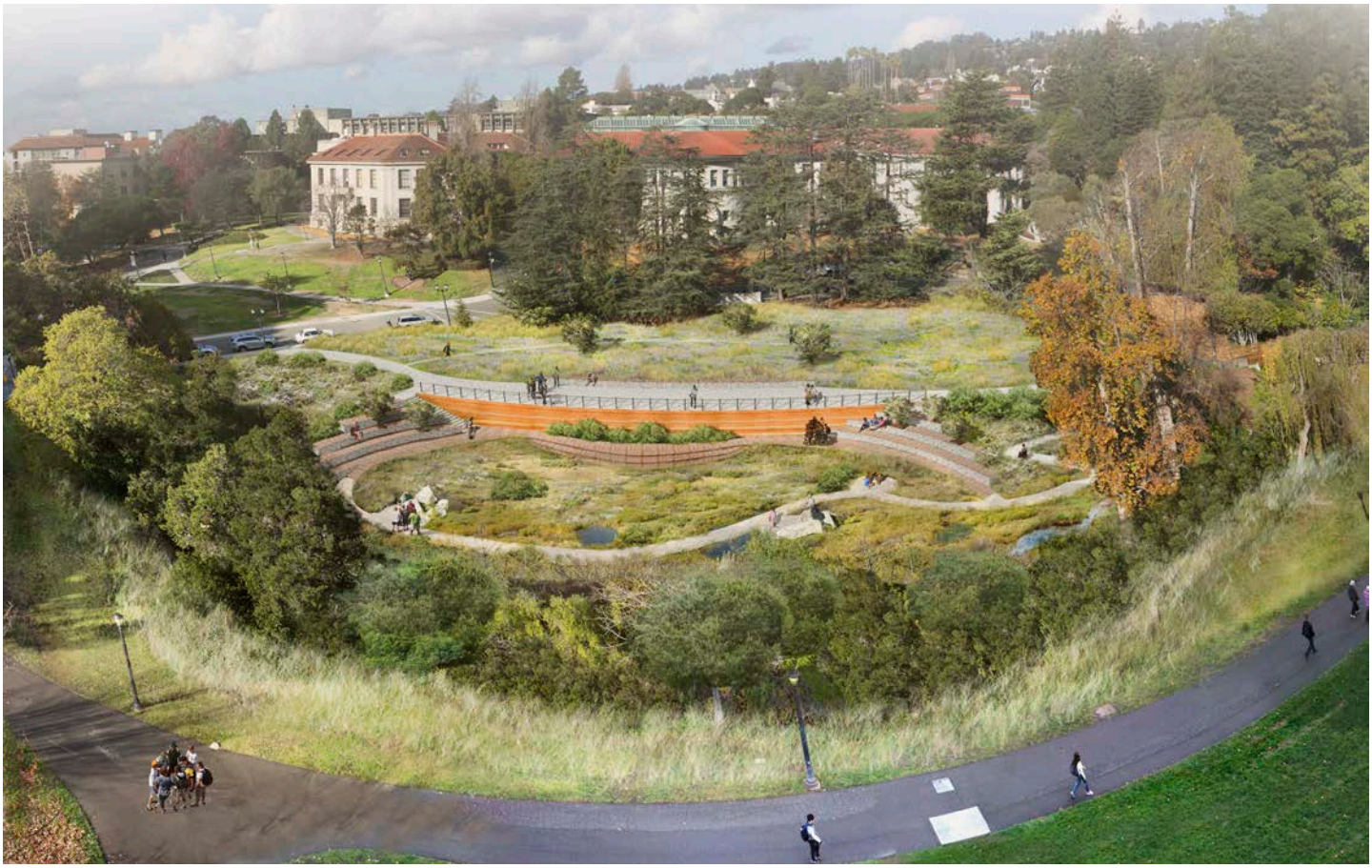
UNBOUND:

Stormwater Infrastructure as Living Laboratory, Habitat, and Human Spaces

2015 EPA RainWorks Competition Submission
University of California, Berkeley - Registration #D70



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Abstract

Many regions of the western United States are acutely feeling the effects of a changing climate. As its saltwaters rise, California is staring down the spectre of decades-long droughts. This year's El Niño is projected to represent a major series of powerful storm events - arriving on the heels of four years of exceptional drought conditions, and posing major impact risks as a function of their combined effects. The need for progressive measures intended to bolster ecosystems and reimagine water management strategies is critical for an era of environmental destabilization. Discovering modes to weave those approaches into culturally valuable space-making gestures represents a profound pivot towards communities, societies, and regions whose harmoniously interacting built and natural environments may become more than the sum of their parts .

UNBOUND seeks to holistically address manifold challenges, weaving together goals in restoration ecology, climate change adaptation & mitigation, stormwater management, and academic and cultural utility of the site. Even under current degraded conditions, the West Meadow site has clear potential to function as a crucial connection between ecologically resilient upstream riparian corridors and recent downstream restoration projects. The persistence of educational usage of the site - primarily by laboratory classes ranging from Ecological Analysis to Ecology, Evolution, and Plant Biology - is evidence of the inherent value of a site that allows the campus community to meaningfully interact with Strawberry Creek. Incredibly, the campus currently has no creekside sites that are intended both for human use and enjoyment and ecosystem performance enhancement. No other point on campus has sufficient undeveloped area to intervene in the creek's capacity and flow regime at as broad a scale as the site investigated herein. This new mosaic rooted in stormwater management and native ecology envisions a multifunctional and floodable space - a critically needed and compelling 'evolutionary aesthetic'.

