

2016 Annual Self-Monitoring Report
Don Edwards San Francisco Bay National Wildlife Refuge
Fremont, California

Prepared for:

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Introduction

The South Bay Salt Pond Restoration Project (Project) 2016 Annual Self-Monitoring Report (Report) has been prepared to provide: 1) an update of the Project's 2016 accomplishments; 2) information on on-going operations of the Alviso and Ravenswood Ponds; 3) results of the 2016 studies conducted at Pond A8, A16 and SF2; 4) results of fisheries monitoring and studies; and 5) an update on Phase II planning efforts.

In previous years, this annual report has focused on water quality monitoring results and has been submitted to the California Regional Water Quality Control Board (Water Board) to comply with the Self-Monitoring Program (SMP) as described in the Final Order (No. R2-2008-0078). This is the sixth year the report will also be submitted to NOAA's National Marine Fisheries Service (NMFS) because we have included additional fisheries monitoring conducted as part of the Project Science Program's Applied Studies, which are intended to fill the most important gaps in our knowledge about South San Francisco Bay (South Bay) ecosystem.

It is anticipated that both water quality and fisheries information will help the Water Board and NMFS: 1) understand the status of the Project; 2) provide feedback and guidance to the Project Management Team on current and future applied studies and monitoring; and 3) assist in identifying emerging key uncertainties and management decisions required to keep the Project on track toward its restoration objectives as we approach Phase 2.

Progress Towards Goals in 2016

Goal 1: Restore & Enhance Habitat

3,040 Acres of Habitat Restored

To date, we have opened 3,040 acres of former industrial salt ponds to the Bay so nature can recreate wetlands. We are now starting our second phase of restoration work, which could include restoring thousands of additional acres to salt marsh. Our initial goal is to restore half of our land, 7,500 acres, to tidal marsh, with the other 50% in managed ponds.

Ponds that have been opened to tidal influence continue to show signs of restoring to functional tidal marsh. In 2016, the endangered Ridgways rail and endangered salt marsh harvest mouse were present in the restoring island ponds unit (A21).

Goal 2: Provide Public Access

No new public access facilities were completed in 2016.

Goal 3: Provide Flood Risk Management

Shoreline Levee near Alviso

A goal of the Project is to maintain or improve existing flood risk. Managers are committed to ensuring that flood hazards to nearby communities and infrastructure do not increase as a result

of the restoration: restoring salt marsh in flood-critical parts of the Project area will not occur until flood protection is established. In 2014, the U.S. Army Corps of Engineers and local agencies begin planning for a 15-foot-high Bay levee near Alviso and the San Jose water pollution plant. This project continues to move through the planning stages. The first section of the project to be completed is projected to be the levee that runs along pond A12. Once the entire levee is completed, more Alviso ponds can be opened to full tidal interaction.

2016 Pond Operations

The 2016 Pond Operation Plans are included in Appendix A. In general, the goal for all ponds is to maintain circulation through the ponds while maintaining discharge salinities. A summary of pond management is described below.

Alviso Pond System A1/A2W

The management objective for Pond System A1/A2W is to maintain full tidal circulation through ponds A1 and A2W while maintaining discharge salinities to the Bay at less than 40 ppt. These ponds are part of Phase 2 of the Project, and are likely to be breached in the next 5 years to restore the ponds to tidal marsh. The Phase 2 EIS/EIR was finalized in 2016.

Alviso Pond System A3W

The Alviso Pond System A3W consists of Ponds AB1, AB2, A3W, A2E, and A3N. The objectives for the Alviso Pond A3W system are to: 1) maintain full tidal circulation through ponds AB1, AB2, A2E, and A3W while maintaining discharge salinities to Guadalupe Slough at less than 40 parts per thousand (ppt); 2) maintain water levels in Pond A3N to cover the pond bottom due to mercury “hotspots” by leaving the A3N / A3W gate fully open, year round; and 3) maintain water surface levels lower in winter to reduce potential overtopping of A3W and A2E levee adjacent to Moffett Field.

Pond System A8

The Pond A8 system consists of Ponds A5, A7, A8N, and A8S. This system is operated to maintain muted tidal circulation through the ponds while maintaining discharge salinities to the Bay at less than 40 ppt. As part of the Phase 1 initial actions, a 40-foot armored notch with multiple bays that can be opened and closed independently at A8 and Alviso Slough was installed. Current operation (2016) is that 5 bays are opened year round. On-going mercury studies continue. Pond A8 is identified as tidal habitat in the long-term programmatic restoration of the Project. In 2014, the gate on the intake at A5 from Guadalupe Slough failed and intakes water at high tides (cannot be fully closed). This structure is also in need of repair; however, the Service has not identified funds at this time.

Pond System A14

The Pond A14 system consists of Ponds A9, A10, A11, A14, and Ponds A12, A13, and A15. The objectives of the Alviso Pond A14 systems are to: 1) maintain full tidal circulation through ponds A9, A10, A11 and A14, while maintaining discharge salinities to Coyote Creek at less than 40 ppt; 2) maintain ponds A12, A13 and A15 as higher salinity ponds and operate at 80 – 120 ppt salinity during summer to favor brine shrimp development, as possible. The winter of

2016/2017, was particularly damaging to the pond side of the levees in Ponds A9-14. Currently, the Service has a need for more material to rebuild the internal levees, which are planned to be repaired in starting in summer of 2017.

Pond System A16/17

Alviso Pond A16/A17 was the final Phase I action and completed in 2012. Pond A17 is now tidal, with uninhibited hydraulic connection to Coyote Creek and Pond A16 provides 243 acres of managed shallow pond habitat with 16 new nesting islands (along with 4 existing islands). The Pond A16 fish screen was repaired is currently running 3 screens.

Pond System SF2

The objectives of the Pond SF2 System is to manage a 155-acre pond with 30 nesting islands for nesting and roosting birds, and an 85-acre seasonal wetland for western snowy plover nesting. The water level in SF2 is designed to maintain shallow water to provide foraging habitat for shorebirds and waterfowl. Water control structures are used to manage water levels, flows into and out of Pond SF2 from the Bay, and flows between cells. The goal of this water management is to create shorebird foraging habitat and to meet water quality objectives.

Sustainability of Managed Ponds

Maintaining dissolved oxygen (DO) levels in the Alviso Ponds while meeting water quality objectives and Final Order requirements has been a significant management challenge for the Service during operation of the ponds. Based on previous lessons learned, the Service has been operating the ponds as continuous flow-through systems to try and reduce the water resident time as much as possible, while supporting species that use these ponds (e.g., migratory, wintering, and nesting birds).

Pond A16 and Pond SF2 Water Quality Data

In 2014, the Service committed to conducting sampling at Pond A16 and Pond SF2 for Water Board compliance with Continuous Circulation Monitoring (CCM) water quality standards (salinity <44 ppt, 10th percentile DO >3.3 mg/L, pH 6.5-8.5). This effort had delays and datasondes were not deployed until August 20, 2014. In review of the data by the USFWS Inventory and Monitoring Program, there was some uncertainty as to the degree of accuracy of all of the DO readings at both sites. What was determined was that in general, we still have low DO in both pond systems with DO falling below 3.3 mg/L. As a result of these complications, this sampling effort was not repeated by USFWS in 2016.

