Cargill, Incorporated
Solar Sea Salt System Maintenance & Operations – Berm Integrity

Presentation to BCDC Engineering Criteria Review Board

November 16, 2022

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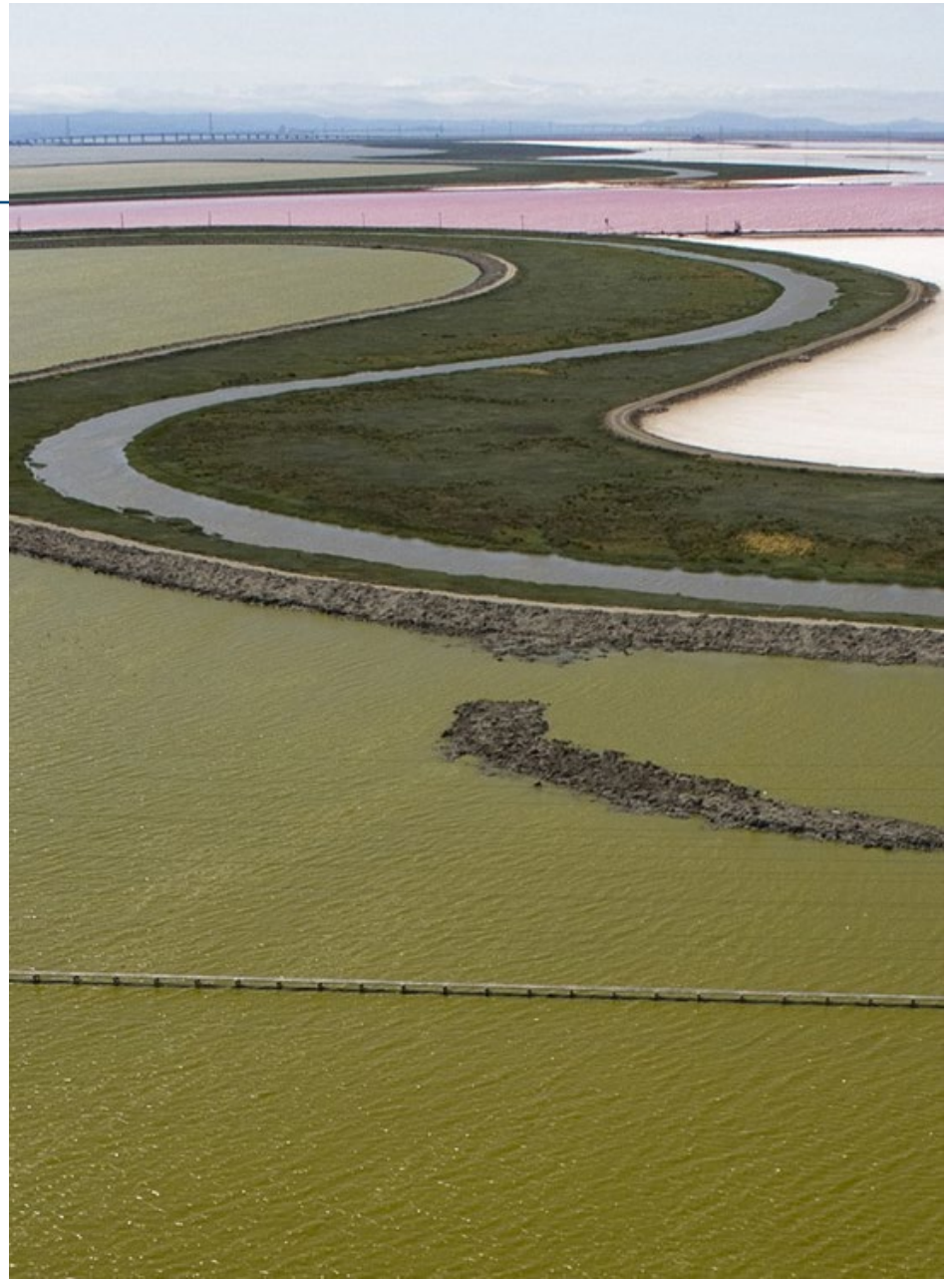
Agenda

- Introductions
- Scope of Permit Application & Today's Review
- Cargill's Solar Sea Salt System
- Sea Level Rise & Adaptation Strategy
- Geotechnical Data and Analysis
- Conclusions
- Discussion



Scope of Permit Application & Today's Review

Scope of Cargill's Permit Application

- Current Permit: Issued in 1995 and renewed to date for operations & maintenance activities

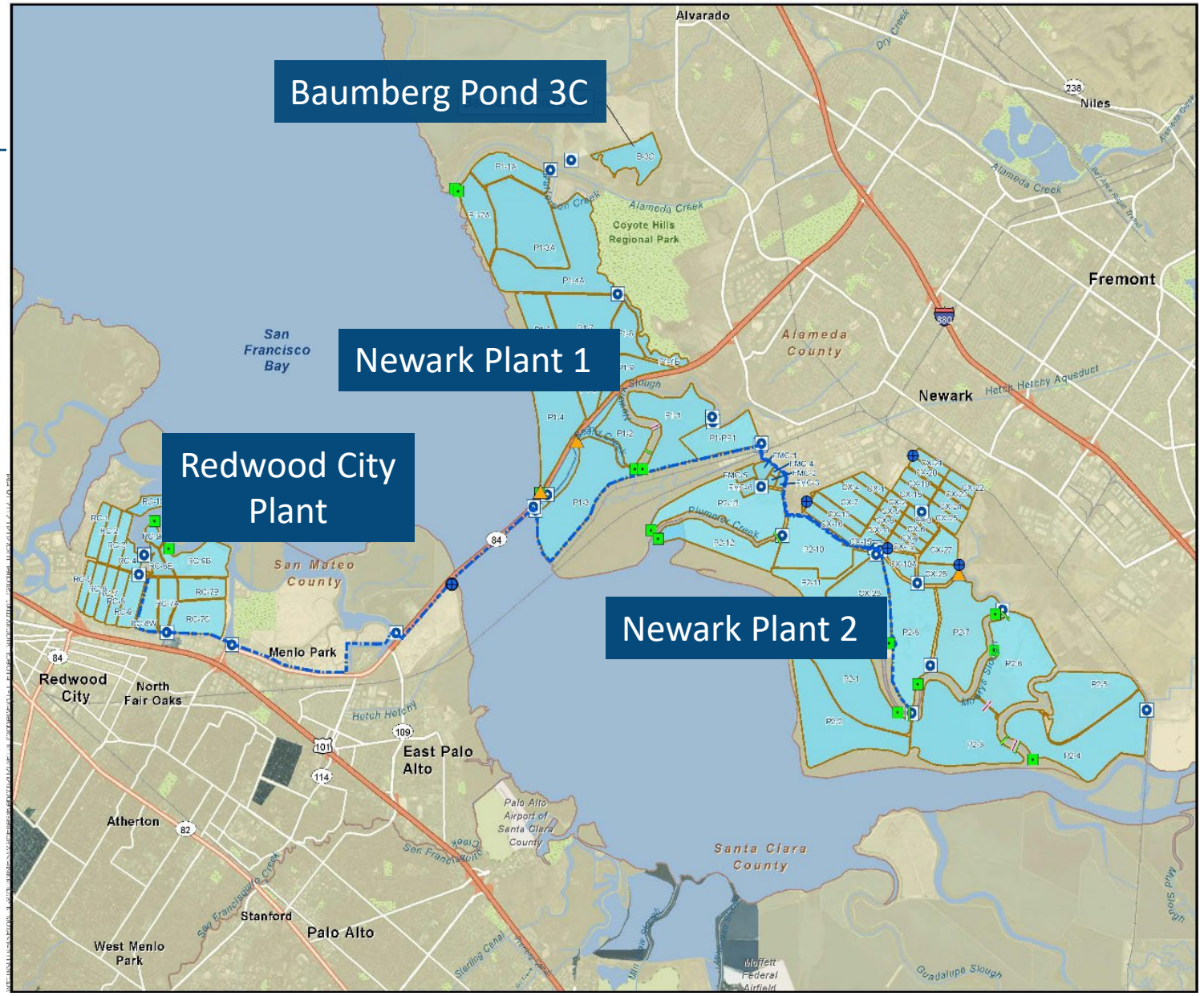
- Permit Renewal: Continue generally the same activities for 10-yr permit cycle
  - Ongoing effort 2017 to present. See Attachments at end of presentation for milestones.

