Unpaving the Way to Creek Restoration in Lower Sausal Creek Watershed:

Applying the EU Water Framework Directive to a US Urban Watershed

by Hong Li and Jane Wardani

Abstract

The European Union Water Framework Directive (WFD) provides a strategy for the protection, improvement and restoration of water bodies across Europe. However, in urbanized areas where the drainage network has been engineered for flood conveyance and floodplains have been densely developed, the cost of restoration is usually disproportionate to the ecological benefits such restoration would provide. This project applies the EU WFD to the densely urbanized Lower Sausal Creek Watershed in Oakland, California. While the WFD provides economic insight, recent popularity of stormwater intervention strategies in US urban areas offer alternatives to in-stream creek restoration with additional community benefits. Our Lower Sausal Creek Watershed Stormwater Management Plan addresses stormwater pollution and detention through small, cost-effective landscape features at the lot level. The strategies include retention/ conveyance swales with trees, neighborhood trees, large lot interventions and the use of native plants, which altogether would deal with 100% of 2-year storm events in the lower watershed as well as allow partial detention of larger storms.

Introduction

The European Union Parliament in 2000 enacted the Water Framework Directive (WFD). In response to increasing awareness of and concern for the need to provide a unified framework for the protection of European waters. The WFD provides a strategy for balancing human uses and ecological functions and values of water bodies, structured around the "three pillars" of participatory, basin-scale management, ecological recovery and cost-effectiveness. The WFD outline steps required of EU member states to define modifications to water bodies, set goals for attaining good ecological status, explore the cost-effectiveness of possible restoration measures, and develop and implement a river management strategy at the basin-scale.

A comparative analysis of the WFD and the legal and institutional landscape of the Russian River basin in California was instructive in identifying critical management strategies and recommending strategic changes to the American management regime (Grantham et al 2008). In particular, the theoretical application of the WFD to a US/California context provided lessons on improving the management of water bodies in the US/California. In the same light, this study sought to apply the WFD to a watershed in the US in order to glean a fresh perspective on the management of water bodies, specifically in urban areas.

Two elements relevant to urban areas are of concern: (1) Variations in hydromorphology and extent of modification among reaches within the same watershed, and (2) Social factors that need to be considered in urban areas supporting dense and diverse populations. In California and other places in the US, specifically, the participation of urban communities in creek and watershed management has facilitated implementation.

This paper applies the water body designation framework outlined by the WFD to develop a management plan for Lower Sausal Creek watershed, the most densely urbanized part of the watershed in the city of Oakland, California, in the San Francisco East Bay (Figures 1 and 2). The Sausal Creek Watershed are divided by transportation infrastructure into three distinct parts: the upper watershed upstream from Highway 13, the middle watershed between Highways 13 and 580, and the lower watershed between Highway 580 and the creek mouth at a tidal channel separating the island of Alameda and the city of Oakland (Figure 2). Sausal Creek remains in a natural setting in many reaches in the middle and upper watershed areas. However, the drainage network in the lower watershed has been engineered for flood conveyance and the floodplains developed for settlement (Figure 3). The City of Oakland Watershed Program, along with the local community creek stewardship group, Friends of Sausal Creek, has implemented creek and riparian restoration projects in the middle and upper watershed areas. The Friends of Sausal Creek has also been recognized by government agencies to be critical partners in the management and stewardship of the creek and watershed (Friends of Sausal Creek website, accessed April 2008). However, creek restoration in the lower watershed face challenges such as high costs, especially the cost of acquiring private property and community opposition to daylighting underground culverts, as occurred in 1997 (Sanborn Park Master Plan 1998).

We use the Lower Sausal Creek watershed as a case study of how the WFD would apply to such an urban stream. At the same time, we explore Low-Impact Development (LID) storm water intervention strategies recently popular in US cities such as Portland, Oregon and San Francisco, California, as an alternative to cost-prohibitive creek restoration in urban areas. (In this paper, creek restoration refers to channel reconstruction to remove engineered structures, mainly within the creek channel.) The management plan we propose for Lower Sausal Creek watershed consists of LID strategies to address water management problems in urban areas including flashy runoff and water pollution from non-point sources. LID strategies can detain and filter storm water, and provide quality-of-life benefits to urban communities. While we focused on the lower watershed of Sausal Creek, we only did so to address the critical challenges dense urban development presents. From our observations, urban development in the upper and middle watershed areas has resulted to similar changes in hydromorphology, and we suggest that a watershed-wide application of strategic LID interventions could benefit the long-term health of the creek and watershed.

Analytical Framework

Based on the WFD, we use the following steps to analyze the Lower Sausal Creek watershed (Grantham et al 2008, Appendix B):

1. Identify changes in hydromorphology due to physical alteration by human activity
2. Assess ecological impact of changes in hydromorphology
3. Consider possible restoration measures
4. Cost-benefit analysis

5. Develop watershed management plan

Methods

As part of an intensive, UC Berkeley-Portugal workshop exploring the WFD, students and professionals of Urban Design, Landscape Architecture and Environmental Planning, and City and Regional Planning from UC Berkeley and Portugal collaborated on this project. In the three days available to us, we employed a variety of data collection methods. We referred to previous studies of the Sausal Creek watershed to understand historical changes to creek ecology and hydromorphology due to urbanization. Examples of LID storm water interventions from the San Francisco Public Utilities Commission (SF PUC) and the Bay Area Stormwater Management Agencies Association (BASMAA) informed our selection of interventions at the lot level (SF PUC 2007, BASMAA 1999). A previous study comparing the WFD to a California context demonstrated how such an application can yield instructive lessons on the management of waterbodies (Grantham et al 2008). Geographic Information Systems (GIS) shapefiles and the Creek and Watershed Map of Oakland and Berkeley from the Oakland Museum of California (Sowers 2000) were available for selected data including parcels, land uses, and creek conditions. Finally, we visited the Lower Sausal Creek watershed and photo-documented problem areas.

Summary analysis of sites

In this section, we describe the location, land uses, creek conditions, and social factors in the Lower Sausal Creek watershed. Lower Sausal Creek watershed is located in

Oakland, California within the Fruitvale district. The Fruitvale district is made up of high-density residential, commercial and industrial uses, with about 90% of the surface area rendered impervious by urban development.

Unlike the upper and middle watershed areas where the creek is open in many reaches and preserved open space (e.g. Joaquin Miller Park and Dimond Canyon Recreation Area) buffer riparian corridors, the creek in the lower watershed has been mostly channelized and put underground, with development occurring right to the edge of the creek or even over the creek. Out of about 2.5 miles of waterway, most of the creek (63%) has been put in underground culverts as part of the city's storm drain network, or channelized in concrete control channels above ground (16%), while open unengineered reaches consist of only 22% of the total length and are visually and physically inaccessible behind private property (Figure 3). The invisibility of the creek in the lower watershed has been identified as a perceptual barrier to getting residents involved in stewardship in this watershed (Wardani 2008).

Socio-economically, residents of the Fruitvale district in Lower Sausal Creek watershed are predominantly Latino, but also represent a diversity of other races, including African-Americans, Asians, and others, while whites make up a minority. Income levels are generally at or below the California Median Household Income for 1999 (Figure 4). Creek stewardship has not been highly prioritized by Fruitvale residents, perhaps due to the community's economic limitation and other more pressing concerns.

Results and Discussion

In this section, we (1) discuss our findings on how changes in hydromorphology may have adversely affected ecological health, (2) consider the cost-effectiveness of two possible restoration measures (namely creek restoration/daylighting and LID storm water interventions), and (3) propose a plan for Lower Sausal Creek watershed that we hope can inspire creative thinking about restoring ecological values in urban watersheds.

