

Annual Revegetation Monitoring Report

for the Southeastern Creekside Marsh Culvert Replacement and
Habitat Enhancement Project

2022 (YEAR 6)

Prepared by:



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Executive Summary

The Southeastern Creekside Marsh Culvert Replacement and Habitat Enhancement Project was initiated in 2016 to increase the tidal prism in the southern portion of Creekside Marsh in order to reduce flooding of the trail and surrounding properties and enhance tidal marsh habitat. The project is separated into three areas: the Culvert Replacement Area, which was revegetated after construction and completed in 2016; the Soil Replacement Area, which was revegetated after soil was replaced with Young Bay Mud in 2017; and the Soil Amendment Area, which was revegetated after soil was enhanced with gypsum and compost green waste in 2018.

The Culvert Replacement Area met Year 5 success criteria for native and invasive species cover, and concluded its five-year monitoring requirement. The Soil Replacement Area met Year 5 criteria in its fourth year of monitoring, and was qualitatively evaluated in 2022. The Soil Amendment Area met Year 4 criteria for native plant cover, but did not meet criteria for invasive species cover due to the presence of *Plantago lanceolata*. This species will be removed by hand by the Friends of Corte Madera Creek Watershed.

Project Description

1.1. Overview

The Southeastern Creekside Marsh Culvert Replacement and Habitat Enhancement Project was initiated in 2016 as a joint project between Marin County Parks and Friends of Corte Madera Creek Watershed (**Figure 1**). The goal of the project was to reduce flooding of the Creekside trail and surrounding properties adjacent to Creekside Marsh by replacing an undersized culvert, while at the same time enhancing tidal marsh habitat within Creekside Marsh by increasing the tidal prism, modifying trails, replacing and amending soil, and planting native marsh vegetation.

1.2. Culvert Replacement

A single bore culvert connecting Corte Madera Creek to the southern end of Creekside Marsh was removed and replaced with three new culvert pipes in 2016 (**Figure 2**). Construction included removing and storing the top layer of marsh vegetation within the construction area, placing coffer dams and relocating fish, excavating the berm between the creek and the marsh to remove the existing culvert, and placing three new 60-inch culverts in its place. In addition, the project closed a path north of the project area by placing soil in these areas as well as signs and fencing to discourage people from using the path.

The culvert replacement project area encompassed salt marsh habitats on both sides of the berm where construction occurred. Temporary impacts, including removal of salt marsh vegetation, occurred in 0.14 acre of estuarine wetland in Creekside Marsh and Corte Madera Creek.

1.3. Soil Replacement

The second component of the project, completed in 2017, was to remove of the top eight inches of compacted soil, unsuitable to support salt marsh vegetation, within approximately 8,290 square feet (approximately 0.2 acre) of marsh area, and replace it with Young Bay Mud to the same elevation as the surrounding marsh (**Figure 3**). Due to the lack of available Young Bay Mud, only half of the proposed area (approximately 0.1 acre) was treated in this way.

1.4. Soil Amendment

Due to the shortage of Young Bay Mud for soil replacement, the specified habitat restoration area could not be achieved. To meet the area requirement, the soil at the remaining 0.1 acre was enhanced with soil amendments to support active planting. First, large rocks were removed from the existing soil. Then, gypsum and composted green waste were added to the soil and native plants were planted in January 2019 (**Figure 3**).

1.5. Native Revegetation

Revegetation with native plants was conducted in each of the project areas: the culvert replacement project area (**Figure 2**), the soil replacement area, and the soil amendment area (**Figure 3**). First, plants salvaged before the culvert replacement were installed after culvert construction was complete. Second,

in the two restoration areas (**Figure 2**), soil was removed and either replaced with Young Bay Mud in late 2017 or amended with gypsum and compost and planted by January 2019.

1.5.1. Culvert Replacement Area

Prior to excavation to remove the existing culvert, salt marsh vegetation was removed (salvaged) and stored on site. Vegetation removal began at the upland edge and continued towards higher quality habitat at the lower elevations. The salt marsh vegetation was removed with six inches of soil underneath.

