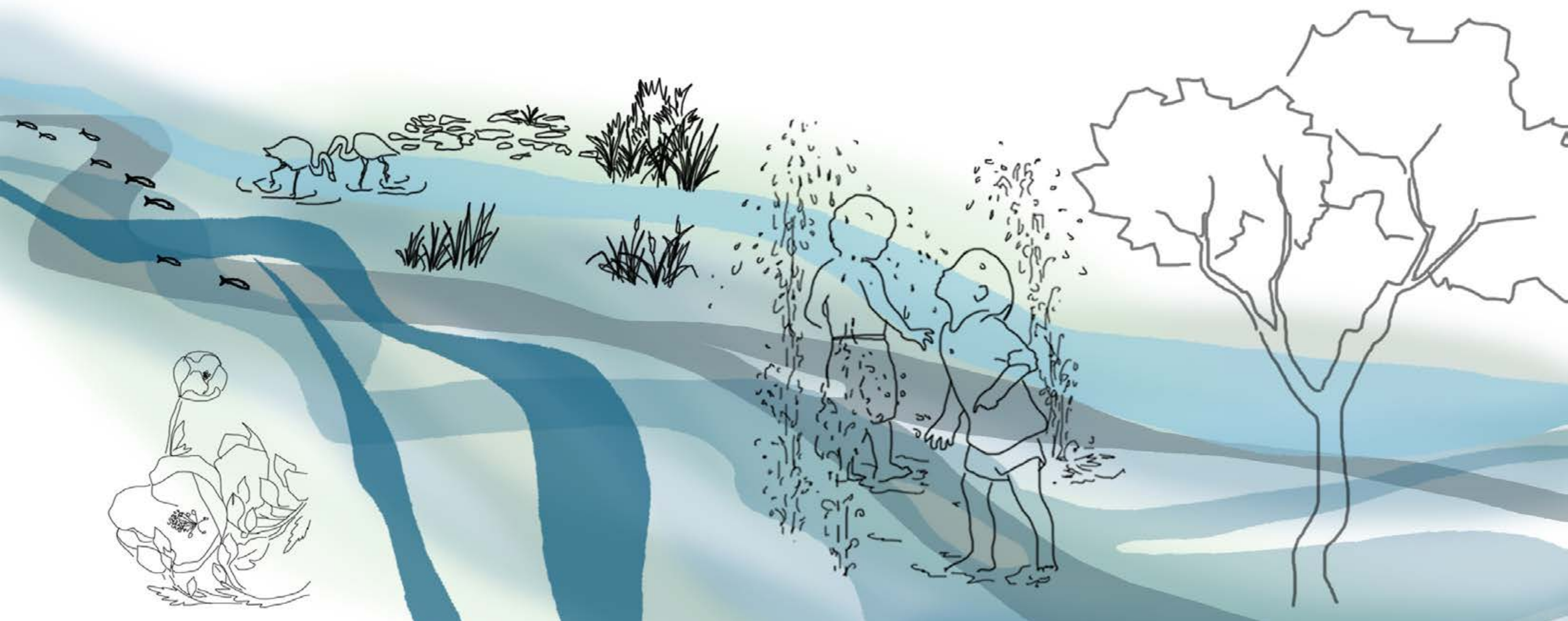
RIVER, REVITALIZED

HOW TO RESTORE THE LOS ANGELES RIVER

DEPARTMENT OF LANDSCAPE ARCHITECTURE
CALIFORNIA STATE POLYTECHNIC UNIVERSITY OF POMONA
MAY 2023



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A MASTER OF LANDSCAPE ARCHITECTURE CAPSTONE PROJECT
DEPARTMENT OF LANDSCAPE ARCHITECTURE
CALIFORNIA STATE POLYTECHNIC UNIVERSITY OF POMONA

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SUGGESTED CITATION

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ABSTRACT

The Los Angeles River must evolve from being entombed in concrete, starved of aquatic and riparian verdancy. Beyond failing to protect the city from flooding during climate-change amplified storm events, the channelization dumps needed water into the ocean (instead of recharging our aquifers). The entire watershed is fragmented into isolated islands of wildlife habitat, where restoring river would provide riparian corridors key for the survival of terrestrial and aquatic species. Revitalizing the river is a much better alteratives to the retrograde 19th century approach of concrete 'deck perks' proposed by the 2020 Master Plan which would irreparably harm the river by burying it. **This study identifies how the river's riparian features can be restored and the concrete bottom safely removed,** allowing habitat and recreation to flourish along the entire river.

To evaluate the impact of naturalizing the river, vegetation and sediment was first measured at 24 transects across the Elysian Valley, where the average obstruction was 30%. Mitigation volumes were modeled for 0.2% (500-year), 0.5% (200-year), and 1.0% (100-year) storm events, with peak flow exceeding 70% design capacity of the channel over 12 hours. To avoid flooding during a 0.2% storm where peak flow exceeding 70% design capacity of the channel over 12 hours, various reaches of the river will require between 4,000 acre-feet to 37,000 acre-feet of retention during peak flow. 14,000 acre-feet retention will allow 1.4 miles of the river to be restored, 28,000 acre-feet retention = 24.6 miles naturalized, and 34,000 acre-feet = 48.5 miles.

Conceptual site designs (n=6, 205-acre average site) tested strategies to integrate retention, habitat restoration, and recreation into a variety of adjacent land-uses. These designs provided an average of 0.18 acre-feet of storage per acre, utilizing an average of 17% of the site to a depth of 12 feet. Within 2.5 miles of the river, 9,300 acres (6.8% of 216.5 square miles) is suitable for retention, providing a potential retention capacity of 1,900 acre-feet to 39,000 acre-feet.

Within 2.5 miles of the river, the study inventoried 14.5 square miles (including parks, golf courses, school yards, power line easements, railroad right of ways, vacant parcels, and parking lots) suitable for constructing between 1,900 to 39,000 acre-feet of retention, more than enough to begin revitalizing the river.

We hope this report inspires the river's community, stakeholders, and regulators to act collectively to revitalize our river, so steelhead trout can swim in the shade of willow and cottonwood trees from the Pacific to Canoga Park.

OBJECTIVES

This Master of Landscape Architecture Capstone Project looked at a wicked problem core to the future sustainability of Los Angeles, a problem many variables, myriad stakeholders, and no easy solutions - the restoration of the Los Angeles River (LAR).

We acknowledge the channelized river protects property and people, but at the expense of habitat, recreation, and dumping massive amounts of needed water into the Pacific. Our goal therefore, was to identify feasible strategies and tactics for revitalizing the ecological river while while improving flood resilience of the city (improving our local water supply is a bonus).

Project objectives to fulfill the Master of Landscape Architecture Project requirements:

1. Critical exploration of the issues related to revitalizing the Los Angeles River.
2. Analyze the potential impact(s) of naturalizing the LAR.
3. Determine the volume of retention and infiltration needed to mitigate flood risk.
4. Evaluate and prioritorize where naturalizing is feasible and most needed.
5. Identify suitable locations for additional retention and infiltration capacity.
6. Design site specific pilot studies exploring a range of naturalization and retention strategies and tactics.

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PROJECT TEAM

GRADUATE STUDENTS

Dani Behr is a 3rd-year graduate landscape architecture student. In previous lives, she was an English teacher and a science fiction writer. She is an avid gardener and generally prefers plants to people.

Lauren DeMott has a bachelor's degree in landscape architecture with a minor in regenerative studies. She works for the design firm Urban Arena and will finish her master's degree in landscape architecture this year.

Caitlin Keller is a 3rd-year graduate landscape architecture student with a bachelor's degree in English and a master's degree in food systems. Originally from Northern California, Caitlin grew up in Sonoma County and currently resides in Los Angeles.

Danielle Lewis is a 3rd-year graduate landscape architecture student with a bachelor's degree in English and a master's degree in social anthropology. She currently works for Los Angeles County Parks in park and open space development.

Annie Woon Yun previously designed for auto companies, with some of her designs featured in movies. Living in the countryside, she realized the importance of nature and fell in love with landscape design.

Jin Zhang is a 2nd-year graduate landscape architecture student in the advanced track of the program. She previously studied landscape architecture through the UCLA extension program, where she was inspired to pursue a higher degree in the field.

UNDERGRADUATE STUDENTS (FALL 2022)

Alvin Lim is a 4th-year undergraduate landscape architecture student with a concentration in conservation biology. He works for the urban design studio LANDmarc, and his interests include zoo and aquarium sciences.

Myer Walden is a 4th-year undergraduate landscape architecture student with associate's degrees in architecture and landscape architecture. His interest in nature grew from his passion for exploring the canyons, beaches, and trails of San Diego.

FACULTY ADVISOR AND PRINCIPAL INVESTIGATOR

Barry Lehrman (PLA, MN license # 47285) is a landscape futurist, focused on visualizing the dynamic connections between infrastructure, ecology, and culture. His scholarship and advanced courses embrace expanding landscape architecture with emerging technologies and practices.

1. INTRODUCTION

Figure 1: Los Angeles River at Griffith Park, ca. 1898-1910 (California Historical Society)

1.1 LOS ANGELES RIVER: REGIONAL CONTEXT

OVERVIEW

Signs displaying an image of a great blue heron are located on every road crossing along the 51 mile-long Los Angeles River Watershed (Elrick). These signs remind commuters that the often forgotten river, which "looks and functions like an oversized concrete sewer," is indeed a real, functioning river here in Los Angeles (Price).

Beginning in Canoga Park, where Bell Creek and the Arroyo Calabasas covers, the river runs through the greater Los Angeles area to its mouth in the San Pedro Bay at the Port of Long Beach (Elrick).

What once served the Tongva people and the entire Pueblo de Los Angeles, was transformed by American settlers in the early 20th century (Elrick). These newcomers who were "unaccustomed to the climate of Southern California and unimpressed by the stream that barely flowed most of the year, drained the river dry and turned it into an industrial site and a dumping ground" (Gumprecht). A series of floods in the 1930s caused concern and led to the channelization of the Los Angeles River by the United States Army Corps of Engineers, who began work in 1936 with the passage of the Flood Control Act (LAR Master Plan). This twenty year project lined the river and its tributaries with 1,240 acre feet of concrete, turning the river into a flood control channel (Price).

Figure 2: The Los Angeles River in Elysian Valley, from Fletcher Drive Bridge, 2019 (by Downtowngal)

The river of today was constructed between 1935 and 1959, and was built to accommodate storm surges twenty thousand times its dry season flow. Today we see that the bulk of the water that the river carries nine months out of the year is "confined to a much smaller, low-flow channel cut through the center of its wide bed" (Gumprecht). Additional improvements to the river channel were made on the lower part of the Los Angeles River in the 1990s and 2000s as part of the Los Angeles County Drainage Area Project to increase the channel capacity in the lower 12 miles of the river (LAR Master Plan).There have been many restoration efforts to convert the river from a concrete-lined channel back to its natural state. Some of these river conservation groups have included the Friends of the Los Angeles River (FoLAR). The Los Angeles River Master Plan 2022 is an update of the Los Angeles County 1996 LA River Master Plan which addresses an array of social and environmental factors of and along the river. On June 14, 2022, the County of Los Angels Board of Supervisors approved the LA River Master Plan. Some environmental groups opposed the plan claiming it would add more concrete to the channel rather than removing concrete to naturalize the river and its habitat.

