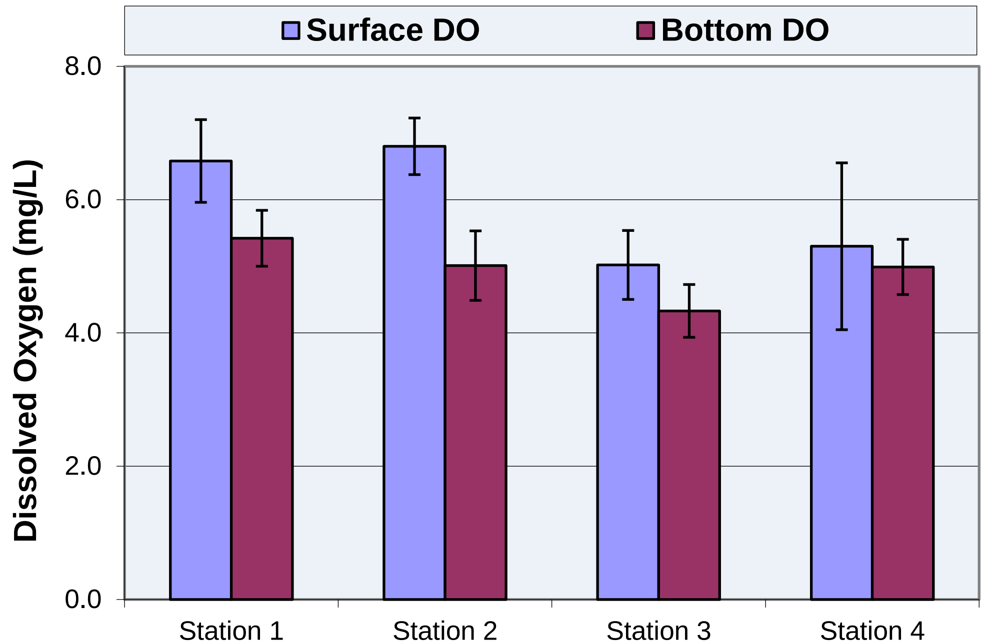

Figure 20. Mean (+ SE) monthly Dissolved Oxygen in receiving water for 2018- Southern discharge

Turbidity

Turbidity was measured monthly at the four monitoring stations (Figure 21). As expected, bottom turbidity was higher at each station, with stratification evident across all stations.

Turbidity was much lower once the monitoring stations were relocated nearer to the Facility (Figure 22). Surface and bottom turbidity increased in a downstream direction from Station 1S to Station 4S, with stratification most pronounced at the two monitoring stations nearest the Facility.