Other DO studies in Ponds A8, A21, SF2, and E9

No new information was collected in 2016.

Update on Mercury Studies

Total Mercury Remobilization - Bruce Jaffe's (USGS) research team continued work measuring how Alviso Slough changed in response to the A8 notch opening and A6 pond breaches. Results

are from repetitive bathymetric surveys combined with data from sediment cores along Alviso Slough.

- The last four surveys show little erosion, which is good news for keeping mercury remobilization low. Maximum river discharge more greatly influences scour than gate openings.
- There was still some concern that opening 8 gates creates erosion and mercury remobilization. There is some evidence of remobilization near the notch, but the greatest remobilization is happening near the Pond A6 breaches. The team measured 42 kg of total mercury, which represents only 35% of EIR projections.
- Remobilization appears to be partly due to restoration efforts, but also part of the natural system. For example, high discharge events in Guadalupe River correspond with erosion occurring in the slough and high mercury remobilization. Erosion from breaches at the Pond A6 appears to be slowing down but requires more data analysis.
- Numerical modeling is a good way to learn from the data. Calibrate these models to large flow events, such as those that occurred at the beginning of the year. We now have a fully geomorphic model for long-term forecasts. We can model for sea level rise, sediment concentrations, standing breach scenarios, and more. Santa Clara Valley Water District (SCVWD) is providing funding to extend the model to include San Tomas Aquino and Calabazas Creek. We can use the model to look what might happen as A8 continues to open.

Waterbird Mercury Concentrations in Response to Wetland Restoration - Josh Ackerman, USGS, continued studies of mercury contamination in birds, bird nesting population status, and efforts to re-establish bird colonies at constructed islands.

- The study tracks mercury concentrations in waterbird eggs at the Pond A8 complex. Study results from 2010-2013 showed an increase in mercury concentrations in Forster's tern eggs after pond flooding. As a result, Refuge managers slowed down the opening of notches. By 2013, mercury concentrations dropped to levels expected if there had been no restoration, and managers resumed opening notches.
- Data from 2015 showed increased mercury concentrations in American avocet eggs. However, data from 2016 showed decreasing mercury concentrations in both avocet and Forster's terns eggs overall. Long-term trend analysis indicates that 2015 levels were among some of the highest. Mercury concentrations in Forster's tern eggs throughout the South Bay are still above the toxicity benchmark (liver demethylation threshold). This is a long-time problem throughout the South Bay, not only near Pond A-8
- The research team does not fully understand the peaks and drops. Birds are sensitive indicators, and there are significantly different mercury concentrations across the South Bay.
- The research team has been monitoring American avocet, black-necked stilt, and Forster's tern nest sites south of the Dumbarton Bridge since 2005. Shorebird species that breed locally have shown dramatic declines in the last few years. Results show an apparent decline in avocet and stilt populations. Tern population levels have varied, but not declined. Colony numbers are also declining on islands.

Mercury Levels in Slough Fish- Darell Slotton (UC Davis) continued work on mercury levels in three-spine sticklebacks and Mississippi silversides in and near Alviso Slough and Pond A8.

- The research team has been monitoring mercury levels over time in relation to A8 notch openings. Mercury levels remained steady over five gate openings through 2015. In 2016, the team saw a huge spike in mercury levels between July and October with no gate change. This spike showed up in smaller fish with higher levels of mercury. By February 2017, the levels decreased, but were still higher than the year before. The results from the next sampling will be critical to determining whether the levels are continuing to return to their pre-spike levels.
- The cause of the spike in mercury levels appears to be happening in the upper part of the slough and does not look like a gate-related phenomenon. One hypothesis is a chemical event occurred that increased the methylation rate, maybe related to dissolved oxygen.
- Another suggestion was that gradual erosion in Upper Alviso Slough might have released an historic deposition or concentrated pocket of mercury.

Water Column Mercury Study Results through Study Year 2016 -Mark Marvin-DiPasquale (USGS) continued work on changes in mercury levels in the water column.

- The research team focused on mercury levels (unfiltered, filtered, particulate, etc.) in the A5/A7/A8 complex, upper Alviso Slough, and lower Alviso Slough.
- The main question: what has happened since the A8 notch and the A6 breach opened?
- Mercury levels decreased inside the footprint of the complex (Ponds A5, A7, A8, and A8S) relative to before and after notch opening. There was a general shift in mercury from the aqueous phase to the particle phase.
- In upper Alviso Slough, unfiltered, filtered, and particulate mercury increased. Particulate methyl mercury decreased. There was a general shift in methyl mercury from the particle to the aqueous phase. In lower Alviso, there was an increase in unfiltered total mercury and a decrease in methyl mercury.
- The positive and/or negative impacts of shifts between aqueous and particle mercury and vice versa vary depending on the type of mercury and the type of particles.

Fisheries Monitoring

The Refuge did not conduct any studies on fisheries during 2016. The results of the multi-year attempt to study salmonids and their use of restoring ponds showed that very few if any salmonids were within the watershed at all. UC Davis studies on salmonids and the entire fish assemblage continue in the South Bay through the efforts and funding of the San Jose-Santa Clara Regional Wastewater Facility.

Reported Fish Kills

Minimal dead fish were observed during 2016 that were associated with pond operations or Phase I restoration ponds. Over the course of the year only a few striped bass were found dead, cause undetermined.

Phase II Planning

The final environmental analysis document detailing the selected alternatives for Phase II was published in May of 2016. It plans for the restoration and management of 2,400 acres of ponds in the Alviso area near San Jose and Mountain View, and the Ravenswood area near East Palo Alto/Menlo Park. A summary of the Phase 2 preferred alternatives is described below:

Island Ponds Preferred Alternative

The Alviso Island Ponds (A19, A20, and A21) were breached to the Bay in 2006. The result has been that the pond complex is filling in from the bayside areas first. In Phase 2, the plan is to further breach A19 on the Mud Slough side and lower levees between the marshes and ponds to increase sedimentation rates to speed the transition to salt marsh. Managers will leave high tide refugia zones.

A8 Preferred Alternative

In Alviso Ponds A8 and A8S, large habitat transition zones will be built on the southern edges, protecting and buffering the landfill and allowing for high tide refugia habitat to build up. The transition zone design leaves a gap to allow a potential project to reconnect adjacent creeks with the Bay.

Mountain View Preferred Alternative

Currently, ponds A1 and A2W are ambient bay salinity type ponds (3-4 feet subsided at 0 feet elevation). The intent in Phase 2 is to turn both ponds fully tidal. However, the Project (in conjunction with the SCVWD) needs to build a flood protection levee along the Coast Casey Forebay and between A1 and the City of Mountain View's Charleston Slough. The plan will also include creating large transition zones (30:1 slope ratio) to protect landfill areas and create high tide refugia habitat. For public access, we will retain and improve existing trails (e.g. add an ADA accessible switch back). A short new spur trail will be built to an observation platform looking out over Charleston Slough and the restored tidal marsh. There will be another out-and-back trail along the edge of Pond A2W leading out to the Bay.