Site Analysis + Selection

The project site is a reach of the North Fork of Strawberry Creek, a heavily degraded and artificially channelized creek running through the UC Berkeley campus. The site itself is a 1.75 acre "cell" defined by campus paths and roads. The intervention within that cell constitutes an earthwork disturbance area of less than 0.5 acres. The entirety of Strawberry Creek's watershed encompasses approximately 1,147 acres (1.8 square miles), with the North Fork draining 388 acres (0.6 square miles) of the total area. Since campus development began in the late 1800s, the creek has been constrained by a series of check dams, culverts, and concrete and masonry retaining walls - leading to severe channel incision, dramatic reduction of riparian buffer zone width, loss of native species diversity, and regular drainage infrastructure failures.

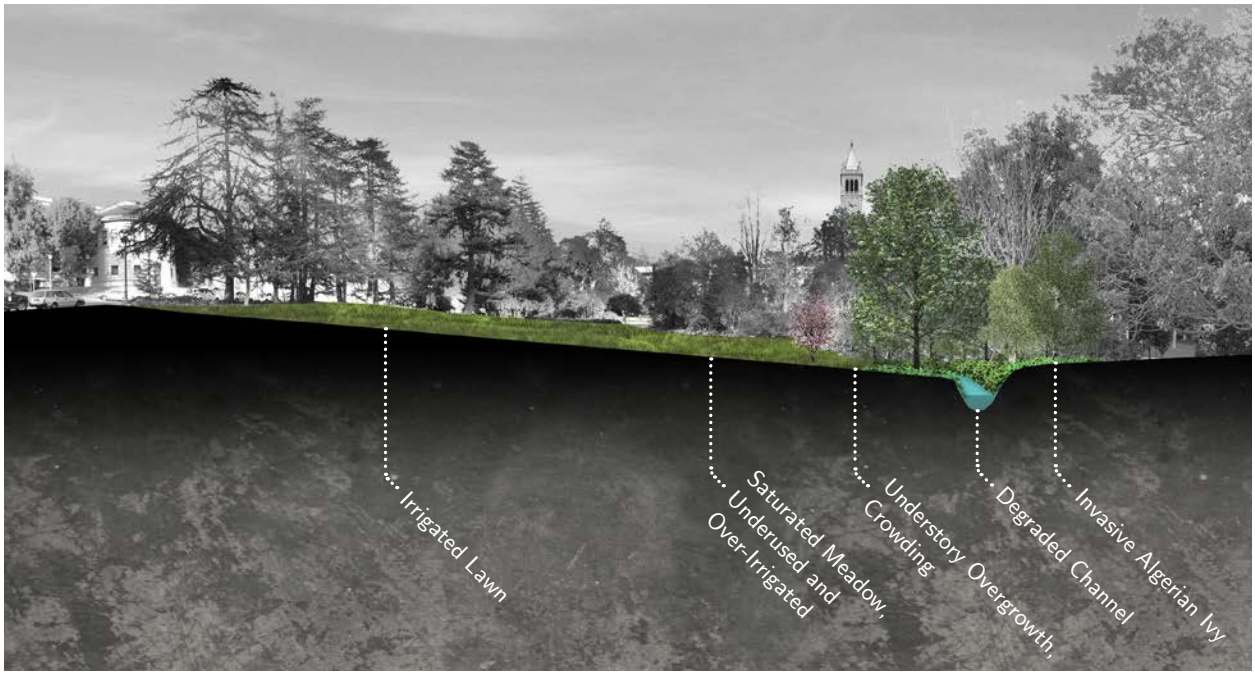
Consultation with administrators in the University's Department of Environment, Health & Safety revealed that a stretch of the creek running through west campus is particularly problematic: the Wickson Meadow. Our zone of intervention is along a 350' reach constrained on both ends by poorly designed culverts, making it one of the most degraded creek segments on campus. On the eastern (upstream) side, the creek flows into the site underneath a heavily trafficked footbridge. A mere half-inch rainfall event typically produces enough debris to block this passage, flooding the footbridge and creating maintenance issues. As it passes through the meadow, the channel is bounded by collapsing, century-old masonry retaining walls that contribute to degraded habitat quality and interfere with creek access. On its west (downstream) end, a culvert channels the creek under a roadway, emerging in an ecologically significant stand of mature Eucalyptus trees. Typical (2-year) storm events overwhelm the culvert, flooding both the road and meadow, and scouring the Eucalyptus Grove with significant sheet flow.

Bordered by the Department of Integrative Biology and the College of Natural Resources, the site served as the University's first botanical gardens during the late 1800s. Vestiges of this legacy remain today in its unusual and exotic tree specimens. Herbaceous natives are essentially absent, replaced or displaced during the site's duration as a botanical library. Of primary concern in our site assessment was the mitigation of the current stormwater infrastructural inadequacies; improvement of ecological stability through increasing species diversity; ameliorating current channel incision and degradation; and improving the ability of professors, researchers, and students to use the site as an engaging living laboratory.

