THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Board Report

Bay-Delta Resources Group

- **Delta Islands Strategic, Fiscal, and Risk Analysis**

Summary

In 2016, the Metropolitan Board approved the purchase of all or part of five islands, approximately 20,400 acres, in the Sacramento-San Joaquin Delta. The focus of this land purchase was to enhance implementation of the Board's Bay-Delta policies, including improving water supply reliability, advancing ecosystem restoration, reducing subsidence, and managing the effects of climate change.

Since the purchase of these islands, staff has appeared before the Board to provide an overview of improvement projects that are being undertaken, grant funding that is being secured, and collaborative efforts with local non-governmental organizations, university experts, and county, state, and federal agencies.

In 2023, the Board requested staff conduct a strategic, fiscal, and risk analysis of the Delta islands to assess the financial resources, identify potential threats to the Delta islands, and evaluate the value of these islands to Metropolitan. Attached is a board report to address that request.

Purpose

Informational

Attachments

Attachment - Delta Islands Strategic, Fiscal, and Risk Analysis

Detailed Report

See Attachment

Date of Report: 2/13/2024

DELTA ISLANDS

STRATEGIC, FISCAL, AND RISK ANALYSIS

February 2024

The Metropolitan Water District of Southern California

Table of Contents

List of Tables

List of Figures

EXECUTIVE SUMMARY

Overview

In 2016, Metropolitan purchased all or part of five islands, approximately 20,400 acres, in the Sacramento-San Joaquin Delta. The focus of this land purchase was to enhance implementation of the Metropolitan Board of Directors' (Board) Bay-Delta policies, including improving water supply reliability, advancing ecosystem restoration, and managing the effects of climate change.

Since the purchase of these islands, staff has appeared before the Board to provide an overview of activities and updates on improvement projects that are being undertaken. In addition, staff has been diligent in securing grant funds and working with a collaborative group of non-governmental organizations and university experts in furthering the development of these efforts.

This white paper provides details on an initial strategic, fiscal, and risk analysis of the Delta islands and a proposed approach for Board discussion on managing the resource.

Key Board Questions

The Board asked staff to analyze and report on the following key issues and questions, including:

- If the islands are not needed for the Delta Conveyance Project (DCP), what is the value of owning them?
- What is the current property value?
- If a levee fails, what is Metropolitan's financial exposure?
- Who else is contributing to the security of these islands and levees?
- Is a self-sustaining (or better) revenue model achievable?
- If Metropolitan can propagate Delta smelt on the islands, could water export regulatory criteria be relaxed?

Improvement Projects and Grants

These islands have provided an opportunity to implement new approaches on how the Delta could be managed. **Table 1** provides a summary of the projects that are completed, ongoing, or under consideration on Metropolitan's Delta islands.

Table 1 – Improvement Projects & Grants

IMPROVEMENT PROJECTS & GRANTS		
Completed	**Ongoing**	**Under Consideration**
$87 million in grants received/approved	Delta Smelt natural propagation	Multi-benefit farming
15 miles of levee improvements	Webb Tract landscape restoration	Carbon Sequestration
First on-island flood fight depot	New modern levee design	Eco-mitigation banking
First real-time levee early warning system	Floating wetland research	Clean energy production integration
First to fully install on-line water diversion meters	Subsidence control program	Waterfowl recreation and preservation
Collaborative Delta Islands landscape planning process	Riverine restoration project	Carbon capture and underground storage
	Aquatic research	Paludiculture farming
	Tribal and NGO engagement	Community farms and education program

Strategic Considerations for Board Discussion

The initial key findings of the fiscal and risk analysis indicate that:

- Land appraisal is below the 2016 purchase price;
- Debt service is interest only until 2041;
- Current revenues do not cover expenses; however, forecasted revenues exceed annual expenses by 2030;
- Real-time levee monitoring allows for early warning from weeks to months in advance;
- Mitigation actions will continue to reduce risks with island ownership and compliment efforts to address Delta challenges; and
- Based on current appraisal, selling the islands now would require a significant use of existing reserves to pay off the loan.

The initial key findings of the strategic analysis indicate that:

- Conditions have evolved since the purchase, but still consistent with board policies;
- The Delta is important to southern California's water supply;
- Island levees are vital to water supply and quality, to protect Delta communities, and to ensure ecosystem stability and climate resiliency; and
- Island ownership provides enhanced opportunities to advance Delta solutions.

In summary, Metropolitan's opportunities have evolved and changed since the purchase of the islands. The islands provide an opportunity for Metropolitan to advance solutions to critical Delta challenges and enhance implementation of the Board's Bay-Delta policies.

# # #

INTRODUCTION

The Sacramento-San Joaquin Delta is a crucial and complex system that plays a vital role in the state's water supply, agricultural industry, and aquatic and terrestrial ecosystem. Given its importance to Metropolitan, and Metropolitan's ownership of islands in the Delta, the Board requested staff conduct a comprehensive strategic, fiscal, and risk analysis to ensure sustainable management and development of the islands in a fiscally responsible approach.

The strategic analysis involved examining the Board's Bay-Delta policies, challenges facing the region, and opportunities to enhance the resource. It also analyzed scheduled milestones and inflection points for the Board to discuss whether to proceed with action, continue to invest in, or divest the Delta islands.

Additionally, a fiscal analysis was conducted to assess the financial resources required to support the maintenance, restoration, and improvement of the Delta islands. This involved evaluating budget allocations, funding sources, and cost-benefit analyses for proposed projects and initiatives.

Lastly, a risk analysis was performed to identify potential threats to the Delta islands, such as climate change, flooding, seismic activities, and habitat destruction. This analysis involved developing strategies to mitigate these risks and ensure the long-term resilience of the many island resources.

STRATEGIC VALUE ANALYSIS

Summary

The Sacramento-San Joaquin Delta is a vital and historically significant region in California. The Delta has been a critical source of water for agriculture, industry, and residential use for over a century. Metropolitan is dependent on the reliability of the Delta's levees and islands to ensure that its State Water Project (SWP) storage in northern California is conveyed, without outages, to its southern California service area.

In 2016, the Board's strategy for purchasing of islands in the Delta included: (1) support for the proposed California WaterFix Delta conveyance project mitigation and tunnel portal site implementation; (2) improved through-Delta reliability and reduced risks of levee failures; (3) limiting Delta land subsidence and enhancing carbon sequestration; (4) advancing ecosystem restoration and regenerative agriculture; and (5) conducting applied science for endemic, aquatic, and terrestrial species.

Since 2016, new opportunities are being pursued including: (1) real-time levee monitoring technologies that reduce maintenance costs and failure risks; (2) Delta smelt natural propagation in island ponds to improve species population and reduce water diversion regulatory risks; and (3) landscape restoration to enhance ecosystem, limit land subsidence, and develop carbon sequestration opportunities.

Recently, In December 2023, the California Department of Water Resources (DWR) approved the proposed DCP that identifies a change in the alignment of the water conveyance tunnel eliminating the need for Metropolitan's islands to be used for tunnel portal sites. Metropolitan's islands are still to be considered for DCP habitat mitigation sites.

Given the changing focus and new opportunities related to Metropolitan's Delta islands, staff has identified the following key findings for Board discussion:

- Changes and opportunities have evolved since the purchase, but still consistent with board policies;
- The Delta is important to southern California's water supply given the continued focus on using the freshwater pathway for our water conveyance;
- Island ownership presents enhanced opportunities to advance solutions to Delta's challenges;
- Island levees are vital to secure water supply and quality for those in and south of the Delta, to protect Delta communities, and to ensure ecosystem stability and climate resiliency. In addition, Delta Island ownership provides the ability to develop valuable improvement tools like real-time early warning

levee monitoring, Delta smelt natural propagation, ecosystem-based subsidence control, large-scale carbon sequestration, and new food sources for native aquatic and terrestrial species;

- The proposed improvement projects and changes to agricultural lease strategies are forecasted to generate revenues that exceed annual expenses by approximately 2030;
- Real-time levee monitoring allows for early warning from weeks to months in advance;
- Mitigation actions will continue to reduce risks with island ownership and compliment efforts to address Delta challenges; and
- Based on current appraisal, selling the islands now would require a significant use of existing reserves to pay off the loan.

The considerations for Board discussion summarized above include a commitment to regular check-ins for the Board.

The following is a summary of the Delta islands fiscal analysis. The analysis uses information from historical and current sources, and utilizes experts from universities, state and federal agencies, and consulting firms to assess and forecast the fiscal costs and revenues from existing and proposed projects under consideration. Additional details of the analysis are included in the following report sections.

Property Valuation

In late 2023, an independent property appraisal was conducted on each of Metropolitan's four Delta-island properties, not including Metropolitan's portion of Chipps Island, which was sold to DWR in 2021. The appraisal indicated that property values on all four Delta Islands are below the original purchase price in 2016. The appraisals, including Chipps Island, total $138 million in 2023 compared to the purchase price of $175 million in 2016.

Although individual island appraisals varied, the appraised land value per acre averaged over all properties (20,404 acres) is $6,760 per acre in 2023, compared to an average purchase price of $8,650 per acre in 2016.

Expenses

The current expenses for the islands include debt service, property taxes, Reclamation District (RD) assessments, vector control, repairs and maintenance, labor and professional services, and travel and incidentals. These expenses currently total an average of $7.8 million per year and are forecasted in year 2030 to range between $7 million and $13 million per year.

Long-term debt service (including interest and principal) is approximately 54 percent of the total expenses for the four islands, with taxes at 19 percent and RD assessments at 18 percent. The remainder 9 percent includes vector control, repairs and maintenance, labor and professional services, and travel and incidentals.

Revenues

The current revenue for the islands includes agricultural and cell tower leases. These revenues total an average of $900,000 per year (based on a three-year average from 2021 through 2023). Forecasted revenues include additional proposed projects under consideration such as longer-term agricultural leases, carbon sequestration, ecosystem mitigation banking, waterfowl recreation and preservation, and clean energy production. The analysis projects that, if several of the proposed projects under consideration are

implemented, the forecasted revenue would increase by year 2030 to a range of $12 million to $20 million per year.

In addition to revenue opportunities, an analysis has been conducted by staff and independent experts on the development of carbon capture and underground storage opportunities in the Delta. The analysis indicates that geological storage formations under Metropolitan's islands are well suited for storage of carbon dioxide (CO_2) from industrial facilities and, if implemented, Metropolitan's share of the forecasted revenue ranges from $112 million to $271 million per year by approximately year 2030.

Grant Revenues. Since the purchase of the Delta islands, Metropolitan has received or has been approved for approximately $87 million in grants from county and state agencies. **Table 2** below provides a breakdown of the grants received to date. It includes levee funding grants for levee improvements, emergency response planning and supplies, collaborative landscape planning, habitat restoration, and Delta ferry repair and maintenance.

Table 2 – Delta Island Grants (received or approved)

DELTA ISLAND GRANTS (Received/Approved)		
Levee Improvements Grants ($50.8 Million)		
Bacon Island West Levee (completed)	RD 2028	$14.5 million
Bouldin Island North Levee (construction 2022-23)	RD 756	$15.8 million
Bacon Island North Levee (construction 2023-24)	RD 2028	$5.7 million
Bacon Island South Levee (construction 2023-24)	RD 2028	$3.8 million
Levee Maintenance – All Islands (~ $0.5 million/yr. x 7 years)	All RDs	$3.5 million
Bouldin Island Southwest Levee (construction 2025-26)	RD 756	$7.5 million
Emergency Response Planning and Supplies Grants ($1.5 million)		
Bouldin Island Emergency Supply Depot (construction 2022-23)	RD 756	$1.2 million
DWR Emergency Supply Material Replenishment (completed)	All RDs	$200,000
Five-Year Plan – Bacon, Bouldin, Webb, Holland ($35,000 per island)	All RDs	$140,000
Collaborative Landscape Planning Grant ($1.1 million)		
Landscape Collaboration Grant (CDFW Prop 1, in process)	Metropolitan	$1.1 million
Habitat Restoration Grant ($32.3 million)		
Bouldin Island West Levee Setback (in design; construction 2024-25)	RD 756	$11.4 million
Webb Tract Restoration and Rice (in design; construction 2025-26)	Metropolitan	$20.9 million
Delta Ferry Authority Grant ($0.8 million)		
Webb Tract Ferry Vessel Repair and Upgrade	RD 2026	$800,000
TOTAL		**$86.6 million**

FISCAL ANALYSIS

PROPERTY VALUATION

Overview

In 2016, the Metropolitan Water District purchased five properties (**Figure 1**) totaling approximately 20,400 acres (32 square miles) in the Sacramento-San Joaquin Delta and Suisun Marsh region. The properties — a portion of Chipps Island, all of Webb Tract, Bouldin Island and Bacon Island, and most of Holland Tract — were purchased from Zurich Insurance and its subsidiary Delta Wetlands Properties to assist in meeting Metropolitan's Board policies related to water supply reliability, habitat restoration, carbon sequestration and subsidence reversal. The properties are located along major portions of the key conveyance channels that convey urban and agricultural water supplies from north of Delta storage to federal and state export facilities located in the south Delta. The properties are currently primarily used for agricultural purposes (predominantly corn, alfalfa, wheat, and triticale). The facilities on the properties include approximately 57 structures (barns, maintenance buildings, farm housing), highway and county roads, automobile bridges, boat docks, water discharge pumps, intake siphons, and an automobile ferry.

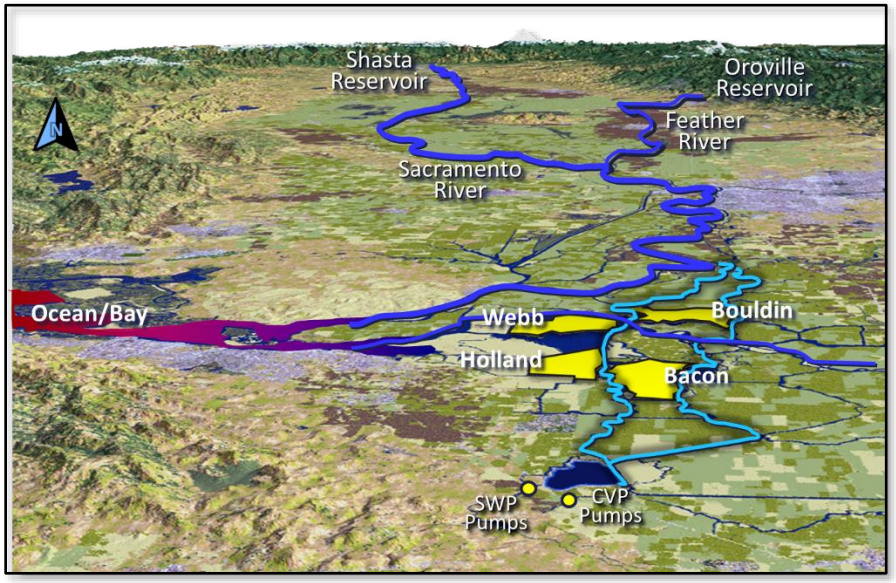

Figure 1 – Delta Islands Map

Investment Opportunities

The five properties were purchased for $175 million, and bond financed with an interest only loan, with principal debt payable in 2041 through 2044. In 2021, the Board authorized the sale of Metropolitan's

roughly half of Chipps Island to DWR for $972,000 to allow development of aquatic habitat restoration that would assist in meeting the requirements under the 2008 Delta smelt biological opinion.

In 2023, an updated land valuation was conducted by an independent land appraiser to assess the change of land value since the property purchase in 2016. This land valuation assessment was dependent on factors such as market conditions, location, physical characteristics, permanent crop suitability, farmable land, etc.

Fiscal Analysis

Updated land values were conducted by an independent appraiser in the Fall of 2023. These appraisals were based on the existing agricultural uses of Metropolitan's Delta Islands and did not include an analysis of utility value or future long-term revenue potential.

Delta Islands Valuation. Land value appraisals were prepared by a licensed independent appraiser for each of the four Metropolitan-owned islands. These appraisals reviewed several property sales located on Ryer Island, Orwood Tract, Liberty Island, Venice Island, Union Island, and Brannan Island from 2018 through late 2022. The adjusted comparable sales ranged from $6,777 to $13,490 per acre for Bacon and Bouldin, and $1,293 to $11,726 per acre for Holland and Webb. The difference in the land valuation comparable sales range was dependent on factors such as market conditions, location, and physical characteristics (e.g., percentage of farmable land, permanent crop adaptability and suitability etc.).

Due to high levels of subsidence, Metropolitan's Delta Islands are currently unsuitable for permanent crops. This results in a downward adjustment in value rendering the islands inferior compared to some of the 2018-2022 comparable sales at the top end of the range.

Land Value Appraisals. **Table 3** includes the 2023 land appraisal compared to the 2016 purchase price:

Table 3 – Delta Islands Property Value Analysis

Island	Gross Acres	Valuation (per acre)		Total	
		Purchase	Current	Purchase[1]	Current[2]
Bouldin	6,053	$8,650	$8,000	$52.4 million	$48.4 million
Webb	5,498	$8,650	$5,000	$47.6 million	$27.5 million
Bacon	5,603	$8,650	$8,000	$48.5 million	$44.8 million
Holland	3,007	$8,650	$5,500	$26.0 million	$16.5 million
Chipps[3]	243	$2,469	$4,000	$ 0.6 million	$0.97 million
TOTAL	**20,404**	---	---	**$175 million**	**$138 million**

[1] Purchase price does not include legal & other associated costs.
[2] Bouldin and Bacon appraisals completed November 2023; Webb and Holland appraisals completed December 2023
[3] Chipps was sold to the California Department of Water Resources in 2021 for $972,000

Overview

Metropolitan's five islands in the Sacramento-San Joaquin Delta span over 20,404 acres (32 square miles) and include over 70 structures, state highways/county roads, automobile bridges, farm housing, boat docks, water discharge pumps, siphon water intakes, and an automobile ferry. Currently, the properties are primarily used for agricultural purposes (predominantly corn, alfalfa, wheat, and triticale) and scientific research. Each island has a separate RD that oversees the maintenance and improvement of 56 miles of levees, and operation and maintenance of 88 water diversion siphons, 9 pump discharge stations, and approximately 100 miles of water distribution and drainage canals.

Fiscal Analysis

The current expenses for the islands include debt service, property taxes, RD assessments, vector control, repairs and maintenance, labor and professional services, and incidentals. These expenses currently total an average of $7.8 million per year and are forecasted in year 2030 to range between $6.5 million and $13.3 million per year depending on debt service interest rates.

Debt service and taxes are approximately 73 percent of the total expenses, with RD assessments at approximately 18 percent. Other expenses, such as repairs, labor, professional services, vector control, and incidentals, round out the remainder of the expense budget.

Table 4 presents the total annual expenses of the four Delta islands separated by expenses centers. It compares the current three-year average (years 2021-23) with a forecasted low and high range of expenses in year 2030.

Table 4 – Total Annual Expenses Forecast by Source

ANNUAL EXPENSES Estimate			
Expense Centers	**Current** Year 2021-23 (Average)	**Forecast** Year 2030 (Low-High Range)	
Debt Service	$2,458,000	$542,000	$6,063,000
Property Taxes	$2,074,000	$2,296,000	$2,806,000
RD Assessment	$2,283,000	$2,527,000	$3,089,000
Vector Control/State Lands	$67,000	$75,000	$91,000

Repairs & Maintenance	$167,000	$184,000	$225,000
Labor & Professional Service	$722,000	$800,000	$977,000
Travel & Incidentals	$29,000	$32,000	$40,000
TOTAL ESTIMATE	**$7.8 million**	**$6.5 million**	**$13.3 million**

Table 5 represents total annual expenses detailed for each of the four Delta Islands. It compares the current three-year average (years 2021-23) with a forecasted low and high range of expenses in year 2030.

Table 5 – Total Annual Expenses Forecast by Island

ANNUAL EXPENSES Estimate			
Delta Island	**Current Year 2021-23** (Average)	**Forecast Year 2030** (Low-High Range)	
Bouldin	$2,585,000	$2,207,000	$4,319,000
Webb	$1,893,000	$2,023,000	$3,307,000
Holland	$989,000	$1,055,000	$1,746,000
Bacon	$2,335,000	$2,512,000	$3,920,000
TOTAL ESTIMATE	**$7.8 million**	**$6.5 million**	**$13.3 million**

Figure 2 represents total cumulative expenses, both actual and forecasted, of the four Delta islands. Each bar in the chart represents the cumulative total from Year 1 (i.e., the purchase date of the islands) through the year indicated on the chart's horizontal axis. Principal payments on the loan debt service begin in year 2041 through 2045.

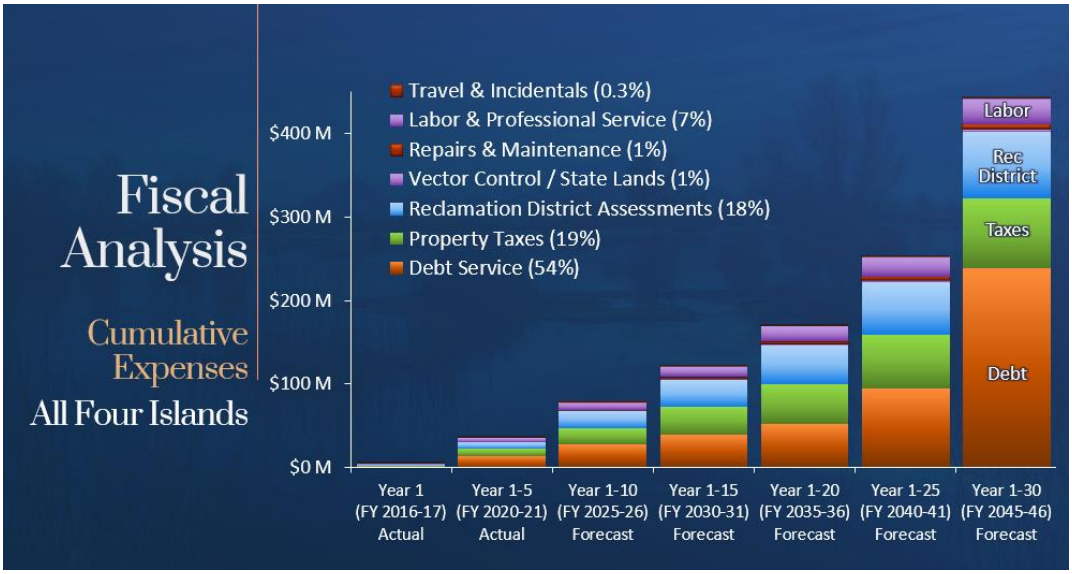

Figure 2 – Total Cumulative Expenses, Actual and Forecasted

Overview

All of Metropolitan's agricultural leases, which now encompass 20,161 gross acres, are due to expire in 2024 (Webb Tract) and 2025 (Bouldin Island, Holland Tract, and Bacon Island). This offers an unprecedented opportunity to develop leases that focus on reducing subsidence at a larger scale and improving the long-term infrastructure of Metropolitan's lands. These leases will, therefore, play an important role in safeguarding Metropolitan's water supply reliability, reducing levee risks, and improving the health of the Delta ecosystem over time, while generating a long-term revenue source for Metropolitan.

When Metropolitan acquired the Delta Islands in 2016, staff's initial land use strategy established short-term renewals with the growers whose leases Metropolitan assumed at the time of purchase. This approach aligned with the Board's Delta Island strategy discussions, but eventually resulted in below-market revenues due to the short-term nature of the leases.

The recent December 2023 approval of the DCP represents a significant change in the alignment of the conveyance tunnel and eliminated the need for Metropolitan's islands to be used for tunnel portal sites (Metropolitan's islands are still being considered for DCP habitat mitigation sites, but a fraction of the total acreage will now be required). Considering the changing focus and new opportunities for the Delta Islands, staff is now proposing for board discussion on an adaptive, multi-benefit strategy that includes longer-term leases with crops (e.g., rice) that can halt/reverse subsidence, reduce greenhouse gas emissions, and enhance revenues.

Investment opportunities will center on preserving agriculture and working with Delta growers who are interested in expanding their crop portfolio to include rice and, in the future, other subsidence-reducing crops. With the introduction of a hybrid-seed variety more suitable to the Delta region's climate, rice has increased over the last few years in the Delta (**Table 8**).

A marshland crop, rice has the added benefit of contributing to the restoration of the Delta ecosystem, including reducing greenhouse gas (GHG) emissions through sustainable rice residue practices, bolstering needed habitat within the Pacific Flyway during bird migration season, and increasing habitat for waterfowl and other species, including species that are of special concern, threatened and endangered.

A total of 16,767 acres are currently farmed on Metropolitan's islands by five growers. Crops include corn, alfalfa, safflower, wheat, triticale, oats, and pasture (grazing). Historic agricultural crops also included sorghum, wheat oats, fruit, mixed vegetables, and rice (**Table 6**).

Table 6 – 2023 Total Farmed Acres[4]

	Bouldin	Webb	Holland	Bacon	TOTAL
Crops/Grazing	5,262	5,081	2,647	5,098	**16,767**

Investment Opportunities

Metropolitan's efforts to reduce subsidence through farming began in early 2022. Approximately 1,500 acres of corn, the highest subsiding crop in the Delta, were replaced with a grazing-only lease on Webb Tract. Upon board approval, and under the auspices of the recently approved $20.9 million Delta Conservancy grant, grazing will be replaced with rice crops and managed wetlands. In 2023, 400 acres of corn on Holland Tract were replaced with grazing while staff works on developing a longer-term lease with the tenant to cultivate rice on suitable acreage. Board action for approval of the longer-term lease is expected in the Spring of 2024.

Corn-to-rice conversions on each of Metropolitan's islands were recently assessed, and approximately 7,400 acres are estimated to be suitable for rice, with acreage being phased in beginning in 2024 (Holland) and 2025 (Bacon, Bouldin, and Webb) until total production is achieved in 2030-31 (**Table 7**).

Table 7 – Projected Land Use Acreages by 2030-31

	Bouldin	Webb	Holland	Bacon	TOTAL
Rice	2,735	1,500	1,005	2,136	7,376
Non-Rice (Crops/Grazing)	2,527	--	402	2,962	5,891
Managed Wetlands	--	3,500	--	--	3,500
TOTAL	**5,262**	**5,000**	**1,407**	**5,098**	**16,767**

'First tier' rice (7,376 acres) has been designated for its overall crop suitability, including the ability to efficiently convert corn ground to rice fields. Incremental 'second tier' acres could possibly be identified and selected after the first-tier acreage is established. However, the cost of conversion likely would be higher and, therefore, less attractive to growers. In consultation with Metropolitan's lessees, rice growers, and other subject-matter experts, each island's rice crop suitability was determined by evaluating a variety of factors, including, but not limited to, soil type and quality, topography, micro-climate, drainage and field location, and crop history.

While total rice acreage in the Delta is small compared to that in the Sacramento Valley where 95 percent of the state's rice is grown, the market has grown steadily over the last several years. The recent loss of Sacramento Valley rice acreage (2020 - 2022), the introduction of an improved hybrid-seed variety that can

[4] USDA Farm Service Agency Reports of Commodities (FSA-578) for Bacon Island, Bouldin Island, Webb Tract, and Holland Tract, 2023.

withstand the Delta region's cooler temperatures, and private-sector market incentives for Delta growers to grow more rice, are some of the factors that have contributed to this commodity growth (**Table 8**).

Table 8 – Delta Rice Acreage and Annual Yields[5]

	2017	2018	2019	2020	2021	2022
Rice Acreage	3,060	3,620	4,360	4,990	7,070	8,930
Average Yield	82	86	81	88	95	101

If approved, Metropolitan's rice acres would have a significant impact on the total rice acres currently grown in the Delta.

Fiscal Analysis

Revenue Structure for Rice. Lease rents in the agriculture sector are generally structured as either cash, crop share, or flexible rent. Metropolitan's leases are currently based on cash rent, e.g., fixed rents that are paid in advance. Cash rent is predictable, poses no risk to the lessor, and is Metropolitan's preferred type of rent for leases. The drawback is that cash rent tends to generate lower revenue than other agricultural rent methods.

Crop share rent is paid based on a percentage of the grower's annual yield and requires lessor and lessee to also share operating expenses (e.g., fertilizer, etc.). While crop share rent can result in higher overall revenue over time, due to the non-fixed nature of crop sharing, it exposes the lessor to cash flow volatility and crop price risk.

Flexible or "flex" rent is also based on a grower's annual yield, however, it requires the lessor to be paid a minimum fixed-rent amount, which is lower than a standard cash rent would be, in addition to getting a percentage of the revenue the grower receives from their annual crop yield that is lower than if it was a crop share rent. The flex rent structure guarantees a minimum fixed rent while still allowing the lessor to profit from higher revenues associated with a good crop yield. In addition, the lessor does not share expenses with the grower.

There is an inherent risk when considering rent based on a grower's annual yields. For instance, severe weather, crop failures, and other factors could result in commodity price declines. However, in California, where rice prices are more resilient and crop profitability has remained stable over time, rent based on annual yields has historically generated higher revenues when compared to cash rent. Flex rent is, therefore, being considered for rice crops on Metropolitan's islands because it could significantly increase revenues without incurring an annual outlay of expenses and associated risks.

[5] San Joaquin County Agricultural Commissioner's Office, 2017 – 2022 Crop Reports, Districts G and I; UC Rice Research and Information Center.

Revenue Structure for Other Crops. Cash rent would continue to be utilized for non-rice crops because of its stability, low risk, and ease of administration.

Projected Annual Revenues. **Table 9** below shows the potential range of annual revenues for long-term leases utilizing the flex rent structure for rice, with acreage increasing annually beginning in 2024 on Holland Tract and annual increases for the remaining islands beginning in 2025, until full rice production is achieved in 2030-31. Conversely, projected revenues for crops other than rice show an annual decrease over the same timeframe due to the phased elimination of subsiding corn crops.

