Aerial of Colorado Lagoon (foreground) with Marine Stadium and Alamitos Bay (background)

PHOTO: CITY OF LONG BEACH

The Complexity of Urban Tidal Wetlands Restoration Projects Exemplified at Colorado Lagoon

ERIC ZAHN

Abstract

Colorado Lagoon is one of the last remaining restorable pieces of coastal salt marsh habitat on the Southern California coast. This 18-acre water body has been the focus of a decade-long conservation effort aimed at improving the site's degraded environmental health. The main goal of the Colorado Lagoon Restoration Project is improving the water quality to promote better conditions for wetlands wildlife as well as marine recreational opportunities. Storm drain upgrades and a culvert cleaning completed in November 2010 have already led to less trash and urban runoff entering the lagoon, as well as improved tidal residence times. The dredging of more than 75,000 cubic yards of contaminated sediments commenced in January 2012 in order for the lagoon to meet state water quality standards. The most critical part of this project will be restoring a tidal channel that once connected Colorado Lagoon to Alamitos Bay. A design for this tidal channel has been chosen, and $10 million in funding is needed. There has been a complex process by which the various necessary components of this restoration project have come together. Navigating these complexities has been a challenge for the project partners, and this case study demonstrates the benefits of supporting similar challenging conservation efforts along our urban coast.

Introduction

Restoring ecosystems along the urbanized coast is complex. Coastlines host a mosaic of biodiverse habitats, while also acting as the most attractive places for humans to dwell. With more than 18 million people living in five coastal counties of Southern California (U.S. Census Bureau 2010), finding a balance between the needs of these urbanized areas and the needs of coastal wildlife is a challenge. No ecosystem has received as much conservation consideration along California's coastline as the coastal salt marsh. This attention is befitting, since more than 75% of the region's salt marsh plant community's historic range has been lost since the arrival of Europeans (Speth 1969; Zedler 1982), with much of the remaining acreage in degraded or recently restored conditions.

Airports, agricultural fields, power plants, marinas, shipping ports, golf courses, neighborhoods, and oil fields have all been developed where there was once salt marsh. Meanwhile, these places have also become major recreational hubs for hiking, biking, birding, fishing, kayaking, and sometimes swimming. Increased edge effects (i.e., impacts from the urbanization due to increased fragmentation of natural habitats) and multiple land uses have intensified the complexity of properly conserving coastal wetland systems. One site that truly exemplifies the challenges of balancing this intricate environmental system and land use conflicts is the Colorado Lagoon in Long Beach, California. After years of poor urban planning, this lagoon is finally getting some much-needed restorative attention and is prospering as ecological functions improve.

Environmental Setting

Colorado Lagoon is a human-made geomorphological feature located within the historical range of the Los Cerritos Wetlands, which once boasted more than 2,400 acres of coastal wetlands at the heart of the incredibly diverse California Floristic Province.

Figure 1. Map of Historical Extent of Alamitos Bay Overlaid with Current Urban Infrastructure

This wetlands' acreage has been reduced to just 500 acres of open space, much of which is still privately owned and operated for industrial purposes (Figure 1). Conversely, Colorado Lagoon has been managed by the City of Long Beach since the 1920s as a park and marine recreational area. In 1923, the naturally occurring tidal wetlands of Alamitos Bay were dredged to form the Lagoon and Marine Stadium. The lagoon became the site of the 1932 Los Angeles Olympic U.S. Diving Trials and was separated from Marine Stadium (the site for rowing competitions) by tide gates designed to maintain an adequate water depth during diving events. In the late 1960s, the north end of Marine Stadium was filled for a never-executed, cross-town freeway. Instead, this filled area became part of Marina Vista Park.

Presently, all that remains on-site is an 18-acre tidal water body connected to Alamitos Bay via a 1,000-foot box culvert that runs under Marina Vista Park into Marine Stadium (Figure 2). A golf course, parking lots, recreational beaches, parks, and residential areas border the lagoon. Development entirely surrounds the lagoon's edges and impacts the lagoon through 11 storm drains. Over time, this has led to the lagoon accumulating one of the worst water quality conditions in the state. Heal the Bay ranked Colorado Lagoon as one of the "Top 10 Biggest Beach Bummers" in the organization's 2011 Annual Beach Report Card; since spring 2007, the lagoon's beaches have received "F" grades each year regardless of the season (Heal the Bay 2011). This poor water quality is of great concern, since thousands of people come to Colorado Lagoon every summer to swim and fish.

