Salton Sea Management Program Conceptual Project Implementation and Cost Estimates to Meet State Board Targets

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Contents

Tables

Figures

Acronyms and Abbreviations

DCA	dust control area
NAVD 88	North American Vertical Datum of 1988
NGVD 29	National Geodetic Vertical Datum of 1929
SSAM	Salton Sea Accounting Model
SSMP	Salton Sea Management Program
SWRCB	California State Water Resources Control Board

Chapter 1. Introduction

The Salton Sea Management Program (SSMP) has developed a 10-year plan for Phase I that envisions a range of activities for habitat creation and dust management as the Salton Sea recedes over 2018–2028. The California State Water Resources Control Board (SWRCB), through an order revising Order WRO 2002–0013, outlines annual and cumulative target areas for restoration through creation of habitat and dust suppression projects. These targets are defined for each year, ranging from a cumulative 500 acres by January 1, 2019, to a cumulative 29,800 acres by January 1, 2029, with a minimum 50 percent of the area being designated for fish and wildlife habitat projects. Areas around the sea are proposed for restoration projects, specifically at the southern end of the sea near the inflows of the Alamo and New rivers, and the northern end of the sea near the inflow of the Whitewater River. In a prior document (*Salton Sea Management Plan Phase I: 10 Year Plan*, March 2018), an overview of the project areas and activities was presented.

This document presents a high-level plan for achieving the annual goals in the SWRCB order, by means of creation of wet habitat and dust control areas in different parts of the Salton Sea lakebed. This document identifies conceptual habitat ponds to be created, the associated wetted areas, and the additional dust control areas required to meet the order targets. For each of the conceptual project areas, there are estimates for berm lengths, heights, and needs for additional infrastructure, such as pumps and pipelines, causeways for equipment access, and levee extensions along river channels for flood protection of newly created habitat. Planned cross sections for the different types of linear structures are shown. Cost estimates are provided for each of the project areas over time to develop a total cost estimate.

The conceptual habitat and dust control areas are based on the best current information on Salton Sea bathymetry, and demonstrate a reasonable path forward to attain the State Board order targets. The costs associated with these targets as presented in this document can be used for additional planning as part of the SSMP over the next decade. It is recognized that the actual footprints of individual projects may change in future years as better information becomes available on lakebed elevations, and relationships with other non-SSMP projects for habitat and dust control are better understood.

These cost estimates are a refinement of estimates presented in the *Salton Sea Management Plan Phase I: 10-Year Plan* (March 2017). The cost estimates incorporate the best available cost information, and include the development of conceptual berm designs and supporting infrastructure, such as water diversions, pumps, and pipelines, and levees for river extensions. For these reasons, the cost estimate presented here supersedes the March 2017 estimate of $383 million for the 10-year implementation. But, all cost estimates at this stage are considered preliminary, and subject to revision as new field and construction data become available, and as designs are adjusted to best meet overall program needs.

In the remainder of this document, two key topics are presented. In Chapter 2, there are estimates of the projected elevations of the Salton Sea over the 2018–2028 period, based on a hydrologic model of the sea. This is needed to allow estimation of exposed lakebed with the goal of constructing new habitat under dry conditions. Proposed conceptual project footprints, design and cost assumptions, and cost summaries are presented in Chapter 3.

Chapter 2. Hydrology and Modeling

The U.S. Bureau of Reclamation's Salton Sea Accounting Model (SSAM), originally developed in 2000, was used for this evaluation. SSAM is a one-dimensional salt and water balance accounting model implemented in Microsoft Excel. Updated bathymetry data for the Salton Sea was used in this analysis to obtain a more accurate area-volume-depth relationship that is essential for siting future habitat and potential berms. SSAM can be used to project future Salton Sea elevation, volume, and salinity based on inflow projections. This model was chosen over similar hydrologic models governed by the same principles of operation because of the transparency and flexibility of the model. Previous modeling for elevation prediction using SSAM was described in Tetra Tech (2015).

Model Inputs and Calibration

Inflows to the model were updated using U.S. Geological Survey flow data from 2012 to 2017 for Whitewater River, New River, and Alamo River. Additionally, drains and small creeks account for 8.8 percent of total inflow to the sea, and were added to the inflows in a manner similar to that used for the Imperial Irrigation District's Salton Sea Analysis (SALSA) model (CH2M Hill 2014). Groundwater inflows were conservatively estimated at 1,000 acre-feet per year from Imperial Valley and 1,470 acre-feet per year from Coachella Valley, for a total of 2,470 acre-feet per year contribution from groundwater (California Department of Water Resources 2007; Coachella Valley Water District 2012). These inflows are shown in Table 1.

For 2018 and beyond, Imperial Irrigation District flow scenario projections (Tetra Tech 2015) were input to the model. These inflows are shown in Table 2. These were the best projected flow estimates available as of August 2018. The elevation calculation can be updated if new inflow estimates become available.

Salton Sea water surface elevations predicted using SSAM show close agreement to observed water surface elevations over the most recent period (ending December 2017) with observed data (Figure 1). Salton Sea salinity concentrations (expressed as total dissolved solids, and reported by the U.S. Bureau of Reclamation) predicted using SSAM show very good agreement to observed salinity concentrations (Figure 2).

Based on the above calibration, and given the flow projections in Table 2, projections for Salton Sea elevations were developed for the SSMP 10-year plan over 2018–2028.

Table 1 **Salton Sea Actual Inflows (2012–2017)**

Calendar Year	Sum of Three Rivers (acre-feet)	Drains and Small Creeks as 8.8% of Total Flow (acre-feet)	Total Inflow[a, b] (acre-feet)
2012	1,120,471	1,228,586	1,231,056
2013	1,031,346	1,130,862	1,133,332
2014	970,140	1,063,750	1,066,220
2015	1,003,523	1,100,355	1,102,825
2016	1,017,623	1,115,815	1,118,285
2017	924,183	1,013,358	1,015,828

Notes:

[a] Total Inflow column input to the Salton Sea Accounting Model.

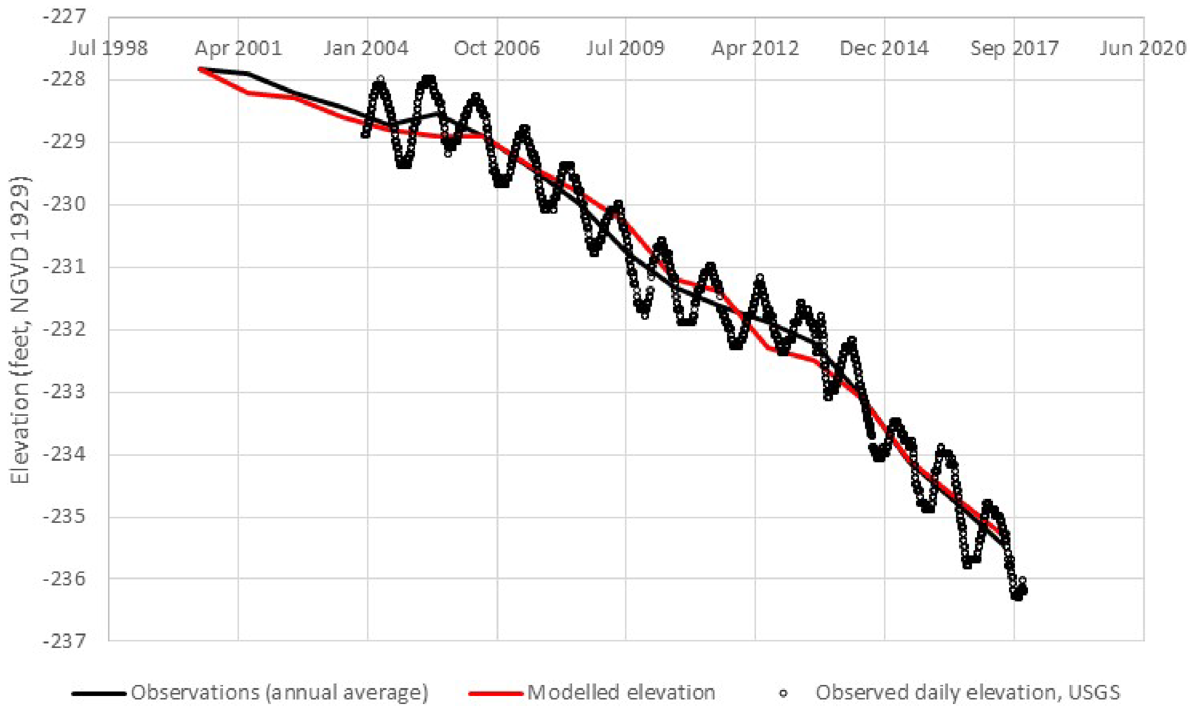
[b] Includes 2,470 acre-feet from groundwater.