(1) Changes in hydromorphology adversely affects ecological health

Using the WFD designation process, we first identify and describe changes to the hydromorphology, which we argue are due to physical alterations human activity (i.e. urbanization). Typical of urban watersheds, the Lower Sausal Creek watershed is impacted by four hydromorphological modifications that adversely affect ecological health (Kondolf 2001): (1) impervious surfaces resulting in increased runoff volumes and velocity, channel incision and bank erosion, (2) urban runoff/non-point source pollution resulting in poor water quality, (3) flood control engineering resulting in upstream-downstream disconnect of ecological habitat, especially for fish and other wildlife migration (Kondolf et al 2006), and (4) invasion of non-native plant species. In addition, the potential for creek stewardship by local communities is limited due to the lack of visibility of underground reaches, the perception of landslide danger, and crime.

Over a century of grazing in the hills and urban development in the watershed resulted in the high percentage of impervious surfaces. Rooftops, parking lots, sidewalks and paved roads, covered by impermeable materials such as asphalt, concrete, brick and stone, seal surfaces, repel water, and prevent precipitation from infiltrating into soils (Figure 5). The high percentage of impervious surfaces has increased the volume and velocity of runoff. Based on a calculation using both the rational and Rantz equations, peak discharge for the 2-year storm was more than twice as large in 1998 than in pre-urbanization conditions in the 1700s (Lowe 1998).

Although the increase in runoff is moderate compared to the increase predicted in Leopold (1968), it has caused severe bank erosion and canyon incision in all parts of the watershed. In the lower watershed, open natural reaches are 15-feet deep in some areas (Figure 6). Coupled with buildings right against the creek, the ecological habitat suffers from lateral disconnect between the channel and the flood plain. The reach below the Macarthur Freeway (I-580) has also seen a history of landslides, with a row of houses taken down in a severe landslide in the 1960s. The creek was seen as the culprit by the city and put in a culvert. The area was converted by the city into what is now known as Wood Park (Figure 7). Increased flood speeds and volumes and channel incision and bank erosion are perhaps related to the negative perception by residents on the flood plain, especially those whose homes are right on the edge of creek banks (Figure 8).

Urban runoff also produces non-point source pollution. In 1987, the US Congress passed an amendment to the Clean Water Act to focus more on addressing non-point source pollution (US EPA website, accessed April 2008). Unlike point sources, e.g. discharge from industrial and sewage treatment plants, non-point sources come from many diffuse sources that are not easily identifiable. When it rains, urban runoff moves over impervious surfaces and picks up and natural and manmade pollutants, such as oil from leaking cars, copper from brake pads, and household garden chemicals. These pollutants end up in the creek and eventually the Bay, designated in 1989 to be an impaired water body, in turn compromising the quality of water for fisheries, wildlife and contact recreation. Igor and Eisenstein (2000) documented the "unambiguous decline" of taxa richness and diversity from a tributary upstream in the upper watershed to the middle reaches of the creek, with the lowest values of the two indicators in the lower watershed (13). Toxic dumping and sewage spills occur rather frequently, the most recent example being a fish kill likely caused by contractors washing their paint brushes at a storm drain (Figure 9, Friends of Sausal Creek website, downloaded April 2008).

The creek's habitat conditions are worsened still by engineered alterations of the creek such as concrete channels and underground culverts. Although the Friends of Sausal Creek have found native trout, these fish mainly live in isolated pools, for example below culvert drops (Figure 10). Traditional engineering approaches pursuing single-objective flood control projects eradicated aesthetic and wildlife habitat values of urban creeks (Kondolf and Keller 1993). Culverts under roads disconnect open reaches, impeding fish migration. This longitudinal disconnect can be considered poor habitat quality (Igor and Eisenstein 2000). Visual disconnect has also made it difficult to engage watershed residents on the value of the creek and preventing urban runoff pollution. At the mouth of the creek in a tidal channel separating the island of Alameda and the city of Oakland, dumping is common, perhaps testimony to people's perception of creeks and water bodies as dumping ground rather than a resource.

Not only has urbanization resulted in aquatic habitat degradation, the watershed's native plant diversity has also been replaced, in many areas, by exotic species including Algerian and Cape ivies, broom, eucalyptus and acacia. Invaded by these non-native species, riparian corridors are likely to provide habitat to a smaller diversity of wildlife (Figure 11). Increased impervious surfaces, channel incision and bank instability, channel engineering, urban runoff pollution, and invasive species have all contributed to both the degradation of ecological habitat and the visual disconnect between people and the creek.

(2) Cost-effectiveness of creek restoration vs. LID strategies

In this section, we consider the cost-effectiveness of two possible restoration measures, creek restoration including daylighting, and LID storm water intervention strategies. According to the WFD, cost-effectiveness is an important criteria when considering possible restoration measures. If we follow the designation process of the WFD, urban creeks would be considered highly modified water bodies, where the potential for ecological restoration is limited. Mitigation measures also must not have a significant adverse effect on the specified uses or the wider environment (Grantham et al 2008, Appendix B). There is therefore little potential for ecologically restoring creeks in such urban areas as the Lower Sausal Creek watershed.

We hypothesize that creek restoration and daylighting projects can incur costs disproportionate to the ecological benefits they perform. Here we assess the limited benefits of creek restoration: Although creek restoration can help address problems with longitudinal disconnect in ecological habitat, culverted reaches, for example under roads, still hinder full connection. Lateral reconnection may also be difficult to achieve due to the deeply incised channels of Sausal Creek and property along creeks. Creek restoration is also not likely to address increased runoff volumes and velocity as it does not reduce impervious surfaces. Research has also shown the limited ecological value of urban creek restoration (Kondolf and Yang 2008).

Considering the suite of storm water intervention tools, SF PUC puts the cost of creek daylighting at $3,000 per linear feet, while the volume of runoff held is unknown (SF PUC 2007). Daylighting undergrounded reaches (about 7,990 feet) would in the Lower Sausal Creek watershed would cost approximately $24 million, not including the cost of acquiring creekside property that have been built too close. Moreover, as the Sanborn Park redesign process in 1997 shows the community is not always amenable to daylighting creeks due to the perception and fear of crime. Creekside property owners are also not always willing to sell their property or be displaced for such purposes. Creek restoration in urban areas, at least in the short run, is not always justifiable, ecologically, economically and socially.

In turn, we consider a set of alternatives for mitigating hydromorphological changes in urban watersheds, namely LID storm water interventions. Such interventions have been recently popular in US cities such as Portland and San Francisco, as well as in Europe. The basic principle of LID is to manage rain where it falls using distributed micro-scale controls, for example at the lot level. Through small, cost-effective landscape features, such as swales and trees, LID strategies slow down storm water, increase permeability by using pervious surfaces, and at least partially filter storm water runoff pollution. Incorporating native plants into landscape features also contribute to the restoration of fauna diversity. Furthermore, LID strategies can be done incrementally, starting with landscape features on public right-of-way such as sidewalks and street medians (BASMAA 1999, SF PUC 2008). We show in our plan below that LID can be a viable approach to managing problems in urban watersheds such as those we outline above. In addition, adding trees in a relatively tree-poor neighborhood can also add quality-of-life benefits such as walkable and pleasant sidewalks. The conceptual cost-benefit comparison is presented in Figure 12. For our LID approaches, we provide costs based on figures estimated by SFPUC (Appendix 2).