Table 9 – Actual vs. Projected Agricultural Annual Revenues

FY 2022-23 Actual	FY 2023-24 Forecast	FY 2024-25 Forecast	FY 2025-26 Forecast	FY 2026-27 Forecast	FY 2027-28 Forecast	FY 2028-29 Forecast	FY 2029-30 Forecast	FY 2030-31 Forecast
$ 0	$ 0	$ 136,750	$ 374,668	$ 677,270	$ 981,452	$ 1,113,107	$ 1,146,500	$ 1,180,895
$ 0	$ 0	$ 45,000	$ 145,638	$ 274,657	$ 411,869	$ 488,383	$ 503,035	$ 518,126
$ 0	$ 29,850	$ 115,857	$ 226,950	$ 351,016	$ 432,419	$ 445,392	$ 458,753	$ 472,516
$ 0	$ 0	$ 96,120	$ 279,261	$ 512,919	$ 753,152	$ 869,322	$ 895,402	$ 922,264
$ 0	**$ 29,850**	**$ 393,727**	**$ 1,026,517**	**$ 1,815,862**	**$ 2,578,892**	**$ 2,916,205**	**$ 3,003,691**	**$ 3,093,802**
$ 399,179	$ 409,551	$ 1,178,793	$ 1,038,026	$ 851,683	$ 690,377	$ 504,509	$ 519,645	$ 535,234
$ 106,000	$ 106,000	$ 109,180	$ 112,455	$ 114,705	$ 87,749	$ 89,504	$ 0	$ 0
$ 89,900	$ 117,000	$ 105,060	$ 60,471	$ 45,895	$ 47,271	$ 50,000	$ 51,500	$ 53,045
$ 156,818	$ 163,909	$ 1,064,475	$ 972,655	$ 848,826	$ 743,000	$ 765,290	$ 788,248	$ 811,896
$ 751,897	**$ 796,460**	**$ 2,457,508**	**$ 2,183,608**	**$ 1,861,108**	**$ 1,568,397**	**$ 1,409,303**	**$ 1,359,393**	**$ 1,400,175**
$ 751,897	**$ 826,310**	**$ 2,851,235**	**$ 3,210,124**	**$ 3,676,969**	**$ 4,147,289**	**$ 4,325,508**	**$ 4,363,084**	**$ 4,493,976**
$ 0	$ 0	$ 136,750	$ 599,608	$ 1,198,568	$ 1,876,348	$ 2,342,098	$ 2,412,361	$ 2,484,731
$ 0	$ 0	$ 45,000	$ 244,332	$ 503,380	$ 804,511	$ 1,027,611	$ 1,058,440	$ 1,090,193
$ 0	$ 29,850	$ 190,498	$ 400,413	$ 610,111	$ 628,414	$ 685,816	$ 895,746	$ 922,618
$ 0	$ 0	$ 96,120	$ 454,936	$ 920,046	$ 1,452,054	$ 1,829,148	$ 1,884,023	$ 1,940,543
$ 0	**$ 29,850**	**$ 468,368**	**$ 1,699,288**	**$ 3,232,105**	**$ 4,761,327**	**$ 5,884,674**	**$ 6,250,569**	**$ 6,438,086**
$ 399,179	$ 409,551	$ 1,178,793	$ 1,038,026	$ 851,683	$ 690,377	$ 504,509	$ 519,645	$ 535,234
$ 106,000	$ 106,000	$ 109,180	$ 112,455	$ 114,705	$ 87,749	$ 89,504	$ 0	$ 0
$ 89,900	$ 117,000	$ 105,060	$ 60,471	$ 45,895	$ 47,271	$ 50,000	$ 51,500	$ 53,045
$ 156,818	$ 163,909	$ 1,064,475	$ 972,655	$ 848,826	$ 743,000	$ 765,290	$ 788,248	$ 811,896
$ 751,897	**$ 796,460**	**$ 2,457,508**	**$ 2,183,608**	**$ 1,861,108**	**$ 1,568,397**	**$ 1,409,303**	**$ 1,359,393**	**$ 1,400,175**
$ 751,897	**$ 826,310**	**$ 2,925,875**	**$ 3,882,896**	**$ 5,093,213**	**$ 6,329,724**	**$ 7,293,977**	**$ 7,609,962**	**$ 7,838,261**

Lastly, the potential revenue range for rice reflects between a low-yield average of 60 CWT per acre and a high-yield average of 90 CWT[6] per acre. For context, historical average annual rice yields in the Delta region between 2009 – 2023 have been reported as low as 69 CWT per acre and as high as 101 CWT per acre.[7]

[6] The abbreviation "CWT" is technically defined as *centum* weight, meaning one hundredweight. An example: one ton of harvested rice (2,000 pounds) divided by 100 is equal to 20 CWT. CWT is typically used for grains (rice) and other agricultural crops that are traded in large-scale quantities.

[7] References: Wetlands Preservation Foundation, 2020 Delta Economics Seminar, 9-year rice yield averages (2009-2017); San Joaquin County Agricultural Commissioner's Office, 2017 – 2022 Crop Reports, Districts G and I; UC Rice Research and Information Center.

Table 10 – Annual Net Revenue Estimate - Agriculture

Delta Islands	Annual Net Revenue Estimate	
	Business as Usual 2030 Forecast	Proposed Approach 2030 Forecast
Bouldin Island	$511,000 – 624,000	$1.7 - $3.0 million
Webb Tract	$125,000 – 153,000	$0.5 - $1.0 million
Holland Tract	$73,000 – 90,000	$0.5 - $1.0 million
Bacon Island	$260,000 – 318,000	$1.8 - $2.8 million
TOTAL	**$1.0 – 1.1 million**	**$4.5 - $7.8 million**

Overview

Metropolitan assumed a cell tower lease on Bouldin Island upon purchase of the property. The subject wireless telecommunication facility is on the northern edge of Bouldin Island in San Joaquin County, just north of State Route 12, approximately 8 miles west of Interstate 5. The lease footprint at that time was 900-square-feet and accessible by an unpaved road that extends from Highway 12. The cellular tower consists of a 101-foot monopole and a raised platform.

Investment Opportunities

In 2021, the Board approved renegotiating with Crown Castle for its site-use rights to expand the footprint of the premises by an additional 900 square feet, extend the term of use, and obtain the right to sublicense space on the telecommunications tower subject to Metropolitan's approval and with additional fee payments.

Fiscal Analysis

The following **Table 11** is a summary of the fiscal analysis using year 2030 as a common reference year for all the current and proposed revenue opportunities. It assumes projected cell tower revenues with sublease in place.

Table 11 – Annual Net Revenue Comparison for Cell Tower Lease

Delta Islands	Annual Net Revenue Estimate	
	Business as Usual 2030 Forecast	Proposed Approach 2030 Forecast
Bouldin Island	$49,000	$49,000
Webb Tract	$0	$0
Holland Tract	$0	$0
Bacon Island	$0	$0
TOTAL	**$49,000**	**$49,000**

Overview

Metropolitan pays annual assessments to each RD based on ownership parcels and land use values. In the case of Bouldin Island (RD 756), Bacon Island (RD 2028), and Webb Tract (RD 2026), Metropolitan owns 100 percent of these properties. For Holland Tract, Metropolitan is one of seventeen owners and pays an apportionment of the associated annual assessment to RD 2025 for maintenance of this property.

The Delta Levees Maintenance Program (commonly referred to as Subventions Program) is an annual DWR cost share program that reimburses eligible costs for annual levee maintenance provided through the RD. DWR pays the RD up to 75 percent of reimbursement claims submitted. The remaining eligible and non-eligible claims are paid through the annual assessments provided by the owners of the properties.

Levees are structures that hold back water from a river. Over time, standards have been established for the Delta which define levee geometry and maintenance requirements. Levee standards include those governed by federal flood control regulations, specifically Title 33 of the Code of Federal Regulations, Section 208.10, and the USACE's Rehabilitation and Inspection Program established under Public Law 84-99 (PL 84-99). General characteristics (see **Figure 2**), standards, and existing requirements for Delta levees are discussed below:

- Hazard Mitigation Plan (HMP): This local levee configuration has been widely used in the Delta since the flood of 1986. The HMP configuration was established as the minimum standard of maintenance under which Delta levees would be eligible for Federal Emergency Management Agency (FEMA) emergency response and recovery assistance. This HMP-FEMA standard provides 1 foot of freeboard above the design requirement to protect against a 1 in 100-year flood event (or 1 percent annual chance of occurrence).

- Public Law (PL) 84-99: PL 84-99 guidance provides better flood protection than the HMP-FEMA standard. The PL 84-99 guidance flattens the levee side slope from those used for the HMP configuration and increases freeboard to 1.5 feet above the design requirement to protect against a 1 in 100-year flood event (or 1 percent annual chance of occurrence).

- DWR Bulletin 192-82: Bulletin 192-82 levee standard was designed where tides are a major consideration for establishing design flood elevations. Bulletin 192-82 guidelines produce a levee design similar to PL 84-99 guidelines with 1.5 feet of freeboard for rural levees, but it is designed to protect against a 1 in 300-year flood event (or 0.3 percent annual chance of occurrence).

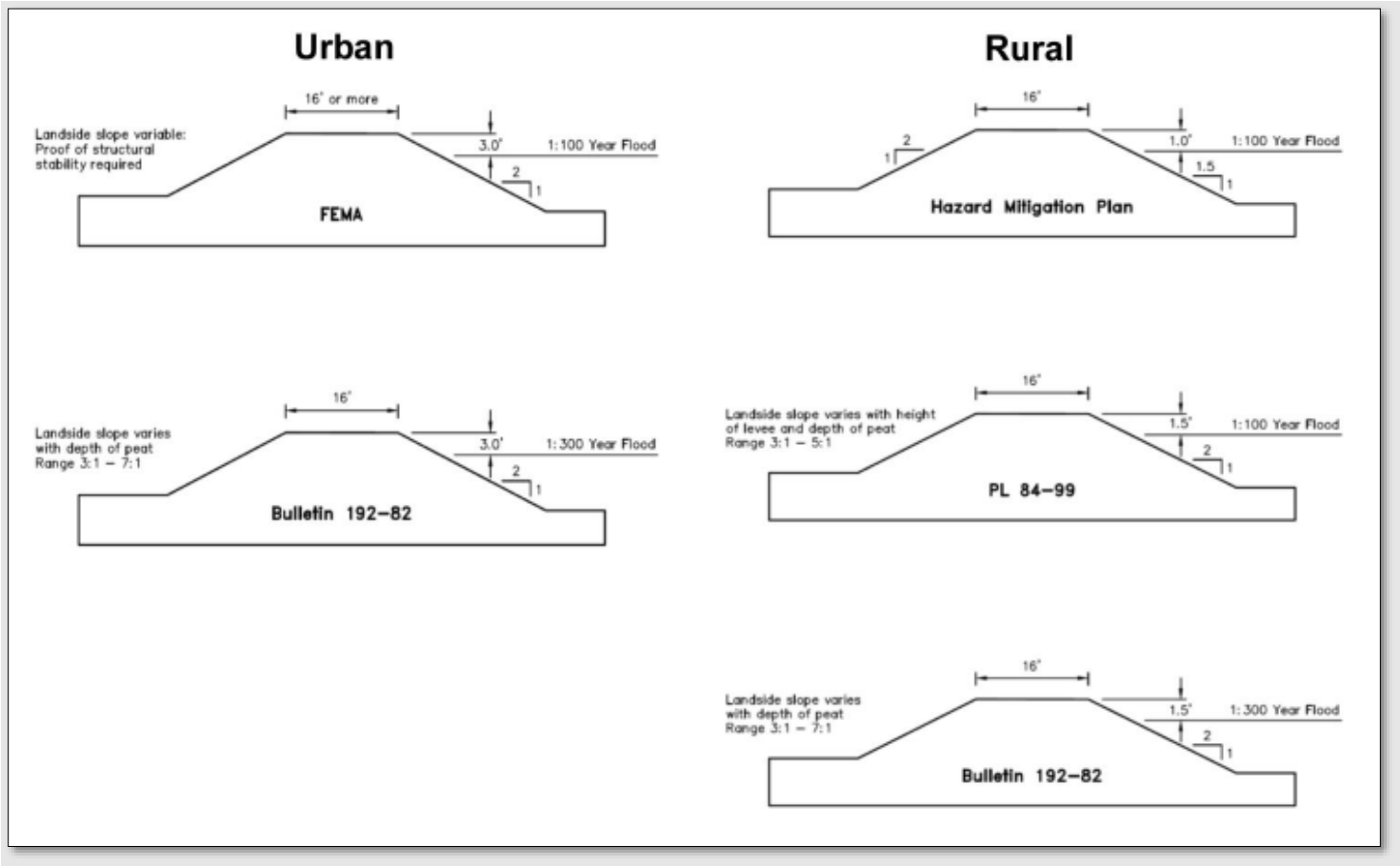

Figure 3 – Federal & State Delta Levee Standards

Investment Opportunities

The Subventions Program[8] is a cost share program (up to 75 percent of eligible costs) that provides technical and financial assistance to approximately 70 local Levee Maintaining Agencies (LMAs) in the Primary Delta[9] for the maintenance and rehabilitation of non-project and eligible project levees. The Subventions Program is authorized by California Water Code Sections 12980 through 12995 and is managed by the DWR for the Central Valley Flood Protection Board (CVFPB).[10]

The Subventions Program was originally authorized in 1973. The passage of the Disaster Preparedness and Flood Prevention Bond Act of 2006 (Proposition 1E) and the Safe Drinking Water, Water Quality and Supply,

[8] California, S. O. (n.d.). Delta levees maintenance subventions. https://water.ca.gov/Work-With-Us/Grants-And-Loans/Delta-Levees-Maintenance-Subventions

[9] Sacramento-San Joaquin Delta Land Use and Boundaries - Water Education Foundation. (2020, June 22). Water Education Foundation. https://www.watereducation.org/aquapedia/sacramento-san-joaquin-delta-land-use-and-boundaries

[10] California, S. O. (n.d.). Central Valley Flood Protection Board – State of California. https://cvfpb.ca.gov/

Flood Control, River, and Coastal Protection Bond Act of 2006 (Proposition 84) authorized DWR to make additional funds available for the program. Since the passage of Propositions 1E and 84, the state has invested approximately more than $245 million in flood control and habitat projects carried out by local levee maintenance agencies in the Delta under the program.

Fiscal Analysis

For Metropolitan's Delta Islands, RD 756,[11] RD 2025,[12] RD 2026,[13] and RD 2028[14] have the responsibility of operations and maintenance of each island's levee and infrastructure network (includes water conveyance system, siphons, and discharge pump stations). Each RD submits annual maintenance costs and receive reimbursements (up to 75 percent of eligible costs) through DWR's Delta Levees Maintenance Subventions Program. As described before, the funding sources are through the state's Propositions 1E and 84 provided under the Disaster Preparedness and Flood Prevention Bond Act of 2006.[15] The state is evaluating additional funding for years including and beyond FY 2024/25. Subventions Program funding for the period of fiscal year (FY) 2021/22 to FY 2023/24 are shown in **Table 12**.

Table 12 – State Delta Levees Maintenance Funding (Subventions Program)

	FY 2021-22	FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26
Delta wide[16]	$11.1 million	$12.5 million	$13 million	TBD	TBD
Metropolitan	$560,000	$576,000	TBD	TBD	TBD

[11] Bouldin Island Reclamation District 756. (n.d.). https://www.bouldinisland.org/
[12] Holland Tract Reclamation District 2025. (n.d.). https://hollandtract.org/
[13] Webb Tract Reclamation District 2026. (n.d.). https://webbtract.org/
[14] Bacon Island Reclamation District 2028. (n.d.). https://baconisland.org/
[15] Thue, C. (n.d.). Proposition 1E - CNRA Bond Accountability. https://bondaccountability.resources.ca.gov/p1e.aspx
[16] Annual Report to the DSC--State Funds Awarded for Delta Levee Improvement and Rehabilitation Projects, FY 19 (ca.gov)

Overview

The Delta Levees Special Flood Control Projects Program[17] (Special Projects Program) administered by the DWR provides grant funding to local LMAs in the Primary Delta and a portion of the Suisun Marsh for levee maintenance and improvement, and for habitat mitigation and enhancement.

The Special Projects Program works directly with LMAs to provide critical financial assistance for flood protection in the Delta. This funding protects and enhances the economic, environmental, and cultural resources in the Delta. The Special Projects Program provides grant funding to safeguard public benefits, including roads, utilities, urbanized areas, water quality, recreation, navigation and fish and wildlife from flood hazards. The Special Projects Program mitigates the habitat impacts of projects approved by DWR and ensures a net long-term habitat improvement in the Delta.

Investment Opportunities

To ensure protection of local and state interests in the Delta, the Special Projects Program was established in 1988 by the California State Legislature under Senate Bill (SB) 34 and later revised under SB 1065 (1991) and Assembly Bill (AB) 360 (1996). Since its inception the Special Projects Program has invested more than $300 million in the Delta for flood protection and related habitat projects. The Program was authorized originally to address flooding on the eight western Delta islands (i.e., Sherman Island, Twitchell Island, Jersey Island, Bradford Island, Webb Tract, Hotchkiss Island, Bethel Island, and Holland Tract), as well as the communities of Thornton, New Hope and Walnut Grove. It was expanded in 1996 to the entire Delta and to portions of the Suisun Marsh (approximately 12 miles of levees on islands bordering the Northern Suisun Bay from Van Sickle Island westerly to Montezuma Slough), as outlined in Section 12311 of Water Code.[18]

Fiscal Analysis

For Metropolitan's Delta Islands, each of the four RDs submits a five-year levee analysis that addresses the structural deficiencies due to levee foundation soil consolidation that may fall below the desired structural standard. DWR then at its discretion requests applications for future levee enhancements under its Program. The Program provides funds for both planning and construction projects. When available, funding is offered to local LMAs through a competitive grant process known as a Project Solicitation Package (PSP) or through a Directed Expenditure (Directed Action). A PSP is released for specific types of projects (multi-benefit, levee

[17] California, S. O. (n.d.). Delta Levees special flood control projects. https://water.ca.gov/Work-With-Us/Grants-And-Loans/Delta-Levees-Special-Flood-Control-Projects
[18] Cal. Water Code § 12311. (n.d.). https://california.public.law/codes/ca_water_code_section_12311

improvement, etc.), while a Directed Action is available to an LMA with a critical need (such as necessary emergency repair work).

Table 13 shows the Program funding for fiscal year (FY) 2021/22 (expenditures under final review and approvals) through FY 2023/24. Metropolitan has received an average of $7 million per year to assist in its Delta islands levee improvement.

Table 13 – State Delta Levees Special Flood Control Projects Program

	FY 2021/22	FY 2022/23	FY 2023/24	FY 2024/25	FY 2025/26
Delta wide[19]	$30 million	$30 million	$28 million	TBD	TBD
Metropolitan	~ $7 million	~ $7 million	~ $7 million	TBD	TBD

As described before, the funding sources were established in 1988 under the SB 34 and later revised under SB 1065 and AB 360. Additionally, these funds will be depleted over the next few years and are currently being evaluated by the state for additional funding.

[19] Annual Report to the DSC--State Funds Awarded for Delta Levee Improvement and Rehabilitation Projects, FY 19 (ca.gov)

Overview

The Delta Flood Emergency Management Plan (DFEMP)[20] issued a report dated October 2019 (draft update November 2023) recognizing that the Sacramento-San Joaquin Delta is an important and complex region that offers a multitude of benefits to the state of California but is susceptible to damages in the event of earthquakes, floods, and other threats.

The Delta's 1,100 miles of levees protect productive farmland, important energy and transportation infrastructure, and rural and urban communities. The Delta serves as a key link in the state's existing water supply conveyance system and is a vital ecosystem for fish and wildlife. Much of the land in the Delta is below sea level and the resulting flood risk is high. As sea levels rise due to climate change and Delta lands continue to subside, the risks continue to increase.

A multitude of local, state, and federal agencies, utilities, residents, and advocacy groups have interests in the Delta and its many resources, and as a result, there are numerous initiatives and programs underway to protect and enhance its valuable assets. The DFEMP is just one element of the complex and evolving set of initiatives and programs that currently includes:

- Formulation of the Delta Plan, led by the Delta Stewardship Council;
- Updates to the SWP conveyance system through the Delta currently led by DWR to improve reliability and resiliency of freshwater conveyance thorough and/or around the Delta. The DCP is designed to provide reliable, clean, and secure water for millions of Californians and millions of acres of farmland south of the Delta with upgrades to water infrastructure within the Delta;
- Efforts to manage Delta lands consistent with wise floodplain management and protection of agricultural resources, led by the Delta Protection Commission;
- Ongoing efforts to maintain and strengthen Delta levees, led by local RDs, and supported by DWR's Delta Levees Subventions and Special Projects programs;
- Numerous efforts to improve Delta habitat quality involving a multitude of public agencies, non-governmental entities, and for-profit organizations;

[20] California, S. O. (2019, October 16). DWR prepares California water system for next 'Big One.' https://water.ca.gov/News/Blog/2019/Oct-19/Great-Shakeout-2019-DWR

- Ongoing investments in Delta highways, utilities, farms, and businesses at all levels, fueled in part by proximity to its navigable network of channels, the Bay Area, Sacramento, and Stockton;
- Investments in emergency response and management, including training, public education, risk assessment, flood fight materials and supplies depots, communications infrastructure, and interagency collaboration to improve flood fight coordination;
- Ongoing efforts to improve DWR's disaster or large-scale response and recovery actions and multi-agency coordination and collaboration in the Delta region; and
- Efforts to improve and restore environmental conditions within the Delta under California's EcoRestore project.

Investment Opportunities

These investments reduce costs associated with emergency levee repairs and reduces risk by ensuring a rapid response effort during emergency situations.

Fiscal Analysis

In 2022, RD 756 (Bouldin Island) received an approximately $1 million grant from Sacramento County to develop a regional emergency supply depot. This depot has been constructed on a fenced, one-acre parcel on the east side of Bouldin Island.

Additionally, emergency flood-fighting supplies are being purchased for Metropolitan's four islands through approximately $200,000 in grants secured from San Joaquin County. Supplies purchased include muscle wall, sandbags, tarps, shovels, ramps, pumps, hoses, cargo nets, rock, trailer containers, and other equipment that will ensure rapid response in the event of an emergency.

Delta Island RDs and Metropolitan staff continue to work with DWR and County Office of Emergency Services for stocking and re-stocking of emergency supplies, emergency response training, communications infrastructure, and interagency collaboration to improve flood fighting coordination on both state and federal levels.

FISCAL ANALYSIS

DELTA ISLAND REVENUES
Waterfowl Recreation & Preservation

Overview

Metropolitan's legacy of environmental protection spans decades and is predicated on the idea that advancing ecosystem restoration and regenerative agriculture is crucial for addressing environmental degradation, enhancing biodiversity, mitigating climate change, and promoting sustainable and resilient food production. Metropolitan has set precedent with the substantial investments and development of public and private partnerships that focus on environmental protection and ecosystem enhancement throughout its service area.

Metropolitan's islands are located along the Pacific Flyway,[21] one of the more important migratory flyways in the world. According to the Audubon Society, each year at least a billion birds migrate along the Pacific Flyway, but these birds are only a fraction of those that used the flyway a century ago. Habitat loss, water shortages, diminishing food sources, and climate change all threaten the birds of the Pacific Flyway.[22] **Figure 3** shows the Pacific Flyway routes and the convergence through the Delta region in California.[23] The Sacramento-San Joaquin Delta hosts numerous bird species during migration including the largest wintering concentration of Lesser Sandhill Cranes in the Pacific Flyway (**Figure 4**).[24] The Audubon Society's annual bird surveys have identified Metropolitan's islands and the Delta region as critical to Pacific Flyway bird migration. Ownership of Metropolitan's Delta islands provides unique opportunities for conservation and enjoyment of waterfowl recreational activities. However, Metropolitan does not currently have a program to enhance waterfowl habitat or to manage the islands to increase populations.

When Metropolitan purchased the islands in 2016, there were two existing duck hunting life estate holders: one on Webb Tract and one on Holland Tract. Grower tenants were managing recreational duck hunting on other parts of the islands mostly for their personal use. Currently the grower tenants continue to manage recreational duck hunting with permission from Metropolitan and no revenue is generated from these activities.

The Delta islands can provide opportunities to partner with resource experts like California Waterfowl, Ducks Unlimited, Audubon Society, Point Blue Conservation Science, and others to ensure the long-term ecological sustainability of migratory bird populations; increase the socioeconomic benefits derived from birds; improve hunting and bird watching and other outdoor bird-related experiences; and increase awareness of the value of migratory birds and their habitats for their aesthetic, ecological, recreational and economic significance.

[21] Pacific Flyway - Water Education Foundation. (2020, June 22). Water Education Foundation. https://www.watereducation.org/aquapedia/pacific-flyway
[22] Pacific Flyway. (2023-01-10). Audubon. https://www.audubon.org/pacific-flyway
[23] https://www.usgs.gov/media/images/map-waterfowl-migration-routes-pacific-flyway (1/10/2023)
[24] Map of waterfowl migration routes in the Pacific Flyway | U.S. Geological Survey. (2023-01-09). https://www.usgs.gov/media/images/map-waterfowl-migration-routes-pacific-flyway

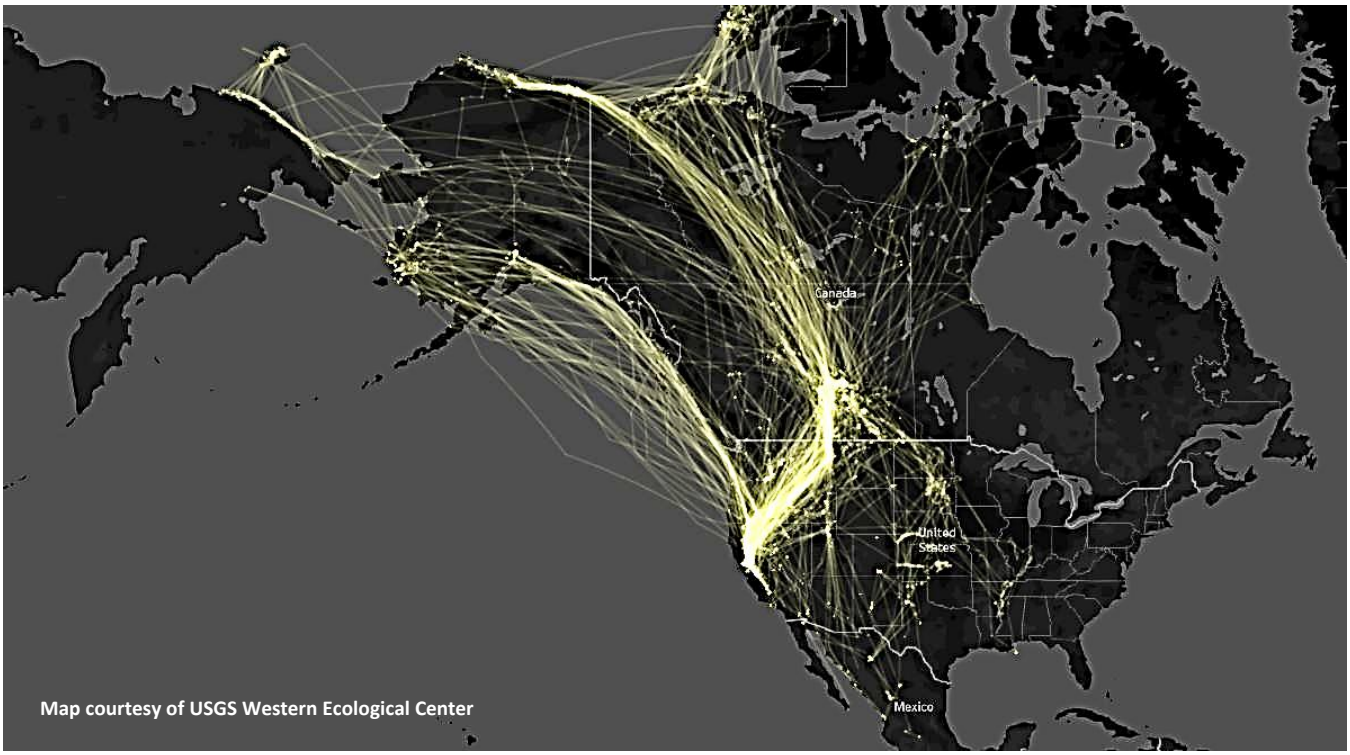

Figure 4 – Map of Waterfowl Migration Routes in the Pacific Flyway

Waterfowl recreational activities encompass a wide range of outdoor pursuits including:

- Birdwatching - Observing waterfowl in their natural habitats, such as wetlands, marshes, and lakes, is a popular recreational activity for birdwatchers and nature enthusiasts. Many people enjoy the challenge of identifying different waterfowl species and observing their behaviors.
- Photography - Capturing images of waterfowl in their natural environment is a popular recreational pursuit for wildlife photographers. Photographers often seek out opportunities to capture striking images of waterfowl in flight, feeding, or interacting with their surroundings.
- Hunting - Waterfowl hunting is a traditional recreational activity enjoyed by many outdoor enthusiasts. Hunters pursue waterfowl such as ducks and geese during designated hunting seasons, often using decoys, calls, and blinds to attract and harvest birds in a sustainable and ethical manner.
- Wildlife viewing tours - Guided wildlife viewing tours and boat excursions offer opportunities for individuals and groups to observe waterfowl and other wildlife species in their natural habitats. These tours may be led by naturalists or experienced guides who provide educational insights into waterfowl behavior and ecology.
- Conservation and volunteer work - Participating in conservation efforts and volunteer programs focused on waterfowl and wetland habitats can be a rewarding recreational activity for individuals

interested in environmental stewardship. This may involve habitat restoration, wetland clean-up, or educational outreach activities.

These activities provide rewarding opportunities for people to connect with nature, appreciate the beauty of waterfowl, and contribute to the conservation and sustainable management of these important bird species and their habitats.

Figure 5 – Sandhill Cranes

Investment Opportunities

Ensuring waterfowl survival through conservation activities protects bird species that play a critical role in healthy ecosystems. For instance, birds are important pollinators for many fruit species, provide a natural fertilizer (otherwise known as guano), play a key role in spreading nutrients, especially migrating birds, and transport seeds ensuring new plants thrive. In addition, some species of birds, like owls and raptors, keep rodent populations in check, while other species, like barn swallows are voracious predators of pests consuming as many as 60 insects an hour.[25]

Metropolitan's investments on the Delta islands ensure its continued legacy of environmental stewardship by supporting the development of more sustainable agricultural practices and its legacy of conservation through protection and restoration of wetlands, all of which provide breeding and nesting areas, migratory stopover sites, and wintering habitats. In addition, these actions can provide opportunities to monitor waterfowl populations and study how wetland restoration and sustainable agricultural practices affect populations

[25] Barn Swallow, Natural Pest Control (2023-01-10) Bird Note. https://www.birdnote.org/listen/shows/barn-swallow-natural-pest-control

density, as well as provide research opportunities on waterfowl ecology, behavior and habitat requirements that can guide conservation efforts.

Fostering waterfowl recreation and research opportunities on Metropolitan's Delta islands provides opportunities to both protect these important species and utilize its Delta lands to increase waterfowl habitat and population.

Fiscal Analysis

While there are many recreational, conservation, and research opportunities associated with waterfowl, most have an intrinsic value that cannot easily be quantified but are, nevertheless, of upmost importance to the conservation and the continued preservation of a healthy ecosystem. Waterfowl hunting is one activity that provides a sustainable approach to wildlife management, ensures that waterfowl populations remain healthy and viable, while also providing a revenue-generating opportunity on Metropolitan's islands.

Staff analyzed opportunities to develop a duck-hunting management plan that included the available capacity for waterfowl hunting opportunities, the number of duck blinds that could reasonably be supported, and the annual revenue that could be generated from the duck blind leases. Bouldin Island and Webb Tract both have existing club facilities and amenities to support waterfowl hunters and each island can be expected to generate income from up to 25 members. Historic seasonal hunting lease agreements on Bouldin (2019, 2021), a 2019 Bender Rosenthal & Associates appraisal, and interviews with Ducks Unlimited (2022, 2023) were used to establish a revenue range that could generated from per member fees on each island. **Table 14** provides a comparison between revenue with a business-as-usual approach and an annual revenue estimate after expenses for each island in the year 2030. The estimate also includes a 3 percent escalation in rates per year.

Table 14 – Annual Net Revenue Comparison for Waterfowl Recreation Leases

Delta Islands	Annual Net Revenue Estimate	
	Business as Usual 2030 Forecast	**Proposed Approach 2030 Forecast**
Bouldin Island	$0	$23,000 – 119,000
Webb Tract	$0	$58,000 – 234,000
Holland Tract	$0	$ TBD
Bacon Island	$0	$ TBD
TOTAL	**$0**	**$81,000 – 343,000**

Overview

Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide (CO_2), which is the most commonly produced GHG. It is one method of reducing the amount of CO_2 in the atmosphere with the goal of reducing global climate change.[26] Carbon sequestration is the process of capturing and storing atmospheric CO_2. This is one method of reducing the amount of CO_2 in the atmosphere with the goal of reducing global climate change.[26] Carbon sequestration is important for reducing GHG emissions because it can help mitigate the impact of human activities that release large amounts of CO_2 into the atmosphere, such as burning fossil fuels, deforestation, and agriculture. By storing CO_2 in stable and secure forms, carbon sequestration can help slow down the rate of global warming and avoid some of its negative consequences, such as rising sea levels, extreme weather events, and biodiversity loss.[27] By storing CO_2 in stable and secure forms, carbon sequestration can help slow down the rate of global warming and avoid some of its negative consequences, such as rising sea levels, extreme weather events, and biodiversity loss.[27]

Carbon sequestration can be done in two major ways: geologic and biologic. Biologic carbon sequestration is the natural ability of ecosystems to store carbon (**Figure 6**). Forests, peat marshes, and coastal wetlands are particularly good at storing carbon. Metropolitan's islands contain a high level of peat soils making them rich in nutrients and carbon that is good for agriculture. However, growing crops such as corn on peat soils can also release CO_2 emissions through soil oxidation that occurs during exposure to the atmosphere.