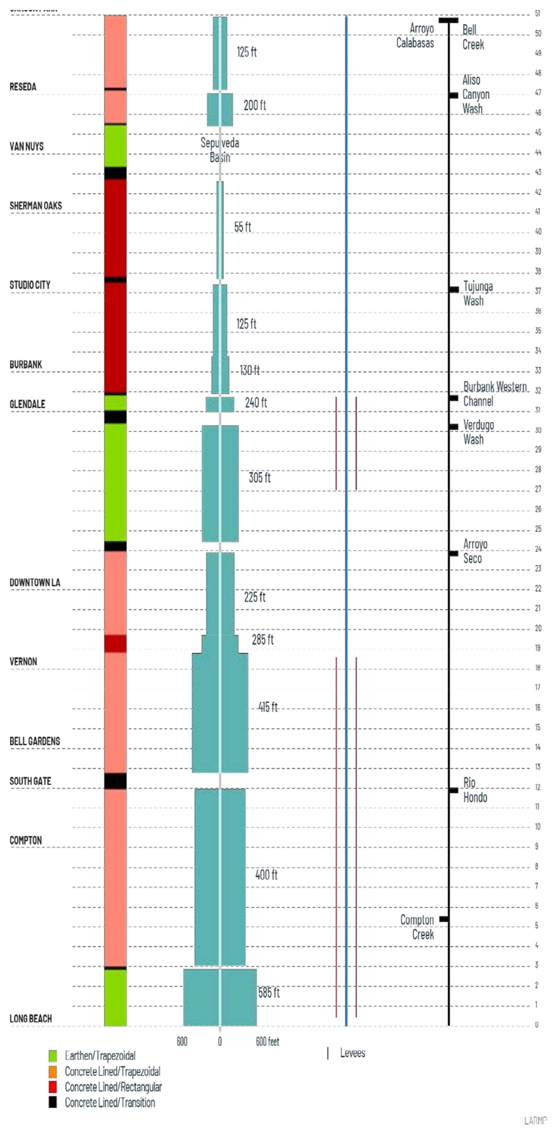

Figure 3: Los Angeles River channel conditions: Channel Type, Width at Top of Channel, Levees, and Tributaries, (LA River Master Plan).

CURRENT RIVER CHANNEL CONDITIONS

The majority of the Los Angeles River is encased in concrete. The existing channel of the river is "artificial, its bed and banks constructed of concrete, reinforced with steel" (Gumprecht). Los Angeles is naturally flood-prone because of the region's climate and topography. Before the river and stream channels were remade by humans, they were not well equipped to carry the quantities of water, mud, rocks, and trees that came down from the surrounding mountain ranges during storms. "The Los Angeles River overflowed its banks at least ten times in the first one hundred years after Los Angeles was founded," states Gumprecht, leading to the concretization of the Los Angeles River. The Los Angeles River drains large amounts of these elements and materials from three mountain ranges into the Pacific Ocean.

There are three areas of the River that are soft-bottom, characterized by soils at the base, found along areas of the River like the Sepulveda Basin, the Glendale Narrows, and in the last few miles of the river in Long Beach (LAR Master Plan. The existing conditions of the remaining areas of the Los Angeles River are concrete and feature a trapezoidal or box shape channel with a low-flow channel at its center (LAR Master Plan).

The present day Los Angeles River is composed of thirteen different channel configurations, varying in shape, width, and depth (LAR Master Plan). Some sections of the Los Angeles River channel "have a rectangular section with vertical sides, while other segments are trapezoidal with tapered sides… modifications to the channel have primarily been made to increase the capacity of the channel" (LAR Master Plan).

CURRENT ECOLOGICAL CONDITIONS

Before the channelization of the Los Angeles River, the channel was known to flood its banks periodically, meandering, and eventually making its way out to the ocean (FoLAR). The periodic flooding caused erosion and widespread deposit of sediment which created floodplains. These flat strips of land allowed for the growth of trees such as willows and cottonwoods, as well as other aquatic and semi-aquatic plants (FoLAR). These floodplains help to capture, break down, and treat pollutants from urban runoff found within the water and soil floating down the River that would otherwise see their way to the ocean (FoLAR).

Channelization has degraded the remaining habitat values of the Los Angeles River by straightening the river's course, "*diminishing its plant and wildlife diversity and quality, disconnecting it from its floodplain and significant ecological zones, and dramatically changing its appearance and function*"

THE RIVER TODAY

(Reader's Guide). There are four stretches along the course of the Los Angeles River that are soft-bottom portions where the natural river bed has not been lined with concrete. These areas are north or upstream of the Sepulveda Dam, the Glendale Narrows, Compton Creek, and the Estuary downstream from Willow Street in Long Beach (FoLAR).

Today, approximately 13 miles of the 51 miles is its natural bottom. Areas of the river where the natural bed is preserved come with a diversity of plants and wildlife" (FoLAR). Plant communities found along the Los Angeles River include: Alluvial Fan Sage Scrub, California Walnut Woodland, Perennial Freshwater Emergent Wetland, Southern Coast Live Oak Riparian Forest, Southern Cottonwood-Willow Riparian Forest, and Southern Sycamore Riparian Woodland (LAR Master Plan).

Floodplain willow forests serve as vital habitat for urban wildlife with *Salix alba* (White Willow) and *Salix lasiolepis* (Arroyo Willow) found most often in the natural bottom portions of the Los Angeles River and its tributaries (FoLAR). These forests of willow trees support populations of local and migrating birds that nest in its canopy (FoLAR, p. 7). Bird populations that have been recorded in the natural button portions of the Los Angeles River have included willow goldfinch, willow flycatcher, yellow warbler,

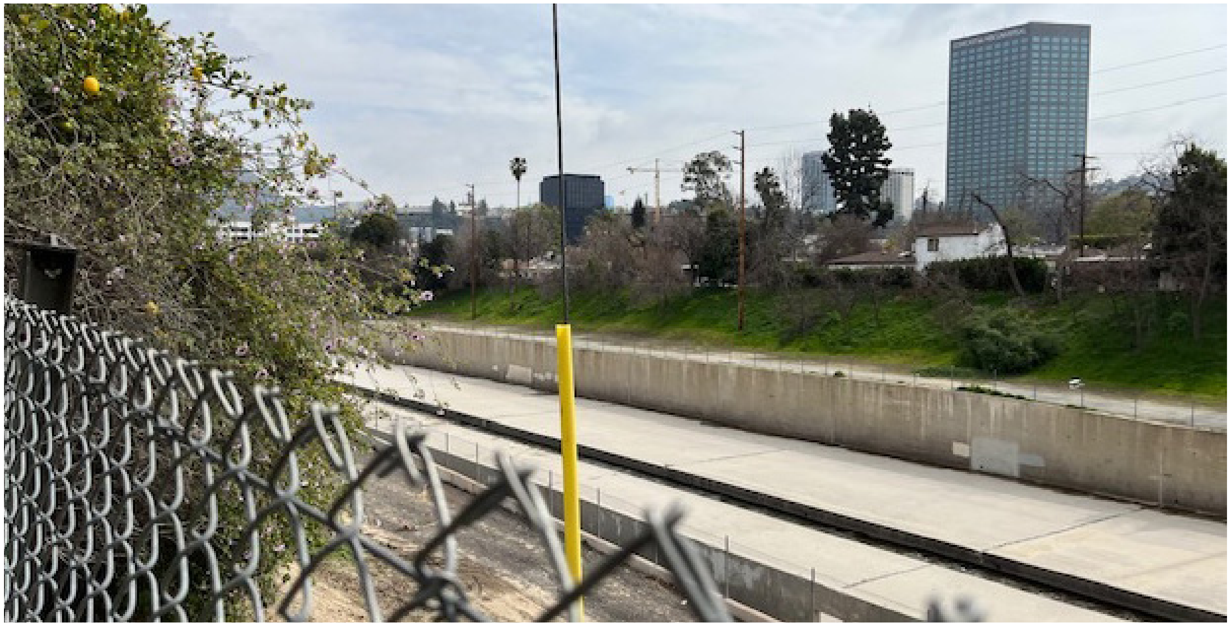

Figure 4: The River below Tujunga Wash from North Weddington Park in Toluca Lake, Los Angeles.

western wood pewee, herons, egrets, cormorants, ducks, redtail hawks, and osprey, to name a few (FoLAR, p. 7).

There are approximately 140 federally protected bird species that are being supported by the Los Angeles River (Reader's Guide) The wetlands of the Los Angeles River serve important hydraulic, biological, and habitat functions for a wide range of river life, "*from planktonic and filamentous algae to animals such as frogs and water fowl*" (FoLAR). Vegetation found in these wetland habitats include cattails, duckweed, as well as grasses and sedges found along the edges of the marsh; these plants stabilize sediment and add organic matter (FoLAR).

Southern California is known as one of the world's biodiversity hot spots (Reader's Guide). The California Floristic Province is one of only five Mediterranean climate regions in the world. These Mediterranean regions make up only 2% of the Earth's land surface yet contain 20% of the world's plant species (LAR Master Plan). Reestablishing habitat communities and reconnecting the river to its tributaries, historic floodplain, and other important ecological areas of the surrounding mountains are crucial to supporting a place that is a biodiversity hot spot (Reader's Guide).

1.2 LITERATURE REVIEW

Previous studies and research into the Los Angeles River, including hydrology and ecology reports, were reviewed and summarized by our team. Most of these reports proved highly relevant to our own research, and we note the potential design uses of each report in our summaries.

ASSESSMENT OF AQUATIC LIFE USE NEEDS FOR THE LOS ANGELES RIVER, 2021

Published in 2021 by the Southern California Coastal Water Research Project

INTRODUCTION

This study was a joint effort of the State Water Board, the City of Los Angeles, the Los Angeles County Department of Public Works, and the Los Angeles County Sanitation District. The purpose of the study is to evaluate the Los Angeles River for habitat suitability. The project has something of a split personality, swinging between measurements of water flow and evaluation of flows for plant and animal habitats. The relationship between these aims comes down to change: If residents, businesses, and industries continue the trends of conserving water and keeping stormwater on site, then the flow of the Los Angeles River will be reduced, a change that could threaten existing wildlife habitat. The report provides complex mathematical models for predicting how flow reduction would affect habitat suitability.

BACKGROUND

Municipalities that have historically used the Los Angeles River for discharge are increasingly managing wastewater on-site, which means reduced flow in the river channel and potential disruptions to species that live there. Reduced flow also leads to reduced output of recycled water and potential disruption to aquatic recreation. To balance these issues, the Water Boards require dischargers who want to reduce discharge to prove that "a change in flow will not unreasonably harm beneficial uses" (AALUN, p. 1). The cities of Burbank, Glendale, and Los Angeles are all anticipating reduced discharge and will need to petition the Water Boards to make these changes.

The study area for this project includes the Los Angeles River from the Tillman Reclamation Plant down to the river's exodus in Long Beach, and also includes two tributaries: the Rio Hondo and Compton Creek. Researchers aimed to create tools for modeling discharge reduction and anticipating the consequences of reduced flow.

OBJECTIVES

The stated objectives of this study are as follows:

1. Develop a process for establishing flow criteria.
2. Apply the process to provide recommendations for flow criteria in the Los Angeles River.
3. Produce tools and approaches to evaluate management scenarios necessary to achieve recommended flow criteria.
4. Assess current hydrologic conditions
5. Identify priority ecological endpoints of management concern (e.g., species or habitats).
6. Determine flow-ecology relationships for priority ecological endpoints.
7. Determine appropriate hydrologic and ecologic tools for analysis (AALUN, p. i).

METHODOLOGY

Researchers selected specific habitats to focus on as well as "*end member species that represent a range of tolerances for each habitat*" (AALUN, p. vii). They then broke down each species into its component life stages, e.g., fry, adults, and established habitat criteria for each stage, ensuring that their analysis considered the entire life cycle of representative species.

The habitat criteria was used to create models that predict the likelihood that endmember species can survive in the river under current flow conditions. According to the report, "This provides a baseline for assessing the potential effects of proposed changes in flow associated with reduced wastewater discharge or increased stormwater capture" (AALUN, p. viii). In addition to flow requirements, species have temperature requirements as well. For example, the river has sufficient flow to support the Santa Ana Sucker fish, but the temperature of the water is too warm.

To measure flow within the river, researchers identified nodes that "represent a range of different hydraulic and hydrologic conditions" (AALUN, p. 6). These nodes served as measurement points that allowed researchers to take sample measurements rather than surveying flows along the entire river. The six representative habitats were mapped along with habitats that could potentially exist if water flow changed. From there, end member species were selected based on the following criteria:

- Present or potentially present in the area.
- Observed within past ten years.
- Occur in comparable habitats in similar watersheds in the region.
- Representative of the range of conditions within the habitat.