During construction, the salt marsh vegetation was stored onsite in a shady area; the low elevation plants (*Spartina foliosa* and *Jaumea carnosa*) were stored in small plastic pools and maintained with several inches of fresh water, and the mid elevation plants (*Salicornia pacifica* and *Distichlis spicata*) were placed on plastic sheeting and watered daily. The salvaged salt marsh vegetation had an approximate survivorship of 90% while out of the marsh.

After completion of construction in October 2016, the salvaged salt marsh vegetation was replanted in the work area. The plants were placed based on species and elevation. Vegetation was not placed higher than where existing salt marsh vegetation was observed on site. Planting was completed using hand tools over a four-hour period at low tide. A coir mat was placed on the upland area, and native grass seed mix was spread over of the impacted upland transition zone.

1.5.2. Soil Replacement Area

The area enhanced with Young Bay Mud was left undisturbed to allow passive recruitment of salt marsh vegetation for about a year after placement of the mud in December 2017. In 2019, pickleweed (*Salicornia pacifica*) was planted to further enhance restoration efforts.

1.5.3. Soil Amendment Area

In 2019, the area previously enhanced with gypsum and composted green waste was planted with native plant species, including saltgrass (*Distichlis spicata*), creeping wild rye (*Elymus triticoides*), alkali heath (*Frankenia salina*), cuman ragweed (*Ambrosia psilostachya*), marsh baccharis (*Baccharis glutinosa*), and California mugwort (*Artemisia douglasiana*).



Figure 1. Project Location Map



Figure 2. Culvert Replacement Project Site Map



Figure 3. Habitat Restoration Site Map

2. Assessment of Enhancement Success

2.1. Permit Requirements

Mitigation Monitoring & Reporting Plan (MMRP): Established five-year monitoring methods for vegetation in the construction area and reclamation areas, beginning in the first September after planting.

California Department of Fish & Wildlife (CDFW): Established success criteria for salt marsh vegetation in areas that are planted/seeded/left for natural regeneration, which shall be monitored for five years following initial installation.

Regional Water Quality Control Board (RWQCB): Established criteria for absolute cover of native and exotic vegetation over five years of monitoring.

Bay Conservation & Development Commission (BCDC): Stated marsh monitoring and reporting shall be in conformity with the MMRP.

2.2. Success Criteria

The MMRP established success criteria for percent cover, invasive species cover, and plant survival in the project area.

2.2.1. Percent Cover

The percent cover criteria for revegetated areas (culvert replacement project site, soil amendment site and soil replacement) are shown in **Table 1**.

Table 1. Success Criteria for Salt Marsh Species

Year	Average Total Plant Cover Compared to Adjacent Reference Site	Average Absolute Cover of Native Species Compared to Adjacent Reference Site	Absolute Cover Undesirable Exotic Species
One	≥10%	≥5%	≤5%
Two	≥20%	≥15%	≤5%
Three	≥35%	≥30%	≤5%
Four	≥55%	≥50%	≤5%
Five	≥80%	≥75%	≤5%

2.2.2. Target Invasive Species

The target invasive species shall not exceed 5% absolute cover in any year. Undesirable exotic species are defined as having a Cal-IPC Inventory Rating of High or in some circumstances newer weeds identified to be invasive and not yet updated on the Cal-IPC lists.

In upland areas, non-native annual grass species that dominate the site prior to project impacts are not considered target invasive species requiring control because they meet pre-construction conditions. The

target exotic species of note called out in the MMRP are invasive cordgrass species (*Spartina alterniflora*, *Spartina densiflora*) and perennial pepperweed (*Lepidium latifolium*).

2.2.3. Establish Reference Sites

To evaluate the percent cover of the project sampling areas, adjacent reference sites were established with following criteria: within 45 meters of the project sampling area, having marsh species that grow at a similar elevation as the adjacent sampling area, are located on the same channel or creek as the adjacent sampling area, and are the same size as the adjacent sampling area. In Year 2, a reference site was established adjacent to the soil replacement restoration area, and in Year 3, a reference site was established for the soil amendment area.

3. Monitoring Methods

To evaluate the progress of restoration in the project site, percent vegetation cover was evaluated quantitatively using the point line intercept method and compared to an adjacent reference site. Plant growth and survival were determined visually on-site. Photo points were established to track revegetation progress in the project area.