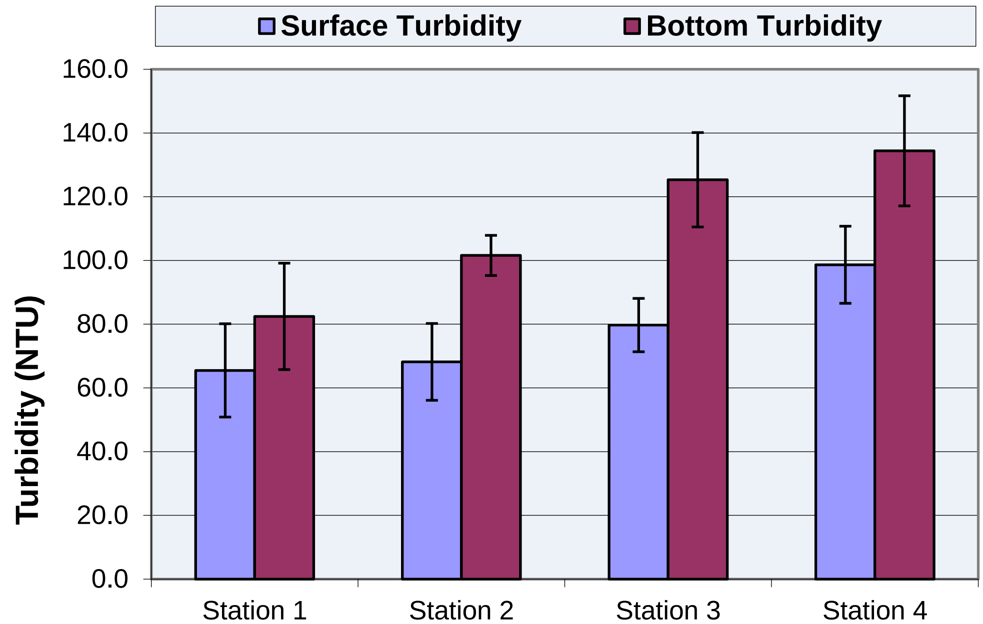

Figure 21. Mean (+ SE) monthly Turbidity in receiving water for 2018- Northern discharge

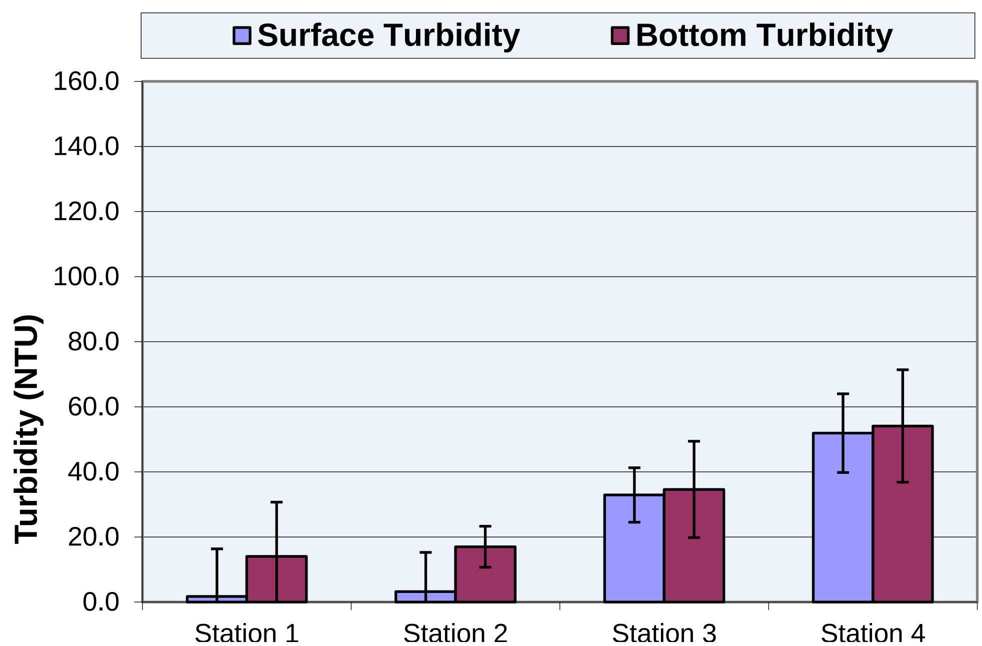

Figure 22. Mean (+ SE) monthly Turbidity in receiving water for 2018- Southern discharge

Chlorophyll-*a* Monitoring

The City measured chlorophyll *a* as an index of phytoplankton biomass in Pond A18 by collecting a monthly grab sample in a 1-liter amber glass jar. This sample, kept cool and out of direct light, was sent by same-day courier to Basic Laboratory services in Redding, CA for analysis.

At the onset of the 2018 monitoring season, chlorophyll *a* concentration measured 333 μg/L, compared to 681 μg/L in 2017. Chlorophyll a varied throughout season, tracking community succession of the pond phytoplankton community.