Table 2 **Salton Sea Projected Total Inflows (2017–2028)**

Calendar Year	Projected Flows (acre-feet)
2018	948,614
2019	915,228
2020	878,069
2021	862,093
2022	860,110
2023	855,364
2024	854,441
2025	852,735
2026	850,544
2027	855,247
2028	857,755

Source: Imperial Irrigation District communication 2015.

Figure 1 Modeled and observed elevation in the Salton Sea



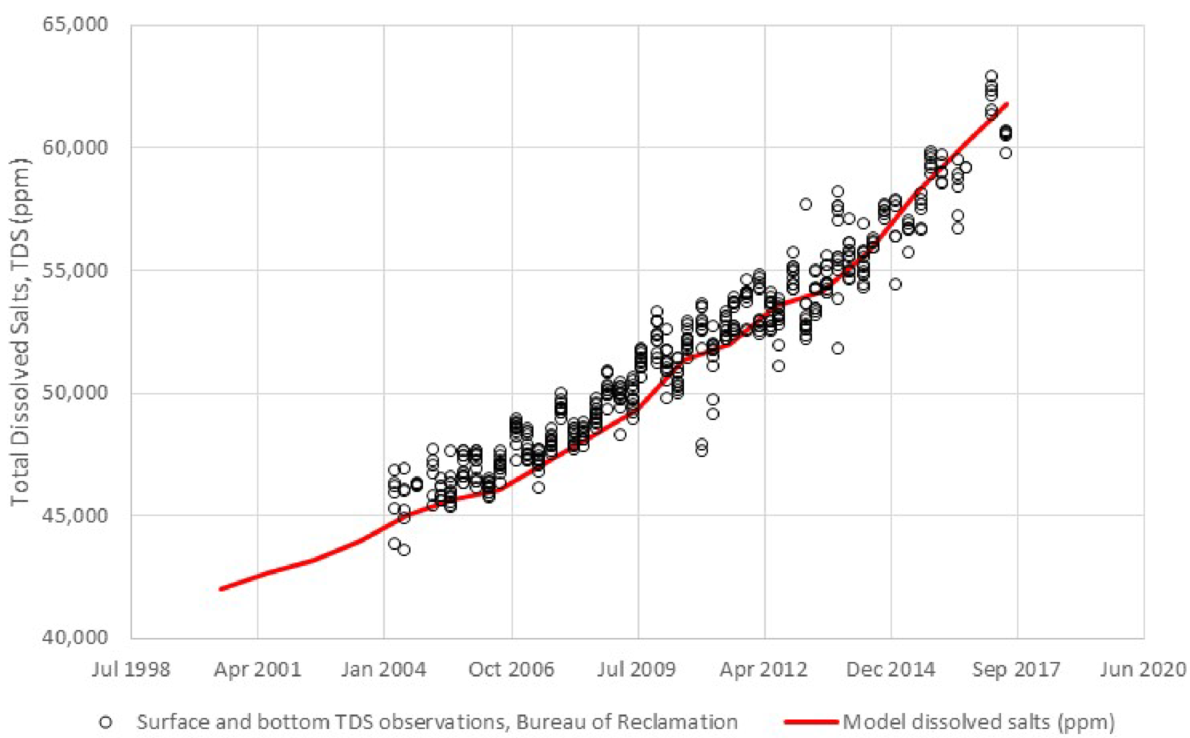
Notes: NGVD 1929 = National Geodetic Vertical Datum of 1929, USGS = U.S. Geologic Survey

The graph was created using annual precipitation data and baseline evaporation of 69.0 inches (before salinity adjustment).

Open circles show daily elevation data; solid lines are annual averages for each calendar year (2004–2017).

Elevation data are from U.S. Geologic Survey Station 10254005 (https://waterdata.usgs.gov/ca/nwis/uv?site_no=10254005).

Figure 2 Salton Sea Modeled and Observed Salinity (2004–2017)



Note: ppm = parts per million

Final Predicted Elevations for Cost Estimation

Estimated Salton Sea elevations are shown in Table 3. To account for model uncertainty, 1 foot is added to the elevations predicted using SSAM.

Although an estimate of Salton Sea elevations is needed for planning future project development, some error or uncertainty, as related to the inflow projections, is acceptable. This is because the construction is not performed at the edge of the sea, but purposely allows for at a least 1 foot of elevation difference between the sea and the lower elevation of the berms.

Note the unit conversion from the National Geodetic Vertical Datum of 1929 (NGVD 29) data to the North American Vertical Datum of 1988 (NAVD 88) data in Table 3. The former is used by the U.S. Geological Survey in reporting Salton Sea elevations, and the latter is used in most design documents. The model estimates converted to units of NAVD 88 are used in the rest of the document.

Table 3 Modeled Salton Sea Surface Elevations

Year	SSAM Predicted Elevation NGVD 29 (feet)	SSAM Predicted Elevation NAVD 88 (feet)	Final Elevation[a] NAVD 88 (feet)
2017	-235.3	-233.2	-232
2018	-236.3	-234.2	-233
2019	-237.5	-235.4	-234
2020	-238.9	-236.8	-236
2021	-240.4	-238.3	-237
2022	-241.8	-239.7	-239
2023	-243.3	-241.2	-240
2024	-244.6	-242.5	-241
2025	-245.8	-243.7	-243
2026	-246.9	-244.8	-244
2027	-247.9	-245.8	-245
2028	-248.8	-246.7	-246

Note: NAVD 88 = North American Vertical Datum of 1988, NGVD 29 = National Geodetic Vertical Datum of 1929, SSAM = Salton Sea Accounting Model, NAVD 88 elevation = NGVD 29 elevation + 2.13 feet

[a] For final elevation, add 1 foot and round to a whole number.

Chapter 3. Conceptual Project Footprints and Cost Estimate

Based on the modeled recession of the Salton Sea, project areas were identified by trial and error to meet annual SWRCB order targets for wet and dry areas, and to allow construction on dry lakebed. This was done based on the general understanding and prior site experience at the Salton Sea confirming that construction under dry conditions is considerably more cost-effective.

The wet area projects were conceptualized to be constructed in phases, and that the first phase would be formed using higher berms and with deeper water. The deeper water in the first phase ponds allows these ponds to provide areal coverage, deep-water fish habitat, and provide a source of water for down-lakebed habitat. The wet area projects include berms for river diversions that are planned to allow passage of flood flows through the rivers without damaging the newly created habitat. In addition, in the wet area projects, certain berms are designated as causeway berms to allow transport of equipment for project construction and future maintenance. Additional lakebed roads are identified that may be required for equipment transport. Overall, the wet area projects assumed that water would be sourced from the Salton Sea and from the rivers, in a manner that is being done for individual projects in a more advanced state of design understanding, such the Species Conservation Habitat project and the New River West project.

Dry area projects were conceptualized to be more distant from the freshwater sources at the river mouths, and along the edges of the wetted habitat areas. They assume no freshwater requirements. Costs are based on prior experience on the Salton Sea lakebed.

The proposed layouts of the berms for New River, Alamo River, and Whitewater River are shown in Figure 3, Figure 4, and Figure 5, respectively. The cost estimate assumes the construction of initial berms in 2020 (Figure 6), middle berms constructed in 2023 (Figure 7), and final berms constructed in 2027 (Figure 8). Also shown are cross sections for causeway berms (Figure 9) and river diversion berms (Figure 10).

The underlying engineering and cost assumptions for the project implementation are presented below. Each wetted area project includes costs for berms, and components for saltwater and freshwater conveyance. There are also generic cost components for engineering design, environmental permitting, mobilization, and construction management.

Overall Engineering and Cost Assumptions

1. All the ponds would be formed by constructing berms while working in the dry lakebed, using traditional earth-moving equipment.
2. Fill for the berm structures would be generated from excavating adjacent soil material directly from the sea bed, near the berm alignment on the up-slope side, and within 200 feet of the berm.
3. No artificial islands, channels in ponds, or dredging is proposed as part of these cost estimates.
4. The New, Alamo, and Whitewater rivers would flow unimpeded into the Salton Sea with no dam or gravity conveyance into the project.