Site Design

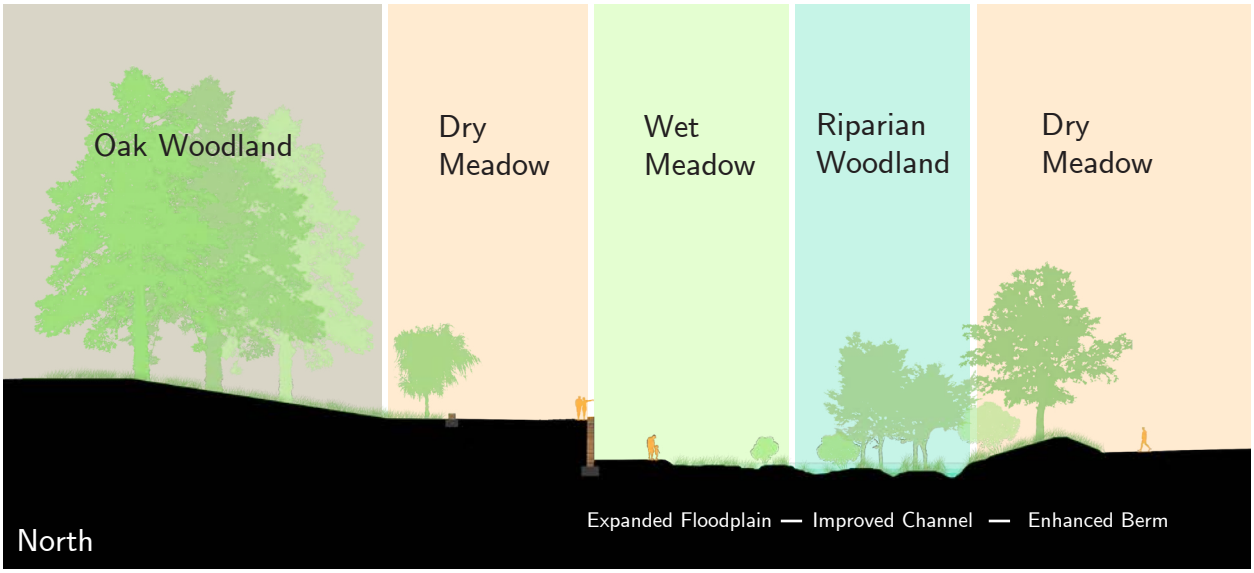
Existing

The site is currently underperforming for the campus is several ways: in its stormwater management; ecological value; human access, and as campus amenity and compelling human space.



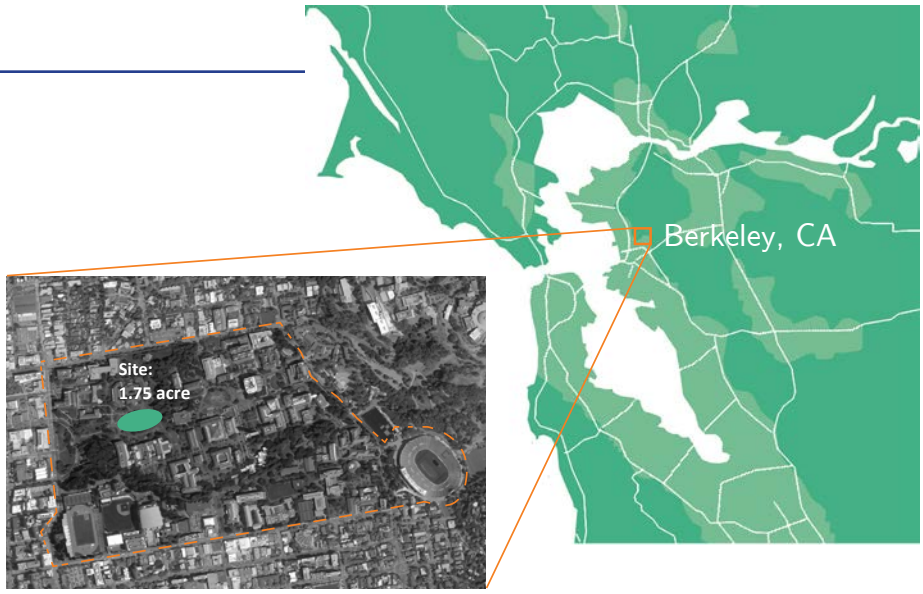
Proposed

The site embodies a major opportunity as a function of its topography and creek presence. *UNBOUND* re-establishes variation and connectivity in native ecotones by expansion of the floodplain and a major vegetation palette overhaul. Reimagining the site as a valuable node of human interaction and observation of nature will catalyze the site and showcase seasonal rhythms historically muted by the channelized creek corridor.



Site Plan

The Wickson Meadow is located on western end of the University of California Berkeley campus. A unique concentration of departmental buildings focused on a variety of scientific disciplines exists along the site's periphery, making this site an excellent location for a *Living and Learning Laboratory*.



Context : Wickson Meadow sits at the base of the Berkeley hills. An approximate 1200 foot elevation change occurs throughout the watershed, making this area vulnerable to soil erosion and bank incision.

Intervention : *UNBOUND* incorporates an enhanced floodplain, bank stabilization and re-establishment of native vegetation to enhance habitat value.

Process + Concept

UNBOUND explores the power of an ecological design framework. It embraces formal interventions in response to scholarly commentary in environmental design concerned with the potential for iconic ecological design interventions to exceed more formally subtle projects in social impact. In the words of Louise Mozingo, a successful ecological intervention must simultaneously inspire "admiration, preservation, and imitation" (1997). In the climate change era, it is imperative that projects seeking to improve ecosystem services do so in a manner that addresses historically negative public perceptions of ecologically-degraded landscapes; an intervention must be socially comfortable, intriguing, and novel if it aims to inspire protection of and investment in the natural world (Mozingo 1997). Precedents that iconically mediated this relationship between the natural and urban fabrics - such as Boston's "Emerald Necklace" informed this intervention. Michael Hough's related contention that "...the formal city landscape, imposed over an original natural diversity, is the one in urgent need of rehabilitation" drove formal gestures that balance the campus community's engagement with their watershed with buffers against anthropogenic degradation.