[26] What is carbon sequestration? | U.S. Geological Survey. (2022, February 1). https://www.usgs.gov/faqs/what-carbon-sequestration#publications

[27] Bradbury, K., & Kliejunas, E. (2023, December 21). Typical NZer's food causes a tonne of climate gas emissions. Newsroom. https://newsroom.co.nz/2023/12/14/buying-carbon-credits-is-not-an-emissions-plan/

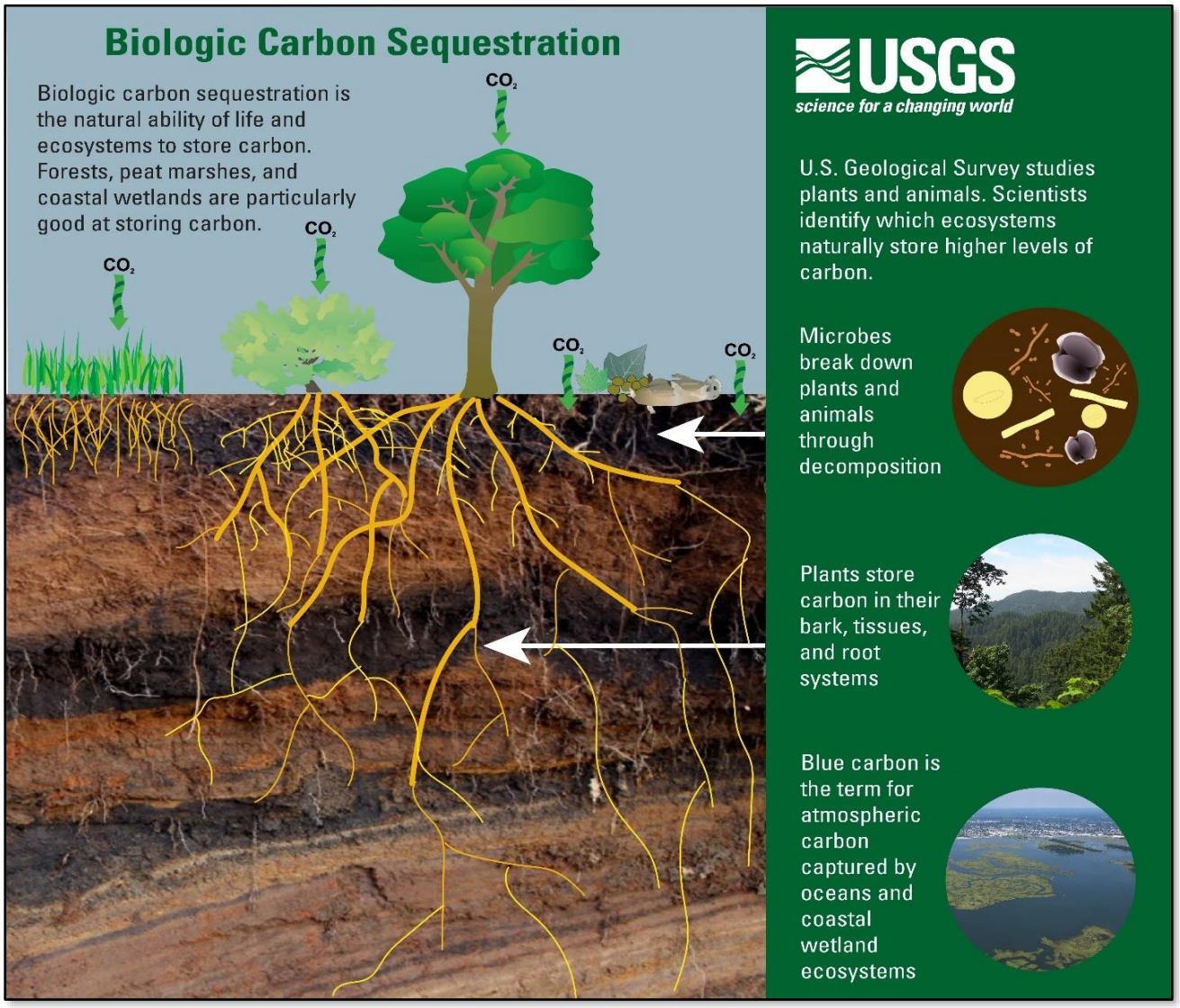

Figure 6 – Biologic Carbon Sequestration Graphic USGS

These emissions can be reduced by shifting agricultural practices to a semi-aquatic crop like rice or reversed by the development of wetlands. Wetting the soil prevents soil oxidation and both rice farming and the development of wetlands create conditions to store carbon (**Figure 7**). The biologic removal of carbon from the atmosphere and storing it creates revenue generating opportunities that Metropolitan can capitalize to its advantage.

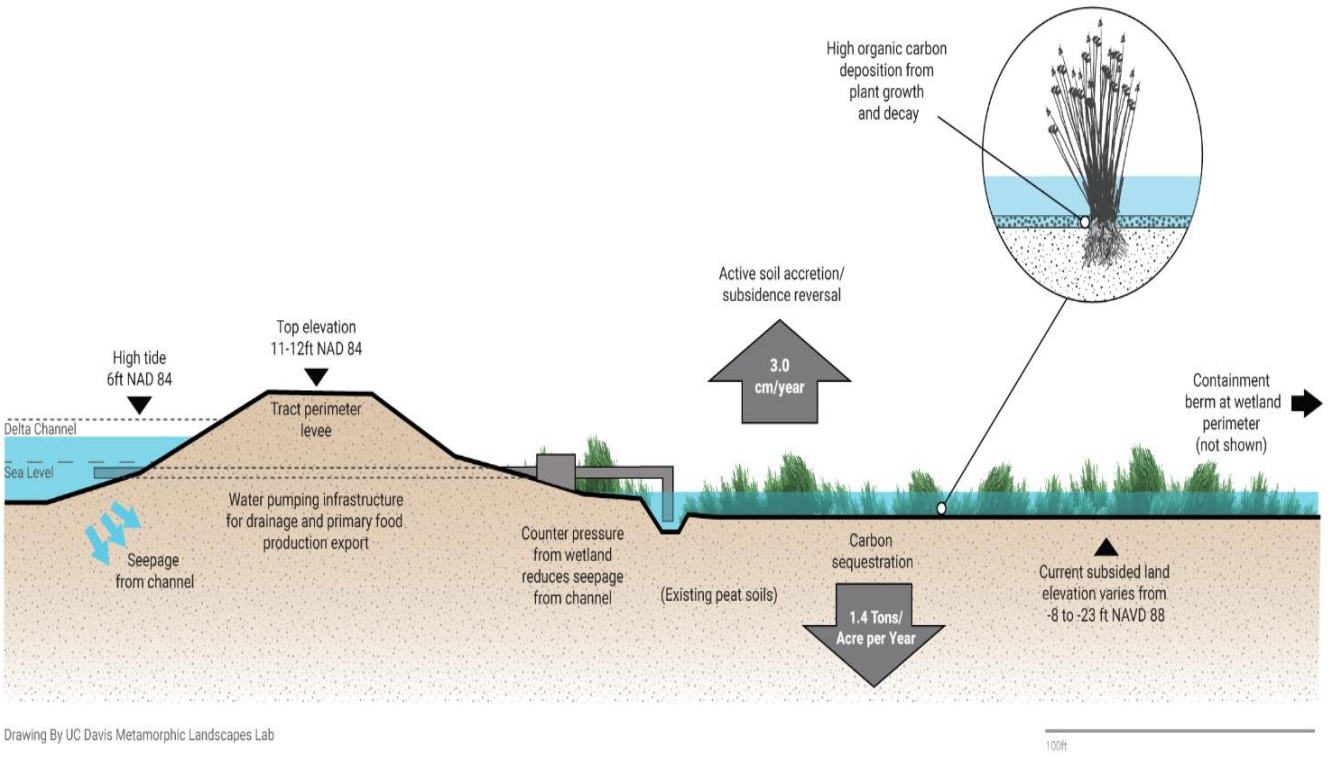

Figure 7 - Multi-Benefit Managed Wetlands[28]

In addition, oxidation of Delta organic soils and tilling of the dry soils during conventional agricultural practices creates erosion that contributes to subsidence. Metropolitan's islands are subsided up to as much as 25 feet below the adjacent river stage levels with subsidence rates are as much as 0.5 to 1.5 inches per year. This is consistent with other non-Metropolitan islands used for farming mostly in the south and central Delta. The islands in the Delta region are protected by roughly 1,115 miles of levees that protect farms, cities, schools and people in and around the Sacramento-San Joaquin Delta and protect a crucial conduit for California's overall water supply. But the Delta's levees are vulnerable to failure due to floods, earthquakes and rising sea levels brought about by climate change. A widespread failure could imperil the state's water supply[29]. Changing agricultural practices to a semi-aquatic crop like rice will stop the subsidence caused by traditional farming in the Delta and the creation of wetlands is expected to reverse subsidence. Reversing subsidence will reduce hydrostatic pressure on the levees surrounding the island reducing the risk of levee failure.

Investment Opportunities

The Kyoto Protocol of 1997 and the Paris Agreement of 2015 were international accords that laid out international CO_2 emissions goals. With the latter ratified by all but six countries, they have given rise to national emissions targets and the regulations to back them. With these new regulations in force, the pressure

[28] Delta Island Adaptations. (n.d.). Delta Island Adaptations. https://deltaislandadaptations-ucdavis.hub.arcgis.com/
[29] Sacramento-San Joaquin Delta Levees - Water Education Foundation. (2020, June 22). Water Education Foundation. https://www.watereducation.org/aquapedia/sacramento-san-joaquin-delta-levees

on businesses to find ways to reduce their carbon footprint is growing. Most of today's solutions involve the use of the carbon markets. The carbon markets turn CO_2 emissions into a commodity by giving it a price and allowing these credits or offsets to be bought and sold on a carbon market [30]. Metropolitan's islands provide opportunities to sequester carbon and generate carbon credits through Mother Nature's carbon sinks – plants. Plants convert CO_2 from the atmosphere into organic matter through photosynthesis, which stores the carbon in the ground and creating a carbon sink. Carbon sinks can be measured and turned into carbon credits, which then have a value in the carbon market.[30]

Metropolitan's Delta islands provide unique investment opportunities because they have large areas of peat soils that can store carbon naturally and, when wetted, prevent its release into the atmosphere. Semi-aquatic crops and wetlands sequester carbon and generate carbon credits that can be quantified and sold on the carbon market generating revenue for Metropolitan.

In addition to generating carbon credits that can be sold on the carbon market, carbon credits can also be used to offset emissions under Metropolitan's Climate Action Plan (CAP).[31] Adopted by Metropolitan's Board in 2021, Metropolitan's CAP is a commitment to reduce its operational emissions to carbon neutrality by the year 2045. The CAP also sets an interim goal of 40 percent below 1990 levels by the year 2030. Annual reports and updates to the plan every five years ensure that Metropolitan tracks its progress and continues to identify new projects that can reduce additional emissions to achieve compliance. The CAP is a tool that meets the requirements of Section 15183.5(b)(1)[32] of the State CEQA Guidelines for a "Qualified GHG Reduction Plan" (CAP). A qualified CAP allows Metropolitan to tier future project-level GHG emissions analyses under CEQA if projects demonstrate consistency with the CAP goals. The carbon sequestration opportunities on the Delta islands were identified as important to Metropolitan achieving its carbon neutrality target and listed in the CAP as a future action that will require further study before implementation.

Additionally, and important for the protection of the freshwater pathway through the Delta, switching to a semi-aquatic crop such as rice stops subsidence by wetting the land and wetlands reverse subsidence through the accretion of organic matter over time reducing the risk associated with levee failure, which could cause flooding and saltwater intrusion.

Therefore, investing in carbon sequestration on the Delta Islands can have multiple benefits – not just for the environment, the economy, and the local communities – it can also help reduce GHG emissions, enhance natural ecosystems, create jobs and revenue, and improve water quality and security, and can assist Metropolitan in achieving its GHG reduction goals.

[30] Credits, C. (2023, March 23). The Ultimate Guide to Understanding Carbon Credits. Carbon Credits. https://carboncredits.com/the-ultimate-guide-to-understanding-carbon-credits/?sl=cc-google-ads&gad_source=1&gclid=Cj0KCQiA4Y-sBhC6ARIsAGXF1g6fo1va-

[31] Metropolitan Water District of Southern California (May 2022). Climate Action Plan. https://www.mwdh2o.com/media/12469/final-cap.pdf

[32] Section 15183.5 - Tiering and Streamlining the Analysis of Greenhouse Gas Emissions, Cal. Code Regs. tit. 14 § 15183.5 | Casetext Search + Citator. (n.d.). https://casetext.com/regulation/california-code-of-regulations/title-14-natural-resources/division-6-resources-agency/chapter-3-guidelines-for-implementation-of-the-california-environmental-quality-act/article-12-special-situations/section-151835-tiering-and-streamlining-the-analysis-of-greenhouse-gas-emissions

Fiscal Analysis

Carbon credits and offsets can generate revenue under two slightly different markets, the compliance market, and the voluntary market, although the basic unit traded – the equivalent of one ton of carbon emissions, also known as CO_2e – is the same. The compliance market is used by companies and governments that by law must account for their GHG emissions. It is regulated by mandatory national, regional, or international carbon reduction regimes. On the voluntary market the trade of carbon credits is on a voluntarily basis. The carbon credits sold on the compliance market must follow strict protocols since companies rely on the validity of the carbon reductions to meet their compliance obligations under CAP and Trade and, therefore, are traded at a higher price point than carbon credits sold on the voluntary market. Currently, rice production has an adopted compliance protocol, while a wetland protocol is in the works.

The fiscal analysis presented here provides a range of expected revenue that can be generated based on the different markets. It is assumed the wetland protocol will be adopted in the near future making carbon credits realized from wetlands more profitable, therefore for purposes of this analysis, Metropolitan has included the current voluntary market price as the lower end and a value that can be expected from an adopted compliance market protocol as the high end. It is important to note that as with all publicly traded commodities, the market can vary significantly. However, it is expected that both regulatory and voluntary carbon credit values will increase in the future as more and more companies struggle to meet their carbon offset obligations.

Initial estimates show that converting about 7,000 acres to rice farming and 3,500 acres to wetlands could yield annual revenue of approximately $780,000 in the Voluntary Market and over $1.5 million in the Compliance Market (**Table 15**).

Table 15 – Potential Net Revenue from Delta Island Carbon Sequestration Projects

Delta Islands	Annual Net Revenue Estimate	
	Business as Usual 2030 Forecast	Proposed Approach 2030 Forecast
Bouldin Island	$0	$579,000 – 661,000
Webb Tract	$0	$677,000 – 773,000
Holland Tract	$0	$123,000 – 141,000
Bacon Island	$0	$130,000 – 148,000
TOTAL	**$0**	**$1.5 – 1.7 million**

The carbon market is evolving, and time will tell how much revenue can be generated in 10, 20, or 30 years into the future. According to Morgan Stanley,[33] the carbon market is seeing a rapid increase in revenue

[33] Carbon-Offsets market set to surge | Morgan Stanley. (2023-01-13). Morgan Stanley. https://www.morganstanley.com/ideas/carbon-offset-market-growth

generated from $2 billion in 2020 to an estimated $250 billion by 2050 and industry expert BCG[34] reports that the carbon market is growing at a rapid pace with buyers seeing spending on carbon credits as non-discretionary as more companies seek to achieve net-zero carbon targets. Carbon credits generated from agricultural activities and wetlands like those created in the Delta are considered "charismatic" with industries willing to pay a premium because of their dual benefit. In addition, the cost to manage rice and wetlands is low compared to other GHG reduction strategies and does not require the increased regulatory oversight that would be required of other methods such as carbon capture and storage, which will require on-going monitoring and testing to ensure no impacts to the environment or surrounding local communities.

Metropolitan's islands provide an opportunity to generate additional revenue over and above the revenue generated from current agricultural practices. In addition, carbon credits generated from wetlands will allow Metropolitan to realize revenue from locations that can no longer support agriculture due to being too wet to farm.

[34] Porsborg-Smith, A., Nielsen, J., Owolabi, B., & Clayton, C. (2023, February 6). The voluntary carbon market is thriving. BCG Global. https://www.bcg.com/publications/2023/why-the-voluntary-carbon-market-is-thriving

Overview

Human use of the Delta and surrounding lands has changed the landscape and water quality in ways that create serious environmental challenges. Meanwhile, many native species and ecological systems in the Delta are on the point of collapse.[35] A conservation or-mitigation bank creates permanently protected land that is conserved and managed for its natural resource values.[36] Conservation and mitigation banks are generally large, connected, ecologically functional areas of preserved, restored, enhanced, or constructed habitat that are conserved to provide mitigation for projects before impacts occur.[37] The purpose of a mitigation bank is to compensate for unavoidable impacts to habitat, such as wetlands, or to specific species at another location.[38] The goals of conservation banking programs are to conserve large blocks of habitats, particularly those with high biodiversity, and to maintain habitat connectivity.

Mitigation banking is a system of credits and debits developed by regulatory agencies to ensure that development impacts to wetlands and streams, or to rare species and habitats, is compensated for by preservation, enhancement, restoration, or creation of similar ecological features in nearby areas so there is no net loss to local ecosystems. Since 1993, California Department of Fish and Wildlife (CDFW) has supported banking as an effective and meaningful approach to mitigation. In 2013, CDFW established a permanent Conservation and Mitigation Banking Program[39] and associated fee structure (Fish and Game Code Section 1797-1799.1).[40] In 2014, CDFW finalized Guidelines for the Conservation and Mitigation Banking Program. In the Banking Program, an established bank is authorized to sell credits that represent habitat values that already exist or habitat that will be enhanced, restored, or created at the bank. Credits are sold to project proponents who need compensation for unavoidable loss of habitat due to land development projects or other impacts, where avoidance or on-site mitigation is unfeasible or undesirable[21]. For instance, Webb Tract has habitat that supports the Giant Garter Snake (GGS), a federally and state listed species (**Figure 8**). An

[35] Challenges Facing the Sacramento-San Joaquin Delta (2014). California Natural Resources Agency. https://resources.ca.gov/CNRALegacyFiles/docs/DeltaChallenges-v13.pdf

[36] Conservation and Mitigation banking. (2023-12-28). https://wildlife.ca.gov/Conservation/Planning/Banking

[37] Report to the Legislature on California Conservation and Mitigation Banking (2023), California Department of fish and Wildlife. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=216355&inline

[38] Wetland Mitigation Banking Program | Natural Resources Conservation Service. (2023-12-28). Natural Resources Conservation Service. https://www.nrcs.usda.gov/wetland-mitigation-banking-program

[39] Report to the Legislature California Conservation and Mitigation Banking. (2022). California Department of Fish and Wildlife. FINAL Banking Leg Report 2022.pdf (ca.gov)

[40] Conservation and mitigation Banking laws and policies. (n.d.). https://wildlife.ca.gov/Conservation/Planning/Banking/Laws-and-Policies

agency needing credits for project impacts to GGS habitat could purchase credits from a mitigation bank that has pre-approved GGS habitat to offset impacts for their project.

A bank sponsor is any individual or entity that develops the lands for use in mitigation banking. The sponsor is responsible for the cost of land development, as well as the long-term maintenance of the bank to ensure that it continues to function as designed in the future. Banks can be approved by one or more regulatory bodies including the CDFW, the U.S. Fish and Wildlife Service (USFWS), the U.S. Army Corps of Engineers (ACOE), the U.S. Department of Agriculture (USDA) and others. Credits are determined using a functional assessment procedure that evaluates the land functions.[36] As the credits are sold, they are subtracted from the bank until all the available credits are purchased. Once approved by the agency(s), the bank can sell credits that can be used to mitigate impacts associated with the regulatory bodies. For instance, impacts to wetlands may be assessed by both state and federal agencies who could require mitigation credits that would satisfy more than one permitting agency.

Figure 8 – Giant Garter Snake[41]

Listed as Threatened under the California Endangered Species Act in 1971 and Threatened under the Federal Endangered Species Act in 1993. Impacts to this species or its habitat must be mitigated under the state and federal Endangered Species Acts (ESAs).

[41] Giant Garter Snake picture - Bing. (n.d.). Bing. https://www.bing.com/images/search?view=detailV2&ccid=ARsnZNnz&id=5B7CCD386BA47DF5465BFE386B228AF193B84D9B&thid=OIP.ARsnZNnz3h809-GGZ6hQMwHaE8&mediaurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.011b2764d9f3de1f34f7e18667a85033%3frik%3dm024k%252fGKIms4%252fg%26riu%3dhttp%253a%252f%252fwww.californiaherps.com%252fsnakes%252fimages%252ftgigas04yolo5.jpg%26ehk%3dFDiDrEmcmYIED4o51ZFAiVp4M%252fj9x2JG7kBnGHPw8kY%253d%26risl%3d%26pid%3dImgRaw%26r%3d0&exph=667&expw=1000&q=Giant+Garter+Snake+picture&simid=607991147241822970&FORM=IRPRST&ck=AB4BAC79674BD9AEE47CCB368AADED27&selectedIndex=0&itb=0&idpp=overlayview&ajaxhist=0&ajaxserp=0

Senate Bill (SB) 1148 (Pavley),[42] Chapter 565, Statutes of 2012, effective January 1, 2013, established a process for a CDFW review and approval of mitigation and conservation bank applications. The Legislature specified that all forms of mitigation banking should:

- Comply with regulatory requirements;
- Be based on the best available scientific information;
- Be capable of being implemented successfully;
- Have adequate funding to achieve mitigation measures; and
- Be monitored for compliance and effectiveness.

As such, an established bank requires that a Bank Enabling Instrument (BEI) or Conservation Bank Enabling Instrument (CBEI) be approved by CDFW. A BEI/CBEI is an agreement between a bank sponsor, bank property owner (if different), and signatory agencies that have jurisdiction over the resources to be conserved. The BEI/CBEI describes the conditions and criteria by which the bank will be established, managed, and operated in perpetuity for its natural resource values. The BEI/CBEI must be signed by CDFW, identify the security provided, and provide proof the land has been protected by recording a conservation easement or transferring fee title.[43] In addition, a Long-Term Management Plan must be adopted that establishes objectives, priorities, tasks, and reporting requirements. Management actions are tailored to achieve desired outcomes for the covered species and habitat and must be designed to adapt to changing environmental factors (adaptive management).

Investment Opportunities

Metropolitan's Delta islands provide opportunities to create long-lasting benefits to both habitat and species, such as the GGS through the development of mitigation banks. Mitigation opportunities, especially for riparian credits are in demand in the Sacramento-San Joaquin Delta region. Habitat diversity can be created within these habitats through modest earth moving (**Figure 9**). By excavating and mounding (generally balancing on-site cut and fill), topographic variations would be introduced, creating shallow depressions or ponds, and elevated berms, creating transitional zones within each habitat.[44]

[42] Pavley. (n.d.). SB 1148 Senate Bill - CHAPTERED. http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_1101-1150/sb_1148_bill_20120925_chaptered.html

[43] Conservation and Mitigation Banking Guidelines. State of California Natural Resources Agency Department of Fish and Wildlife, August 2014, Updated July 2019. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=79095&inline=1

[44] Delta Island Adaptations. (n.d.). Delta Island Adaptations. https://deltaislandadaptations-ucdavis.hub.arcgis.com/pages/the-adaptations

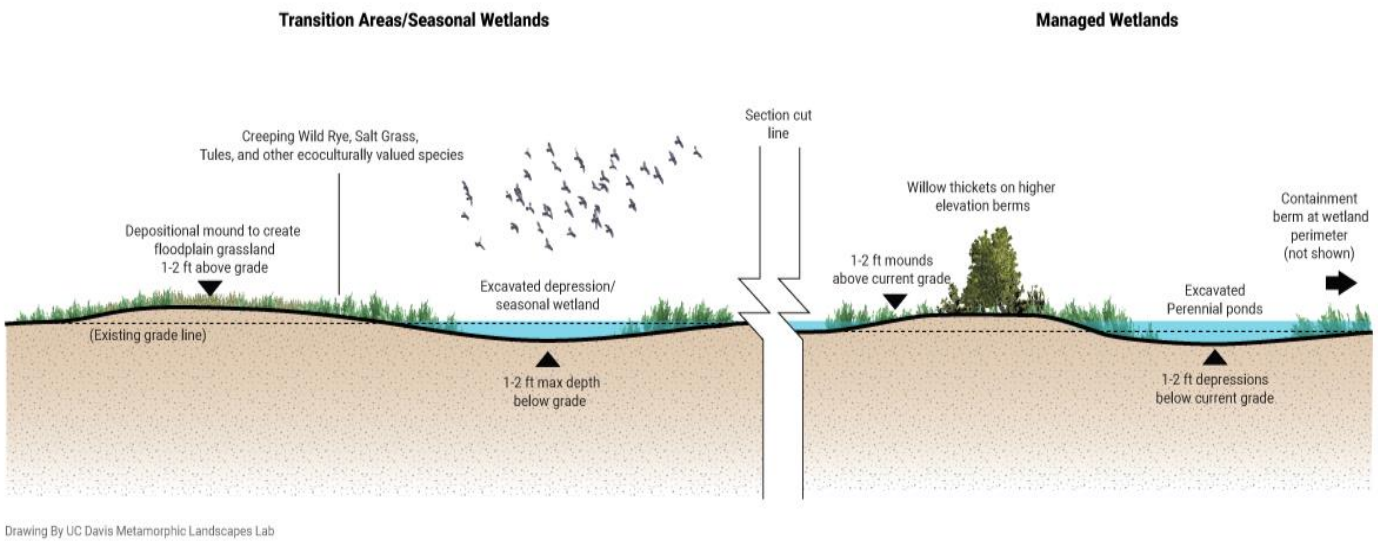

Figure 9 – Creating Habitat Diversity for Mitigation Banking[44]

While each of Metropolitan's islands provide opportunities to develop a mitigation bank, Webb Tract provides a unique opportunity due to its availability of extensive contiguous land. In 2023, Metropolitan was awarded a grant from the Sacramento-San Joaquin Delta Conservancy to design and construct up to 3,500 acres of wetland on Webb Tract. Staff is currently in the design phase and expect to return to the Board for authorization to proceed with wetland construction in late 2024 or early 2025. The wetland could provide opportunities to develop a mitigation bank that could provide much needed credits in the Delta region. Additional opportunities exist on Bouldin Island and to a lesser extent Holland Tract. In addition, staff is investigating potential opportunities for mitigation credits for set-back levees, which have the potential to provide added structural protection to existing island levees while also providing substantial shaded riverine aquatic cover (SRA). While SRA provides excellent opportunities for establishing mitigation credits, the enhanced levee structures have not been fully vetted.

According to Amanda Dwyer at Westervelt Ecological Services, floodplain mosaic wetland credits in the Delta are currently selling for $150,000 to $225,000 per acre and upland habitat including grassland and brush scrub is selling for $45,000 to $75,000 per acre.[45] Streamside mitigation credits are in high demand as available credits in the Delta region are nearly exhausted and agencies such as DWR, San Joaquin County, and Contra Costa County struggle to find land to mitigate for impacts from flood control projects, providing additional mitigation banking opportunities.[46]

[45] A. Dwyer, Westervelt Ecological Services, personal communication November 29, 2022
[46] T. Gardner, CDFW, personal communication December 20, 2023; A. Calderaro, Department of Water Resources, personal communication, December 28, 2023

Fiscal Analysis

Staff identified acreage on each island that could be developed and used to provide wetland or species banking credits **(Table 16)**. Webb Tract has the most suitable acreage for the development of a mitigation bank, followed by Bouldin Island and Hollard Tract. Bacon Island does not provide suitable habitat. This data was then used to provide an estimate of the projected annual revenue that could be generated from eco-mitigation banking on each of Metropolitan's islands **(Table 17)**. As discussed below, mitigation credits are not generally purchased in bulk, so for the purposes of this study, the analysis assumed that 1/3 of available credits will be sold every six years. The analysis also includes estimated costs to develop and maintain (operations and maintenance costs) the mitigation bank. Both the revenue and the development and maintenance costs include an annual cost escalation of 3 percent over 30 years. The projections include the estimated costs to develop and maintain the mitigation bank(s), which are discussed further below.

Table 16 – Converted Mitigation Credits (Estimated Acreage)

Eco-Mitigation Banking Available Acreage by Island		
Island	**Upland**	**Wetland**
Bouldin	0	500
Webb	500	3,000
Holland	0	250
Bacon	0	0
TOTAL Acreage	**500 acres**	**3,750 acres**

Table 17 – Potential Net Revenue from Delta Island Eco-Mitigation Banking

Delta Islands	Annual Net Revenue Estimate	
	Business as Usual 2030 Forecast	**Proposed Approach 2030 Forecast**
Bouldin Island	$0	$0.9 – 1.5 million
Webb Tract	$0	$6.0 – 9.2 million
Holland Tract	$0	$0.5 – 0.8 million
Bacon Island	$0	$TBD
TOTAL	**$0**	**$7.4 – 11.5 million**

Fees to establish a mitigation bank are estimated to be $100,000 to $250,000 depending on the complexity of the BEI/SBEI and number of participating approval agencies. Additional development costs include design and construction of habitats to ensure market viability, development of a long-term management plan and financial instruments, and marketing of mitigation credits. These costs will vary depending on the habitat type, acreage to be conserved, and project location. Project development costs on Webb Tract were estimated by Hydrofocus, Inc. to be $4,200 per acre for design and construction of wetlands. These numbers are higher than those on other islands due to accessibility issues. However, the higher construction costs were used as a

conservative figure to generate the revenue estimates for all the islands. Operations and maintenance (O&M) costs were estimated using actual O&M costs reported by DWR for similar operations on nearby Twitchell Island. DWR reported 2023 annual O&M costs on Twitchell Island to average between $100 to 133 per acre. Again, using a conservative estimate, staff used an average of $150 per acre per year for the revenue analysis. All numbers included a 3 percent annual cost escalation for inflation.

Of note, Metropolitan recently received a $20.9 million grant from the Sacramento-San Joaquin Delta Conservancy which, in part, funds the creation of up to 3,500 acres of wetland and upland habitat on Webb Tract. The grant funds design, construction, and some studies for the project. This is the first large-scale wetland restoration project in the south/central Delta area and the information collected and lessons learned will inform future cost estimates to develop similar projects in the Delta. Staff used the estimated $4,200 per acre for the design and construction of the wetlands and upland habitat in the grant application, which the approved grant fully funds. Staff did not include this grant offset in the estimate provided because the Board has only approved design. Staff will return to the Board once design and CEQA are complete to request approval of the project, which will allow implementation funds for the project to be released.

Mitigation credit pricing is directly tied to demand and availability. Demand for mitigation credits for riparian (wetland and stream) and upland habitat can vary depending on a variety of factors, including the economy, building permits issued, political will to build, and even natural disasters. In the central Delta region, where Metropolitan's islands are located, there are very few banks with available mitigation credits, which ensures that a robust mitigation market exists now and into the foreseeable future a trend that has been reflected in increased purchase price per acre over the last five years, a trend that is expected to increase over time.[Error! Bookmark not defined.,46]

As mentioned earlier, credits are sold to project proponents who need compensation for unavoidable loss of habitat due to land development projects or other impacts. Depending on the habitat or species value, regulatory agencies can require anywhere from 1:1 to 5:1 mitigation compensation for habitat loss. Sale of mitigation credits can be purchased in varying increments depending on demand. While mitigation bank credits can be purchased in small increments, larger purchases do occur, generally by public agencies like the DWR that know, in advance, they will need credits to offset future impacts. Pre-purchasing mitigation credits in large blocks provides certainty in both availability of credits and the cost associated with the credit purchases.