Surprisingly, this site hosts a sliver of heritage salt marsh plant community that emerges from amid the many impacts. Despite the urban constraints, Colorado Lagoon hosts 16 native salt marsh plant species and more than 75 species of marine birds, such as the state and federally endangered California least tern (*Sterna antillarum browni*) (Chambers Group 2004; Sonnenberg, pers. comm.). This protected bird and other migratory bird species flock to the lagoon to forage on 21 species of marine fish and other available food sources (Figure 3). The presence of juvenile white seabass (*Atractoscion nobilis*) and California halibut (*Paralichthys californicus*) has led to the recognition of the site as a nursery and population source for critical commercial fisheries. The lagoon is also a home for innumerable marine invertebrate species that inhabit this estuary. A recent study found evidence of 23 species of bivalves in the lagoon (Burnaford, Henderson, and Pernet 2011), which demonstrates its capacity as a marine ecosystem at a low trophic level. When compounded by numerous cnidarians, annelids, gastropods, insects, and crustaceans, the nutritional resources for marine predators become quite evident, and the web of life becomes as complex as its urbanized environment.

Figure 2. Colorado Lagoon's Existing Conditions and Pre-Restoration Constraints

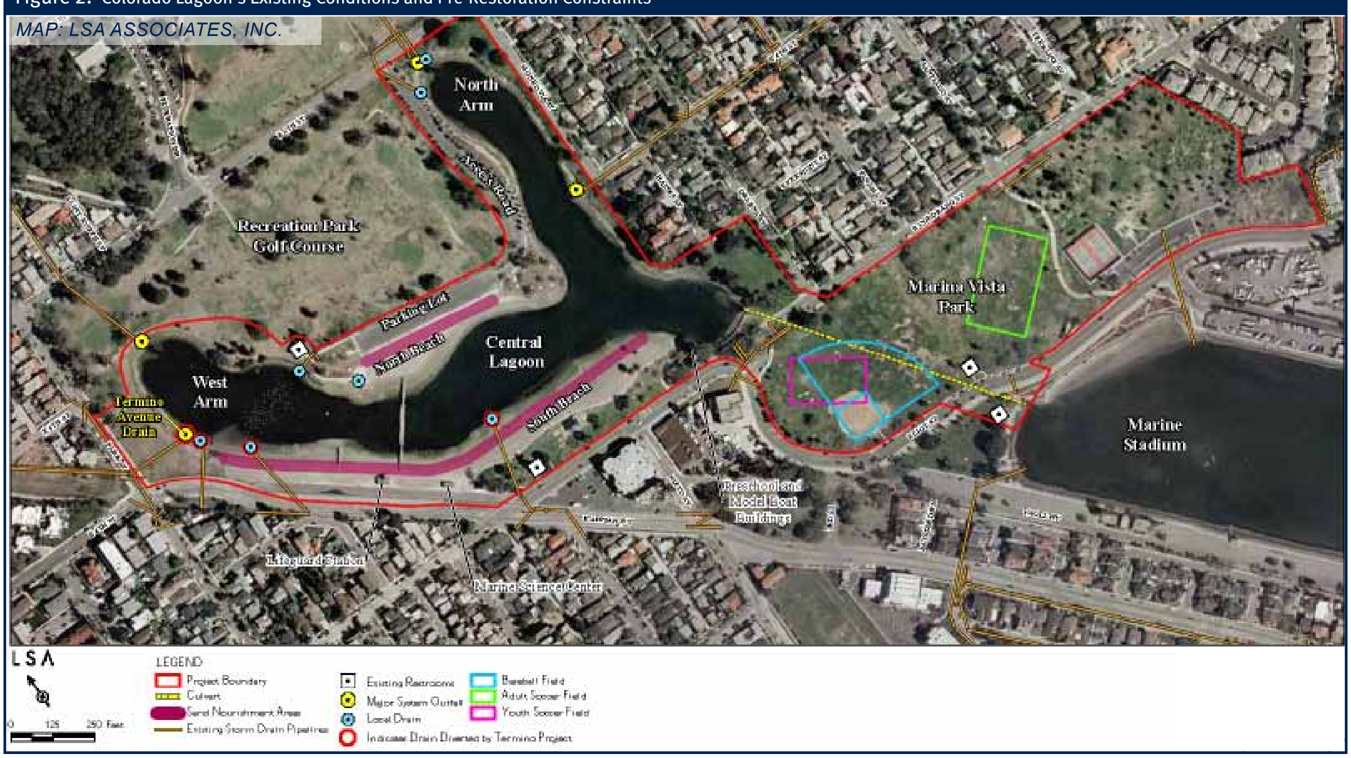


Figure 3. Turbot from Colorado Lagoon


PHOTO: ERIC ZAHN

Project Partners

Restoration projects depend on strong partnerships and collaboration among all parties of interest. Creating the proper alliances, which effectively further the objectives of the restoration, can take time. The Friends of Colorado Lagoon (FOCL) is a coalition of concerned citizens whose mission is to restore and preserve an important urban wetland in their community. FOCL promotes cooperative solutions to ensure a healthy balance among recreation, flood management, water quality, wildlife habitat, and native plant communities in Colorado Lagoon. FOCL serves as the lagoon's voice and provides a sounding board for those in the community who share a passion for this local, coastal treasure. This 501(c)3 non-profit organization was formed in 1999 and has advocated, alongside the City of Long Beach, for the lagoon's restoration.

The City of Long Beach's Department of Parks, Recreation, and Marine and Department of Public Works have been cooperatively managing the lagoon restoration project since its inception. The City had been the lagoon's long-time landowner until a recent land swap traded the lagoon to the holdings of the State Lands Commission. However, this ownership shift should not affect the City's dedication to the restoration project and will not thwart any of the conservation efforts.