<u>Unpaving the way to urban creek restoration: An urban watershed management plan</u>

Based on the urban watershed problems of impervious surfaces, increased runoff volumes and channel incision, and urban runoff pollution, our main strategy involves reducing the volumes of flow into the creek by (1) increasing permeability to allow filtration and partial treatment, (2) slowing down storm water before they enter the creek or storm drain by conveying it through vegetated swales, (3) planting trees to reduce the force of rainfall, (4) providing detention storage for larger storms (Figure 13). Our plan for Lower Sausal Creek watershed treats and/or handles 100% of rainfall in the lower watershed and allows additional rainfall from larger storms, assuming a design rainfall of 2.5 million cubic feet, which is the 1-inch, 2-year storm (Figure 14).

Specifically, we propose three sets of strategies that can be implemented incrementally, based on community acceptance and financial availability:

(a) Detention/conveyance swales with trees along wide streets parallel down to the creek

Designed to divert storm runoff from narrower streets in residential areas in the outer parts of the watershed, we identified two possible parallel conveyance routes: Fruitvale Ave (the main commercial drive of the neighborhood) east of the creek, and wider neighborhood streets west of the creek, such as Sheffield Ave, E 29^{th} St and 25^{th} Ave. These alternative retention conveyance swales slow down storm water before having to enter the creek or storm drain (Figure 15). In addition to the benefits of slowing down and partially treating 1.3 million cubic feet, or about 50% of the design rainfall (assuming an infiltration rate of 0.5 inch/hour), vegetated swales and trees also provide neighborhood amenity and greenery. Swale dimensions, site plan and cross section design are presented in Figure 16. Our calculations for all strategies are shown in Appendix 1.

(b) Neighborhood trees for the series of cul-de-sacs abutting into creeks

We propose planting trees to intercept rainfall, coupled with small storage/treatment cubes, to slow down and partially treat 16,000 cubic feet of water, by planting an average of 8 small trees per cul-de-sacs leading to the creek (Figure 17). Although this may seem like a small proportion of storm water, trees act as the first barrier to slow down falling rain and can store gallons of water in its mass. Tree and cube dimensions, plan and cross section are shown in Figure 18, calculations in Appendix 1.

(c) Large lot interventions including commercial parking lots and schoolyards (Figure 19)

The purpose of our large lot interventions include increasing permeability of surfaces, partially filtering and treating storm water, and storing large storm overflows for possible reuse (e.g. irrigation and flushing toilets). Our integrated approach would convert a prototypical 500,000-square-foot lot from being 100% impervious with a high C factor of 0.9, to partially permeable surfaces with a weighted average C factor of 0.61. Using a combination of permeable pavement (on about 60% of the lot), eco-roofs typically covering 20% of the lot area, and bioretention areas on about 20% of the lot area, this strategy could contain and partially treat about 1.3 million cubic feet of water, or about 60% of the 2-year design rainstorm. In addition, an underground storage cistern under layers of pervious material (pervious pavement, gravel and sand could offer a storage capacity of about 4 million cubic feet of water in case of large storms and to handle additional water from upper and middle watershed areas (Figure 20).

Cost of proposed restoration techniques

Conclusion

To summarize, we refer back to the three pillars of the WFD, namely ecological status, cost-effectiveness, and governance. In terms of ecological status, the potential for improvement or restoration is limited in urban in the short-term. Creek restoration may be more feasible as a long-term ecological goal. In terms of economy, our analysis suggests that LID measures may be more cost-effective than creek restoration/daylighting in the short-term. Creek restoration may incur disproportionate costs to the current specified uses (urban development), and may also have social costs associated with displacement of communities. The WFD also highlights the importance basin-wide governance, where a holistic management needs to not narrowly focus on the creek itself, but also consider land uses in the watershed that have caused adverse changes to the hydrologic regime and ecological health with increased impervious surfaces and non-point source pollution. As well, the management of urban watersheds inherently necessitates the consideration of social factors and public participation to ensure the effectiveness, equity, and appropriateness of management decisions. The WFD has provided a fresh perspective in considering the ecological potential of highly modified water bodies such as those in urban areas and the cost-effectiveness of possible restoration measures. The US case study itself provided a useful lesson in integrating social needs and participation by watershed communities for better governance of urban watersheds.

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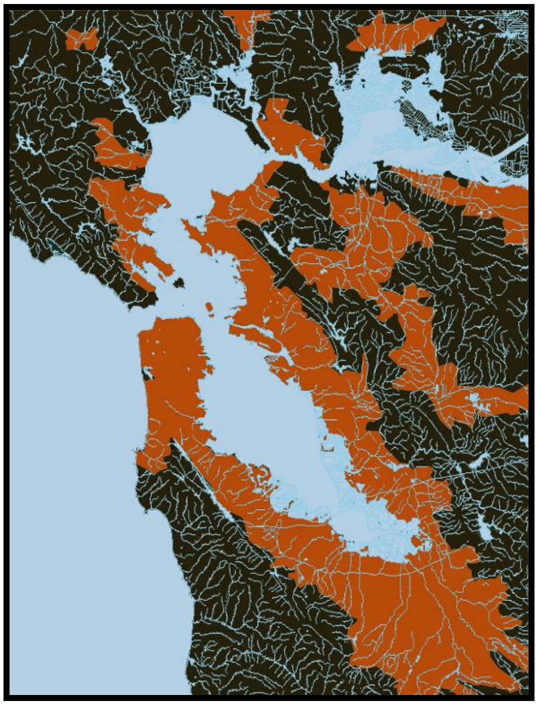
Figures

Figure 1: Urbanized areas in the San Francisco Bay Area



The red indicates the urbanized area of San Francisco Bay (redrawn from USGS 1990).

Figure 2: Sausal Creek watershed with lower watershed shaded

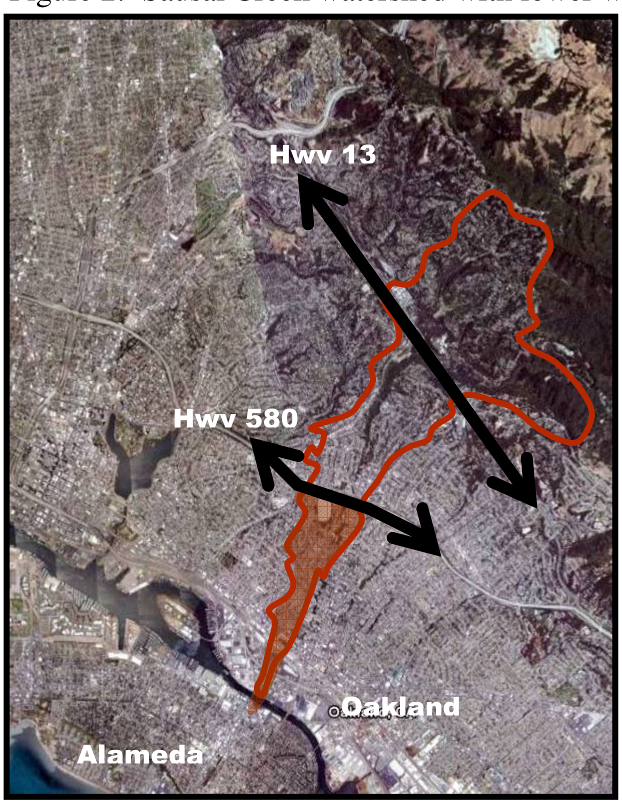


Figure 3: Existing physical conditions of lower Sausal Creek. Within the lower watershed area, there are 2,820 (22%) feet of open unengineered channel, and 1,985 feet (16%) in concrete channel, 7,990 (62%) feet in culverts.