Creation of a mitigation banking program on Metropolitan's islands can provide long-term protection of habitat and species in the Delta region while also ensuring that sufficient revenue is generated that will support the long-term maintenance of the mitigation bank and the levees that protect the islands. Providing an additional mechanism to fund levee protection in the Delta supports Metropolitan's overall goals of protecting the flow of water through the Delta and ultimately, to Southern California via the SWP.

Overview

Metropolitan's island properties are surrounded by water and have land elevations that range from five to 25-feet below sea level. Seepage of water onto the land from the surrounding rivers requires the islands to operate water discharge pumps to maintain appropriate groundwater levels for agriculture purposes and prevent flooding of the land.

In total, there are nine pump stations on the four islands. The pump stations are connected to the local Pacific, Gas, and Electric (PG&E) power grid, and use approximately 1.6 million kilowatt hours (kWh) of electricity per year. The annual total power cost ranges from $400,000 to $500,000 per year.

To align with the Metropolitan's Climate Action Plan objective of carbon neutrality by 2045, Metropolitan partnered with the non-profit Clean Coalition[47] to conduct a study, which analyzed the feasibility of installing solar microgrids at each pump station on the islands. Solar microgrids[48] are defined as a small-scale footprint, solar generation facilities that would be installed at and power each pump station. A solar microgrid consists of solar panels to capture solar energy and a battery energy storage system (BESS) to store excess power for discharge after hours or during a power interruption.

Investment Opportunities

The key objectives of installing solar microgrids is (1) reducing annual energy costs (economic benefit); (2) eliminating GHG emissions (environmental benefit); and (3) providing backup power to maintain pumping during local power grid outages (resilience benefit).

The key findings of the analysis indicate:

- Economic. Solar microgrids would achieve an estimated energy cost-savings of 40 percent or approximately $18 million over 25 years ($720,000 per year);
- Environmental. Clean energy power through solar microgrids will reduce GHG emissions by approximately 29,000 metric tons over 25 years; and

[47] Home - Clean Coalition. (2021, December 23). Clean Coalition. https://clean-coalition.org/
[48] Djksadf4_Nd. (2022, June 9). What is a Solar Microgrid? (And How Exactly Does It Work?). Solar Power First. https://solarpowerfirst.com/what-is-a-solar-microgrid/

- Resilience. Solar microgrids will provide backup power of up to two hours in the event of a power outage on the local power grid.

Table 18 below summarizes the costs and savings associated with installation of solar microgrids at each of the nine-pump discharge stations.

Table 18 – Solar Microgrid Cost and Savings Analysis

Solar Microgrid Cost and Savings Analysis			
	Without Solar	**With Solar + Battery**	**Total Cost Savings**
PG&E Electric Bills	$45 million	$19 million	$26 million
Capital + O&M costs	$0	$8 million	<$8 million>
TOTAL	**$45 million**	**$27 million**	**$18 million ($720,000/year)**

The microgrid cost and savings calculations assumes that each battery energy storage system (BESS) has a capacity of at least two hours of resilience, the utility cost escalation rate is 10 percent, a federal incentive under the Investment Tax Credit (ITC) of 40 percent (Direct Pay) will be available, and an average capital investment payback is between 10 and 16 years.

Fiscal Analysis

The economic analysis of solar microgrids uses the following assumptions:

- The solar microgrid system is sized for 100 percent net zero, which is defined as the average load of solar generated over a year equal to the amount of electricity consumed over the year; and
- The BESS is designed to cover each pump's peak load for two hours.

The analysis uses the following current market prices and incentives:

- Solar system cost: $4 per kilowatt (kWh);
- BESS cost: $1,500 per kWh;
- 10 percent annual utility cost escalation; and
- 40 percent Direct Pay Investment Tax Credit (ITC).[49]

Determine Solar and Battery Size, Costs, Incentives, and Siting. The solar system at each pump station was sized based on calendar year 2022 using the Baseline Land Profile (BLP),[50] a tool developed by the National Renewable Energy Laboratory to estimate the solar energy potential of a given area. Using this BLP will ensure

[49] Treasury and IRS release guidance on direct pay and transferable tax credits. (2023, June 14). KPMG. https://kpmg.com/us/en/home/insights/2023/06/tnf-irs-guidance-on-direct-pay-and-transferable-tax-credits-under-ira-and-chips-act.html

[50] Solar Geospatial Data Tools. (n.d.). Geospatial Data Science | NREL. https://www.nrel.gov/gis/solar-geospatial-data-tools.html

the annual solar energy generated will be at least as much as the annual electricity consumed by the pump station on Metropolitan's islands.

The BESS sizes were selected to ensure that maximum hourly load experienced in the past year could be maintained for at least two hours.

Figure 10 below is a picture illustrating a typical smaller scale solar microgrid and BESS that would be installed at each pump station on Metropolitan's islands. These solar facilities, with the capacity of producing kWh, would be smaller than the solar facilities installed at Jensen, Lake Mathews, and Skinner, which have a capacity of producing megawatts.

Figure 10 – Small Scale Solar Microgrid with Battery Energy Storage System[51]

[51] solar microgrid Battery Energy Storage Systems - Bing. (n.d.). Bing. https://www.bing.com/images/search?view=detailV2&ccid=xghvDkuQ&id=41F3AD89D0A9862DFC67A69B294265B15FD5FDCC&thid=OIP.xghvDkuQH2jdhCImr66_SQHaE7&mediaurl=https%3a%2f%2fwww.pv-magazine.com%2fwp-content%2fuploads%2f2021%2f09%2fLord-Howe-Island-Photon-Energy-Tesla-battery-768x511-1.jpeg&cdnurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.c6086f0e4b901f68dd842226afaebf49%3frik%3dzP3VX7FlQimbpg%26pid%3dImgRaw%26r%3d0&exph=511&expw=768&q=solar+microgrid+Battery+Energy+Storage+Systems&simid=607996945452316130&FORM=IRPRST&ck=04A004616B15340B1AA5F2BCB6C59A89&selectedIndex=21&itb=0&ajaxhist=0&ajaxserp=0

Figure 11 is a picture of one of the water pump discharge stations on Bouldin Island.[52]

Figure 11 – Delta Island Pump Discharge Station[53]

Figure 12 summarizes the power usage by month for calendar year 2022 at all of Metropolitan's nine-pump stations on all four islands.

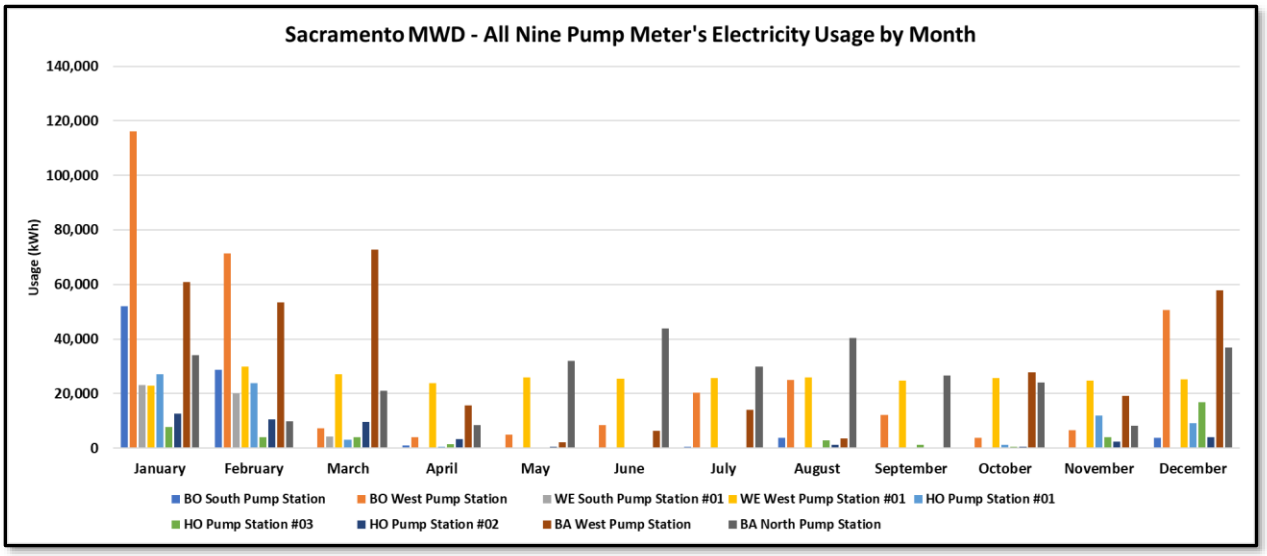

Figure 12 – Delta Island Pumps, Electrical Usage

[52] Wikipedia contributors. (2023, October 21). Bouldin Island. Wikipedia. https://en.wikipedia.org/wiki/Bouldin_Island
[53] Ryan, Russell. (2020). Bacon Island west discharge pump photo

Figure 13 and **Figure 14** are samples of the annual energy demands from the PG&E power bills at selective pump stations on Bouldin Island and Webb Tract. These figures illustrate the variability of energy demand at the pump stations. For example, **Figure 13** depicts high energy demand during winter with incidental spikes between June and September at the Bouldin South Pump Station. In contrast, **Figure 14** shows an even spread of energy demand throughout the year at the Webb Tract West Pump Station.

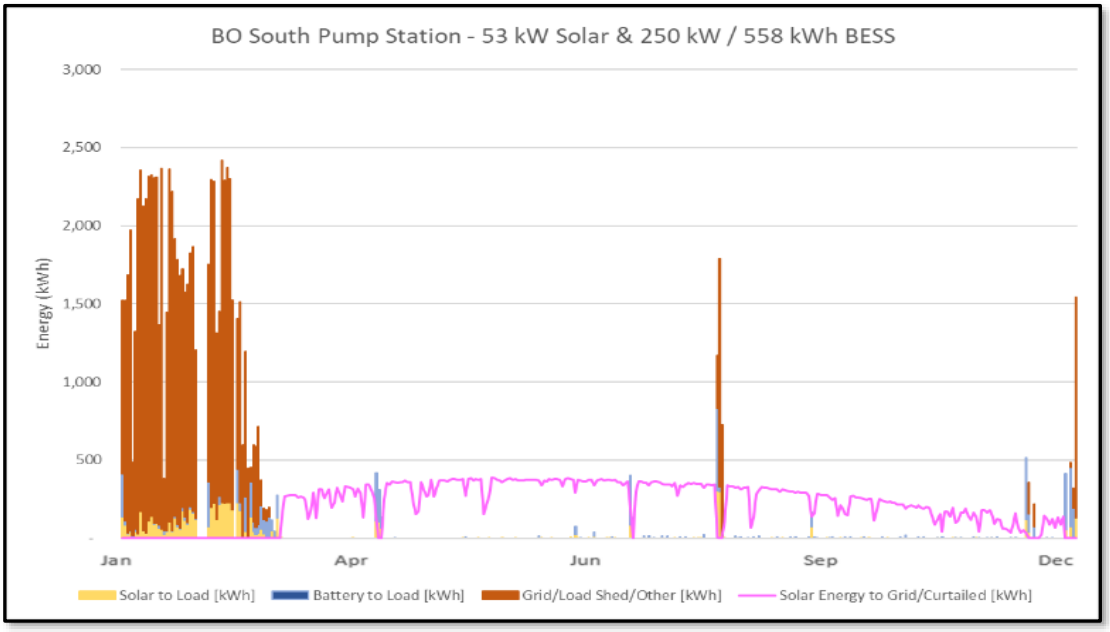

Figure 13 – Bouldin Island South Pump Station

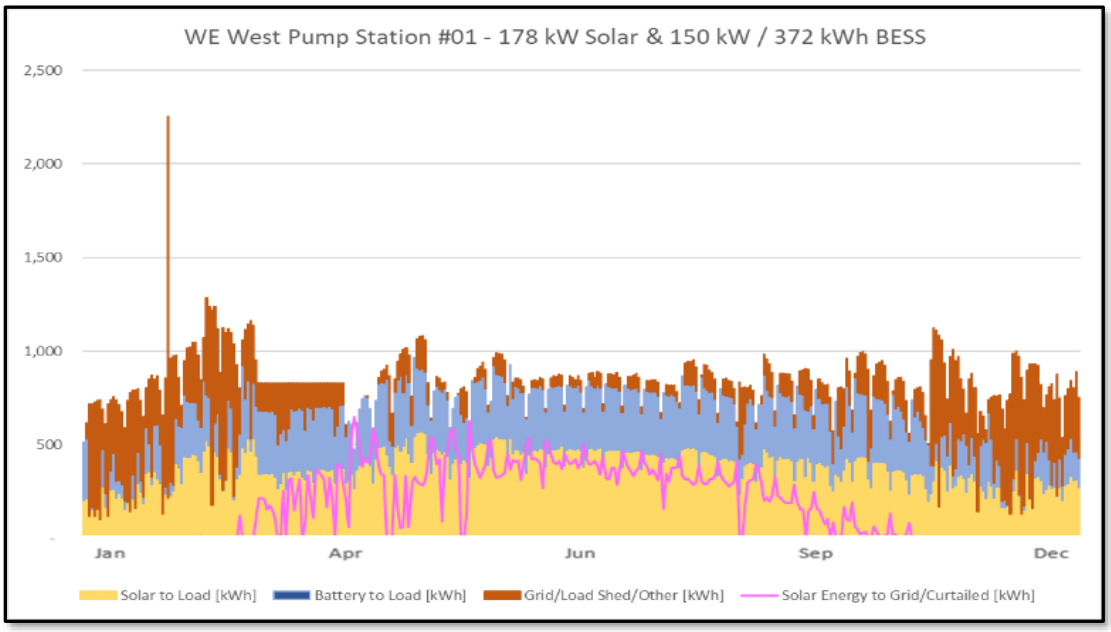

Figure 14 – Webb Tract West Pump Station

Table 19 details the solar system and battery storage sizes needed to meet the project objectives identified in the draft November 2023 Clean Coalition report to Metropolitan. In addition, **Table 19** identifies the current costs and federal tax credits available.

Table 19 – System Size, Costs, and Incentives

MWD - System Size, Costs, and Incentives								
Meter	Solar System Size & Cost		Battery Storage System Size & Cost			Solar Microgrid Capital Expenditure	40% ITC Direct Pay (30% ITC + 10% Low-Income Bonus Adder)	Net Capital Expenditure
	Solar System Size	Solar System Cost	Battery Storage Power Capacity (kW)	Battery Storage Energy Capacity (kWh)	Battery Storage System Cost			
BO South Pump Station	53	($211,200)	250	558	($837,000)	($1,048,200)	$419,280	($628,920)
BO West Pump Station	192	($768,000)	250	558	($837,000)	($1,605,000)	$642,000	($963,000)
WE South Pump Station #01	29	($115,200)	100	186	($279,000)	($394,200)	$157,680	($236,520)
WE West Pump Station #01	178	($710,400)	150	372	($558,000)	($1,268,400)	$507,360	($761,040)
HO Pump Station #01	46	($182,400)	100	372	($558,000)	($740,400)	$296,160	($444,240)
HO Pump Station #03	26	($105,600)	50	186	($279,000)	($384,600)	$153,840	($230,760)
HO Pump Station #02	26	($105,600)	100	186	($279,000)	($384,600)	$153,840	($230,760)
BA West Pump Station	197	($787,200)	300	744	($1,116,000)	($1,903,200)	$761,280	($1,141,920)
BA North Pump Station	182	($729,600)	250	558	($837,000)	($1,566,600)	$626,640	($939,960)
Total	929	($3,715,200)	1,550	3,720	($5,580,000)	($9,295,200)	$3,718,080	($5,577,120)

Table 20 summarizes the solar siting analysis from the draft November 2023 Clean Coalition report to Metropolitan. This analysis calculates baseline energy load and the size of the solar facility needed to meet project objectives.

Table 20 – Solar Siting Summary

MWD - Total Solar Siting Summary						
Meter	Baseline Annual Load (kWh)	Solar System Size (kWdc)	kWh per kWp	Annual Solar Generation (kWh)	Solar Siting Potential as a Percentage of Net Zero	Square Feet
BO South Pump Station	90,302	53	1,741	91,916	102%	2,981
BO West Pump Station	330,795	192	1,723	330,848	100%	10,877
WE South Pump Station #01	47,520	29	1,744	50,223	106%	1,636
WE West Pump Station #01	307,170	178	1,733	307,770	100%	10,057
HO Pump Station #01	77,378	46	1,738	79,259	102%	2,582
HO Pump Station #03	42,688	26	1,741	45,975	108%	1,491
HO Pump Station #02	45,015	26	1,742	45,994	102%	1,506
BA West Pump Station	333,308	197	1,705	335,580	101%	11,009
BA North Pump Station	314,998	182	1,733	316,176	100%	10,247
Total	1,589,175	929	1,733	1,603,741	101%	52,386

Fiscal Analysis

In identifying financing options, staff evaluated four types of business models that could be used to finance the capital costs to purchase solar microgrids for each pump station:

- Cash Purchase
- Power Purchase Agreement (PPA)
- Solar-Only Cash Purchase
- Solar-Only PPA

Cash Purchase. Under this business model, property owner (e.g., Metropolitan) pays cash for the solar microgrid system and both owns and operates the system. This approach normally yields the most favorable economics for the property owner over the long-term.

As shown in **Table 21**, the cash price estimate for installation, including operation and maintenance costs over a 25-year lifetime is estimated to be $7.9 million after application of available federal incentives.

Table 21 – Estimated Costs of Solar Microgrids

Costs of the Solar Microgrids (at the nine pump stations)	
Estimated Expenditures	**Cost**
Solar Panels and Battery Energy Storage Systems	$9.3 million
O&M	$2.3 million
Subtotal (25-year lifetime cost)	**$11.6 million**
Federal Incentives (Direct Pay feature - Inflation Reduction Act	$3.7 million
TOTAL	**$7.9 million**

Table 22 – Estimated Cost Avoidance - Power Savings

Estimated Cost Avoidance – Power Savings	
Estimated Electricity (PG&E Electric Bill)	**Cost**
Without Any Solar	$45 million
With Solar Microgrid	$19 million
Net Savings	**$26 million**

PPA. Under this business model, a third party owns and operates the solar microgrids, covering all capital expenditures and operations and maintenance costs. The third-party owner assumes the development and performance risks. The property owner (e.g., Metropolitan) would purchase the generated solar energy. This business model approach usually has lower yields and less cost savings to the property owner.

Solar-Only Cash Purchase. Under this business model, the property owner (e.g., Metropolitan) owns the solar-only system, but does not fund purchase and installation of the BESS. Although cheaper, this approach does not provide backup energy in the event of a power outage on the local power grid and resiliency is lost.

Solar-Only PPA. Under this business model, a third party owns and operates the solar-only system. This approach results in less cost savings for the property owner and does not provide backup energy in the event of a power outage on the local power grid.

Table 23 summarizes the payback period of the each of the business models (Solar Microgrid Cash Purchase, PPA, and Solar-Only Cash Purchase), applying the project's economic assumptions. As mentioned, each pump station's electric load demand is seasonal and dependent on the location and pump discharge station usage. The results of the payback analysis reflect these distinctive characteristics.

Overall, the economics of the Solar-Only Cash Purchase business model results in an average payback period of 11 years compared to the Solar-Microgrid Cash Purchase, which has an average payback period of 16 years. Note, the Solar-Only Cash Purchase does not include a battery energy storage system and thus does not meet the criteria of increased resiliency. The green highlighted cells in **Table 23** indicate a payback period of 10 years or less.

Table 23 – Summary of Payback Period Based on the Business Model Type

MWD BDI - Payback Period Summary by Transaction and System Type				
Site Name	Payback Period (Years)			
	Solar only		Solar Microgrid	
	Cash Purchase	PPA	Cash Purchase	PPA
BO South Pump Station	11	16	19	20
BO West Pump Station	11	16	10	21
WE South Pump Station #01	11	16	19	25
WE West Pump Station #01	9	10	10	24
HO Pump Station #01	12	18	19	22
HO Pump Station #03	12	17	19	24
HO Pump Station #02	12	19	20	25
BA West Pump Station	10	13	13	25
BA North Pump Station	9	11	12	25
Average	**11**	**15**	**16**	**23**

BO = Bouldin Island, WE = Webb Tract, HO = Holland Tract, BA = Bacon Island

Key Findings. The following is a summary of the key finding of the analysis:

- Solar microgrids, if implemented at the Delta islands pumping stations, forecast an energy cost-savings of $26 million or 40 percent **(Table 22)** and a reduction in GHG emissions of 1,150 metric tons of CO_2 per year over the 25-year lifetime;

- Solar microgrids achieve the clean energy goals identified in Metropolitan's Climate Action Plan and provide resilience benefits in the event of a power outage.;
- Solar microgrids provide additional resiliency benefits by providing battery storage that can discharge energy during power outages or interruptions; and
- Small-scale solar projects are more costly per unit of energy and have a longer payback period than larger-scale facilities.

Recommended Future Studies. To find optimal energy resilience and cost savings solutions, the following studies are recommended:

- Conducting a pilot study at one of the pumping plants would assist in better understanding benefits, costs, and implementation issues; and
- Supplemental studies could be conducted to compare other alternative approaches including: (1) pumps with diesel generators; (2) pumps with diesel generators and solar; and (3) pumps with solar.

Overview

Carbon capture and storage (CCS) involves capturing CO_2 emissions produced by industrial facilities and power plants and storing it underground in deep geologic formations to mitigate global warming and facilitate carbon reduction goals. A report in 2020 by Stanford University's Doerr School of Sustainability stated that "carbon capture and storage is a critical decarbonization pathway for helping California meet its 2045 carbon neutrality goal."[54] The Intergovernmental Panel on Climate Change highlighted that, "if we are to achieve the ambitions of the Paris Agreement and limit future temperature increases to 1.5°C (2.7°F), we must do more than just increasing efforts to reduce emissions – we also need to deploy technologies to remove carbon from the atmosphere." CCS is one of these technologies and can play an important role in halting global warming.

GSG Emission Legislation. In 2018, the Governor's Executive Order B-55-18 committed California to achieve a just and equitable transition to carbon neutrality by 2045. This goal requires significant reductions in GHG emissions and removal of CO_2 from the atmosphere, including sequestration in forests, soils, and other natural landscapes.

In 2020, Governor Gavin Newsom signed Executive Order N-82-20,[55] directing the state to leverage California's natural and working lands (NWL) to implement nature-based solutions that will deliver meaningful and credible climate outcomes that achieve carbon neutrality and build resilience to climate change impacts. The California Natural Resources Agency (CNRA) leads the Expanding Nature-Based Solutions Initiative, which includes:

- Developing a Climate Smart Lands Strategy, in collaboration with other state agencies including the Office of Planning and Research, to accelerate and expand climate smart land management across California to increase carbon removal and sequestration and build climate resilience; and
- Advancing the 30x30 goal to conserve at least 30 percent of California's land and coastal waters by 2030 as part of the international effort to combat the biodiversity and climate crises.

In August 2022, Governor Newsom presented Climate Proposals[56] to the State Legislature that includes:

- Codifying statewide carbon neutrality goal to dramatically reduce climate pollution;

[54] Roadmap for carbon capture and storage in California. (2020, October 27). Stanford Doerr School of Sustainability. https://sustainability.stanford.edu/news/roadmap-carbon-capture-and-storage-california
[55] Expanding Nature-Based solutions. (n.d.). https://resources.ca.gov/Initiatives/Expanding-Nature-Based-Solutions
[56] Villasenor, D. (2022, August 12). Governor Newsom's ambitious climate proposals presented to legislature | California Governor. California Governor. https://www.gov.ca.gov/2022/08/12/governor-newsoms-ambitious-climate-proposals-presented-to-legislature/

- Ramping up the 2030 climate goal target from 40 percent to 55 percent below the 1990 level;
- Protecting communities from the harmful impacts of the oil industry;
- Establishing a pathway toward the state's clean energy future; and
- Advancing natural and engineered technologies for carbon removal and carbon capture, and carbon sequestration for NWLs.

CCS is essential to meet the state of California Administration's goal of 40 percent emission reductions by 2030, and ultimately carbon neutrality by 2045.

Figure 15 shows the progression of California's emission goals then and now.

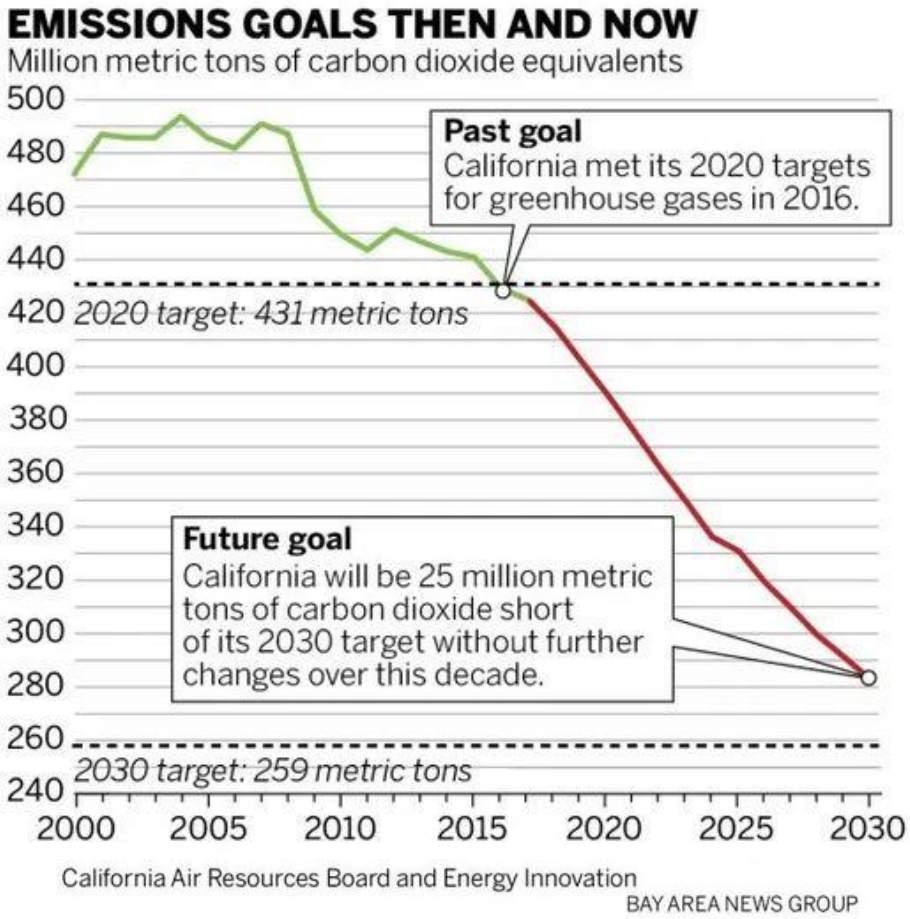

Figure 15 – California Emission Goals Then and Now [57]

The past goal of meeting 2020 targets of reducing 431 MTCO2e was met in 2016. It is estimated that if California continues the current trajectory, the state will fall short of its 2030 target by 25 million MTCO2e.

[57] Rogers, P. (2020, January 16). California's behind on its 2030 climate goals. What's at stake if it doesn't catch up? The Mercury News. https://www.mercurynews.com/2020/01/16/new-study-more-renewable-energy-electric-vehicles-needed-for-california-to-hit-greenhouse-gas-targets/

This highlights the need to identify additional emissions reduction measures to meet both the state's interim 2030 goals but also its goal of carbon neutrality by 2045.

History of Carbon Capture and Storage. Large CCS operations have been in operation around the world for over 40 years. One of the notable early CCS projects is the Sleipner Project in Norway, which began operation in 1996 and involved the injection of about 1 million tons per year of CO_2 into a saline aquifer for long-term storage. This project provided valuable insights and technical knowledge that influenced CCS research and development in the United States.

In the United States, CCS dates back several decades. In the 1970s, the U.S. Department of Energy (DOE) began researching and developing CCS technologies as part of efforts to reduce GHG emissions. In the 1990s, the DOE launched the Clean Coal Technology Program, which included funding for CCS research and demonstration projects.

In the early 2000s, the U.S. government, through various initiatives and partnerships, supported the development of CCS technologies, including the FutureGen project, which aimed to build a near-zero emissions coal-fired power plant with CCS. The enactment of the Energy Policy Act of 2005 further provided funding and incentives for CCS research and development.

In more recent years, the U.S. has seen the development of several large-scale CCS projects, including the Petra Nova facility in Texas, which captures CO_2 from a power plant and stores it underground, and the Illinois Industrial CCS project, which aims to capture and store CO_2 from industrial sources.

With growing recognition of the need to address climate change, there is renewed interest and investment in CCS as a potential tool for reducing carbon emissions in the U.S. This has led to ongoing research, development, and demonstration efforts to advance CCS technologies and facilitate their widespread deployment in the country.

Carbon Capture and Storage Projects in California. California has several CCS projects in various stages of development. These projects are part of the state's efforts to reduce GHG emissions and combat climate change. Some notable CCS projects **(Figure 16)** in California include:

- The Shute Creek Gas Processing Plant: Located in Kern County, this project captures and stores CO_2 from natural gas processing. The captured CO_2 is then transported via pipeline to oil fields for use in enhanced oil recovery (EOR) operations.

- The West Ranch Oil Field CCS Project: This project, situated in the San Joaquin Valley, involves the injection of captured CO_2 into depleted oil reservoirs for EOR. The CO_2 is sourced from a nearby hydrogen production facility.

- The Northern California CO_2 Reduction Project:[58,59] This project, located in Solano County (Montezuma Hills), focuses on capturing CO_2 emissions and injecting into underground geologic formations.

- The California Carbon Capture and Storage Review Project: This initiative involves the assessment and evaluation of potential CCS sites across California, with a focus on identifying suitable geological formations for CO_2 storage.

These projects demonstrate California's commitment to exploring CCS as a means of reducing carbon emissions and meeting its climate goals. Additionally, the state's strong regulatory framework and support for clean energy technologies provide a conducive environment for the development of CCS projects.