Funding partners are numerous for this project, and the total cost is estimated to easily exceed $25 million. Thus far, funding has been provided in varying dollar amounts from (in no significant order) the State Coastal Conservancy, State Water Resources Control Board, Port of Long Beach, Army Corps of Engineers, Rivers and Mountains Conservancy, National Oceanic and Atmospheric Administration (NOAA), Southern California Wetlands Recovery Project, U.S. Fish and Wildlife Service, and the California Coastal Commission. Many of these entities have also acted as permitting agencies, along with the Department of Toxic Substances Control and the California Department of Fish and Game.

Project Approach

Phasing is often one of the best implementation strategies for a complex restoration project. The Colorado Lagoon Restoration Project has been developed as a two-phase project. Phase 1 is concerned with improving the condition of the lagoon proper through storm drain improvements, culvert cleaning, dredging of contaminated sediments, and intertidal revegetation. Phase 2 involves day-lighting the connection between the lagoon and Marine Stadium by creating a tidal channel through Marina Vista Park. The objective of Phase 1 is to remove the existing contaminants and prevent current contamination sources from entering the lagoon. Phase 2 intends to improve the tidal regime of the lagoon so that it more closely resembles that of the Pacific Ocean. Both phrases are necessary to completely restore the structure and function of the lagoon's ecosystem.

The project is phased for several reasons. Project cost is one of the leading reasons for dividing this singular project into approachable sub-projects. At around $12 million, the cost of Phase 1 is so large that Phase 1 was divided into Phase 1a (storm drain upgrading and culvert cleaning) and Phase 1b (dredging, resloping, and revegetating). Other important reasons for this phasing included consensus building and political motivations. Initially, Phase 2 met resistance from some community members due to the assumed impacts to existing active recreation facilities. To appease all constituents, Long Beach City Council voted to have the Phase 2 concept studied in greater depth before accepting it, thus delaying implementation of Phase 2 without halting the project in its entirety.

Project Progress

On October 14, 2008, the Long Beach City Council certified the Environmental Impact Report (EIR) for the Colorado Lagoon Restoration Project. The Colorado Lagoon EIR included phases 1 and 2 and was based on the findings of a feasibility study completed in 2004.