Ravenswood Preferred Alternative

This pond complex (R3, R4, R5 and S5 ponds) is right next to Bedwell Bayfront Park, an old landfill. Managers are proposing several types of ponds to achieve a variety of habitats. The plan is to restore Pond R4 to tidal marsh and reinforce the All American Canal inner levee. Pond R3 will remain as a managed pond for snowy plovers, with additional water control structures better management capability. Ponds R5 and S5 will be managed for deep-water habitat for waterfowl. The design includes large transition zones along the landfill/park and levee. The plan is to connect the existing Bay Trail to the pond complexes from the highway to converge the public access area where the three habitat types meet. There will be benches and interpretive panels in a similar style to what has been done in other Project areas and in neighboring parks.

APPENDIX A

DON EDWARDS SF BAY NWR

POND OPERATION PLANS

Updated 8/25/17

Monitoring

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

Monitoring Program

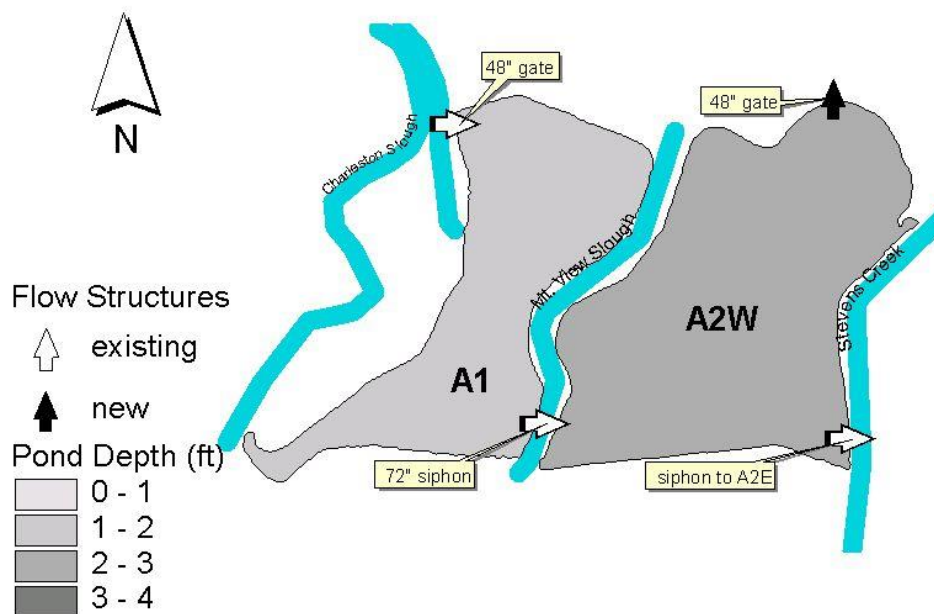
| Location | Parameter |
|------------|-------------------------------|
| Intakes | Salinity |
| In-pond | Depth, Salinity, Observations |
| Discharges | Depth, Salinity, Observations |

The monitoring program includes visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees.

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A1 AND A2W



Objective

Maintain full tidal circulation through ponds A1 and A2W while maintaining discharge salinities to the Bay at less than 40 ppt. These ponds are part of the SBSRP Phase 2, and will likely be breached in the next 5 years.

Structures

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

- 48" gate intake at A1 from lower Charleston Slough
- NGVD gauge at A1
- 72" siphon under Mountain View Slough between A1 and A2W
- staff gauge (no datum) at A1
- 48" gate outlet structure with 24' weir box at A2W to the Bay
- NGVD gauge at A2W
- The siphon to A2E is present, but closed

The system will discharge when the tide is below 3.6 ft. MLLW.

Summer Operation: May through October

Summer Pond Water Levels

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

Water Level Control

The water level in A2W is the primary control for the pond system. The outlet at A2W includes both a control gate and control weir, either may be used to limit flow through the system.

The A1 intake gate can be adjusted to control the overall flow through the system.

Design Water Level Ranges

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

Based on system hydraulics, pond A2W is typically about 0.1 feet below pond A1.

Winter Operation: November through April

Winter Pond Water Levels

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

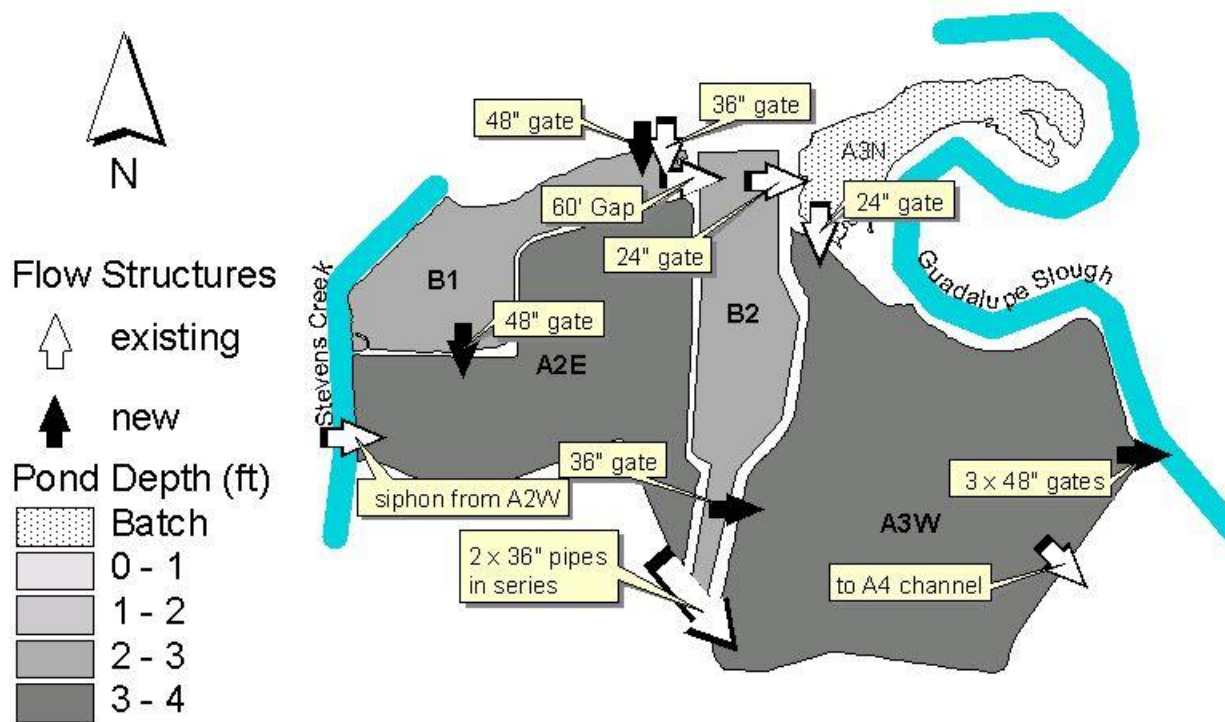
Water Level Control

Normal winter operation would have the intake gate partially open to reduce inflow during extreme storm tides. The pond water level may vary by 0.2 ft due to the influence of tides, and over 0.5 ft due to storms

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

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

B1, B2, A2E, AND A3W



Objectives

1. Maintain full tidal circulation through ponds B1, B2, A2E, and A3W while maintaining discharge salinities to Guadalupe Slough at less than 40 parts per thousand (ppt).
2. Due to mercury hotspots in Pond A3N when managed as a seasonal pond, maintain water levels to cover the pond bottom. This can be done by leaving the A3N / A3W gate fully open, year round. However, this limits western snowy plover nesting habitat.
3. Maintain water surface levels lower in winter to reduce potential overtopping of A3W and A2E levees adjacent to Moffett Field.
4. The water control structure at A3W/Guadalupe Slough was replaced September 2015.