5. All costs have been prepared in 2017 U.S. dollars.
6. Earthwork items have been included with a 25 percent contingency. For pumping and backbone infrastructure, a 15 percent contingency was added to the cost.
7. Dust control areas would be utilized using tillage of the lakebed material with no associated import or export of materials.
8. Each phase of wet habitat construction would need to be done concurrently at all three river deltas (New, Alamo, and Whitewater). Each phase is estimated to take two to three years.

Initial Berms (Year 2020)

1. The first phase of would need to be built in 2020 at an elevation of -235 feet (NAVD 88).
2. The Salton Sea water level would be at a projected elevation of -236.8 feet, or 1.8 feet below the construction elevation of -235 feet (NAVD 88).
3. The initial 2020 berm would be 10 feet tall, retain 8 feet of water with 2 feet of freeboard, and have 8:1 side slopes on either side. The water surface elevation would be maintained at -227 feet (NAVD 88).
4. An estimated 33 percent of the length of the berms would require a vinyl-sheet pile, 25 feet deep, to control seepage. These costs are summarized under "other costs."
5. The wetted side of the berm would be reinforced with 1-foot thick riprap to control erosion.
6. The top of the initial 2020 berm would be 24 feet wide and have a 1-foot thick Class II aggregate base road over an 8-ounce per square yard non-woven geotextile fabric.
7. A 184-foot wide structural woven geotextile fabric would be placed ahead of the berm fill to distribute loading and minimize differential settlement.
8. Water control structures every 2,000 feet would provide water to the down-slope lakebed ponds in a cascade manner. This cost was built into the per linear foot cost of constructing the initial 2020 berms.
9. The Species Conservation Habitat project ponds would serve as the initial ponds and provide the backbone infrastructure to the downstream ponds at New River. No costs were assumed for the construction of the Species Conservation Habitat projects in the cost estimate.

Middle Berms (Year 2023)

1. The second phase would begin construction in 2023 at an elevation of -240 feet (NAVD 88).
2. The Salton Sea water level would be at a projected elevation of -241.2 feet, or 1.2 feet below the construction elevation of -240 feet (NAVD 88).
3. The middle berm would be 6 feet tall, retain 4 feet of water with 2 feet of freeboard, and have 8:1 side slopes on either side. The water surface elevation would be maintained at -236 feet (NAVD 88).
4. The wetted side of the middle berm would be reinforced with 1-foot thick riprap to control erosion.
5. The top of 2023 middle berm would be 16 feet wide and have an 8-inch thick Class II aggregate base road over an 8-ounce per square yard non-woven geotextile fabric.
6. A 112-foot wide structural woven geotextile fabric would be placed ahead of the berm fill to distribute loading and minimize differential settlement.
7. Water control structures every 4,000 feet would provide water to the down-slope lakebed ponds in a cascading manner. This cost was built into the per linear foot cost of constructing the 2023 middle berms.

Lower Berms (Year 2027)

1. This phase would begin construction in 2027 at an elevation of -244 feet (NAVD 88).
2. The Salton Sea water level would be at a projected elevation of -245.8 feet, or 1.8 feet below the construction elevation of -244 feet (NAVD 88).
3. The lower berm would be 6 feet tall, retain 4 feet of water with 2 feet of freeboard, and have 8:1 side slopes on either side. The water surface elevation would be maintained at -240 feet (NAVD 88).
4. The wetted side of the lower berm would be reinforced with 1-foot thick riprap to control erosion.
5. The top of 2027 lower berm would be 12 feet wide and have a 6-inch thick Class II aggregate base road over an 8-ounce per square yard non-woven geotextile fabric.
6. A 108-foot wide structural woven geotextile fabric would be placed ahead of the berm fill to distribute loading and minimize differential settlement.
7. Water control structures every 6,000 feet would provide water to the down-slope sea-brine pond for dust suppression or overflow back into the Salton Sea. This cost was built into the per linear foot cost of constructing the 2027 lower berms.

Causeway Berms

1. These berms would be constructed perpendicular to the shoreline to create the end caps, or terminations of the ponds, to provide maintenance access, and contain the ponds.
2. The berm height of the causeway would vary from 10 feet to 0 feet. An average height of 4 feet to 6 feet was assumed for costing purposes.
3. The causeways would be built mainly from imported granular fill. They would have a core built from sea-bed material to help prevent seepage.
4. The wetted side of the causeway would be reinforced with 1-foot thick riprap to control erosion.
5. The top of berm would be 16 feet wide and have a 6-inch thick Class II aggregate base road over an 8-ounce per square yard non-woven geotextile fabric.
6. A structural woven geotextile fabric would be placed ahead of the berm fill to distribute loading and prevent differential settlement.

Diversion Berms

1. These would be constructed perpendicular to the shoreline along both sides of each of the rivers adjacent to the ponds to create protection against damage to the from periodic river flooding.
2. The berm height of the diversion would be 8 feet for most of the length, with a minimum 2 feet of freeboard and 4:1 side slopes on either side. Some portions of the diversion berms would be required to be 10 feet where they are retaining water close to the 10-foot tall initial berms. The additional cost for the 10-foot portion was within the 25 percent contingency fee estimate.
3. The diversion berms would be built mainly from imported granular fill. They would have a core built from sea-bed material to prevent seepage.
4. Both sides of the diversion berms would be reinforced with 1-foot thick riprap.
5. The top of berm would be 24 feet wide and have a 12-inch thick Class II aggregate base road over an 8-ounce per square yard non-woven geotextile fabric.
6. A 104-foot wide structural woven geotextile fabric would be placed ahead of the berm fill to distribute loading and minimize differential settlement.

Lakebed Roads

1. These would be constructed in areas without ponding to provide access from the existing infrastructure to the berm project.
2. The lakebed roads would be constructed out of 12 inches of imported fill material. A 6-inch thick course of base material would be prepared with a 3-inch asphalt concrete overlay.
3. A 19-foot wide structural woven geotextile fabric would be placed ahead of the berm fill to distribute loading and prevent differential settlement.
4. The road width would be 12 feet, with occasional turnoffs for traffic control.
5. The costs for lakebed roads are summarized under "other costs."

Harbor Restoration

Because of the recession of the sea, harbors along the shoreline have been above the water elevation since 2010 and do not allow boat access. To continue to provide access to the harbors, especially along the west shore of the sea, costs are allocated for creating berms and supporting infrastructure that would keep the selected harbor areas underwater by pumping water from the Salton Sea. Detailed designs will be developed on a case-by-case basis, but estimated costs for harbor restoration are included in the 10-year plan as a separate line item.

Dust Control Areas

1. Tillage of the lakebed material into windrows approximately 3 feet tall and 10 feet apart in a serpentine path perpendicular to the predominant wind direction is assumed for these dust control areas (DCAs).
2. The DCAs assume tillage of the lakebed material adjacent to and up-lakebed from the pond areas.
3. DCAs would be phased similar to the ponds. Construction would begin at the highest point of the lakebed and follow down slope to the sea as it recedes.
4. A unit rate of $5,000 per acre was assumed for tillage of the DCAs. A 25 percent contingency factor was applied.
5. To comply with areas required in the SWRCB order, it may be necessary to begin certain DCAs prior to pond construction. It was assumed in Table 5 that New River DCAs would begin in 2018, and Alamo would begin in 2019. By 2026, construction of the DCAs will need to begin before the 2027 pond construction in order to keep up with the state requirements on total acreage constructed.

Conveyance and Other Costs

1. Units for determining conveyance costs were assumed based on the wetted acreage of coverage for the project. The costs were assumed as being installed up-front in the initial 2020 phase. The costs for pumping and pipelines were summarized under the "conveyance" item.
2. A unit cost for delivery of water supply and pumping requirements was estimated based on $24,000 per cubic foot per second, plus a 15 percent contingency.
3. The flowrates were determined by assuming the total area of wetted coverage at 6 feet of evaporation per year plus an added 50 percent, or 3 feet per year, to account for seepage. These units were converted to cubic feet per second and this number was applied as the fresh water demand.