UNBOUND is grounded in an *evolutionary aesthetic:* a dynamic morphology that allows the creek to present as a single super-organism on which evolutionary forces (for example, climate change-induced aberrations of the hydrologic cycle) act (Mozingo 1997). A vital component of *UNBOUND* is the integration of Espace de Liberte - a dynamic approach to fluvial morphology within the floodplain.The floodplain in this context is a complex mosaic experiencing constant transformation by the creek, which itself is treated as a living and vital force. Formally, it innovatively echoes contemporary theories in evolutionary environmental physiology regarding adaptive morphological responses to abiotic abnormalities. Broadcasted spatially on a macro-scale, this unending conversation between the creek and its floodplain makes visible otherwise-ignored environmental dynamics and the physical changes they produce; spotlighting the creek as an energetic force that is constantly in dialogue with its environment promotes the advancement of an increasingly relevant environmental paradigm--that ecosystems must be conceived of as dynamic systems constantly experiencing flux, rather than as static states (captured in symbolic 'snapshots' of conditions) in which complex and intriguing ecosystem processes are dramatically oversimplified. In this paradigm, the role of the ecological designer is to facilitate balance and harmony in the system rather than dictate artificial spatial constraints on its natural temporal fluxes.

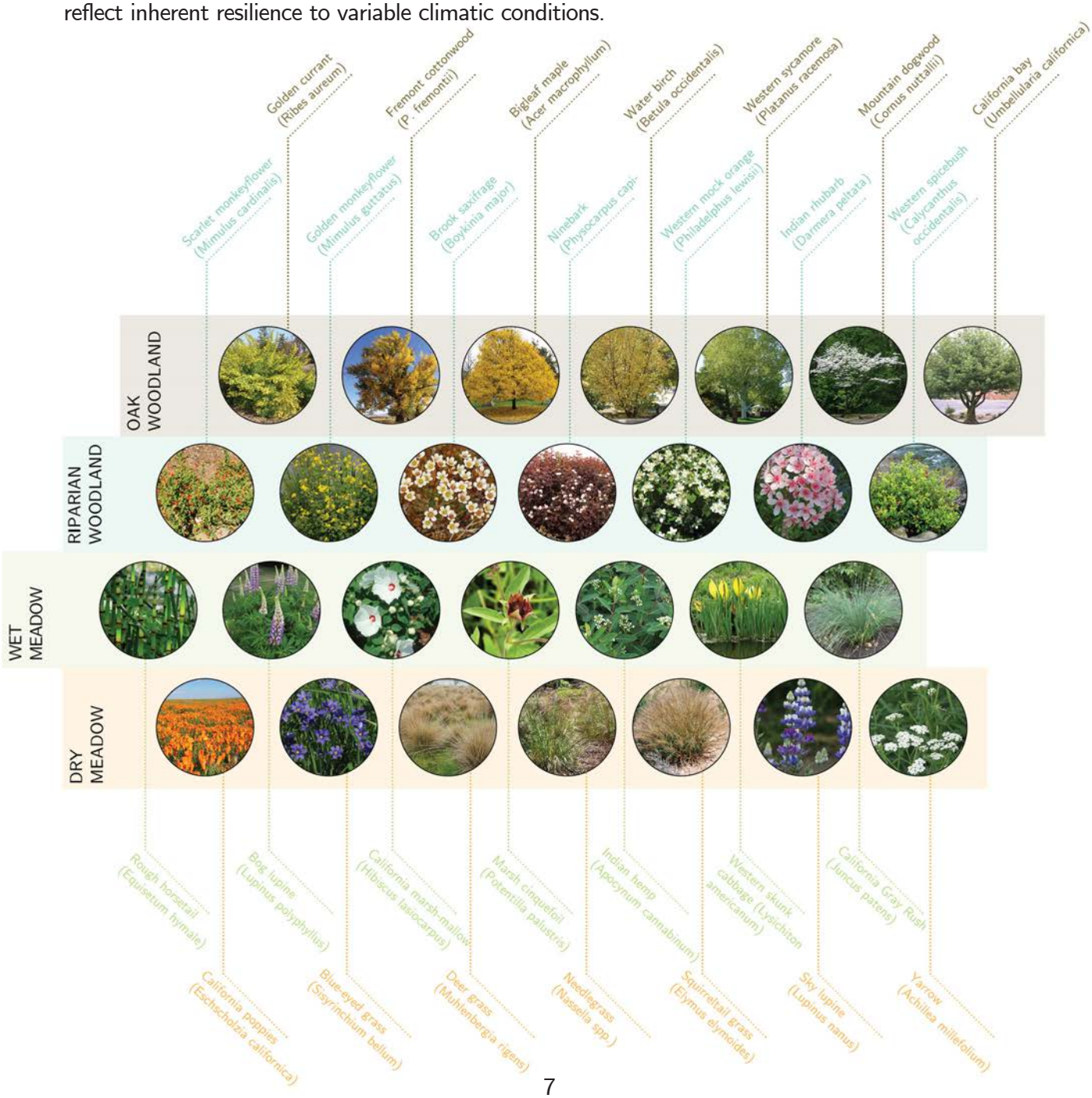
Crucially, however, the proposal far exceeds the environmental and social impact of a restoration project alone; it is a multi-functional and magnetic gathering point for a complex array of stakeholders, from students to researchers to campus managers to fauna. It is a potent and appealing leverage point for green infrastructure on campuses everywhere in that it tackles improving hydraulic functionality by facilitating incremental percolation into soils, thus supporting groundwater recharge in the site. Through reestablishment of ecotone variations, a California native landscape will replace the current mosaic of invasive species and oversaturated/compromised native vegetation. Consideration of an appropriate plant palette will afford proper integration of dry grasses and suitable riparian vegetation to reduce irrigation and maintenance needs. Additionally, the expansion of the floodplain supports a landscape that can endure intense variability, from prolonged drought to concentrated rainfall events - two varying impacts of current climate change projections for California.