Phase 1: Lagoon Improvements

Phase 1a was initiated in September 2009 and completed in November 2010. The first completed component was the creation of a 600-foot bioswale, constructed between the golf course and the lagoon (Figure 4). This bioswale transformed a drain,

Figure 4. Bioswale Before Planting


PHOTO: ERIC ZAHN

Figure 5. 4th Street Storm Drain Improvements

PHOTO: ERIC ZAHN

Figure 6. Inside the Low Flow Diversion Vault

PHOTO: D. PIRAZZI

which formerly transferred runoff directly to marine waters, into a phytoremediation system designed to filter out fertilizers and other pollutants before reaching the wetlands. Phytoremediation works by utilizing the symbiotic bacteria that naturally live in the roots of many species of aquatic plants. These bacteria break down inorganic and organic pollutants in soils and water, which allows the plants to uptake the pollutants as part of the plants' metabolic processes. As water passes slowly through the bioswale, the plants will remove much of the harmful nitrates, phosphates, and other chemicals used in the golf course landscaping before the pollutants enter the lagoon.

The chief component of Phase 1a was improving the area's three largest storm drains by installing low flow diversion systems and trash separation devices (Figure 5). The dry weather drainage that would normally enter the lagoon through these drains was redirected into a vault, which releases the wastewater into the sewer system during much of the year (Figure 6). The remaining storm drains have all been diverted as part of Los Angeles County's Termino Avenue Drain Project, which occurred at the same time as Phase 1a. Data indicates that the trash separation devices had an immediate impact and are reducing the amount of trash littering the lagoon's banks. Weekly trash collections averaged 32.31 pounds of trash from March 2009 to November 2010, but this weight has been reduced by nearly 50% to 17.17 pounds of trash per week since the separation devices were activated in November 2010 (Parker pers. comm.).

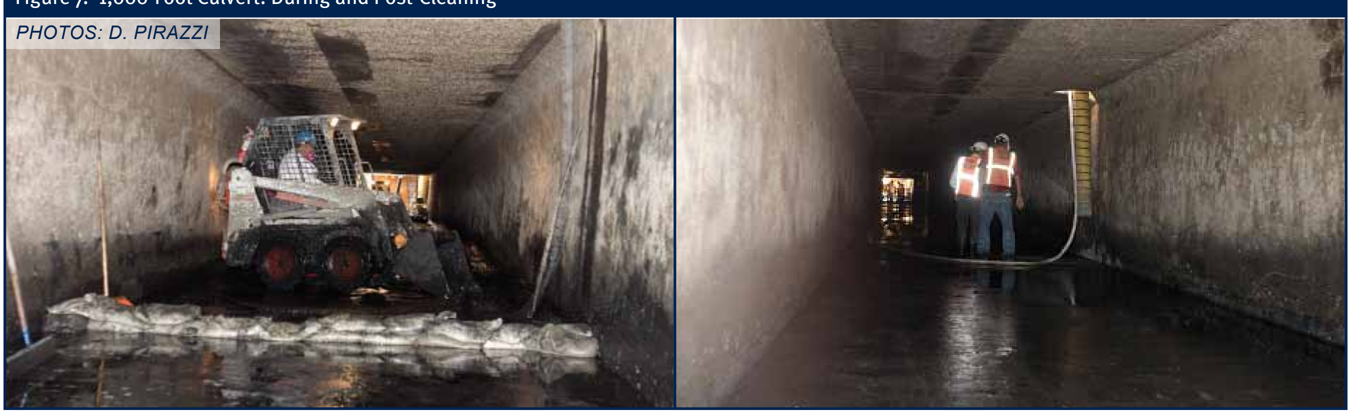
The last element of Phase 1a was the cleaning of the culvert connection between the Lagoon and Marine Stadium (Figure 7). This sensitive endeavor required the lagoon be cut-off from tidal influence for nearly two weeks in order to complete the cleaning. However, the removal of three feet of marine sediment, running the entire length of the culvert, decreased the residence time of tidal waters entering the lagoon from 8.5 days to 7.7 days, according to modeling completed by Moffat & Nichol (2010). This decrease in residence time brings the tidal flushing rate much closer to the 6.0-day residence time in Marine Stadium. However, the 1.7 day difference (which is due to the culvert's small size and perch above mean low tide) still affects the lagoon's overall health; therefore, more improvements to the tidal connection are needed to bridge the gap (Table 1).

The final cost for the Phase 1a construction work, excluding design, came to $4,397,841. This phase was funded through the American Recovery and Reinvestment Act (ARRA), dispersed through the State Water Resources Control Board (Lopez pers. comm.), as well as a $1.3 million contribution from the Port of Long Beach.