4. An assumption of 50 percent of the freshwater demand was used to obtain a flow rate in cubic feet per second for saline demand, which would result in a salinity level of approximately 25 parts per thousand.
5. Blended water would need to be pumped to the opposing side of the river mouth to feed the adjacent ponds. The blended pump station was assumed as requiring 66 percent of the capacity of the freshwater pump station.
6. Electrical lines were assumed to be $200 per linear foot because installation of marine grade cable may be necessary to run power into the Salton Sea for the saline pump station. The costs for electrical lines were summarized under “other” items.
7. A unit rate of $370 per linear foot was used for the pipelines assuming a 36-inch minimum high-density polyethylene (HDPE) pipe.
8. Required lengths for pipelines and electrical lines were assumed to be the total length of the diversion berms plus an additional 2,000 feet.
9. The vinyl sheet piles were assumed to be required for 33 percent of the initial berms length and to be 25 feet deep.
10. A cost of $2 million was used for miscellaneous structures such as boat ramps, buildings, gates, and related infrastructure as required for the operations and maintenance of the facilities. The cost was divided equally among the three river projects.

Mobilization, Engineering Design, Environmental Permitting, and Construction Management

1. Costs for these items were added to the project as a percentage of the construction costs.
2. Because the initial phase consists of the majority of the backbone infrastructure, multipliers were used which place more emphasis on the upfront initial costs.
3. A multiplier of 6 percent was used for mobilization during the initial phase; 5 percent was used for subsequent phases.
4. A multiplier of 6 percent each was used for the engineering design and environmental permitting during the initial phase. It was reduced to 3 percent for subsequent phases.
5. A multiplier of 8 percent was used for construction management during the initial phase; 6 percent was used for subsequent phases.
6. All costs were rounded to the nearest $10,000.

Coinciding Projects

1. Approximate areas for the California Natural Resources Agency Phase I, Redhill Bay, and Torres-Martinez projects were used in conjunction with the areas from the ponds and DCAs to achieve the minimum average.
2. It was assumed that the coinciding projects would be completed by 2021.

Summary of Costs

Based on the engineering and cost assumptions, and the proposed project layout and berm cross sections, a spreadsheet was used to develop total projects costs over time. The total estimated cost is $417.2 million, including $344 million for the primary infrastructure elements, and $73.2 million for the supporting costs (Table 4). A breakdown by river area and year of construction is shown in Table 5. Details of cost calculations are presented in the attached Excel spreadsheet.

Comparison with SWRCB Order Area Targets

The cumulative acreage added to the Salton Sea over time is compared to the SWRCB order in Figure 11. As laid out, the proposed projects meet or slightly exceed the cumulative area targets in the order. This conceptual plan and estimate is based on a coverage of 30,410 acres, including 20,845 acres of wetted area and 9,564 acres of dry DCA. A summary of the wetted areas and the DCAs, by river, are shown in Table 6.

Table 4 Summary of Costs

	Cost Element	Total
Primary Infrastructure Elements	Storage Ponds	$153,830,000
	Causeways	$24,850,000
	Conveyance	$29,220,000
	Extension	$57,660,000
	Other	$18,640,000
	Dust Control Areas	$59,793,750
	Harbor Restoration	$3,000,000
	Sub-Total	$346,998,000
Supporting Costs	Mobilization/Demobilization	$18,830,000
	Engineering Design	$15,240,000
	Environmental Permitting	$15,240,000
	Construction Management	$23,920,000
	Sub-Total	$73,230,000
	Total	**$420,227,500**

Note: All figures rounded to the nearest thousand.
Amounts are in 2017 U.S. dollars.

Table 5 Summary of Costs by Year and River Area

	2018–2019	2020			2023			2027			
	Harbor Areas	**New River**	**Alamo**	**Whitewater**	**New River**	**Alamo**	**Whitewater**	**New River**	**Alamo**	**Whitewater**	**Total**
Storage Ponds		$0	$21,990,000	$24,100,000	$25,540,000	$20,420,000	$13,420,000	$19,380,000	$18,480,000	$10,500,000	$153,830,000
Causeways		$0	$8,540,000	$2,930,000	$2,080,000	$2,210,000	$1,380,000	$3,790,000	$2,530,000	$1,390,000	$24,850,000
Conveyance		$9,940,000	$12,890,000	$6,390,000	$0	$0	$0	$0	$0	$0	$29,220,000
Extension		$0	$18,750,000	$3,580,000	$7,190,000	$4,920,000	$2,640,000	$10,190,000	$6,740,000	$3,650,000	$57,660,000
Other		$3,640,000	$8,390,000	$6,610,000	$0	$0	$0	$0	$0	$0	$18,640,000
Dust Control Areas		$17,468,750	$12,562,500	$6,056,250	$3,462,500	$5,781,250	$2,400,000	$6,887,500	$3,725,000	$1,450,000	$59,793,750
Harbor Restoration	$3,000,000										$3,000,000
Sub-Total	**$3,000,000**	**$31,048,750**	**$83,122,500**	**$49,666,250**	**$38,270,000**	**$33,330,000**	**$19,840,000**	**$40,250,000**	**$31,480,000**	**$16,990,000**	**$346,997,500**
Mobilization/ Demobilization		$1,860,000	$4,990,000	$2,980,000	$1,910,000	$1,670,000	$990,000	$2,010,000	$1,570,000	$850,000	$18,830,000
Engineering Design		$1,860,000	$4,990,000	$2,980,000	$1,150, 000	$1,000,000	$600,000	$1,210,000	$940,000	$510,000	$15,240,000
Environmental Permitting		$1,860,000	$4,990,000	$2,980,000	$1,150, 000	$1,000,000	$600,000	$1,210,000	$940,000	$510,000	$15,240,000
Construction Management		$2,480,000	$6,650,000	$3,970,000	$2,300,000	$2,000,000	$1,190,000	$2,420,000	$1,890,000	$1,020,000	$23,920,000
Sub-Total		**$8,060,000**	**$21,620,000**	**$12,910,000**	**$6,510,000**	**$5,670,000**	**$3,380,000**	**$6,850,000**	**$5,340,000**	**$2,890,000**	**$73,230,000**
Total	**$3,000,000**	**$39,108,750**	**$104,742,500**	**$62,576,250**	**$44,780,000**	**$39,000,000**	**$23,220,000**	**$47,100,000**	**$36,820,000**	**$19,880,000**	**$420, 227,500**
Grand Total	**$3,000,000**	**$206,428,000**			**$107,000,000**			**$103,800,000**			**$420,227,500**

Note: Amounts are in 2017 U.S. dollars.

Table 6 Constructed Area in Acres

	Year	New River		Alamo River		Whitewater River		Redhill + Torres	Area by Year	Cumulative Area	Required Area	SWRCB Order
		Wetted Area	Dust Control Area	Wetted Area	Dust Control Area	Wetted Area	Dust Control Area	Wetted Area				
	2018		699						699	699	500	500
	2019		699		670				1,369	2,068	1,300	1,800
2020 Phase Initial Berms	2020	1.300	699	1,178	670	760	485	568	5,659	7,726	1,700	3,500
	2021	1,300	699	1,178	670	760	485	568	5,659	13,385	3,500	7,000
	2022								–	13,385	1,750	8,750
2023 Phase Middle Berms	2023	1,398	277	939		445			3,058	16,443	2,750	11,500
	2024	1,398	277	939	925	445	384		4,367	20,810	2,700	14,200
	2025		276						276	21,085	3,400	17,600
	2026		276		199		77		552	21,637	4.000	21,600
2027 Phase Final Berms	2027	2,094	276	1,260	199	483	77		4,388	26,025	4,000	25,600
	2028	2,094	276	1,260	199	483	77		4,388	30,413	4,200	29,800
Total Area		9,583	4,451	6,753	3,531	3,374	1,585	1,136	**30,410**			