3.1. Monitoring Schedule

An OEI biologist conducted the vegetation monitoring on October 6, 2022.

3.2. Percent Cover of Native Salt Marsh Species

The culvert replacement project site (**Figure 2**) concluded its five-year monitoring requirement in 2021. Year 5 success criteria were achieved in 2020 for percent cover of native species and presence of invasive species. This project site was not assessed in 2022.

The soil replacement project site (**Figure 3**) was not evaluated quantitatively this year. Year 5 success criteria were achieved in 2021 for percent cover of native species and presence of invasive species. Photo point monitoring and a visual assessment of the project site were completed this year to ensure no major plant die offs or invasive species occurred that could jeopardize the success of the soil replacement project site.

The soil amendment habitat restoration was evaluated using the point line intercept method (**Figure 3**). Three 9m transects were established from low to high elevations and were sampled every half meter, yielding 54 data points. A reference site was established south of the restoration area at a similar elevation to compare the percent cover of the restoration site, which was conducted by establishing three 9m transects in the reference site from low to high elevations and sampling every half meter.

3.3. Data Analysis

Absolute cover of each species was calculated using the point intercept data. Species composition was calculated by dividing the number of hits of a species by the total number of data points (54) taken along that transect. This is multiplied by 100 to yield a percentage of each species.

Absolute cover of vegetation was calculated as the number of hits of vegetation divided by the total number of points recorded along the transect and multiplied by 100.

Cover of invasive species was calculated as the number of hits of invasive species recorded along the transect divided by the total number of points and multiplied by 100.

Percent cover compared to an adjacent reference site was calculated as the native vegetation cover of the project site divided by the native vegetation cover of the reference site and multiplied by 100.

The soil amendment site was evaluated using Year 4 success criteria.

3.4. Presence of Invasive Species

In addition to invasive species recorded using the point intercept method, all invasive species were visually estimated at the project site. Visual surveys were conducted for invasive species including cordgrass species (*Spartina alterniflora*, *Spartina densiflora*) and perennial peppergrass (*Lepidium latifolium*). Due to the small size of the project area, any invasive species found were recommended for removal.

3.5. Plant Survivorship

Due to the small size of the project area, plant survivorship of the salt marsh species was visually estimated.

3.6. Photo Point Monitoring

Four photographs were taken on October 6, 2022, documenting the habitat restoration area. The compass bearing of each and GPS coordinated were recorded for each photo point.

4. Results

4.1. Culvert Replacement Area (Completed)

The culvert replacement project site (**Figure 2**) concluded its five-year monitoring requirement in 2021 and was not monitored in 2022.

4.2. Soil Replacement Area (Year 5)

The habitat restoration conducted at Creekside Park is separated into two areas: The soil replacement area which was restored using Young Bay Mud in December 2017, and the soil amendment area that was restored in January 2019 (**Figure 3**).

The soil replacement area (**Figure 3**) was not monitored quantitatively because all Year 5 success criteria were reached in Year 4. Photo point monitoring, plant survival, and invasive species monitoring were completed this year to ensure no major plant die offs or invasive species occurred that could jeopardize the success of the soil replacement habitat restoration site.

4.2.1. Percent Cover of Native Salt Marsh Species

Year 5 success criteria were achieved in Year 4 as shown below (**Table 2**). Percent cover compared to an adjacent reference site was not evaluated this year. The site was visually assessed to ensure that no major plant mortality occurred since success criteria were achieved. The soil replacement area appears to have plant cover equal to the surrounding marsh.

Table 2. Percent cover at Soil Replacement Area compared to an adjacent reference site.

Percent Cover (%) of Native Salt Marsh Species Compared to Reference Site		
Monitoring Year*	Success Criteria	Soil Replacement Site
Year 1 (2018)	≥5	12.7
Year 2 (2019)	≥15	45.1
Year 3 (2020)	≥30	73.5
Year 4 (2021)	≥50	85.8
Year 5 (2022)	≥75	Not Measured

*The soil replacement restoration took place in December 2017. In 2021 it met Year 5 criteria.