Structures

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

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

- 24” gate between B2 and A3N
- 24” gate between A3N and A3W
- 3x48” gate outlet at A3W to Guadalupe Slough. Two are outlet only, and one allows both inflow and outflow, no weir
- staff gauges at all ponds and NGVD gauges at all ponds
- siphon from A2W is closed, but available if needed
- siphon to A4 is available (via pump) for emergency purposes in conjunction with SCVWD

Summer Operation: May through October

Summer Pond Water Levels

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

* Pond B1 and B2 will be operated at lower water levels on an experimental basis in an attempt to improve shorebird nesting and foraging habitat. If water quality or operations are jeopardized from lower water levels in Ponds B1 or B2, the system will be reverted back to normal operating levels, during non-hunting season.

Water Level Control

The flow through B2 to A3W is only required to maintain circulation through B2. This circulation prevents local stagnant areas, which may create areas of higher salinity or algal blooms.

The flow through A2E is controlled by the gates from B1 to A2E. The partial gate opening is to maintain the water level differences between A2E and B1. There are no gates on the culverts between A2E and A3W, therefore the water levels in those two ponds should be similar.

The B1 intake gates should be adjusted to control the overall flow through the system. The water levels in B1 (and therefore B2) will change due to the change in inflow.

Water levels in Pond AB1 and Pond AB2 of Pond A3W system will be lowered during the summer to improve shorebird nesting and foraging habitat.

Design Water Level Ranges

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

Salinity Control

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

Winter Operation: November through April

Winter Pond Water Levels

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

Water Level Control

The water levels in A3W are important to prevent levee overtopping. The south levee separates the pond from the Moffet Field drainage ditch. The levee is low, and subject to erosion with high water levels.

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

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

A5, A7, AND A8



Objectives

The Pond A8 system is operated to maintain muted tidal circulation through ponds A5, A7, A8N and A8S while maintaining discharge salinities to the Bay at less than 40 ppt.

Structures

The A8 system includes the following structures needed for water circulation in the ponds:

- 2x48" gate intake at A5 from Guadalupe Slough. As of October 2014 this tide gate is broken and intakes water a high tide (cannot be fully closed)
- 2x48" gate in/outlet with two 24' weir boxes at A7 from Alviso Slough; this functions as the outlet for the system when needed
- NGVD gauges at A5 and A7 structures
- Notches in the levees between A5/A7/A8/A8S; these ponds effectively function as one siphon between A4 to A5 will generally be closed; this siphon is pump driven rather than gravity fed.
- 40-foot armored notch with multiple bays that can be opened and closed independently at A8 and Alviso Slough. Current operation (2017) is 8 bays open year-round.

Weir Structure: A portion of the levee adjacent to Pond A8 was reconfigured as part of the Lower Guadalupe River Flood Protection Project to act as an overflow. The 1,000-ft long overflow weir at Pond A8 would allow high flood flows to exit Alviso Slough when water levels reach approximately 10.5 ft NAVD88. The water levels have never overtopped the weir since 2004, but it remains in place in case of a flood event.

A4 Siphon: It is possible to pump water from Pond A4 into Pond A5 or vice versa, if necessary, in accordance with the SCVWD Pond A4 Water Management Operations Plan (December 2005).

System Description

Water exchange through the notch connection is limited and the tidal range within the ponds is muted. All gravity intake flow occurs at high tide, and all outflow occurs when the tide is below 8.12 ft. MLLW. Previous seasonal water levels no longer apply here.

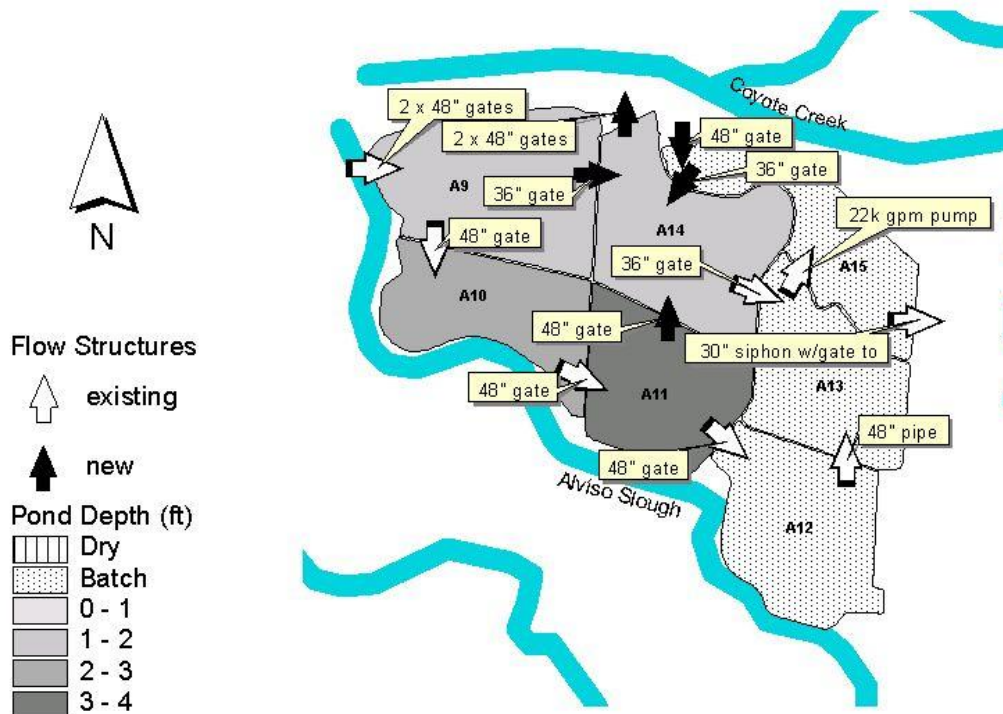
Water Level Control

The A5 and A7 intake gates can be adjusted to control the overall flow through the system. After the installation of the “notch”, water levels are much higher here due to a muted tidal system into A8.

Winter Operation

All 8 bays of the notch are left open year round as of June 2017. Note that without pumping, rainfall or inflow, it will take approximately 3 weeks to drain 1.0 ft from the ponds.

A9, A10, A11, A14 AND A12, A13, A15



Objectives

1. Maintain full tidal circulation through ponds A9, A10, A11 and A14, while maintaining discharge salinities to Coyote Creek at less than 40 parts per thousand (ppt).
2. Maintain pond A15 as a higher salinity pond and operate at 80 – 120 ppt salinity during summer to favor brine shrimp development, as possible.
3. CURRENT CONDITIONS (as of 2016): A9-A14 are currently being operated at lower levels due to levee erosion along Alviso Slough.