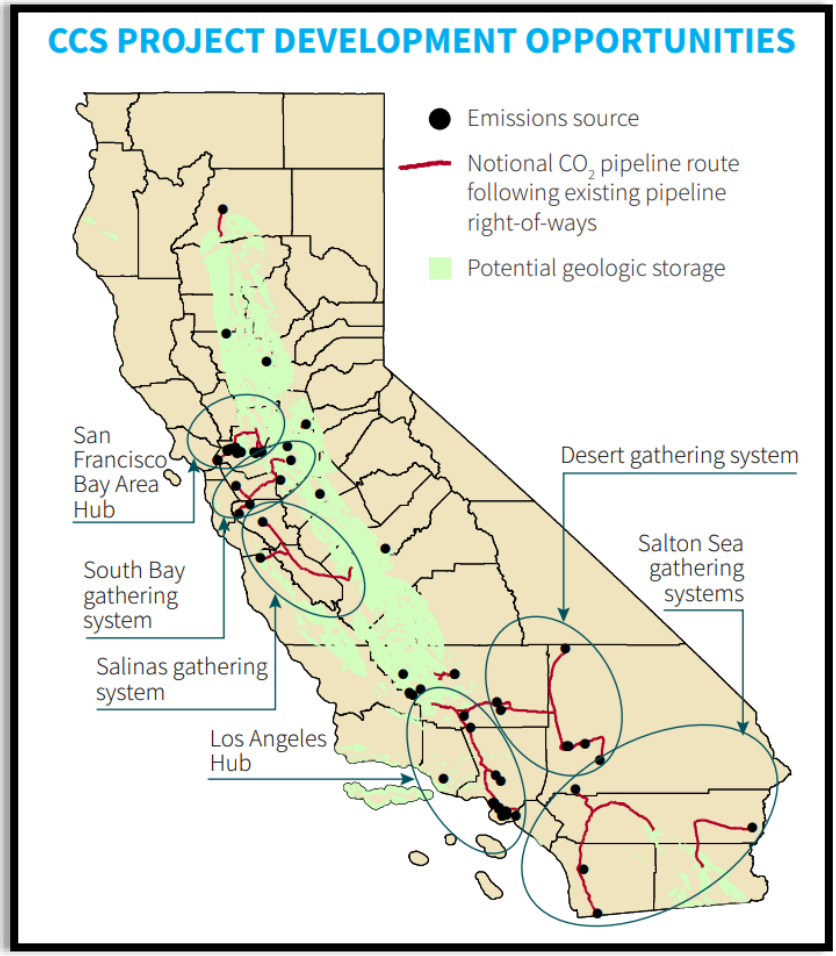

Figure 16 – Carbon Capture & Storage Development Opportunities[60]

[58] Siteadmin. (2023, August 31). Major carbon capture and Sequestration project unveiled for SF Bay Delta Region | KPFA. KPFA. https://kpfa.org/episode/terra-verde-september-1-2023/

[59] Wagoner, J. L. (2010). Final Report for Phase I Northern California CO2 Reduction Project. https://doi.org/10.2172/1018780

[60] Carbon Capture and Storage project development opportunities in California - Bing. (n.d.). Bing. https://www.bing.com/images/search?view=detailV2&ccid=xybq51bg&id=2294699769EE8C2C240EFC29F8E48EB45FC8A6A0&thid=OIP.xybq51bgzoHzqhO2WAFSiAHaHv&mediaurl=https%3a%2f%2fsccs.stanford.edu%2fsites%2fg%2ffiles%2fsbiybj17761%2ffiles%2f

Carbon Capture and Storage Safety. CCS can be safely stored underground if proper safety measures and protocols are followed. The storage of captured CO_2 underground involves injecting the CO_2 into deep geological formations, such as saline aquifers, and then sealing the storage site to prevent leakage. The safety of underground storage depends on thorough site characterization to ensure the geological formations are suitable for long-term CO_2 storage. Additionally, monitoring and verification processes are essential to continuously assess the integrity of the storage site and detect any potential leaks. Regulatory frameworks and industry standards also play a crucial role in governing the safe implementation of CCS projects and ensuring compliance with safety requirements.

Lawrence Livermore National Laboratory Report on Carbon Capture and Storage in the Delta. In August 2021, Lawrence Livermore National Laboratory provided a reconnaissance report for Carbon Dioxide Capture and Storage in the California Delta on Metropolitan's Delta islands.[61] The report identified the potential of Carbon Capture Storage in three geologic formation underlying Metropolitan's islands. The report estimated a total storage of between 3.5 to 14.1 billion tons of CO_2 that could provide potential new revenues of up to hundreds of million dollars annually. **Figure 17** summarizes information about CCS in the Delta.

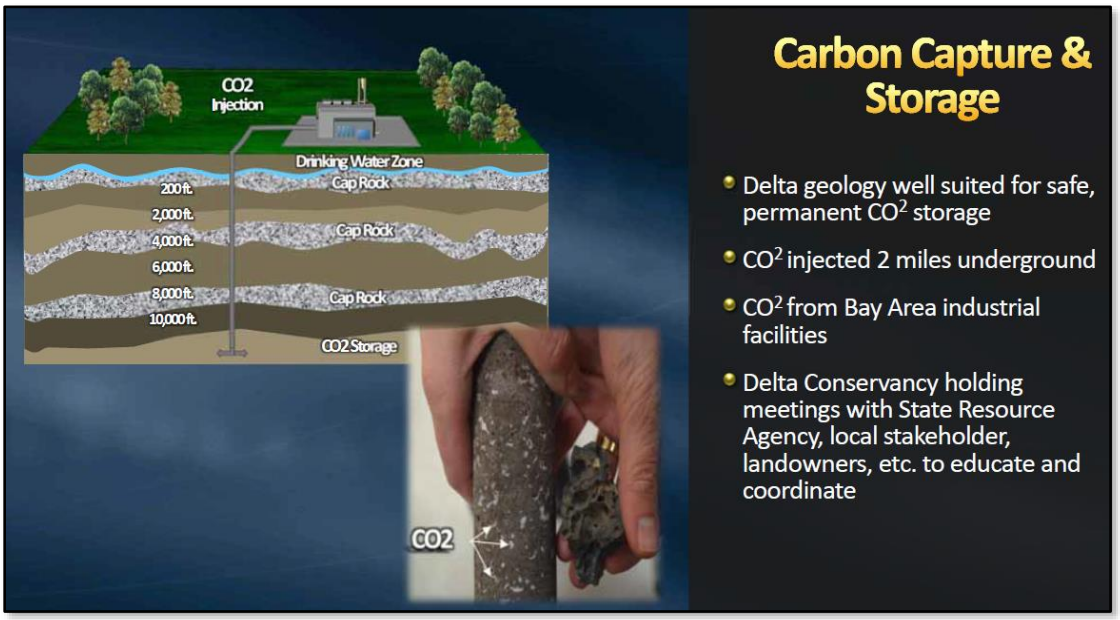

Figure 17 – Carbon Capture and Storage Summary

Metropolitan Water District's properties in the Delta (Bouldin Island, Webb Tract, Holland Tract and Bacon Island) are located within the southern Sacramento sedimentary basin.[62] The Sacramento Basin forms the

styles%2flarge%2fpublic%2fmedia%2fimage%2fccs_project_dev1_0.png%3fitok%3dOB8wGSQr&cdnurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.c726eae756e0ce81f3aa13b658015288%3frik%3doKbIX7SO5Pgp%252fA%26pid%3dImgRaw%26r%3d0&exph=502&expw=480&q=ccs+project+development+opportunities+in+california&simid=608046990408164383&FORM=IRPRST&ck=4D7857D4347D5FCEBE7E938B5E91FBEC&selectedIndex=1&itb=0&ajaxhist=0&ajaxserp=0

[61] Schmidt, Briana; Peridas George. (August 2021). Carbon Dioxide Capture and Storage in the California Delta. Lawrence Livermore National Laboratory

[62] A sedimentary basin is a topographic depression in which sediment accumulates.

northern part of California's Great Valley Basin and is separated by the Stockton Arch from the San Joaquin Basin, which forms the southern part of the Great Valley. It is bounded on the east by the Sierra Nevada and on the west by the Coast Range. The Sacramento Basin contains more than 20,000 feet of marine and nonmarine sedimentary rock that was deposited beginning in the Early Cretaceous.[63] The basin is bisected lengthwise by the northwest-southeast trending Midland Fault. The geology has been extensively explored and characterized for hydrocarbon production and the basin contains more than 120 gas fields that have collectively produced more than 9 trillion cubic feet of natural gas.[64,65]

Three formations show the greatest promise for carbon sequestration in the southern Sacramento Basin based on factors such as areal extent, depth, and history of gas production: the Upper Cretaceous Mokelumne River, Starkey, and Winters sandstones.[66] Locally, other formations may also be suitable sequestration targets.

- Winters: The Winters Formation consists of sand-rich slope and submarine fan deposits. It is underlain by the Sacramento Shale and overlain by the Sawtooth Shale.[67]
- Starkey: The Starkey Formation is a fluvial-deltaic deposit, consisting of at least six deltaic cycles.[68] The Starkey sands thin and pinch out to the southwest, grading into shales. It is sealed by the H&T shale. The formation has been partly to completely eroded by the Markley submarine canyon.[69]
- Mokelumne River: The Mokelumne River Formation (MRF) is a fluvial-deltaic deposit consisting of interbedded sandstones and shales in the northern part of the deposit and grading into massive sandstone in the southern part of the deposit.[70] The formation has locally been partially to completely eroded by the Paleocene Markley, Martinez, and Meganos submarine canyons, which were subsequently filled with fine-grained sediments. It is underlain by the H&T Shale and sealed by the Martinez and Capay Shales, west and east of the Midland fault, respectively.

In 2010, as part of the West Coast Regional Carbon Sequestration Partnership organized by the Department of Energy (DOE), the California Geological Survey also conducted a preliminary regional geologic assessment of

[63] Scheirer, A. H., Tennyson, M. E., Magoon, L. B., Charpentier, R. R., Cook, T. A., Klett, T. R., ... & Schenk, C. J. (2007). Assessment of undiscovered natural gas resources of the Sacramento Basin province of California, 2006 (No. 2007-3014). Geological Survey (US).
[64] Scheirer, 2007.
[65] Schenk, C.J., Mercier, T.J., Tennyson, M.E., Woodall, C.A., Marra, K.R., Leathers-Miller, H.M., and Le, P.A., 2020, Assessment of undiscovered gas resources of the Sacramento Basin Province in California, 2019: U.S. Geological Survey Fact Sheet 2020–3036, 4 p., https://doi.org/10.3133/fs20203036.
[66] Downey, C. & Clinkenbeard, J. P. (2010). Preliminary Geologic Assessment of the Carbon Sequestration Potential of the Upper Cretaceous Mokelumne River, Starkey, and Winters Formations: Southern Sacramento Basin, California: PIER Collaborative Report. California Energy Commission.
[67] Moore, D.W., and Nilson, T.H. (1990). Upper Campanian and Lower Maestrichtian Depositional Systems, Southern Sacramento Basin, California. Sacramento Valley Symposium and Guidebook: Pacific Section SEPM. Vol 65. p. 133-142.
[68] Moore and Nilson, 1990
[69] Downey & Clinkenbeard, 2010.
[70] Johnson, D. S. (1990). Depositional Environment of the Upper Cretaceous Mokelumne River Formation, Sacramento Basin, California. Sacramento Valley Symposium and Guidebook: Pacific Section SEPM. Vol 65. p. 81-93.

the carbon sequestration potential of the southern Sacramento Basin, focusing on the Mokelumne River, Starkey, and Winters.[71] The authors used a set of three screening criteria to assess storage suitability:

- Depth to storage formation greater than 1000 meters, to ensure that CO_2 will remain in the supercritical[72] state;
- Caprock thickness greater than 100 meters, to provide adequate seals to prevent CO_2 migration; and
- Absence of submarine canyon erosion, to eliminate locations that may lack adequate storage capacity.

Figure 18 shows the locations where the MRF, Starkey, and Winters formations are present and meet the four criteria for CO_2 storage described above (caprock greater than 100 meters thick, storage formation depth greater than 1000 meters, and absence of submarine canyon erosion).[73]

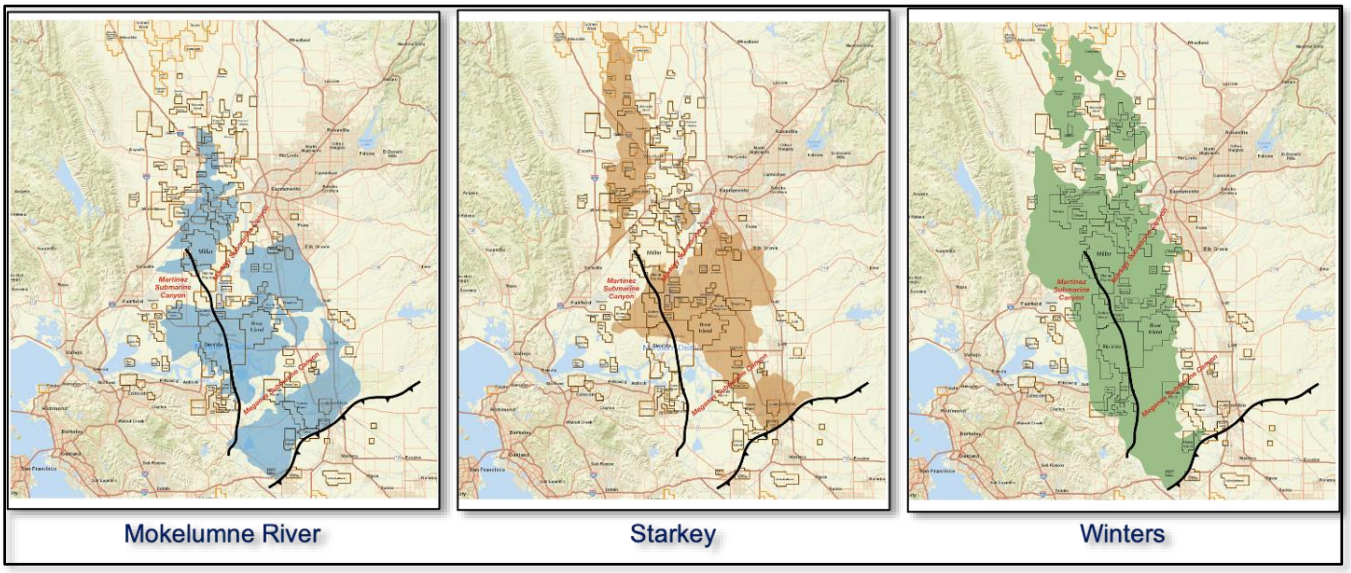

Figure 18 – Mokelumne River, Starkey, and Winters Geologic (CO_2) Storage Formations

Metropolitan Islands Initial Storage Estimates. Storage capacity estimates were made using rock volumes derived from the 3D geologic model and using the prospective storage resource estimation methodologies developed by the National Energy Technology Laboratory (NETL), as described in Goodman et al., 2011;[74]

[71] Downey & Clinkenbeard, 2010.
[72] A supercritical fluid is a substance at a pressure and temperature at or above the "critical point" and has properties of both a liquid and a gas – it has densities similar to the liquid phase but expands to fill its container like a gas. The critical point for CO2 is approximately 88°F and 73 atm (73 times the pressure at earth's surface).
[73] Baker, S.E., Stolaroff, J.K., Peridas, G., Pang, S.H., Goldstein, H.M., Lucci, F.R., Li, W., Slessarev, E.W., Pett-Ridge, J., Ryerson, F.J., Wagoner, J.L., Kirkendall, W., Aines, R.D., Sanchez, D.L., Cabiyo, B., Baker, J., McCoy, S., Uden, S., Runnebaum, R. Wilcox, J., Psarras, P.C., Pilorgé, H., McQueen, N., Maynard, D., McCormick, C. Getting to Neutral: Options for Negative Carbon Emissions in California, January, 2020, Lawrence Livermore National Laboratory, LLNL-TR-796100.
[74] Goodman, A., Hakala, A., Bromhal, G., Deel, D., Rodosta, T., Frailey, S. & Guthrie, G. (2011). US DOE methodology for the development of geologic storage potential for carbon dioxide at the national and regional scale. International Journal of Greenhouse Gas Control, 5(4), 952-965.

Goodman et al., 2013;[75] and Goodman et al., 2016.[76] The large uncertainties (see **Table 24**) regarding key inputs such as rock properties (porosity, permeability, etc.), water saturation, and others are reflected in the large storage resource estimate range. Note that storage volumes were calculated for only the portion of Holland Tract owned by Metropolitan (**Table 25**).

Table 24 – CO_2 Storage Potential by Statistical Confidence Under Metropolitan's Islands

Estimated CO_2 Storage Potential by Statistical Confidence (Millions of metric tons)			
Island	**P90**	**P50**	**P10**
Bacon	4	16	46
Bouldin	32	121	343
Holland	17	65	187
Webb	37	139	402

Estimated CO2 storage potential for Metropolitan Delta properties by statistical confidence level: P90 represents the value that 90 percent of estimates exceed (low end), P50 represents the value that 50 percent of estimates exceed (mean), and P10 represents the value that 10 percent of estimates exceed (high end).

Table 25 – Potential CO_2 Storage under Metropolitan's Islands

CO_2 Storage Potential by Geologic Formation (Millions of metric tons)				
Geologic Formation	**Bacon**	**Bouldin**	**Holland**	**Webb**
Mokelumne River	0	72	45	78
Starkey	0	12	0	0
Winters	16	37	20	62
Total	**16**	**121**	**65**	**139**

(1) Estimated mean (P50) CO2 storage potential by island for Metropolitan's Delta properties.

Investment Opportunities

Revenue Sources for CCS Projects. Capturing CO_2 from point sources is almost always more expensive than venting it (emitting it to the atmosphere). Depending on the concentration of the CO_2 in the flue gas and its pressure, the cost to capture CO_2 from different types of industrial sources may vary, but all projects typically

[75] Goodman, A., Bromhal, G., Strazisar, B., Rodosta, T., Guthrie, W. F., Allen, D., & Guthrie, G. (2013). Comparison of methods for geologic storage of carbon dioxide in saline formations. International Journal of Greenhouse Gas Control, 18, 329-342.
[76] Goodman, A., Sanguinito, S., & Levine, J. S. (2016). Prospective CO2 saline resource estimation methodology: Refinement of existing US-DOE-NETL methods based on data availability. International Journal of Greenhouse Gas Control, 54, 242-249

require a significant capital investment in infrastructure and involves ongoing operating costs. Removing CO_2 directly from the atmosphere is currently one of the most expensive forms of carbon removal, due to its even lower concentration in the atmosphere than in industrial emission streams. Possible exceptions are applications where the CO_2 has value and/or is utilized for a specific purpose that has economic value. For example, CO_2 – enhanced oil recovery, whereby CO_2 is injected in oil fields to produce oil that would otherwise remain stranded. Depending on the price of oil and other parameters, the practice may or may not be economical on its own. Processes are currently under development that can convert CO_2 to useful products. However, there is no enhanced oil recovery opportunity in the California Delta, and CO_2 conversion processes are generally at the nascent or early technological scale, thus here it is assumed that industrial CO_2 will be injected in saline formations.

Because of the added cost of CCS, projects are not currently viable in general without incentives or policies that encourage the use of the technology. No such mandates exist federally, and to date no state – not even California – mandates the use of CCS for applications. Therefore, CCS projects in California today have to rely on two programs: the California Low Carbon Fuel Standard, and the federal 45Q tax credit.

California's Low Carbon Fuel Standard (LCFS). LCFS was instituted in response to California's first overarching climate statute, the Global Warming Solutions Act of 2006, also known as AB 32.[77] The LCFS is part of the portfolio of tools under AB 32, and it aims to reduce the carbon intensity (CI – measured in gCO2e/MJ) of California's transportation fuels. The California Air Resources Board (CARB) first approved the LCFS regulation in 2009, with a target of decreasing transportation fuel CI by at least 10 percent by 2020 compared to a 2010 baseline. The regulation was amended in 2018 (effective Jan. 1, 2019)[78] with an updated target of a 20 percent CI reduction by 2030.

In the 2018 LCFS regulation amendments, CARB also adopted a CCS Protocol and opened eligibility for credit generation under the program to certain types of CCS projects – those that affect the lifecycle CI of transportation fuels used in California – and to direct air capture projects around the world. LCFS credits have generally been trading near the $200 per ton CO_2 mark since that time, generating a good deal of interest in CCS projects that qualify under the program.

Choosing to pursue certification under the LCFS for CCS projects is voluntary. However, certification requirements are substantial, and CARB's CCS Protocol has been characterized as the most comprehensive CCS regulation in any jurisdiction. Two basic steps are required for CCS projects to generate credits under the LCFS: certification of a fuel pathway under the program for the project type in question, if none already exists or if the project does not fall under one of the types explicitly listed in the program, certification under the CCS Protocol.

[77] "Global Warming Solutions Act of 2006." California Air Resources Board. Accessed November 2020. https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006
[78] LCFS Regulation | California Air Resources Board. (n.d.). https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/lcfs-regulation

The LCFS allows for credit generation in three main ways.[79]

- Fuel pathway-based crediting;
- Project-based crediting; and
- Capacity-based crediting.

Under fuel pathway crediting, applicants obtain a certified CI score for their fuel, which is based on a lifecycle analysis of the process for producing and supplying the fuel to the California market. Fuel pathways fall under two tiers: Tier 1 comprises the most encountered applications and fuel types and includes a pre-approved look-up table for these pathways, whereas Tier 2 comprises the less common and more complicated pathways that CARB evaluates and certifies individually. Currently, CCS pathways are not included in Tier 1 and the LCFS regulation requires CCS fuel pathways to be Tier 2. New Tier 2 fuel pathways are typically submitted to CARB for informal review while in the draft stage, until they eventually undergo formal review and are subject to public comment when the details have been refined. The public comment window is usually 10 business days or 45 days for some pathway types. Verification occurs after credits have been issued, and credits are calculated relative to annual CI benchmarks. The 2018 LCFS amendments also introduced a design-based pathway as a special circumstance for fuel pathway applications.[80] Generally, LCFS fuel pathways are developed based on 24 months of operational data. To encourage development of innovative fuel and other technologies, CARB now allows a design-based pathway for a fully engineered and designed facility with no operational data. After a design-based pathway has been in production for at least three months, it is eligible to report and generate credits but first must complete a provisional pathway application. Approval of a provisional pathway application allows a transportation fuel or project to generate credits during its 24-month period of developing operational data.[81]

Under project-based crediting, CARB allows for certain types of explicitly listed projects to generate credits. These project types include emission-reduction actions at refineries, crude oil production, and transportation facilities, as well as direct air capture projects. Verification occurs before credits are issued, and the credits are equal to the lifecycle GHG emission reductions.

Under project-based crediting, CARB allows for certain types of explicitly listed projects to generate credits. These project types include emission-reduction actions at refineries, crude oil production, and transportation facilities, as well as direct air capture projects. Verification occurs before credits are issued, and the credits are equal to the lifecycle GHG emission reductions. Currently, capacity-based crediting does not apply to CCS.

[79] "Low Carbon Fuel Standard." California Air Resources Board. https://ww2.arb.ca.gov/sites/default/files/2020-09/basics-notes.pdf
[80] 17 CCR 95488.9(e) -- Section 95488.8 - Fuel Pathway Application Requirements Applying to All Classifications, Cal. Code Regs. tit. 17 § 95488.8 | Case text Search + Citator. (n.d.). https://casetext.com/regulation/california-code-of-regulations/title-17-public-health/division-3-air-resources/chapter-1-air-resources-board/subchapter-10-climate-change/article-4-regulations-to-achieve-greenhouse-gas-emission-reductions/subarticle-7-low-carbon-fuel-standard/section-954888-fuel-pathway-application-requirements-applying-to-all-classifications
[81] 17 CCR 95488.9(c).

CARB's CCS Protocol is a self-standing document but has been incorporated by reference into the LCFS regulation (but not yet under any of California's other climate programs, such as the Cap-and-Trade program).[82]

Federal 45Q Tax Credit. In 2008, Congress enacted a tax credit for CO_2 sequestration under Section 45Q of the Internal Revenue Code.[83] The credit amounted to $20 per ton CO_2 for pure storage and $10/ton CO_2 for settings in which CO_2 was being injected with enhanced hydrocarbon recovery. The credit soon proved too low to incentivize any CCS projects. Congress amended the 45Q tax credit in the Bipartisan Budget Act of 2018, increasing its value up to $50/ton CO_2 for pure storage, up to $35 per ton CO_2 for settings in which CO_2 was being injected with enhanced hydrocarbon recovery, and allowed other types of CO_2 utilization.

Other Revenue Sources. Other revenue sources may also be available for CO_2 sequestration projects. For instance, the U.S. Department of Energy distributes funding appropriated by Congress under its various research, development, and demonstration programs. Funding could apply to the capture stage or engineering aspects thereof, to the underground storage stage, or to project development. It could take the form of capital assistance, cost share for certain tasks, loan guarantees or other forms.

Assuming a total credit value of $250 per ton from both LCFS and 45Q, a project that captures and injects 1 million tons of CO_2 per year (a realistic, medium project size) could generate up to $250 million annually for a decade or more. This revenue would likely be used to cover capital, finance, and operating costs, but for some applications will be more than sufficient and should leave room for additional uses of the funds. For example, a portion of CCS revenues could be channeled to serve local community needs in the Delta, such as subsidence control, levee/road maintenance or other uses. The exact portion of the revenue stream that may be available is yet to be determined, and it is anticipated that community benefit agreements will be required for the benefits to accrue to Delta residents more generally.

Economic Viability Report. In 2023, Lawrence Livermore National Laboratory and the Clean Air Task Force published a report titled "Sharing the Benefits, How the Economics of Carbon Capture and Storage Projects in California Can Serve Communities, the Economy, and the Climate."[84] The report, studied the economics of different classes of CCS projects in California to assess their broad economic viability, the potential need for additional policy support, and their potential for local landowner and community benefits.

[82] "Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard." California Air Resources Board. https://ww2.arb.ca.gov/sites/default/files/2020-03/CCS_Protocol_Under_LCFS_8-13-18_ada.pdf

[83] 26 USC 45Q: Credit for carbon dioxide sequestration. (n.d.). https://uscode.house.gov/view.xhtml?req=granuleid:USC-2015-title26-section45Q&num=0&edition=2015

[84] Grove, Benjamin and Peridas, George (May 2023). Clean Air Task Force and Lawrence Livermore National Laboratory. Sharing the Benefits, How the Economics of Carbon Capture and Storage Projects in California Can Serve Communities, the Economy, and the Climate. https://www.llnl.gov/sites/gs/files/2023-06/ca-ccs-economic-study-report-v06.pdf

Fiscal Analysis

This analysis uses technical and economic data from Lawrence Livermore National Laboratory and the Clean Air Task Force to develop an estimate of revenue that could be generated from storage of CO_2 in geologic formations under Metropolitan's Delta islands.

Storage and Injection Capacity. The underground storage capacity for carbon dioxide (CO_2) is estimated to be between 3 to 14 billion metric tons, under all four islands, with the largest geological storage capacity under Bouldin and Webb. The injection capacity for CO_2 is projected to be 2.0 million metric tons per year for 30 years at Bouldin Island, and 1.0 million metric tons per year for 30 years at Webb Tract.

Revenue Credits. The two main revenue sources for CCS projects are the federal 45Q Tax Credit, which currently ranges from $50 to 80 per ton, and the California Low-Carbon Fuel Source Credit, which is currently $175 per ton of CO_2. These two revenue sources total approximately $225 to $255 per ton of reduced CO_2 emissions. Further economic analysis by Lawrence Livermore National Laboratory and the Clean Air Task Force, dated June 2023, estimates the net revenue after all expenses, including CO_2 capture, transportation, and injection, ranging from $93 to 114 per ton.

This analysis assumes that Metropolitan engages a partner to assist in the development of a CCS project on the Delta islands and uses a hypothetical 50/50 revenue share for discussion purposes only. **Table 26** below summarizes Metropolitan's estimated share of the net revenue potential of CCS project development on Metropolitan's islands.

Table 26 – Potential Net Revenue from Delta Island Carbon Capture and Storage

Delta Islands	Annual Net Revenue Estimate	
	Business as Usual 2030 Forecast	**Proposed Approach 2030 Forecast**
Bouldin Island	$0	$47 – 114 million
Webb Tract	$0	$47 – 114 million
Holland Tract	$0	$12 – 29 million
Bacon Island	$0	$6 – 14 million
TOTAL	**$0**	**$112 – 271 million**

Summary

The Risk Analysis considers several key risks facing the Sacramento-San Joaquin Delta, which includes the threat of flooding, earthquakes, land subsidence, sea-level rise, and the decline of native species and habitats. With aging levee and waterway infrastructure, combined with the effects of climate change, this poses significant challenges to the region's future. Additionally, the ongoing struggle to balance the needs of agriculture, urban development, and environmental conservation in the Delta presents a complex and ongoing challenge. However, as California continues to face water scarcity and environmental degradation, the Sacramento-San Joaquin Delta remains a critical and vulnerable area in need of careful management and protection. Metropolitan, through ownership of its Delta Islands, can play an important role in reducing key risks and safeguarding its source water supply from the Delta.

Risks. As a property owner, Metropolitan is responsible for maintaining the safety and security of its property and may be held liable for any accidents or injuries that occur on these lands. These risks are similar on all of Metropolitan's properties. Staff further analyzed the potential risk associated with levee failure and flooding since these Delta Island properties are below sea-level and surrounded by adjacent rivers and waterways. The analysis indicates that even potential flooding due to a complete levee failure would still leave considerable amount of time (i.e., ranging from multiple hours to days) for farm personnel to evacuate, reducing the potential of loss of life. Emergency response and evacuation plans have been developed and updated by each RD, which are on file with the County Offices of Emergency Services. In addition to the initial flooding from a levee breach, flooding would be expected to occur over multiple days, potentially inundating facilities on the island including barns and farm-worker housing owned by Metropolitan. Pump discharge stations, siphons and other facilities are located on the higher-elevation levees and likely would not be impacted. Most of the larger farm equipment is stored on the higher property elevations which lessens potential equipment losses.

The cost of reclaiming an island after flooding in the wake of a complete levee failure was analyzed based on costs associated with Jones Tract flooding in 2004, and other levee failures (see **Table 27**). The analysis included the cost of repairing the levee breach, island pump out, facility/equipment damage, crop damage, and flood fight labor. The estimated cost of recovering a single island after a levee failure ranges from $40 to $70 million. The financial risk to Metropolitan is estimated to be lower due to potential state and federal disaster relief funding, agricultural lease terms, etc. Based on other levee failures (**Table 27**), the time to repair a similar sized levee breach is approximately one month or less.

Introduction of FEMA standards for levees and significant investments to update Delta levees since the 1990s have reduced levee failures significantly. In addition, Metropolitan's current risk management practices including real-time early warning monitoring systems, daily levee inspections, weekly meetings with

Reclamation District staff, regular coordination meetings with County, State, and federal emergency management agencies, active disaster preparedness and response plans, flood fight training certification, levee enhancement activities, and efforts to further modernize the levee standards to reduce the risk of levee failure from potential seismic and sea-level rise events into the future.

Management Actions to Reduce Risks. To reduce risks in the Sacramento-San Joaquin Delta, management actions must be taken to address the unique challenges of the region. Metropolitan has taken an active leadership role in working with local interests and governmental agencies in developing and implementing these actions. In summary, these risk management actions include implementing levee improvements, developing on-island flood fight warehouses, conducting flood/seismic/sea-level rise vulnerability analyses, evaluating real-time early warning levee monitoring systems, and designing a modernized Delta levee standard to reduce flood, seismic and sea-level rise risks.

Background

The next three Sections will look at risks associated with the Delta region and then show how work on Metropolitan's islands has provided specific management actions that has reduced or potentially could reduce the same risks.

Key Risks. The four key risks in the Delta are flood and seismic (levee integrity), sea-level rise (due to climate variability), fishery declines, and subsidence control (**Figure 19**).

Figure 19 – Key Delta Risks

Flood. The Delta is a unique area of California, located at the confluence of the Sacramento and San Joaquin rivers, where the elevation of the land surface is as much as 25 feet below sea level. This area is protected from daily flooding by an extensive system of privately owned levees (730 miles) and 380 miles of levees that are part of DWR's State Plan of Flood Control Descriptive Document.[85]

DWR works with local governments to maintain and improve the levees that protect river inflow from becoming brackish with seawater intrusion and assure conveyance of fresh water across the Delta. The Delta is the source of irrigation, municipal, and industrial water supplies for two-thirds of California's population.

Seismic. The Sacramento-San Joaquin Delta in central California is particularly susceptible to damage in a large seismic event due to the vulnerability of the levees that protect cities, farms, and infrastructure. The Delta is located adjacent to the seismically active San Andreas fault system and is also subject to strong ground shaking from numerous other seismic sources in central California, including faults within the Delta. **Figure 20** shows some of the many large fault located in the San Francisco Bay area. In 2016, the USGS predicted that a 72 percent chance of at least a 6.7 magnitude earthquake could strike the Bay Delta region in the next 30 years.