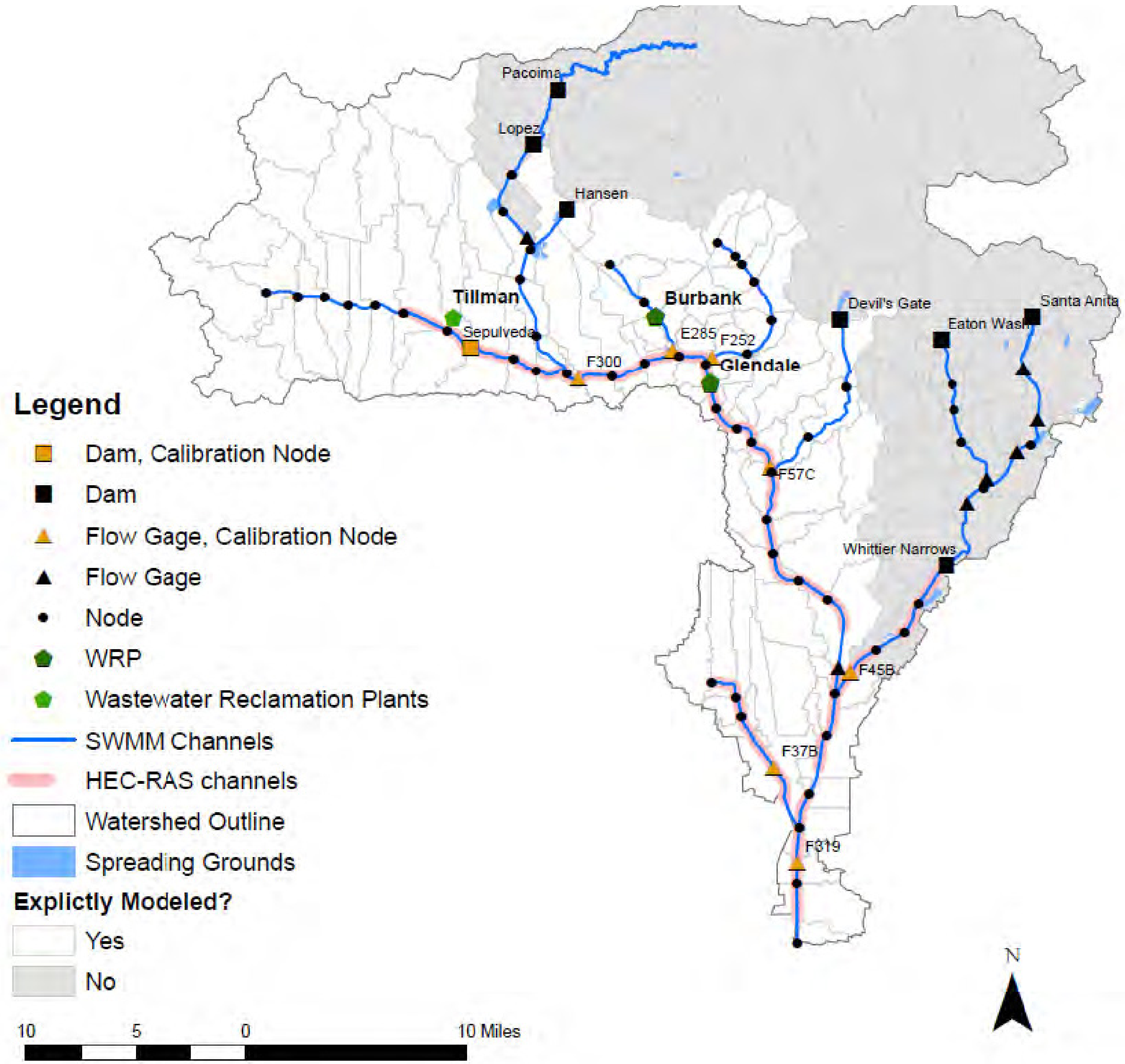

Figure 5: Hydraulic and hydrologic model of the Los Angeles River (Stein et al, 2021).

LITERATURE REVIEW

- Representative of diversity of species.
- Mix of sensitive and more common species.
- Life history traits fairly well understood.
- Dependent on aquatic habitats for key life history stages. Sensitive to changes in flow, temperature, and hydraulics (AALUN, p. 36-37).
- With end member species established, researchers then established relationships. between habitats and end member species using the following process:
- Compile habitat requirements for life history phases.
- Coalesce available data for each life stage and habitat variable.
- Create species' habitat suitability curves: life stage ~ habitat variable.
- Apply management scenarios to response curves to estimate habitat suitability.

DISCUSSION

Based on the criteria for species and habitats and established base line flow rates, researchers were able to use their model to "estimate the probability that each of the focal habitats and species can be supported under current flow conditions" (AALUN, p. 51). Marsh was the category of habitat found most frequently along the river. Researchers were unsurprised by this, as "marsh habitat is

Habitat	End member species	Description
Cold water habitat	Santa Ana Sucker Unarmored threespine stickleback	Not currently present
Migration habitat	Steelhead/Rainbow trout	Currently, only designated for Reach 1. Overlays with other habitats
Wading shorebird habitat	Cladophora spp	Green algae to support prey of wading birds
Freshwater marsh habitat	Typha Duckweed	Dominant plant species used to represent overall habitat
Riparian habitat	Black Willow	
Warm water habitat	African clawed frog Mosquitofish	Surrogate for invasive spp. habitat

Figure 6: Habitats and representative species in the Los Angeles River (Stein et al, 2021).

generally an early successional habitat when water (and substrate) are present and velocities are sufficiently low" (AALUN, p. 51).The river's existing flow rates were also frequently conducive to riparian habitat. Flow rates indicate a high overall probability of habitat for wading shorebirds, particularly in tidal portions of the river. Flow rates indicate partial suitability for cold water fish such as the Santa Ana Sucker, but high water temperatures render this suitability insignificant. Finally, researchers concluded that conditions for Steelhead Trout (a species endangered in Southern California) were only suitable within and north of the Glendale Narrows (AALUN, p. 52).

CONCLUSION

The contents of this report are highly relevant to discussions about re-designing the Los Angeles River. Existing habitat – particularly that of endangered species – should be maintained, and those interested in expanding habitat could use the models in this report to zero in on areas of the river most conducive to habitat expansion. The flow rates of the river used to determine habitat suitability have additional utility: They can be used to test the efficacy of new designs that alter the river's existing flow. For example, if a designer wants to divert water from the river into a reservoir for the purpose of recycling, infiltration, or recreation, they can use this report's models to determine how much water could fill the reservoir, how fast it could be filled, and how this hypothetical reservoir would affect flow through the remainder of the river.

LITERATURE REVIEW

ONE WATER LA 2040 PLAN

Published in 2018 by Los Angeles Sanitation

INTRODUCTION

The One Water LA 2040 Plan was a collaborative effort between Los Angeles Sanitation, the Los Angeles Department of Water and Power, and a large number of other governmental and non-government agencies. This project's title comes from the idea that all of the city's water – stormwater, groundwater, potable water, wastewater, and recycled water – are one water, to be considered as a single resource. The plan uses the year 2040 as its horizon, aiming to address its goals and implement effective strategies by that time (ES, p.1).

The overarching goals of the project are:

1. Develop a vision and implementation strategy to more sustainably and cost-effectively manage water.
2. Identify ways for City departments and regional agencies to integrate their water management strategies.
3. Guide strategic decisions for integrated water projects, programs, and policies within the City.

BACKGROUND

One Water LA 2040 was born from the coalescence of several factors: less water from rain due to drought (particularly since 2012), rising water needs in Los Angeles, water insecurity due to climate change, and a large number of agencies attempting to manage various aspects of water in isolation. The One Water LA 2040 vision statement is to collaboratively "develop an integrated framework for managing the City's water resources, watersheds, and water facilities in an environmentally, economically, and socially beneficial manner (ES, p.2).

OBJECTIVES

The objectives of the One Water LA 2040 plan are:

1. Integrate management of water resources and policies by increasing coordination and cooperation between City departments, partners, and stakeholders.
2. Balance environmental, economic, and societal goals by implementing affordable and equitable projects and programs that provide multiple benefits to all communities.
3. Improve health of local watersheds by reducing impervious cover, restoring ecosystems, decreasing pollutants in our waterways, and mitigating local flood impacts.
4. Improve local water supply reliability by increasing capture of stormwater, conserving potable water, and expanding water reuse.
5. Implement, monitor, and maintain a reliable wastewater system that safely conveys, treats, and reuses wastewater, while also reducing sewer overflows and odors.
6. Increase climate resilience by planning for climate change mitigation and adaptation strategies in all City actions.
7. Increase community awareness and advocacy for sustainable water by active engagement, public outreach, and education (ES, p.3).

METHODOLOGY

One Water LA 2040 is a highly collaborative project. Stakeholders in the city's water were identified and invited to join at the beginning of the planning phase. Representatives from over 30 city and regional agencies participated, and over 350 stakeholders were identified. Engagement between stakeholders included monthly meetings, 10 workshops, and over 40 inter-agency meetings (ES, p.11). Based on this collaboration, a number of projects were proposed. These were categorized as:

- Stormwater Projects
- Wastewater Projects
- Current Integration Opportunities
- Future Integration Opportunities

LITERATURE REVIEW

Policies and Programs Stormwater projects were rated on how well they addressed flood risk mitigation, water supply augmentation, and water quality improvement. Examples of water quality improvement include reducing impervious groundcover, reducing water pollution, and restoring ecosystems. Water supply augmentation focused on capturing stormwater and urban runoff "to help offset potable water use" (ES, p.13). Projects that addressed all three issues were given highest priority.

A database of 1,142 stormwater projects was created. Many of these (445) were Green Streets projects, "which are critical to the City's stormwater management system since they allow distributed stormwater projects to be further developed" (ES, p.15). Green Streets capture stormwater and use it for infiltration and groundwater recharge.

Wastewater projects focused on water reuse. The City of Los Angeles has a goal of sourcing 50 percent of its water locally by 2035 (ES, p.19), which means not only using what we can find, but re-using what we already have. Several proposed wastewater projects have "triggers" that must preclude their execution. For example, a proposal for "potable reuse with treated water augmentation" first requires that the city establish regulations applicable to this type of augmentation (ES, p.5).

Advanced treated recycled water delivery to LAX and Scattergood Generating Station	This project would offset the need for potable water by using exclusively recycled water for irrigation. It also calls for removing turf and replacing it with mulch or gravel.
Capture of off-site stormwater at Los Angeles Unified School District schools	LAUSD schools are already responsible for retaining all on-site stormwater. This project would keep more water – as well as trash and solid materials – out of storm drains and use the captured water for irrigation or infiltration.
Rancho Park water reclamation facility	This project would construct a new water reclamation facility. Recycled water from this facility would meet extensive non-potable water needs, including industrial uses and irrigation for both the UCLA campus and the city's largest municipal golf course.
Restoration of G2 parcel at Taylor Yard	This project would assess how recycled water could be used to remediate Taylor Yard as well as how stormwater could be collected from the site.
Water management strategies for the LA Zoo's master plan	The objective of this project is to reduce potable water use at the zoo by assessing areas where stormwater can be collected and recycled water can be used for exhibits, washing animals, and irrigation. Once studies have determined how recycled water can safely be used for animals, this information would be shared widely with zoos and animal shelters.

Figure 7: Projects categorized as current integration opportunities.

LITERATURE REVIEW

DISCUSSION

Proposed projects were assessed for how well they meet the following goals:

- Minimize cost
- Maximize environmental benefit
- Maximize institutional collaboration
- Maximizing local water supplies (ES, p.33)

The result of this study was a portfolio of preferred projects, each with an average unit cost of $1,600 per acre-foot (ES, p.41). While some of these projects were already established or even partially executed, others were brand new (ES, p.35).

Project	Description	Water Yield acre-feet/year	Unit Cost per acre-foot
Dry weather low flow diversions	Diverts polluted urban runoff into the sewage system to be reclaimed, treated, and reused	6,200	$1,000
LA River recharge into LA forebay using injection wells	Retains water that would otherwise drain to the ocean and uses it to replenish the Central Basin groundwater aquifer	25,000	$2,100
Potable reuse via membrane bioreactors	Uses 100% of flow to the Hyperion Water Reclamation Plant for recycling, eliminating water loss to the ocean; water would be used for groundwater recharge and later extracted for potable reuse	95,000	$1,500
Potable reuse	Augments potable recycled water with raw water before treatment at the Los Angeles Aqueduct Filtration Plant	15,000	$1,500

Figure 8: The table shows examples of projects categorized as current integration opportunities.