Structures

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

- 2 x 48" gate intake at A9 from Alviso Slough
- 48" gate between A9 and A10; 48" gate between A9 and A14- left open always
- 48" gate between A10 and A11; 48" gate between A11 and A14- left open always
- 48" gate between A11 and A12; 48" gate between A12 and A13
- 36" gate between A14 and A13
- 36" gate between A15 and A14; 22,000 gpm pump from A13 to A15 (no power, would need a generator to operate)
- 48" gate intake at A15 from Coyote Creek
- 2 x 48" gate outlet at A14 into Coyote Creek
- staff gages at all ponds and NGVD gages at all pond
- internal breaches in levees between A9/A10/A11/A14 were put in place in 2008 to improve water flow

System Description

The normal flow through the system proceeds from the intake at A9, then flow through A10-A11- to the outlet at A14. All gravity intake flow would occur at high tide, and all outflows would occur when the tide is below 6.2 ft. MLLW.

Summer Operation: May through October

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

Summer Pond Water Levels

Water Level Control

The water level in A14 is the primary control for the pond system. The system flow is limited by the inlet capacity at A9. Normal operation would have the outlet gates fully open. Water levels are controlled by the weir elevation at A14. The A14 weir should be at approximately 0.0 ft NGVD to maintain the summer water level in A14 at 0.9 ft NGVD (2.3ft gauge).

Due to the internal levee cuts, water flows freely between ponds A9 to A10 to A11 to A14.

Operating the ponds at or near minimum depths will interfere with circulation through the ponds and may cause significant increases in pond salinity during the summer evaporation season. Exposing the pond bottom at A9 also brings in western snowy plovers to nest, further reducing our capacity to manage water here. Recently, lower water levels have allowed western snowy plovers and American avocets to nest on the pond bottoms of A11 and A12 as well.

Salinity Control

Increased flow may increase the water level in A14. The inflow at A9 is constrained by the tide level in Alviso Slough since the intake gates would be fully open. Water levels in pond A14 above elevation 2.0 ft NGVD (3.4 ft gauge) should be avoided as they may increase wave erosion of the levees.

Batch ponds A12, A13, and A15 summer salinity levels should be between 80 and 120 ppt, to provide habitat for brine shrimp and wildlife which feeds on brine shrimp. However, due to limited flow through here (ultimately from the intake at A9) this batch system does not usually function this way. Further, we have reduced water levels in A12 and A13 in recent years to promote nesting by terns and shorebirds. These two ponds are often mostly dry during the summer with only high salinity water in the borrow ditches and some standing water. Recently,

lower water levels have allowed western snowy plovers and American avocets to nest on the pond bottoms of A12 and A13.

Ponds A12 and A13 operate as a single unit, with inflow from pond A11 and outflows to either A14 or A15. The water levels in A12 and A13 would generally be between the elevations in A11 (higher than A12) and A14 (lower than A13); inflows from A11 and outflows to A14 would be by gravity. Pond A15 operates as a separate batch pond to some extent with inflow from A14 or by gravity from Coyote Creek.

If the salinity levels are high in A14, it may be necessary to reduce or suspend outflows from the batch ponds and allow the batch pond salinity to increase until later in the season. The salinity in a batch pond will increase by ~ 10 ppt per month during the peak evaporation months.

Winter Operation

During the winter season, the A9 intake will be closed to prevent entrainment of migrating salmonids; December through May 31. Excess water from rainfall would be drained from the system after larger storms and will require additional active management to adjust the interior control gates. In years with low rainfall and because there is no inflow to this entire system during the winter, water levels in A9 are often very low by spring.

Winter Pond Water Levels

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

A16



Objectives

243 acres of managed pond habitat in Pond A16, with 20 nesting islands. Some of the islands are enhanced to recruit terns to nest.

Structures

- 63" culvert intake at A16 near the southwest corner of A17 (200 cfs capacity)
- outlet structure into Artesian Slough (180 cfs capacity) with 140-ft outlet pilot channel
- siphon into New Chicago Marsh

System Description

Flows into and out of Pond A16 can be changed by adjusting slide gates.

Pond A16 is managed for shallow water habitat. A large majority of the pond bed has elevations ranging from 2.2 to 3.1 feet NAVD. In addition to the 20 islands, you can often see parts of the pond standing above the water line. The intake culvert has a tide gate to prevent water from flowing back into A17.

The Refuge and the USACE finished a project to place toppings on two islands for use by nesting Caspian terns (islands 11 and 12) and one for nesting western snowy plovers (island 3) in winter 2015. Decoys and sound systems were placed 2015-2017. In 2017, Forster's tern decoys were placed on islands 14, 15, 16, 17, 18, 20.

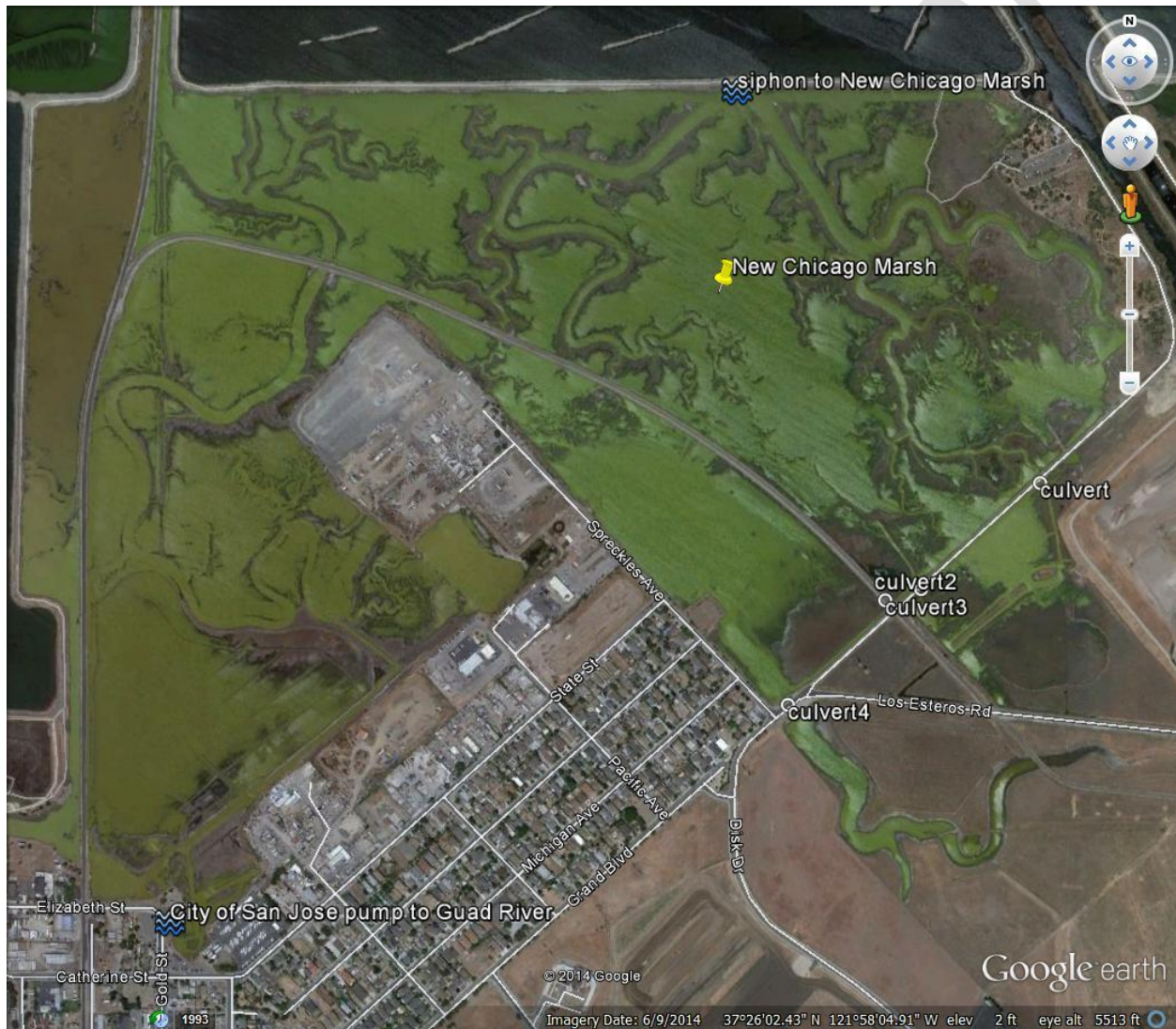
Outlet structure:

- Discharge a maximum capacity of 180 cfs to Artesian Slough during low tide events.
- Prevent water from flowing back into A16 through the outlet structure.

NEW CHICAGO MARSH

The siphon from A16 into NCM is closed in the winter unless water levels drop significantly due to low rain fall. In spring and summer the siphon is open ~3 inches to keep up with evaporation and not flood out nesting birds. Recommendations are to keep water levels between -2.5 to -2.7.

There is no outlet, although a small pump is available in the case of emergency. The pump is located in the southeast corner, along the entrance road into the EEC and releases water into Artesian Slough. Water in NCM drops ~1/10 or one inch every two days with the pump running full time. City of San Jose has a pump in the SW corner of NCM that is used to prevent flooding in Alviso.



A22 AND A23



There is one 48" gate located on Mud Slough at the cross levee between the two ponds. It takes a very high tide to get water to flow through the gate. There is no outlet for this system and these ponds currently function as seasonal ponds. Currently, the internal "donut" levee is cut to allow water to flow into A22 but not A23. These two ponds are used for snowy plover nesting habitat and need to remain dry during nesting season. Some water can be brought in during summer to allow for foraging habitat within channels and the borrow ditch. Water is brought in during the winter to provide foraging habitat for waterbirds.

SF2



Objectives

Manage 155-acre pond with 30 nesting islands for nesting and roosting shorebirds, and an 85-acre seasonal wetland for western snowy plover nesting. The water level in SF2 is designed to maintain shallow water to provide foraging habitat for shorebirds and waterfowl. The Refuge and the USACE finished a project to place toppings on three islands for use by nesting Caspian terns (islands 17, 21, 12) and one for nesting western snowy plovers (island 10) in winter 2015. Decoys were in place 2015-2017. Decoys and sound systems were placed here in 2015. Decoys for Forster's terns were placed on island 22 only in 2016.

Structures

- intake structure consisting of 5: 4-foot intake culverts with combination slide/flap gates on each end of the culvert
- outlet structure consisting of 6: 4-foot outlet culverts, with combination slide/flap gates on both ends of each culvert
- there is one staff gauge at the outlet channel

System Description

Water flows into and out of pond SF2 through water control structures at the northern (cell 1) and southern ends (cell 4) of the bayfront levee. Weirs with adjustable flashboard risers are used to control flow in and out of cells 2 and 3. Water flows out of SF2 during low tides through the structures located along the bayfront levee. Within SF2, flashboard riser weirs are installed to convey flow into and out of cells. The Refuge replaced many of the internal weir boards in the spring and summer of 2017.

The seasonal wetland area has 1 intake and 1 outlet structure. In addition, 4 cell outlet culvert structures are located where the berms cross deeper, historic channels and borrow ditches to

drain deeper water from these channels for periodic maintenance and as a water quality management approach.

Summer Operation

June 1-January 31, the southern water control structure is operated as a one-way outlet and the northern water control structure is operated as a one-way intake. However, during the peak shorebird months, we may manipulate the water levels in cell 1 by operating the intake as a two-way flow. With this option, cells 2 and 4 would continue to operate as a one-way continuous flow, but cell 1 would drain through the intakes at low tide and provide mud flat areas for foraging habitat (until the rising tides refill cell 1). The 2 way flow also helps remove built up sediment in the intake channel on Bay side.

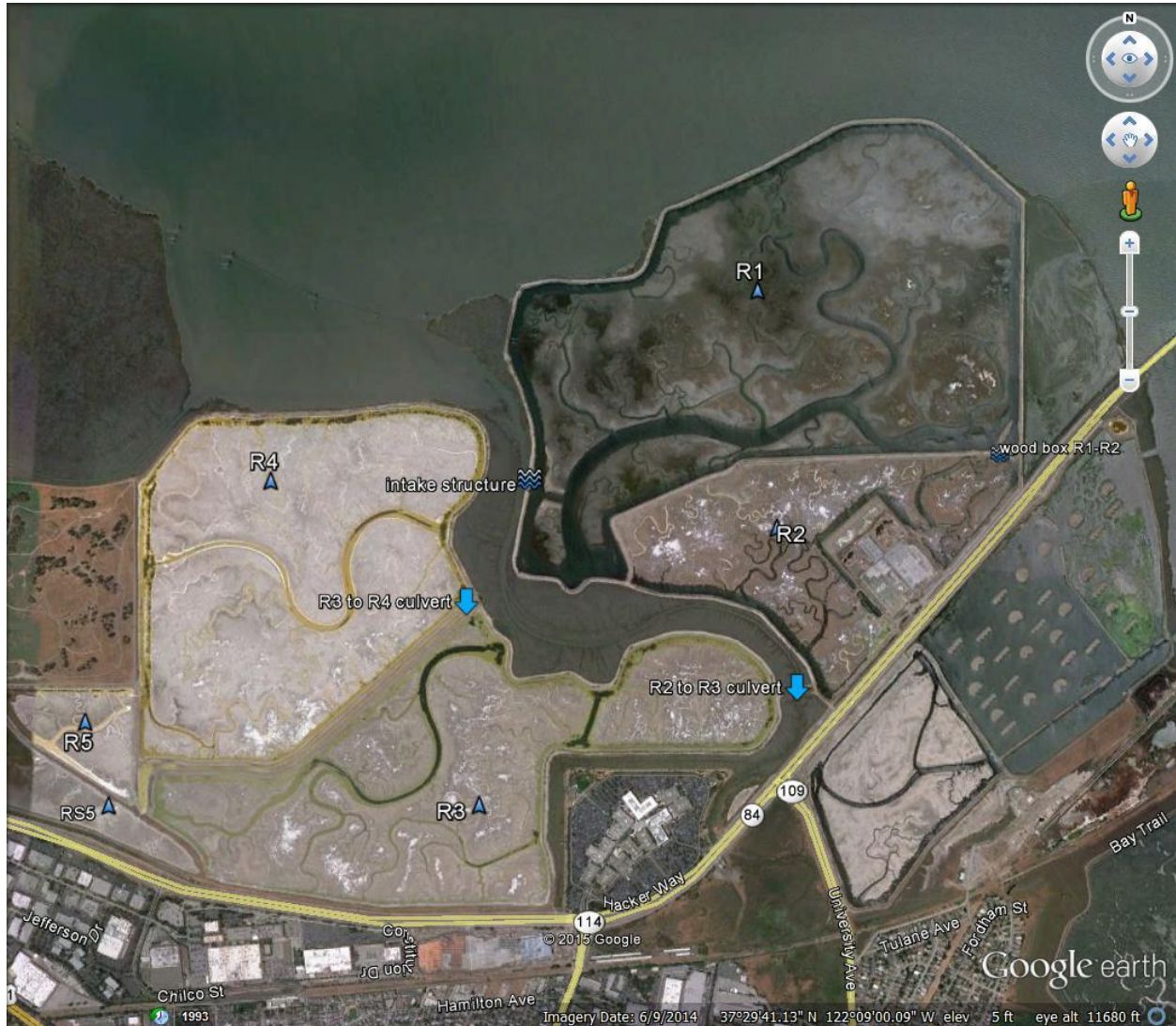
Water Level Control

Water levels are controlled by the outlet weirs located on cell 4.