Table 12. Monthly chlorophyll a measurements at Pond A18 discharge. Salinity measurements are included for context to indicate general changes in pond characteristics

Month	Date sampled	Chlorophyll *a* (μg/L)	DO (mg/L)	Salinity (PSU)
June	6/21/2018	333.0	6.0	7.7
July	7/20/2018	192.0	4.3	8.8
August	8/22/2018	203.0	6.2	12.1
September	9/20/2018	59.6	7.0	12.9
October	10/19/2018	117.0	9.4	13.5

D. Sediment Monitoring

A letter from the Water Board's Executive Officer Bruce Wolfe, dated 15 September 2010, modified the annual mercury sediment monitoring requirement, allowing for a change in location from Pond A18 to the receiving water and adjusting the sampling frequency to every other year during the months of August through September. Sediment sampling was performed in Artesian Slough in 2011, 2012, and 2013, 2015, and 2017. Consistent with the revised sampling frequency, the City did not conduct sediment sampling in 2018.

III. EXCEEDANCES AND TRIGGERED ACTIONS

A. Summary of Exceedances and Triggers

Table 6 lists the DO trigger events for pond discharges in 2018 and subsequent responses.

B. Summary of Corrective Action

There were seven weeks in which the weekly 10^{th} percentile DO level in the pond's discharge dipped below the trigger threshold. The City responded by conducting additional weekly discrete water column measurements at three stations in Artesian Slough and Coyote Creek (Figure 1; Table 10).

An evaluation of trigger data revealed no negative effects in the receiving water that could be attributed to Pond A18 discharge, so no additional corrective actions were necessary.

IV. DISCUSSION AND INTERPRETATION OF 2018 RESULTS

Temperature

The pond's mean temperature remained consistent with the previous year, however there was a 2°C minimum temperature increase coupled to a 2°C maximum temperature decrease. Temperature varied little between discharge and non-discharge periods through mid-August, after which time temperature varied considerably more than prior years. Pond temperatures generally peak in July/August and exhibit large fluctuations depending on heat waves or cloud cover.

Salinity

Discharge salinity in 2018 was consistent with the previous year, with lower salinity water entering the pond from the southern intake point throughout the majority of the monitoring season. In past years when the intake point was the northern structure, pond salinities averaged significantly greater. The mean pond salinity in 2018 was 10.8 PSU, slightly higher than the 2017 value of 7.9 PSU, which is significantly lower than the mean salinities of 30.5 PSU and 29.4 PSU for years 2014 and 2013, respectively, in which the pond was managed in a southern release scenario throughout its entire dry season monitoring. Similar to patterns observed over the previous years, salinity climbed steadily through the season and peaked in late October.

Consistent with prior years, salinity gradients in the receiving water were driven by tidal cycles and fresh water effluent from the Facility. The less dense freshwater tends to float on top of the saltier bay water that is pushed into Coyote Creek and Artesian Slough by the flooding tide.

pH

Increases in pond pH are driven by high rates of photosynthesis, accompanied by high irradiance and temperatures. Conversely, high salinity can act as a buffer, limiting pH increases. Regardless of the pond's flow regime, pH in 2018 was consistent with years past, albeit more varied. pH increased due to episodes of intense photosynthesis, followed by declines when algae experienced periodic decomposition. Pond pH followed the typical pattern of climbing gradually throughout the dry season in 2018, and remained elevated at the conclusion of the monitoring season.

Dissolved Oxygen

Pond dissolved oxygen concentrations in 2018 were higher (mean DO of 8.2 mg/L) compared to the previous year (mean DO of 7.1 mg/L). Pond DO patterns in 2018 mirrored that of the previous year, exhibiting the boom and bust cycle of super-saturation to low DO occurring in June and throughout the remainder of the monitoring season, but with a lesser degree of variability. Higher concentrations of nitrogen entered the pond through the southern intake point, just downstream of the Facility discharge between the months of June through early October. elevated nitrogen inputs to a shallow system with long hydraulic residence time can lead to high algal biomass (> 60 ug/L chlorophyll-a). Pond A18's chlorophyll concentrations measured above this threshold every month except for September (59.6 ug/L). As abundant phytoplankton or macro-algae die and decay, the decomposition process consumes dissolved oxygen in the water column and drives DO concentrations down. Consequently, there were a total of seven trigger events in 2018.