4.2.2. Invasive Species Cover

No invasive species were present within the soil replacement site.

4.2.3. Plant Survivorship

Plant survivorship was visually estimated where active plantings had taken place. Plant survivorship at the soil replacement site was above 90%. The soil replacement site is a mix of planted pickleweed and passive recruitment. These areas have intermixed with the surrounding marsh.

4.2.4. Photo Point Monitoring

Photo points were recorded at the soil replacement project area to monitor the success of the plantings (**Appendix A**).

4.3. Soil Amendment Area (Year 4)

The habitat restoration conducted at Creekside Park is separated into two areas: The soil replacement area which was restored using Young Bay Mud in December 2017, and the soil amendment area that was restored in January 2019 (**Figure 3**). Restoration of the soil amendment area was completed 4 years ago, so it was evaluated using Year 4 criteria.

4.3.1. Absolute Percent Cover

Absolute cover determined at the soil amendment site and the adjacent reference site is shown in **Table 3**.

Table 3. Absolute percent cover at the soil amendment site..

Cover Type	Absolute Percent Cover (%) of Soil Amendment Area	
	Soil Amendment Site	Reference Site
Bare Ground	33.3	28.4
Wrack	0	0
Target Invasive Cover	8.3	0
Native Vegetation Cover	58.3	71.6
Absolute Vegetation Cover	66.7	71.6

4.3.2. Percent Cover of Native Salt Marsh Species

Native vegetation had a percent cover of 81.4 compared to the reference site (**Table 4**), above the minimum cover criteria of 50%.

Table 4. Percent cover compared to an adjacent reference site at the soil amendment site.

Percent Cover (%) of Native Salt Marsh Species Compared to Reference Site		
Monitoring Year*	Success Criteria	Soil Amendment Site
Year 1 (2019)	≥5	43.3
Year 2 (2020)	≥15	59.6
Year 3 (2021)	≥30	62.8
Year 4 (2022)	≥50	81.4
Year 5 (2023)	≥75	

* The soil amendment site was planted in January 2019 and evaluated for the first time in Summer 2019. Monitoring in 2022 is thus compared to Year 4 criteria.

4.3.3. Invasive Species Cover

Plantago lanceolata was found above the acceptable percent cover at the soil amendment site (**Table 5**). This species is found in areas adjacent to the restoration site and easily invades disturbed areas. The absolute cover of this species decreased by 55.4% compared to 2021.

Table 5. Invasive species cover at the soil amendment site.

Year 3 Absolute Cover (%) of Invasive Species at Habitat Restoration Site	
Success Criteria	Soil Amendment Site
≤5	8.3

4.3.4. Species Composition

Marsh baccharis (*Baccharis glutinosa*), saltgrass (*Distichlis spicata*), and pickleweed (*Salicornia pacifica*) are growing successfully in the soil amendment site (**Table 6**). Invasive *Plantago lanceolata* is still present within the habitat restoration area and will be removed by hand and monitored quarterly.

Table 6. Species composition at the soil amendment site and adjacent reference site.

Cover Type	Species Composition (%)	
	Soil Amendment Site	
	Project Site	Reference Site
<i>Distichlis spicata</i>	17.5	25
<i>Salicornia pacifica</i>	47.5	2.1
<i>Frankenia salina</i>	2.5	20.8
<i>Elymus triticoides</i>	7.5	0
<i>Ambrosia psilostachya</i>	0	0
<i>Baccharis glutinosa</i>	12.5	0
<i>Artemisia douglasiana</i>	0	0
<i>Symphotrichum chilense</i>	0	0
<i>Grindelia stricta</i>	0	0
<i>Jaumea carnosa</i>	0	29.2
<i>Limonium californicum</i>	0	22.9
Annual Upland Grass	0	0
<i>Atriplex spp.</i>	0	0
Invasive <i>Plantago lanceolata</i>	12.5	0

4.3.5. Plant Survivorship

Plant survivorship was visually estimated where active plantings had taken place. Plant survivorship at the soil amendment site was 70-80%.

4.3.6. Photo Point Monitoring

Photo points were recorded at the soil amendment project area to monitor the success of the plantings (**Appendix A**).