- Primary Project Objectives:
  - Continue to maintain (a) integrity & stability of earthen berms, (b) water control structures, and (c) other infrastructure necessary for salt-making
    - 100+ yr program of maintaining berm height/surfaces and fortify against erosion
    - Berm maintenance activities consist of: Resurfacing berm top surfaces, replacing and compacting internal berm fill where necessary, and adding, replacing, or rearranging protective riprap armoring where wind-derived waves and currents have caused localized erosion
  - Adapt to Sea Level Rise
  - Improve efficiency, adapt to climate change, and avoid/reduce environmental impacts
  - Make discrete improvements, including making more berms all-weather (drivable) to reduce the amount of maintenance done using water-based equipment

- **Permit is for maintenance of existing berms, not new construction**

Cargill's Solar Sea Salt System

- Sea Salt System earthen berms were constructed at various times and by various salt production companies from the 1860s to the 1950s.
- Since 1978, Cargill has been sole operator of the historic sea salt system.
- Over the last 40 years, Cargill reduced the footprint of its operations by 60% and transferred to wildlife conservation agencies and organizations (40,000 acres).
- Current system consists of approximately 123 linear miles of earthen berms, of which approximately 62 miles are "outboard" berms.
- Regular inspection program to identify as-needed maintenance.



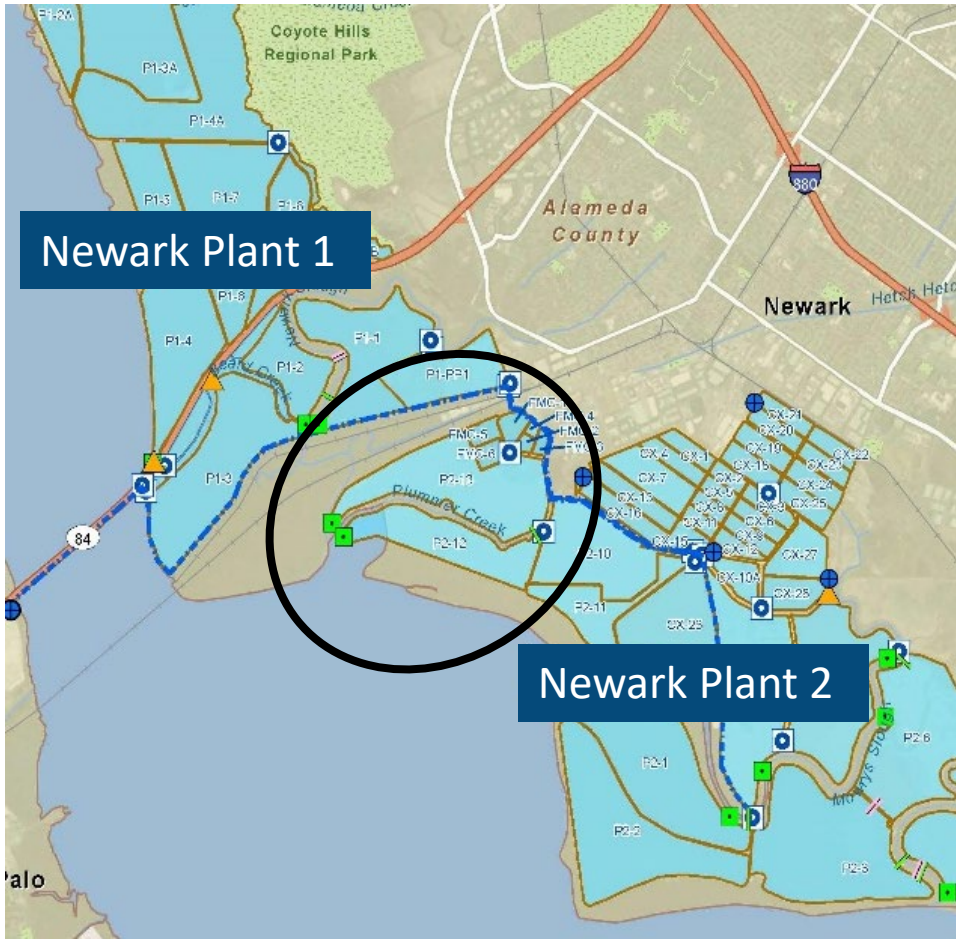
Berm Maintenance

- Cargill maintains the berms through a regular program of:
  - Inspections
  - Resurfacing of the berm crest
  - Internal berm core compaction, where necessary
  - Adding or replacing protective riprap face armoring where wind-derived waves, storms and currents have caused localized erosion of marshland buffers
  - Emergency Contingency Plan
- Berm core compaction explained: existing berm materials (previously dredged Bay muds containing occasional vegetation content/peat) are replaced by compacted lifts of imported fill soils to create a more homogeneous and consistent core of low-permeability materials
- These methods effectively address erosion and other forces at work on the berms

