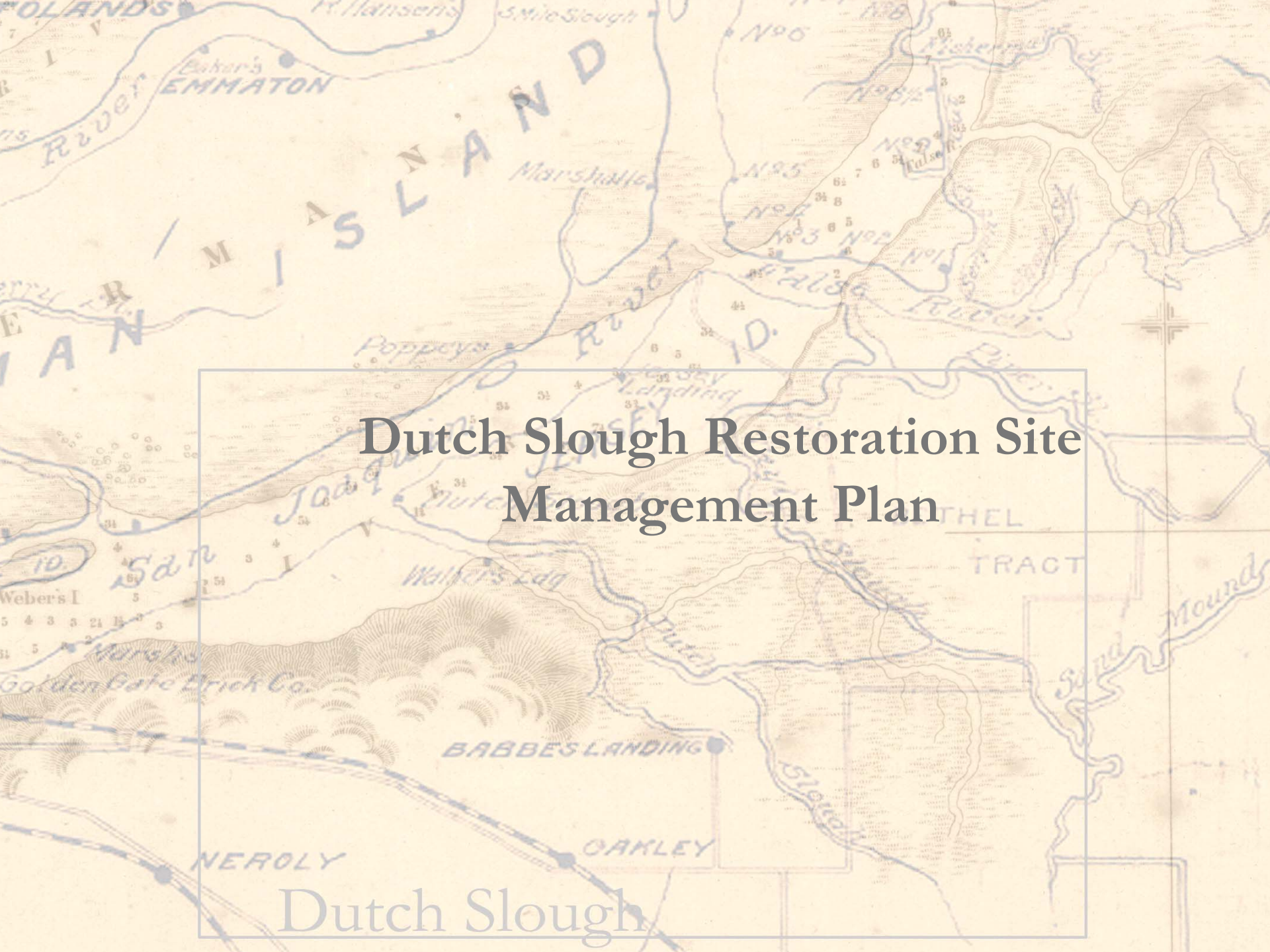
Dutch Slough Restoration Site Management Plan



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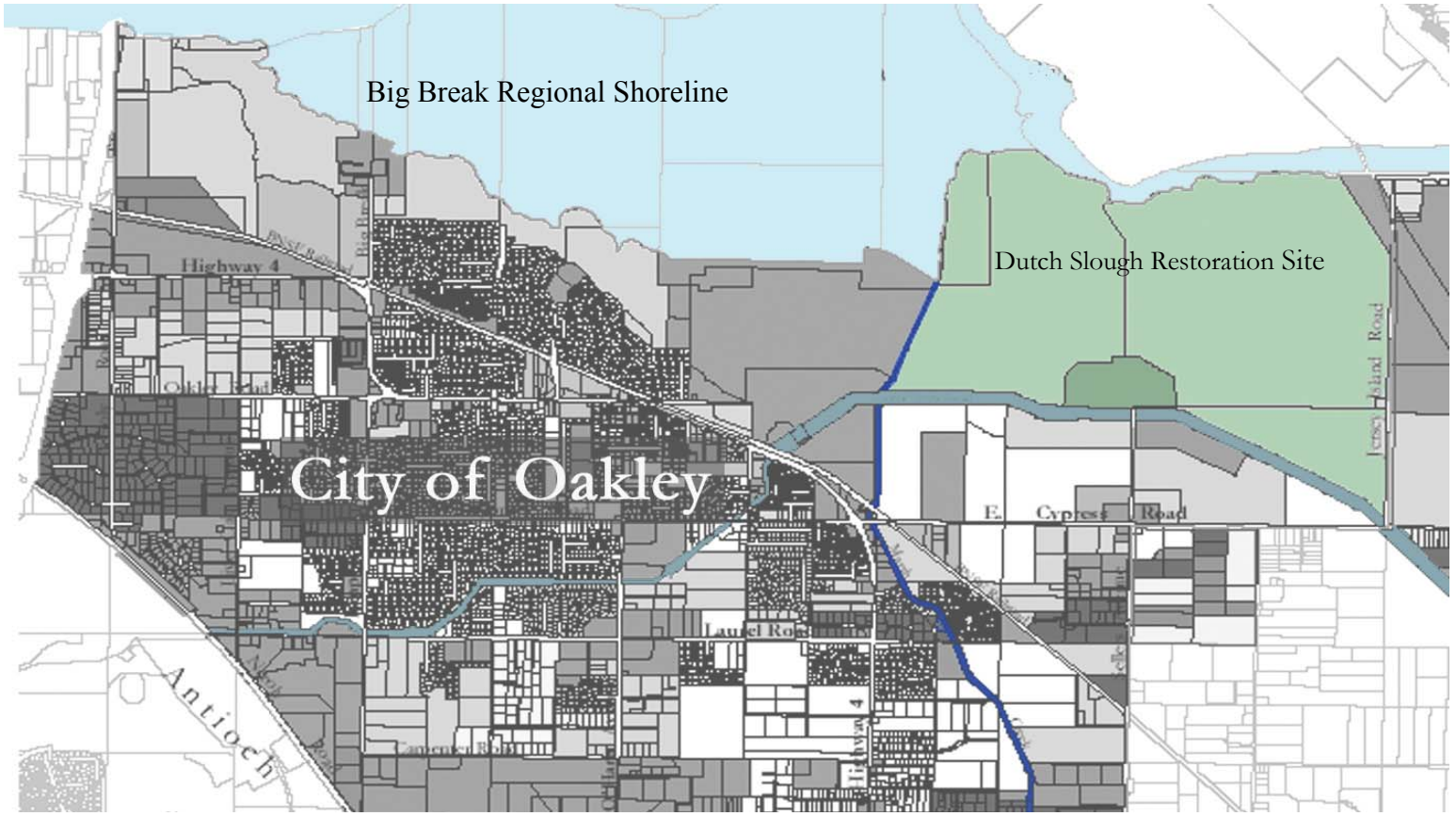
The Dutch Slough Restoration Project is a 1200-acre parcel in California's Sacramento- San Joaquin Delta that the Coastal Conservancy and the CAL-FED Bay-Delta program are acquiring for large-scale ecological restoration. *The main objective of this study is to anticipate and resolve potential conflicts that might arise between creating viable habitat for juvenile salmon and other threatened species while at the same time providing access for the human population.* The intent is to create parallel, although not identical experiences between the improvement of ecological function and the development of thriving human communities. Rarely is there an opportunity to transform a site at the magnitude that has been suggested for Dutch Slough, where ecosystems and human systems can be developed in harmony with one another. Integrating the human experience into the ecological function of the site will make it easier to control the adverse effects of human presence on ecological restoration and provide the community with access to valuable open space so that an appreciation of the site can be understood firsthand by the public.


Sacramento-San Joaquin
Delta
Suisun Bay
San Pablo Bay
Dutch Slough
Restoration Project
Carquinez Straits
Oakley
Marin
Pacific Ocean
San
Francisco
Oakland
San Jose

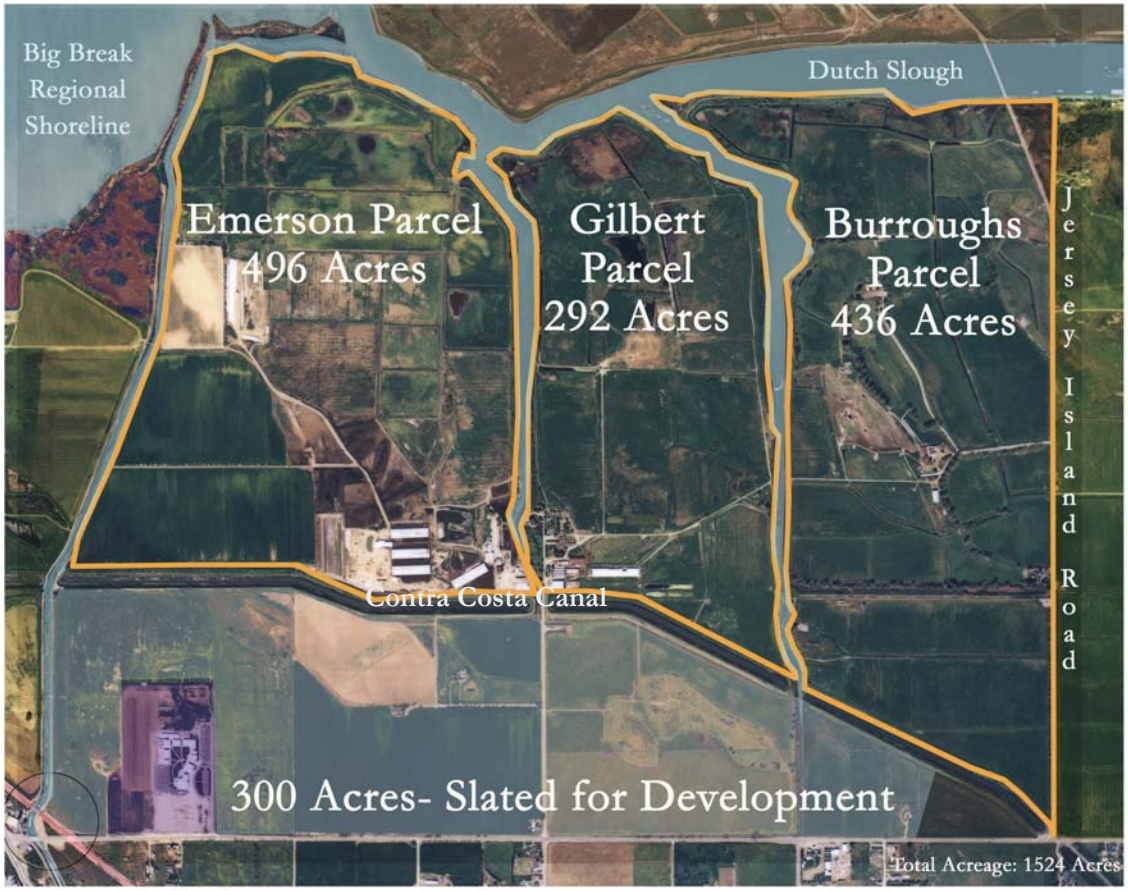
Designing spaces that enhance our sense of connectedness to the landscape is essential to any restoration project. To make not only a physical, but an intellectual connection between the project and the surrounding human population is important. Communities near Dutch Slough can ensure the long-term success of such a restoration effort through direct participation and political support. The growth of a new open space can create better habitat for threatened species and also act as a visible connection between the built environment and the human population.



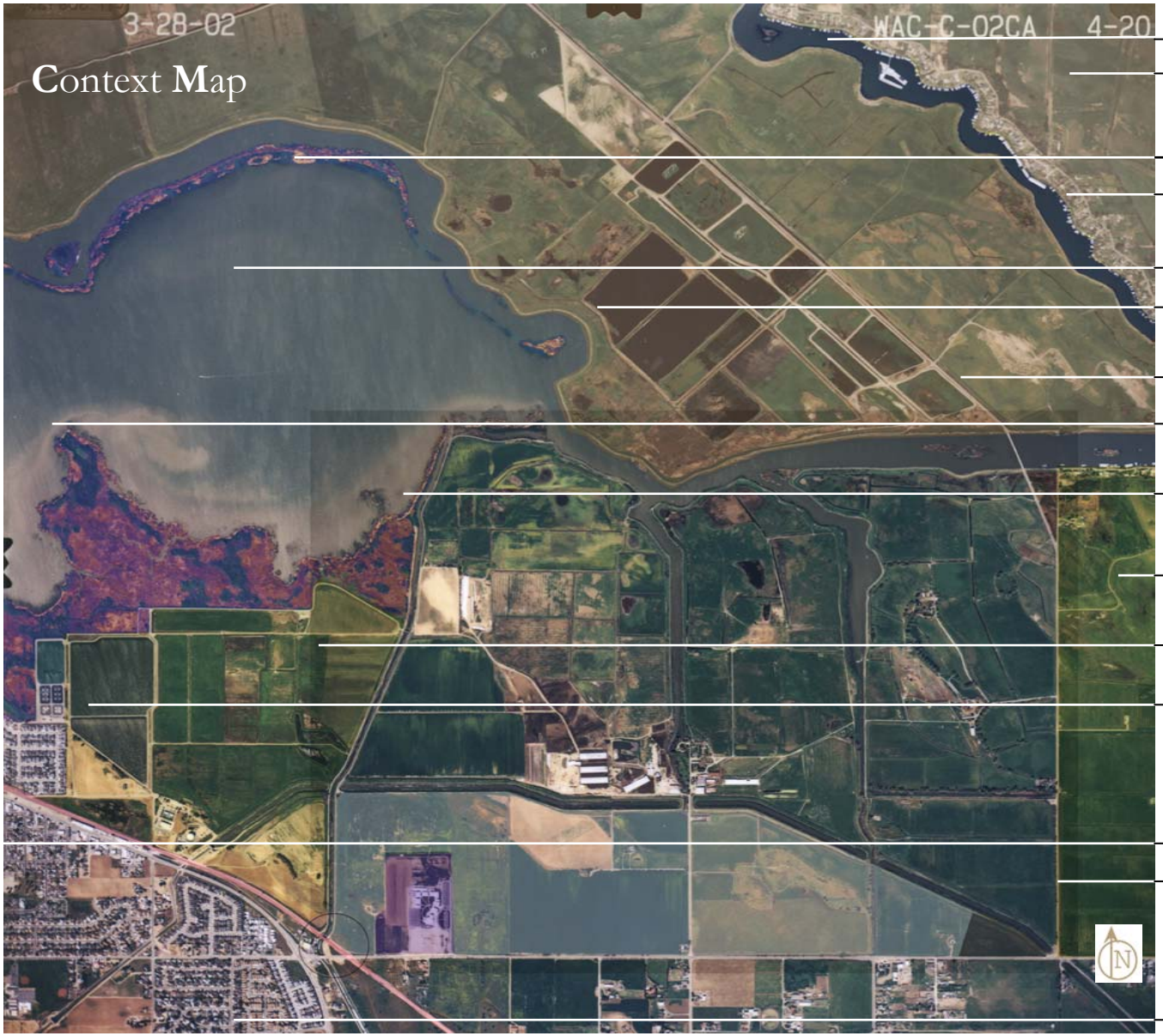
Local context map, the 1,200-acre restoration site is approximately one-quarter the size of Oakley in 2002

Site Description

The restoration site at Dutch Slough is located in the City of Oakley in northeast Contra Costa County and encompasses nearly two square miles bounded on the north by Dutch Slough, on the south by the Contra Costa Canal, on the east by Jersey Island Road, and on the west by Marsh Creek. The site includes 1,500 acres of land of which 300 lay south of the Contra Costa canal and 1,200 acres north of the canal.



The three parcels slated for freshwater tidal marsh restoration are the three northernmost parcels referred to by their current ownership: the Emerson, Gilbert and Burroughs properties. The southernmost section of the property will be developed for housing and commercial uses.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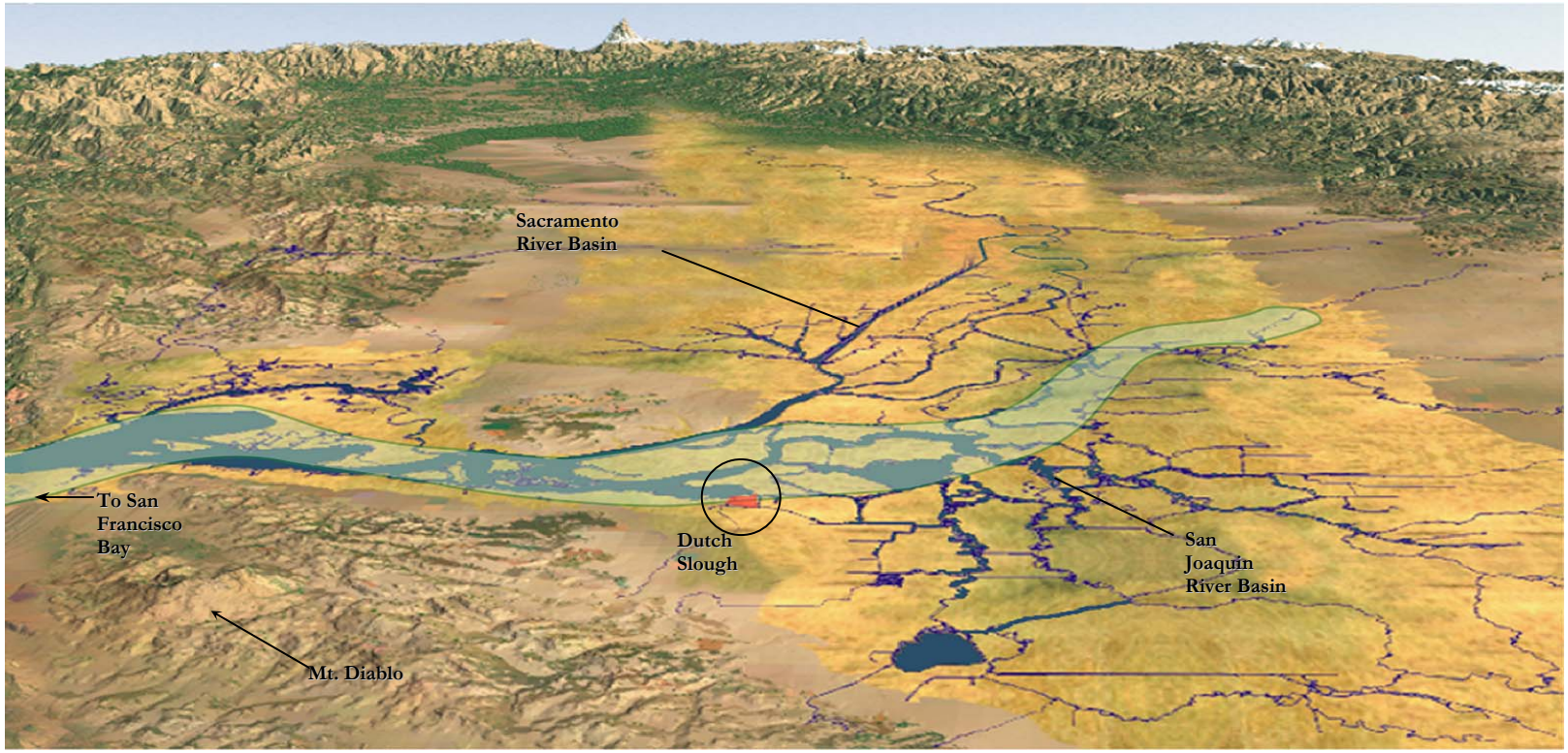
Context Map
Taylor Slough
Bethel Island: Vacation hotspot
Remnant Levee
Boating in the Delta leaves an im-print on the landscape
Big Break Regional Shoreline, EBRPD
Jersey Island (Owned by Ironhouse Sanitary District, much of the land is leased to farmers
Jersey Island Road
East Bay Regional Parks District Tidal Marsh, Owned by Ironhouse Sanitary District
Marsh Creek
Farmland currently under cultivation But up for sale
Future site of the Marsh Creek Restoration Project
Tertiary treatment ponds at Ironhouse Sanitary District
Historic center of Oakley
South of Dutch Slough, Jersey Island Road is the legal boundary between the City of Oakley and the unin-corporated community of Knightson
New sub-divisions in Oakley