LITERATURE REVIEW

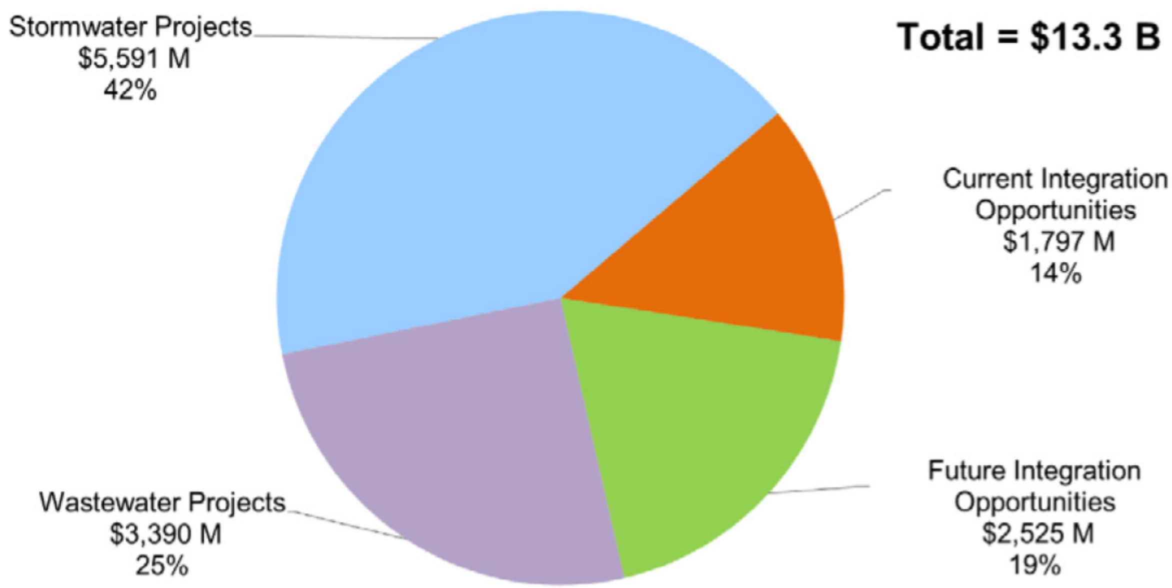

Figure 9: Total cost of all of the projects proposed by the One Water LA 2040 Plan.

CONCLUSION

The entire portfolio of prioritized projects is available to read and includes the lead and support agencies that are involved (ES, p.46). This list provides a solid overview of projects already in the works as well as proposed plans, many of which are highly relevant to the Los Angeles River. The table of project costs would be helpful to anyone aiming to estimate how expensive certain types of plans might be (ES, p.50). Additional useful resources can be found in the attachments to the Executive Summary:

- A glossary of terms related to water management, e.g., dry weather runoff, injection well, reverse osmosis
- A list of abbreviations used in this and similar reports, e.g., LASAN (Los Angeles Sanitation), GWR (groundwater replenishment), and SIP (stormwater improvement program)

HISTORICAL ECOLOGY OF THE LOS ANGELES RIVER WATERSHED AND ENVIRONS, 2020

Published by the Spatial Sciences Institute

INTRODUCTION

With major ecological restoration efforts currently underway and also actively being proposed along the Los Angeles River, sustainable development projects are in need of "reliable, evidence-based knowledge about the underlying natural ecology" (Historical Eco, pg. 1). Areas throughout the region where restoration projects are proposed or underway include areas along the Los Angeles River such as Ballona Wetlands, Baldwin Hills, and in the Lower Los Angeles River as it passes through Bell, Cudahy, and Downey (Ethington, pg. 2).

In a two-year long project, the research team behind the "Historical Ecology of the Los Angeles River Watershed and Environs" developed an evidence-based report on the historical natural habitats of the Los Angeles River and its watershed (Ethington, pg. 1). The project was funded by the John Randolph Haynes and Dora Haynes Foundation and established a knowledge base for public-use at a one kilometer scale (Ethington, pg. 1). The authors of the study saw a lack of knowledge of the surrounding and underlying ecology of the Los Angeles River, and were interested in knowing more about the history of the natural vegetation as well as the "ever-shifting rivers, tributaries, creeks, and the springs" (Ethington, pg. 2).

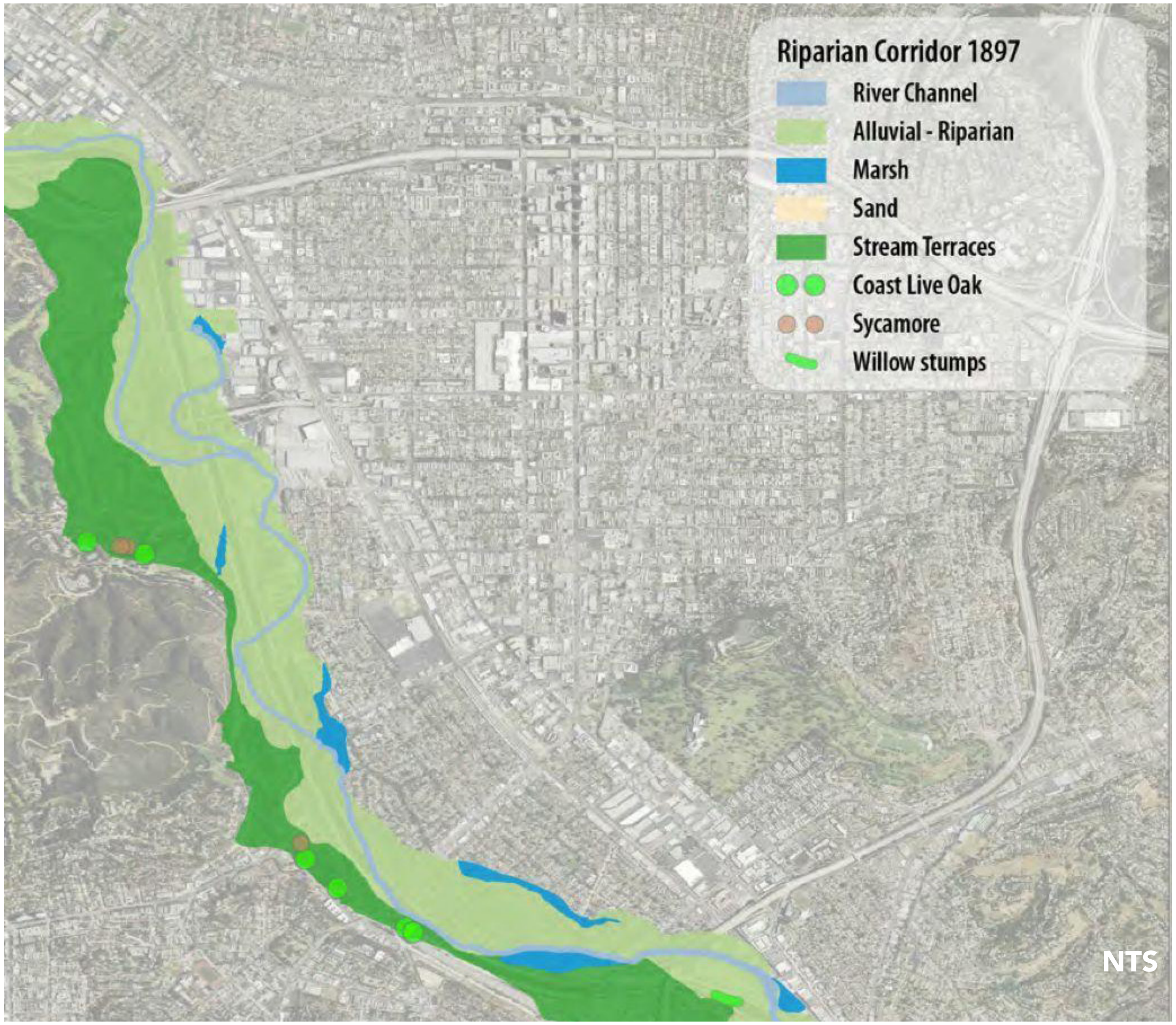

Figure 10: Habitats historically associated with the Los Angeles River through the Elysian Valley.

LITERATURE REVIEW

More specific questions came about pertaining to the historical ecology, such as: What was the natural extent of native oaks in the Los Angeles Basin? Other questions arose regarding flooding during the pre-channelization period; the distribution of grasslands, forelands, and scrublands; and the extent of perennial freshwater ponds in the foothills and plains (Ethington, pg. 2).

The report's team found it critical for development and restoration projects happening today to be informed by accurate information and extensive research about what "green" means in the Los Angeles Basin and what is "natural" in a place such as Los Angeles? (Ethington, pg. 2). The environmental history of the Los Angeles River and its watershed ought to have "a relatively uniform geographical knowledge base" with a "high degree of spatial resolution – down to the neighborhood scale" (Ethington, pg. 2).

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OBJECTIVES

The "Historical Ecology of the Los Angeles River Watershed and Environs" report's goal was to collect in depth information and create a framework that would be the basis of a detailed historical ecology study of the Los Angeles River watershed and environs. While the authors found existing maps documenting many features of the river, these maps did not provide results at a high spatial resolution to inform local restoration and management efforts (Ethington, pg. 8). The study sought out to establish a reliable account of the potential natural vegetation.

To achieve this goal of developing such a framework, the study created four objectives. These objectives included: 1. To discover and geolocate historical information in archives that had not previously been widely available to researchers; 2. To develop, test, and share an online mapping tool and associated spatial database to support sharing and analyzing historical information in many formats (maps, text, photographs); 3. To synthesize and describe the historical periods leading up to the modern era; and 4. To develop a map of the historical ecology of the Los Angeles River watershed and environs in the form of the potential natural vegetation at a 1-km square resolution (Ethington, pg. 9).

BACKGROUND

Development patterns have transformed the landscape of the Los Angeles Basin, making it challenging to find examples of the pre-urban natural ecosystem. This has resulted in misconceptions about the natural landscape of Los Angeles (Ethington, pg. 3). Knowledge of the historical ecology surrounding the Los Angeles River has been forgotten or misconstrued: "Memory has been lost of the hazardous power of natural water features, along with memory of the original extent of riparian flows through canyons, across floodplains, collected in wetlands, and returned to the sea in estuaries" (Ethington, pg. 3).

With growing interest and investment in green infrastructure of natural open spaces, restoration efforts of the Los Angeles River and its watershed are attracting attention. The authors of the report ask, "what is 'natural' in a place that has been continuously inhabited for at least 9,000 years, and urbanized for more than a century?" (Ethington, pg. 3). The study's goal was to collect data that is currently lacking in order to develop a geographical knowledge base at a high spatial resolution about the historical ecology of the Los Angeles River, documenting the extent of flooding, the natural conditions of the vegetation and natural habitats of the river and its watershed (Ethington, pg. 4).