Scope of Today's Review

Targeted review of maintenance activities in a specific area

- Focus on "Ponds" 12 and 13
  - Inventory of the most concentrated salts: "mixed sea salts" (MSS)
  - Primarily a solid matrix, with 20% entrained brine
  - Located adjacent to SF Bay
- Priority area shown in SLR Analysis due to the above factors
  - These berms are not under additional stress compared to others because they are not subject to direct wave action
  - These berms do not currently, or for the foreseeable future, require outboard armoring (i.e., riprap)
- BCDC & Cargill Goal
  - Ensure maintenance activities to be authorized by the permit for the Pond 12 & 13 berms will not endanger life and safety of people in the event of major seismic activity or in the face of other environmental conditions

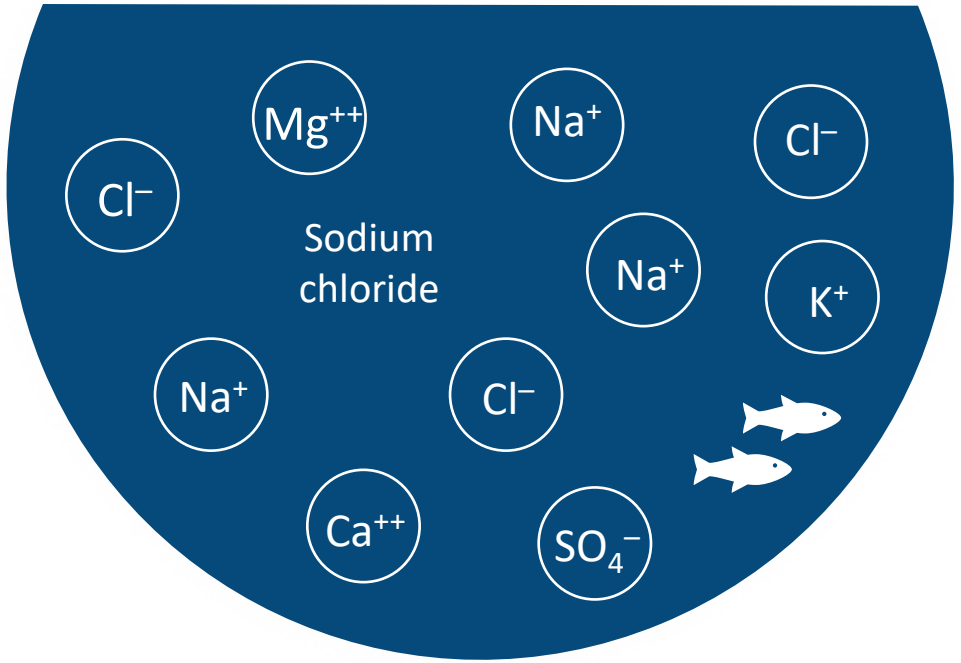


Cargill’s Solar Sea Salt System

Composition of Sea Water

Occurring naturally in the Bay

Salt ions in solution	Sea water (3.5% salt)
Na^+	1.1%
Mg^{++}	0.13%
K^+	0.04%
Ca^{++}	0.04%
Cl^-	1.9%
SO_4^-	0.27%

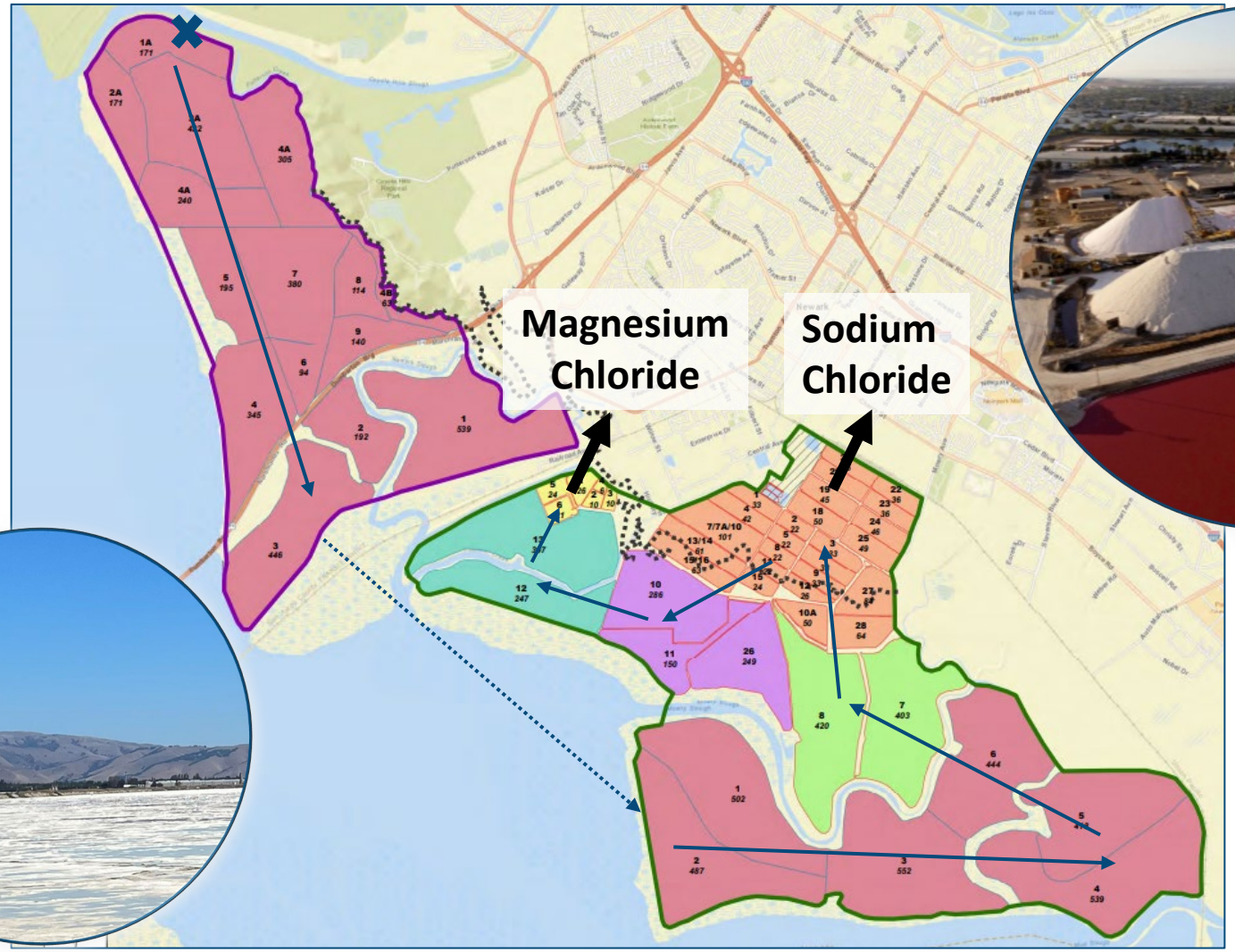


When crystallized out of solution

Salt compounds	(Dry basis)
Sodium chloride	78%
Magnesium chloride	9%
Magnesium sulfate (Epsom salts)	7%
Calcium sulfate (Gypsum)	4%
Potassium chloride	2%