Phase 1b mobilized in January 2012 and is scheduled to be completed by April 2013. This portion of the project will include massive construction equipment for dredging and bank resloping as well as a community-based revegetation component. The planned dredging has been the most scrutinized part of Phase 1, since the dredging intends to remove the numerous organic and inorganic pollutants that contaminate the lagoon's sediment. Initial estimates indicated that

Figure 7. 1,000-Foot Culvert: During and Post-Cleaning

PHOTOS: D. PIRAZZI



Note the remnant stain from the removed marine sediment.

Table 1. Differences in Tidal Flushing Rates: Pre- and Post-Project; Note 4a was not analyzed because it was added late in the study.

CREDIT: MOFFAT & NICHOL

Modeling Scenario	Residence Time (Days) In:		
	Colorado Lagoon	Marine Stadium	Mother's Beach
Pre-Project Lagoon and Culvert	*8.5*	*6.9*	*5.3*
Post-Phase 1 Project Condition - Dredged Lagoon and Cleaned Culvert; No Open Channel	*7.7*	*6.0*	*4.9*
Alternative 1 - Parallel / Second Culvert	7.5	6.0	4.9
Alternative 2 - Open Channel with Bridges	7.2	6.0	4.9
Alternative 3 - Combination Open Channel and Culverts	7.4	6.0	4.9
Alternative 4 - Maximum Wetland	7.3	6.0	4.9

22,500 cubic yards of sediment would need to be removed from the western arm. However, the Regional Water Quality Control Board set total maximum daily loads (TMDLs) for chlordane, dieldrin, lead, zinc, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dichlorodiphenyltrichloroethane (DDT) for this 303(d) listed water body in late 2009 (Los Angeles Regional Water Quality Control Board 2009). Further studies discovered that around 75,000 cubic yards of sediment throughout the entire lagoon needs to be removed in order for the lagoon to meet strict, new water quality standards.

Throughout the water quality standards revision process, the appropriateness of using NOAA's effects range low (ERL) and effects range median (ERM) values for TMDLs was heavily debated because these levels do not represent toxicity thresholds for marine organisms. Instead, these levels represent a low- and mid-point, respectively, within the range of bulk chemical concentrations in sediment and do not directly relate to sediment toxicity (O'Conner 2004). These redefined contamination level standards were eventually accepted for the project, leading to an increase in the implementation cost, particularly due to the expense of the required stabilization process and the increase in the amount of sediment being defined as contaminated. All of the contaminated sediment will be tested upon removal, and the sediment determined to be hazardous will be stabilized on-site so that it can be trucked to the Port of Long Beach for use in the Middle Harbor Redevelopment Project. Depending on the hazardous constituents identified, the sediment will be stabilized using a variety of techniques including cement stabilization.

The dredging, along with proper resloping of the banks to increase intertidal habitat, should be completed by July 2012 for about $7 million. FOCL will then manage the revegetation of the intertidal and upland habitats. FOCL has already begun salvaging nine salt marsh plant species that inhabit the soon-to-be-disturbed shorelines. These plants will be nurtured in a nearby growing space and returned to the lagoon in the 2012–2013 planting season.

Phase 2: The Open Channel

Although all of the Phase 1 improvements are integral to recovering the health of this urban ecosystem, the ultimate, long-term solution is reconnecting the marine habitat to full tidal flushing. FOCL has been advocating for restoring a tidal channel that once connected Colorado Lagoon to Marine Stadium. Upon certifying the restoration project's EIR, the Long Beach City Council requested an additional study to take a closer look at alternatives that could improve the site's tidal circulation (Figure 8). Loss of park space was considered in this study as well as maximizing salt marsh habitat and fundability and minimizing construction and maintenance costs. Another constraint examined in the design study were the two roadways that fall between the lagoon and Marine Stadium that must either be bridged or outfitted with short underground culverts. This study analyzed four alternatives and was completed in June 2010 by Moffat & Nichol. All of the alternatives were designed to have similar tidal conditions (Table 1). The alternatives are as follows:

- Alternative 1: Installation of a second, parallel underground culvert (0 acres of wetlands created)