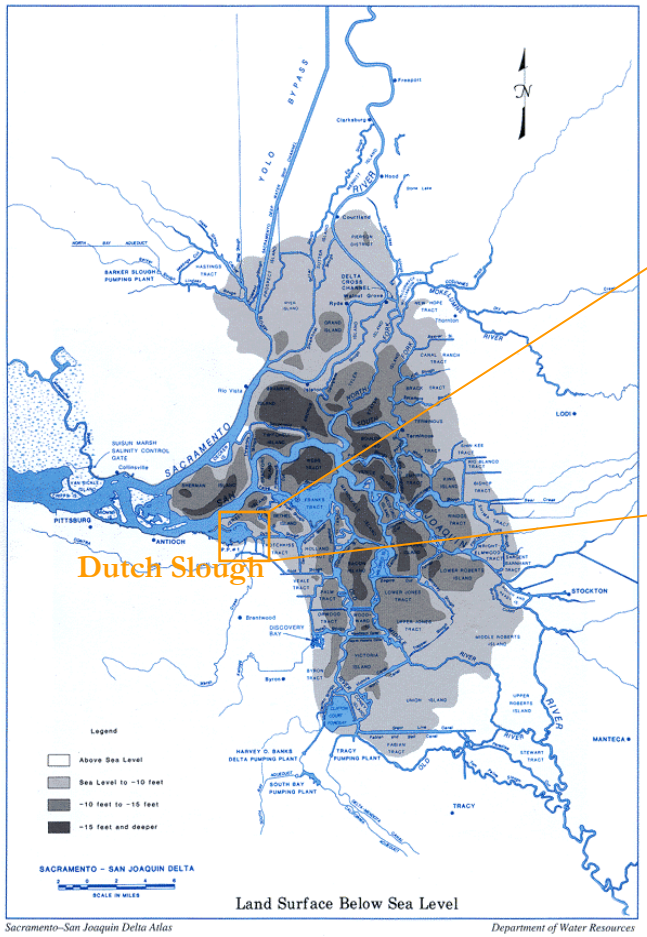
Regional **C**ontext

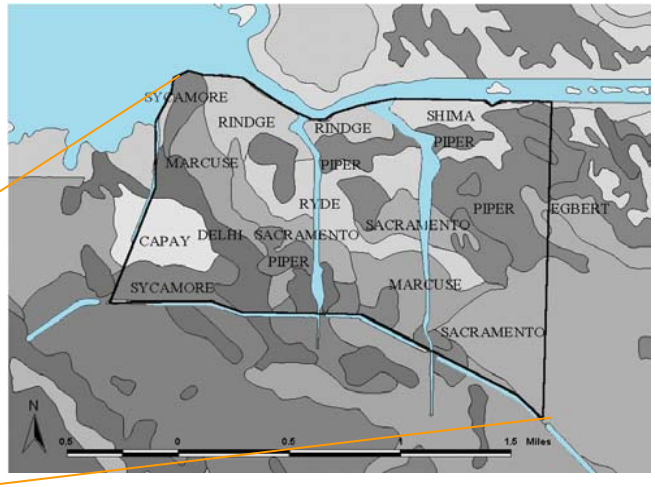
Dutch Slough is located at the southwestern edge of the Sacramento - San Joaquin Delta, at the confluence of the southward-flowing Sacramento and the northward-flowing San Joaquin rivers. These two rivers are the largest in the state. Their combined drainage is over 41,000 square miles (Army Corps 1999). The Delta includes 57 islands, 1,100 miles of levees, and hundreds of thousands of acres of marshes, mudflats and farmland. The eco-region supports habitat for migratory and warm water fish, anadramous fish (salmon), and numerous species of aquatic birds and waterfowl.



This oblique perspective of the Northern Central Valley shows the project at the convergence of the Bay–Delta systems. Image courtesy of Curt Schmutte, California Department of Water Resources .

Dutch Slough is also at the outlet of the historic Marsh Creek alluvial floodplain. Marsh Creek drains the north side of Mt. Diablo including the cities of Oakley, Brentwood, and part of Antioch and runs along the western edge of the three parcels slated for restoration (NHI 2002). The creek provides a vital ecological link between the Delta and the rich yet fragmented habitats of Mt. Diablo. Although much of the riparian corridor has been channelized through Brentwood to its outlet into Big Break, a restoration project is planned to restore a meander on the Ironhouse Sanitary District property directly adjacent to the Emerson parcel.





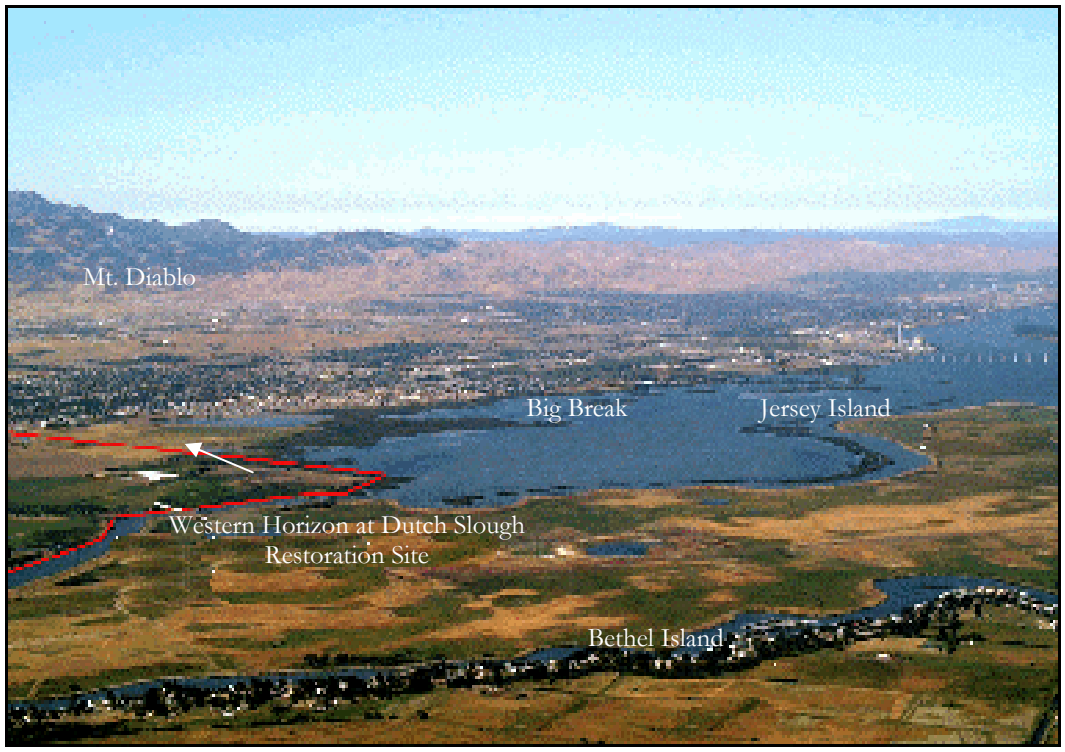
The soils on the site are a complex mosaic of mineral and organic types, they provide a diverse selection of substrates upon which to test marsh evolution and successional ecology.

The restoration site is characterized by gently sloping topography and mineral soils that were deposited on the Marsh Creek alluvial fan. Agriculture over the last 150 years has resulted in a manipulation of the topography, most notably in the creation of separate levee systems around each of the properties.

Restoration of the Dutch Slough site will extend the complex of marshes from Suisun Marsh, Browns Island, and Sherman Lake further into the western Delta along a range of salinity gradients providing more habitat options for native fish that congregate in the vicinity. This may help increase populations of fish in the Bay-Delta system by specifically providing the type of habitat (and food sources) required during the juvenile phases of development.

Local Context

The City of Oakley was incorporated on July 1, 1999. It is located in eastern Contra Costa County, near the cities of Pittsburgh, Antioch, and Brentwood. It is 55 miles east of San Francisco and 55 miles southwest of Sacramento. In the 2000 census, the city listed 25,619 residents. That number is expected to grow to almost 32,000 by 2005, roughly a 25% increase. More than two thirds of the population work outside the city limits. (City of Oakley website)



Project site in relation to other prominent topographic features

Geomorphologic **C**ontext

Ten thousand years ago, at the end of the last ice age, mean sea level was lower and today's Central Valley was a vast inland sea. As sea levels rose with the melting of glaciers, the Pacific Ocean entered the Coast range through the Golden Gate. Tule marshes accreted (grew up) as sea level rose creating organic peat soils composed of layers of partially decomposed tules. These accretions led to the formation of much of the rich habitat encountered by the first European explorers in the 19th century. The current restoration site was once part of this vast system of wetlands.

Glacial deposition in old inland seas from glacial activity, and of sediment transported by the many rivers and streams draining the surrounding mountain ranges has created today's great Central Valley. These processes have deposited gravel, silt, sand and clay that reach thousands of feet deep and form the moist, fertile soils that define the region. The Sacramento and San Joaquin meet in the Delta and drain the entire valley, forming a distinct drainage area known as the Central Valley Province (Army Corps 1999).

Mt. Diablo rises in the distance behind the levees of the Burroughs parcel.

The deep alluvial soils that have washed down from the Marsh Creek watershed created the unique topography found on the site. The area also received sediment during seasonal flood events in the San Joaquin River catchment. This system delivered a variety of mineral sediments originating from the Sierra. The Marsh Creek alluvial fan is comprised of a mosaic of deep soil deposits including Capay, Rincon, Brentwood and Sorrento soils.

Elevation on the site ranges from eight feet below sea level to over 15 feet above sea level on some remnant dunes. The median elevation is at sea level rendering the site ideal for tidal marsh restoration. The elevation of the levees surrounding the site maintained to agricultural standards are generally nine feet NGVD, approximately two feet above the 100 year flood level.

Generations of intensive farming has caused oxidation and subsidence of fragile peat soils throughout the Delta and left much of the area 10-25 feet below sea level. Dutch Slough lands, especially in the northwestern most portion of the site, have also experienced some subsidence. However, at this site the problem is not as severe as in other parts of the Delta because it is on the delta of Marsh Creek and therefore has mostly mineral soils rather than peat soils (NHI 2002). The Dutch Slough site is one of the only large-scale sites in the Delta not already acquired for restoration that is at a suitable elevation for tidal marsh restoration. Other parts of the Delta have become too subsided and therefore an earnest restoration effort at this time would be cost prohibitive. The diverse topography and soil composition of the site will allow for restoration of tidal wetland, low marsh, high marsh, riparian habitat, and upland transition zones - including inland dune scrub habitat - with only minimal grading.

Planning **C**ontext

In November of 2002 CALFED approved funding for the Dutch Slough Restoration Project. The Dutch Slough site is a collaborative effort to restore approximately 1,200 acres of diked lands to freshwater tidal marsh. The Coastal Conservancy is administering the project and will act as lead agency; the Conservation Fund is managing the land acquisition phase; the Department of Water Resources will implement the physical restoration and assume long-term ownership of the property; and the City of Oakley will develop a community park at the entrance of the site. The Natural Heritage Institute (NHI) initiated the project

with the present property owners, developed the present partnership, led the effort to obtain funding, and is now assisting with project planning and the development of a long-term adaptive management plan. In the future, NHI will help facilitate community participation and begin the initial planning and design phases of the project. This document is the preliminary design examination of restoration and development possibilities for the project. The goals of the Dutch Slough project are to:

1. Implement a large-scale, locally supported restoration project that will serve the local community with shoreline access as well as educational, recreational, and economic opportunities.
2. Restore the Dutch Slough properties to a fully functioning, self-sustaining ecosystem that includes shallow water, emergent marsh, inter-tidal marsh, seasonal wetlands and floodplains, Antioch dune scrub, riparian forest, and oak savannah.
3. Significantly contribute to scientific understanding of tidal marsh and floodplain restoration through experimentation and monitoring under an adaptive management framework. (CALFED Proposal, 2002)

The design guidelines developed in this document are based on the goals expressed in the CALFED proposal. In a memorandum of understanding reached between the project partners, several future land uses were defined for the property. Agreed Land Uses:

☑ Ecological Restoration: 1,166 acres

☑ Community park: 55 acres at entrance of site between Emerson Slough and Sellers Avenue

☑ Trails: city of Oakley to maintain 4.5 miles as depicted in Figure 1 – mostly on the levees

☑ Public Shore Access: 9 acres at the end of Jersey Island Road

☑ Swim Lagoon: 5 acres (optional)

☑ Residential Development: 300 acres

☑ Maintain Historic Buildings such as the historic Iron House schoolhouse (which will be moved to community park,) Gilbert house, etc

Opportunities at **D**utch **S**lough

Remnant exterior levee: heavily vegetated with native riparian species

Acreted tule marsh islands

7- acre waterfront access for the City of Oakley

Marsh Creek

Existing network of irrigation ditches

40-acre vineyard on historic dune scrub community

Burroughs residence

Public Access water-ski course

Site of future Marsh Creek Restoration project

Site of Historic Babbe's Landing

Gilbert House

Operating Commercial Dairy

Contra Costa Canal

Site of historic Ironhouse Elementary School, which will be moved

Delta Vista Middle School

27-acre parcel given to the City of Oakley by owners

Intersection of Railroad, Hwy 4, and Cypress Corridor

Opportunities and **C**onstraints for **D**esign

Opportunities

The socio-political, engineered, and natural characteristics of the site will, if fully explored through design, lead to distinct experiences for future visitors to Dutch Slough. Several key sections of the site provide unique restoration and development opportunities:

- The City of Oakley has set the urban edge at the Contra Costa canal. The character of the surrounding urban development through which most access to the site will take place is at this point relatively undefined, although will be subject to a planning process with the City of Oakley. This creates an opportunity to extend the restoration project past its delineated boundaries into the urban context.
- None of the project partners have designated a main entry to the site, a well designed entrance will be a major element in creating positive public visibility of the project.
- The Ironhouse Sanitary District lands and the East Bay Regional Parks District wetlands along the Big Break Regional Shoreline adjacent to the Emerson parcel are an opportunity to manage several large parcels of open space as one large contiguous wildlife management area in conjunction with Dutch Slough. The Ironhouse Sanitary District also owns substantial portions of Jersey Island just north of Dutch Slough that are currently leased out to agricultural interests.
- Marsh Creek is an opportunity to recreate the delta of Marsh Creek and restore sediment transport into a tidal marsh.
- Remnant sand dunes are an opportunity re-establish a rare and endangered habitat.
- It is likely that an interpretive science facility to conduct research and educational programs on the Delta will be developed. Funding is available and there is a possibility that the Delta Science Center will have a satellite facility at Dutch Slough.

Constraints

Certain constraints need to be considered throughout the design, restoration and development process:

- Levees have to largely remain intact (with controlled breaches) to prevent wave erosion of levees on neighboring islands, and to reduce the potential for changes in Delta salinity patterns.
- Funding is limited. CALFED approved approximately $25 million primarily for acquisition of the properties and preliminary planning. The Coastal Conservancy has committed an additional $10 million. Estimated costs for full-scale restoration exceed currently available funding.
- A large portion of the cost of restoration would be the purchase fill from dredged sites around the Bay-Delta region to raise the parcels to elevations suitable for marsh restoration. There is not enough fill on site to grade the entire site to inter-tidal elevations. Even if there were, mining upland areas would not be appropriate in all cases because of the loss of topographic diversity. Locating possible sources for appropriate and economical fill could be problematic.
- Public concern has been raised over the possibility of mosquitoes and other agents posing health threats to public safety.
- Protecting the water quality in the Contra Costa Canal is a major issue and will likely require the restriction of public access to the canal.

II. Culture

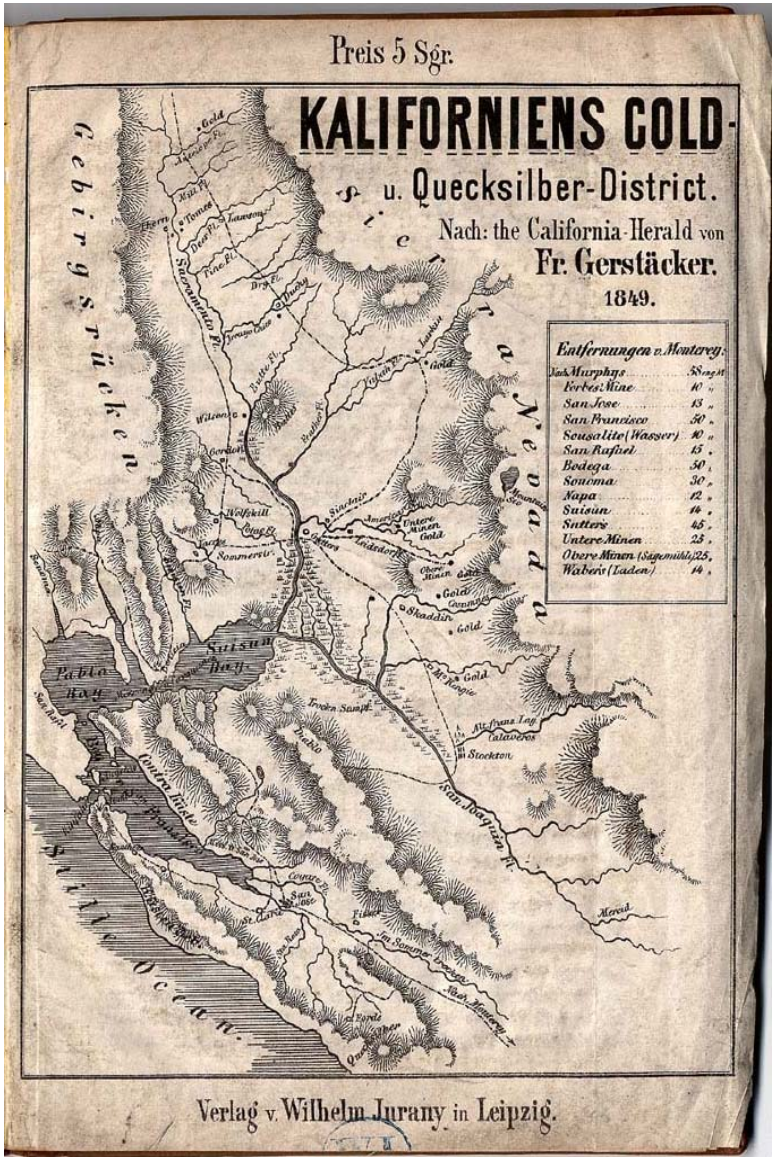
Regional **H**istory

In much of California, human settlement can be traced back 10,000 years ago by small tribes of Native Americans whose nomadic lifestyle left a distinct yet minimal impact on much of the landscape. Though many of villages were located along the shores of the Delta, the Miwok, Yokut and Ohlone tribes suffered the common national fate of almost complete extripation in large part due to epidemic illness in the early 1800's (Leighton, 2000) but small community of Native American Indians still calls Oakley home (Census 2000). The present properties were most likely inhabited by the Julpin tribelet of the Miwok Indians. This time of relative equilibrium between human and ecological systems is often used to define historic conditions because in the last two centuries, the California landscape has undergone massive changes due to the increase in human population. This chapter looks at the impacts that socio-cultural changes have caused on the region and the site in order to inform the design of a place that can work to re-integrate the human and ecological systems in the area in a contemporarily relevant way.

Historic range of Native American Tribes in Contra Costa County

Although there were a few scattered settlements in the area prior to 1849 (John Marsh was the first white settler in the area in 1836), the Gold Rush drew people to the area from around the globe. A German map of 1849 shows the Quicksilver mining district and surrounding areas including the Dutch Slough site. Travel was limited almost exclusively to waterways and rail transport.