Note: SWRCB = California State Water Resources Control Board

Figure 3 Berm Configuration

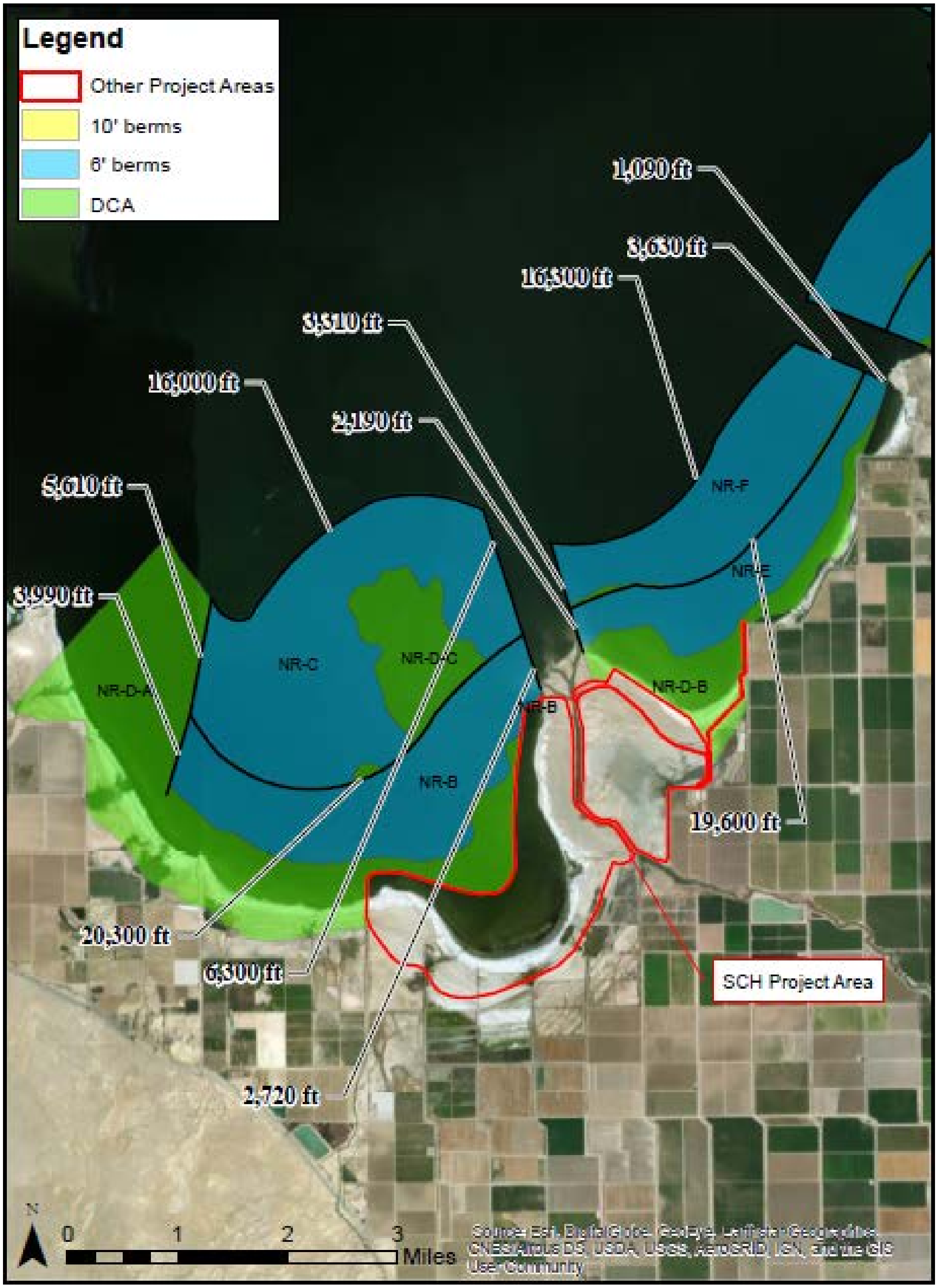


Figure 4 **Berm Configuration for Alamo River**

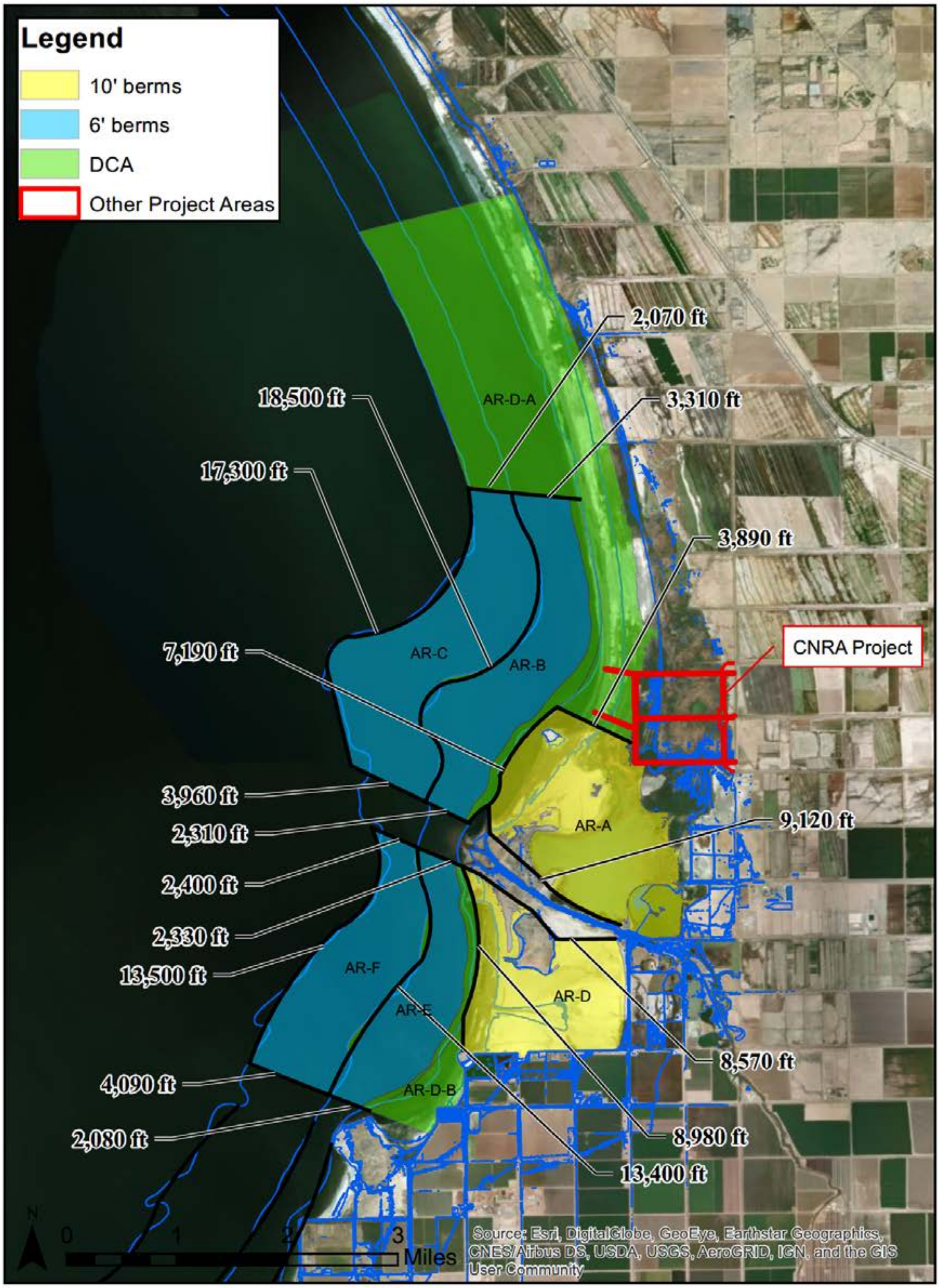