Solar Salt Production Process

- ✖ Coyote Slough intake
- Concentration ponds
- Pickle ponds
- Crystallization ponds
- Desalting ponds
- MSS ponds
- FMC ponds



Sea Level Rise & Adaptation Strategy

Sea Level Rise Assessment

Purpose:

- Assist Cargill in better understanding its vulnerability to SLR hazards.
- Identify potential adaptation strategies to incorporate into ongoing and future maintenance and operations.

Method:

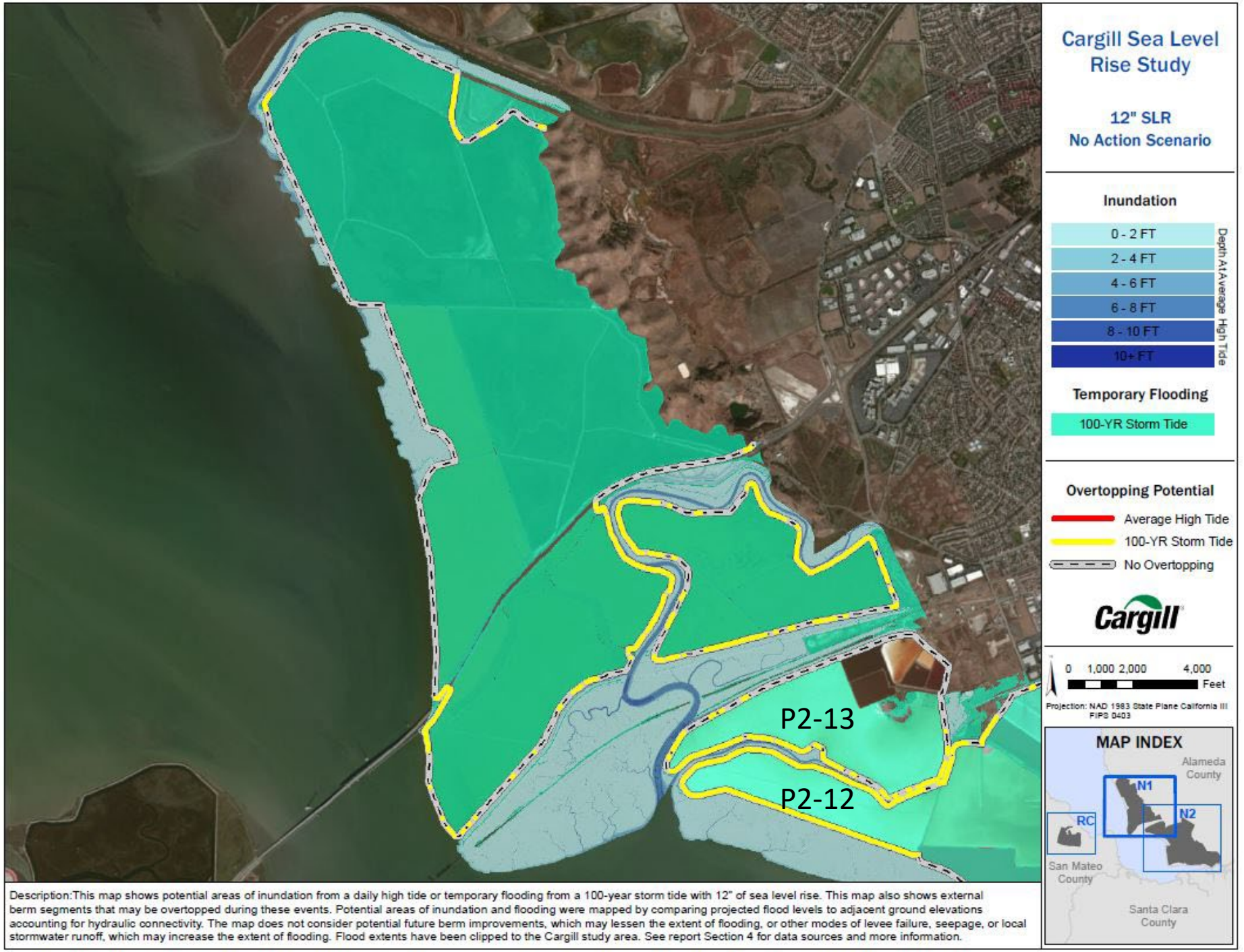
- Prepared by AECOM
- Focused on combined SLR and storm tides projections
- Considered the following “likely” sea level rise projections: +6 inches by 2030 and +12 inches by 2050

Conclusion:

- MSS ponds are at the highest risk from SLR.
- Reduce risks to the extent feasible (MSS inventory).
- Prioritize maintenance and adaptation of outboard berms.
  - Berms are the most vulnerable assets, due to their role in enabling salt production operations, protecting other Cargill assets, and preventing mixing of concentrated brine with bay waters