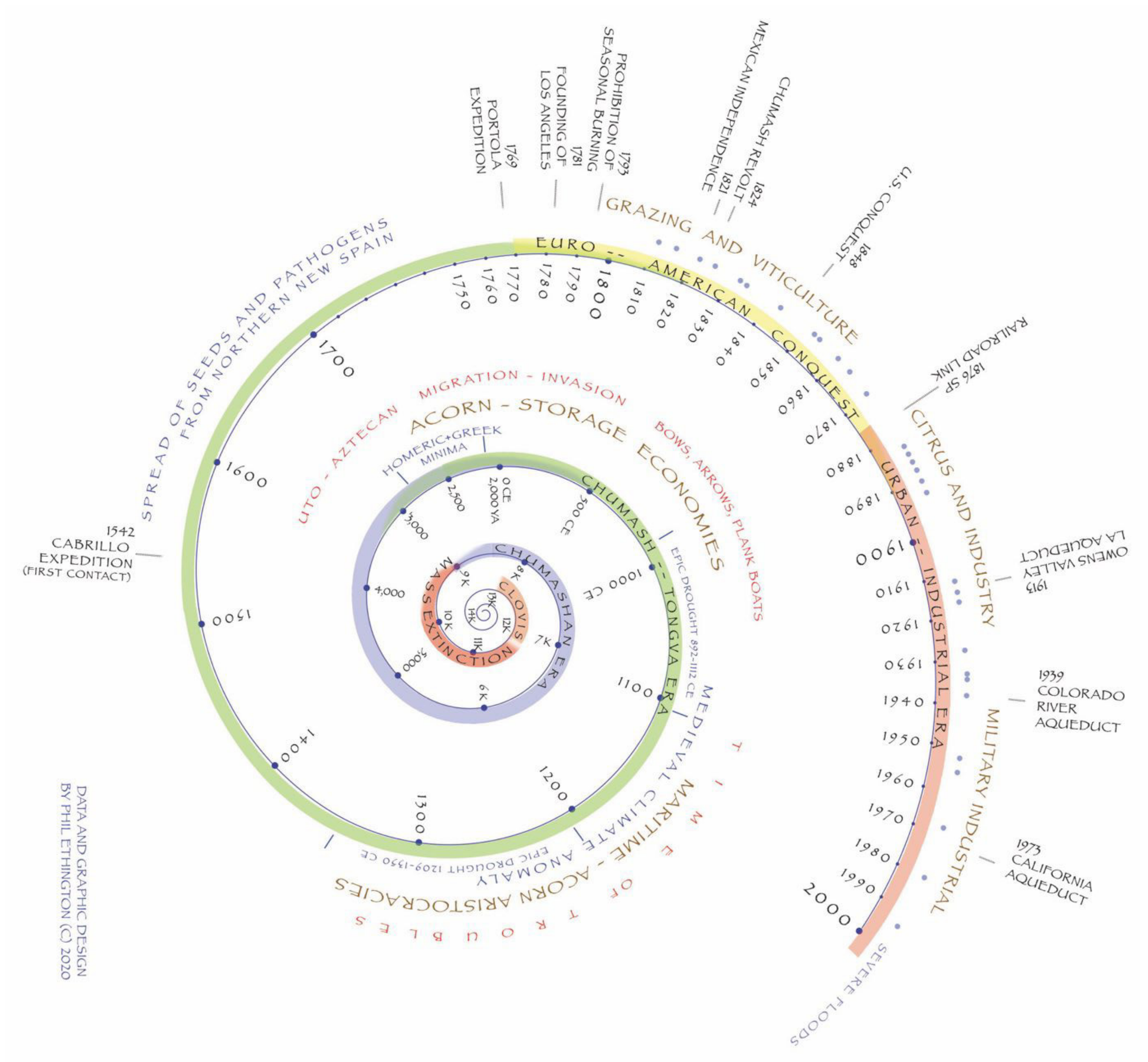

Figure 11: Historical Ecological Eras of the Los Angeles River within the South Coast Bioregion.

METHODOLOGY

To develop a historical ecology framework of geographical knowledge, the authors needed to establish a coherent chronology for the historical ecological eras. This included archival research that allowed the study's authors to decipher ecology compared across different time periods (Ethington, pg. 10). The main bodies of knowledge as defined by the report have been categorized for the Los Angeles region below:

1. Geologic and climate history
2. Ecological and environmental sciences
3. Human archeology, anthropology, paleolinguistics, and paleogenetics
4. Indigenous oral memory and eyewitness testimony
5. Euro-American historical eyewitness accounts during their conquest of the region and
6. Contemporary research into ecological dynamics and relict landscapes – native plant and animal communities where non-native invasive species have not become dominant (Ethington, pg. 14)

The ecological history of the Los Angeles River and its watershed is divided into four historical ecological eras with sub-periods that mark important shifts within each major ecological era (Ethington, p.16).

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The methodology used to conduct the study included archival research to "gain insight into the Los Angeles River as it was before heavy urbanization at the end of the 19th century" (Ethington, pg. 11). The methodological approach used with the archives "pinpointed certain selection criteria such as locations or infrastructure near the Los Angeles River, hydrological or geological sources, and any other types of materials that could help in understanding the ecology of the river and its watershed" (Historical Eco, pg. 11). Examples of sources found and incorporated into the report include surveyor field books, journals, archival maps, flood control reports, city ordinances and more (Ethington, pg. 12).

Geographic locations associated with historical information helped with the development of a geodatabase. As an initial synthesis of data amassed from the study, the research team developed a map of the historical ecology at the 1-km scale (Historical Eco, pg. 15). The development of the historical ecology map consisted of compiling "an extensive set of historical data in the form of maps, texts, and geolocated records of natural history observations" (Historical Eco, pg. 16). The methodology for the map includes macrogroup classification in order to consider regional topographic differences and provide a starting point to understand landscape processes in shaping vegetation patterns (Ethington, pg. 16).

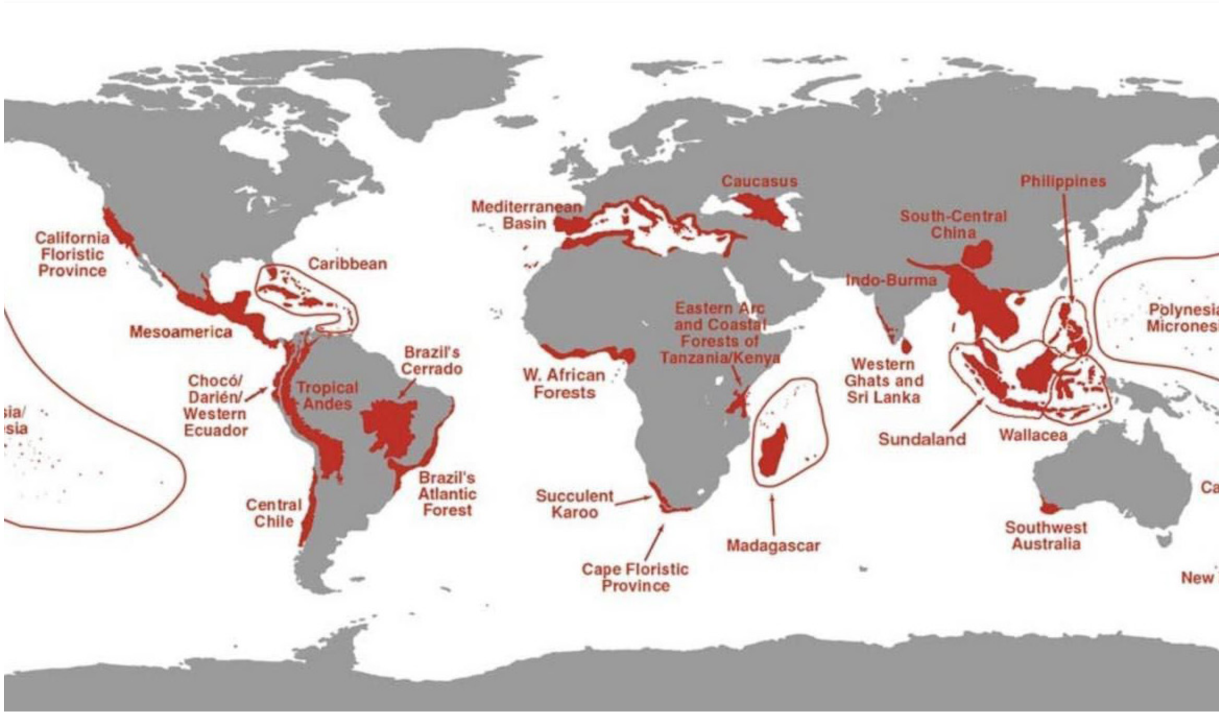

Figure 12: The California Floristic Province within the top 25 Global Biodiversity Hotspots. "As many as 44% of all species of vascular plants and 35% of all species in four vertebrate groups are confined to 25 hotspots comprising only 1.4% of the land surface of Earth.

DISCUSSION

The California Floristic Province is home to thousands of endemic plant and animal species. There are native plants as well as plants that are geographically restricted to the area (Ethington, pg. 21). Southern California is part of the Transverse Mountain Ranges, which run about 275 miles east to west from Point Arguello to the Mojave Desert with peaks exceeding 10,000 feet (Ethington, pg. 22). The five Transverse Ranges are: Santa Ynez, Santa Monica, Castaic (or Liebre), San Gabriel, and San Bernardino. Between ridges are watersheds and drainages. From northwest to southeast, these watersheds are: the Santa Ynez, Ventura, Santa Clara, Calleguas, Los Angeles, San Gabriel, and Santa Ana watersheds (Ethington, pg. 22).

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The Los Angeles River and its watershed "lies at the very center of this region and shares every one of its sub-regional ecological zones, from saltwater estuaries to coastal shrublands, chaparral scrub, oak savannas, prairie flower fields, and montane coniferous forests" (Ethington, pg. 22).

Understanding potential natural vegetation, in landscapes such as the Los Angeles Basin, "provides a reference point to understand the distribution and effects of the long period of human occupation, and guideposts to understand the processes that shape the landscape and could be incorporated into future ecological restoration and management" (Ethington, pg. 16).

CONCLUSION

This study set out to develop a framework for providing a reliable and accessible geographical knowledge base on the historical ecology of the Los Angeles River and its watershed. The authors also wanted to ensure this data was at a high degree of spatial resolution. According to the study, the vegetation along the Los Angeles River appears to have been a mix of types, depending on the gradient and hydrology (pg. 70). The study created a map of potential natural vegetation – a hypothesis, based on the information currently available and on the study's interpretation of that information. Potential natural vegetation can help to

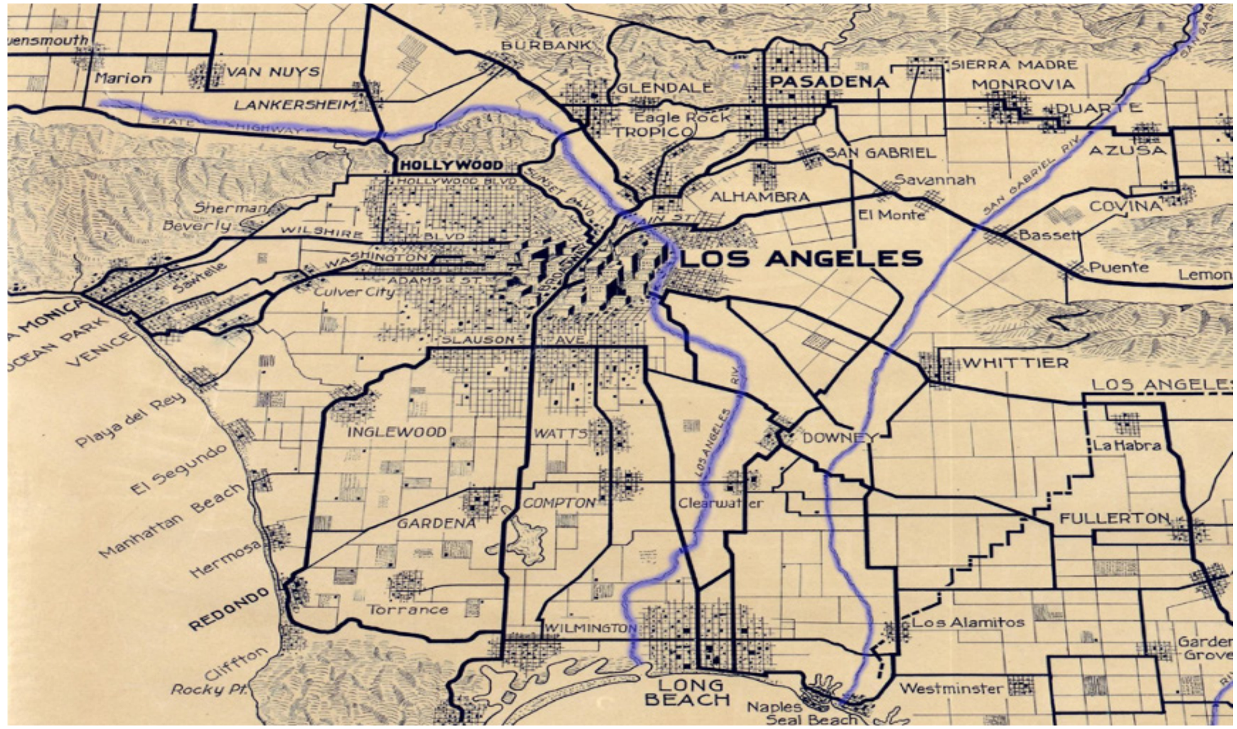

Figure 13: Uneven Urbanization: The Auto Club of Southern California Map of 1915. (Detail, rivers added).

describe a landscape's conditions that do not exist, highlighting the types of habitats "most lost to urban development and to help interpret the units (ecotopes) of the modern landscape" (Ethington, pg. 72).