Figure 8. Culvert: Pre-Project

PHOTO: ERIC ZAHN

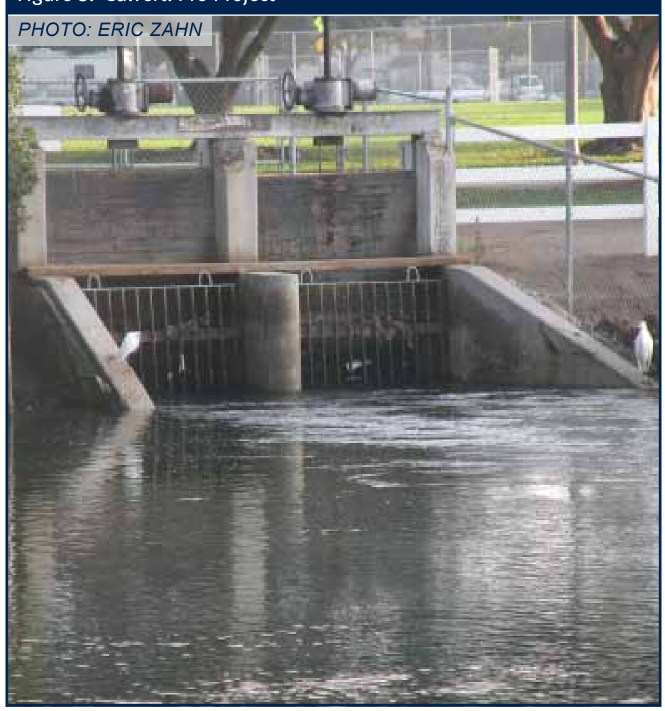
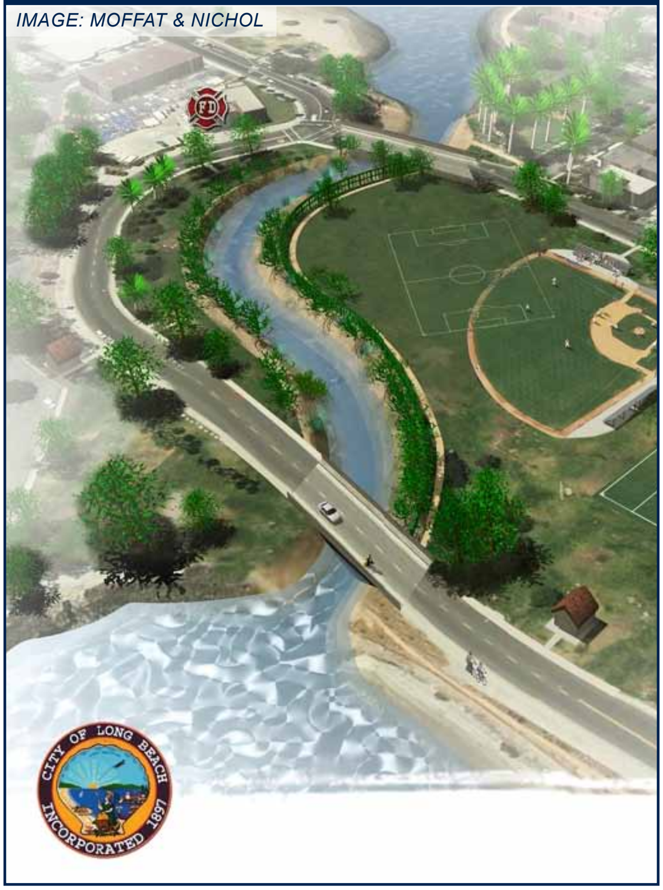


Figure 9. Illustration of Post-Project; Most Similar to Alternative 2

IMAGE: MOFFAT & NICHOL



- Alternative 2: Complete open tidal channel with two automobile bridges at each end and the existing culvert left in place (1.98 acres of wetlands created; Figure 9)

- Alternative 3: Incomplete open tidal channel with short culverts at each end running under the roads and the existing culvert left in place (1.47 acres of wetlands created)

- Alternative 4: Incomplete open tidal channel with one bridge on the Marine Stadium end and one short culvert on the lagoon end and the existing culvert abandoned (2.21 acres of wetlands created)