Figure 5 Berm Configuration for Whitewater River

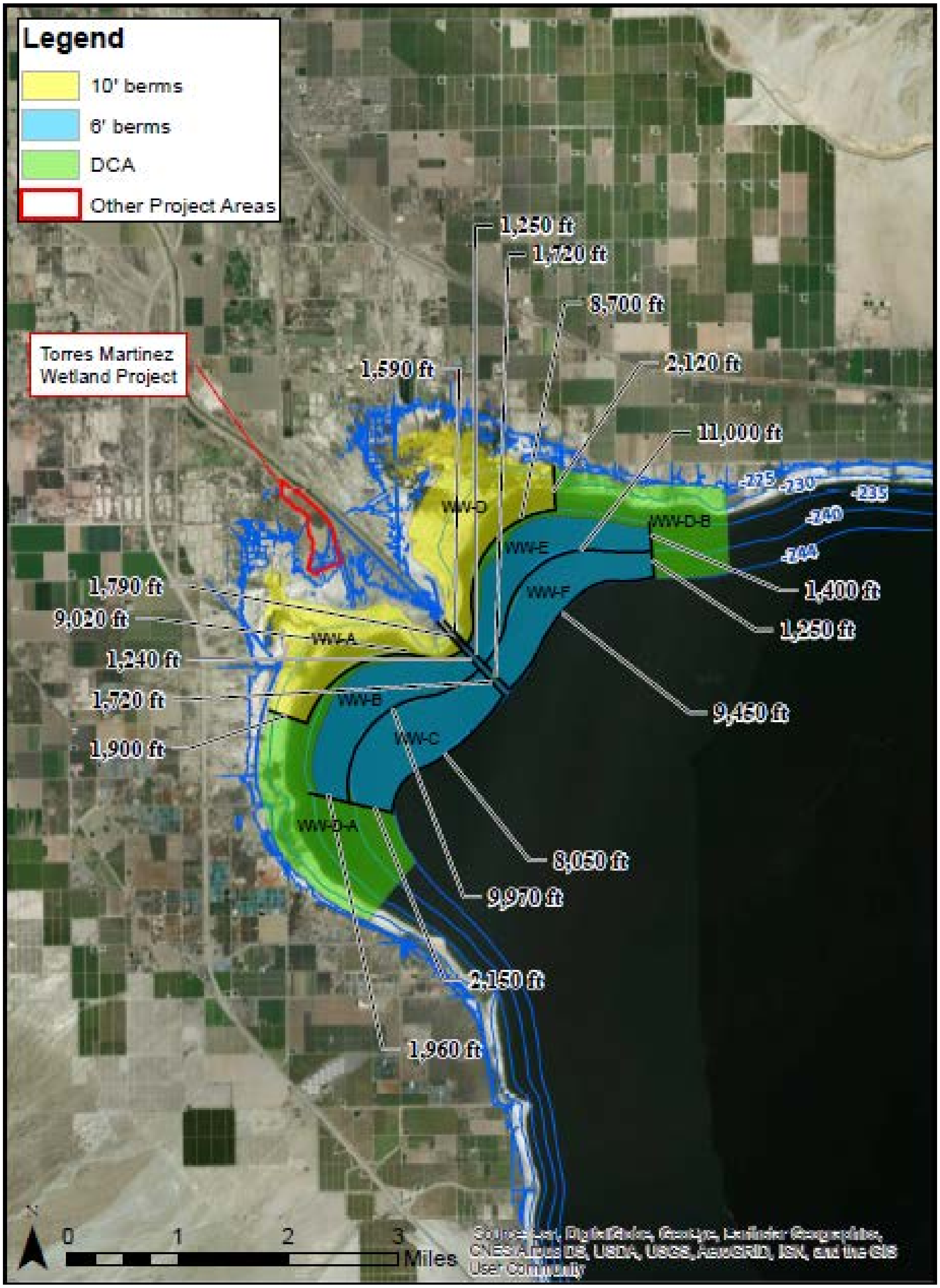


Figure 6 **2020 Initial Berm Cross Section**

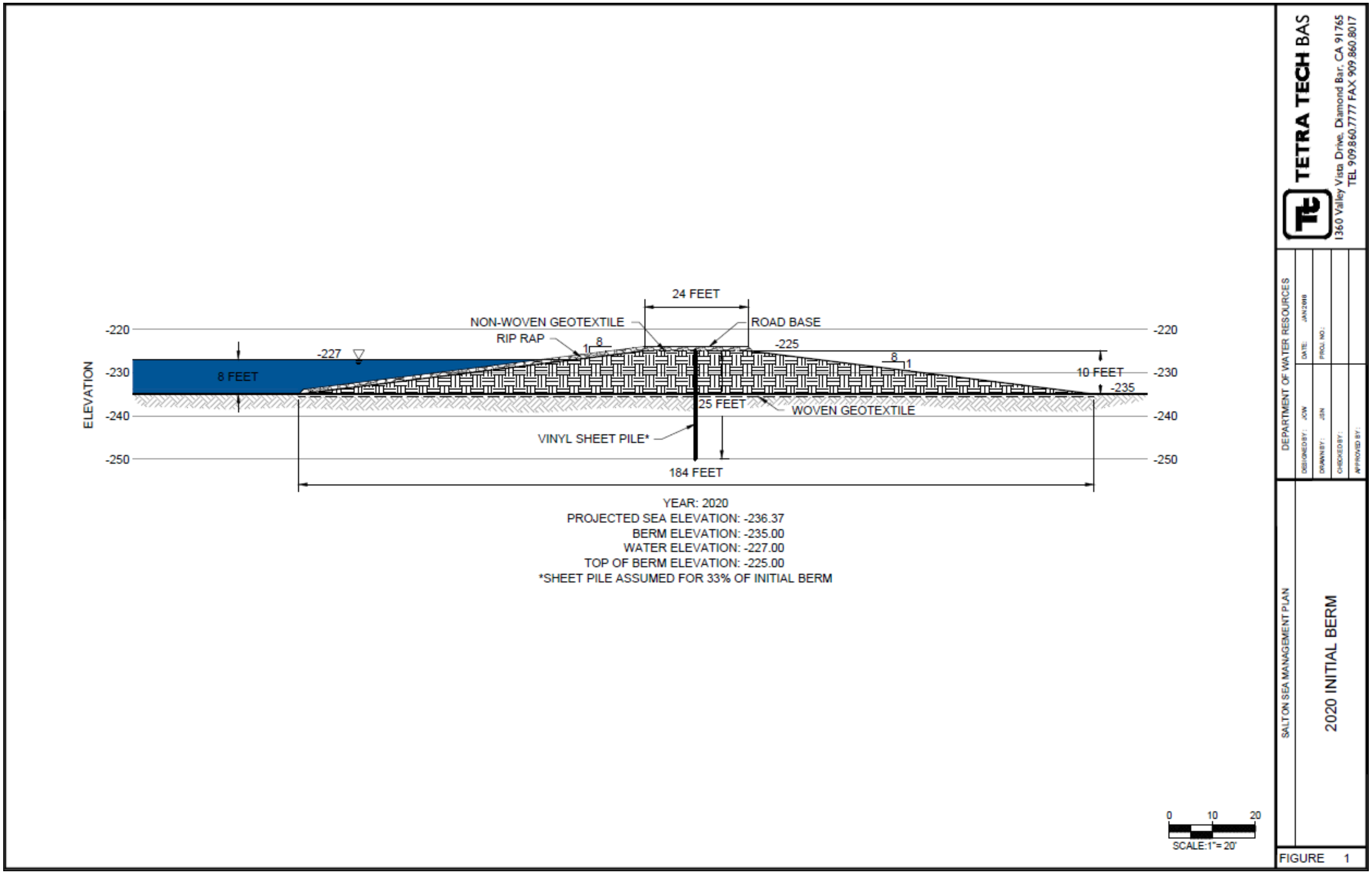


Figure 7 2023 Middle Berm Cross Section