From the study, the report's authors classified 3,197 1-km 2 blocks in the study area by potential natural vegetation. The most common macro groups were California Chaparral and Coastal Sage, making up 63% of the landscape. The Foothill and Valley Forests and Woodlands made up 9% of the study area, while riverwash and riparian forest made up 7%. Grasslands and flower fields were 13% of the landscape, and open wet meadows and alkali meadows (or Salt Marsh Meadows) made up 4% (Ethington, pg. 67). The cultural history and the underlying function of the landscape is necessary and critical to the future planning of sustainable development and restoration projects (Ethington, pg. 75).

LOWER LOS ANGELES RIVER REVITALIZATION PLAN, 2018

Published by Los Angeles County Public Works

INTRODUCTION

In 2015, the California State Assembly Bill 530 (AB530) was passed with the goal of reviving the lower Los Angeles River (the river) through the development of watershed-based, equitable, community-driven plan. The bill called for Secretary John Laird of the Natural Resources Agency to consult with the Los Angeles County Board of Supervisors to appoint individuals to participate in the Lower Los Angeles River Working Group. This working group was chaired by the San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy. Under the direction of Los Angeles County Public Works, city representatives, consultants, and the community came together to create the Lower Los Angeles River Revitalization Plan (the Plan) (LLARRP Vol. 1, p.3).

The Lower Los Angeles River Plan addresses the 19-mile corridor within one mile on either side of the river from the City of Vernon to the estuary in the City of Long Beach. Within this corridor 64.1% of households are considered low-income and are more environmentally disadvantaged than 90% of Californians (LLARRP Vol. 1, p.21). The goals of this plan fall into three main categories: Community Economics, Health and Equity; the Public Realm; and Water and Environment (LLARRP Vol. 1, p.24).

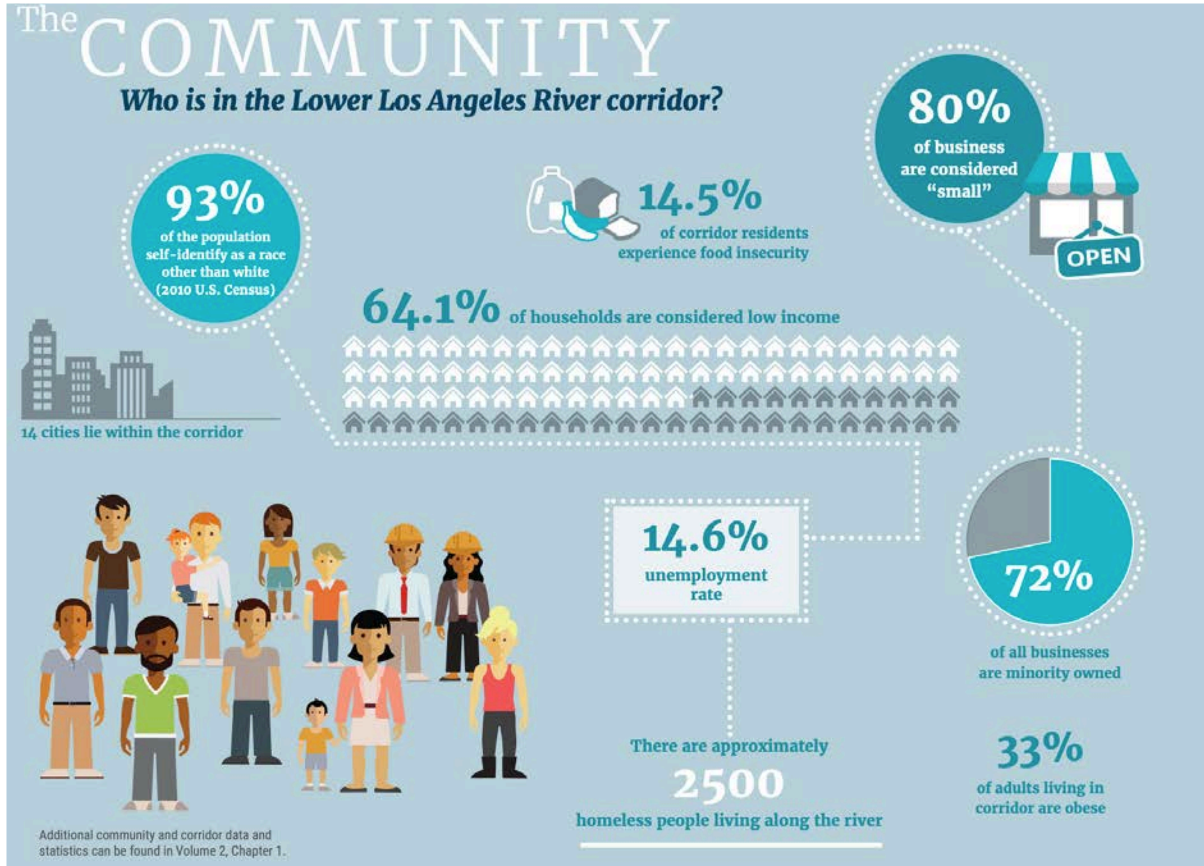

Figure 14: The Community of the Los Angeles River.

OBJECTIVES

The Community objectives are focused on preventing gentrification through thoughtfully developed commercial development plans, addressing homelessness by preventing residential displacement, increasing equitable community river access, promoting health equity and wellness, supporting existing businesses, and increasing community green infrastructure. The objectives

LITERATURE REVIEW

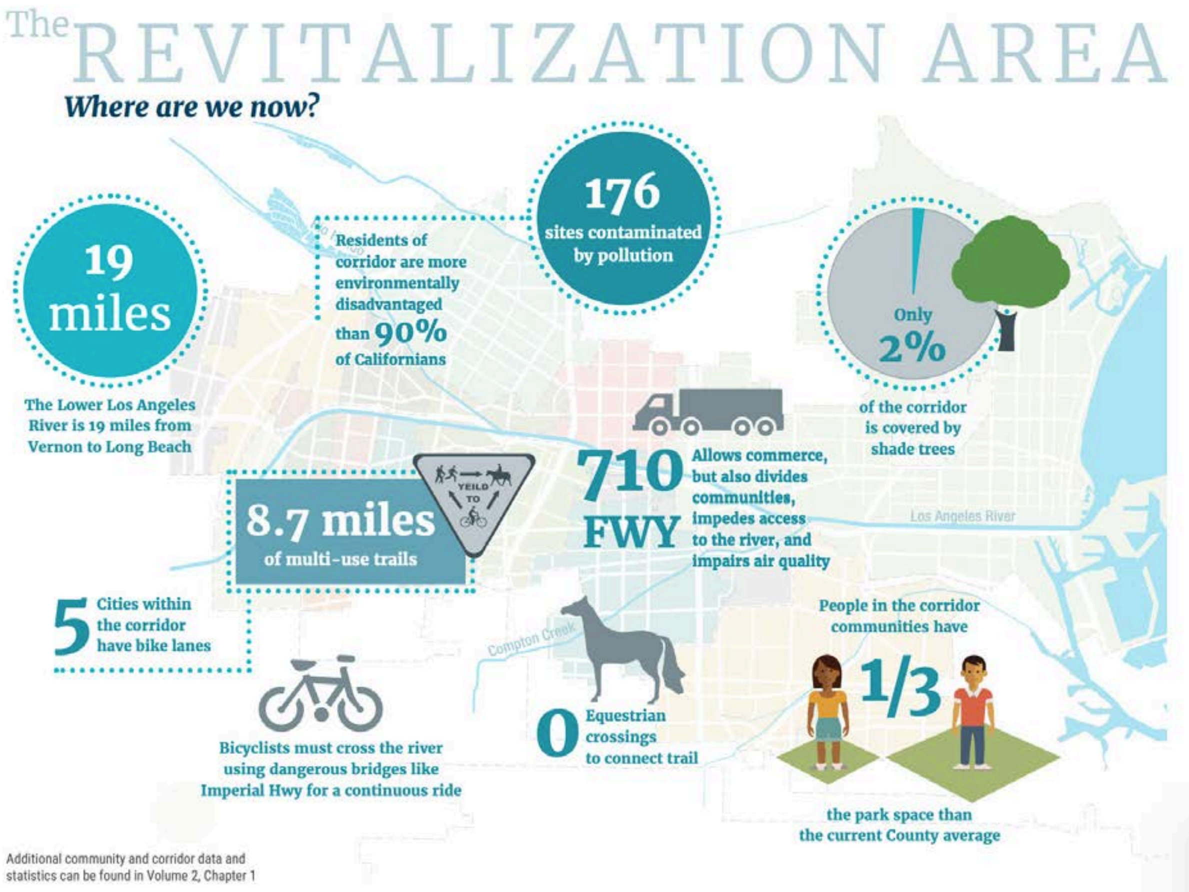

Figure 15: The River Area of the Los Angeles River.

for the Public realm include enhancing connectivity by improving and expanding connections like streets, bike paths and multi-use trails, creating and enhancing vibrant public spaces, and by increasing access to the river as a place of enjoyment. The objectives seek to also increase public safety and offer various amenities along the river like restrooms, picnic tables, lighting, signage, and equestrian amenities (LLARRP Vol. 1, p.72).

The plan objectives for the Water and Environment component consist of protecting life and property though flood management while also prioritizing floodplain reclamation, enhancing local water capture and use, improving ecological and recreational benefits by using nature-based solutions to capture pollutants and improve air quality, and restoring biodiverse, climate-resilient ecosystems. Including native species of plant life being implemented both in-stream and upland (LLARRP Vol. 1, p.135).

This plan makes it clear that its intentions are to serve as a guide for how revitalization can be advocated for by the community, nonprofit organizations, or government agencies. This plan is not meant to be a master plan for the lower Los Angeles river, but rather show how through advocacy and partnerships, revitalization can extend beyond levees of the river into the surrounding neighborhood and have a positive impact on these communities now and in the future (LLARRP Vol. 1, p. 137).

BACKGROUND

From around 5,000 BCE to the 1700's, the Tongva and Yangna Native American tribes build villages and live along the River. This begins to change with the infiltration of the Spanish explorations throughout the later 1700's and in 1781, El Pueblo de la Reina de Los Angeles is founded where Olvera Street is today. This caused infrastructure to being to be developed from this point along the river

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and surrounding area. In 1825 a massive flood cut a new path south of the pueblo to San Pedro Bay-the path that is the most like the path the river has today (LLARRP Vol. 1, p. 6).

Throughout the late 19th and early 20th centuries development takes off in the Los Angeles region resulting in many homes and businesses being built within the floodplain of the river. At this time many bridges and roads were also installed along the river only to suffer when floods continued to happen in the early 1900's, wiping out much of the infrastructure and killing many (LLARRP Vol. 1, p.7).

In 1934, after a devastating flood, the decision to channelize the river with concreted was approved and the Army Corps of Engineers began channelization in 1935. It wasn't until 1989 that the first task force was established to look at potential River improvements. In 2007 the City of Los Angeles adopted the Los Angeles River Revitalization Master Plan and in 2015 Assembly Bill 530 was adopted to establish the Lower Los Angeles River Working Group (LLARRP Vol. 1, p.9).

METHODOLOGY

The Lower Los Angeles River Revitalization Plan (LLARRP) was designed to be a watershed-based, community-centric plan that addresses both the needs of the Los Angeles River and the communities it runs through (LLARRP, p.27).

The first step in the process was conducting an assessment of the river as it applies to each objective of the plan in the following areas:

Community Economics, Healthy, and Equity

- Prevent local gentrification-induced displacement:
- Address homelessness
- Support/develop local business/workforce
- Increase equitable community access to multi-use trails, bike-way, and assets
- Promote wellness and physical activity
- Increase nature-based solutions

Public Realm

- Enhance connectivity
- Improve user experience and equitable access
- Enhance and create diverse public spaces
- Summary of public baseline conditions

Water and Environment

- Manage flood risk
- Enhance local water capture and use
- Improve environmental quality
- Conserve, enhance, and restore habitat, biodiversity, and floodplain functions
- Summary of water and environment baseline conditions

After this assessment, the Working Group was tasked with was getting the community involved and soliciting ideas and inspiration from the community to help systematically identify locations suitable for strategies that address the full range of goals and objectives for the areas in and around the LA River. Via the numerous meetings and community outreach events, the Working Group was able to identify 145 Opportunity Areas that have the potential to be developed into revitalization projects aligned with the guiding principles of the LLARRP. This phase of planning was especially useful for the project goals pertaining to Community Economic, Health and Equity and the Public Realm (LLARRP Vol. 1, p.34).