This proposal is groundbreaking in making visible the invisible in aesthetically engaging ways --without doing so at the expense of ecosystem services--and achieving functional goals in stormwater

management and riparian restoration through an ever-changing, novel, and experiential journey for users. It allows the most vital and magnetic component of the site, the creek, to act 'freely' and in alignment with its natural behavior--an innovative response to the shortcomings of both socially uninviting restoration projects and ecologically disengaged formal design interventions. These foundational concepts are both iconic and modular, giving the project the capacity to promote the proliferation of ecologically sound stormwater management across campuses everywhere.

Planting Palette

Plant species were chosen from four different habitat zones: oak woodland, riparian woodland, wet meadow and dry meadow. Selections focus on species native to California that reflect inherent resilience to variable climatic conditions.



Re-grading of the site expanded the floodplain thus facilitating a wet meadow ecology. Dry meadow plants are placed in a transitional zone that intersects the oak woodland ecotone and vegetated berm on the site's southern boundary. Plants within the riparian woodland were chosen to endure periodic high flows in addition to stabilizing the channel and minimizing soil

Hydrologic Modeling

Two tributaries, the North Fork and the South Fork, converge on campus to define Strawberry Creek. The North Fork of Strawberry Creek runs from largely undeveloped Strawberry Canyon through the University of California Berkeley campus. The North Fork connects with the South Fork at the edge of campus before being culverted underneath the cities of Berkeley and Oakland, eventually discharging into the San Francisco Bay (Haltiner 1988). The North Fork watershed analyzed for this report extends over 388 acres with an average basin slope of 23%. Land cover types were computed by performing an unsupervised classification using high-resolution NAIP imagery in ArcGIS in order to calculate the extent of impervious surfaces. Results indicate that the watershed is comprised of approximately 33% forested areas, 29% commercial development and 38% open grassland (Table 1). A composite runoff coefficient of 0.45 was calculated with respect to land uses and soil types. Storm data was adapted from a recent report on a downstream portion of Strawberry Creek for 1.5, 2, 5, 10, 25 and 100 year recurrence intervals with peak flow estimates of 134, 147, 170, 188, 220 and 259 cfs respectively (ESA-PWA Memo). Based on these estimates, the site analyzed will experience flooding between 1.5 - 2 years.

Table 1. A weighted runoff coefficient of 0.45 was calculated for the watershed draining to the site.

Composite Runoff Factor - Strawberry Creek, North Fork								
Soil Type	**Hydro Class**	**Land Use**	**Area of Watershed (%)**	**Estimated Slope (%)**	**Runoff Coefficient (C)**	**Average Runoff Coefficient**	**Weighted Runoff Coefficient**	**Source**
Xerothents-Millsholm	B/D	Forest	32.6	6+ *	B = 0.14 – 0.18 D= 0.20 – 0.25	(0.14 + 0.18 + 0.20 + 0.25) / 4 = 0.19	0.326*0.193 = **0.63**	Soil type = 1987 Strawberry Creek Mgmt Plan; Area =NAIP Imagery Analysis, unsupervised classification of 2012 CA001_Alameda using ArcGIS (atlas.ca.gov)
Urbanland - Tierra	D*	Commercial (University)	29.2	2 - 6 *	0.72 - 0.89	(0.72+0.89)/2 = 0.805	0.292 * 0.805 = **0.24**	Soil type = 1987 Strawberry Creek Mgmt Plan; Area = Streamstats (USGS) estimate
Maymen Loam	D	Meadow	26.7	6+ *	0.4 - 0.5	(0.4 + 0.5)/2= 0.45	0.267 * 0.450 = **0.120**	Soil type = 1987 Strawberry Creek Mgmt Plan; Area =NAIP Imagery Analysis, unsupervised classification of 2012 CA001_Alameda using ArcGIS (atlas.ca.gov)
Urbanland - Tierra	D	Open Space	11.5	2 - 6 *	0.21 - 0.27	0.24	0.115 * 0.24 = **0.023**	Soil type = 1987 Strawberry Creek Mgmt Plan
						SUM	0.63 + 0.24 + 0.12 + 0.023 = **0.45**	

* = estimate

Frequent flooding on campus poses imminent threats to critical infrastructure and human safety. The analysis and project development process revealed the difficulty in adopting projects that address systemic solutions for flood management measures.Due to a lack of available hydrologic data for the portion of Creek flowing to our site, historic storms that caused significant flooding were used to inform our design. In February 2004 an 11-year, 1-hour storm event with an intensity of 1.3 inches per hour exceeded the approximate 130 cfs capacity of the on-site culvert, overtopping the banks. The peak flow lasted for approximately 15 minutes but caused significant damage in the immediate vicinity and further downstream (LBL Hydrology Report 2004). In addition to inundation along the pedestrian paths and streets, a significant amount of debris clogged the Oxford Street Culvert which exists downstream of our site. The Oxford Street Culvert receives water from both the North and South Forks and sits on the edge of the City of Berkeley. When the capacity of the Oxford Street Culvert is exceeded due to clogging or a large storm event, the City of Berkeley suffers significant flooding impacts. Any improvement to relieve the amount of stormwater draining to this point during intensive storm events will be benefit the University and City, in addition to the functional ecologic and habitat improvements.

The maximum storage capacity of the proposed intervention is approximately 37,000 cubic feet (Figures 1 and 2). A lowpoint acting as an emergency spillway above the culvert will become activated in a high flow event exceeding this capacity. We recommend a phased implementation plan that integrates an engineered bypass structure to alleviate excess flow.