The California Gold Rush of 1849 had an immediate and lasting effect on the landscape of the Bay-Delta. Eager miners headed from San Francisco for the 'Motherlode' in the foothills of the Sierra on ferries that ran from the newly established urban centers along the coast as far inland as possible. Oakley became an important settlement at the foot of the Delta, the gateway to Sacramento. In addition to its role as a transport system, the entire Delta became an important region for food production. Between 1860 and 1930, almost all of the Delta's freshwater marshes (approx 550 square miles) were diked and leveed to create farmlands to feed the growing population (SFEP 1999). In the late 1800's, Contra Costa county farmers were producing large wheat



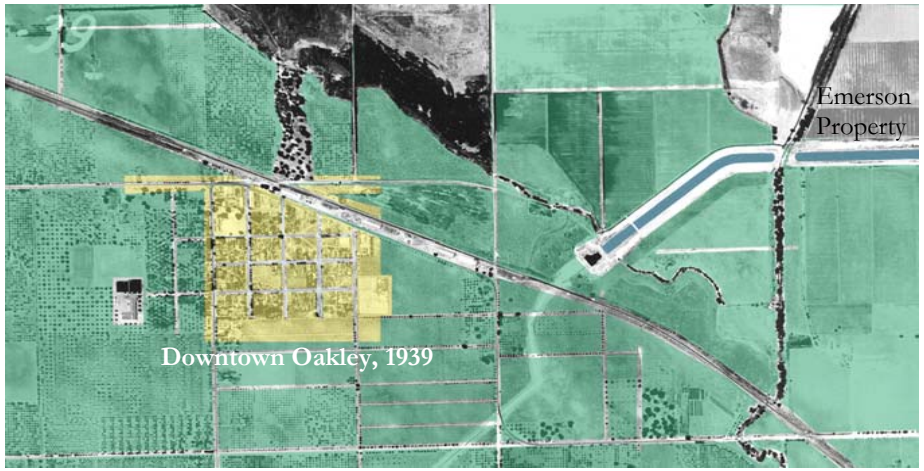
Map of the Bay Area and Sierra Nevada at the time of the Gold rush, highlighting the importance of water as a transportation system.

crops that yielded high prices in markets as far away as London. By the turn of the century, a wave of Italian and Portuguese immigrants had settled in the Oakley area (predominantly the upland areas) and began growing wine grapes in the sandy alluvial soils of eastern Contra Costa (Leighton 2000)

Local **H**istory

The Town.

Gold Rush immigration populated many towns like Oakley, located along Delta waters where the larger watercraft could navigate. Marsh Landing (near today's Antioch bridge) was the first dock in the area constructed in the 1840's. Iron House Landing was located on a small slough approximately two miles east of Oakley on a constructed waterway later known as Iron House Slough. This landing was abandoned when shipping merchant Fred Babbe built a 7-foot deep, 2,838-foot long, 42 foot wide canal (today's Emerson Slough) off of Dutch Slough around his property to accommodate commercial shipping to reach the grain houses and international markets in San Francisco(Leighton 2000).



Aerial photograph of Oakley in 1939, surrounded by oarchards and agricultural fields. The southwest corner of the Emerson parcel is visible in the top left corner.

The City of Oakley has its modest beginnings as a settlement established on the USGS Mt. Diablo township and range grid, with agricultural fields emanating from the original small downtown (northwest corner of section 25, Jersey Island quad). The first five streets in town bear the stamp of the towns' founder, Randolph C. Marsh: Main, Acme, Ruby, Star and Home. Marsh named the town after the majestic trees that graced the landscape at the time. Sandlappers, the nickname of the original settlers, found a radically different landscape than we see today. Sand dunes, coyotes and jackrabbits defined the area (Leighton 2000).

As the town grew, it attracted immigrants from many cultures. A large Portuguese community was well established by 1927, and Italian newcomers helped develop the burgeoning community. Although information on migrant workers is sparse, it is commonly acknowledged that Chinese laborers built the first levees by hand for Delta landowners throughout the later half of the 1800's.

Settlement was originally concentrated around the development of rail and waterways. The downtown developed between World Wars I and II as a service center for the surrounding agricultural landscape. Orchard production soared as farmers learned to adapt crops to the mild climate and sandy soils of the area.

Modest images of early development in Oakley stand in stark contrast to the development pressures of rapid urbanization currently facing the community. Images from Footprints in the Sand (Leighton 2000).

The Parcels.

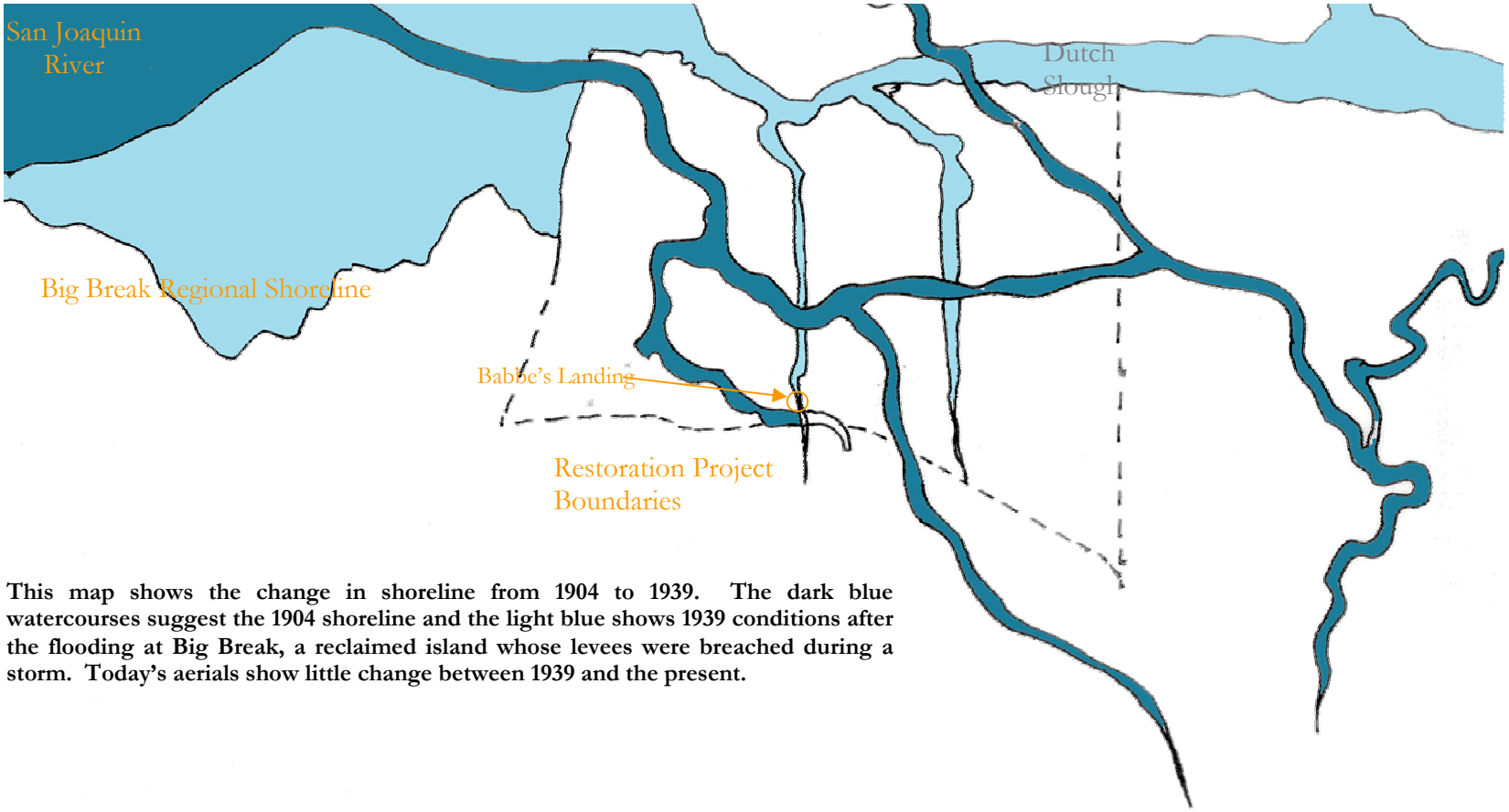
The Emerson family has owned land along Dutch Slough since the mid-nineteenth century. Babbe's landing (mentioned earlier) was located at the end of what is now known as Emerson Slough, the channel that divides the Emerson and Gilbert parcels. The Burroughs family purchased the lands between Emerson Slough and Jersey Island Road in 1906 and managed them as a dairy farm for several decades. In 1974, they sold the parcel immediately east of Emerson Slough to the Gilbert Family. The Burroughs and Gilbert parcels have been managed as rangelands for almost three decades.

Remnant Infrastructure

Several buildings of historic importance remain on the site. Most culturally significant are the old Ironhouse school building and the Gilbert family residence. Other interesting structures exist, such as the dairy operation buildings, a water ski course in Little Dutch Slough constructed by the Burroughs family (open for use by the general public) and a boat launch at the end of Emerson Slough.

The Gilbert family house, the old Ironhouse school building, and a water-ski course on Little Dutch Slough will be incorporated into the site design

Nautical maps of the project area from 1850 (dark blue) and 1904(teal) are overlaid in this image to show the landscape scale changes that occurred during the Gold Rush era.



This map shows the change in shoreline from 1904 to 1939. The dark blue watercourses suggest the 1904 shoreline and the light blue shows 1939 conditions after the flooding at Big Break, a reclaimed island whose levees were breached during a storm. Today's aerials show little change between 1939 and the present.

Implications **F**or **D**esign

The population of the City of Oakley has exploded over the last few decades- from less than 3,000 residents in 1980 to over 26,000 today - a 10-fold increase. The history of human development in a particular area shapes the landscape and mirrors the principles of its human community. In the Bay-Delta, a rich ecological history is complemented with a unique human temporal experience. By examining historical and present infrastructure, based on a cultural relationship to place, we can prescribe goals for future alterations on a site scale. At Dutch Slough, there is the opportunity to create visual and mechanical connection between the design of human and natural systems- both require the consideration of certain basic functions on a landscape scale and these can be interwoven and integrated to perform multiple functions. As communities develop into large urban and suburban centers over time, there is an almost inevitable tendency to want to reveal the natural and cultural history of the place. This usually occurs after said histories have been for the most part obliterated. The Dutch Slough project is an excellent place to showcase the cultural history of the area.

In the planning of a new restoration project, it is important to consider how the surrounding communities will perceive and react to the project. It is helpful to look at self- declarations, like this one from the city of Oakley's website:
"Oakley's motto, *A Place for Families in the Heart of the Delta*, is manifest in many areas: the availability of affordable housing, a focus on the quality of education evident in low student-to-teacher ratios, and the proximity of numerous water recreation sites." The City of Oakley is at a pivotal point in its development. As Dutch Slough is converted into a community supported restoration site, Oakley has the opportunity to incorporate a new resource into their plans for development.

Much has been written on the transformation of the American rural landscape. A succinct and applicable analysis is provided in the technical publication *Landscape Architecture in the Rural Landscape.* "Shaped for human adaptation and survival, the rural landscape exhibits natural and human elements subject to ecological, economic and cultural forces. This relationship creates a pattern upon the landscape- a complex and changing pattern of agriculture, rural communities, industrial and residential development, wildlife habitat, soil water and plant life." (Duane, et al. 1987) Considering the rural landscape on a regional scale is important to understand the transformation of land uses in many areas that are within driving distance to urban centers (The City

of Oakley is 55 miles from San Francisco and 55 miles from Sacramento.) As these elusive boundaries between city, suburb, and country shift over time, new opportunities may arise for a reassessment of use and value. One if the most telling indicators of change due to urbanizing pressures is that of population growth. Tom Stienstra, in a recent article written for the *San Francisco Chronicle* states "Exploring the Delta can be like entering a vast human void – and a paradise for wildlife and boating, water sports and fishing. And yet just over the hills to the west are 6.8 million residents, where the nearby highways are jammed with angry people squeezing the life out of their steering wheels, pushing, pushing, pushing." (Stienestra, 2002) This statement suggests that there is an underlying schism, based not on geographical distance as much on cultural perception of place.

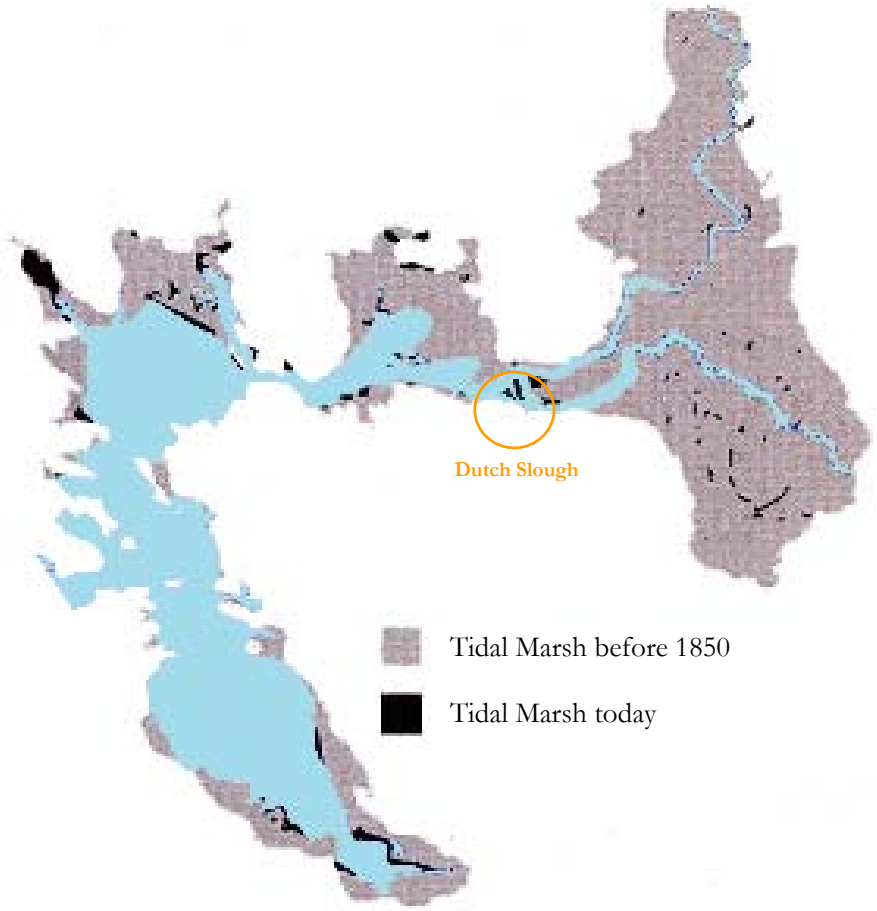
A restoration landscape must relate meaning back to the human population if it is to be successful. Louise Mozingo urges us to weave the ecological and cultural processes together to create places that function as ecological habitats but also resonate human habitats- as cultural establishments. " A re-conception of these realms suggests a culturally integrated aesthetic of ecological design, evocative of our own particular time and place." (Mozingo 1997) In other words, the form of human development has to be integrated with the process of ecosystem regeneration. Networks people have created and superimposed on natural processes can be used as vehicles to return greater ecological function to the system.

III. Ecology

This chapter discusses the need for restoring the Dutch Slough properties to the greater ecosystem, the existing conditions of the site and concludes with a section addressing design logic for the integration of the restoration project into the fabric of surrounding human systems by considering a scientific approach to design. The goal of the restoration effort at Dutch Slough focuses on creating habitat for target aquatic species, thus establishing a foundation of understanding in the specific environmental processes acting on the site is required before considering the extent that human systems and access can be interwoven into the design of the project.

The **I**mportance of **W**etlands

Only 3-4% of the Bay-Delta's historic wetlands remain intact today (State of the Estuary 2000). Historically, the Delta was characterized by vast tidal marshes with extensive networks of dendritic channels (Atwater 1982) and supported several unique native fish that are now endangered. Tidal wetlands provided juvenile salmonids a place to feed and gather strength before swimming out to sea as mature adults. Tidal marsh restoration in the western Delta is particularly important to create a habitat corridor between the Delta and Suisun Marsh that encompasses a range of salinity gradients. Target species such as Delta smelt and splittail congregate in the Suisun Marsh and the western Delta and, unlike tidal marsh on the periphery of the Delta, all anadramous fish pass through the western Delta. Because all of the Delta's tidal wetlands with extensive marsh plain and dendritic channel networks have been destroyed (The Bay Institute 1998) it is not possible to determine whether native fish would benefit from their presence. A recent CALFED-sponsored paper on the fish benefits of tidal marsh restoration concluded that:
"Large-scale adaptive management experiments (100's to 1,000's of hectares) appear to be the best available option for determining if tidal wetlands can be restored in ways to provide significant benefits to native fish populations. Even if these experiments are unsuccessful at increasing native fish populations, the ecosystem benefits of such restored sites would make them worthwhile" (NHI 2002).



Historic extent of tidal marsh in the Bay-Delta (SFBJVP,2001)

Restoring tidal wetlands is important ecologically. A major goal in the restoration of wetlands is to promote diverse native fish assemblage, which in the Delta has undergone significant reduction in population numbers in recent years. Restoring shallow water habitats may promote primary productivity and increase spawning, rearing and refugee habitat for fish. (BREACH 2000). Evidence from the Yolo Bypass and Consumnes Rivers suggests that seasonal inundation of floodplains and riparian forests at Dutch Slough (30 days between February and May) will create spawning habitat for splittail and rearing habitat for juvenile salmon and splittail. (Sommer 2001; Sommer et al. 1997, Sommer 2001, Crain et al 2000).

There still remains a significant lack of understanding in the scientific community of how to reconstruct these systems. The functional variability within habitat categories makes it difficult to reliably forecast the ecological value or proposed engineered habitat and results in an unspecified level of uncertainty in the restoration processes (Lucas 2000).

1999	South Bay	Central Bay	San Pablo Bay	Suisun Bay	The Delta	Total
Open Water	19,700	43,500	26,000	13,800	21,200	124,200
Tide Flat	6,100	1,600	3,700	500	200	12,100
Tide Marsh	3,800	400	6,600	5,500	7,700	24,000
Estuary	29,600	45,500	36,300	19,800	29,100	160,300
Non-Tidal Marshlands	14,800	800	18,700	22,700	215,100	272,100
Upland	5,700	10,300	3,300	1,500	12,900	33,700
Total	50,100	56,600	58,300	44,000	257,100	466,100
1800-1850						
Open Water	18,200	45,700	30,500	16,500	21,200	132,100
Tide Flat	8,600	5,500	5,400	1,000	200	20,700
Tide Marsh	22,700	5,400	22,300	26,500	235,700	312,600
Estuary	49,500	56,600	58,200	44,000	257,100	465,400
Non-Tidal Marshlands	500	0	100	0	0	600
Upland	0	0	0	0	0	0
Total	50,000	56,600	58,300	44,000	257,100	466,100

Extent of tidal and non-tidal environments in the San Francisco Estuary, 1800-2000. All data are in hectares, rounded to the nearest 100ha. (reprinted from Malamud-Roam 2000)

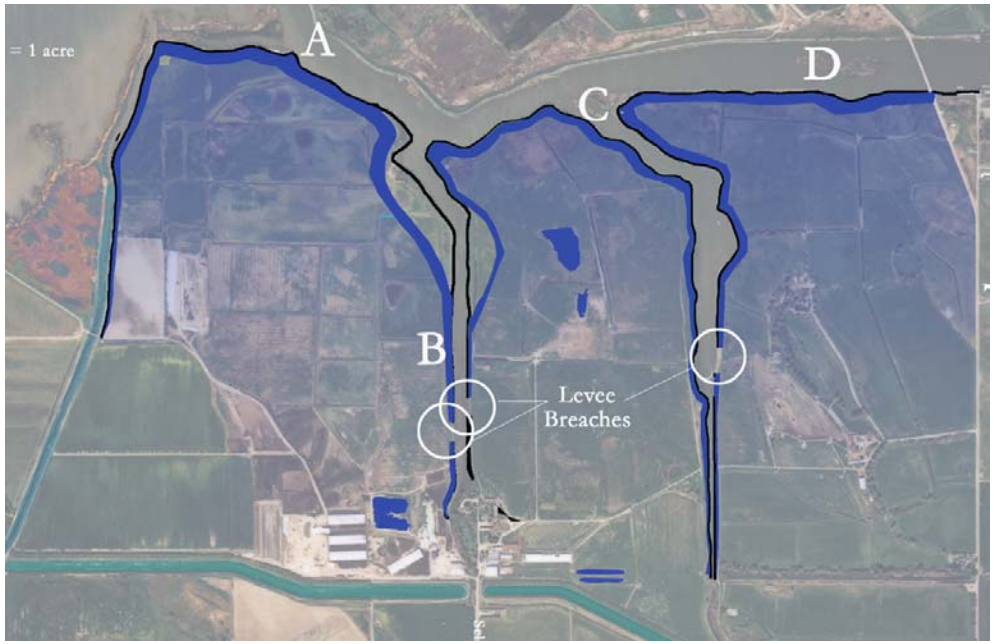
Current Conditions

Topography

As stated in Chapter One, site elevation of the parcels in comparison to other sites throughout the Delta lends itself to marsh restoration. Subsidence of reclaimed lands throughout the Delta creates unique challenges for returning these lands to fully functioning parts of the greater eco-system. Some islands in the Delta have subsided as much as 25 feet below sea level (DWR, 1993). Lands near sea level on the eastern and southern fringes of the Delta cannot be restored to marsh without deeply inundating large tracts of farmland or building a new network of levees.