To address the goals pertaining to Water and Environment, a comprehensive assessment was done of the suitable areas within the riverbed itself where pollutants should be addresses as well as how to improve the environmental quality. The baseline conditions were summarized with respect to mitigation of water quality, improvement of wet and dry weather quality, and increasing the areal extent of green stormwater infrastructure (LLARRP Vol. 1, p.47).

DISCUSSION

As a result, from the many community meetings, the Plan identified 155 different project sites within a mile of the Los Angeles River that could be suitable for meeting the community goals of providing more park equity and access to residents with these cities along the Los Angeles River corridor. Each potential project was assessed via an opportunity assessment that identified which

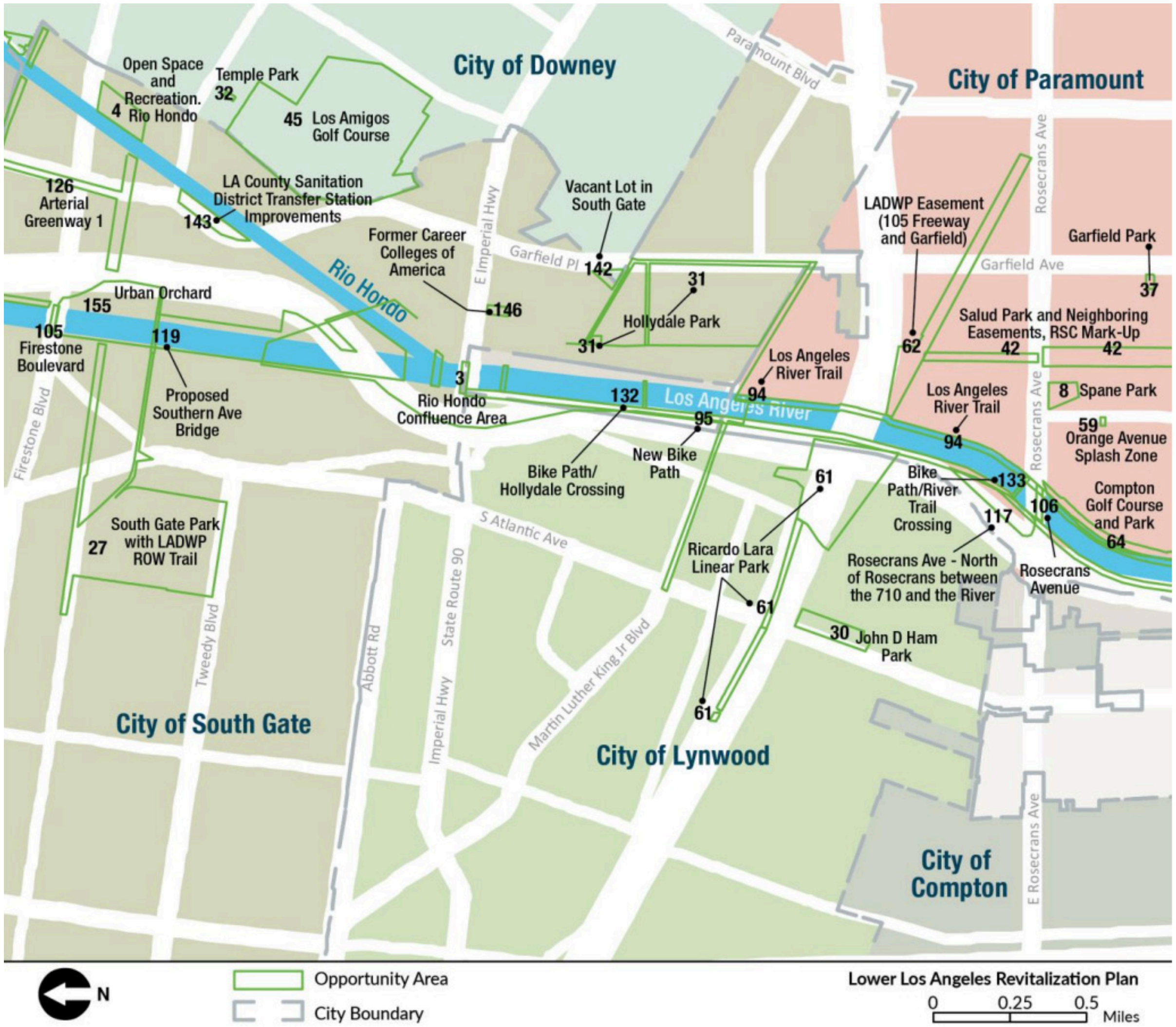

Figure 16: Opportunity Areas identified by the Working Group.

plan elements the project fulfills as well as potential implementations that help fulfill these objectives. The potential list for each project has 67 building block opportunities to attempt to achieve the Plan goals. Some of these include provision of active space, boardwalks and overlooks, commercial zone access and the use of tactics like bioswales, floodplain expansion, infiltration basins and trenches, habitat corridors and more (LLARRP Vol. 2, p.3.3-3).

In addition to these recommendations for site criteria, the Plan also recommends various interventions pertaining to water and environment. One of these is the placement of stormwater infrastructure throughout the watershed as a valued outcome of the LLARRP. Green stormwater infrastructure can include systems that use natural process to improve the hydrologic and water quality function of developed landscape and help restore these functions closer to pre-development conditions of the river (LLARRP Vol. 2, p. 3.3-14).

The plan suggests using the implementations in Long Beach, Compton confluence, Los Cerritos, Dominguez Channel and upper Los Angeles River as examples to identify known and planned green stormwater infrastructure projects as a model. Several Wetlands Modification Projects recommend implementation of green stormwater infrastructure on all suitable public parcels. This would assist with remediation of contaminated sites and would address the objectives of the Plan for new open space and ecological restoration. Along the lower Los Angeles River, the parcels identified as brownfields constitute a baseline of approximately 460 acres of potentially contaminated parcels. Implementation of green infrastructure could restore these sites to more functional wetlands areas (LLARRP Vol. 2, p. 3.3-17).

CONCLUSION

Restoration of biodiverse and self-sustaining ecosystems under the Plan objectives could focus on protecting species that are currently threatened or endangered. Defining the species at risk will help ensure that strategies pursued in the lower Los Angeles River will not adversely impact the habitat on which these species rely. The U.S. Fish and Wildlife Service lists 55 species of plants and animals that are presently recovering, threatened, or endangered in Los Angeles County. Of the 55-species listed, nine baseline species of threatened and endangered plants and animals have notable occurrences within the LLAR (LLARRP Vol. 2, p. 3.3-24).

The Los Angeles River Ecosystem Restoration Environmental Impact Summary determined that although most special species identified in Los Angeles County were unlikely to occur due to small sizes of the habitat areas and their fragmented nature, species that were highly mobile and those that could survive for particular periods of their life history in small and possibly temporary habitat patches may occur. Species that would generally fit these criteria are migratory birds, and of these, species such as the yellow-breasted chat (Icteria virens) and the yellow warbler (Sensu lato) are most likely to utilize the remaining riparian habitat left in the riverbed. These species nest in scrubby patches of willow and have been identified nesting in the river. Other species that utilize open areas or shallow water habitat may also occur. The LLARRP can potentially impact this baseline condition by implementing measures to protect existing habitat and creating new habitat to reduce stressors on endangered and threatened species.

LITERATURE REVIEW

GRASS II: GREENWAYS TO RIVERS ARTERIAL STORMWATER SYSTEMS, 2018

By F. Chang, J. Harnish, E. Rowan, and T. Vail

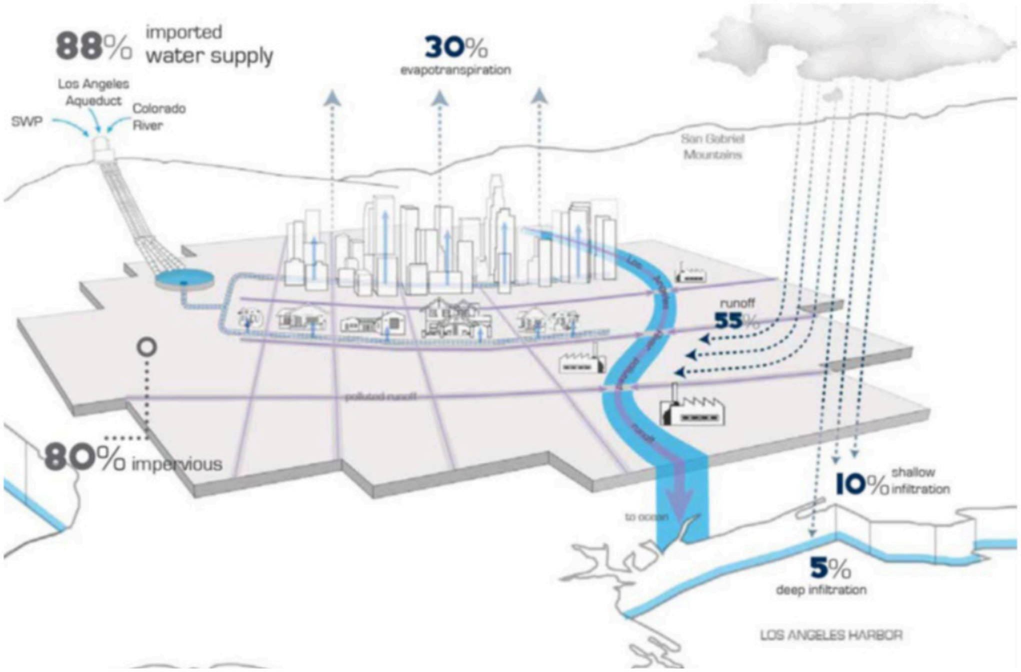

Figure 17: Urban water cycle.

INTRODUCTION

Greenways to Rivers Arterial Stormwater System Phase II (GRASS II) is a tool meant to strategize the maximum potential of stormwater project within the Los Angeles River, Dominguez Channel, and Ballona Creek Watersheds via an integrated system. The partner involved was the City of Los Angeles-Bureau of Sanitation (LASAN), Watershed Protection Program. It is their primary goal to supplement Enhanced Watershed Management Plans (EWMPs) with a holistic strategy that helps meet water quantity modeling projections and stormwater runoff pollution reductions.

The Los Angeles River is directly impacted by urban runoff from over 88 cities in Los Angeles County due to the separate storm systems of the various municipalities. Stormwater systems in Los Angeles County are well designed to transport runoff quickly to waterways and prevent large-scale flooding. While this is an effective technique for limiting flooding risks, the channelization of the Los Angeles River and the region's waterways fails to address the needs for recharging the aquifer and cleaning water resources.

Channelization is not a sustainable model for the future of Los Angeles as it does not utilize or facilitate stormwater capture nor sub-surface storage or groundwater recharge. Furthermore, county streets and stormwater infrastructure systems retain pollutants such as automobile and pet waste, resulting in urban runoff that concentrates contaminants over the dry season, and then rapidly moves them to receiving waters via the Los Angeles River during rainfall events.

This project focuses on the identification of four primary stormwater greenways within the comprehensive stormwater network to connect the upper Los Angeles River Watershed with the lower Los Angeles River, Ballona Creek, Santa Monica Bay, and Dominguez Channel Watershed to develop a strategy to manage stormwater within the Greater Los Angeles Area while maximizing the social, economic, and environmental benefits for the region.