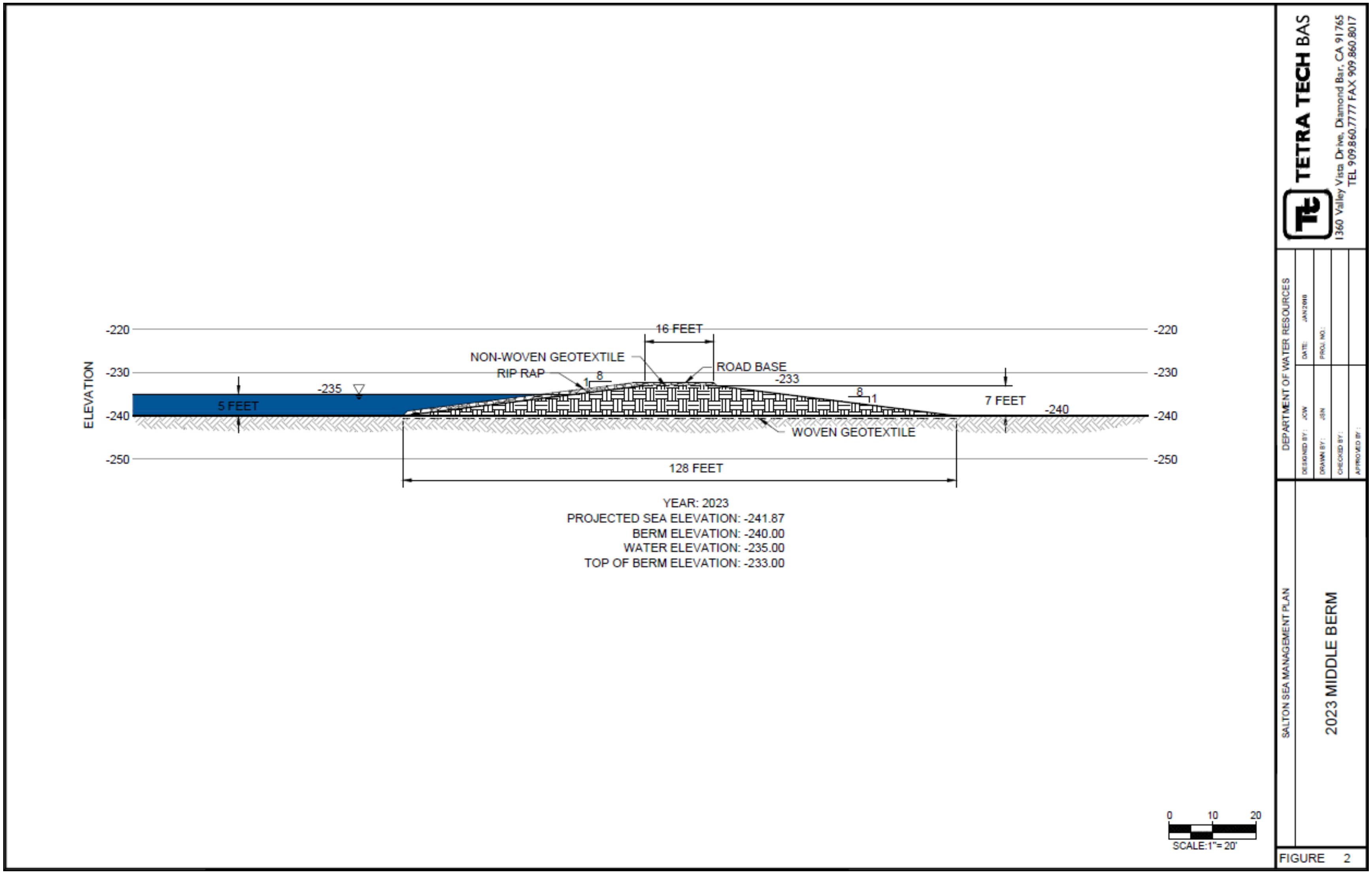


Figure 8 **2027 Lower Berm Cross Section**

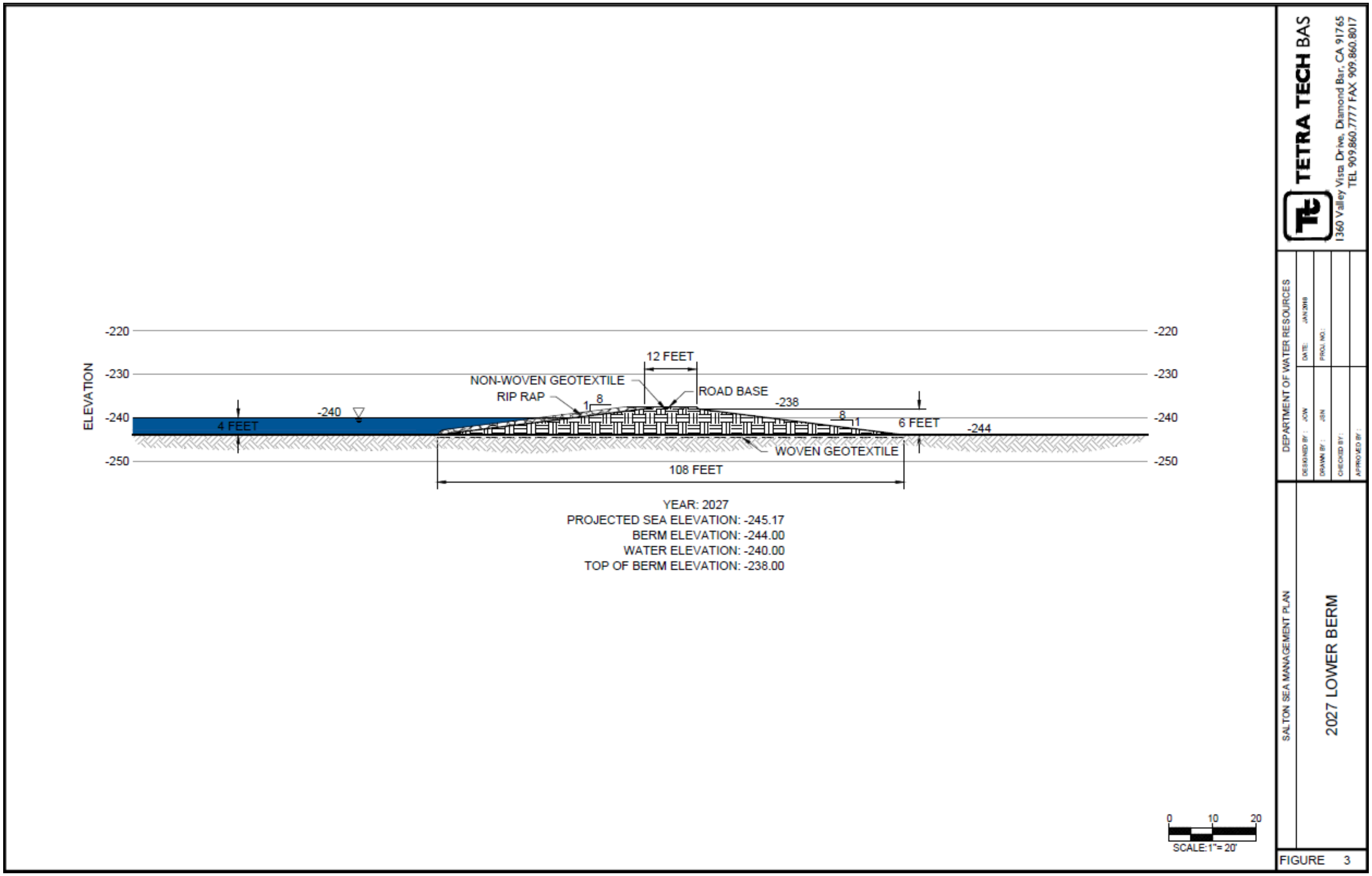


Figure 9 Causeway Berm Cross Section

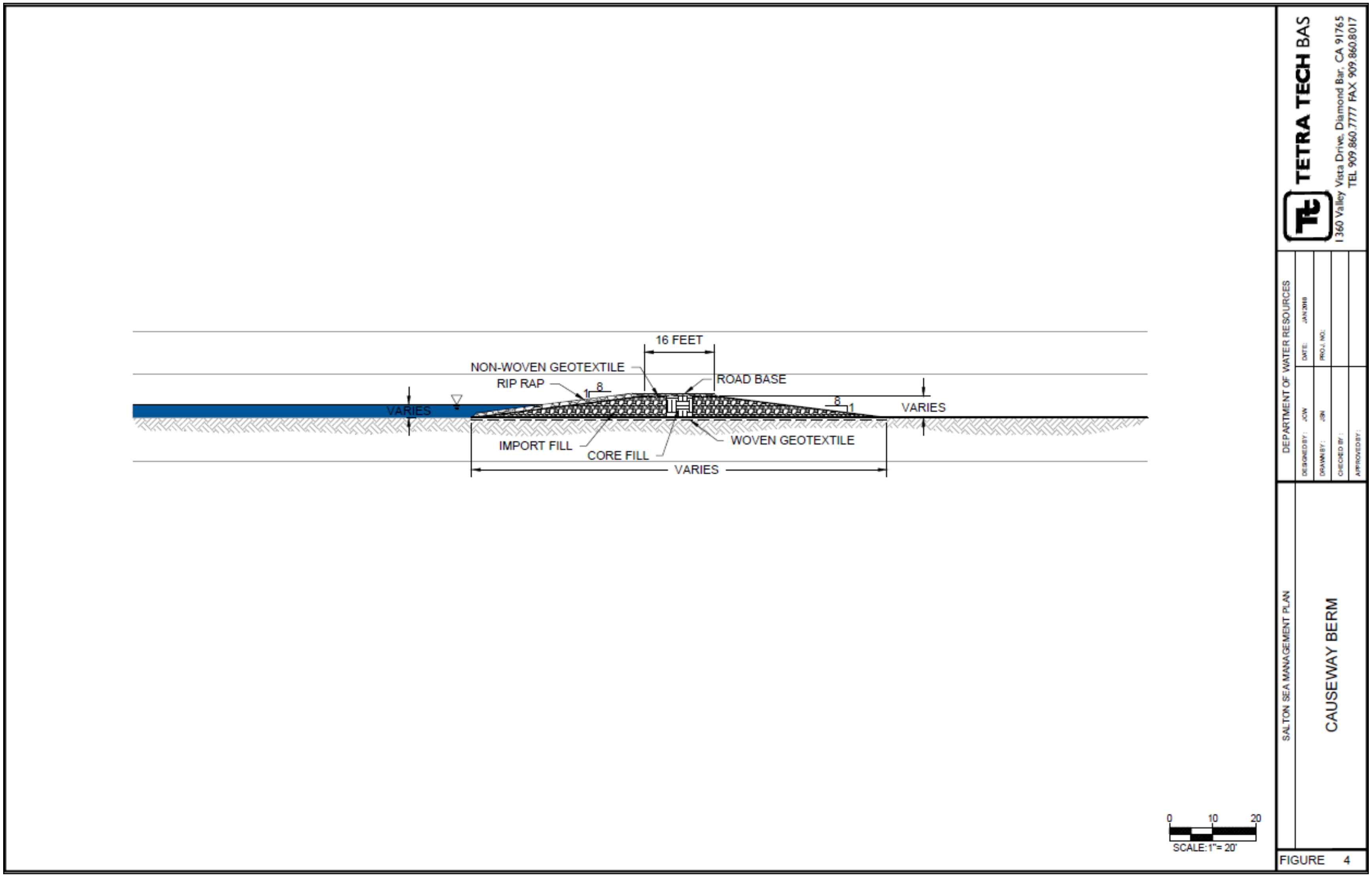


Figure 10 Diversion Berm Cross Section