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 benthic filter feeders and filter-feeding zooplankton (copepods, cladocerans, rotifers, shrimp, aquatic insects) are not able to utilize them effectively. Further, filamentous algal mats impede light penetration through the water column, thereby decreasing phytoplankton production and overall pond productivity.

During the first few months of the 2018 monitoring season, filamentous algae grew in sparse patches along the Pond A18's margins. The expansive surface and benthic accumulations that have been observed in years past were not established at any point in the 2018 season.

Figure 23. Google Earth satellite imagery details the erosion on the outboard side of the southern hydraulic structure

Condition Assessments of Southern Hydraulic Structure

In March 2015, the U.S. Army Corps of Engineers authorized the emergency replacement of Pond A18's northern hydraulic structure to prevent critical structural failure and subsequent breach of the levee system. During the reconstruction of this structure in the summer of 2015, the southern structure was used to pulse water into and out of the pond to maintain pond water elevation and water quality. This pulsing of water exacerbated bank erosion and active scouring/slumping on the outboard levee proximal to the southern structure (Figure 23; Figure 24).

Figure 24. Bank erosion areas at the southern hydraulic structure

Construction of the northern structure was completed in August 2015, and the water control structures were configured to return to the pond's normal continuous circulating regime of intake at the northern structure and discharge from the southern structure. The erosion around the southern structure progressed to the extent that Facility engineering staff and consultant geotechnical engineers recommended an alternate flow regime to mitigate risk of levee failure and breach.

The extent of the active scouring rendered the southern structure's trash rack ineffective in preventing fish from entering the pond. Facility staff installed fish screens in early 2016 (Figure 25), and continuous circulation of Pond A18 was re-oriented for inflow at the southern structure and discharge from the northern gate.

This northern discharge configuration was maintained from June through early October of the 2018 monitoring season, and subsequently reversed to initiate a southern discharge once the repairs to the southern structure were complete. Staff calculated 10th percentile weekly DO values on discharge water consistent with the discharge configuration in place. The monitoring stations in the receiving water for monthly discrete sampling, along with trigger monitoring sites, were adopted in accordance with the respective release scenarios detailed in the WDR and A18

Figure 25. Steel flap gates were replaced with slotted fish screens to allow for inflow while preventing fish passage

Operations Plan (Figure 1).

Pond Infrastructure

The City contracted HydroScience Engineers, Inc. to prepare a biddable set of plans and specifications to repair/reinforce the levee embankments in the vicinity of Pond A18's southern structure to allow for flow in either direction. The environmental consulting firm Environmental Science Associates (ESA) was contracted to shepherd the regulatory permit process, consisting of the following jurisdictional agencies:

- U.S. Army Corps of Engineers (USACE)- Section 404 Nationwide Permit, and Verification of Delineation of Jurisdictional Wetlands Report
- San Francisco Regional Water Quality Control Board- Section 401 Water Quality Certification
- San Francisco Bay Conservation and Development Commission- Abbreviated Regionwide Permit
- U.S. Fish and Wildlife Service- Informal Section 7 Consultation
- National Marine Fisheries Service- Informal Section 7 Consultation
- California Department of Fish and Wildlife (CDFW)- Section 1600 Lake and Streambed Alteration Agreement, and Informal Consultation under the California Endangered Species Act for longfin smelt
- State Historic Preservation Office for cultural resources- Section 106 Consultation and approvals

Sweetwater Construction was awarded the construction contract, and in advance of their mobilization on-site, City personnel replaced the fish screens with the steel flap gates to allow for outflow through the southern structure (Figure 26).