5. Discussion

The following sections discuss the results of the monitoring that occurred on October 6, 2022.

5.1. Culvert Replacement Area (Completed)

The culvert replacement project site (**Figure 2**) concluded its five-year monitoring requirement in 2021 and was not monitored in 2022.

5.2. Soil Replacement Area (Year 5)

The soil replacement area (**Figure 3**) was visually monitored to ensure that the percent cover of salt marsh species still met the Year 5 success criteria. The plantings continue to be successful and net cover appeared similar to the surrounding marsh. This concludes the fifth year of monitoring for this site.

5.3. Soil Amendment Area (Year 4)

5.3.1. Percent Cover of Native Salt Marsh Species

Year 4 success criteria of $\geq 50\%$ native vegetation cover was met at the soil amendment area (**Figure 3**). The site had a native vegetation cover of 81.4% compared to a reference site. This area was actively planted and irrigated which has allowed plant survival to be approximately 70-80%.

5.3.2. Invasive Species Cover

Invasive species cover was greater than 5% in the soil amendment site. Invasive *Plantago lanceolata* was found invading the planted area. *Plantago lanceolata* had a percent cover of 8.3, down from 18.5 when compared to 2021. This species is found throughout the upland areas surrounding the site and grows well in disturbed soils.

The University of California Cooperative Extension's Weed Research & Information Center suggests hand pulling as an effective method for controlling this species. The University of California's Statewide Integrated Pest Management Program suggests mulching as an effective method for controlling *P. lanceolata* seedlings if applied 2 to 4 inches deep. Removal of this species is recommended immediately as well as follow up monitoring that will be conducted quarterly by OEI biologists.

5.3.3. Species Composition

Marsh baccharis (*Baccharis glutinosa*), saltgrass (*Distichlis spicata*), and pickleweed (*Salicornia pacifica*) were the most successful upland plantings. Installing irrigation has been vital to the survivorship of the upland plantings. *S. pacifica* was the most abundant species and will hopefully continue to fill in the area through passive recruitment. Both *B. glutinosa* and creeping wild rye (*Elymus triticoides*) set seed within the project site, which will hopefully assist with passive recruitment of these species. Additionally,

although cuman ragweed (*Ambrosia psilostachya*) was not counted in the established transects, it is present along the eastern edge of the habitat restoration area.

Invasive *Plantago lanceolata* made up a significant part of the species composition and has been recommended for removal by hand.

5.3.4. Plant Survivorship

Plant survivorship at the soil amendment site appeared to be 70-80%. The plantings have spread and are now intermixed with plants that have recruited passively. *Baccharis glutinosa* and *Distichlis spicata* were the most successful planted species. Plants appear to be healthy, but are still fairly small. This may be due to the harsh soils they were planted in. It is also likely that several years of drought have influenced growth of the plantings and passive recruitment of native species.

5.4. Wildlife Observations

Species observed in or adjacent to the project site were documented during onsite vegetation monitoring. One Ridgway's rail (*Rallus obsoletus obsoletus*) was heard calling approximately 150m northwest of the soil amendment site.

6. Adaptive Management and Remedial Actions

6.1. Removal of *Plantago lanceolata*

OEI recommends a combination of hand removal and mulching to manage *Plantago lanceolata* within the soil amendment site. Removal will take place by Friends of Corte Madera Creek Watershed.

6.2. Quarterly Site Visits

OEI will conduct quarterly site visits throughout 2023 and will make additional recommendations as needed to ensure project goals are met. OEI biologists will monitor the treatment efficacy of invasive *Plantago lanceolata* and recommend further treatment if necessary.

6.3. Annual Vegetation Monitoring

The Culvert Replacement Area and Soil Replacement Area have completed five years of monitoring and has met the MMRP established success criteria for percent cover, invasive species cover, and plant survivorship.

OEI will conduct the next vegetation monitoring for the Soil Amendment Area in fall 2023.

7. References

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Appendix A- Photo Point Monitoring

Photo point monitoring was conducted on 10/6/22.



P-5. Project Site: Soil Replacement Site



P-6. Reference Site: Soil Replacement Site



P-7. Project Site: Soil Amendment Site



P-8. Reference Site: Soil Amendment Site