Although lands with suitable elevations are relatively abundant on the southern margins of the Delta, the CALFED ERP cautions against marsh restoration in this area out of concern that it will increase entrainment of native fish in the south Delta pumps. Agricultural use has also eliminated topographical diversity on most sites, making it difficult and expensive to restore diverse habitats because of the extensive grading required (NHI 2002). While there has been significant subsidence in the northernmost portions of the site (up to 10' below sea level) the Dutch Slough parcels are an economically feasible opportunity to recreate ecological conditions suitable for target species. In order to return the site to tidal influence and create inter-tidal habitat, the series of independent levees on each of the parcels must be breached. Although the levees themselves are not considered 'natural' features of this landscape, and they do not inherently possess ecological value, their failure is likely to jeopardize other diked lands in the area by affecting the volume of water during storm events and increasing wave fetch.

The integrity of the levees must be maintained in order to protect surrounding properties from increased wave erosion of levees on neighboring islands, as well as to alleviate the concern that greatly altering the tidal prism with a large-scale restoration project could negatively affect the salinity gradient in the Delta disrupting the state's water supply. Therefore the Department of Water resources suggests reinforcing the levees with a 10-to-1 back slope on the interior side of the levees prior to breach. The cross sections on the following page address the amount of fill this endeavor alone might require. This type of topographic manipulation is the first necessary step in a process further explored in Chapter Five.



These rough calculations give a general idea of the amount of fill that may be required to re-enforce the levees on each of the parcels according to guidelines suggested by the Department of Water Resources.

Emerson Parcel :

.5mi @ 16' difference (47.4 cubic yards/foot)	2640' x 47.4	= 125,136 yd^3
.5mi @ 14.3' difference (37.8 cubic yards/foot)	2640' x 37.8	= 99,792 yd^3
.5mi @ 12' difference (27 cubic yards/foot)	2640' x 27	= 71,280 yd^3
		296,208 yd^3

Gilbert Parcel

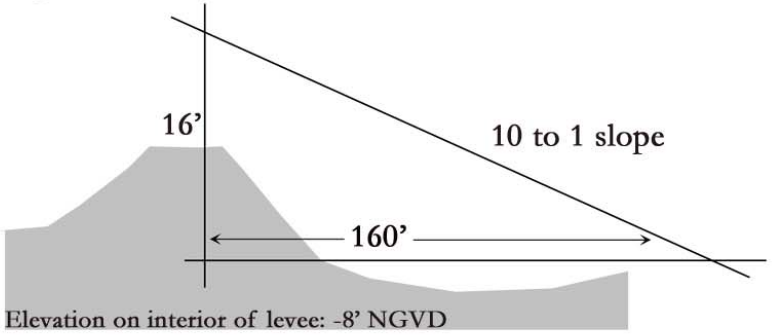
.75mi @ 15.6' difference (45 cubic yards/foot)	3960' x 45	= 178,200 yd^3
.5mi @ 11' difference (22.4 cubic yards/foot)	2640' x 22.4	= 59,136 yd^3
		237,336 yd^3

Burroughs Parcel

.5mi @ 18.1' difference (60.6 cubic yards/foot)	2640' x 60.6	= 159,984 yd^3
.5mi @ 11' difference (22.4 cubic yards/foot)	2640' x 22.4	= 59,136 yd^3
		219,120 yd^3
		Total: **752,664 yd^3**

A

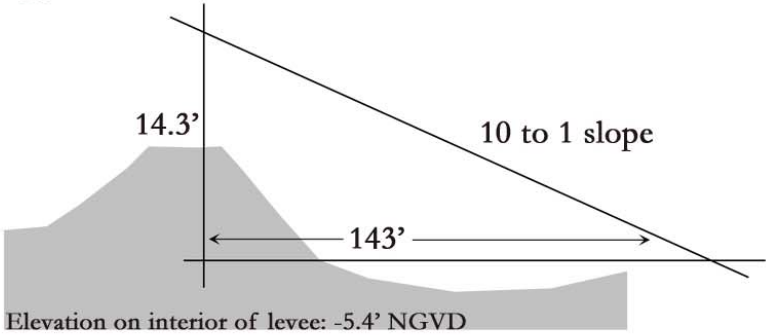
Height at Top of Levee:
+8



Fill required to re-inforce one linear foot of levee: 47.4 yd^3

B

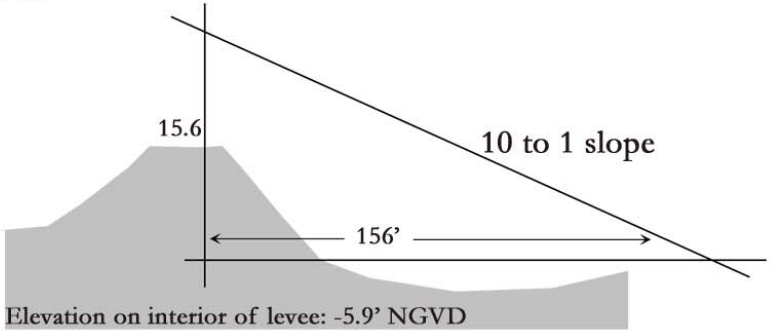
Height at Top of Levee:
+8.9



Fill required to re-inforce one linear foot of levee: 37.8 yd^3

C

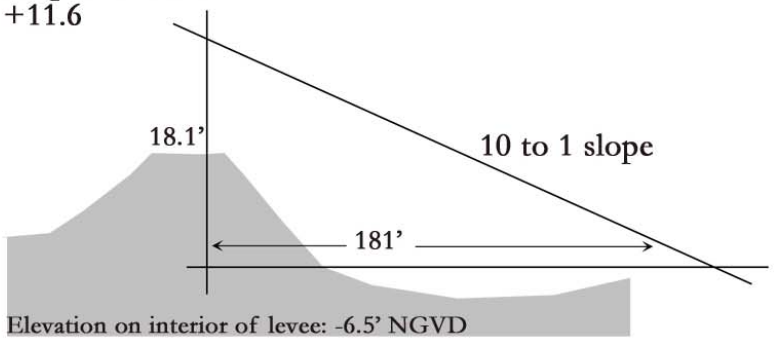
Height at Top of Levee:
+9.7



Fill required to re-inforce one linear foot of levee: 45 yd^3

D

Height at Top of Levee:
+11.6

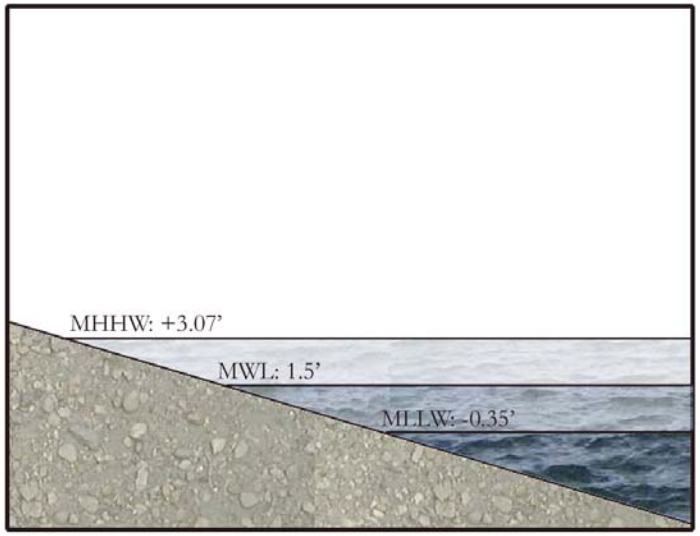


Fill required to re-inforce one linear foot of levee: 60.6 yd^3

Hydrology

In an unaltered system, the land/water interface is an ever-changing edge, responding to daily and seasonal tidal fluctuation, annual flood inundation, pulses of water and sediment from riverine systems, seasonal changes in salinity, and wind and wave action. This creates conditions that foster biodiversity in plant and animal communities. In the Delta, these climactic, landscape-scale variables have been restricted or eliminated, creating a homogeneous shoreline that provides little habit value in the larger ecological matrix. The two major hydrologic systems that effect the site are the tidal processes of the Delta and the Marsh Creek system.

In the Delta, tidal action raises and lowers the water level on inter-tidal mudflats and in the marshes along the shoreline, exposing and flooding these areas twice daily. This washes decaying plant material out of the marshes and also helps disperse the young life forms of many plants and animals. Tides also affect conditions for aquatic organisms in the Delta as they alternately accelerate or slow the seaward motion of fresh water (SFEP website). The levee systems on each of the parcels are designed to limit this natural tidal action in order to prevent flooding and create arable agricultural lands. Because the project site is at a lowered elevation due to subsidence, simply flooding the parcels by breaching the levees would not return the site to its pre-settlement conditions. As with the adjacent reclaimed land at Big Break, where the levees failed in a storm over 70 years ago, it is likely that significant portions of the proposed project would remain permanently under water, not only reducing the square acreage of habitat provided but possibly creating habitat for exotic species such as large mouth bass



This diagram shows the elevational change in tides between Mean Higher High Water (MHHW), Mean Water Level (MWL), and Mean Lower Low Water (MLLW) that define the inter-tidal zone targeted for restoration at Dutch Slough.

that feed on target species. The ideal elevation for tidal marsh restoration in this part of the Delta is between –0.35' and +3.07', the elevations that are exposed to tidal action.

Restoration projects that create heterogeneous wetlands with complex tidal and riverine hydrology benefit native endangered fish including Sacramento splittail, juvenile Chinook salmon and potentially, Delta smelt. Bayley, 1991 indicates that a range of elevation gradients within a wetland site will result in greater biodiversity and utilization by native aquatic species.

Today Marsh Creek's natural flows and meanders have been straightened to provide flood control throughout the watershed. Flows are currently diverted into Big Break, bypassing the Emerson parcel on its western boundary. In an unaltered system, the land/water interface is an ever changing edge, responding to daily and seasonal tidal fluctuation, annual flood inundation, pulses of water and sediment from riverine systems, seasonal changes in salinity, and wind and wave action. This creates conditions that foster biodiversity in plant and animal communities. In the Delta, these climactic, landscape-scale variables have been restricted or eliminated, creating a homogeneous shoreline that provides little habit value in the larger ecological matrix. Marsh Creek A full scale hydraulic model is still needed for a better understanding of how the restoration project might be implemented.

Marsh Creek looking north from the Emerson parcel

Vegetation

Current vegetation on the site includes 40 acres of grapes under cultivation and many hundreds of acres of active rangelands and grain production. Riparian areas remain throughout the site, especially concentrated at the outermost levees where maintenance has not recently occurred. Blackberry thickets blanket some levees. Along ditches and irrigation channels, emergent species can be found. There is a large exotic seed bank throughout the site. Extensive portions of the site have been colonized by exotic invasive weed species such as Brazilian water weed (*Egeria densa),* giant reed (*Arundo donax)*, fennel (*Foeniculum vulgare)*, yellow star thistle (*Centaurea solstitialis*), amoung others.

There was most likely a complex mosaic of habitat types and plant communities that inhabited the current Dutch Slough site. Some of these habitat types currently exist on the site in some truncated form. In an active system, these areas are constantly migrating as a result of succession. The restoration will include the re-establishment of five main plant communities:

1.Emergent marsh. This plant community tends to form at elevations of –3'-0' and is characterized by the presence of tule reeds and cattails *(Scirpus ssp.* and *Typha ssp.*)

2. Intertidal marsh. Elevations of 0'-3' feet support a variety of rushes and sedges (*Juncus ssp.*, *carex ssp., cyperus ssp.*) and other phreatophytes (water-loving plants)

3. Seasonal marsh and floodplain. At elevations beyond seasonal mean higher high water (3'-5') shrubs and small trees establish. The characteristic species of this plant community is willow (Salix sp.) dominant.

4. Mixed riparian-Oak woodland Upland areas (5'-8') with freshwater sources likely supported large stands of riparian tress, including cottonwoods, alders, and buckeyes. Transitional zones to drier areas are defined by the presence of valley oak, live oak, and interior live oak woodlands and savannahs.

5. A unique community known as Antioch Dune Scrub persisted on the Delhi sand dunes located in the southeastern section of the site. Bush lupines still persist on the site, and if dunes are successfully restored on the site endangered species such as the Contra Costa wildflower and Antioch dune primrose would benefit from the increase in habitat (NHI 2002.)

The property is already host to a variety of thriving native plant communities

Aquatic **S**pecies of **C**oncern

Drastic landscape changes throughout the region have led to a decline in the number of native fish species once abundant in the area. The Dutch Slough restoration project is primarily targeted at providing high quality habitat for:

Species name	**Endangered Status**
Winter-run Chinook Salmon, *Oncorhynchus tshawytscha*	(State Endangered, Federal Threatened)
Sacramento Splittail, *Pogonichthys macrolepidotus*	(Federal Candidate)
Delta Smelt, *Hypomesus transpaciJicus*	(Federal Threatened)

Adopting a **S**cientific **P**erspective to **D**esign

Dramstad, Olson, and Forman have presented a practical guide for applying landscape ecology principles. They have distilled the forms of ecologically valuable landscapes at macro and micro scales into a basic typology: patches, edges/boundaries, corridors/connectivity, and mosaics. (Dramstad, et al. 1996). These spatial patterns express the fundamentals of biologically rich systems and as principles can be used in a variety of to determine spaces that relate the human experience to this natural system. Trails (corridors) need resting places, or patches. Humans, as much as any other community of species are attracted to the edges, or changes in pattern. This may be where the greatest biological productivity occurs, but it also seems to be where we find the greatest connection to the inherent qualities of a place (for example, a sunset over the ocean viewed from shore- a biological land/water edge, and the place where many people, regardless of culture, class or race, find deep connection to the processes of the biosphere.) Developing a design logic that relates these ecological principles to cultural spatial organization reinforces the functionality of both human and ecological systems.

Adaptive management is a conceptual framework tool that can be employed in ecosystem management and is at the foundation of many CALFED sponsored restoration and management projects. Using this approach it is possible to manage natural systems in "such a way as to ensure their recovery and improvement and simultaneously ensure the increased understanding of how they function so that future management actions can be more effective." (Strategic Plan Core Team 1998) This approach was outlined in the CALFED proposal for the Dutch Slough restoration project. In much the same way that the current thinking in restoration science views implementation of an idea, an Adaptive Management technique can be employed when designing the human interface at Dutch Slough. Allowing for flexible management of the site within a formal framework will foster spaces that

1. Respect established regional and local patterns. Find a way to use these same patterns in a new way on the site that relates back to their theoretical inception.
2. Retain the same logic (system of reasoning) to design human pathways and transportation networks that are used to re-design habitat networks and water networks for ecological benefit.
3. Formulate a new set of relationships using the same elements by contrasting textures and repeating frameworks in a way that is legible to the human audience and that enhances natural ecosystem function.

IV. Precedent

Evaluating the **L**andscape

To date, no complete inventory of Delta restoration projects exists. Further, no site is identical to the Dutch Slough project in terms of complexity, constraints and opportunities, but much can be learned from observing the successes and failures of other sites. The map to the right shows the locations of eight projects, all of which relate to the restoration project at Dutch Slough in some way. In this chapter, each case study site is discussed in terms of three major functions that are likely to be addressed at Dutch Slough: 1.) Ecological value and integrity, 2.) Education, recreation, and community opportunities, and 3.) Connectivity to surrounding open space.

Location of case study sites in relation to Dutch slough

Defining **C**ategories for **E**valuation

1. ***Ecological Value and Integrity.*** Project designs that enhance the local flora and fauna are critical to achieving project success. Each has systemic processes that create a heterogeneous matrix of plant and animal communities. Some restoration projects simply recreate the form of 'historic' conditions while others focus on process-based design that restores or enhances specific processes to the land (Kondolf 1998). Assessing ecological integrity can be as complex as a full environmental impact report or a basic evaluation of the apparent biodiversity (species richness, population size, and trophic structure) and ecosystem function (productivity) in relation to various stressors such as habitat fragmentation and negatively impacting human land use patterns (Maher 2002).

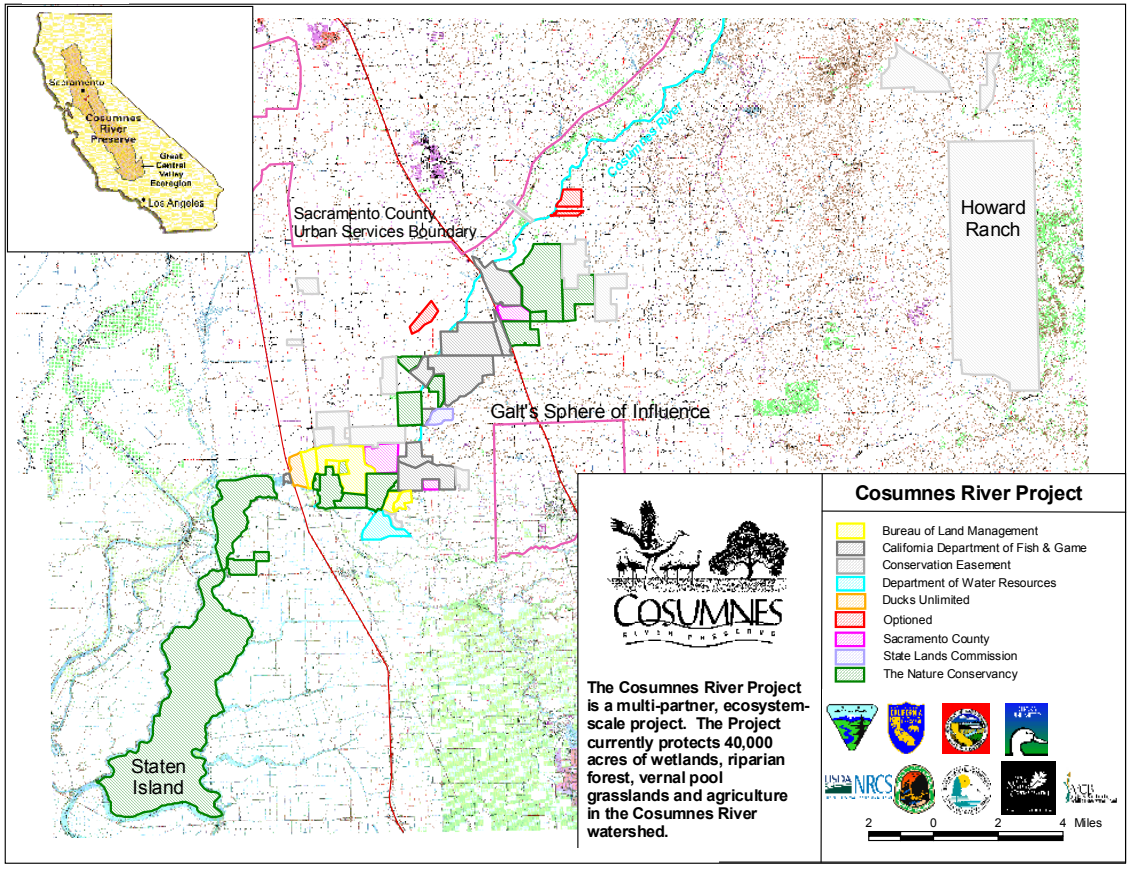
2. Education, recreation, and community opportunities. Although agricultural lands currently surround the Dutch Slough properties, the City of Oakley's general land use plan depicts Dutch Slough as a large open space surrounded by a web of suburban and urban zones. Providing opportunities for recreation is a priority for the project and an implicit part of the Memorandum of Understanding reached by between the project proponents and the City of Oakley in 2002. Projects under similar urbanizing pressure can be evaluated to ascertain whether human use has an impact on ecological function.

3. Connectivity to surrounding open space. The ecological value of a single patch of open space is always limited by its proximity to the next patch of habitat. Many species require different eco-types throughout their life cycles, therefore in order to provide high quality habitat that increases the survival rates of a particular species, it is imperative to link these areas. Dramstad, Olson, and Forman stress the importance of connecting patches of open space (Dramstad, et al. 1996). The most profound land use conversions in the name of struggling wildlife entail the provision of corridors linking useful habitats. Dutch Slough stands to be a large island of sanctuary or an integral part of a lager functioning ecosystem. The latter can be achieved by employing design that encourages connectivity to the surrounding landscape. Other sites can be evaluated in terms of their edge conditions and if they are considered a part of a larger open space network. A sense of entry to the project, inviting curiosity of the site and creating an. amenity that can be enjoyed by the larger community are focus points for the design of Dutch Slough, and considerations of other projects.