Figure 26. City personnel replacing the slotted fish screens to allow for outflow through the southern structure

On August 23, 2018, the Pond A18 South Gate Levee Repair Project commenced with ESA's collaboration with environmental monitoring. The project consisted of installing four rows of sheet piles into the levee extending from the wingwalls of the southern structure,

Figure 27. South Gate Levee Repair Project

Figure 28. Walers affixed to sheet piles

driven approximately 40 feet down below the top of the levee surface elevation. 30- to 40-foot long walers were then affixed to the outboard side of the sheet pile rows, and reinforced with concrete entombed tie-rods connected to the opposing sheet pile to strengthen the repair and reduce the required depth of the sheet piles (Figure 27; Figure 28). The levee crown was re-graded, and excavated areas back-filled to complete the levee restoration.

City staff then repaired the southern structure's inboard and outboard stairways and decks. On October 9, 2018, the pond's continuous circulation was configured for inflow through the northern hydraulic structure and discharge from the southern structure.

Figure 29. Repaired south levee images upon project completion

Once the project concluded on September 24 (Figure 29), the City again contracted Hydroscience to provide consultation to further develop the City's monitoring methodology and reporting of the repair project's ongoing condition. The City continues to monitor the mechanical and geotechnical vulnerabilities of the pond's southern structure, and adjust operations to minimize sediment transport, scour and levee erosion.

Avian Habitat Value

The City partners with the Santa Clara Valley Audubon Society to evaluate local Christmas Bird Count (CBC) data to assess avian population trends. The Alviso Complex CBC dataset, encompassing the Facility and surrounding wetlands, most notably Pond A18, extends back to 1975 and provides 40+ years of data which has been instrumental in evaluating bird recovery in the context of Facility treatment advancements and large-scale wetlands restoration efforts (Figure 30).

Figure 30. Image of a Great Blue Heron (courtesy of chesapeakebay.net), one of the many bird species found in the Alviso area

2018 waterfowl abundance data underscores the habitat value of the Alviso Complex system, with overall counts roughly double the population tallies before Pond A18, along with nearby Ponds A16, A17, A19, and A20 were breached and managed for long-term restoration in 2005-2006. Such positive trending illustrates Pond A18 continues to provide foraging and congregating habitat for many resident and migrating waterbirds.

V. LESSONS LEARNED AND RECOMMENDATIONS

1. Sampling chlorophyll *a* is useful for characterizing the variability of phytoplankton abundance in pond A18.

   Recommendation: Continue monitoring chlorophyll *a.*

2. Pond A18's primary productivity can decrease with cloud cover and rain events, which can decrease photosynthesis and temporarily lower DO. No adverse effects on receiving water DO have been measured during these short-term decreases in the fourteen years of monitoring.

   Recommendation: Continuous pond discharge provides the most stable conditions in the pond. Shutting the discharge valve as a result of temporary low DO due to uncontrollable conditions may exacerbate low DO due to stagnation of pond water.

3. Adoption of a northern discharge regime since 2016 has resulted in higher nitrogen inputs to Pond A18 due to a greater percentage of Facility effluent rich slough water entering the pond. While phytoplankton biomass in 2018 was lower during most of monitoring season compared to last year, it was still higher than in years where the pond discharged through the southern structure. Dissolved oxygen concentrations were less variable in 2018 than in years past, but still had maximum values indicating supersaturation and short duration hypoxic events. As with all previous years, the low DO conditions in 2018 did not affect water quality in either Artesian Slough or Coyote Creek, indicating that the pond discharges have minimal spatial influence on receiving water DO.

   Recommendation: Operating the pond in either the northern discharge or southern discharge configurations has had negligible effect on receiving water DO as demonstrated by multiple years of receiving water monitoring. However, the northern discharge scenario has resulted in higher phytoplankton biomass in the pond and less stable in-pond conditions compared to the in-pond conditions documented during years of southern discharge. The City shall continue to manage the pond's operations to minimize sediment transport, scour, and levee erosion by adjusting flow and discharge configuration with levee integrity in mind. If levee condition is stable, the default operational setting will be the southern discharge configuration to provide for more stable in-pond conditions.