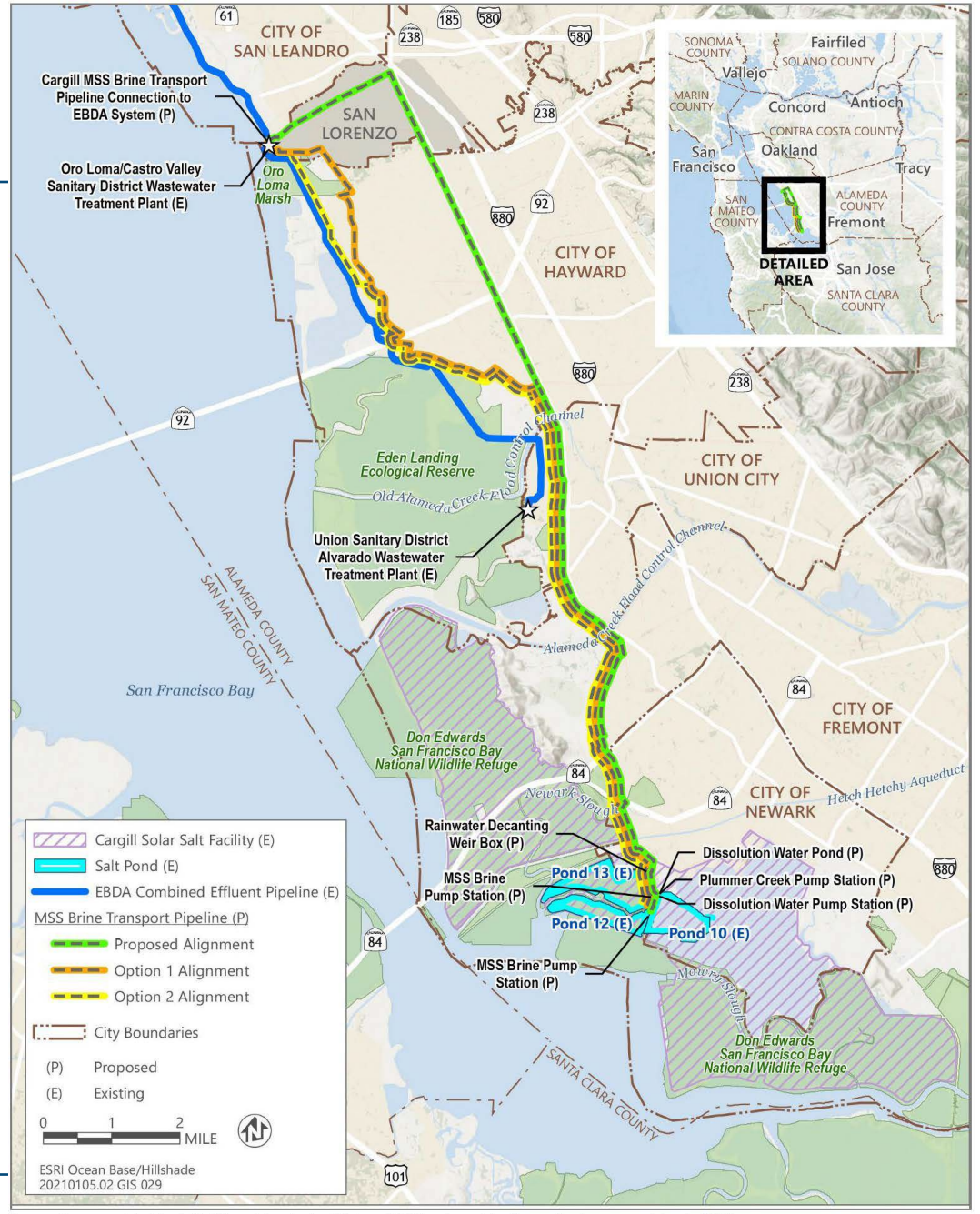
Berm Overtopping Potential

- *Based on 12” SLR <u>plus</u> 100-year storm tide*
- *Overtopping ≠ release to the Bay*



SLR Response Strategy

- Cargill is investing in new infrastructure to avoid/reduce risk
  - Enhanced MSS processing capabilities to be added to the facility
  - New infrastructure will include facilities to safely return all unused salts to the Bay
  - Not a maintenance activity and therefore will be permitted separately with EBDA as the lead agency
  - Will substantially reduce the volume of concentrated salts in Ponds 12 & 13 and increase capacity to accommodate overtopping of the berms



Source: Data provided by AECOM and Jacobs in 2021 and 2022, adapted by Ascent Environmental, Inc. in 2022

Summary of Sea Level Rise Adaptation Strategy

- **Near Term Actions (0-10 yrs)**
  - Targeted maintenance of outboard berms segments, based on identified risk, to maintain existing level of protection
  - Begin the proactive processing and removal of MSS from Ponds 12 & 13
- **Mid-Term Actions (10-30 yrs)**
  - Continued maintenance and raising of outboard berm segments based on identified risk
  - Retrofit critical assets located outside of the external berms (such as pumps and Bay water intakes)
  - Complete the proactive processing and removal MSS from Ponds 12 & 13
- **Long-Term Actions (30+ yrs)**
  - Continued monitoring of sea level rise and risks of storm-tide impacts to external berms and assets
  - Explore options to reduce operating footprint or decommission solar salt systems in the long-term future, based on a continually improving understanding of the risks
  - Evaluate new technologies to either fortify the berms or manage infiltration

Berm Stability Assessment Based On Geotechnical Data and Analysis

Existing Geotechnical Conditions

- Numerous geotechnical investigations have been performed over the last 20 years all around the South San Francisco Bay area.
  - Provide understanding of conditions and berm performance and stability implications.
- Salt pond berms at Cargill have demonstrated long term integrity and stability for over a century.
  - Berms remained operational through the larger 1906 San Francisco earthquake.
  - Berms, including Pond 12 & 13 berms, endured devastation of the 1989 Loma Prieta earthquake without much, if any, damage.
- Cargill performs routine maintenance, which includes riprap placement.
  - Minimum amount and extents needed to maintain berm protectiveness against natural erosion.
- Limited evidence of significant groundwater seepage through berms (water head differences and soil permeabilities are low).