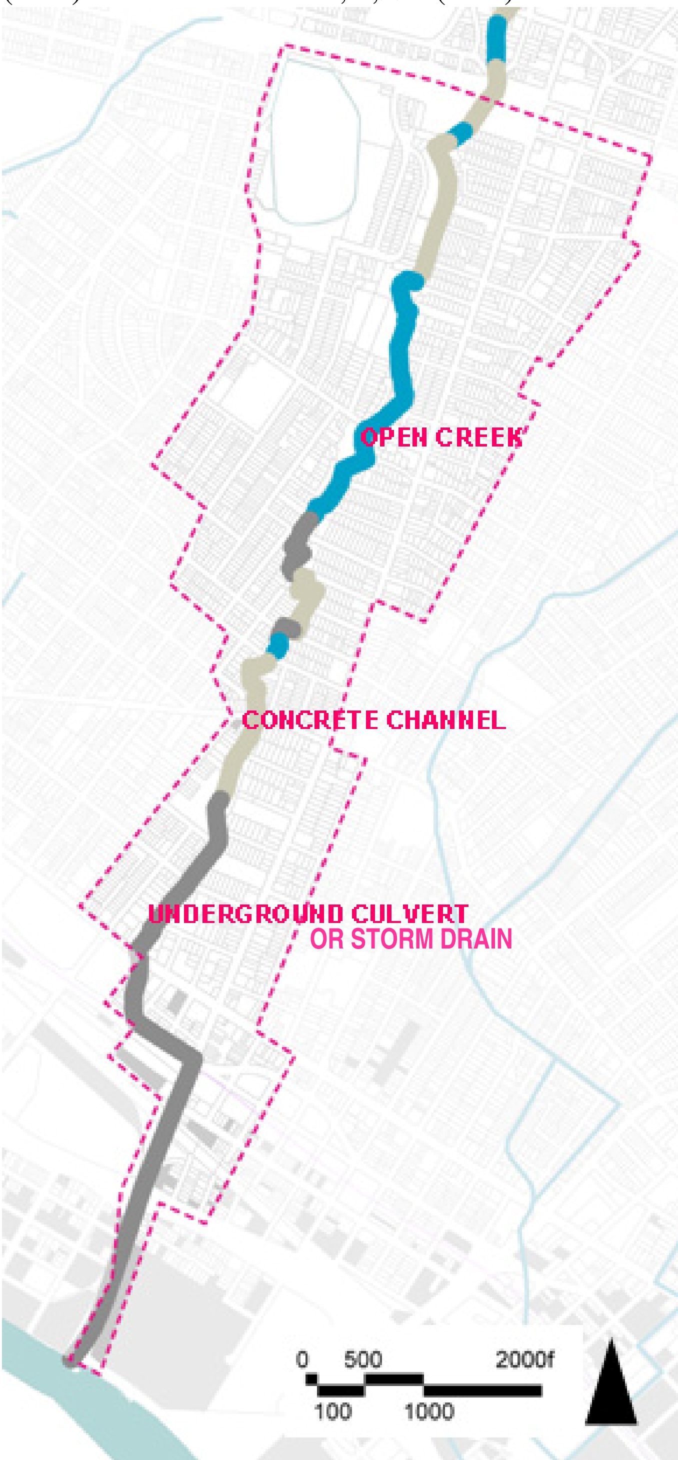


Figure 4: Socio-economic indicators in Lower Sausal Creek watershed

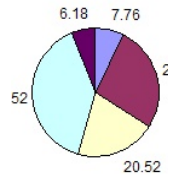
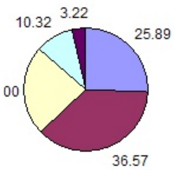
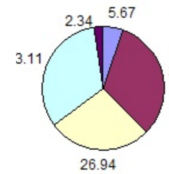
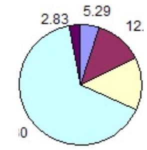
Census Tracts	4065	4064	4063	4062.02
Population	6,262	2,267	4,401	5,084
Median Household Income (1999 $)	34,283	48,618	29,849	33,277
Ethnic Composition 				
Language Isolation (%)	17.2	11.1	21.2	33.6
Bachelor's Degree or Higher (%)	14.7	28.5	8.1	9.9

Figure 5: Dominance of impervious surfaces

Figure 6: Deeply incised channel and eroding banks in Lower Sausal Creek watershed

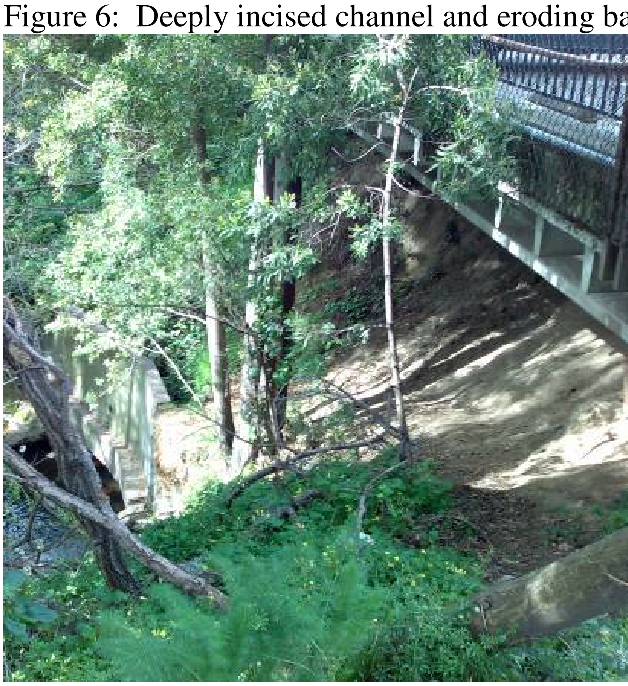


Figure 7: Creek under Wood Park, in place of row of houses after landslide in 1960s

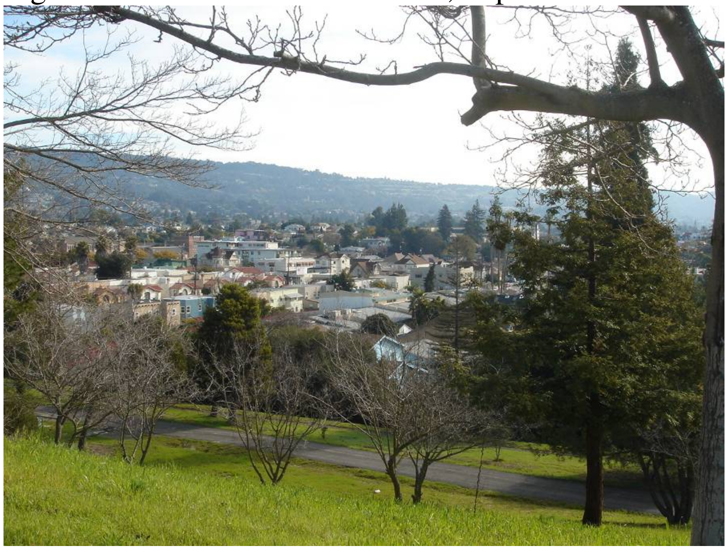


Figure 8: Landslide in 2006 took down 2 houses along McKillop Street

Figure 9: Fish kill in Sausal Creek in February 2008
(Photo by Kristina Cervantes-Yoshida)