Case Study: Cosumnes River Preserve **Focus** connectivity to other high quality habitats

Cosumnes River Preserve is a 40,000-acre area within the Cosumnes River watershed. Targeted as a pristine area of great ecological value by The Nature Conservancy (TNC) originally because it contains of some of the largest remaining stands of old growth riparian forest in the state, today it encompasses a variety of habitat types. The preserve, although managed as a whole, is owned by TNC, government agencies (DFW, BLM, etc.), and private landowners that have voluntarily placed conservation easements on their properties. Preserving and increasing biodiversity is the main objective, but the preserve also attempts large-scale restoration projects (see McCormack-Williamson Tract)

Application to **D**utch **S**lough: The creation of a connected network of open spaces according to Curt Shmutte's regional plan would enable this particular parcel to have a greater positive and collective landscape impact of benefit to both humans and other wildlife.



Map of the Cosumnes River Preserve geographically identifying project partners, courtesy of the Nature Conservancy

Case Study: McCormack-Williamson Island **Focus**: levee breaches

Prior to any structural change, the levees at Dutch Slough must be re-enforced on their interior side so that inundating the interior of the site does not erode the interior levee slopes and wash out the levees. According to Curt Shmutte at the Department of Water Resources, a 10-to-1 slope is needed to insure the integrity of the levees. As stated in chapter two, the reasons for this are to 1.) prevent increased wave fetch and wave action and 2.) prevent change in the regional hydrodynamics to the detriment of Delta water quality (salinity). At McCormack Williamson Tract, on the Nature Conservancy's Cosumnes River Preserve, a restoration effort similar to that being planned for Dutch Slough is already under way. Like the Dutch Slough properties, this northern delta

Re-sloped (10-to-1) and re-vegetated levee, with safflower production in the foreground.

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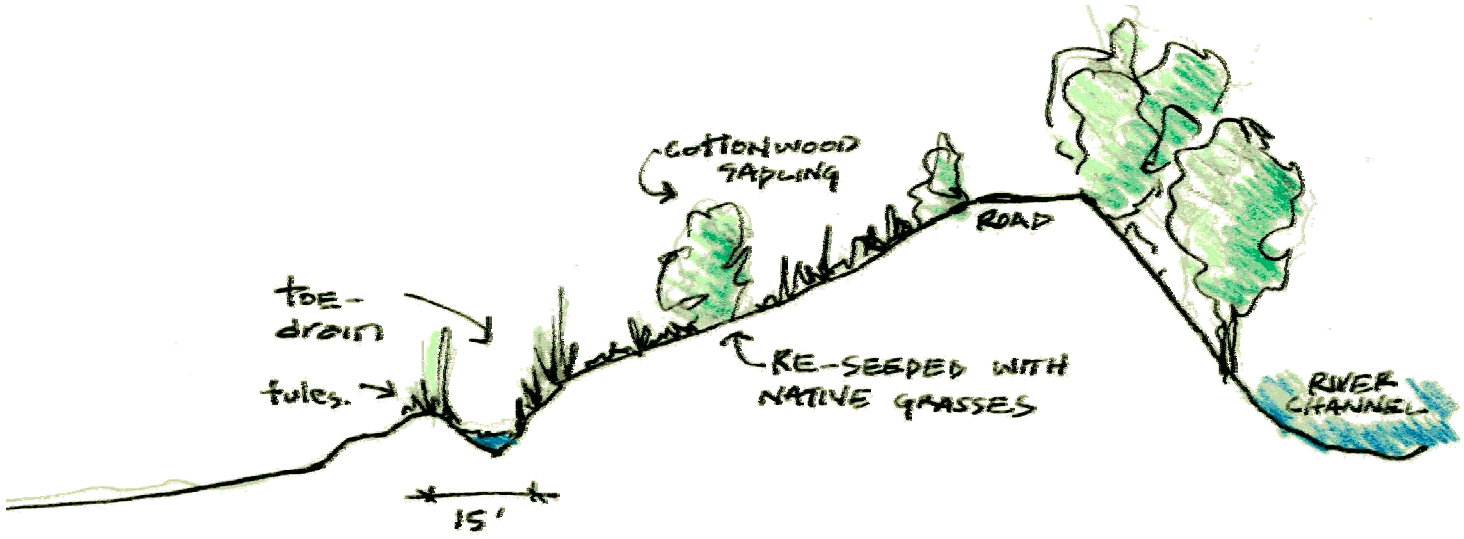
island was leveed in the 1800s to create arable farmland. Now that ownership has transferred into the preserve, experiments on levee re-enforcement have begun. One of the 14 miles of levees has been re-enforced on the interior side of the island the land is

still being leased to farmers and actively cultivated. The interior slope was re-graded at a 5-to-1 slope, and re-vegetated with native grasses and forbs. Levee breaches are planned for the future with the similar intent of restoring a tidal marsh system. The behavior of this project will directly impact the recontouring efforts at Dutch Slough.

Application to **D**utch **S**lough**:** The timeline on McCormack-Williamson is a few years ahead of Dutch Slough; it is currently the best, largest, and most directly applicable example of levee enhancement for restoration purposes throughout the delta. Tracking the success/challenges that this specific project faces will offer directly translatable information to the adaptive management/design team.



Cross section of newly re-enforced levee at McCormack- Williamson Tract

Case Study: Liberty Island **Focus:** reverting to dendritic channels

Liberty Island has a similar land use history to that of Dutch Slough. Currently owned by the Trust for Public Land, the parcel is slated to be sold to the California Department of Fish and Game in the near future (Brady Moss, pers. comm, 2002). In 1997 the levees at Liberty Island failed and subsequently the island flooded. It serves as an excellent example of recently converted marshland, and provides an understanding of how Dutch Slough might react when the levees are breached. The island is quickly reverting back to tidal wetland, and yet a few elements of the site's agricultural history still dot the landscape. The roads are rapidly being encroached upon and no longer navigable. A dendritic channel network, based on the old linear irrigation lines, is re-establishing and dissecting the site.

End of navigable roads on Liberty Island

Former irrigation canal reverting to dendritic channel sform

Liberty Island is accessible by a bridge reconstructed by the Army Corps of Engineers in 1991. Accessibility is also available to watercraft, but is relatively isolated from the bulk of Delta recreational boating traffic by the Yolo bypass channel. There is a high level of ecological function at the site, evidenced by heavy colonization of tule reeds and cattails, and along the former levees, an overstory of riparian vegetation persists (Fig. 3). The site is frequented by aquatic, terrestrial and aviary species. Much of the island however, is now deep-water habitat that may host exotic fish species.

Application to **D**utch **S**lough**:** Even with minor adjustments to the property elevations, the capacity of the land to revert to a more 'natural' stable state is tremendous. The Dutch Slough project is poised to take advantage of that process.

Remnant levee at the southern end of Liberty Island

Case Study: Decker Island **Focus:** restoration of native plant communities

Decker Island, located just east of the Carquinez Strait is a large infill island created from a dredge project completed between 1917 and 1937 (DWR 2002). The Department of Water Resources has created a small restoration demonstration site on the northeast corner of the island, approximately 15 acres in size. The fill from this project went to stabilize several levees in the Delta. One of the project goals was to create as much water/land interface as possible to provide emergent tidal marsh habitat for endangered species (Curt Shmutte pers. comm. 2002).

A series of connecting channels was excavated and the site was heavily planted. The cost for planting, maintenance, and monitoring of vegetation alone was $15,000/acre (Curt Shmutte pers. comm. 2002). Although the planting is still being monitored for change/success/etc., some preliminary conclusions can be derived from close examination of field conditions.

It is clear, in terms of the vegetation planting, that some areas of the project are performing better than others, due to both site-specific species selection and proximity to available water table. Slight changes in slope and elevation create enough difference to determine specimen mortality. Some hardy upland species are doing well, but many of the overstory trees plantings do not

Aerial view of Decker Island before and after restoration (DWR website)

appear to be successful. The rest of the 470-acre island is fallow, and DWR has plans to acquire the land and continue restoration efforts at the site. The project site is relatively free of invasive species, presumably because of active maintenance. If a similar planting scheme at Dutch Slough were employed, approximately 4,607,500 plants would be needed.

The published habitat planting plan for 15 acres of Decker Island includes:

Plant community	**# planted**
Tule	6,091
Tule / Rush	4,124
Riparian Scrub	7,322
Mixed Cottonwood	19,088
Valley Oak/ Sycamore Woodland	4,384
Upland Scrub	5,749
Total planted (DWR 2002)	**46,758**

An established breach on the exterior of a breached levee

Application to **D**utch **S**lough: While the Decker Island project differs in scale and scope, (i.e. small scale, no public access), many of the successes and lessons in terms of revegetation can be directly applied to Dutch Slough. Many species are appropriate to both sites, and their long-term monitoring will be useful in a Dutch Slough planting design. A greater understanding about recreating plant communities vs. individual specimens will be a priority. A heterogeneous plant pallete is desirable; however mass planting does not ensure success.

Case Study: Delta Meadows **Focus:** community water access

Delta Meadows is a relatively pristine, proposed state recreation area located just outside Walnut Grove in the heart of the Delta. Draining waters from the south fork of the Sacramento and Mokulumne Rivers, 'the Meadows' is simply a course of meandering waterways speckled with isolated islands of native vegetation. This area is a favorite spot for local sport fishermen and recreational boaters. Throughout the summer, many watercraft can be seen perusing the slow waters.

Even with a significant, albeit transient human presence, the Meadows is a biologically rich piece of the Delta. In terms of community access, there are no limits or restrictions of any kind placed on those visiting the site, and there seems to be a great respect demonstrated in the area (i.e. no trash, just a few shipwrecks for effect.) While water access is excellent and well-used, terrestrial access is limited to an unmarked paved road just past the Delta intake pumps. The one remnant trail has been closed. The Meadows is comparable to Dutch Slough design challenges with respect to the terrestrial access issues.

Abandoned watercraft in the Meadows

Application to **D**utch **S**lough**:** The Delta Meadows has been preserved largely due to its isolation and inaccessibility. This is not a place where a design solution has been developed to accommodate people and the native landscape, but co-existence continues nonetheless. In order to provide public access to the restoration site, Dutch Slough will have to be more intentionally conceived. There is a quality of place (perhaps due to the serenity created by a sense of isolation) at Delta Meadows that should be a goal for creating places at Dutch Slough.

Large woody debris provides excellent cover for aquatic species, making the Meadows one of the hottest fishing spots in the Delta

Case Study: Stevens Creek Marsh, Palo Alto Baylands **Focus:** trail networks

The definitive characteristic of any trail system is inherently dependent on location. However, much can be done to enhance the pedestrian/ bicycle/equestrian experience. The Stevens Creek Marsh restoration project at Mountain View is an excellent example of a trail system that highlights the sites' unique character. A triangular shaped marsh was recreated in 1992 to provide habitat for migrating shorebirds. The site is visited year- round by several avian species, and clearly demonstrates high ecological value. There are no restrictive signs at the site, only educational ones. The paths, instead of trying to avoid mixing human and wildlife uses, are laid out so as to enhance the viewing experience by bringing the viewer face to face with marsh processes. In the design, these spaces can be viewed, but not *accessed.* In many cases this means simply elevating the viewer to an appropriate (and varying) height above the floor of the marsh- i.e. the tops of levees. This design intent is carried out through to the unique design details of path boardwalks, bridges and railings. Views are well planned and elegantly choreographed. All types of trails link together, from dirt paths to more elaborate boardwalks; no trails dead end. The overall effect is that of a seamless experience of the marsh.

The trails at Stevens Creek Marsh provide a variety of experiences, moving the viewer along, over, and through the marsh with grace.

Application to **D**utch **S**lough**:** At Dutch Slough, the trails networks should provide connectivity throughout the site. Attention to detail can enhance the experience and create an overall aesthetic that is place specific, further creating the sense of a regional amenity. Creating unique experiences and access for human visitors can be done in a way that does not affect the quality of habitat created.

Path along top of levee

Marsh overlook

Case Study: Sand Mound Slough **Focus:** adjacency to rural landscape

Located close to the project site and accessible exclusively by watercraft, Sand Mound slough rests in the cradle of delta valley farmland. The area directly adjacent to Sand Mound to the east is a parcel known as Franks Tract. Now shallow and deep open water habitat, Franks Tract was flooded in the forties when levees failed during a high water event. In the resulting 60+ years, little has been done to improve the condition of this parcel, neglect which has led to the establishment of several exotic plant and fish communities. Runoff from the surrounding agricultural lands has impacted water quality, and the high nutrient content has caused significant eutrophication in the area. Sand Mound itself remains as fragments of wild islands. Although highly used and

Party on the shores of Sand Mound Slough

impacted by the surrounding human population, there is continuity in visual transition from surrounding farmlands to native wetlands. Boating is one of the definitive characteristics of the Delta lifestyle. Sand Mound Slough is a quiet, seemingly disregarded place that stands in paradox to the most rapidly urbanizing areas of the state.

Application to **D**utch **S**lough**:** Sand Mound Slough is a remnant, undersigned place that is appealing as a space. There is a sense of boundaryless-ness, because this is a place with no edge. The challenge at Dutch Slough will be to create this open feeling within the confines of a clear boundary. Quite possibly, this could be achieved by a seamless visual connection to the surrounding landscape.

A dense bed of tule reeds grows along a deep channel at Sand Mound Slough

Case Study: Bair Island **Focus:** adjacency to suburban landscape

Bair Island is a 3,000-acre, subdivided island in the South Bay off of Redwood City, and a part of the Don Edwards National Wildlife Refuge. For decades, salt ponds on the island have been in full production, but through public support, the land has been acquired and restoration plans for the entire site are in development. The pedestrian entrance to the traversable third of the island is off a Highway 101 exit. Many people drive or bike to the site to use the rudimentary trail system. Demand for open space appears to be high along this stretch of coast. Two thirds of the island, however, is inaccessible by foot, and signage deters boaters as well. Some smaller mitigation projects have been done in these areas, but a full-scale restoration is planned dependent on funds becoming available. What is of key importance is the delineation between accessible and restricted space. Not allowing land crossing greatly diminishes impact on much of the island, and although some signage is employed for boaters, pedestrian access becomes self-limiting. It is questionable how valuable the experience of walking through the inaccessible salt marsh would be for the general public, but some other visceral experience might be appropriate.

Application to **D**utch **S**lough**:** The design options for Dutch Slough may require a division of lands, or at any rate, restrictions placed on use and accessibility for the human population in areas deemed ecologically sensitive. Bair Island represents one approach that is neither grossly offensive or harmonious and consistent with stated project goals.

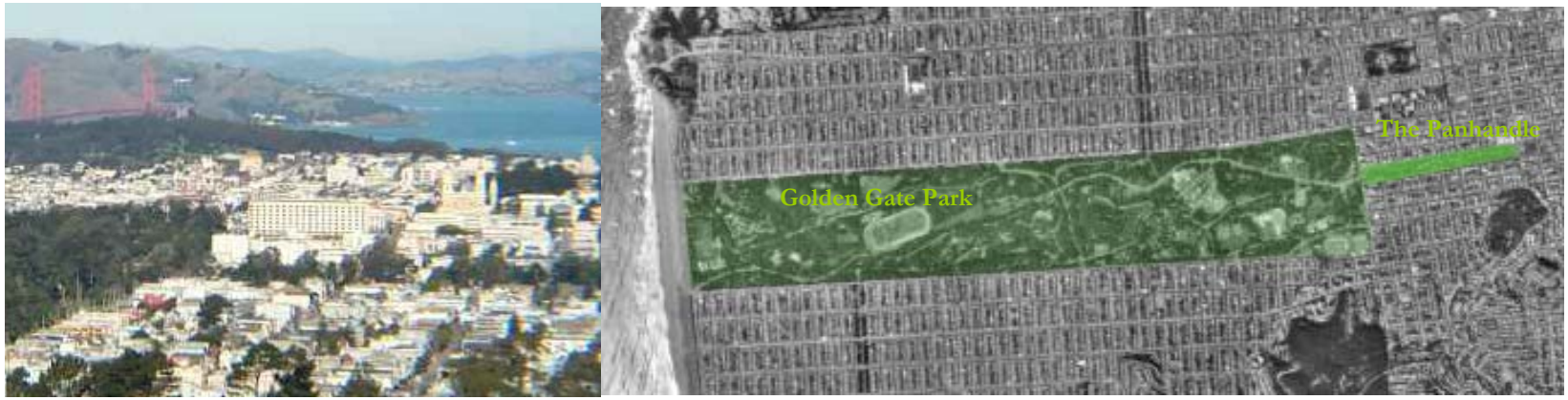
Human elements in a restoration landscape provide a perch for wildlife

Aerial view, eastern edge of Bair island

Case Study: San Francisco's Panhandle, Golden Gate Park **Focus:** creating a sense of entry

Golden Gate Park is world renowned for the majesty it lends to San Francisco's landscape. The park stretches from Ocean beach west to Stanyan St., except for a strip called the Panhandle, which juts east between Fell and Oak St. into the Haight. Originally the "carriage entrance," the Panhandle contains the oldest trees in the park. It is approximately 320 feet wide, spanning between Oak and Fell Streets. Approaching from the east, the Panhandle provides the first visual clues that Golden Gate Park is approaching. It extends the park into the city.

Application to **D**utch **S**lough: While Oakley's population density is not likely to rival San Francisco's any time soon, this example of a successful urban/natural interface and sense of arrival could easily be replicated to extend the Dutch Slough restoration project into its surrounding urban context



Aerial photograph and map of the Panhandle as it intersects Golden Gate Park

V. Design

Proposed view from the Gilbert house over Emerson Slough

The restoration at Dutch Slough is a cultural response to regional urbanization. This project ameliorates the environmental pressure that demand for water places on certain target species, but its location on the margins of large-scale development pose compelling possibilities for design. Karl Linn in the *Ecology of Cities* discusses the relationship of citizens of a community to their built environment. Linn urges the professional design community and members of society, to realize that to "establish a self-perpetuating order between the community of people and their cities should be our goal" (Linn 1960). Understanding the transformations of the past and present in their greater cultural context might give us clues to creating a new system of inter-relationships that strengthen individual connection to place in the future by building strong temporal and spatial connections.

Restoration is not a recreation of past conditions but the provision of an ecologically sound system.

Design Goal: Weave the Dutch Slough Restoration Project into the City/County Fabric

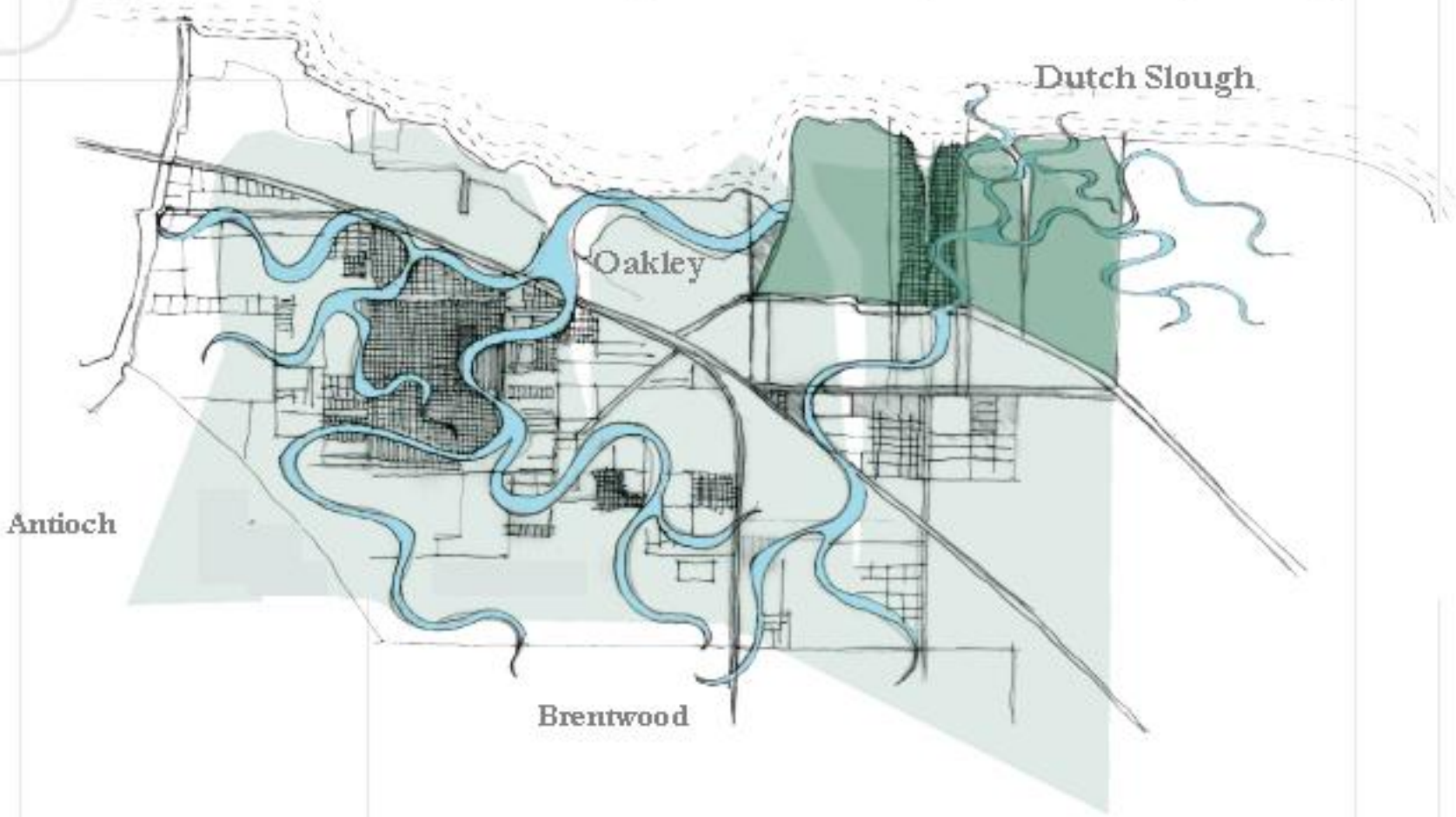


Diagram illustrating the design goal of connecting the restoration project at Dutch Slough to the local human community. Bringing a sense of restoration into the surrounding urban context can provide visual connection to the project and increase the positive ecological effect of restoration by extending past the boundaries of the property. Pulling a formal design into the park as an extension of the city will increase visual contrast and provide an area for people to feel at home in a naturalistic setting.