Winter/Spring Operations

During the winter/spring season, both water control structures will be operated as 2-way flow to create muted tidal conditions, February through May. These measures also help protect juvenile salmon and steelhead entrainment.

R1, R2, R3, R4, R5 AND RS5



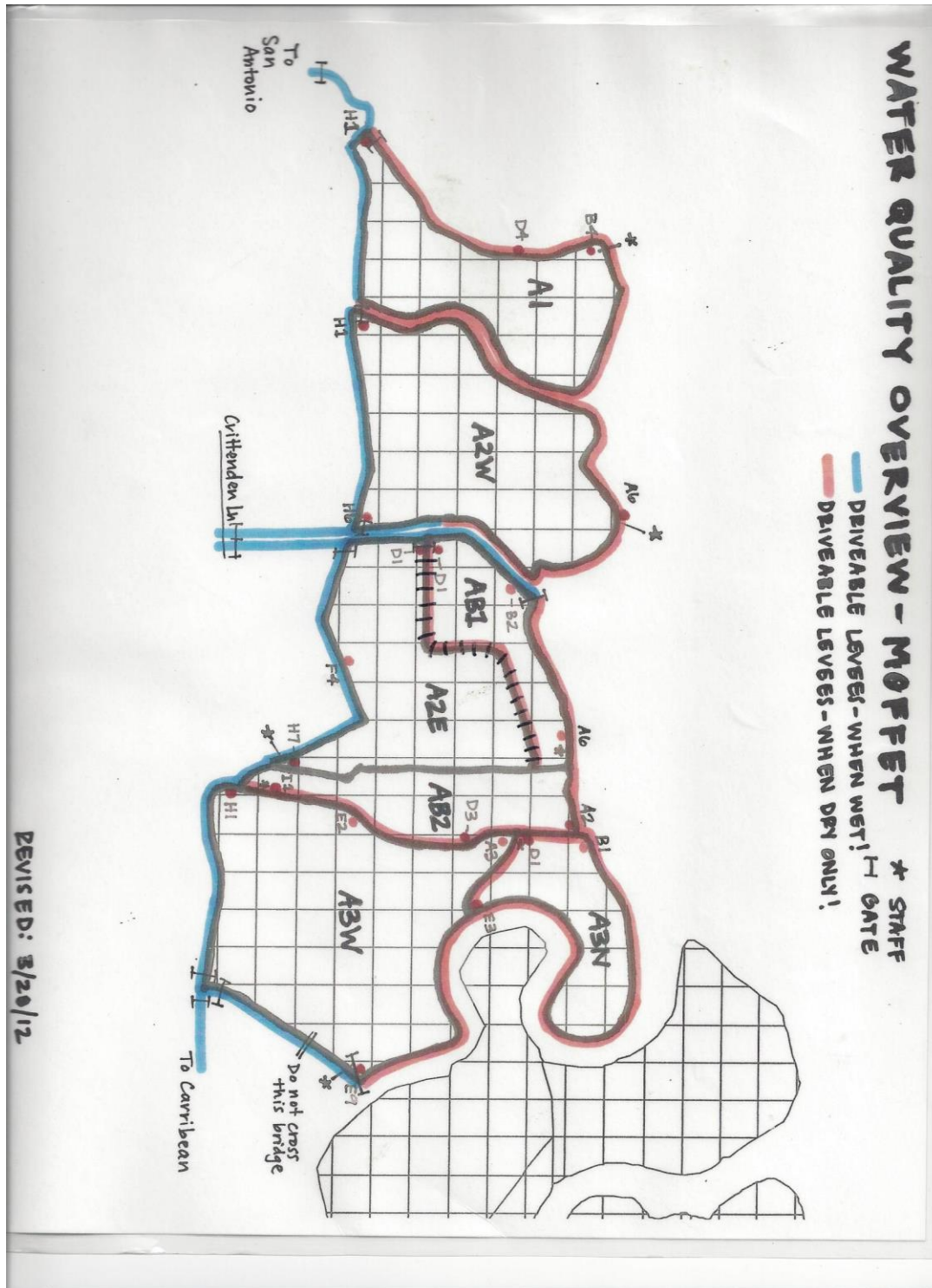
There are two 72" gates located at R1 to feed this entire pond system; there are no discharge points for the system. Water moves from R1-R2-R3-R4, and in general the previous pond must be filled before beginning to fill the subsequent pond. The All American Canal can no longer be used to get water to R5 and RS5. All of the water control structures in this system are old, and may not be totally operational. In particular the culverts R2-R3 and R3-R4 appear to not open and/or close properly.