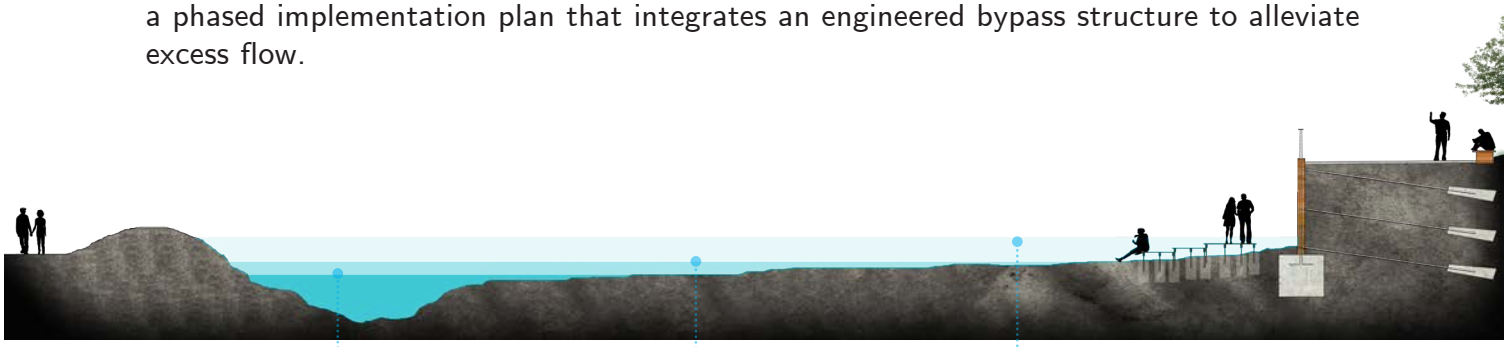


Figure 1. The site is designed to handle a maximum capacity of 37,000 cubic feet of water before activation of the emergency spillway. The volumes are represented in 3-dimensions to give a sense of scale.

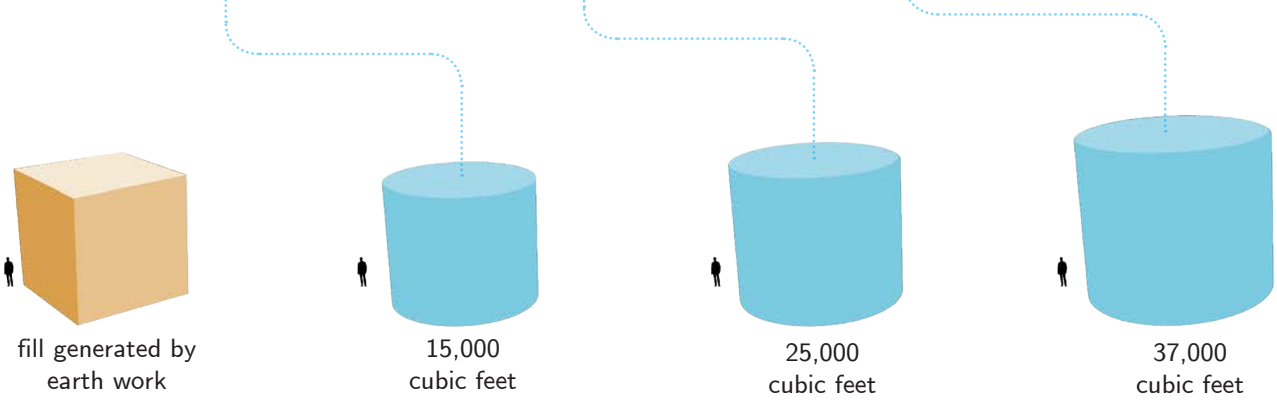
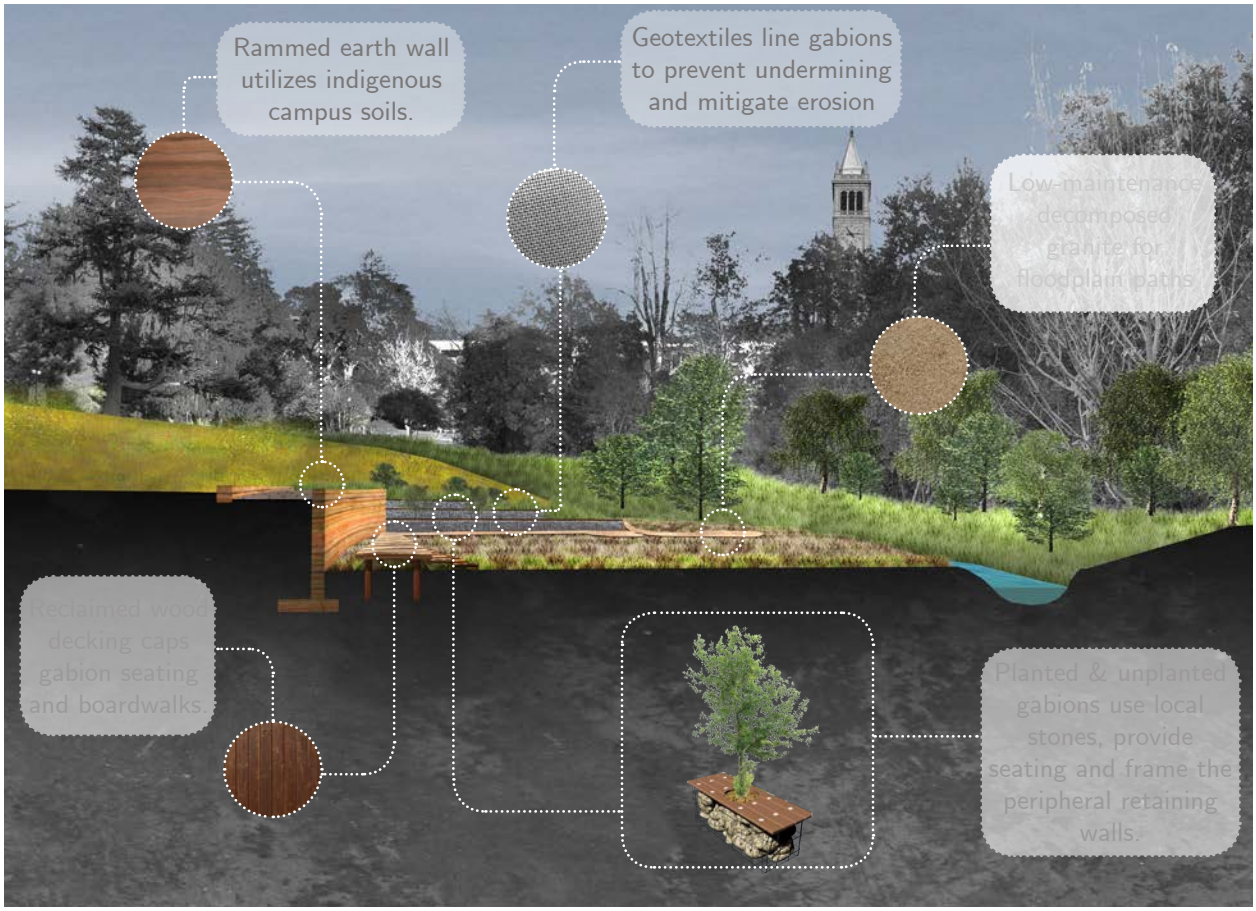