The design of ecologically relevant restoration sites is as dependent on an understanding of the structure and mindset of the involved and affected human community surrounding the sites as it is on sound environmental science. These human systems (visible as land use patterns and human use of a site) define the parameters and form artificial boundaries of many restoration projects. Typically, this happens in a way that benefits neither human settlements or ecological function, when in fact these are both part of the same larger set of patterns that can be developed in a way that positively accentuates both.

Oakley's original agrarian land use pattern has been supplanted with unplanned, uncontrolled spreading of development of the Bay Area urban fringe. The original downtown area has been lost in a maze of residential winding streets, and thus Oakley has no strong central focal point. This is due in large part to the development of Oakley as a satellite community of the Bay Area. Over 70% of Oakley's residents commute outside the city every day for employment (City of Oakley website). But there is also another cultural reality that exists in the area. "The Delta is still 90 percent devoted to agriculture." Tom Stienestra points out that "Out on the Delta, everybody acts nice to each other, even though just four miles away on the highway, it seems like exactly the opposite" (Stienestra 2002).

The design moves presented on the following pages integrate the two components of this project: human infrastructure and ecological systems into the regional context: it weaves the restoration project into its surrounding urban and agricultural landscape. This design seeks to:

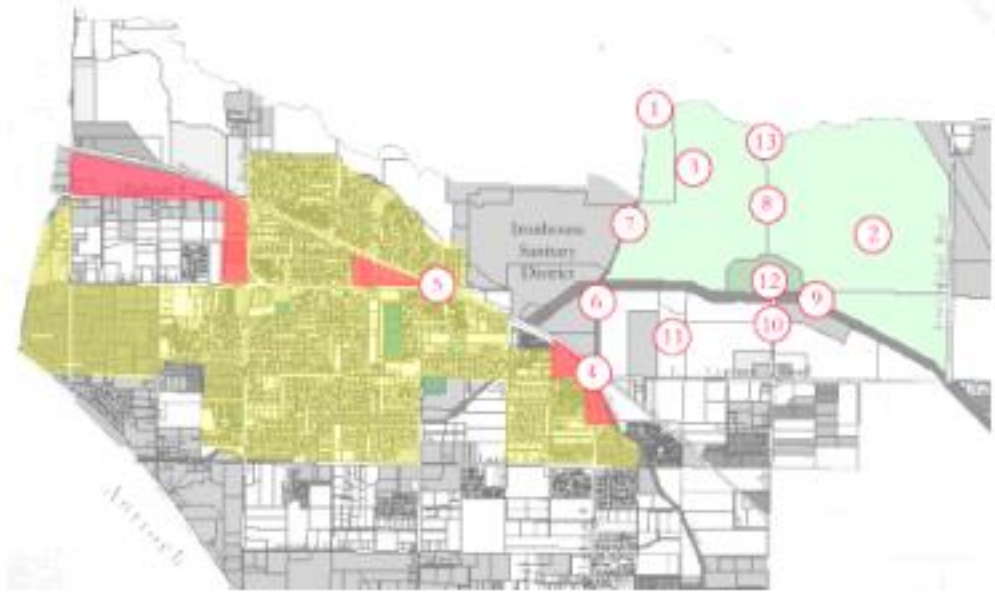
1. Restore ecosystem value
2. Integrate with human uses
3. Provide an arena for constructive and applicable scientific inquiry
4. Create a sense of entry to the restoration project
5. Create a place that will be seen as a regional amenity

The map above shows the fundamental land use assignments that underlie the Dutch Slough Master Plan. Closest to the water, a marsh restoration zone is created by breached levees. Between the tidal zone and the Contra Costa Canal lie upland restoration, buffer zones, and a community park. Below the canal new residential development is structured to create a series of entries to the restoration project

Designing the Community Interface

The residential and commercial development project planned for the 300 acres south of the Contra Costa Canal has to date been only vaguely defined, creating a unique opportunity to design the development to integrate with the restoration project. The central organizing theme of this design exploration is to unify the various past, present and future histories of the site into a programmatic whole in order to create a comprehensive design strategy. Determining a design logic that is based on the intricate connections that already exist on site involves understanding existing and historical site patterns of the natural, vernacular, and engineered patterning of the land..

Thirteen moves, described in detail on the following pages, outline a sequence of design interventions expressing the program for the site and describe how the restoration project might be integrated into the surrounding human context.



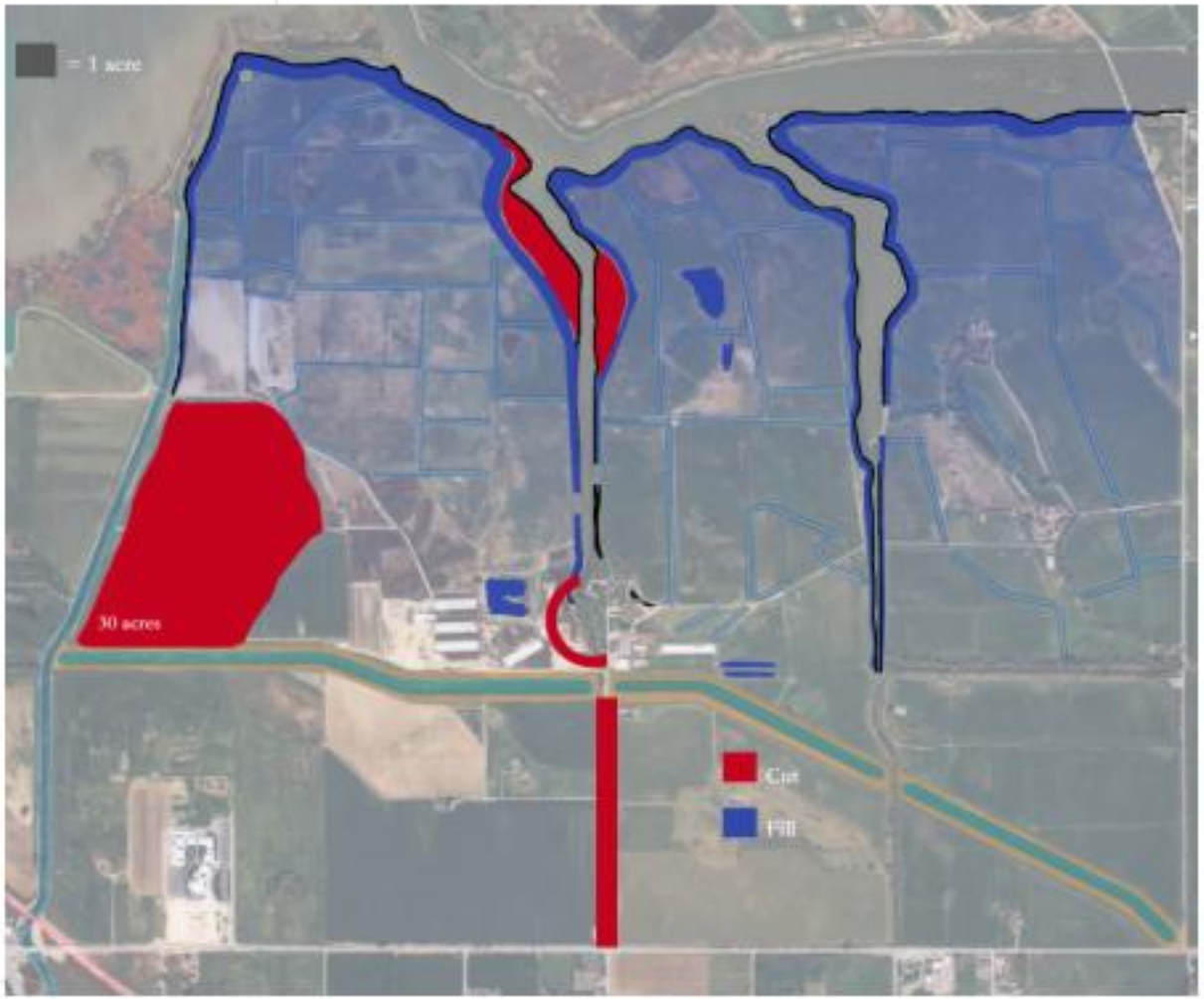
1. **Reshape Topography**
2. **Establish a Dendritic Slough Network**
3. **Recreate freshwater tidal wetlands**
4. **Create a Visible Entry to the Site**
5. **Use Street Trees to Weave Dutch Slough Into the City Fabric**
6. **Extend Restoration of Marsh Creek from Contra Costa Canal to Cypress Road**
7. **Create Connectivity With Trails**
8. **Create a Bridge Between City, Park, and Restoration Project**
9. **Buffer the Contra Costa Canal**
10. **Place Commercial Corridor Along Sellers Avenue**
11. **Restructure Density**
12. **Establish a Community Park**
13. **Create Beaches**

The above map shows the parcels as they might look once restoration is completed.

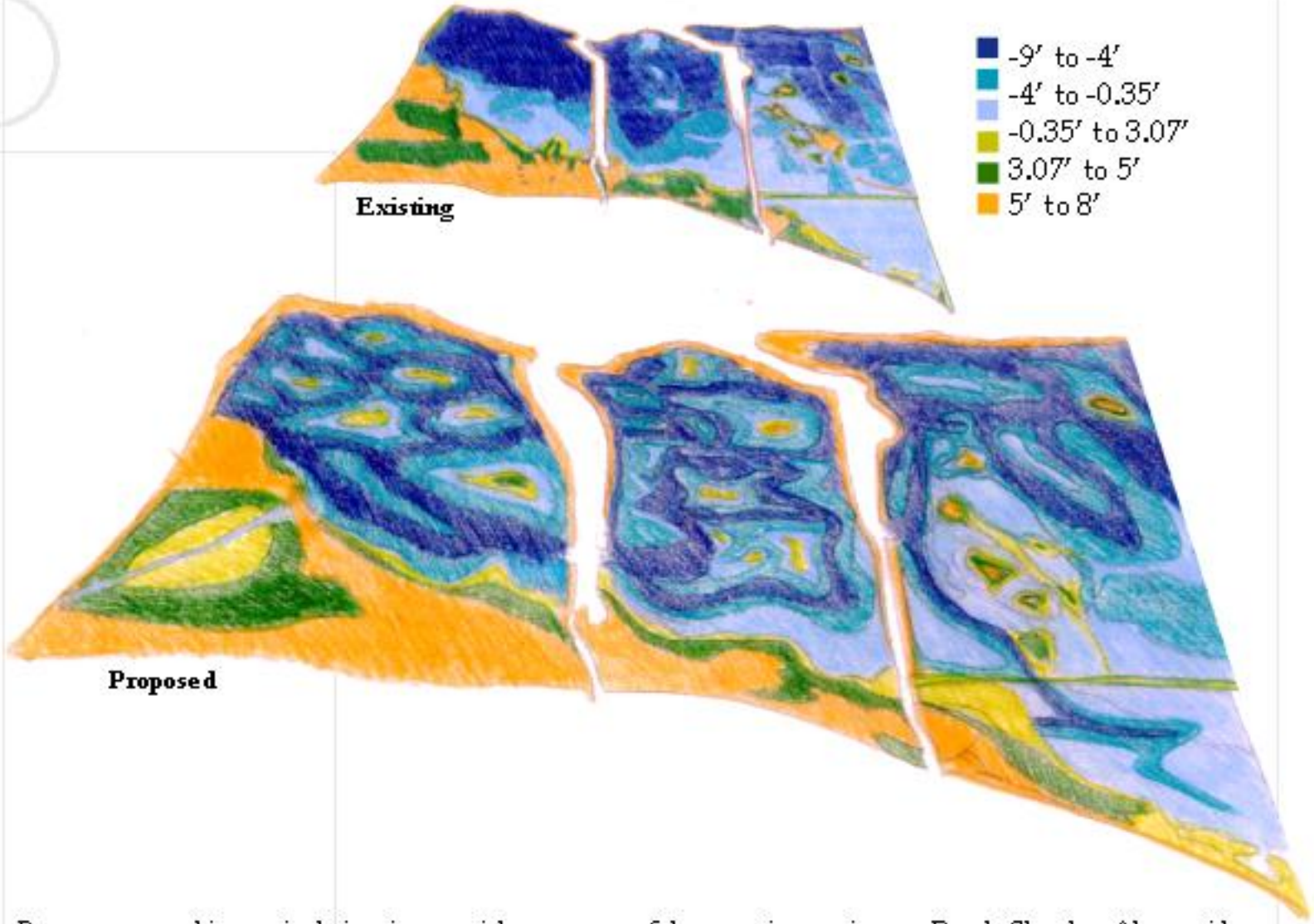
1 Reshape Topography

Objectives:

1. Create elevations suitable for tidal marsh restoration
2. Provide flood protection
3. Enhance experience for visitors



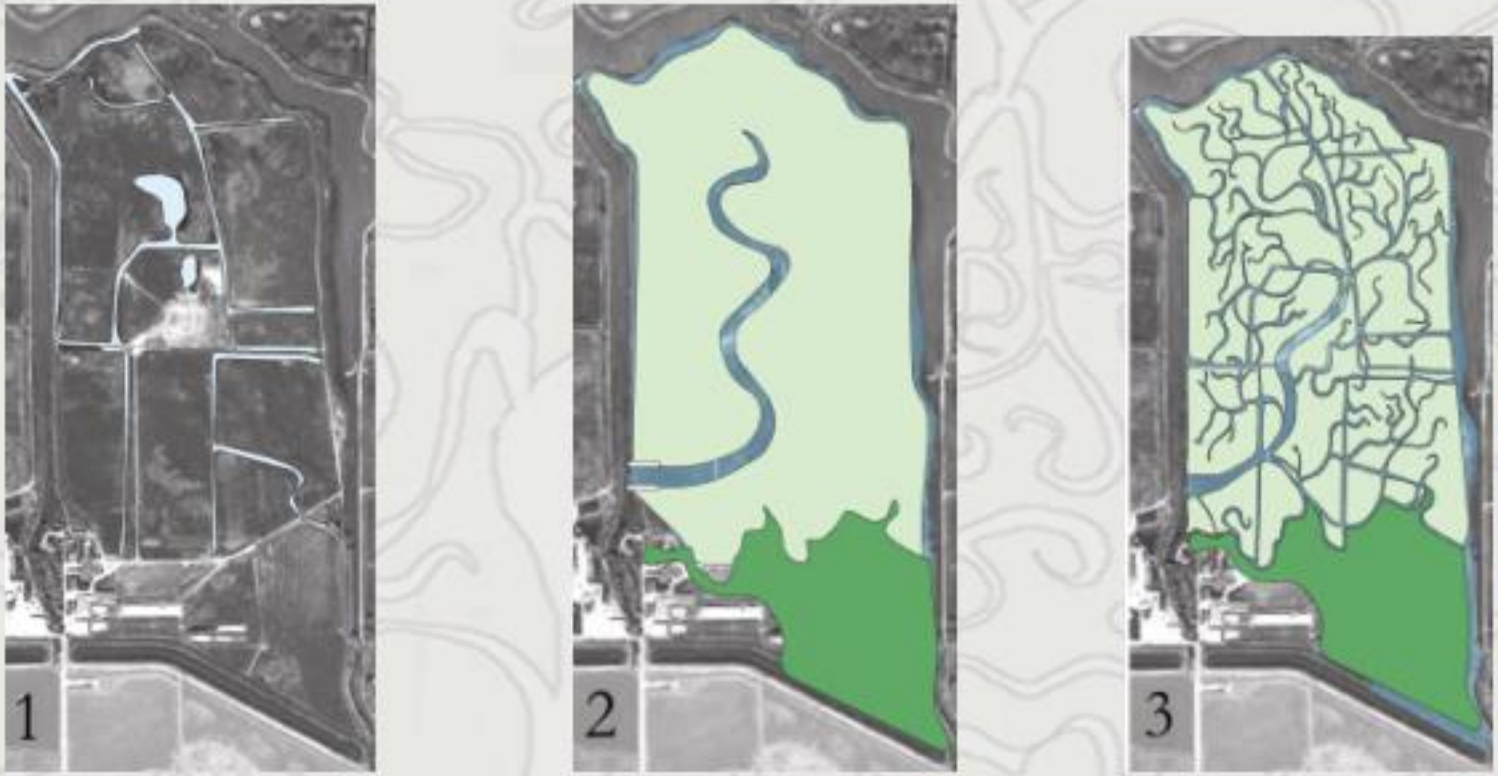
This cut and fill diagram shows the basic movement of fill required to reinforce levees and raise the interiors of the parcels to elevations suitable for tidal marsh restoration.



Proper topographic manipulation is essential to a successful restoration project at Dutch Slough. Along with reinforcing levees, breaching and regrading for restoration planting creating changes in the ground-plane can be used to enhance visitor experience, create view corridors, and restrict pedestrian traffic to sensitive areas.

2 Establish a Dendritic Slough Network

Using the Gilbert Parcel as an example for the transition that will happen on each of the parcels, the above diagrams illustrate the formation of a dendritic channel network.



In the Bay-Delta, sloughs are formed at the margins of the estuary, usually in brackish water areas, where vegetation builds up on accreted surfaces and drainage. Either freshwater from a riparian system or intrusion from tidal action drains surface water to a low elevation. The main characteristic of these channels is that their flow is tidally influenced.

In a well-established, relatively stable system, these channels tend to form a series of dendritic networks, creating sinuous channels that develop distinctive characteristics sensitive to only slight changes in elevation. A complex network of multiple channels gives a greater amount of a water-land edge condition (greater area of wetted perimeter), increasing habitat for the target species.