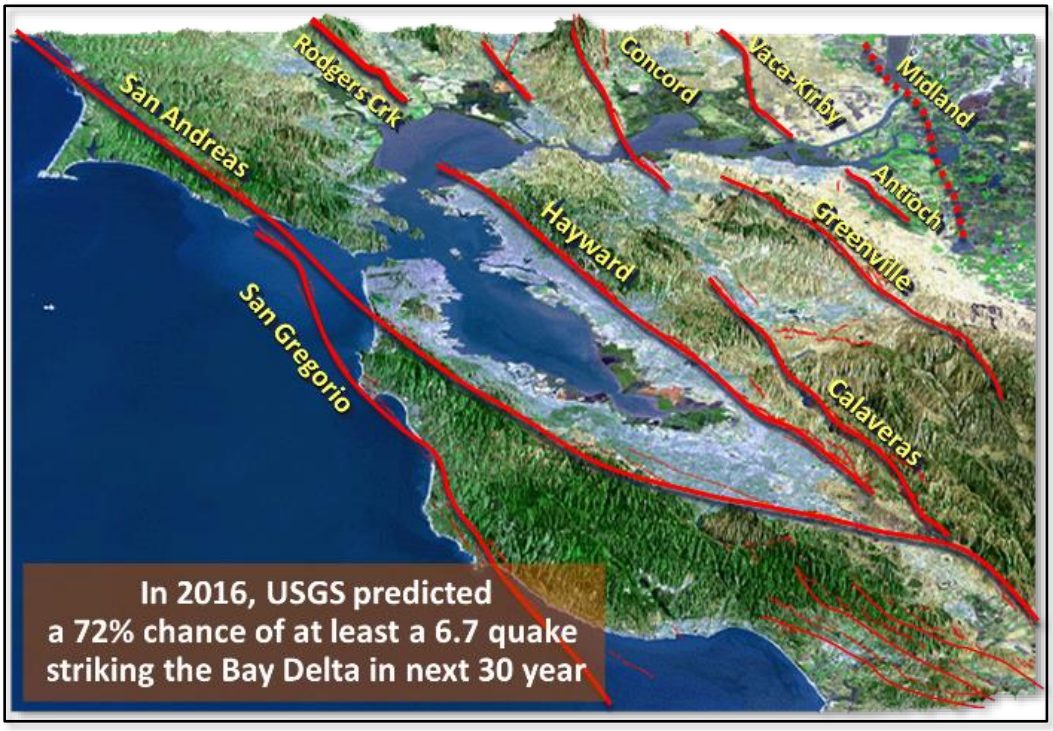

Figure 20 – USGS Earthquake Risk and Fault Locations[86]

[85] CENTRAL VALLEY FLOOD PROTECTION PLAN State Plan of Flood Control Descriptive Document. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Flood-Management/Flood-Planning-and-Studies/FSSR-and-SPFC/2022-SPFC_508.pdf

[86] Earthquake hazards of the Bay Area today. (n.d.). https://earthquake.usgs.gov/earthquakes/events/1868calif/virtualtour/modern.php

The Delta Risk Management Strategy Report[87] and the Delta Seismic Risk Report[88] were prepared by DWR's consultants including Jack Benjamin and Associates, Resource Management Associates, URS Corporation, Economic Insights, and others. Other information on seismic vulnerability is from the Public Policy Institute of California in their reports entitled "Envisioning Futures for the Sacramento-San Joaquin Delta"[89] and "California Water Myths."[90]

Additional information on the freshwater pathway emergency response approach was developed by the Metropolitan Water District in cooperation with the Department of Water Resources, the State Water Contractors, and the Central Valley Project Contractors.[91]

DWR and USGS have identified a significant seismic risk (from nearby faults) to Delta life, property, and services including a risk from widespread liquefaction, which could result in flooding of more than 20 to 30 islands which are currently below sea level. Salt water from the San Francisco Bay would likely rush into the central and south Delta quickly filling this the islands below sea level in a scene not too unlike the tsunami in northern Japan. While most subsided islands are sparsely populated, there could be significant loss of life on a few islands such as Bethel and Sherman Islands. In addition, this 'in-rush' of salt water is likely to render major Delta water supplies unusable as a freshwater source for up to many years.

The south Delta is a significant component of the state's water infrastructure, servicing two-thirds of California's residents, which includes the Bay Area, Central Valley, and Southern California. The Delta provides irrigation for 45 percent of the fruits and vegetables produced in the nation, as well as providing habitat for 500 species. Submerging many Delta islands would disrupt critical goods movement as well as natural gas and power transmission lines which traverse the Delta. In short, the Delta supports nearly half of California's $1.6 trillion economy, while Delta agriculture was valued at $1.4 billion in 2016.[92,93]

To help insulate the Delta water supplies from such catastrophic events, State Water Contractor agencies have worked together with DWR and USACE staff to explore options to preserve through Delta freshwater conveyance. Through extensive modeling and study, a freshwater "Pathway" plan was formulated, which could be implemented following catastrophic multi-island failures from severe earthquake or flood events. The 2018 Delta Flood Emergency Management Plan (DFEMP) identifies emergency response measures to neutralize salinity intrusion and identifies reasonable response priorities to benefit life and property, which

[87] Delta Risk Management Strategy Phase 1. (2010). California Department of Water Resources. DDJ_172_Flood_Hazard_TM.pdf (ca.gov)
[88] Delta Flood Risk Management Assessment District Feasibility Study and Delta Levee Financing Options (2018-05-17) Delta Protection Commission State of California. DFRMADFS_Final_Report_508.pdf (ca.gov)
[89] Envisioning futures for the Sacramento-San Joaquin Delta. (2021, June 8). Public Policy Institute of California. https://www.ppic.org/publication/envisioning-futures-for-the-sacramento-san-joaquin-delta/
[90] California Water myths. (2019, May 7). Public Policy Institute of California. https://www.ppic.org/publication/california-water-myths/
[91] California-Great Basin, Bureau of Reclamation. (n.d.). CVP Water Users/Contractors and Other sources | Central Valley Project Water Supply | California-Great Basin | Bureau of Reclamation. https://www.usbr.gov/mp/cvp-water/water-contractors.html
[92] Maven. (2019, October 6). MAVEN'S NOTEBOOK | California Water News Central. MAVEN'S NOTEBOOK | California Water News Central. https://mavensnotebook.com/2015/08/26/legislative-hearing-are-the-delta-tunnels-good-for-california-part-2-of-2/
[93] Michael, Jeffrey. University of the Pacific, Center for Business and Policy Research. (March 2019). Presentation to the Delta Protection Commission

includes the use of existing Middle River levees, incorporates the ability to be implemented within a reasonable timeframe using cost-effective means and ensures applicability under a full range of hydrologic and seismic conditions. An update to the 2019 DFEMP report that incorporates flood emergency exercises conducted 2021 is under DWR management review.

Feasibility analyses indicate that pre-positioning of materials and equipment is a prudent way to reduce the time needed to restore critical water supplies, since many of the severe economic consequences of a Delta disaster are related to the duration of an outage. Therefore, in 2007, DWR stockpiled initial rock materials for emergency operations which would be supplemented from outside sources during emergency flood fight operations. Advance placement of additional emergency material stockpiles is in planning and implementation stages. In addition, Metropolitan performed geotechnical stability analyses of freshwater pathway levees and encouraged measures to reduce levee slumping and levee breach repair time. While the emergency preparedness plan cannot, nor was it designed to, provide a long-term solution for the Delta, it is nonetheless necessary to ensure that California is able to preserve an important portion of statewide water supplies following a catastrophic seismic event.

Sea-Level Rise. Rising sea levels will increase the long-term risk of salinity intrusion throughout the Delta, which will impact operations and water quality, as well as potential threats to levees.

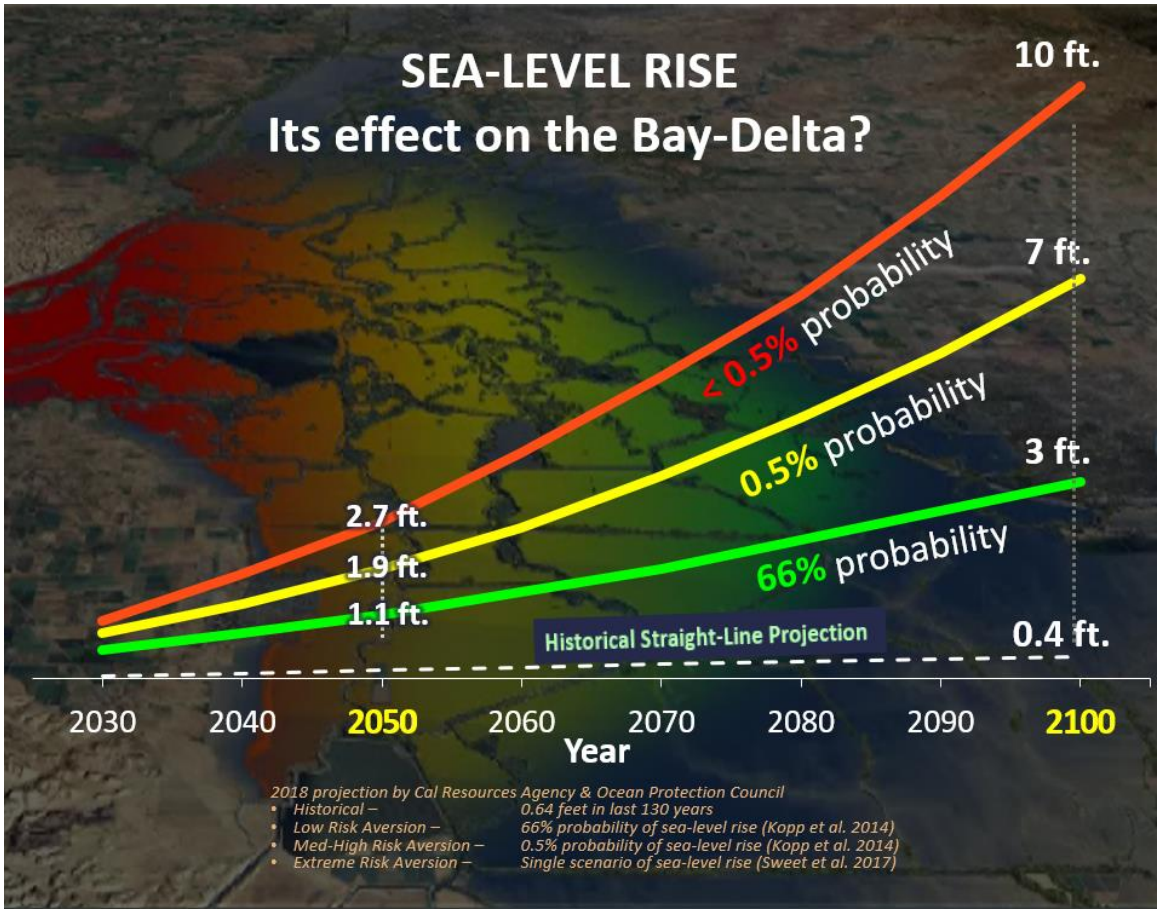

Figure 21 – San Francisco Bay Sea-Level Rise Projections

In 1854, at the height of the gold rush, a tidal gauge was built near where part of the Golden Gate Bridge sits now. It's the longest continuously operating tidal observation system in the Western Hemisphere. It has recorded 9 inches of sea level rise since its installation.

Scientists have predicted that for every foot of global sea-level rise caused by the loss of ice on West Antarctica, sea-level will rise approximately 1.25 feet along the California coast. Global sea level has been rising over the past century, and the rate has increased in recent decades. In 2014, global sea level was 2.6 inches above the 1993 average, the highest annual average seal level rise in the satellite record (1993 to present). Sea level continues to rise at a rate of about one-eighth of an inch per year.

According to the California Resources Agency and Ocean Protection Council (2018), sea-level rise projections at Golden Gate[94] will increase the long-term risk of salinity intrusion throughout the Delta, which will impact SWP operations and water quality and increase potential threats to levees.

The 2050 sea-level rise projection of 1.1 feet to 2.7 feet was included in the Delta levee analysis (**Figure 21**). The sea-level rise projection of 7 feet to 10 feet was not analyzed since, at these levels, a more comprehensive solution, likely near the Golden Gate Bridge, would have already been developed. At 7 feet to 10 feet of sea-level rise, major areas of the San Francisco Bay would see flooding including Oakland, Palo Alto, San Mateo, Napa, San Francisco International Airport, Oakland International Airport, Stockton, and parts of Sacramento (**Figure 22**).[95] The sea-level rise projection of 7 feet to 10 feet was not analyzed since, at these levels, a more comprehensive solution, likely near the Golden Gate Bridge, would likely have already been developed.

In January 2024, the OPC, in collaboration with the Ocean Science Trust and a scientific task force, released a draft update to their 2018 report.[96,97] The draft report includes changes to the sea-level rise projections (**Table 25**). The OPC's 66 percent probability projections have been lowered to 2.7 feet of sea-level rise by 2150 (versus 2100 in the 2018 report). In addition, the upper projection (i.e., 10 feet sea-level rise by 2100) was removed from the draft report.

[94] California Resources Agency & Ocean Protection Council (2018): Sea-Level rise projections at Golden Gate, rising-seas-in-california-an-update-on-sea-level-rise-science.pdf

[95] See your local sea level and coastal flood risk. (n.d.). Climate Central. https://riskfinder.climatecentral.org/place/stockton.ca.us?comparisonType=place&forecast%20Type=NOAA2017_%20int_p50&level=3&unit=ft

[96] California, S. O. (n.d.). State of California Sea level rise Guidance: 2024 Science and Policy Update – Draft released for public comment – California Ocean Protection Council. https://opc.ca.gov/2024/01/draft-slr-guidance-2024/

[97] Sea level rise and coastal flooding impacts. (2023). Sea Level Rise Viewer. https://coast.noaa.gov/slr/#/layer/slr/10/-13581792.555895444/%204611326.858201512/12/

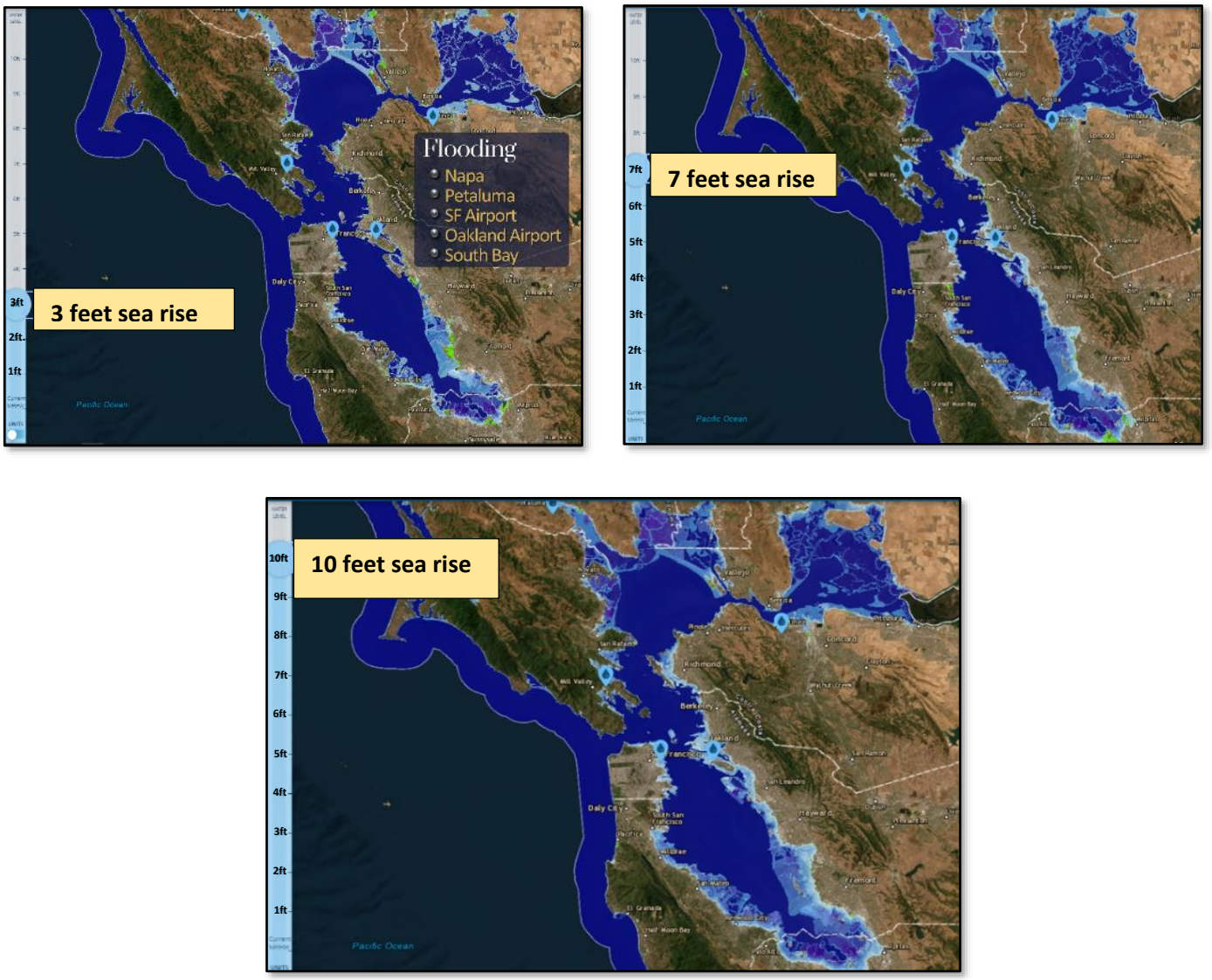

Figure 22 – Sea-Level Rise Projections/Flooding in San Francisco, San Pablo, and Suisun Bay Regions

Subsidence Control. There have been considerable discussions of the science of organic soil oxidation due to various agricultural and natural processes that contributes to land surface subsidence. Continued land subsidence puts additional pressure on levees from the island side and increases the risk of levee failure. By addressing land surface subsidence from agriculture practices and modernizing the levee structures, many of the key Delta risks are reduced. In addition, reducing subsidence (i.e., soil oxidation) allows for associated CO_2 reductions. Metropolitan has been actively pursuing carbon market opportunities through improved agricultural practice.

Figure 23 illustrates the generalized cross-section of a Metropolitan Delta Island, which has similarities with pre-Katrina levees that protect the New Orleans region.

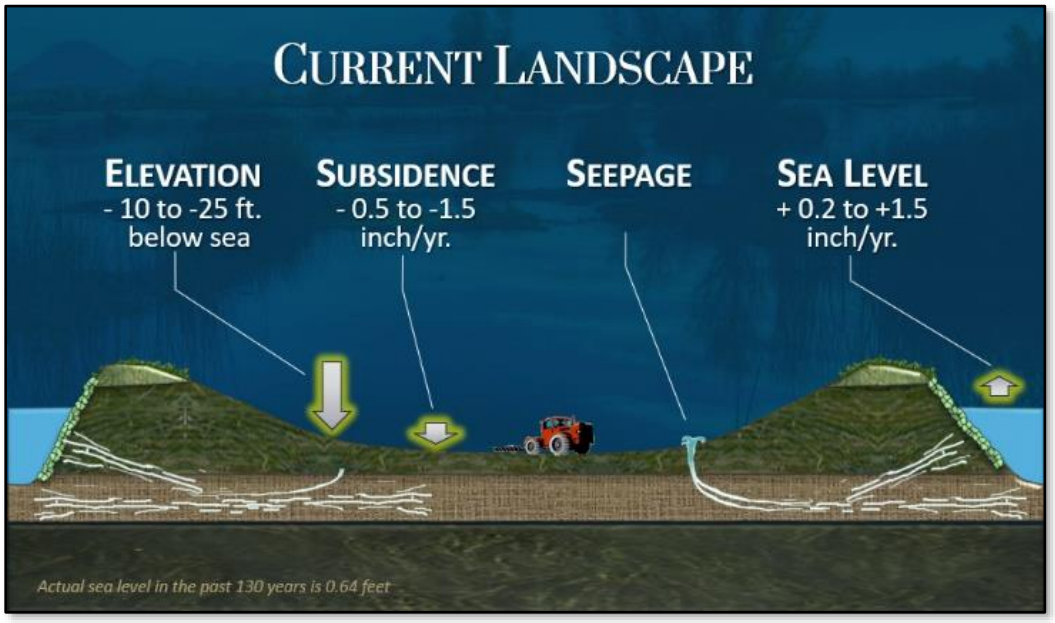

Figure 23 – Current Delta Island Landscape Elevation Changes[98]

These reclaimed Delta Islands are surrounded by levees that protect the Island interior from flooding, while also keeping the water in-channels. The interiors of islands within the Delta can be 10 feet, 20 feet, even 30 feet below sea level in some areas. Subsidence occurs when the highly organic peat soils in the Delta oxidizes. Subsidence can occur at a rate of up to 1.5 inch per year. With the water elevation being so much higher than the land elevation, the pressure differential causes water to flow towards the center of the islands, through the levees and soil. This condition is referred to as seepage. Increased seepage increases costs associated with the pumping needed to remove the seepage water from the islands to prevent flooding. Additionally, climate change, specifically sea level rise, continues to increase the difference in elevation between the water surface and the island interiors. Sea level rise is estimated to occur at a rate of between 0.2 inch to 1.5 inch per year.

One method for reducing pressure on the levees it to rebuild the peat soils. Several studies including one on Webb Tract will investigate how developing tule marshes can rebuild the peat soils through continued deposition of plant material. Peat soil restoration would increase island elevation (subsidence reversal), thus reducing the water supply consequences of island flooding from levee failure. In addition to reversing subsidence, these wetlands trap carbon dioxide through carbon sequestration. This is discussed further in the Carbon Sequestration section of this document.

In 2009, California Department of Water Resources published the Delta Risk Management Strategy that analyzed the risks and consequences of levee failure in the Sacramento-San Joaquin River Delta Region.

[98] Delta Island Landscape Elevation Changes, (2022). Metropolitan Water District of Southern California

Delta Risk Management Strategy Report (Phase 1).[99] Analysis considered current and future risks of levee failures from:

- Earthquakes;
- High water conditions (storms and tides);
- Climate change;
- Subsidence;
- Dry-weather events; and
- Combination of these factors.

The analysis also estimated the consequences of levee failures to the local and state economy, public health and safety and the environment. One of the objectives of Phase 1 was to determine whether current [business-as-usual] management practices can sustain the Delta Region through the next 100 years. Business-as usual practices include current management practices and regulatory requirements.

Strategy Report (Phase 2).[100] Various scenarios to reduce risks and consequences of levee failure were considered. If a major earthquake occurs, levees could fail and as many as 20 islands could be flooded simultaneously. This would result in economic costs and impacts of $15 billion (2005 dollars) or more.

Investment Opportunities

The risk analysis demonstrates the need for Metropolitan to continue evaluating and prioritizing key risks that begin with the following initial activities:

- Support the proposed new modern levee standard;
- Create a unified approach for efficient levee management with other island owners and stakeholders.
- Support continued funding for levee protection programs and studies that lead to increased protection of the Delta region from flooding, seismic activities, and sea level rise.

The previous funding tables show secure funding up to FY 2023-24. Source of this funding is running out and future funding needs are being considered.

[99] Delta Risk Management Strategy (DRMS) Phase 1. (2008-03-04). URS Corporation/Jack R. Benjamin & Associates, Inc., California Department of Water Resources. https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/dd_jardins/DDJ_172_Flood_Hazard_TM.pdf

[100] Delta Risk Management Strategy (DRMS) Phase 2. (2011-06). URS Corporation/Jack R. Benjamin & Associates, Inc., California Department of Water Resources. https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/SJRECWA/SJRECWA_2.pdf.pdf

Overview

Owning property comes with a range of risks that must be carefully managed. From potential hazards such as natural disasters, like floods or earthquakes, to legal responsibilities for injuries that occur on the property, owners must take proactive measures to minimize risk.

Additionally, property owners are also responsible for adhering to local regulations and zoning laws, ensuring the property is maintained to a certain standard, and managing any environmental concerns that may arise. These risks require constant attention and investment to protect the property and mitigate potential legal and financial issues.

Owning agricultural property in the Sacramento San Joaquin Delta comes with a unique set of risks that require careful management. From flooding and environmental regulations to potential risks associated with agricultural operations and subsidence control, landowners must develop a proactive risk management strategy. This includes a thorough understanding of the legal and environmental obligations associated with owning agricultural property.

On Metropolitan's islands, the key risks include:

- Agricultural Operations. Agricultural operations are subject to a variety of risks that must be carefully managed. These include potential risks related to weather-related disasters, crop failure, and market fluctuations that can impact revenue and expenses. Additionally, agricultural operations are subject to environmental regulations, water usage restrictions, and labor laws that require compliance and careful management. The use of heavy machinery, handling of livestock, and storage of agricultural chemicals also pose potential risks for accidents. Furthermore, agricultural operations can impact the surrounding ecosystem, necessitating responsible land stewardship to minimize environmental risks. Overall, the complexities of agricultural operations require proactive risk management, adherence to regulations, and a keen understanding of the potential hazards associated with farming and ranching.

- Environmental Regulations. Owning agricultural property in the Sacramento-San Joaquin Delta comes with a myriad of environmental regulations that must be carefully navigated. The Delta is a critical and fragile ecosystem, home to a diverse range of wildlife and plant species. As a result, landowners are subject to strict regulations aimed at protecting the Delta's environment. These regulations include water usage restrictions, pesticide and fertilizer management, water quality discharge standards, and habitat conservation measures. Additionally, landowners must comply with regulations aimed at

preventing soil erosion, managing wetlands, and preserving water quality. The complex and ever-evolving nature of environmental regulations in the Delta requires landowners to stay informed, adapt to changing requirements, and invest in sustainable agricultural practices to mitigate their environmental impact and ensure compliance with the law.

- Flooding. Although the risks associated with flooding have been significantly reduced over the last two decades, the Delta islands are still susceptible to flooding, posing risks for property owners (**Figure 24**). The low-lying topography and the network of levees that protect agricultural land make the area vulnerable during periods of heavy rainfall or storm surges. Flooding can result in damage to crops, infrastructure, and equipment. As a result, property owners must invest in flood mitigation measures, such as levee maintenance, to safeguard their agricultural assets and mitigate the risks posed by this recurring natural hazard.

Figure 24 – Delta Island Flooding

- Seismic. The Sacramento-San Joaquin Delta is a fragile landscape with subsiding peat soils and vulnerable levees. Earthquakes are a familiar hazard in California, and the Delta specifically has several known smaller faults and is close to three major Bay Area active fault lines (**Figure 18**)[101,102,103]. In the event of a major seismic event, the Delta's levees could be susceptible to failure. Over the last two decades significant analysis has been completed on the vulnerability of the Delta's levees to seismic events of various magnitudes (**Table 28**). In addition, mitigation measures have been developed to assist in reducing these risks and understand the costs of repair.

- Subsidence. The Sacramento-San Joaquin Delta is a region that has been experiencing subsidence for over a century. The Delta's vast historical wetlands were drained to make way for agriculture on dry

[101] When the Levee Breaks: Cascading failures in the Sacramento-San Joaquin https://temblor.net/earthquake-insights/when-the-levee-breaks-cascading-failures-in-the-sacramento-san-joaquin-river-delta-california-7959/
[102] Q/A: What are the risks of a major earthquake in the Sacramento-San https://water.ca.gov/News/Blog/2021/May/What-are-the-risks-of-a-major-earthquake-in-the-Sacramento-San-Joaquin-Delta
[103] Water Reliability and Seismic Risk. https://water.assembly.ca.gov/sites/water.assembly.ca.gov/files/hearings/Water-Seismic%20Risks%20Backgrounder%20-%20Final.pdf

"islands" surrounded by waterways and protected by 1,100 miles of levees. The exposure of previously water-logged wetland peat soils to air caused them to decompose and subside below sea level by 9 to 26 feet or more.[104,105,106] The subsided Delta islands are perpetually at risk of flooding in the event of levee breaks or overtopping and many have flooded in the past, causing millions of dollars in damage. As subsidence progresses, the levees must be regularly maintained and periodically raised and strengthened to support the increasing stresses on their banks. Delta island flooding can also interfere with freshwater exports from the Delta.

The USGS has conducted studies about subsidence in the Delta, focusing on rates of subsidence, how the Delta's thick peat soils were created, and ways to mitigate or reverse peat soil degradation. For example, on deeply subsided Twitchell Island in the Delta, the USGS spearheaded the creation of an experimental wetland that, through the growth of marsh plants, "sequestered" or stored carbon, accumulated peat sediments, and reversed subsidence.[107,108] The Delta's subsidence increases stresses on the levee system, and failure of levees would cause salt water to move further up the Delta system by disrupting favorable gradients. This would degrade the quality of water that is the heart of water supply for California.

- Climate Change – Sea-Level Rise. The Delta is vulnerable to the effects of climate change, including rising sea levels and increased salinity. [109,110,111] In 2018, the California Natural Resources Agency and Ocean Protection Council (OPC) released a report on the impacts of climate change and sea-level rise on California's coasts and oceans. [112] **Figure 22** show a graphic summary of three potential sea-level rise projections for the San Francisco Bay. The report highlights the risks of rising sea levels and increased salinity to California's coastal and ocean habitats and resources, as well as the impact on coastal communities. In addition, the California Fourth Climate Change Assessment report [113] provides information to build resilience to climate impacts, including temperature, wildfire, water, sea level rise, and governance.[114] In January 2024, the OPC, in collaboration with the Ocean Science Trust and a

[104] Subsidence in the Sacramento-San Joaquin Delta Active - USGS.gov. https://www.usgs.gov/centers/land-subsidence-in-california/science/subsidence-sacramento-san-joaquin-delta
[105] Decomposition of Organic Soils in the Sacramento-San Joaquin Delta. https://www.usgs.gov/centers/land-subsidence-in-california/science/decomposition-organic-soils-sacramento-san-joaquin
[106] Managing Subsided Lands to Increase Sustainability in the Sacramento https://deltacouncil.ca.gov/pdf/isb/meeting-materials/2023-07-11-isb-draft-subsidence-prospectus.pdf
[107] Subsidence and carbon fluxes in the Sacramento/San Joaquin Delta https://pubs.usgs.gov/publication/fs04994
[108] Sacramento-San Joaquin Delta | U.S. Geological Survey - USGS.gov. https://www.usgs.gov/centers/land-subsidence-in-california/science/science-topics/sacramento-san-joaquin-delta
[109] Sea Level Rise Planning | Delta Stewardship Council - California. https://viewperformance.deltacouncil.ca.gov/pm/sea-level-rise-planning
[110] Future Sacramento could be underwater due to climate change - abc10.com. https://www.abc10.com/article/weather/sacramento-would-be-underwater-if-greenlands-ice-sheet-melted-geek-lab/103-ad94ce56-3121-4a8c-9305-35a9ee8536cf
[111] Sea Level Rise Inundation Model - Sacramento San Joaquin Delta - UC https://map.dfg.ca.gov/metadata/ds2694.html
[112] OPC Climate Change Program – California Ocean Protection Council. https://www.opc.ca.gov/climate-change.
[113] California, S. O. (n.d.). California climate change assessment. https://climateassessment.ca.gov/
[114] Ocean Protection Council Adopts Updated Guidance on Sea-Level Rise. https://resources.ca.gov/CNRALegacyFiles/wp-content/uploads/2018/03/OPC-Adopts-Guidance-on-Sea-Level-Rise.pdf

scientific task force, released a draft update to their 2018 report.[115] The draft report includes changes to the sea-level rise projections (**Figure 22**). The OPC's 66 percent probability projections have been lowered to 2.7 feet of sea-level rise by 2150 (versus 2100 in the 2018 report). In addition, the upper projection (i.e., 10 feet sea-level rise by 2100) was removed from the draft report.

History of Delta Levees. The history of levees in the Sacramento-San Joaquin Delta dates back to the mid-19th century when settlers began to reclaim and develop the fertile agricultural land in the region. Early levee construction was driven by the need to protect farmland from seasonal flooding and to facilitate agricultural expansion. Over time, a network of levees was established, forming a complex system of flood control infrastructure that enabled the cultivation of crops and the establishment of rural communities in the Delta.