Figure 2. The site is designed to handle a maximum capacity of 37,000 cubic feet of water before activation of the emergency spillway. The volumes are represented in 3-dimensions to give a sense of scale.

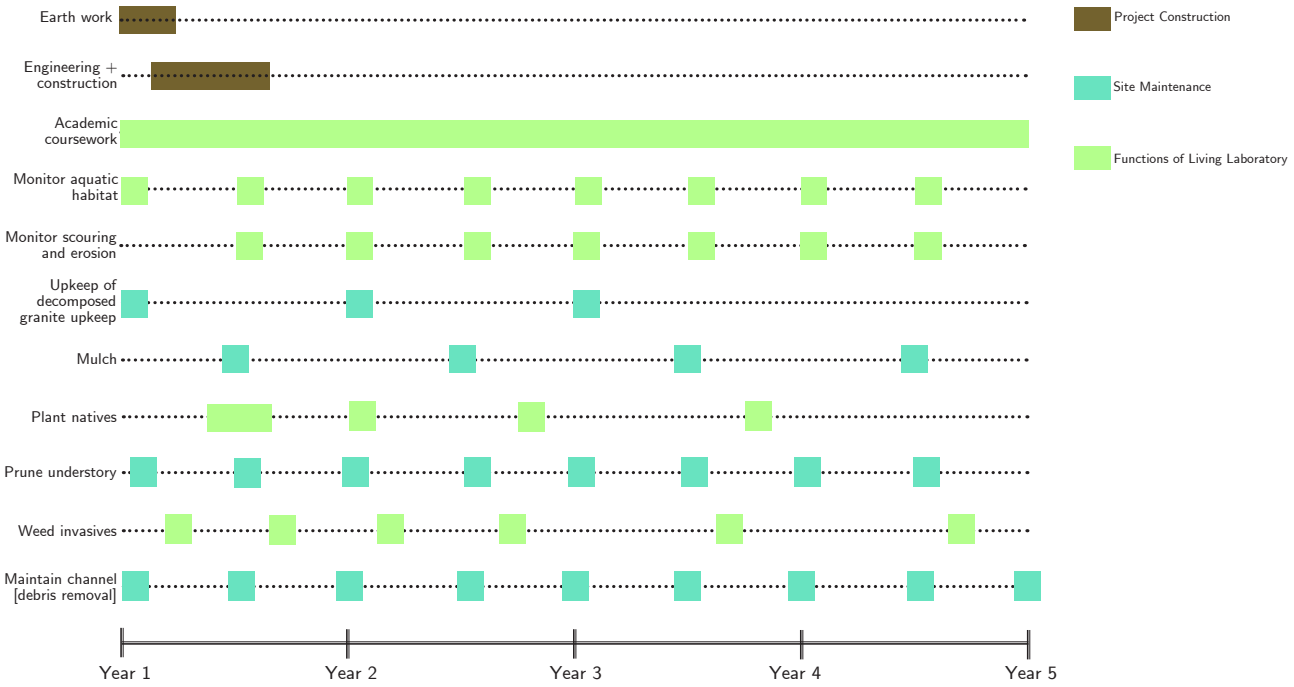
Materials *Indigenous, Reclaimed + Rediscovered*



Our proposal plays off of the existing topography of the site, leveraging space and directionality to reduce construction costs. Operational/design alternatives present a variety of overall costs and maintenance regularity all while embracing the natural sustainability of the site. A rammed earth wall using indigenous soils will be constructed to stabilize a deep cut into the saturated lawn. Reclaimed wood atop gabions will provide the structure for both terracing and walkways within the extended floodplain. Gabions within the floodplain will be lined with geotextiles to reduce undermining. Current and planned capital projects throughout the UC Berkeley campus generate huge amounts of raw materials such as fill, stones and reclaimed wood. There are eight projects either currently under development or slated to break ground within the next calendar year. This project proposes to integrate these excess materials from such sites to minimize costs and resources. Specifically, the Wheeler Hall Renewal Project will begin in May of 2016 and encompasses nearly 137,000 gross sq. ft., posing substantial potential to incorporate reclaimed wood or stones.