Figure 10: Concrete channel and culverts

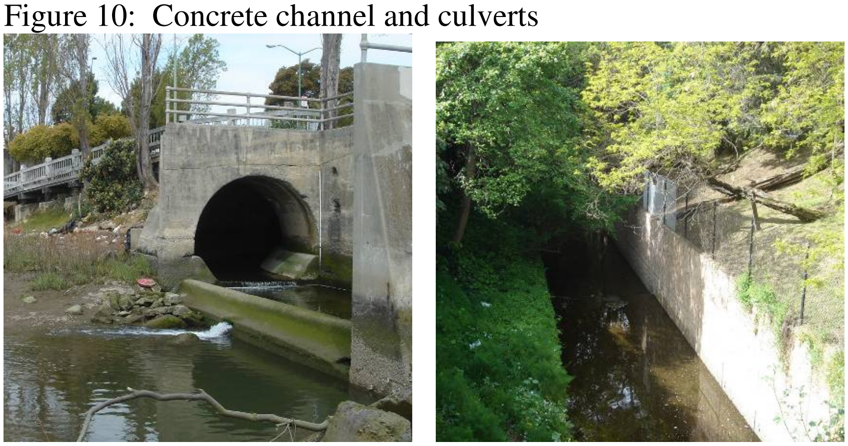


Figure 11: Non-native species: Eucalyptus, ivy, French broom

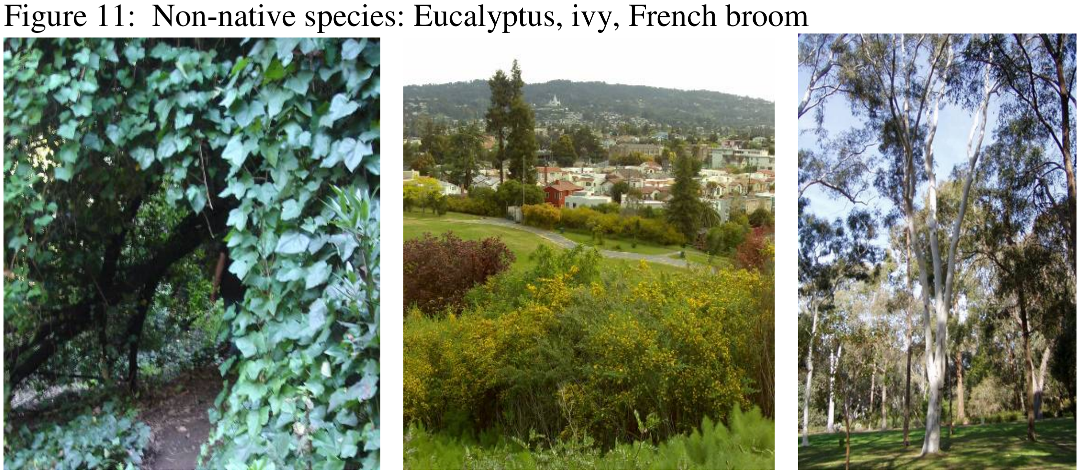


Figure 12: Cost-benefit analysis of possible restoration measures

MEASURES / PROBLEMS ADDRESSED	Increased Runoff Volumes & Velocity	Nonpoint Source Pollution	Invasive Species	Upstream-Downstream Disconnect
Creek Restoration	◐	○	●	●
Low-Impact Development	●	●	●	○

Both measures need to include
- Public Involvement and
- Native Plant Restoration

MEASURES / COSTS	Construction	Property Acquisition	Cost-Benefit Ratio
Creek Restoration	$$	$$$$$	Disproportionate
Low-Impact Development	$$		Reasonable

(calculations of costs provided in Appendix 2)