Overview of Existing Geotechnical Data for Surrounding Areas near Cargill Ponds

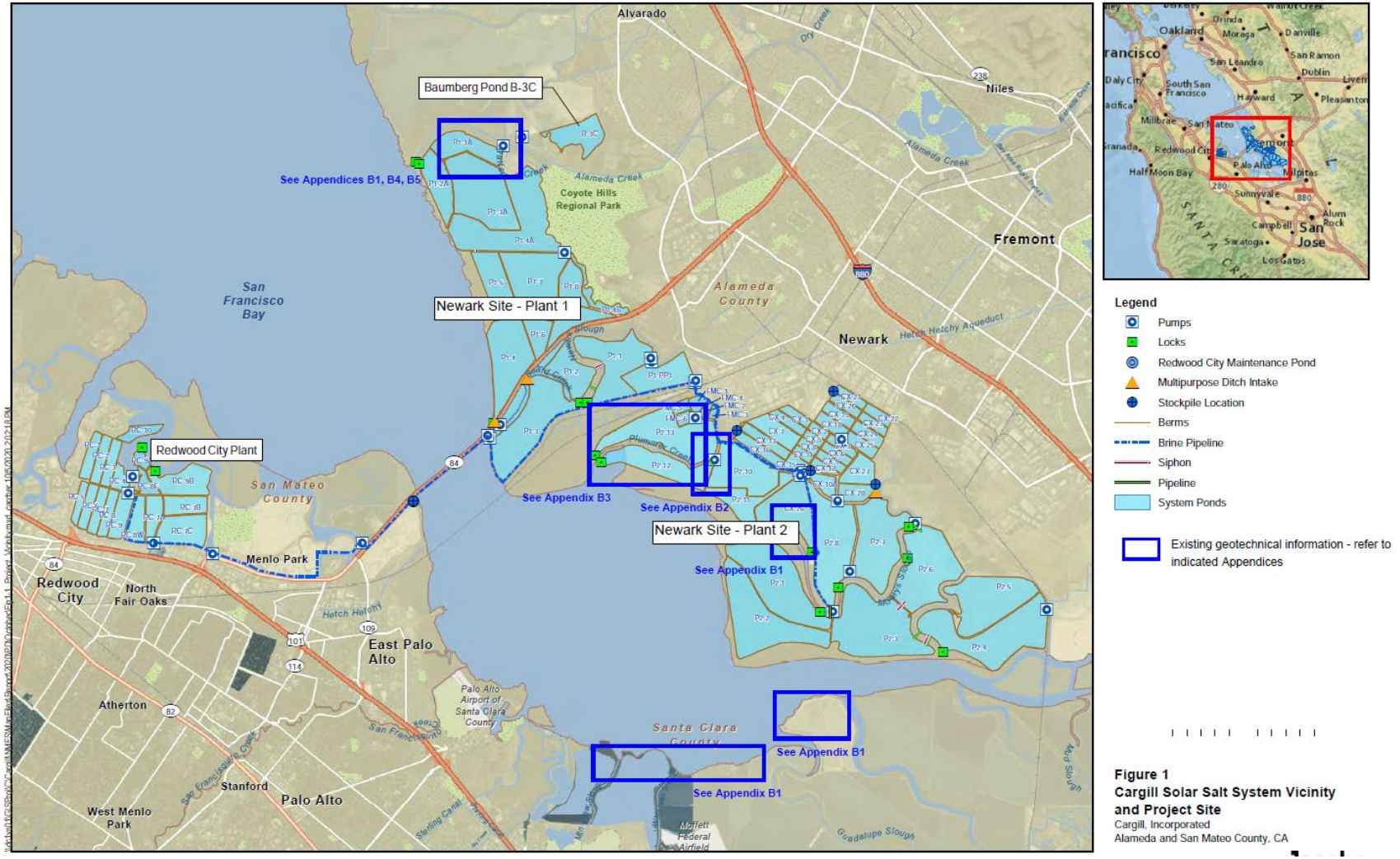


Figure 1
Cargill Solar Salt System Vicinity and Project Site
Cargill, Incorporated
Alameda and San Mateo County, CA

Boring Log Example – Document Bay Mud / Fill Presence

BORING LOG B-1

Job No.: 3813.400	**Client:** Cargill	**Elevation:** 7-1/2 feet
Job Name: Haul Road by BP13 and Plummer Creek Bridge	**Drill Method:** Rotary-wash	**Date Drilled:** 10-4-16

SAMPLER TYPE:	DRIVE WEIGHT (LBS.)	HEIGHT OF FALL (IN.)
2.5-inch I.D. Split Barrel	140	30
Standard Penetration Test	140	30

Moisture Content (%)	Dry Unit Weight (PCF)	Penetration Resistance (Blows/foot)	Depth (feet)	Sample Symbol	USCS Classification	DESCRIPTION AND REMARKS	Elevation (ft Relative MSL)
			0				7.5
-	-	17			CL/ML	CLAY with SILT, light to medium gray-brown, moist, very stiff, trace fine-grained sand, fine-to coarse gravel on surface (fill) Pocket Penetrometer = 4.5	
-	-	10	5		CL	SILTY CLAY, dark gray-brown, moist, stiff to medium stiff, trace fine-grained sand, light gray mottling, trace fine-to medium-grained sand (fill) Pocket Penetrometer = 1.25 below 6 feet, saturated, soft	2.5
32.8 60.2	88.5 63.2	4			CH	SILTY CLAY, dark gray, saturated, medium stiff, trace fine-grained sand (fill) Pocket Penetrometer = 1.5 Unconfined compressive strength = 571 psf at 13.9%	
19.8	107.4	15	10		CL	CLAY with SILT, light gray-brown, saturated, stiff, trace fine-grained sand Pocket Penetrometer = 1.25	-2.5
23.8	104	7	15			below 16 feet, medium stiff, trace fine-grained sand Unconfined compressive strength = 1,019 psf at 15.0 %	-7.5
23.9	101.4	12	20		SM	SILTY SAND, light gray-brown, saturated, loose to medium dense, fine-grained sand, trace clay 47% Passing #200 sieve Φ=32°, C=470 psf	-12.5

A-1

Geomatrix

APPENDIX A
BORING LOG DATABASE
South Bay Salt Ponds Restoration Project
San Francisco Bay Area, CA

Boring Identifier	Ground Surface Elevation (ft)	Depth to Groundwater (ft)	Depth to Bottom of Fill (ft)	Depth to Bottom of Bay Mud, or Bay Mud Fill (ft)	Depth of Exploration (ft)	Depths of Potentially Liquefiable Layers (ft)	Predominant Unit below Bay Mud (USCS)	Consistancy of Predominant Unit below Bay Mud
T5S/R1W-26QB1	N/A	14.5	1	14.7	20	N/A	CL-CH	hard
T5S/R1W-29QB1	5	N/A	6	24	58	36-58	SM, GP	medium dense
T5S/R1W-31EB1	8	N/A	1	17	43.5	23-43.5	SM	medium dense
T5S/R1W-31FB1	8.6	N/A	5	26.5	44	34.5-44	CL, SC, SM	stiff
T5S/R1W-31LB1	7.9	N/A	2.5	27.5	49.5	36-49.5	CL, SM, SP	firm
T5S/R1W-31NB1	8.2	N/A	2.5	21	49.5	41-49.5	CL	very stiff
T5S/R1W-31RB1	7.9	N/A	N/A	20	47	36-47	CL, SC, GP	stiff, medium dense
T5S/R1W-33KB1	4.5	N/A	4.5	17	55	17-21, 43-48	CL	firm
T5S/R1W-33KB2	N/A	N/A	N/A	>12	12	N/A	N/A	N/A
T5S/R1W-33RB1	6	N/A	7	29	60	29-44	CL, SP	Firm, medium dense
T5S/R1W-35AB1	0	N/A	7	14.6	20	N/A	CL	stiff
T5S/R1W-35DB1	0	N/A	N/A	13	20	N/A	CL	stiff
T5S/R1W-35DB2	N/A	N/A	N/A	N/A	12	N/A	N/A	N/A
T5S/R1W-35FB1	N/A	N/A	N/A	N/A	10	N/A	N/A	N/A
T5S/R1W-35GB1	N/A	N/A	N/A	13	51.5	13-21	CL	stiff
T5S/R1W-35JB1	N/A	N/A	N/A	N/A	8.5	N/A	N/A	N/A
T5S/R1W-36E1	N/A	N/A	4	16	500	N/A	CL	N/A
T5S/R1W-36M1	N/A	N/A	4	17	408	N/A	CL	N/A
T5S/R1W-36E2	N/A	N/A	4	23	400	N/A	CL	N/A
T5S/R1W-36EB1	0	6	6	22	25	N/A	CL	stiff
T5S/R1W-36FB1	2	7	7	13.2	25	17.5-18.4	CL	stiff
T5S/R1W-36GB1	N/A	N/A	N/A	N/A	20.5	N/A	CL	very stiff
T5S/R1W-36GB2	N/A	N/A	N/A	N/A	15	N/A	CL	hard
T5S/R1W-36GB3	N/A	N/A	N/A	N/A	10	N/A	CL	hard
T5S/R1W-36GB4	N/A	N/A	N/A	N/A	15	N/A	CL	hard
T5S/R1W-36H1	N/A	N/A	N/A	N/A	368	N/A	CL	N/A
T5S/R1W-36J1	N/A	N/A	N/A	N/A	320	28-44, 57-60	CL	N/A
T5S/R1W-36LB1	N/A	N/A	1	14.5	51.5	6-9, 14.5-18.5	CL	very stiff