Interpretive signage will guide visitors to areas of particular significance, including the riparian woodland and wet meadow ecotones. Additional features will highlight the diversity of native species and the important function of an expanded floodplain, which is also utlized by the academic core of the University as a research asset. Creating a variety of relaxing,recreational. contemplative and educational spaces.

Operations + Maintenance



Budget

Project Elements	Total Project Costs	River Parkways Grant	Local Contributors	Other Funding Sources (UCB)
Non-Construction Costs				
Staff Time	$45,000	$25,000	$10,000	$10,000
CEQA	$5,000			$5,000
Consultants	$15,000	$15,000		
Subtotal - Direct Mangement	$65,000	$40,000	$10,000	$15,000
Planning, Design & Permitting				
Staff Time	$24,000	$14,000		$10,000
Consultants	$60,000	$60,000		
Permit Costs	$6,000	$3,000		$3,000
Subtotal - Planning, Design & Permitting	$90,000	$77,000		$13,000
CEQA Compliance (If applicable)				
Staff Time	$5,000			$5,000
Consultants				
Subtotal - CEQA	$5,000			$5,000
Construction Costs				
Implementation/Construction Contracted				
Installed Cost (labor & materials) - creek bio-engineering	$300,000	$150,000		
Installed Cost (labor & materials) - floodplain	$500,000			
Installed Cost (labor & materials) - walks, overlooks, etc.	$750,000	$100,000		
Implementation/Construction - Applicant				
University component				
Labor	$50,000			$12,000
Materials - Plants, signs, etc.	$25,000	$5,000		
Equipment				
Project Partners Components				
Labor (mostly volunteers)	$13,000	$3,000	$10,000	
Materials - Plants, signs, etc.	$50,000	$10,000		
Equipment				
Subtotal - Construction Costs	$1,188,000	$368,000	$10,000	$12,000
Contingency	$15,000	$15,000		
Project Grand Total:	$1,848,000	$500,000	$20,000	$40,000

Value Engineering

Unbound is a bold vision for the UC Berkeley Campus. The architectural design proposed represents a significant undertaking to improve the campus and creek functionality. The basic concept, however, is very straightforward: laying back the hill's slope to broaden the floodplain and restore habitat variation. There are multiple iterative approaches to this earthwork approach, and would entail different construction applications and resulting cost estimates. Bringing stakeholders together to invest in these systems is a critical step forward.

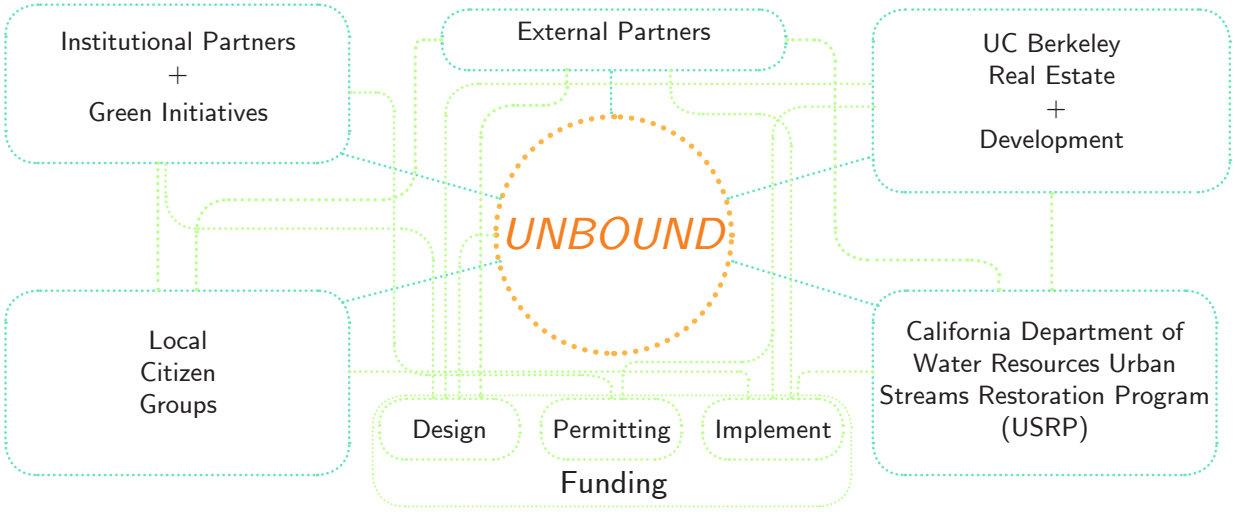
Unbound : As-Built

Terraced Retaining Walls

2:1 Vegetated Slope

Funding Resources + Strategic Partnerships

In presenting a bold vision, multiple stakeholders, organizations and potential resources are galvanized by the project goals and approach.



UC Berkeley and stakeholders will collaborate with partnering organizations to involve the community in the design, planting, and maintenance of the Wickson Restoration Project. These partners include Kids for the Bay, Friends of Five Creeks, Berkeley High School, the Center for Independent Living, and the City of Berkeley, all of whom have pledged collaboration as indicated in their letters of support. The estimated in-kind contribution of our partner organization is estimated to total $20,000 (3.5% of total project costs).

In addition, UC Berkeley will donate staff time to components of project management and outreach. Staff from the Office of Environment, Health and Safety and members of the Strawberry Creek Environmental Quality Committee will contribute in-kind services of approximately $45,000 (8% of total project costs) (Wickson Restoration Project 2015).

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