Figure 13: Conceptual plan

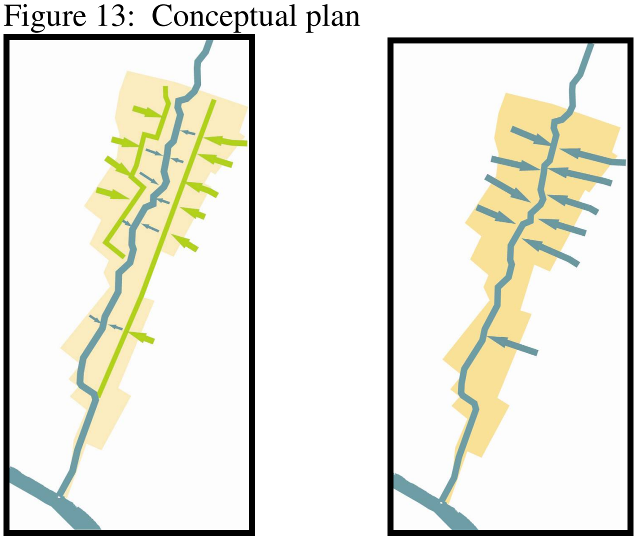


Figure 14: Lower Sausal Creek Watershed Management Plan

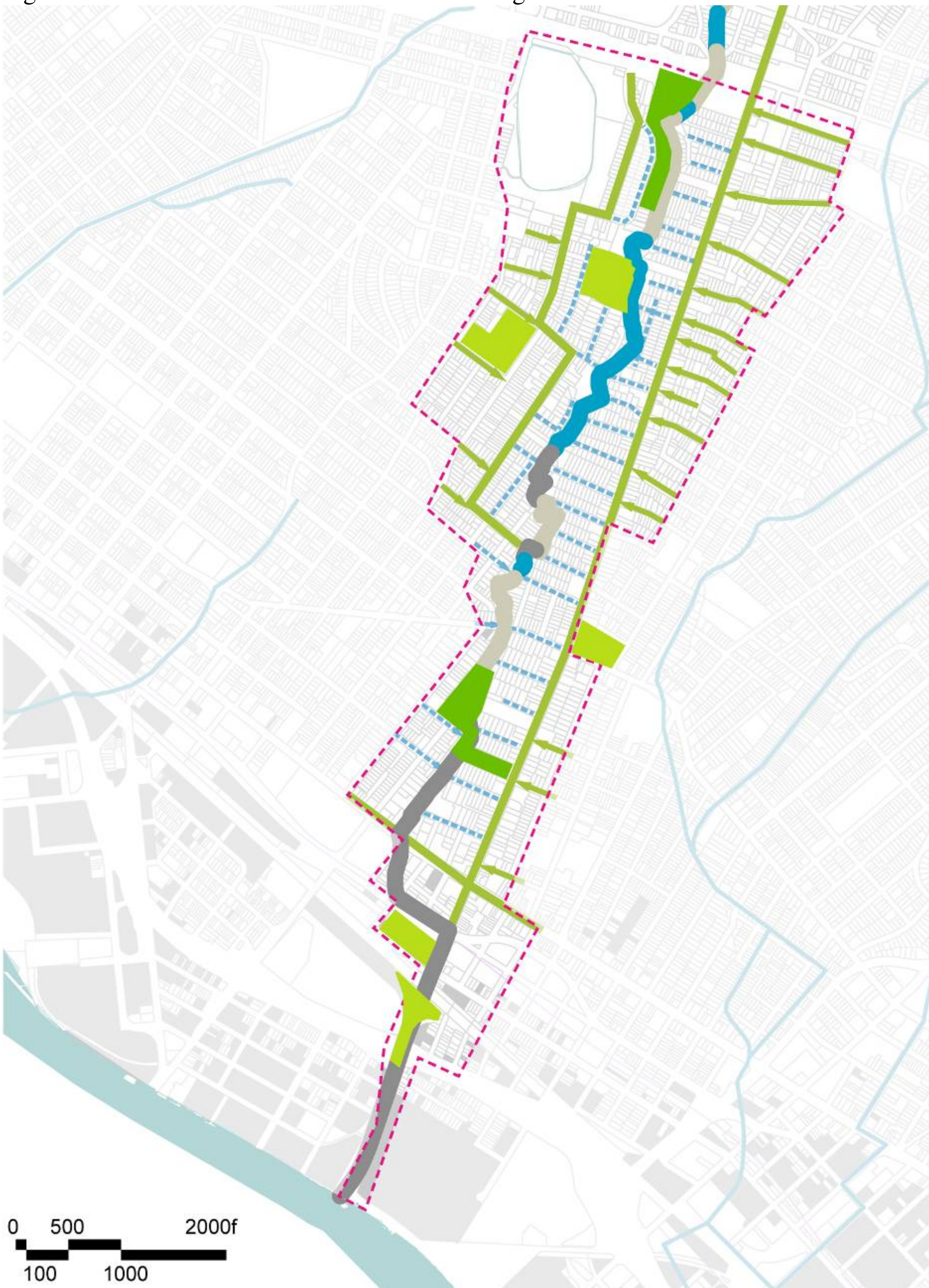


Figure 15: Strategy 1: Location of swales with trees

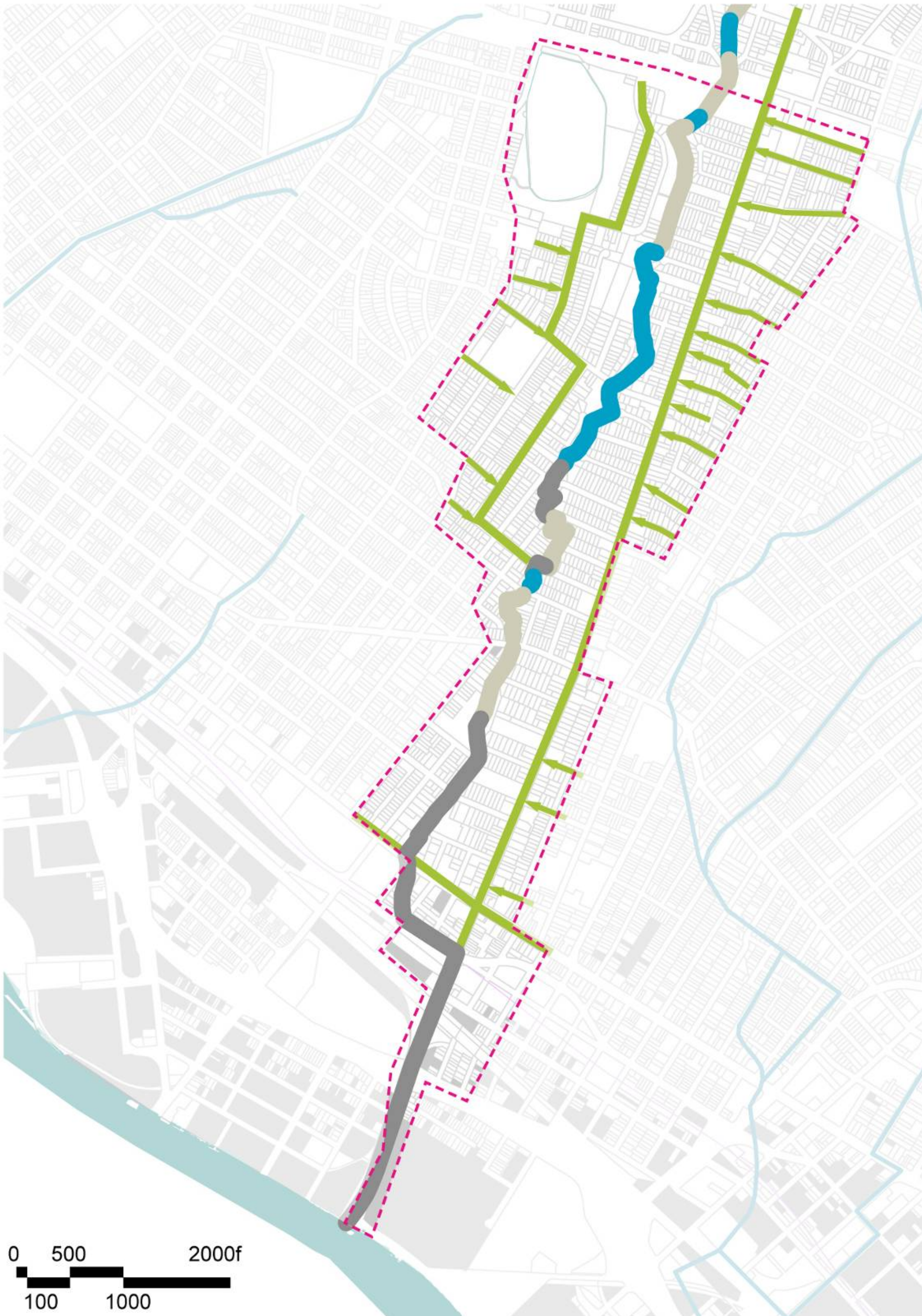


Figure 16: Strategy 1: Dimension, plan and section

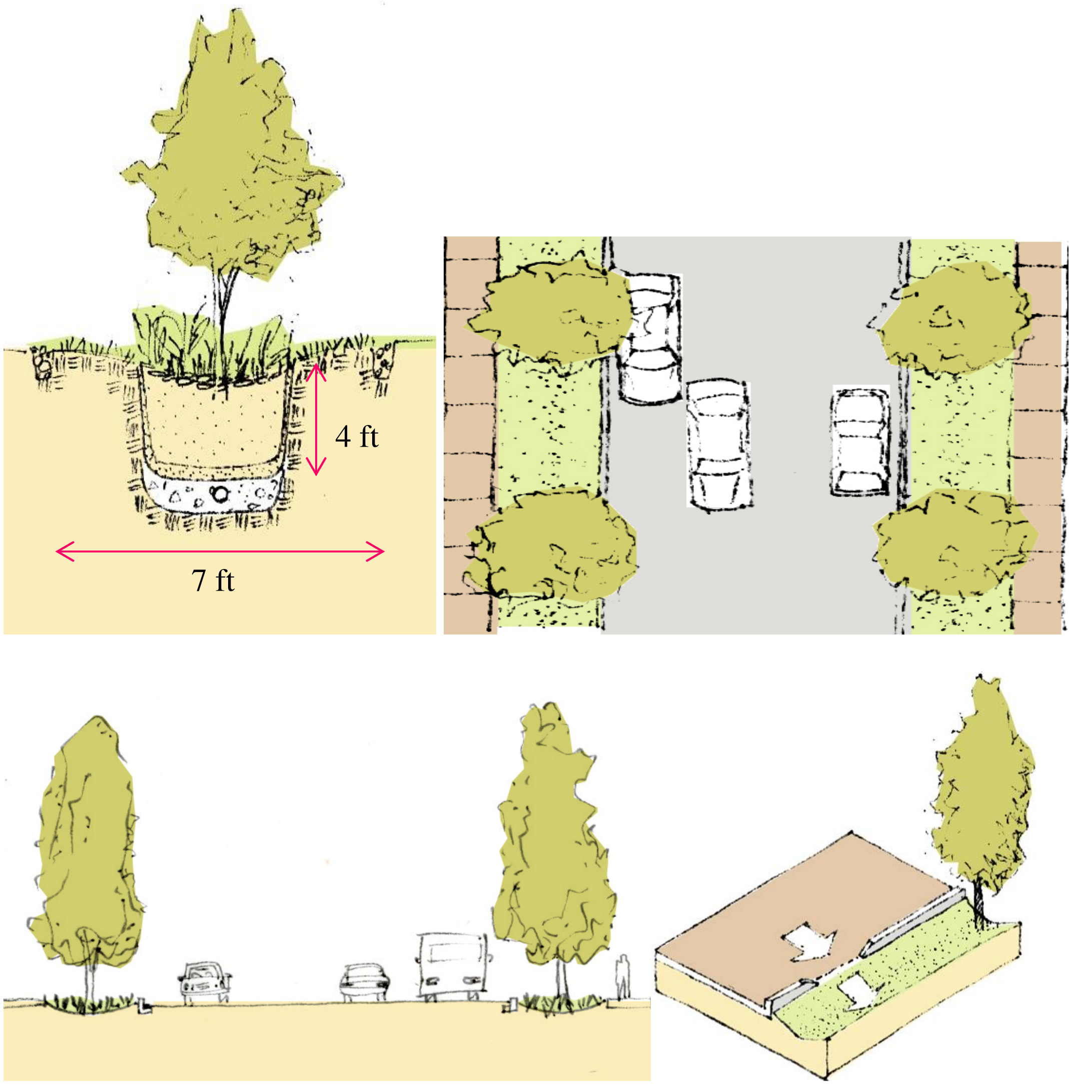


Figure 17: Strategy 2: Location of neighborhood trees with detention cubes

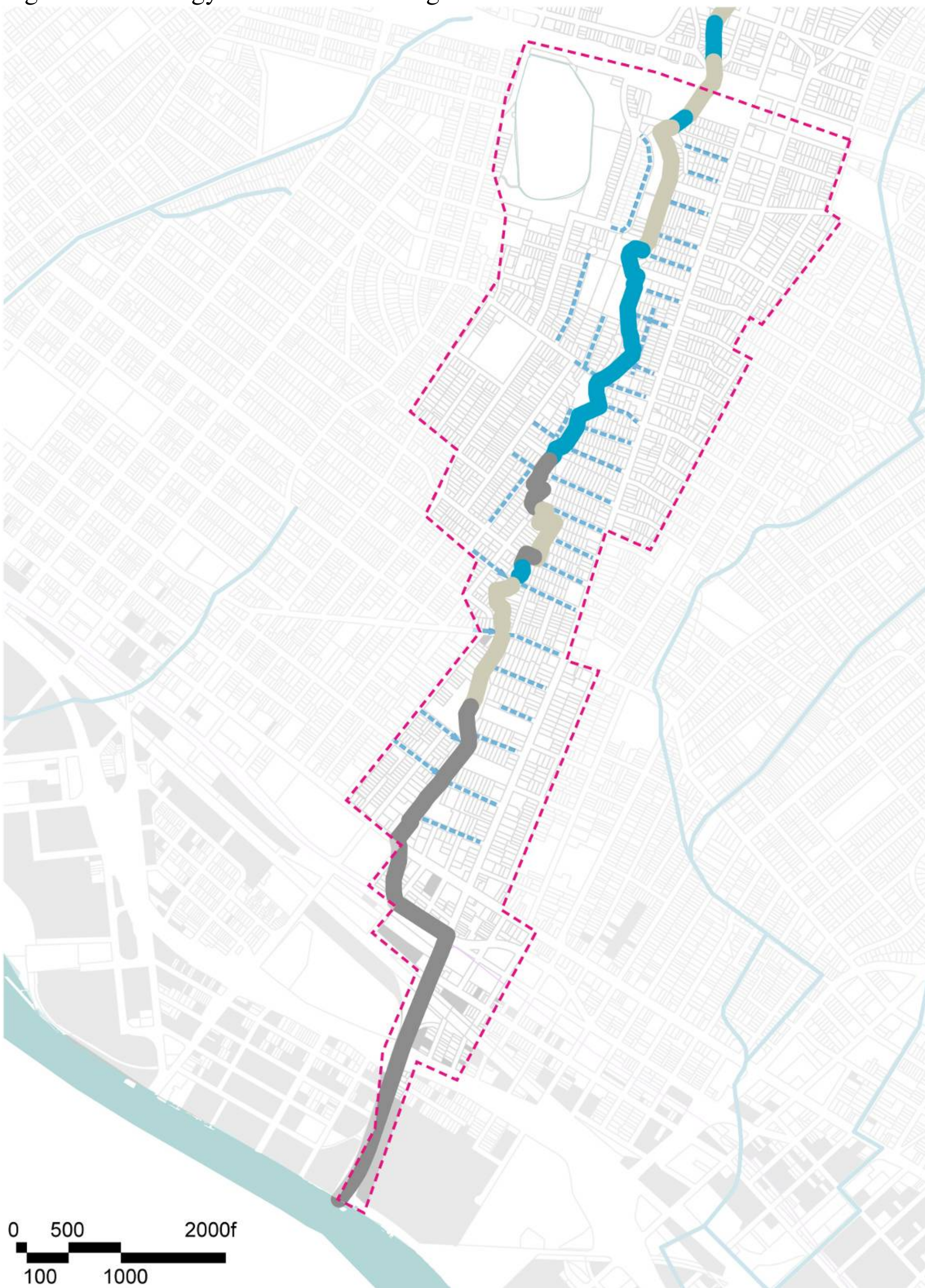


Figure 18: Strategy 2: Dimension, plan and section

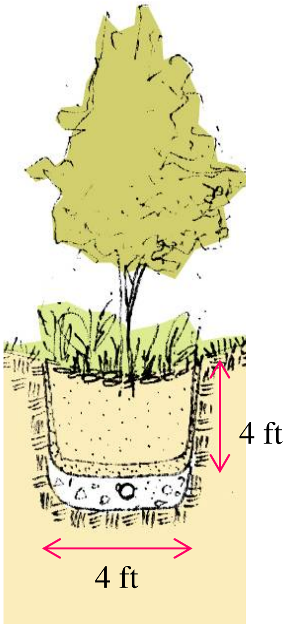


Figure 19: Strategy 3: Location of large lot interventions

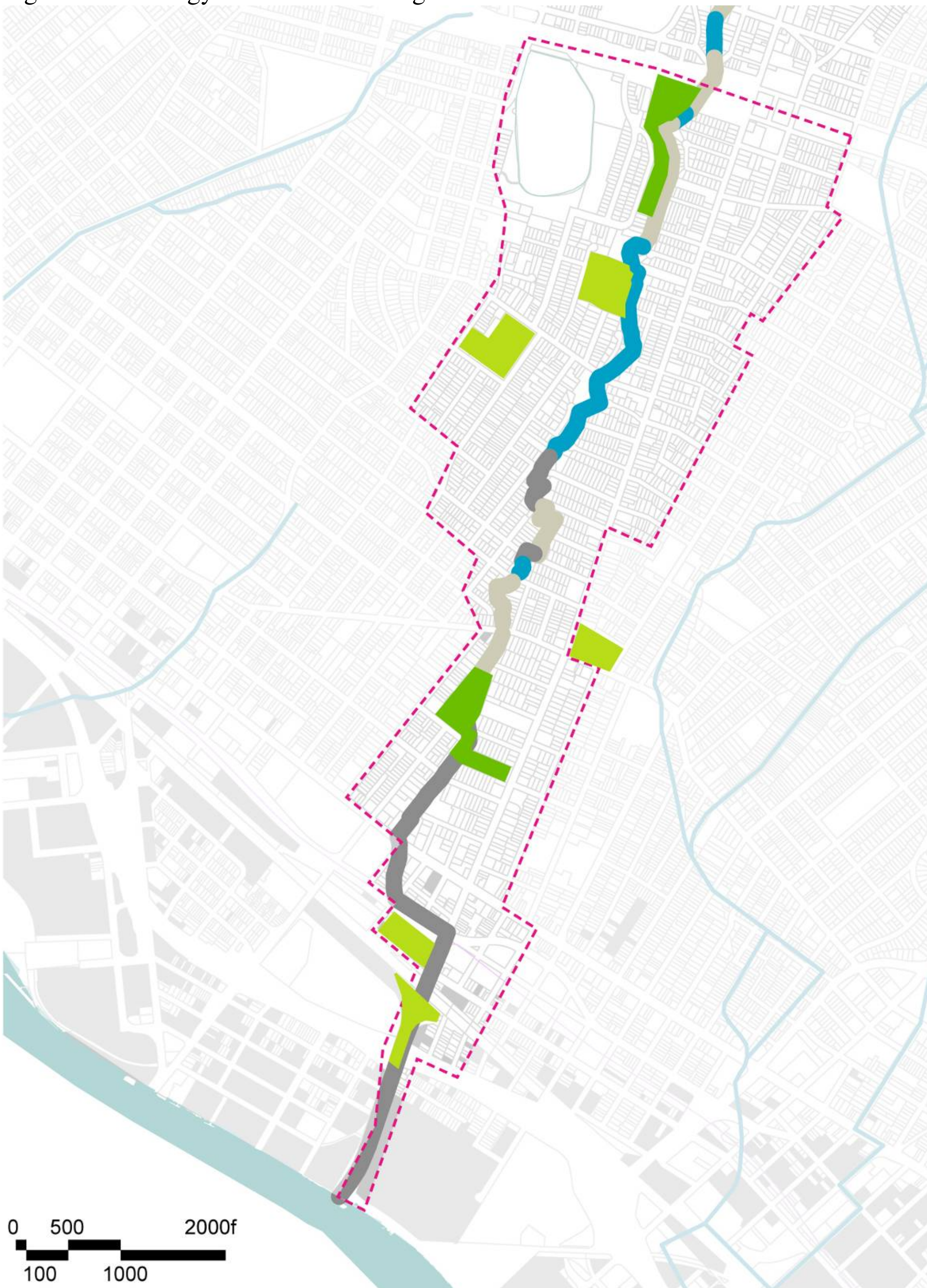
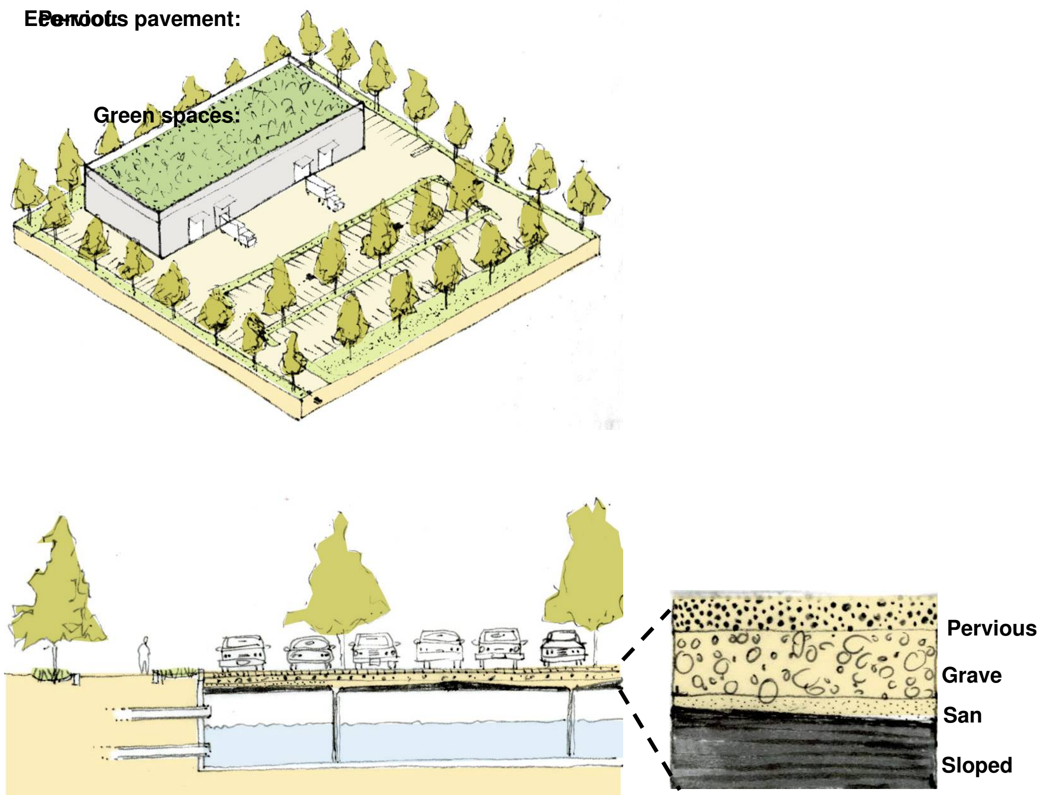


Figure 20: Strategy 3: Perspective and section



Appendix 1: Storm Water Calculations

			Area (sq. ft.)	C	Rd (ft)	V (cubic ft)
Design Volume			34,000,000	0.9	0.083333	2,550,000
Interventions	**Units**	**Dimensions**				
(1) Trees along bioretention/ conveyance swales						
Large trees	1,070 trees	2.29 gallons per tree*				326