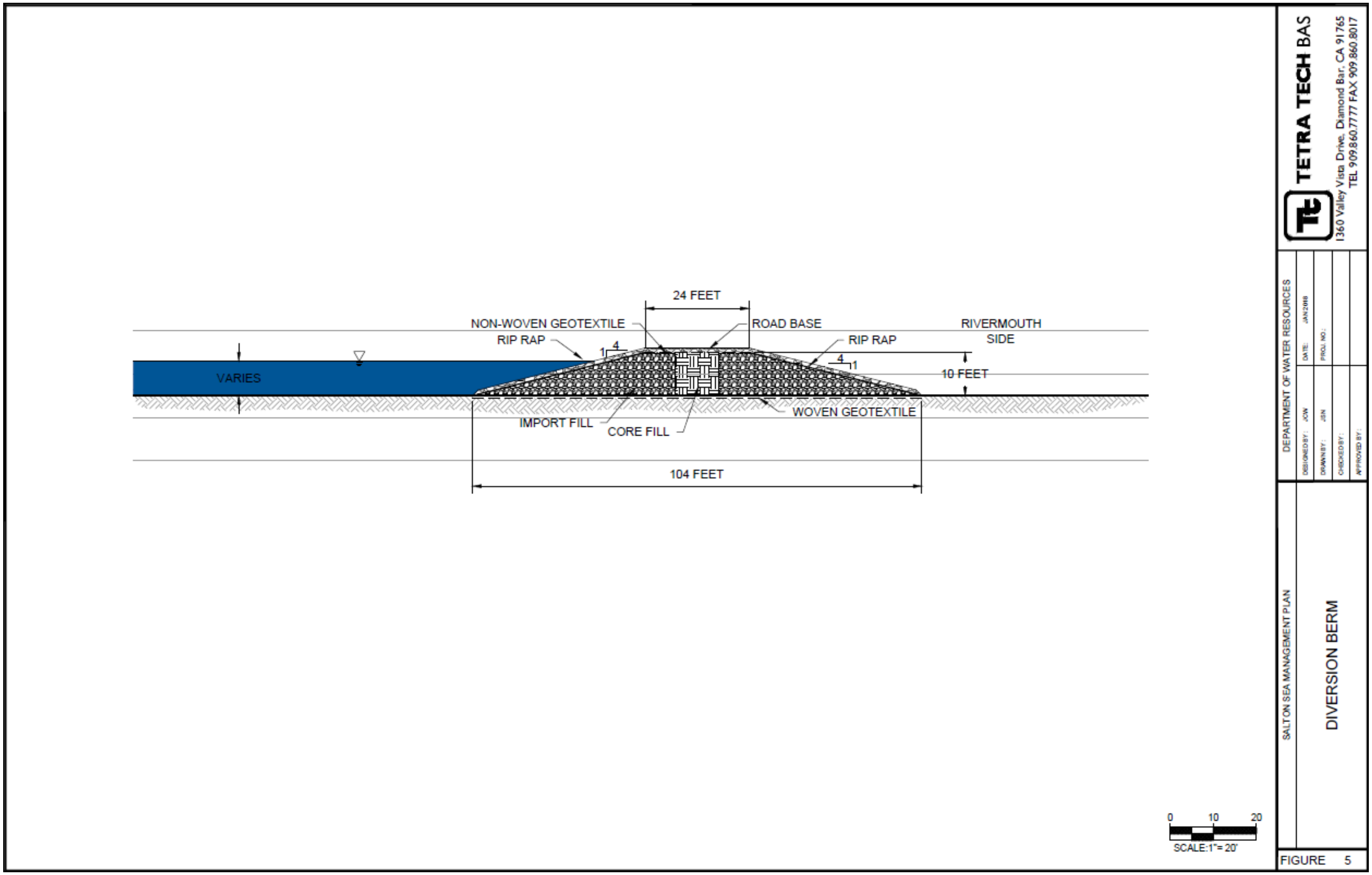
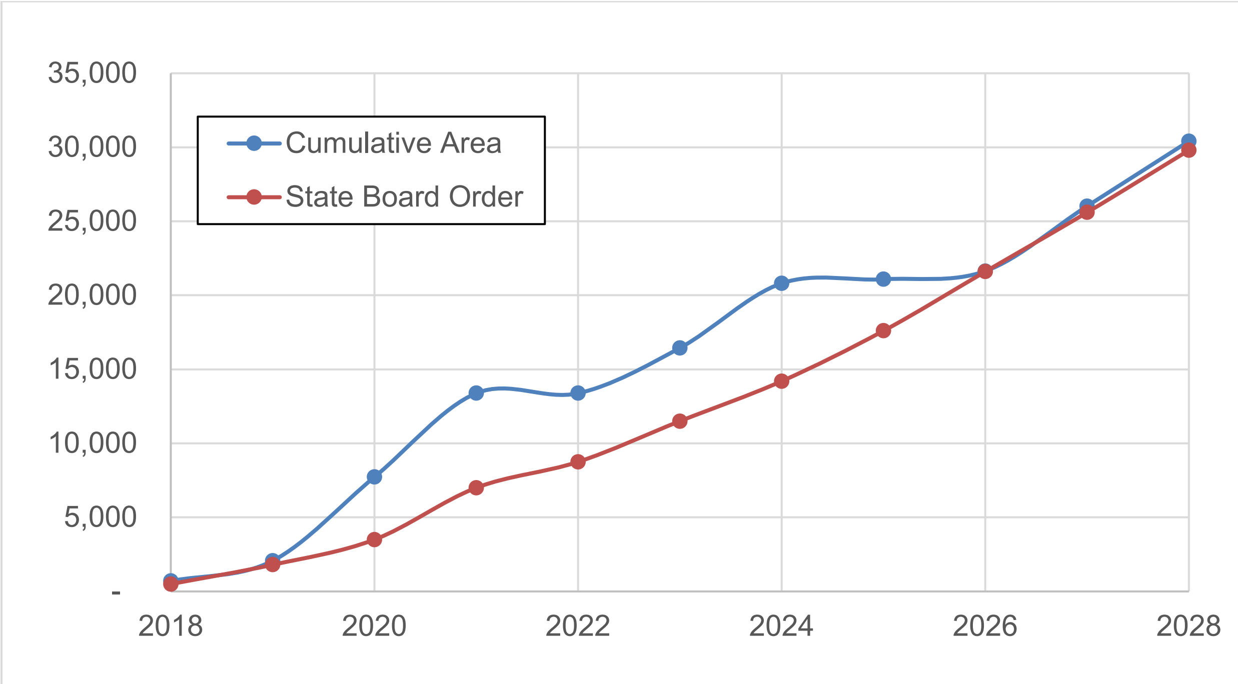


Figure 11 Cumulative Area of Added Acreage Compared to State Board Order



Chapter 4. References

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