Discussion of Studies Available

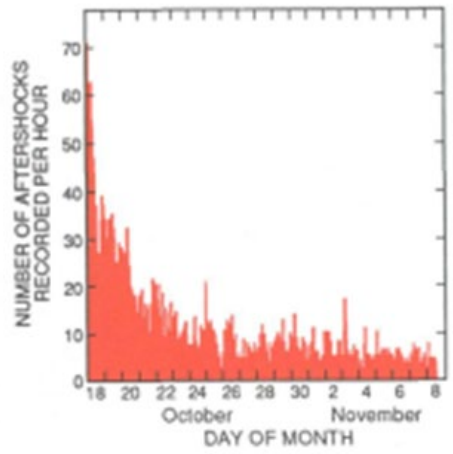
- Previous slides serve to display existing studies and information which exhibit understanding of subsurface properties and geotechnical condition within, below and around the Cargill berms.
  - Widespread presence of fine-grained Bay Mud
  - Berms historically constructed using Bay Mud Materials excavated from immediate vicinity.
  - Bay Mud thin (<5 feet thick) along boundary between salt ponds and thickens (35-40 feet) along outboard berms and the Bay.
  - Bay Mud underlain by alluvial deposits which include sand layers, silts and clays.

Seismic Performance - 1989 Loma Prieta Earthquake and Series of Aftershocks

Loma Prieta aftershocks

4,760 aftershocks of the Loma Prieta earthquake had been recorded by noon on November 7, 1989. The diminishing number of aftershocks with time is typical for large California earthquakes.

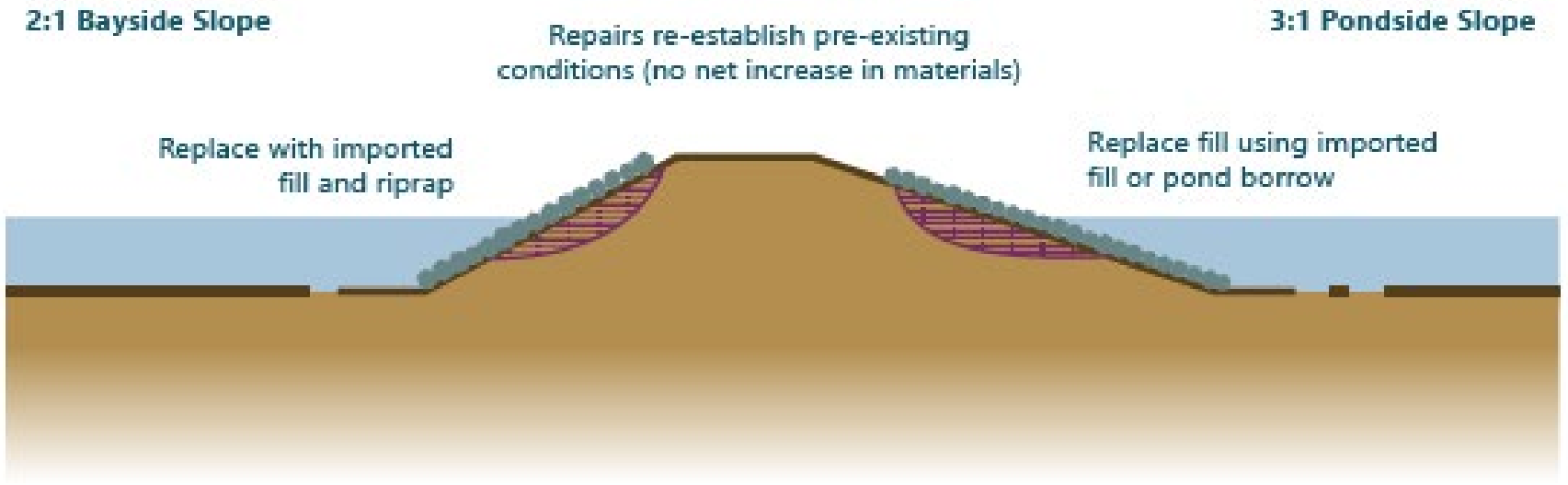
Magnitude	Number	Effect
5	2	Damaging
4	20	Strong
3	65	Perceptible
2	384	Not felt
1	1,855	Not felt
<1	2,434	Not felt
Total	4,760	



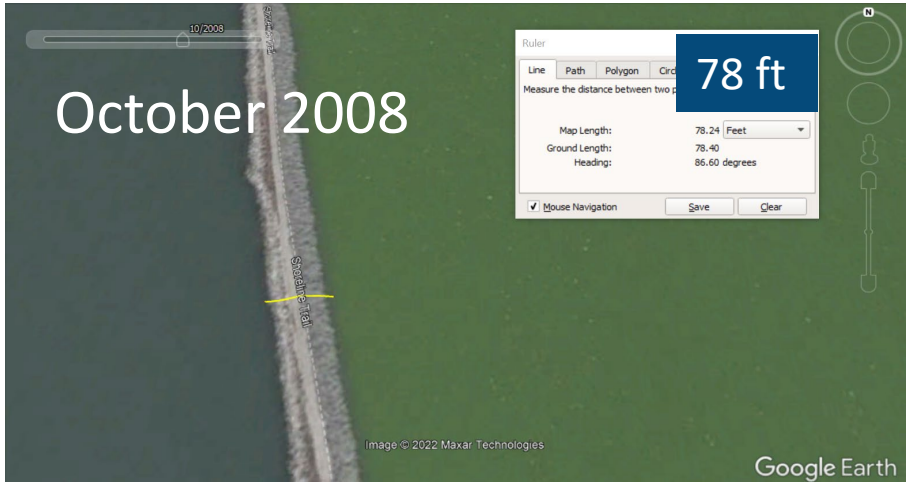
- The initial seismic event was followed by thousands of aftershocks taking place over a 3-week period.
- Following the event, Cargill identified only minor cracking and settling in occasional locations.
  - Difficult to extrapolate berm future performance, but Loma Prieta provided an important indicator of their overall resiliency.