Bioretention/conveyance swale along commercial street	17,580 feet	7' wide x 4' deep; 2 rows	246,120	N/A	N/A	984,480
Bioretention/conveyance swale along neighborhood streets	11,600 feet	4' wide x 4' deep; 2 rows	92,800	N/A	N/A	371,200
(2) Trees in lawn cubes						
Small trees	256 trees (8 trees per street)	2 gallons per tree*				68
Tree boxes along neighborhood streets	15,000 feet (8 per street)	4' x 4' x 4' cubes; 2 rows	120,000			16,384
(3) Large lots (commercial, schools, parks)	5 in lower wshd	500,000 sq ft	25,000,000			
Permeable pavement	60% of lot	300,000 sq ft	1,500,000	0.63	0.083333	78,750
Eco-roofs public/commercial uses	20% of lot	100,000 sq ft	500,000	0.63	0.083333	26,250
Parking lot bioretention areas	20% of lot	100,000 sq ft, 2.5' deep	500,000			1,250,000
Underground cistern	2 for large storm overflows	100,000 sq ft, 8' deep	N/A			1,600,000
				Total volume treated		3,636,218
* Figures from SF PUC						

Appendix 2: Estimated cost of proposed intervention

Strategy	Items	Units proposed	Cost per unit (in millions)	Subtotal (in millions)
(1) Trees with bioretention/conveyance swales	Trees	1,070	$1.89 per 1,300 trees	$1.56