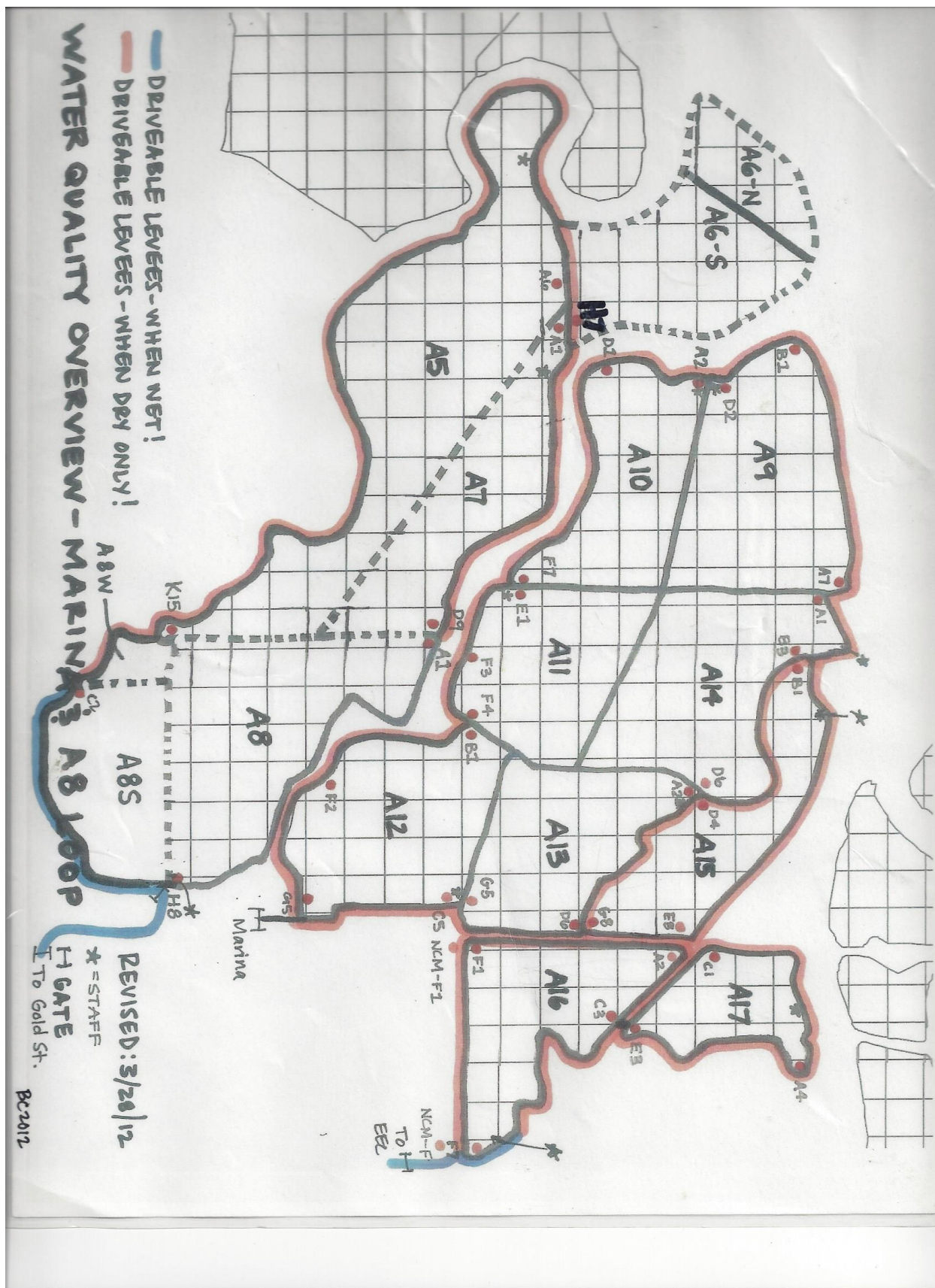
R3, R4, R5, and RS5 currently function as seasonal ponds and receive only rainwater.

For R1 and R2, during summer operations, these ponds are drawn down for snowy plover nesting habitat. During winter operations, one of the intakes is opened ~ 20", and left open for several weeks to cover the pond bottom in R1 and R2 for waterfowl habitat and hunting season, Oct-Jan.

If there is a build-up of vegetation on R3 and R4, then the Refuge has flooded up the ponds to cover the pond bottom after nesting season by bringing in water: R1-R2-R3-R4. Drying time is at least a few months depending on rain. This was last done in ~2009.

LEVEE DRIVING AND STAFF GAUGE MAPS
Updated May 2012, by Stacy Moskal USGS

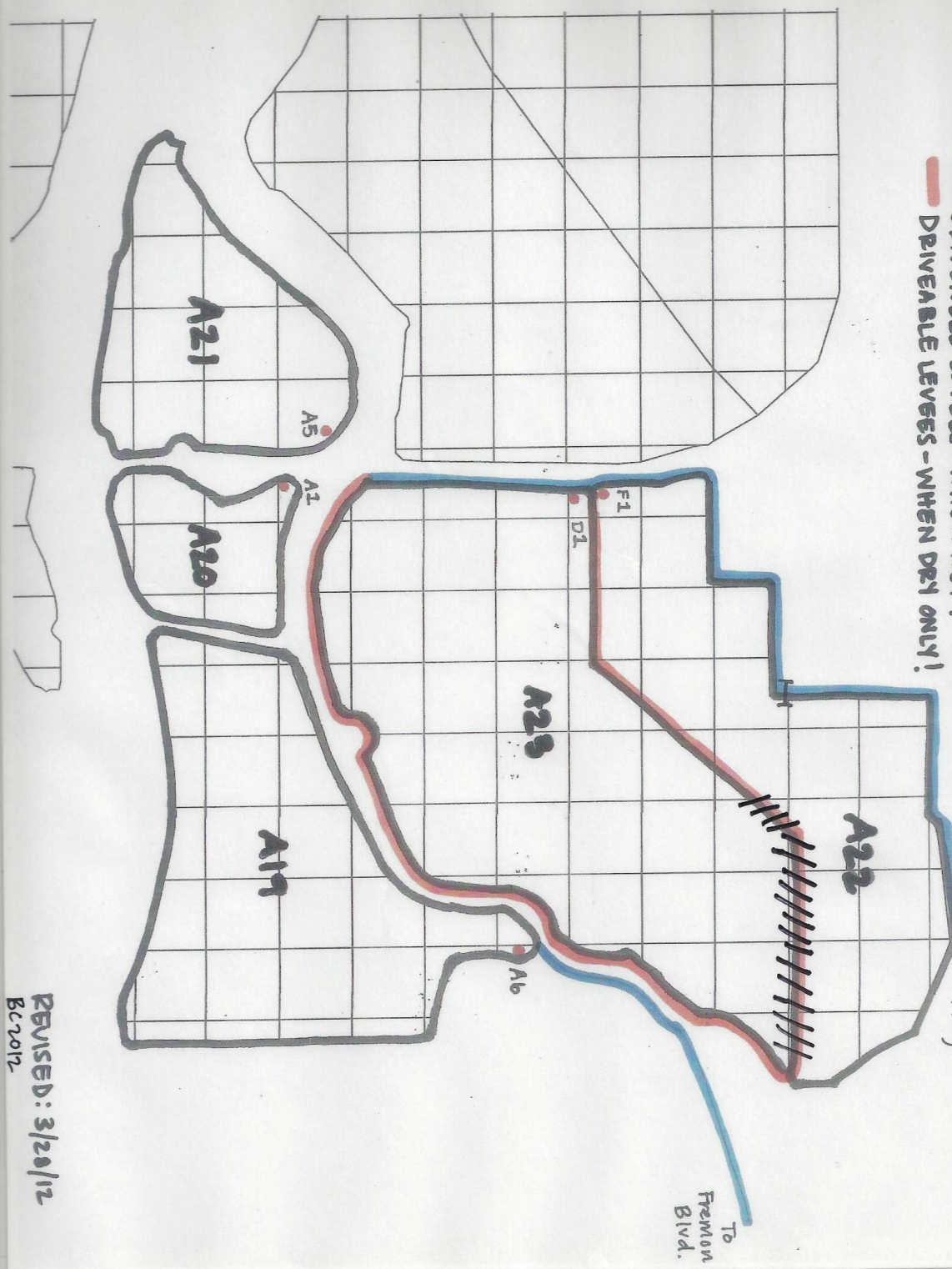




WATER QUALITY OVERVIEW - ISLAND PONDS

*-STAFF H GATE
To Cushing's
Pkwy

— DRIVEABLE LEVES - WHEN WET!
— DRIVEABLE LEVES - WHEN DRY ONLY!



REVISED: 3/20/12
BC2012

WATER QUALITY OVERVIEW - RAVENSWOOD

- * STAFF
- DRIVEABLE LEVEES - WHEN WET; H GATE
- DRIVEABLE LEVEES - WHEN DRY ONLY!