However, the history of levees in the region has been marked by challenges, including inadequate maintenance, subsidence, and the threat of flooding. Levee failures, such as the catastrophic floods of 1855, 1927, and 1955, exposed the vulnerabilities of the Delta's flood control infrastructure and underscored the ongoing need for effective flood management strategies.

Historical levee failures in the Sacramento-San Joaquin Delta have varied over the last century (**Figure 25**). However, since the State of California started a program in 1982 in invest in funding annual maintenance of the levees, the number of levee failures has dropped significantly. In fact, the 2004 breach of the Jones Tract levee was the last levee failure in the Delta.

The risk of levee failures remains a persistent concern that needs to be proactively managed, particularly in the face of climate change and the potential for more extreme weather events.

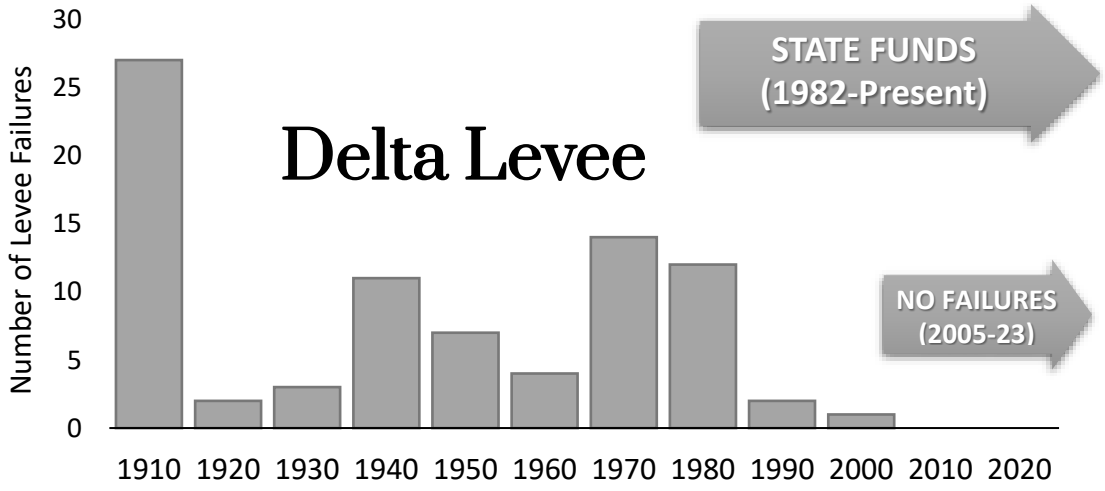

Figure 25 – Delta Island Failures (1910 – Present)

[115] with Ocean Science Trust and a scientific task force to update the California Sea Level Rise Guidance. The updated guidance will expand upon the 2018 update.

Risk Analysis

The following is a summary of an analysis conducted by staff on the risks related to a failure of an island levee. It analyzed the risks and costs associated with the potential loss of infrastructure, equipment, life, crop damage, levee repair, recovery time and salinity intrusion/flushing costs. The following is a summary of that analysis:

- Response Time. Most historical levee breaks in the delta have occurred slowly over a series of hours. Furthermore, to fully inundate an island takes multiple days. In many cases, if caught early enough, an island levee can be repaired before it fully breaks. In either case, it allows island residences and farm workers time to evacuate personnel and equipment off the island or onto high ground.

  Currently, all four of Metropolitan's Delta Island RDs (RD 756, RD 2025, RD 2026, and RD 2028) participate in the Delta Islands Levee Emergency Response Team (DILERT) that meets regularly to coordinate regular and emergency activities due to levee related activities. The Team is responsible for ensuring materials are available for placement and use of pre-positioned rock stockpiles, coordinating emergency events (includes high river stage periods that typically occur during the winter months), or responding to other emergencies such as fires and other situations that occur on these properties. For instance, when a recent Delta earthquake (October 18, 2023) occurred near Isleton, the DILERT was activated minutes after notice of the seismic event. Team members were dispatched to each of the four Metropolitan islands. All 56 miles of levees were inspected, and the initial assessment showed no structural levee damage had occurred as a result of the seismic event. The response and assessment were completed within 60 minutes of the seismic event.

- Infrastructure/Real Property. Infrastructure on the Delta islands consist of farm housing, equipment sheds, barns, roads, bridges, water intake siphons, and water discharge pump stations. This infrastructure is owned by Metropolitan. In the event of a flood, there would likely be little to no damage to bridges, siphons, or discharge pump stations which are located on the levee above the flood elevation. Farm housing equipment sheds and barns (between 2 and 10 structures per island) could be inundated by the floodwaters depending on the extent of the levee break.

- Equipment. Equipment on the Delta islands mainly consists of farming equipment, automobiles, and personal property located at the farm labor residences. As a proactive risk management strategy, during periods of high water most of the farm equipment (tractors, graders, sprayers, automobiles, etc.) are relocated to higher elevations on the island such as on the levees.

- Life. Typically levee breaks in the Delta occur slowly over a series of hours. This allows residents and farm workers time to evacuate the island or relocate to higher locations on the islands mitigating the potential loss of life. In addition, each of the islands have individual evacuation plans posted on-line and filed with each county, and boats and boat docks that allow personnel safe passage off the island.

- Crop Damage. In the event of a potential flood, there would be significant crop damage on an island if it happened during the crop season, primarily during April through October. During the months from November through March, most of the islands are not being used for agriculture. Moreover, many parts of the islands are being flooded up to one to two feet in depth, to reduce weed growth, assist in waterfowl habitat, and leach salts out of the soil.

- Levee Repair. The cost of a levee repair can vary depending on the extent of the damage, (i.e., overtopping damage only or a full breach of the levee).

- Recovery Period. An analysis of the recovery period associated with repairing a levee was prepared for the DWR Delta Flood Emergency Preparedness, Response and Recovery Plan in coordination with the ACOE. This analysis showed that a single island failure could be repaired in less than one month, whereas a multi-island failure could take up to six months.

  Note, the time to repair a levee has been significantly reduced over the last decade due to: (1) Deployment of State and federal regional flood fight supply warehouses and rock stockpiles; (2) scalable local/state/federal Delta Emergency Operations Plans; (3) On-call emergency response equipment contracts; (4) Distributed smaller on-island flood fight supplies and rock stockpiles; (5) Availability of a real-time emergency response water quality model to predict hydrodynamic consequences; and (6) In-place emergency response contracts.

- Salinity Intrusion/ Reservoir Water Release Flushing Costs. During a potential levee breach, water from the Delta and higher salinity water from the Bay are pulled through the breach as it fills in the lower elevation island. Depending on the size of the accommodation space in the island and the magnitude of freshwater flows in the adjoining rivers, water from upstream reservoirs will need to be released to maintain the same water quality in the Delta.

  In 2020, Resource Management Associates (RMA)[116] conducted a water quality impact modeling analysis [117] for the Delta Stewardship Council of conceptual levee breach scenarios in the Delta, including Bacon Island. The metric used by RMA to assess a given island's impact was days of export disruption – the number of days following a breach during which Delta water quality is insufficient for export. As expected, the RMA model results showed large variations in the impact of an individual island associated with breach start times, the number of additional breached islands, and future hydrology. On average though, days of export disruption was linearly dependent on the volume of the breached island. Larger islands in the north Delta, however, were less impactful than their volume would suggest, and islands in the south Delta were more impactful. As the number of islands involved in a breach event increased, so too did their individual impacts on export disruption. This results from salt being pulled further into the Delta, making it significantly harder to flush and recover.

[116] RMA | Resource Management Associates. (n.d.). https://rmanet.com/

[117] Resource Management Associates, Inc. (April 2020). Draft Technical Memorandum to Delta Stewardship Council. Pilot Modeling to Examine Regional Effects of Delta Geometry Changes – Phase 1 and 2 Summary Report.

The RMA model simulated the impact of a levee breach on Metropolitan's Bacon Island. On average, a breach to one of Bacon Island's levees could cause a disruption in exports of at least 15 days, with a potential for an additional 50 days of export disruption depending upon the number of additional breached islands. Assume for this conceptual analysis the SWP is pumping at 3,000 to 6,000 cubic feet per second, and the cost of replacement water is $1000 per acre-feet. In this scenario, the breach of Bacon Island's levee equates to a range of $90 to 180 million in replacement water costs.

- Cost of Single-Island Levee Failure. An analysis of the overall risk of a single island failure was conducted using costs associated with historical failure events (**Table 27**) at Jones Tract (2004), Webb Tract (1980), Holland Tract (1980), and McDonald Island (1982). This includes the cost to repair and close the levee breach, pump water off the island, repair infrastructure, and pay for personal property damage, crop damage, and labor during the flood event. The preliminary analysis, conducted by Earth Economics,[118] estimates that a single island failure in year 2023 would cost between $40 to $70 million.

Table 27 – Delta Island Levee Failures – Breach Repair Cost & Closure Time

DELTA ISLAND LEVEE FAILURES – BREACH REPAIR COST & CLOSURE TIME				
Date	**Island**	**Repair Cost**	**Repair/Closure**	**Description**
Jun 2004	Jones Tract	$16 million	27 days	Breach: 200,000 tons of material to repair
Jan 1980	Webb Tract	$12 million	4 months	Breach: 850 feet wide, 60 feet deep
Jan 1980	Holland Tract	$8 million	n/a	Breach: 250 feet wide, 40 feet deep
Sep 1980	Lower Jones Tract	$5.6 million	n/a	Breach: 275 feet wide, 55 feet deep
Nov 1982	McDonald Island	$13 million	1 month	Breach: 600 feet wide, 40 - 85 feet deep
Nov 1982	Venice Island	$9 million	1 month	Breach: 500 feet wide, 40 feet deep

Seismic/Flood Risk Analyses. On August 29, 2005, Hurricane Katrina hit New Orleans causing levee failures in multiple locations and flooding. Following the event, DWR testified before a Joint Session of the California Legislature on October 31, 2005, reporting that the Delta levee system could experience sustained damage and possibly not recover from the effects of a severe earthquake in the Delta region. Since 2005, Metropolitan has been collaborating with state and federal agencies, universities, international seismic experts, and northern and southern California engineering firms to analyze the probability and potential impacts from a large seismic event or multi-island failure in the Delta. A number of these analyzes are included in **Table 28**.

The analyses show potential earthquakes within the region from a "probabilistic" approach, which looks at the seismic effects of multiple potential earthquakes within the region. More current studies analyzed the seismic effect of an individual fault more locally within the Delta it from a "deterministic" approach. The analyses also show levee slumping at various ground acceleration rates,[119] disaster response strategies (levee repairs and

[118] Earth Economics. (2024, January 18). Earth Economics. https://www.eartheconomics.org/
[119] Wikipedia contributors. (2024, January 22). Peak ground acceleration. Wikipedia. https://en.wikipedia.org/wiki/Peak_ground_acceleration

reservoir releases optimization), repair and recovery cost estimates, and water quality impacts. The results of the studies in **Table 28**, generally indicate:

- Scientist experts have concluded that both the probabilistic and deterministic analyses indicated that seismic 'peak ground accelerations' between 0.02 to 0.05 g could cause liquefaction of the soils and slumping of the levees;
- For a 200-year seismic event (associated with a magnitude of 6.8), levee slumping is 2.2 and 4.4 feet, but remains above high-water level; and
- For a 500-year seismic event (associated with a magnitude of 7.0 or greater), levee slumping is 3.3 and 6.6 feet, which could go below the high-water level.

Table 28 – Seismic/Flood Risks Analyses

SEISMIC/FLOOD RISKS ANALYSES		
Date	**Study**	**Agency**
2008	Delta Risk Management Study	DWR, URS, JBA
2011	Levee Stability Analyses of Freshwater Pathway[120]	URS
2012	Peat Deformation/Consolidation Mechanisms	UCLA
2013	Seismic Hazard Analyses of the Freshwater Pathway[121]	URS
2017	Post-Cyclic Settlements of a Levee Structure on Organic Soil[122]	UCLA
2019	Updated Seismic Hazard Analyses of Freshwater Pathway[123]	Lettis
2018	Emergency Response Bay Delta Model[124]	DWR, RMA
2019	Updated Levee Stability Pathway Analysis	AECOM, Lettis
2020	Technical Evaluation for Delta Levees	AECOM, Schnabel
2021	Seismic hazard analyses of the Emergency Freshwater Pathway[125]	Lettis
2022	Central Valley Flood Protection Plan Conservation Strategy Update [126]	Lettis

[120] Ehasz, Joe. URS (2011-06-16). Additional Levee Stability Analysis Model report to the Metropolitan Water District of Southern California

[121] Wong, I. G., Thomas, P. A., Dober, Mike, Rerra, Fabia. URS. (2013). Seismic hazard analyses of the Emergency Freshwater Pathway, California.

[122] Lemnitzer, A. (2017, July 1). Post-cyclic settlements of a levee structure on organic soil during centrifuge testing. https://escholarship.org/uc/item/0wv6t758

[123] Wong, I. G., Thomas, P. A., Lewandowski, N., Unruh, J. R., Darragh, B., Silva, W., & Majors, D. G. (2019). Seismic hazard analyses of the Metropolitan Water District Emergency Freshwater Pathway, California.

[124] RMA Bay-Delta model | RMA. (n.d.). https://rmanet.com/services/numerical-modeling/rma-bay-delta-model/

[125] Wong, I. G., Thomas, P. A., Lewandowski, N., Unruh, J. R., Darragh, B., Silva, W., & Majors, D. G. (2021). Seismic hazard analyses of the Metropolitan Water District Emergency Freshwater Pathway, California. Earthquake Spectra, 38(2), 981–1020. https://doi.org/10.1177/87552930211047608

[126] California, S. O. (n.d.). Central Valley Flood Protection Plan (CVFPP) Conservation Strategy 2022 update. http://bdms/eo/bl/2024/2/638404769403632376/Shared%20Documents/Forms

Overview

Over the last two decades, Metropolitan has been working with state and federal agency, and local stakeholder interests to develop a proactive risk management approach to enhance the reliability of the Delta in the event of a possible seismic or flood event. The actions that are a part of this proactive approach include:

- Securing County Office of Emergency Services (OES) approved Local Flood Safety Plans and Emergency Operations Plans;
- Development of a through-Delta Freshwater Pathway approach as part of DWR's Delta Flood Emergency Management Plan (October 2019),[127]
- Support for funding and construction by DWR of regional flood-fight material warehouses and rock stockpiles;
- Construction on Metropolitan's islands of local flood-fight material warehouses and rock stockpiles;
- Targeted levee improvements in the Delta and along the through-Delta Freshwater Pathway;
- Development of regional and local Delta seismic and flood vulnerability analyses;
- Assessing and implementing real-time, early-warning levee monitoring technologies;
- Regular coordination with DWR, ACOE, State and County OES, and Delta Reclamation Districts;
- Development of a Delta Islands Levee Emergency Response Team (DILERT) to coordinate resources and response needs between Metropolitan and the RDs;
- Twice daily levee patrols of the island levees. These patrols are changed to hourly during critical hydrologic and emergency conditions;
- Flood fight training through DWR and County Office of Emergency Service;
- Collaboration with the California Department of Fish and Wildlife on invasive species (e.g., nutria) control and understanding it's impacts on habitat and levee reliability; and
- Developing a new modernized levee design with stakeholder interests that mitigates for potential flood, seismic, and sea-level rise risks.

[127] California, S. O. (2019, October 16). DWR prepares California water system for next 'Big One.' https://water.ca.gov/News/Blog/2019/Oct-19/Great-Shakeout-2019-DWR

Risk Management Actions

Emergency Operations Plans and Models. Each of the Reclamation Districts on Metropolitan's islands have developed an Emergency Operations Plan that is posted on-line and filed with the applicable County Office of Emergency Services (**Figures 26 and 27**).[128,129,130,131]

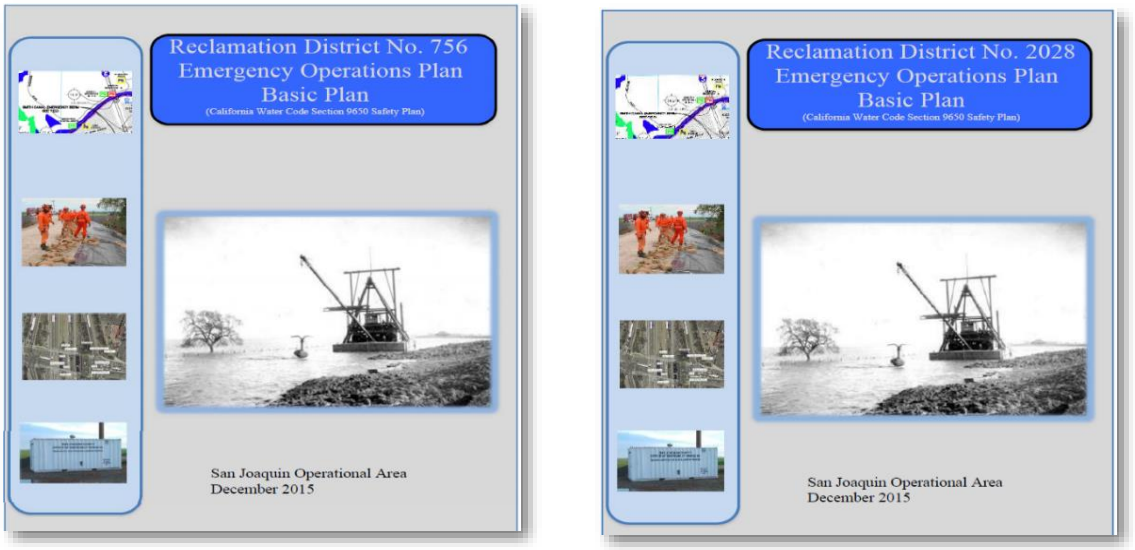

Figure 26 – Bouldin Island (RD 756) and Bacon Island (RD 2028) Emergency Operations Plan

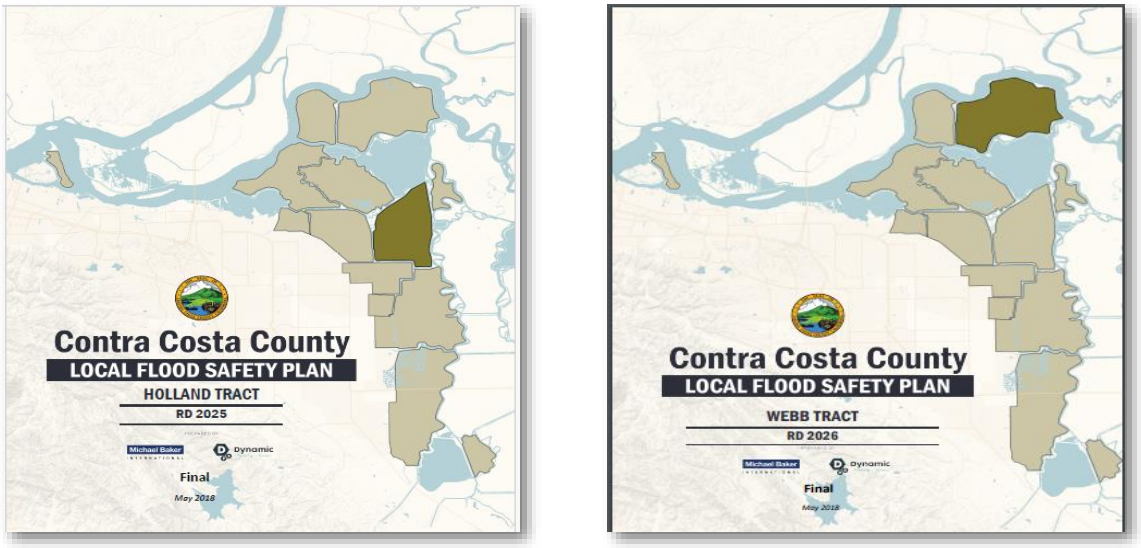

Figure 27 – Holland Tract (RD 2025) and Webb Tract (RD 2026) Flood Safety Plan

[128] Bouldin Island Reclamation District 756. (n.d.). https://www.bouldinisland.org/docs/736
[129] Bacon Island Reclamation District 2028. (n.d.). https://baconisland.org/docs/941
[130] Webb Tract Reclamation District 2026. (n.d.). https://webbtract.org/docs/740
[131] Holland Tract Reclamation District 2025. (n.d.). https://hollandtract.org/docs/725

In addition, the emergency operations plans and emergency response modeling tools for the state and federal authorities are coordinated and shown in **Table 29**.

Table 29 – Emergency Operations Plans And Emergency Response Modeling Tools

EMERGENCY OPERATION PLANS		
Date	**Study**	**Agency**
2018	Emergency Operations Integration Plan	DWR, USACE
2018	Northern California Catastrophic Flood Management Plan[132]	Cal OES
2018	Emergency Response Tool Model	DWR, RMA
2019	Delta Emergency Operations Integration Plan	DWR, USACE

All of Metropolitan's Delta Islands levees are maintained by each Reclamation District (RD) and RD personnel participate in a Delta Islands Levee Emergency Response Team (DILERT) that meets regularly to coordinate regular and emergency activities due to levee related activities. The Team is responsible for ensuring materials are available for placement and use of pre-positioned rock stockpiles, coordinating emergency events (includes high river stage periods that typically occur during the winter months), or responding to other emergencies such as fires and other situations that occur on these properties. For instance, when a recent Delta earthquake (October 18, 2023) occurred near Isleton, the DILERT was activated minutes after notice of the seismic event. Team members were dispatched to each of the four Metropolitan islands. All 56 miles of levees were inspected, and the initial assessment showed no structural levee damage had occurred because of the seismic event. The response and assessment were completed within an hour of the seismic event.

Levee Improvements. Metropolitan has been implementing targeted levee improvement projects on its islands to enhance the safety and reliability of the existing through-Delta Freshwater Pathway. As of 2023, approximately 12 miles of levee improvements have been completed, with another 3 miles in the design and permitting phase.

The first of these projects started in 2014, prior to Metropolitan's purchase of Bacon Island. The Metropolitan Board approved participation and cost-share funding for the Bacon Island West Levee Improvement Project with DWR and six urban Bay Area water agencies (Alameda County Water District, Contra Costa Water District, East Bay Municipal Utility District, San Francisco Public Utilities Commission, Santa Clara Valley Water District, and Zone 7 Water Agency). The $14.5 million improvement project cost share was split – 95 percent DWR, and 5 percent Bay area water agencies and Metropolitan.

[132] California, S. O. (n.d.). Catastrophic planning | California Governor's Office of Emergency Services. https://www.caloes.ca.gov/office-of-the-director/operations/planning-preparedness-prevention/planning-preparedness/catastrophic-planning/

Metropolitan's final cost share project came in at $243,800, or less than 2 percent. This 5-mile improvement project added 24 inches to the height of the levee and reduced the steepness of the side slopes.

As of December 2023, the following levee improvement projects have either been completed, or funding has been approved by DWR to begin design and permitting:

- Bacon Island West-Side Levee Improvement. 4.7-mile levee improvement, $14.51 million total cost, DWR share 97 percent, California Urban Water Agencies share 3 percent, Metropolitan's share $243,848 (1.7 percent), completed construction in 2019;

- Bacon Island North Levee. 2.1-mile levee improvement, $5.7 million total cost, approximately $1.2 million planning/design/permitting, DWR share 95 percent, RD local share $285,000 (5 percent), construction in FY 2022-23 and FY 2023/24;

- Bacon Island South Levee. 1.3-mile levee improvement, $3.8 million total cost, approximately $840,000 planning/design/permitting, DWR share 95 percent, RD local share $190,000 (5 percent), construction in FY 2022/23 and FY 2023/24;

- Bouldin Island North Levee. 4.3-mile levee improvement, $15.8 million total cost (approximately $2.5 million planning/design/permitting), DWR share 93 percent, RD share $1.1 million (7percent), construction in FY 202/-23 and FY 2023/24;

- Bouldin Island West Levee Setback. 3/4-mile levee improvement, multi-benefit project, $11.4 million total cost, DWR share – 95 percent levee, 100 percent habitat, 50% discharge pumping station replacement, start of design and permitting in FY 2022-23; and

- Bouldin Island Southwest Levee. 2-mile levee improvement, $7.5 million total cost, DWR share 97 percent, RD share $225,000 (3 percent), construction in FY 2025-26.

Flood Fight Material Warehouses and Rock Stockpiles. In addition, to working with DWR on finalizing the Delta Flood Emergency Management Plan, and implementation of these large, regional emergency rock stockpiles (535,000 tons of rock at Stockton and Rio Vista – **Figure 28**) and warehouses, each of Metropolitan's RDs have also began staging smaller, local rock stockpiles, muscle wall (**Figure 29**), emergency supply storage bins on each island (**Figure 30**), sheet piles (currently around 5,300 linear feet) (**Figure 31**), steel pipe piles (**Figure 32**), and DWR and ACOE regional stockpiles and warehouses (**Figure 33**). The goal is to have enough rock on Metropolitan's islands to close up to four small breaches and adequate flood fight materials (includes sandbags, visqueen tarp, stakes, etc.) on hand to respond in the event of an emergency.

As of 2023, Metropolitan's Delta Islands through each of its Reclamation Districts received grants of approximately $50,000 per island to purchase flood fighting materials and rock, and a grant of approximately $1,200,000 from Sacramento County to purchase flood fighting materials construct a regional warehouse/depot on Bouldin Island.

Figure 28 – DWR Stockton Regional Material Depot and Rock Stockpile

Figure 29 – Bouldin Island Regional Material Depot – Muscle Wall

Figure 30 – On-Island Material Storage Container

Figure 31 – Sheet Pile at DWR Stockton Yard

Figure 32 – Steel Pipe Piles at DWR Stockton Yard

Figure 33– Delta Regional Stockpiles and Warehouses

Real-Time Early-Warning Levee Monitoring Tool. One of the key questions posed to staff is "Does real-time levee monitoring lead to early warning of potential levee failures?" In response to this question, Metropolitan has been developing tools to reduce risks associated with potential levee failures. The approach will inform levee risk reduction actions throughout the Delta. The following are key elements to this approach:

- Development of an early-warning notification tool;
- Allows detection of small movements inside the levee structure;
- Allows corrective management actions to be taken weeks to months in advance of a potential problem; and
- Shifts levee response from a reactive mode to a proactive mode response mode.

Metropolitan has been actively testing first-of-its-kind, real-time levee monitoring technologies through its Bouldin Island Monitoring and Instrumentation Pilot Project (Pilot Project). Results from the project have provided significant data and information that allows Metropolitan to assess potential levee issues, in advance, to avoid or minimize risk impacts due to seismic or other emergency events. Bouldin Island (**Figure 34**) was selected for this pilot project due to Bouldin Island's west levee movement that occurred in the high-river stage events in 2017.

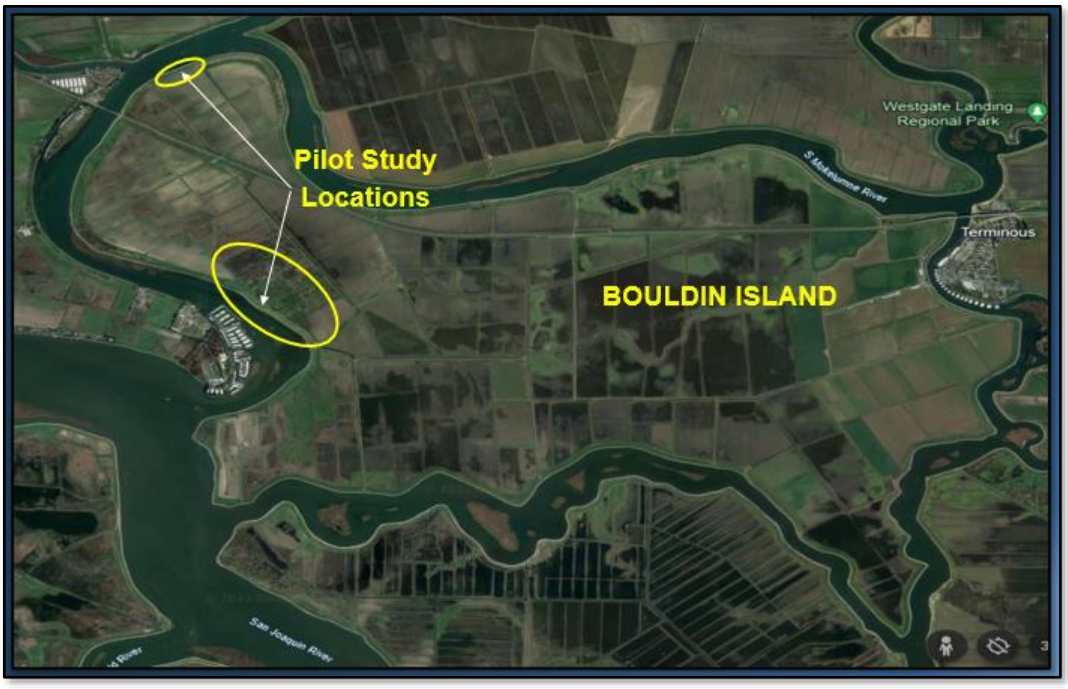

Figure 34 – Bouldin Island Real-Time Levee Monitoring Pilot Research

The pilot project, which began in 2019, tested the following new technologies using either stationary instrumentation or flown by aerial drones:

- Terrestrial scanning;

- LiDAR & magnetic drone scanning (**Figure 35**);[133]
- Drone thermal and photo sensors;
- Tide gauge instrumentation;
- Coaxial cable vertical/horizontal deformation;
- Piezometers water level measurement;[134]
- Telemetry installations;
- Shape array inclinometers;[135. 136]
- Vibrating wire piezometers;[137]
- Horizontal time-domain reflectometer cable;
- Levee slope erosion gauges; and
- Scent detection dogs (**Figure 36**).

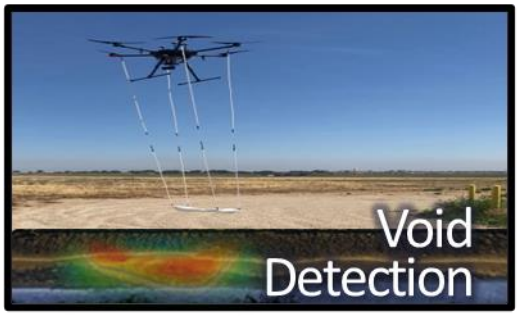

Figure 35 - Void Detection

Figure 36 – Invasive Species Detection Dogs

In addition, an innovative approach incorporated into the pilot project is measuring changes in soil properties through a Vadose Zone Monitoring System (VMS) [138]. This allows for real time, continuous monitoring of water percolation and contaminant transport across the entire unsaturated zone (also termed as the vadose zone), from land surface to groundwater. Once in place, the VMS forms a state-of-art monitoring station, which is equipped with the most advanced sampling units and data collection instrumentation for the unsaturated zone enabling receipt of real time critical information on the hydrological and chemical conditions in the unsaturated zone. Data obtained by the VMS enable direct assessment of water percolation velocities and contaminations migration fluxes in the subsurface. It offers a new innovative approach in the understanding of what happens in the subsurface level.