These alternatives polarized members of the community who cherished park space for active recreation and supported Alternative 1 versus those who supported the creation of new wetlands in alternatives 2, 3, or 4. Interestingly enough, resources agencies that were part of the project's technical advisory committee asked City staff and consultants to investigate a fifth alternative, 4a, with a similar open channel to Alternative 4, except at the channel's lagoon end where the underground culvert is replaced with a bridge. The resultant Alternative 4a has an open channel along its entire length similar to Alternative 2, but with a maximum channel width of 230 feet resulting in a maximum wetlands habitat area of 2.40 acres (Moffatt & Nichol 2010). This additional alternative was analyzed and added late in the study. Its addition further alienated supporters of Alternative 1 and became the chosen alternative for the wetlands advocates. Alternative 4a is as follows:

- Alternative 4a: Complete open tidal channel with two automobile bridges at each end and the existing culvert abandoned (2.4 acres of wetlands created)

Alternative 1 anticipated no long-term impact on park space and was the second most affordable alternative to construct at $6.8 million. However, this alternative had the highest cost at $8.4 million for maintenance over 50 years and would create zero acres of new wetlands habitat. Additionally, culvert removal is often funded, but sources of funding are scarce for new culvert construction, as required for Alternative 1. Alternative 3 was the least costly alternative, at $5.7 million, while Alternative 4a was the most expensive to construct, at $9.4 million. However, due to its natural conditions, Alternative 4a was projected to have the lowest maintenance cost at $4.0 million over 50 years (Table 2; Moffatt & Nichol 2010).

Ultimately, the community overwhelmingly supported Alternative 4a, and the Long Beach City Council approved this alternative on November 16, 2010. The next steps for Phase 2 are to complete a summary report on the new mitigation laws, determine a funder, produce 100% engineering designs, finalize permitting, and break ground. This phase may take anywhere from three to ten years to begin construction.

Funding the second phase of the Colorado Lagoon Restoration Project will be challenging. However, the Port of Long Beach has repeatedly expressed interest in being the sole funder due to the requirement to mitigate future impacts on intertidal and subtidal marine habitats. As the port expands, the Port of Long Beach must create similar habitat elsewhere. Historically, the Port of Long Beach has funded coastal salt marsh restoration projects at the Bolsa Chica Wetlands, Upper Newport Bay, and Anaheim Bay, but never within the Long Beach city limits where the port's impacts are greatest (Short 1988). The Port of Long Beach would receive mitigation credits for its involvement in Phase 2, but the amount of credit the port would be eligible for by funding the creation of 2.40 acres of tidal wetlands habitat has yet to be determined. Nevertheless, the fact that a site that was converted from wetlands to parkland is now proposed to be turned back into wetlands is a rare occurrence in Southern California, and this forward-thinking

Table 2. Cost Estimates for Phase 2 Alternatives 1–4a

CREDIT: MOFFAT & NICHOL

Alternative	Construction Cost	Maintenance Cost	Total Long-Term Cost
1	$6.8M	$8.4M	$15.2M
2	$9.0M	$4.7M	$13.7M
3	$5.8M	$7.1M	$12.9M
4	$7.3M	$5.0M	$12.3M
4a	$9.4M	$4.0M	$13.4M

Figure 10. Godwit in Colorado Lagoon

project should prove to be attractive to all funding agencies advocating coastal wetlands restoration projects.

Conclusion

Even very small coastal restoration projects can be extremely complex, especially when the coastal ecosystems are encompassed by Southern California's urban sprawl. The Colorado Lagoon Restoration Project, while lacking in acreage, has already overcome large hurdles and will continue to face challenges as it aims to set precedents for the need to invest resources towards converting developed tidal areas back into the coastal wetlands they once were (Figure 10). Non-sustainable and poorly devised urban planning from the past challenges our present-day coastal engineers, ecologists, and interest groups. These people are working hard to restore balance by allowing for both urban and natural environments, through the installation of natural and engineered solutions. The combination of bioswales, low flow diversion systems, trash separation devices, dredging of contaminated sediments, wetlands habitat revegetation, and improvements to the tidal connection will allow the health of Colorado Lagoon's coastal ecosystem to recover. This complex and relatively expensive restoration project deserves recognition and should act as motivation for similar restoration projects to endure the struggles of restoring ecosystems along the urban coast.

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