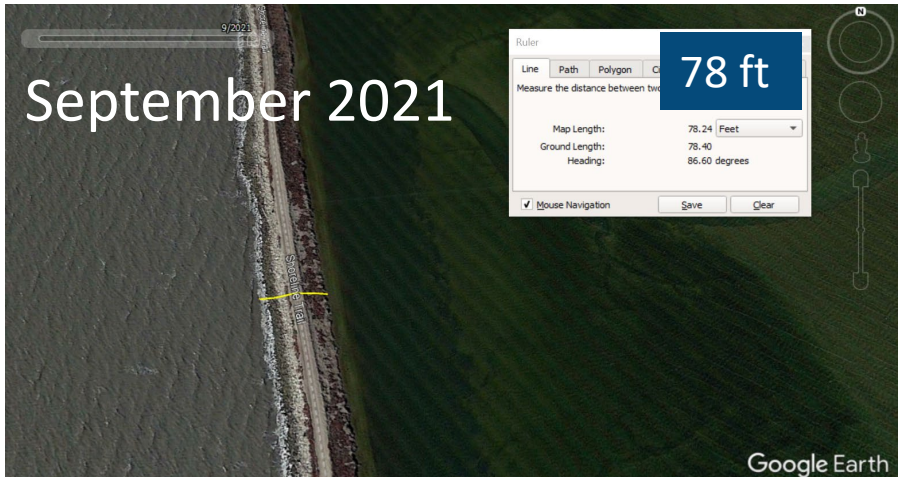
Slope Stability Expectations

- Slope Stability – Function of strength properties of the berm soil mass and underlying soils and the distribution of loading weight within the slope.
- Berm Performance to date suggests that the replacement of riprap facing has not caused a measurable change to overall stability levels.
- Cargill maintains berm faces at inclinations of 3 horizontal:1 vertical (3H:1V) or flatter (footprint and geometry never significantly change either).



Berm Footprint Maintained During Routine Maintenance – Google Earth Historical Visual Evaluation





Potential for Groundwater Seepage

- Factor for Long-term Berm Function
  - Impacting Performance as Separation Barriers and Undermining Stability
  - Prolonged Seepage would be evident of form of channels at berm base.

- Potential Water Seepage would be driven by differential pressure head – limited at Cargill Facility.
  - Fine-grained, low permeability composition of the underlying Bay Mud.
  - Small pore spaces of the silts and clays hinders water transmission.
  - Permeability range is .001-.00001 cm/sec while sand is .01-1 cm/sec.
- No evidence of seepage observed that would contribute to a breach or instability
  - Possible indicators of seepage observed leads to prioritization of maintenance

Conclusions

- The berms are structurally sound for their intended purpose.
  - Geotechnical Information collected at numerous salt ponds at Newark Facility allow for an understanding of the relevant subsurface characteristics in the region. Further investigations are not necessary.
  - Berms at Cargill site and elsewhere have maintained their integrity, stability and performance well over 50 years, including through seismic events, while also protecting against natural wave action.
  - Ongoing maintenance inspections are sufficient to understand berm stability and performance.
  - Current maintenance methods for berm repair activities will not result in significant changes to historical berm geometry or footprint over the period of repair work to date.
  - Therefore, it is reasonable to anticipate berms will continue their stability and display satisfactory operational performance.

Attachments

Cargill Permit Renewal Project Timeline (November 2017 – Present)

Date	Activity
November 7, 2017	Meeting at BCDC office to discuss maintenance permit renewal
January 22, 2018	Amendment No. 18 – BCDC extends permit to December 31, 2019
June 22, 2018	Cargill sends Project Description to BCDC
November 29, 2018	Meeting at BCDC office to discuss maintenance permit renewal
October 16, 2019	Meeting at BCDC office to discuss progress of permit renewal, with a brief presentation from AECOM about proposed SLR vulnerability and adaptation study
December 17, 2019	Amendment No. 19 – BCDC extends permit to December 31, 2021
January 30, 2020	RFP/RFQ to develop CEQA documentation sent out to consultants
February 27, 2020	CEQA Technical Proposals received
April 3, 2020	BCDC notifies Cargill that GAIA Consulting has been selected as the CEQA Analysis Consultant
May 27, 2020	CEQA Kick-off Meeting with GAIA, BCDC, and Cargill
June 11, 2020	Cargill sends Sea Level Rise Assessment to GAIA and BCDC

Cargill Permit Renewal Project Timeline (November 2017 – Present)

Date	Activity
June – August 2020	CEQA NOP is drafted, revised, and posted for public comment.
July 2020 – Present	Administrative Draft of Environmental Assessment is drafted and revised
September 2020	NOP public comment period ends, and comments are received.
April 28, 2021	Cargill officially submits permit application package for Solar Sea Salt System Maintenance and Operations Project to BCDC.
June 4, 2021	BCDC sends request for information (RFI) letter to permit application
September 8, 2021	Cargill sends response letter to BCDC's June 4, 2021 RFI letter.
October 15, 2021	BCDC sends 2nd RFI letter.
November 15, 2021	Cargill sends response letter to BCDC's 2nd October 15, 2021 RFI letter.
December 7, 2021	Amendment No. 20 – BCDC extends permit through December 31, 2022.

Cargill Permit Renewal Project Timeline (November 2017 – Present)

Date	Activity
March 4, 2022	BCDC site visit at Cargill
April 1, 2022	Cargill submits white paper on analysis of repurposed concrete rip rap
April 1, 2022	Cargill submits white paper on analysis of geotechnical and seismic berm integrity
May 2, 2022	BCDC sends response to Cargill's April 1st technical white paper submission.
July 19, 2022	BCDC sends response to Cargill's technical white paper submission for geotechnical and seismic and proposes a brainstorming session with the ECRB.
September 5, 2022	Cargill sends BCDC a technical analysis of placement of rip rap to maintain berms.
October 4, 2022	Cargill and BCDC agree to postpone October 19 ECRB meeting to allow for additional coordination on ECRB package submission.
November 16, 2022	ECRB Presentation and Discussion

Discussion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the world
thrive