	Bioretention/conveyance		$0.25 per 10,000 sq ft	
	along wide streets	246,120 sq ft		$6.15
	along narrower streets	92,800 sq ft		$2.32
(2) Trees in lawn cubes	Trees	256	$1.89 per 1,300 trees	$0.37
	Treeboxes (bioretention)	120,000 sq ft	$0.25 per 10,000 sq ft	$3.00
(3) Large lot interventions	Permeable pavement	1,500,000 sq ft	$0.1 per 100,000 sq ft	$1.50
	Eco-roofs	500,000 sq ft	$1.8 per 100,000 sq ft	$9.00
	Parking lot bioretention areas	500,000 sq ft	$0.25 per 10,000 sq ft	$12.50
	Underground cistern	200,000 sq ft	$0.8 per 10,000 sq ft	$16.00
				$52.40
Creek restoration***	Daylighting culverted creeks	399,500 sq ft**	$0.8/8,000 sq ft	$39.95
	Open channel	141,000 sq ft**	$3.78/100,000 sq ft*	$5.33
	Engineered channel	1,985 ft	???	???
				$45.28
Cost per unit figures from SFPUC, except				
*From City of Oakland, based on cost of Peralta Creek restoration project in lower watershed				
**Assumes 50 feet riparian width for restoration				
***Not including cost of property acquisition; not including above-ground engineered channel				