[133] Van Rees, E. (2021, September 15). Everything you need to know about LiDAR from drones. Geography Realm. https://www.geographyrealm.com/everything-you-need-to-know-about-lidar-from-drones/
[134] Piezometers and groundwater levels | U.S. Geological Survey. (n.d.). https://www.usgs.gov/centers/land-subsidence-in-california/science/piezometers-and-groundwater-levels
[135] Bing Videos. (n.d.). https://www.bing.com/videos/riverview/relatedvideo?q=Shape+array+inclinometer+definition&mid=5B6B3ABB0989CA197BCF5B6B3ABB0989CA197BCF&FORM=VIRE
[136] Shape arrays. (2023, December 10). GEO-Instruments. https://www.geo-instruments.com/technology/shape-arrays/
[137] Jtmadsen. (2021, November 25). How do vibrating wire piezometers work? - Factor Geotechnical Ltd. Factor Geotechnical Ltd. https://factorgeo.com/how-do-vibrating-wire-piezometers-work/
[138] Vadose Zone Hydrology Technology by Sensoil. (2023, December 19). Sensoil. https://sensoil.com/technology/

VMS technology is based on more than 15 years of research, led by Professor Ofer Dahan at Ben Gurion University (Israel) including two registered patents. Sensoil, the creator of this technology is used worldwide in multiple working installations. The Delta levee application is the first of its kind and already providing informative data through its contributions to the Pilot Project.

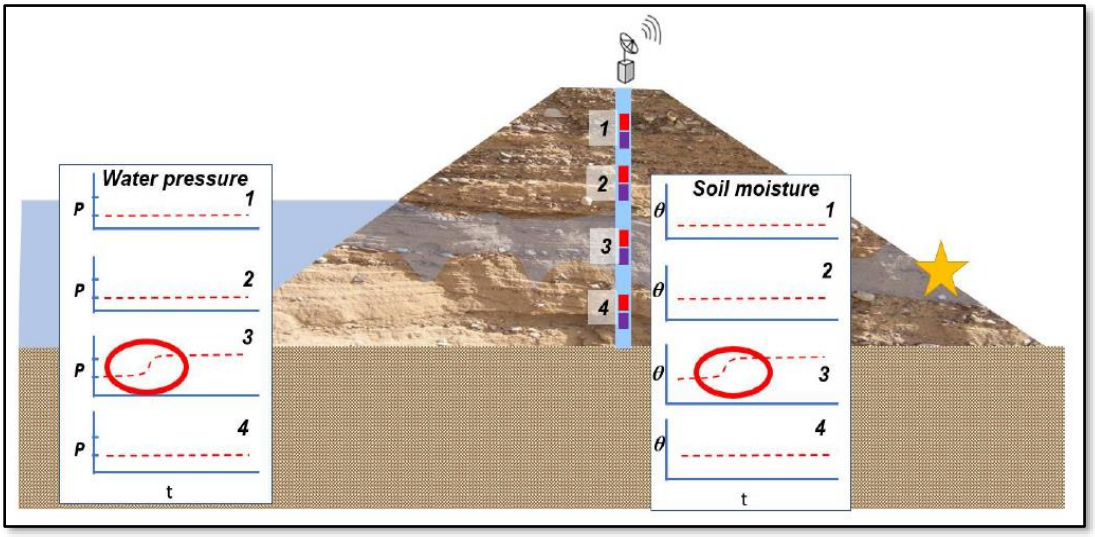

Figure 37– Levee Instrumentation Monitoring Schematic

Figure 37 illustrates the Vadose zone monitoring system installed in an earthen dam measuring temporal

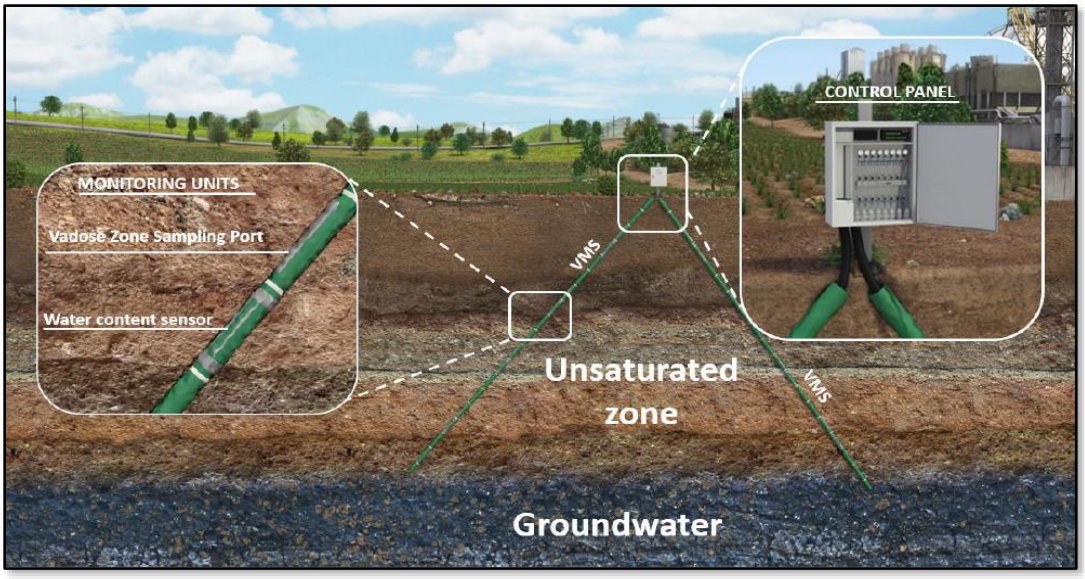

Figure 38– Levee Monitoring System (Unsaturated Zone)

variation in the soil moisture and water pressure at multiple levels.

Figure 38 shows the cross sections and installation locations for the vadose zone monitoring system in the levee at the Bouldin island pilot site.

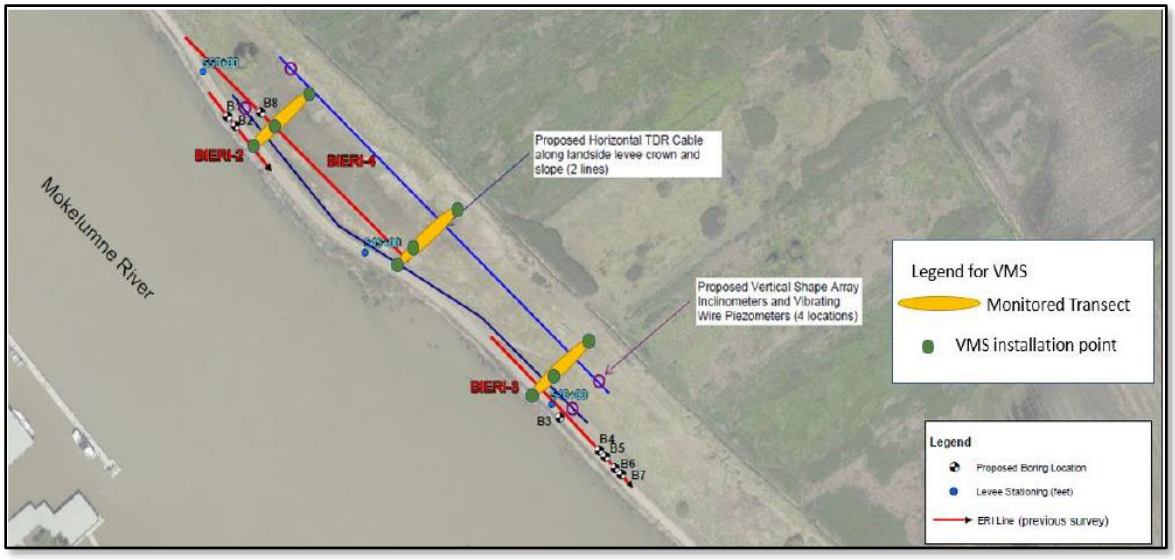

Figure 39– Bouldin Island (West Levee) Pilot Instrumentation Locations

Figure 39 and Figure 40 show a plan view and cross section of the VMS locations and measurement points with respect to different water level monitoring locations.

Another company, Rezatec, is providing an innovative approach of real-time monitoring and tracking of ground surface changes via NASA satellite imagery applications and the WaterSAT service they developed. This

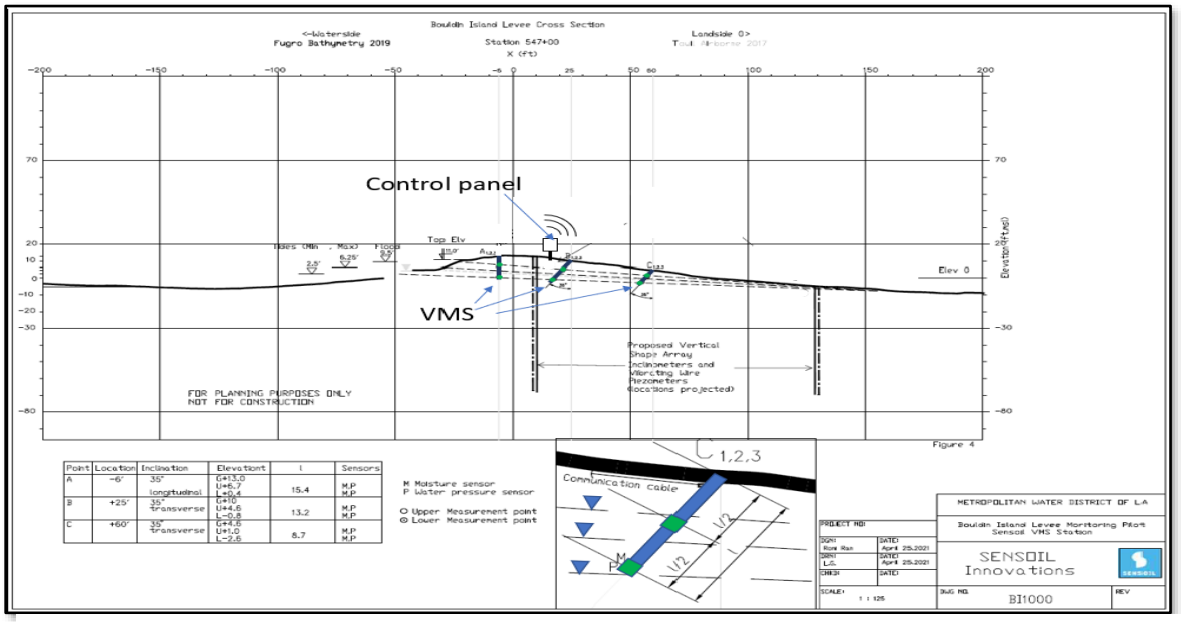

Figure 40 – Unsaturated Zone Monitoring (Bouldin Island West Levee Cross Section)

service, which is in place in other countries, is being tested through a pilot project on Metropolitan's Bouldin Island.

Rezatec's WaterSAT[139] service is a cloud based Geospatial Artificial Intelligence (AI) platform, that provides risk analysis derived from both satellite and ground based data sets. Using its patented Levee Monitoring algorithms and machine learning methods, WaterSAT combines multiple data sets to provide both historical and ongoing analysis of levee-to-levee behavior highlighting changes and heighten risks.

WaterSAT under the Pilot Project will be to monitor changes in levee surface movements, vegetation vigors, and vegetation moisture along the entire levee footprint.

Rezatec provides this capability within an online real-time platform accessible by users, requiring no downloads or installations. Data is visible both via interactive map or spatially and asset management dashboard with table and graphical presentation. Analysis data from other platforms can also be ingested and shared with WaterSAT.

These real-time monitoring tools have changed levee analysis in the Delta, as this new approach has never been pursued for these levees. Small movements can be detected in the levee prism up to weeks and months in advance. In February 2023, Metropolitan detected small movement in the landside berm on a portion of the west levee on Bouldin Island. After consultations between RD 756, DWR, Metropolitan, and geotechnical engineers, DWR approved the release of funds to install land-side earthen fill material to stabilize the levee footprint. On October 18, 2023, a magnitude 4.2 earthquake occurred on an adjacent island, two miles west of Bouldin Island. Metropolitan and RD 756 were able to access the real-time monitoring tool to ensure the security of these levees.

Invasive Species Control and Monitoring. Other potential threats to Delta levee system are those related to beavers and, in more recent years, nutria.[140] Whether the North American beaver (Castor canadensis – **Figure 41**)[141] is native or non-native, they continue to burrow dens under the levee prism near water passages. Metropolitan continues to work with CDFW and USFWS through existing beaver relocation programs. The RDs with assistance from growers provide levee patrols that identify potential beaver dens. Once these dens are identified, beaver relocation efforts are pursued, and levee is repaired to its proper standard.

Another species, nutria (**Figure 41**), was originally introduced to the United States (Elizabeth Lake, California)[142] for the fur-trade in 1899 but failed to reproduce. Subsequent introductions were successful, as records indicate nutria were present in the Central Valley and South Coast of California in the 1940s and 1950s but were eradicated from the state by the 1970s. There are established populations of nutria on every continent except Antarctica and Australia. In the United States, nutria have been found in 30 states, but are

[139] Geospatial AI for Water Utilities | Rezatec. (2023, November 28). Rezatec. https://www.rezatec.com/solutions/water-utilities/
[140] Wikipedia contributors. (2024, January 3). Nutria. Wikipedia. https://en.wikipedia.org/wiki/Nutria
[141] Wikipedia contributors. (2023, December 5). North American beaver. Wikipedia. https://en.wikipedia.org/wiki/North_American_beaver
[142] Wikipedia contributors. (2023, November 1). Elizabeth Lake (Los Angeles County, California). Wikipedia. https://en.wikipedia.org/wiki/Elizabeth_Lake_(Los_Angeles_County,_California)

currently established in as many as 18, including Washington, and Oregon. In 2017, a reproducing population of nutria was discovered in California's San Joaquin Valley.

Nutria is a large, light to dark-brown, fur-bearing, aquatic rodent. Nutria strongly resembles beavers, but with arched backs and long, round, sparsely haired tails, rather than wide and flattened like the beaver. Adults typically reach a body length of 2 feet, weigh 15 to 20 pounds, and have tails 1 to 1.5 feet long. An adult nutria is about one-third the size of an adult beaver, and over 5 times the size of a muskrat, which has a thin, laterally flattened (side to side), nearly triangular tail. Nutria is distinguished from beavers and muskrats by their long, white whiskers and rounded tails; beavers and muskrats have black whiskers and flattened tails. Once present, nutria populations increase rapidly. Nutria reach sexual maturity as early as 4 to 6 months of age and can produce their first litter by 8 months of age. They breed year-round, producing up to 3 litters per year, with 2 to 13 young per litter.

Figure 41 – Nutria, Beaver, Groundhog, Muskrat Comparisons [143] [144]

[143] Nutria, Beaver, Groundhog, Muskrat Comparisons - Bing. (n.d.). Bing. https://www.bing.com/images/search?view=detailV2&ccid=ROsz6QVH&id=4FC6148FD4046E72A232865FB59E57DA781233B0&thid=OIP.ROsz6QVHatHjkXNcXk1RSQHaFu&mediaurl=https%3a%2f%2fwww.thatshamori.com%2fwp-content%2fuploads%2f2012%2f08%2fcoypu.jpg&cdnurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.44eb33e905476ad1e391735c5e4d5149%3frik%3dsDMSeNpXnrVfhg%26pid%3dImgRaw%26r%3d0&exph=806&expw=1042&q=Nutria%2c+Beaver%2c+Groundhog%2c+Muskrat+Comparisons&simid=608021937849192864&FORM=IRPRST&ck=BF0B3EB5F746DAD833D4B33A086CFD46&selectedIndex=13&itb=0&ajaxhist=0&ajaxserp=0

[144] Nutria, Beaver, Groundhog, Muskrat Comparisons - Bing. (n.d.). Bing. https://www.bing.com/images/search?view=detailV2&ccid=DJEZ5JJZ&id=6E19CF4DC4D454716279F9F816FBD549C68677D0&thid=OIP.DJEZ5JJZXPrVKH0-6ZI8lwHaHF&mediaurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.0c9119e492595cfad5287d3ee9923c97%3frik%3d0HeGxknV%252bxb4%252bQ%26riu%3dhttp%253a%252f%252f1.bp.blogspot.com%252f-Sn6dTkwdU4k%252fT0273BhmM9I%252fAAAAAAAAA58%252f90gQPS3rDIY%252fs1600%252fnutria-teeth-

Nutria causes various kinds of damage through burrowing, intense herbivory, and carrying pathogens and parasites. Nutria do not construct dens, they burrow, frequently causing water-retention or flood control levees to breach, weakening structural foundations, and eroding banks. They can consume up to 25 percent of their body weight in above- and below-ground vegetation each day, but they waste and destroy up to 10 times as much causing extensive damage to the native plant community and soil structure, as well as significant losses to nearby agricultural crops. The loss of plant cover and soil organic matter (roots, rhizomes, tubers) results in severe erosion of soils, in some cases destroying marshlands and leaving behind open water. The destructive feeding habits of nutria threaten populations of rare, threatened, or endangered species that rely on critical wetland habitats.

Metropolitan staff is currently coordinating monitoring efforts with both CDFW and USFWS. Currently, Holland Tract, Bouldin Island, and Webb Tract have been survey by USFWS and are no confirmed evidence of nutria present. These monitoring activities are allowed through entry permits with Metropolitan.

New Modernized Levee Design. As the threat of climate change and sea-level rise continues to grow, there is an urgent need to modernize the levee system in the Delta to ensure its resilience and long-term sustainability. The development of a modernized levee standard for the Delta is essential to protect the region from flooding, saltwater intrusion, seismic activity, sea-level rise, and other potential hazards.

Following the 1983 and 1986 floods in the Delta, the Hazard Mitigation Plan (HMP) design standard was established through negotiations among FEMA, DWR, State Office of Emergency Services, and the Delta Levee Maintaining Agencies. The goal was to create a minimal, short-term standard (with 1 foot of freeboard above the design standard to protect against a 1 in 100-year flood event) to reduce levee/island damages and prevent the need for FEMA disaster assistance funds after minor floods. The standard was supposed to be implemented for all Delta levees by 1991, but many have not yet complied. FEMA denies disaster assistance claims when levees are not in compliance, and the HMP standard is considered a basic level of flood protection, providing minimal protection and no defense against earthquake-caused failures. It is not suitable for long-term flood avoidance and was not intended to be a long-term standard by the state or FEMA.

In 1982, DWR developed an improved levee standard, defined in State Bulletin 192-82,[145] designed to protect against a 1 in 300-year flood event (0.33 percent annual change of occurrence). Bulletin 192-82 also included 1.5 feet of freeboard above the design standard for rural levees and 3 feet for urban levees.

2.jpg%26ehk%3dYQ4tqmxvLWXsgub%252f48QJroQGFRqsYWQqpKRF4y4Dioc%253d%26risl%3d%26pid%3dImgRaw%26r%3d0&exph=880&expw=920&q=Nutria&simid=607998087929992727&FORM=IRPRST&ck=A6B0ACFA7317D45E0A0B0BC8FDB1FFDA&selectedIndex=27&itb=0&ajaxhist=0&ajaxserp=0

[145] State of California Department of Water Resources. Delta Levees Investigation. Bulletin 192-82 (1982). https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/dd_jardins/ddjx30.pdf

As part of the federal design standard, Public Law (PL) 84-99 (also known as the Flood Control Act of 1944)[146,147] is a minimum requirement for federal flood control project levees, but non-project levees can also become part of the program if they meet the standard and pass an initial inspection. This makes them eligible for Corps emergency assistance and levee rehabilitation expenses in the event of damage or a breach. The Corps has developed a "Delta-Specific" version of the standard for non-federal levees in the Delta, taking into account the Delta's organic soils and foundation conditions. Some LMAs have qualified under this program, particularly those with urban, commercial, or infrastructure uses.

Levee systems that are eligible for rehabilitation assistance under PL 84-99 following flood or storm damage include those federally authorized, operated and maintained by a non-federal sponsor or non-federally built, operated, and maintained by a non-federal sponsor. These levees remain eligible if operated and maintained to acceptable or minimally acceptable standards. Federal government policy regarding repairs to levee systems and flood control projects damaged by floods is as follows:

- Federally constructed or enhanced, locally maintained systems (in PL 84-99 program): Will be repaired by the federal government at 100 percent federal cost. Pending letter of request by maintaining authority and funding by Congress.

- Non-federally constructed, locally maintained systems (in PL 84-99 program): Will be repaired by the federal government at 80 percent federal/20 percent local cost share. Pending letter of request by maintaining authority and funding by Congress.

- Systems not in the PL 84-99 program, federally or non-federally constructed or enhanced, locally maintained systems: Will not be repaired by the federal government.

Figure 42 identifies the state and federal, and urban and rural levee standard utilized in the Delta.

Over the last few years, Delta interests including Metropolitan have been collaborating to develop and propose an update to the 44-year-old 1982 State Bulletin 192-82 levee standard. This proposed new modern levee standard would be better prepared to withstand the challenges of future climate change, sea-level rise, flood, and seismic activity.

The proposed new levee standard is illustrated in **Figure 43.** The design incorporates recent geotechnical field data and seismic vulnerability modeling information (**Table 92),** including the effects of individual faults in the Delta, their associated peak ground accelerations, and soil slumping impacts. It is also designed to mitigate potential future climate change[148] and in the Delta.

[146] Portland District. (n.d.). Public Law 84-99 (Levee page). https://www.nwp.usace.army.mil/Missions/Flood-Risk-Management/Levees/PL84-99/
[147] Public Law 84-99 Brochure. https://www.swl.usace.army.mil/Portals/50/siteimages/MKARNS%20Update/SWL%20PL84-99%20Brochure.pdf?ver=2019-12-10-164906-920
[148] California, S. O. (n.d.). California climate change assessment. https://climateassessment.ca.gov/

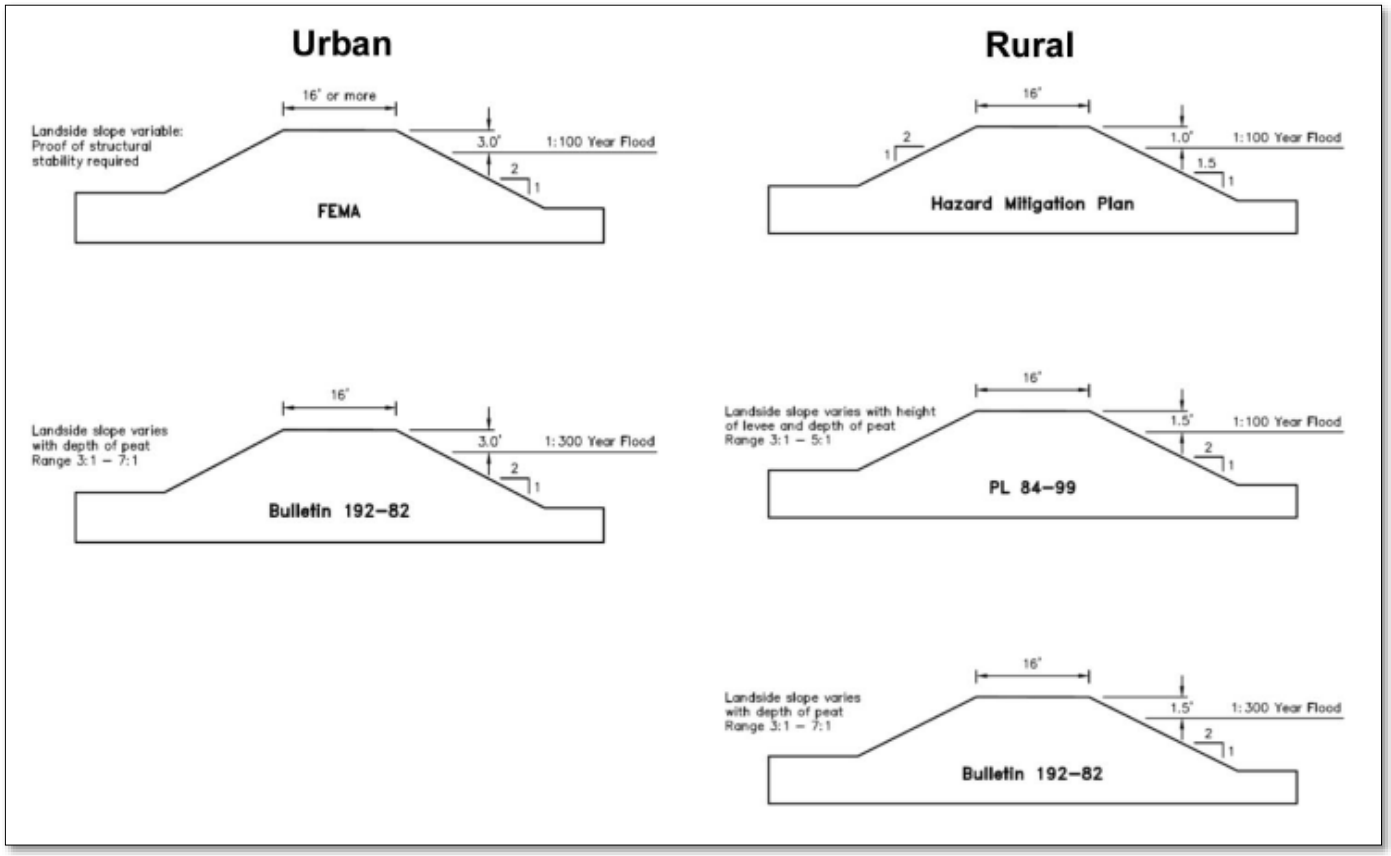

Figure 42 – Federal and State Levee Design Standards[149]

New Modern Levee Design Cost Estimate. A cost estimate of the new modern levee design was developed by MBK Engineers using cost information from ongoing levee improvement projects in 2023. The estimate analyzes the cost of improving levees in two areas: 1) along Old and Middle River, south of the San Joaquin River (**Figure 44**); and 2) along all levees in the larger Primary Delta region (**Figure 45**).

[149] Urban Levee Design Criteria – California Water Library. (n.d.). https://cawaterlibrary.net/document/urban-levee-design-criteria/

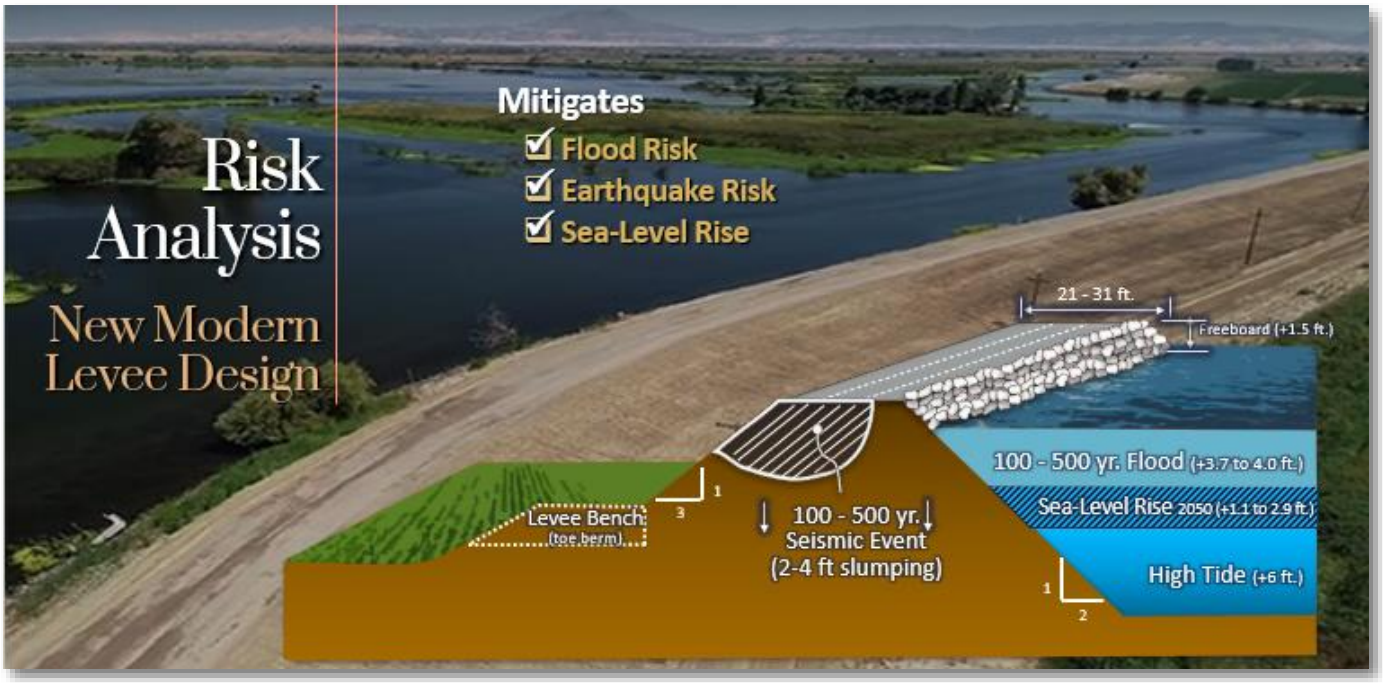

Figure 43 – New Modern Levee Design

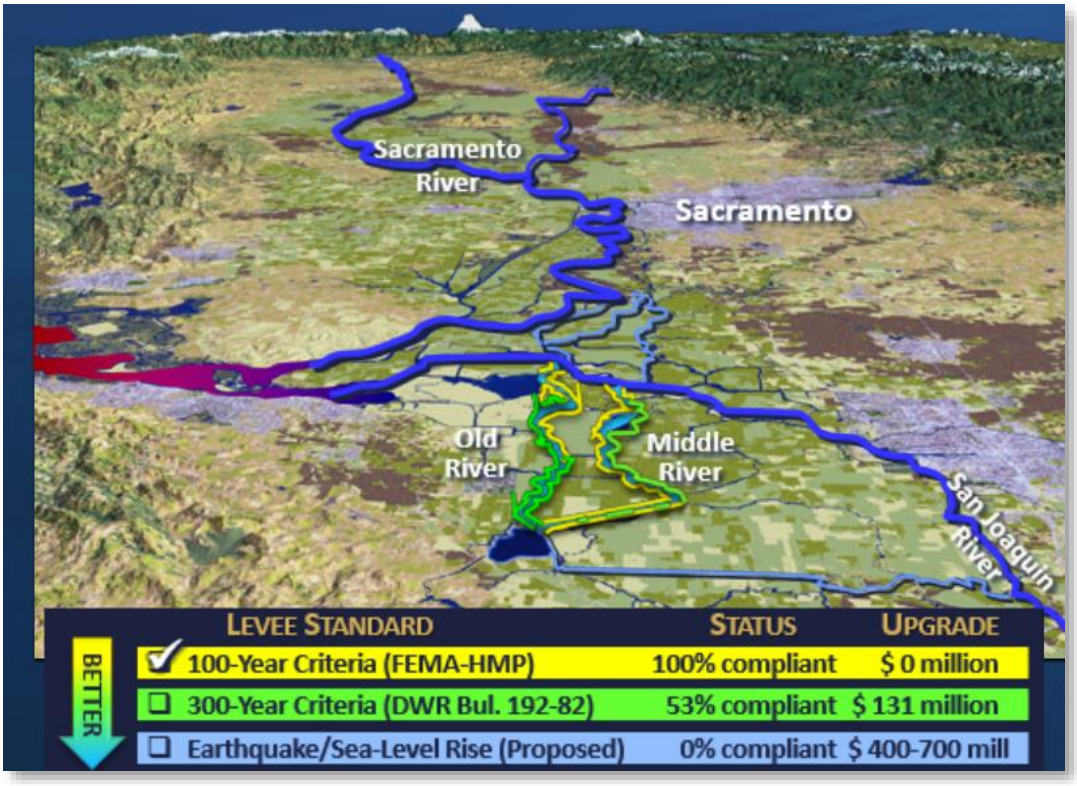

Figure 44 – Thru-Delta Freshwater Pathway Cost Estimate

Figure 45 – Primary Delta and Thru-Delta Freshwater Pathway Cost Estimate

There have been no major levee failures over the last two decades, all Metropolitan's islands meet the minimum FEMA standard to allow for state/federal emergency disaster funding, and the proposed levee modernization standard is designed to meet future sea-level and seismic risks.

In addition, real-time levee monitoring promises to be a useful tool for early warnings of potential levee leaks or levee failures weeks to months in advance resulting in quick response actions. Combining a new modern levee standard with these real-time monitoring tools will substantially reduce the risk associated with levee failures.

# # #