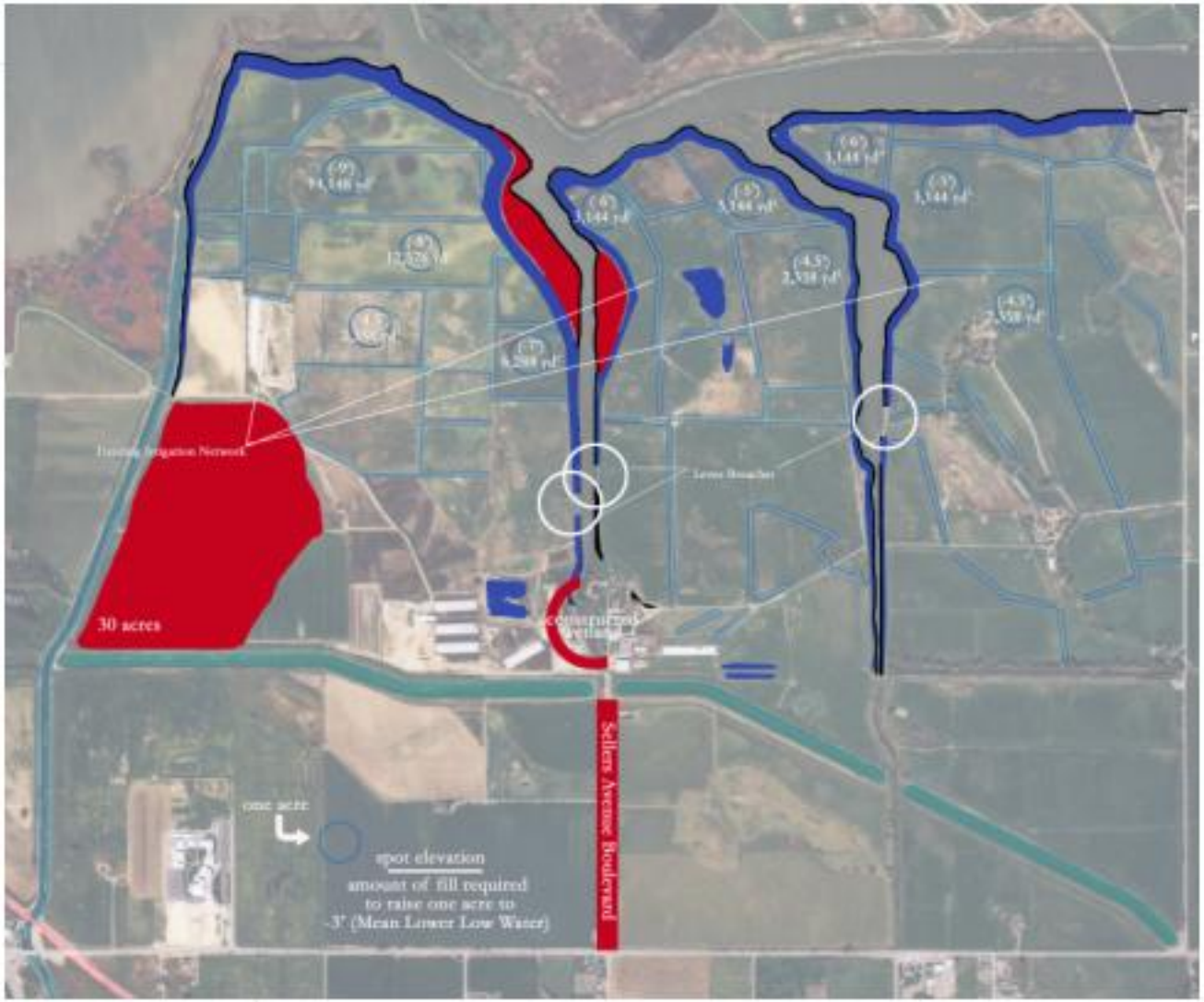
Objectives:

1. Create habitat that supports the life cycle of target species

2. Support the human community by providing open space, recreation and educational opportunities

Diagram 1 highlights the existing irrigation channels on the property. Diagram 2 shows a schematic levee breach and the delineation between tidal marsh (shown in light green) and upland habitat. Ideally, the area would be graded to heights suited to tidal fluctuation (roughly between -3' and +3') with fill imported from another site. Diagram 3 shows the transition to tidal marsh with the establishment of meandering sloughs based on the existing channel network. Finally, Diagram 4 depicts the a mature tidal marsh system with fully formed sloughs that provide optimal habitat for the target species.

3 Recreate Freshwater Tidal Wetlands



This diagram outlines the amount of fill needed per acre to raise different areas of the site to elevations suitable for tidal Marsh restoration. The 30-acre area of high ground in the southwest portion of the Emerson parcel could be excavated to a depth Of two feet, providing 157,170 cubic yards of fill.

Objectives:

Current conditions on the Emerson Levee

View of restored wetlands from a path on the top of a levee

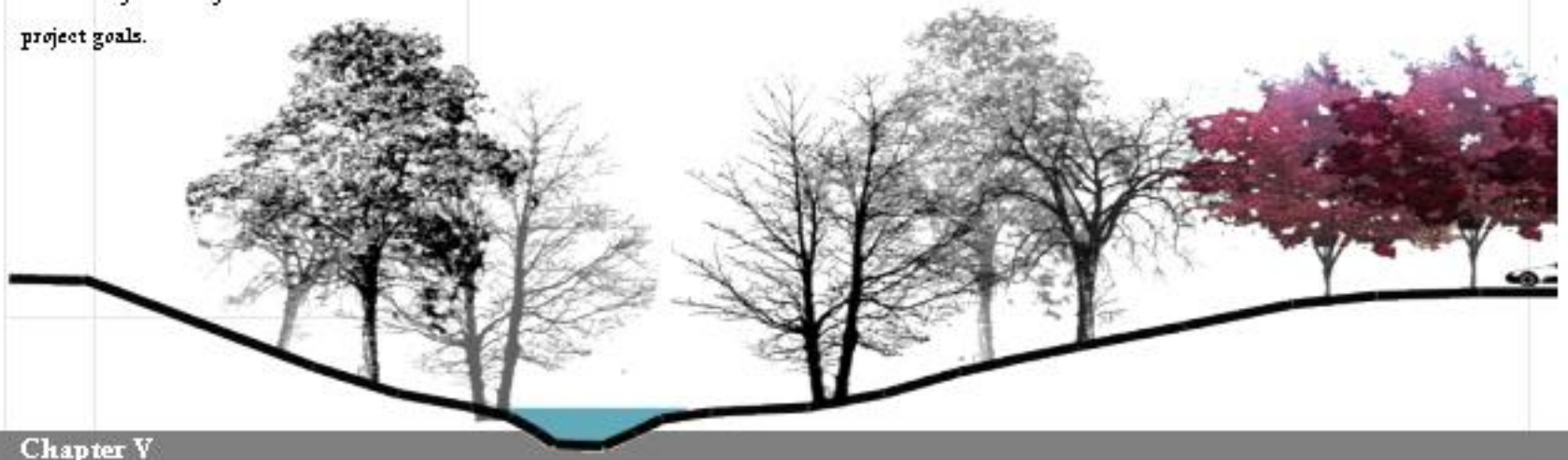
Proposed siphon to help drain parcels during low tide

Augmenting the levee breach, a series of large siphons could be buried at the base of the northernmost levees on each of the parcels where subsidence is greatest. These devices would operate when there is a differential between high tide in the interior portions of the parcels and low tide in Dutch Slough. With a backflow device, these siphons would act as drains, lowering water levels on the parcels by shunting water into Dutch Slough . Installing these would ensure that shallow water habitats would not dominate the restoration project and still allow for natural accretion (a gradual building up of soil) to take place, eventually making these mechanisms obsolete. The opportunity of using this type of restoration technique as a design feature would highlight the restoration process to the public.

4 Create a Visible Entry to the Site

There is a small parcel of land at the intersection of Marsh Creek, Cypress Road, and the railroad tracks running through the Southwest corner of the Dutch Slough properties. The site is currently managed as a parking lot and trailhead for the East Bay Regional Parks District. Incorporating this land into the plan for restoration would create a visible entry to the site and build partnerships with other agencies working in the area. Orchard plantings are used to reference Oakley's agricultural roots and structure a new parking area. Using creative visuals such as this fish flag can help the community identify with the restoration project goals.

Location map



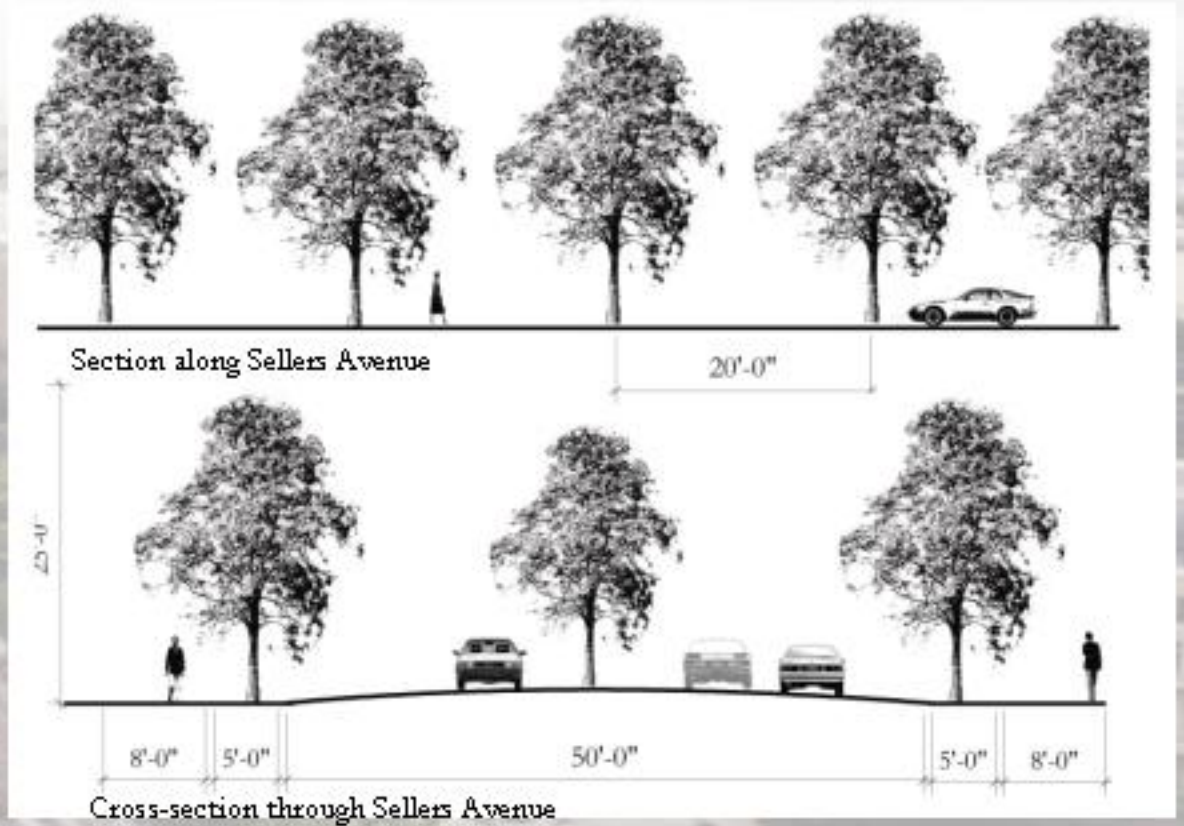
Objectives:

1. Extend the restoration project into the structure of the city
2. Create more fluid connections between open space systems
3. Increase access and parking for the Marsh Creek trail

Cross-section through marsh creek and parking lot

5 Weave Dutch Slough into City Fabric

One way to extend the restoration effort past the boundaries of the project into the city is by using street trees. Sycamores make a popular street tree in this climate because in addition to being majestic, long lived trees, they are tolerant to a variety of urban conditions. Using contiguous planting along the travel corridors to the park will not only beautify the city, it will give a sense of what is at the literal end of the road. In employing this simple design move, the ecological benefits of the project can move out into the city fabric the added benefit of providing flyways for avian species.



Objectives:

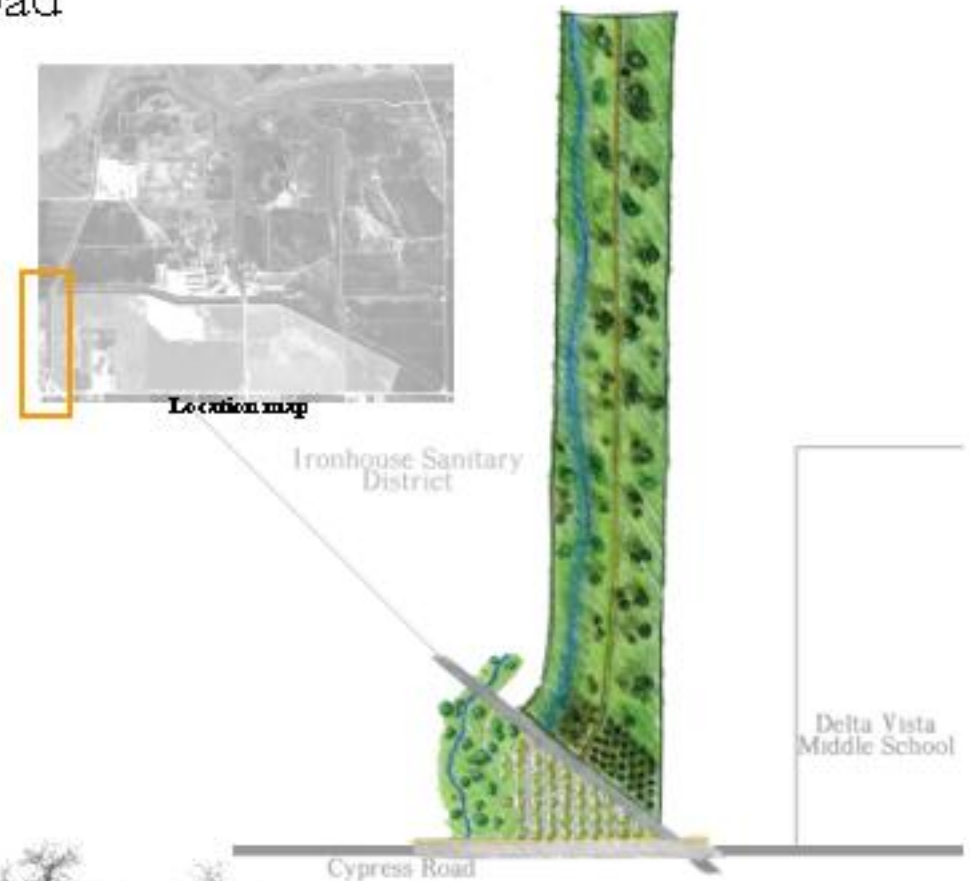
1. Use street trees to integrate restoration effort into broader context

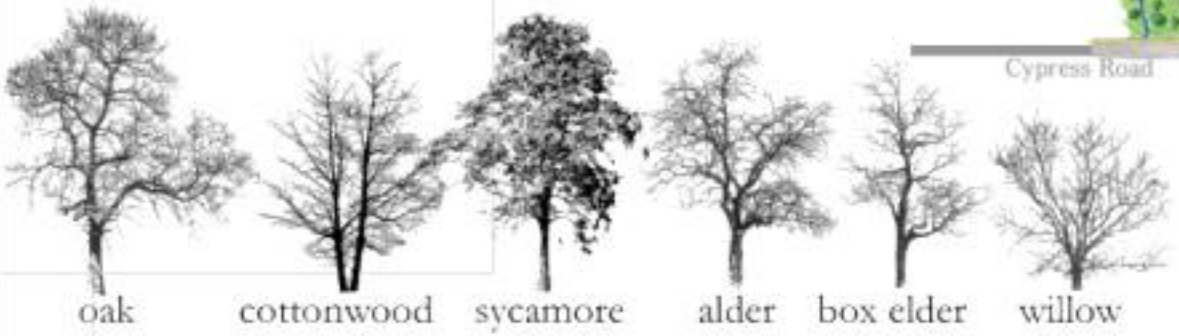
2. Create strong visual identity for City of Oakley

3. Connect restoration project to other patches of open space

6 Extend Restoration of Marsh Creek from Contra Costa Canal to Cypress Road

Marsh Creek provides an important connection between Mt. Diablo and the waterways of the Delta. However this watershed has been negatively impacted by urbanization limiting the riparian corridor and degrading water quality. There is an opportunity to protect this important landscape feature before development begins, providing the local community with enhanced pedestrian access to the trail system and increasing ecological connect-ivity between the site, the city and other open spaces.





Tree palette suggested for the restoration of riparian areas along Marsh Creek

Objectives:

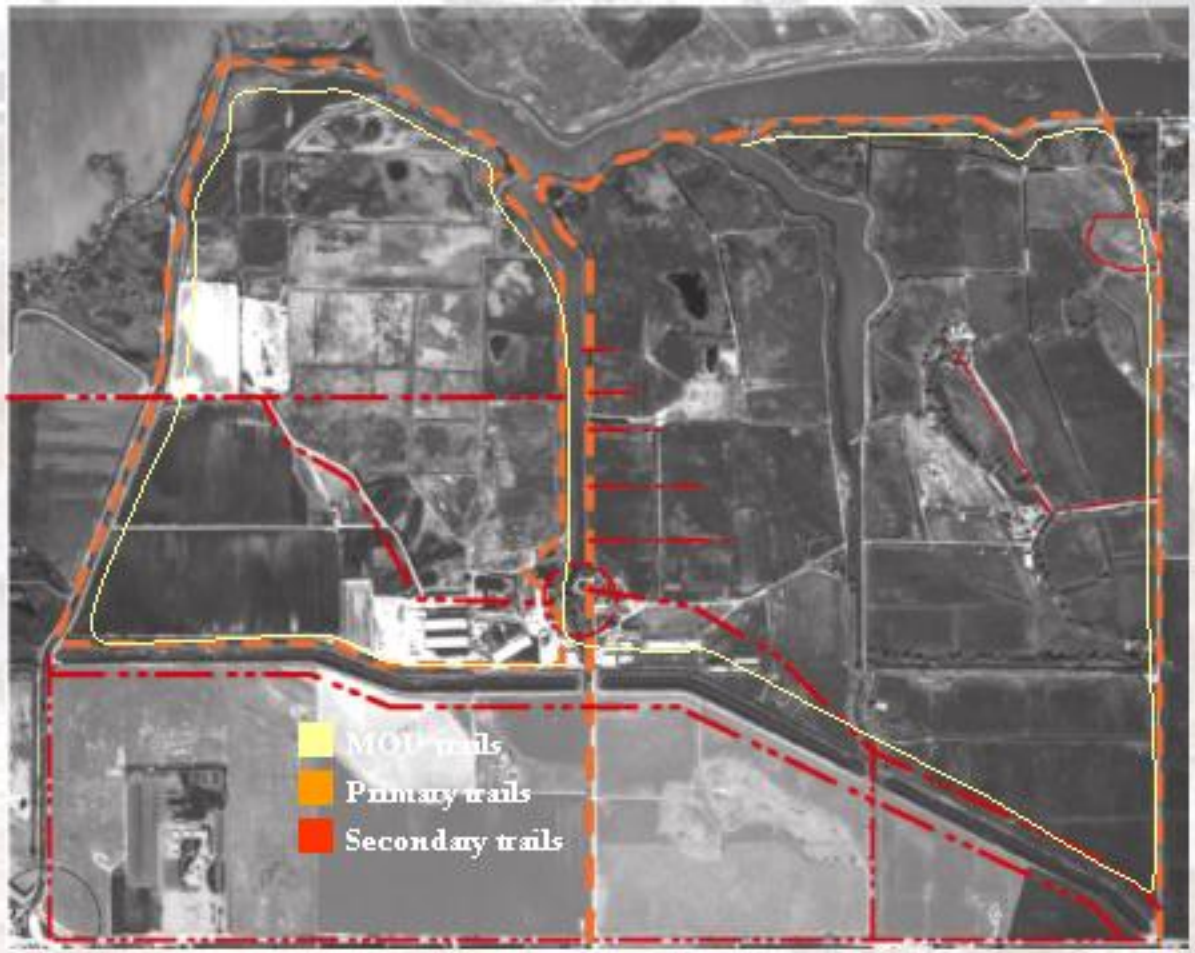
1. Increase habitat for target fish population
2. Prevent loss of property due to bank erosion
3. Help provide a continuous link between Mt. Diablo and the Bay Delta

Before

After

7 Create Connectivity with Trails

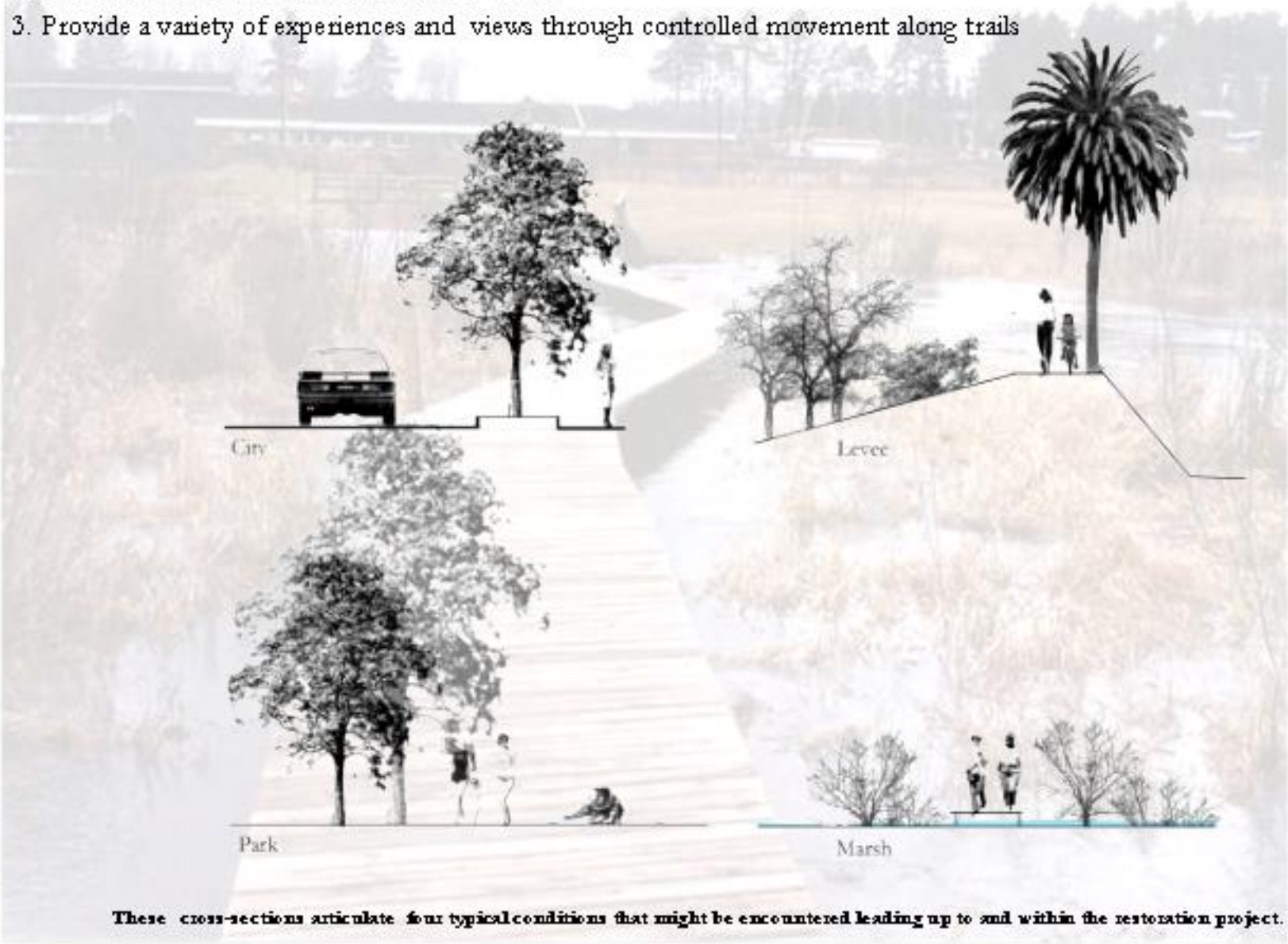
This trails plan uses the existing levee roads as the primary conduit for pedestrian and emergency vehicular travel. The system is further augmented with secondary trails that allow people to 'get down' in the marsh, providing a variety of experiences. These trails link to the community park through to the city. It will be possible to travel around the Emerson parcel and to walk around the western and northern edges of the Gilbert parcel. From there, a bridge is constructed over Little Dutch Slough to continue access along the shoreline of the Burroughs parcel.



The Memorandum of Understanding between the City and project partners outlines a perfunctory trail system that provides public access to the site but does not allow for a symbiotic integration of human and ecological systems. The proposed primary and secondary trails still leave a significant portion of the site dedicated to wildlife while allowing for a variety of experiences in around and through the constructed restoration.

Objectives:

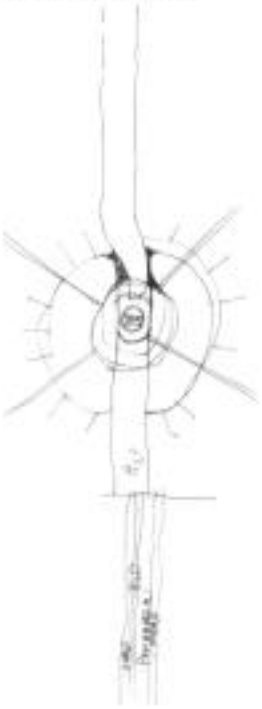
1. Provide public access to natural resources
2. Protect sensitive habitats from human traffic
3. Provide a variety of experiences and views through controlled movement along trails

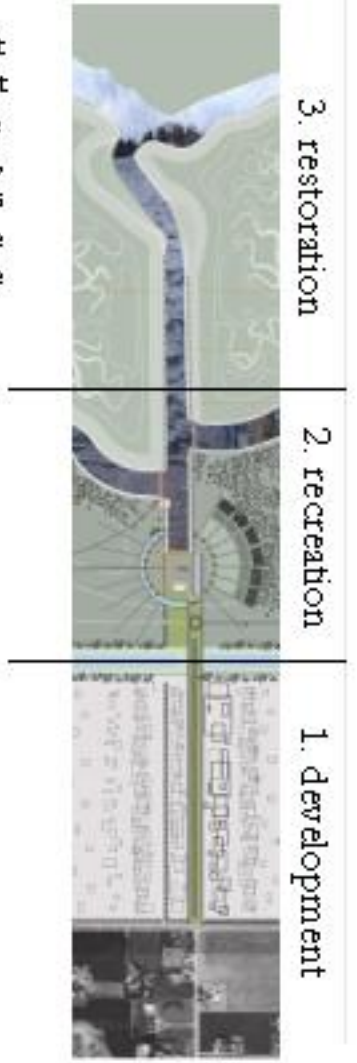


These cross-sections articulate four typical conditions that might be encountered leading up to and within the restoration project.

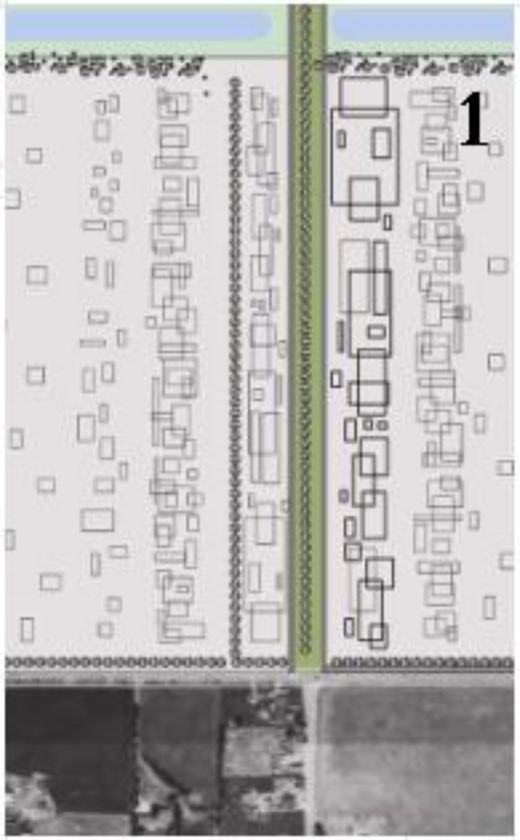
8 Create a Bridge Between City, Park, and Restoration Project

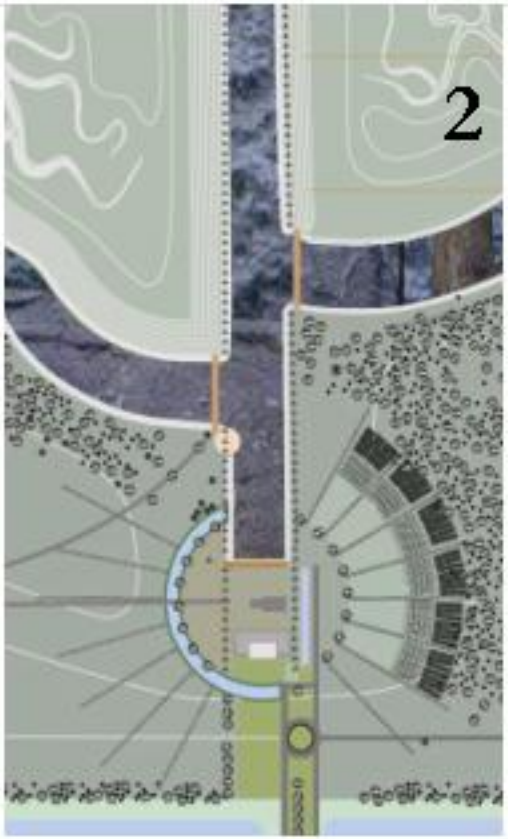
This design move identifies the heart of the project as the strip of land that runs from Dutch Slough through the community park to Cypress Road, creating a central spine of access along the eastern edge of the Emerson parcel and the western edge of the Gilbert parcel

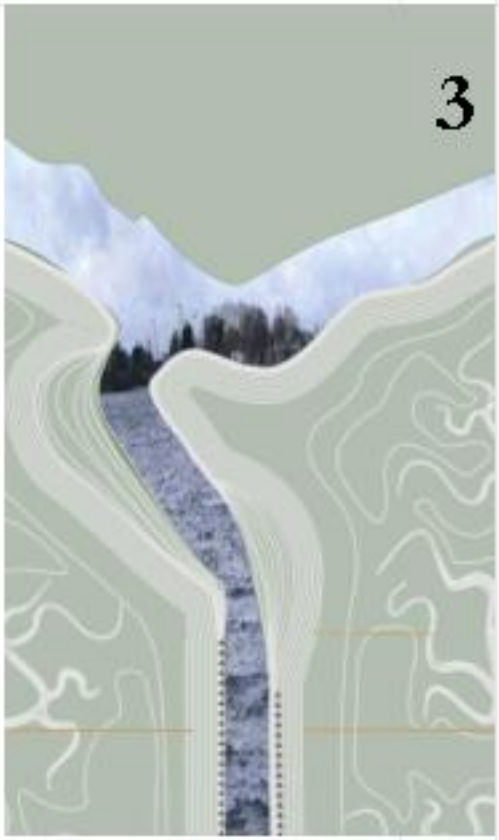




Cross-section through the area of study showing the transition from commercial corridor to park to restoration project



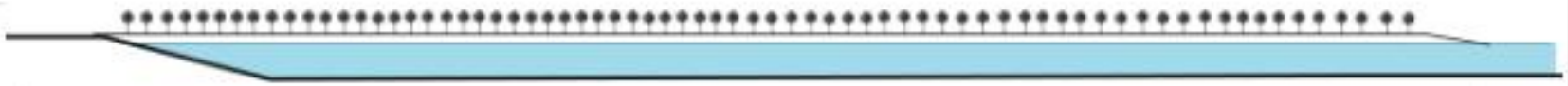




Three distinct land uses create a gradient of experience that defines the new development at Dutch Slough. A commercial corridor (1) provides the intensity of urban uses and acts as the threshold for a 55-acre community park and education center (2). The tidal marsh restoration (3) is the next experiential event, with Emerson slough acting as a connection to the entire Delta.

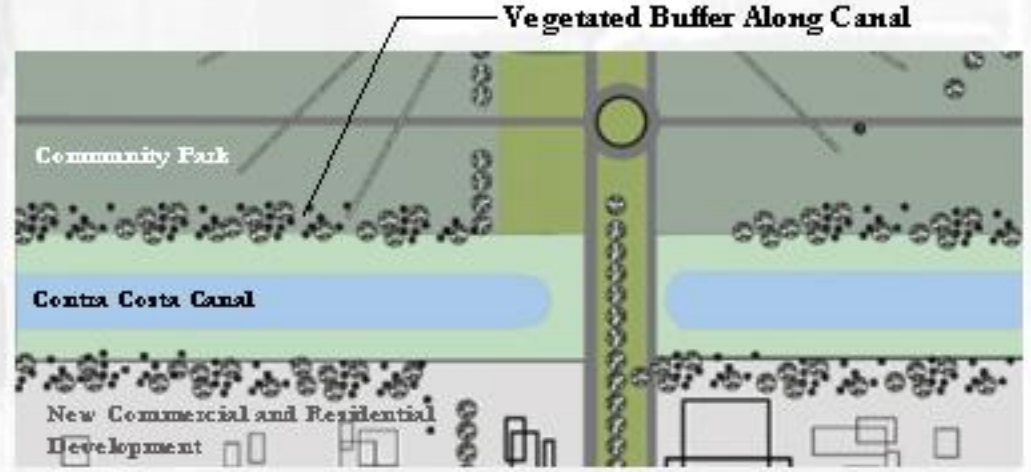
Objectives:

1. Identify the optimal access point to recreation and views
2. Enhance experience of entire project while concentrating activity to one area
3. Create framework for a fluid connection between human and natural systems



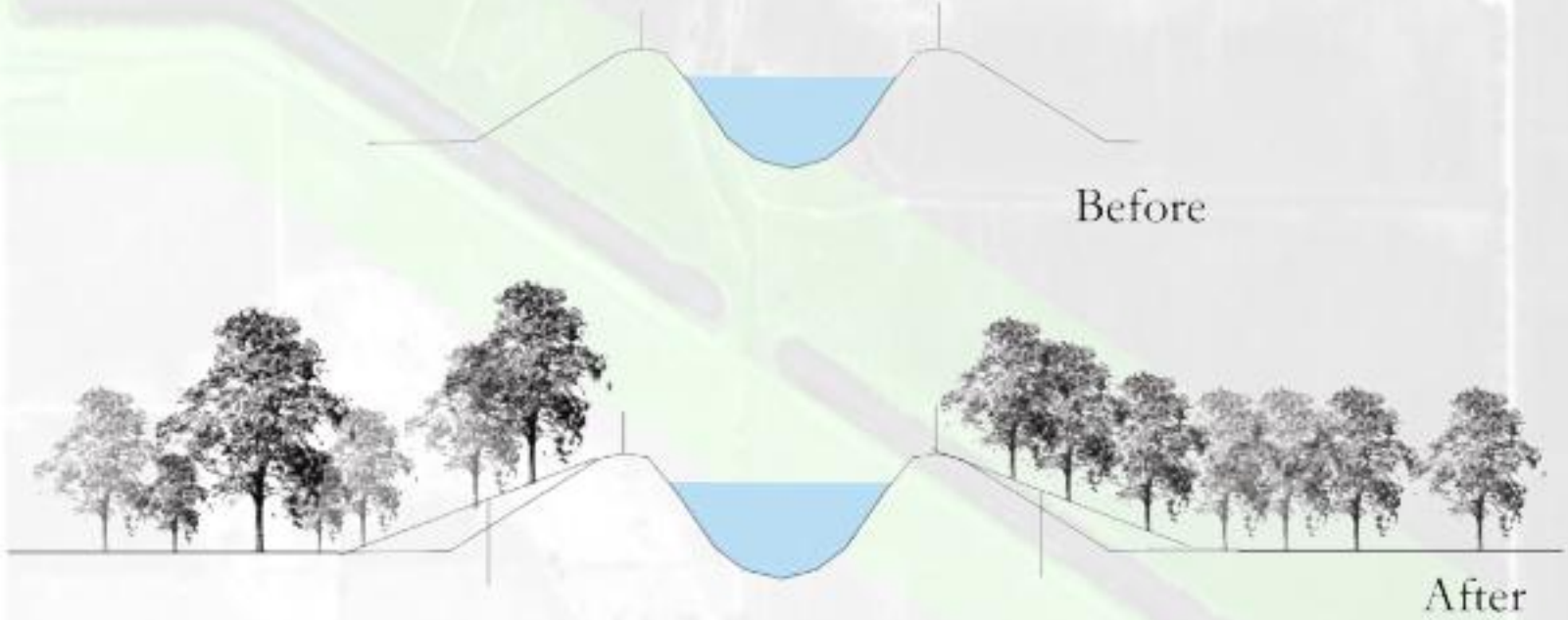
9 Buffer the Contra Costa Canal

The Contra Costa Canal provides drinking water to thousands of residents in Contra Costa county. Water quality in the canal is negatively affected by urbanization and farming activities adjacent to the canal. The water quality control board has placed restrictions on access to the canal in order to protect this important source of water. For the restoration project, the canal creates an important buffer limiting access to sensitive areas and directing traffic to a few key intersections. This design move enhances this buffering effect by using plantings to further separate public from private space in an aesthetic way. In-ground reactive barriers can be installed to help reduce the risk of water supply contamination. This buffer also provides space to extend the public trail system.



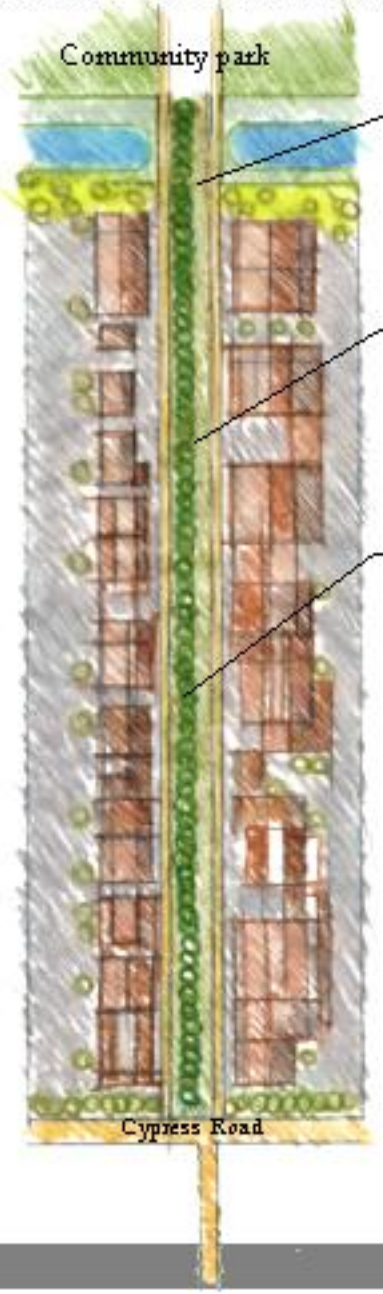
Objectives:

1. Protect berms from erosion
2. Filter polluted urban runoff
3. Keep foot traffic away from canal



10 Place Commercial Corridor Along Sellers Avenue

Extending the park into the city fabric can be accomplished by creating a 100' wide green median that would stretch from the park entrance to Cypress Road along what is currently Sellers Avenue. The strip is graded with a low point in the center, turning Oakley's new 'panhandle' into a giant swale designed to filter storm-water runoff and other urban pollutants and direct water to the center of the community park. Additionally, zoning the area as a commercial corridor along this new vegetated boulevard will amplify public activity and direct attention to the project.



Structured along Sellers Avenue, a new commercial corridor creates a visible entry to the community park.

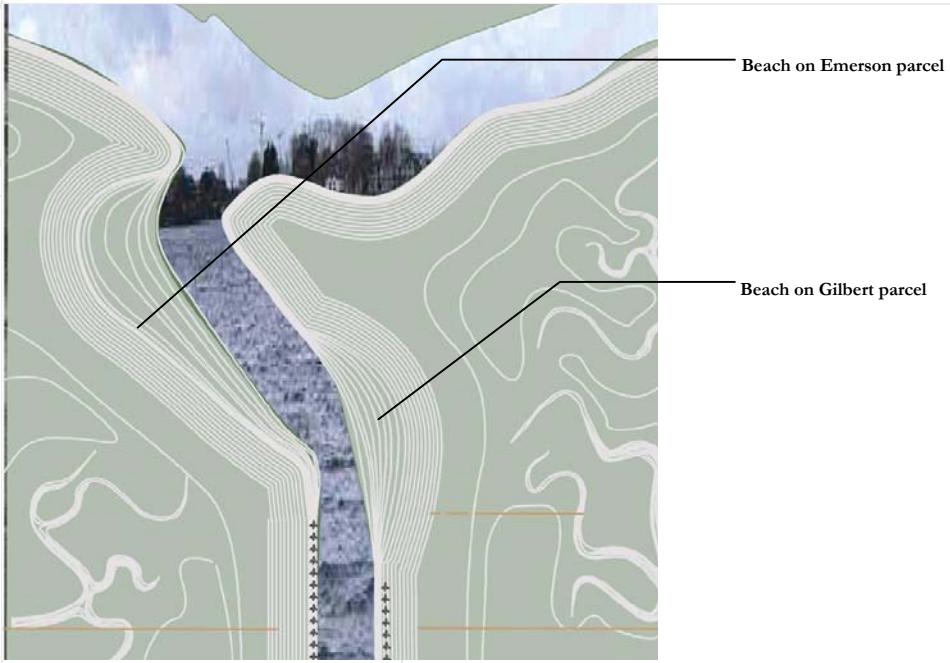
A 100' wide median based on the Panhandle case study extends the verdant atmosphere of the restoration project into the city fabric

The new greenway acts as a swale, directing water into the constructed remediation wetland in the park, cleaning stormwater before allowing it to travel into the Delta system.

Conceptual perspective looking down Sellers Avenue

Objectives:

1. Enhance visibility and awareness of park by introducing transitional corridor
2. Develop a hierarchy of experience



Objectives:

1. Increase habitat value

2. Create a public amenity

3. Provide more fill for interior restoration

Proposed view from the Gilbert levee trail to the Emerson beach

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