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OBJECTIVES

Just one-inch of rainfall in a typical 24-hour storm event in Los Angeles County can produce over 31,000 acre feet of stormwater. It is critical that an intentional urban arterial storm water management system be implemented, and it has so much potential positive impact in this area. *"Public lands, excess street rights-of-ways, power line corridors, and other under-utilized spaces can be used to provide recreational and habitat connections that capture, filter, and infiltrate stormwater."*

Though the main objective of this plan study is rooted in water conservation and water quality, the other project goals are to identify potential available space within cities for stormwater and other sociocultural needs like recreation and economic revitalization, incorporate existing and planned stormwater projects along transportation networks, and improve urban ecology to enhance biodiversity, mitigate urban heat island effect, and increase carbon sequestration. Additional project objectives include:

- Connect stormwater projects with supply-use benefits into a self-regulating infrastructure
- Achieve concentration and load reduction objectives for the waterways
- Create surface BMP systems that enhance performance and function

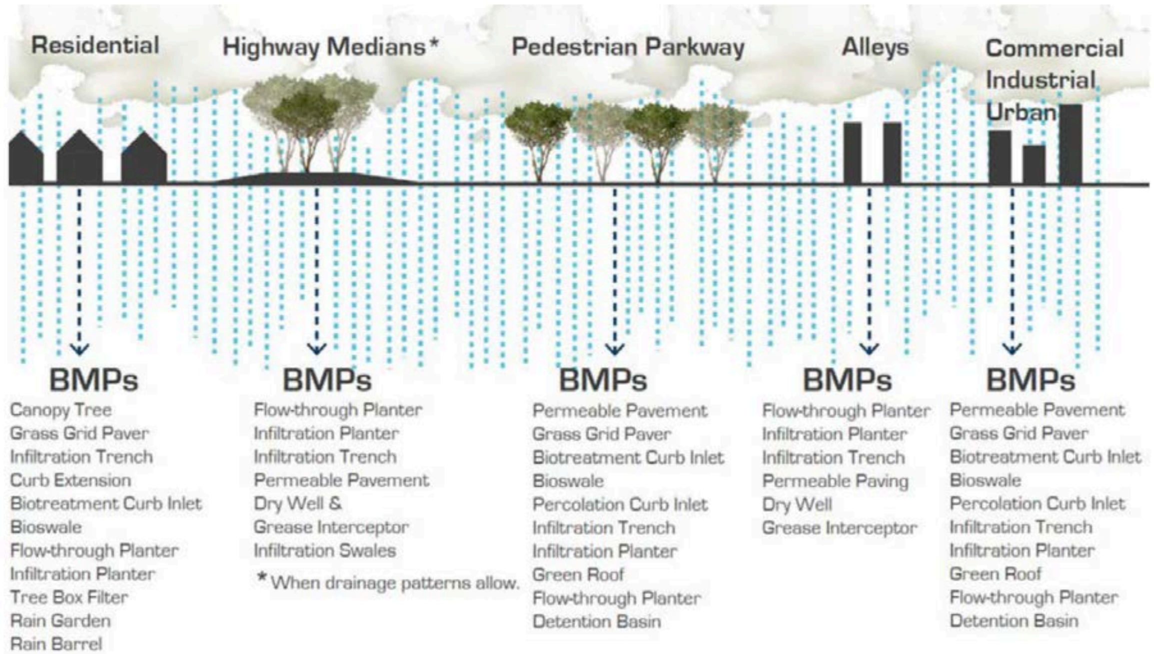

Figure 18: Best management practices categorized by location.

- Build green infrastructure systems to have benefits exceed hydration needs
- Reduce reliance of public landscapes on potable water
- Build alternative water supplies for vegetation and buffer extremes in climate and air quality
- Infiltrate water where systems can ensure upstream pollutant removal
- Increase filtration via bioretention treatment to improve water supply, quality, and reliability
- Provide increased storage capacity to support vegetation and mitigate flooding

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BACKGROUND

By the 1930's much of Los Angeles previously open space and underdeveloped land was transforming into impervious urban infrastructure like buildings, roads and sidewalks. This imperviousness increased the pollution and the quantity of runoff from storm events with the 4,000 square mile Los Angeles Basin. This quickly began to overwhelm local waterways like the Los Angeles River, increasing their flooding frequency and causing widespread damage. This is what led to the river becoming encased in concrete and essentially converted to a drainage ditch.

Today the increase in impervious surfaces has greatly altered the water cycle, reduced stormwater infiltration, and polluted runoff. Untreated stormwater runoff containing pesticides, fertilizers, and household chemicals flows into the river with natural processes or filtration that previously occurred in natural flood plains. Channelized waterways do not contribute to natural process of filtration or groundwater recharge, and pollution reducing that are a part of natural hydrological systems are essential for maintaining healthy ecosystems and watersheds.

The impacts of these past stormwater management practices on public health and welfare, economy and the environment are the impetus a for a fundamental rethinking of stormwater management in Los Angeles. With Los Angeles County's Municipal Separate Storm Sewer System, widespread Enhanced Watershed Management Programs would require the use of low impact development (LID) to take under-utilized land such as parkways, right-of-ways, street medians, and power line corridors for the provision of future large-scale stormwater management systems.


Figure 19: Results of the 1938 Flood (scouring, infrastructure collapse, channel breaches and widening).

METHODOLOGY

The GRASS II project is a result of iterative GIS data modeling and discourse with professionals in various disciplines.

The first step of the process was research and analysis to identify opportunities, policy constraints, and use conflicts. This involved quantitative GIS data analysis with a baseline system investigation as well as a participatory urban assessment with local professional discourse resulting in initial GIS data layer inventories.

From there, GIS data was used to identify arterials within the watershed network that were suitable to become potential greenways. These stormwater greenways were refined through expert input at a Participatory Urban Assessment and categorized by clean water storage opportunities and high ecological value. The next step was impact analysis to assess performance stormwater greenway systems as a whole and fully connect primary stormwater greenways.

1. Stormwater Impact: hypothetical right-of-way-cross-sections were proposed to facilitate stormwater capture estimates and impact analysis to make calculations based on minimum, moderate and maximum storage along the SWG Network.
2. Biophysical Impact: increases in vegetative cover, tree canopy, and the replacement of impermeable surfaces with mulched, vegetative, or permeable surfaces to identify the impact of the GRASS II network on climate change and the urban heat island effect were assessed in this analysis.

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3. Sociocultural Impact: evaluated the performance of the SWG network regarding its contribution to human quality of life factors like walkability and trail and open space access.

Taking these analyses into consideration, the final step was to develop site design options of green infrastructure. GRASS II developed a hierarchy of implementation approaches that differentiate between user populations, number of users and impact on aesthetics, park poverty level, location in roadway corridor, and land use types.

RESEARCH QUESTIONS

As part of the method used for assessing potential primary and secondary stormwater greenway networks, three main research questions were posed over the course of three participatory events with experts in several related fields. The questions included:

1. What criteria should be used to locate the SWG (and why those criteria)?
2. Where should the origin and terminus points be located (and why those locations)?
3. What routes should be considered for the SWGs (and why those routes)?

DISCUSSION

Mapping for GRASS II involved GIS refinement of criteria for locating the stormwater greenways, selecting origin and terminus points, identifying alternative routes to get from those origin points to the Santa Monica Bay or Port of Los Angeles. These routes were evaluated based on environmental, stormwater, and sociocultural rationales, and maximizing the impact of the routes by adjusting them within a ½ mile distance.

Stormwater BMP's consist of unit water collection or infiltration tools, or a treatment train of connected tools on a single site to maximize infiltration opportunity. GRASS II seeks treatment approaches that conceptualize stormwater infiltration from the micro scale to site scale, to regional scale. Treatment trins can be designed to connect a series of BMP's into "green" corridors at any scale. These BMP's are usually located along roadways because roads are crowned to drain water to the gutter which transports it to catch basin and pipes. Roadways provide adjacent supportive systems to move water off private land and into the public realm of the street. By connecting these linear components to large adjacent land parcels that create spreading grounds or bioretention areas, collected water can be efficiently used, stored, and infiltrated.

Tree canopy was also considered of high priority by experts as it can address air and water quality, remove particulates, provide habitat, support active transportation to school and increased exercise as a result of shade), mitigates urban heat island effect, sequesters carbon, prevents erosion, and assists in the infiltration of water.

The other important elements GRASS II took into consideration were the community, park poverty, and vegetation density. Sensitive populations along waterways will benefit from safer physical environments created by stormwater greenways and have the potential to give park poor communities linear corridors with park-like environments. Vegetation is a key tool for enhancing pollutant removal through phytoremediation and can make a huge impact when implemented with green infrastructure in vertical and horizontal density plantings.

GRASS II can help with the understanding of how to naturalize the Los Angeles River in a variety of ways. First, the GRASS corridors can be used to collect and store water for later use, especially in areas with open channel river cross-section. In waterway adjacent areas, large cisterns have the potential to capture deflected flows from wet wells and/or rubber dams as to regulate flow and storage and prevent flooding. During flood events, elevated flow levels would be directed into a series of cisterns for storage and reuse purposes. As calculated based on the average depth of groundwater along the waterways segments, each cistern would have the storage capacity of approximately 0.3 acre feet, and when combined, the cisterns comprise a system capable of storing approximately 75 acre feet of captured runoff per square mile of SWG.

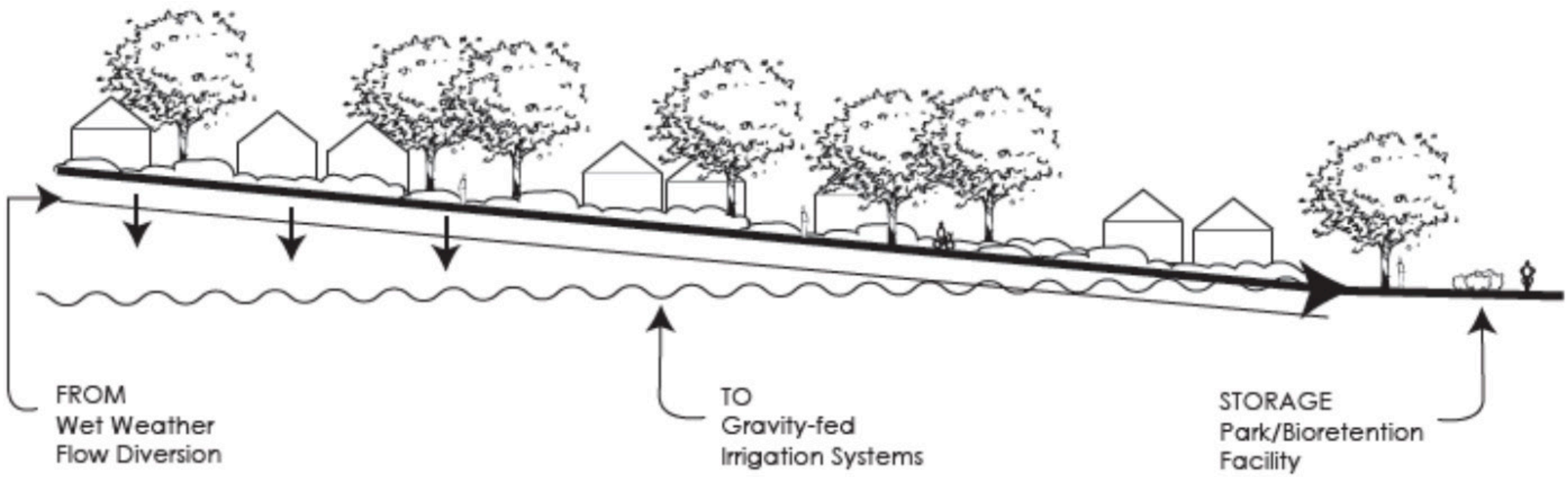

Figure 20: Flow Diversion diagram.

CONCLUSION

GRASS II is a flexible stormwater management approach that supports phased implementation of best management practices to create green infrastructure corridors. The goal is to help resolve water supply and use issues in Los Angeles while providing sociocultural, economic, and environmental benefits.

These projects help balance irrigation deficits and built a new urban reality that functions like nature; creating a closed system of water collection and use in the Los Angeles metropolitan area.

LITERATURE REVIEW

FLOODPLAIN MANAGEMENT PLAN, 2020

Published by Tetra Tech for the City of Los Angeles Department of Public Works

INTRODUCTION

While the City of Los Angeles has adopted mitigation and flood control plans, due to the history of flooding in the region it is endlessly seeking additional ways to mitigate flood impacts throughout the city (FMP, p. xv). The city is a participant in the "Community Rating System" and can use an updated management plan to work towards significantly reducing flood insurance premiums (FMP, p. xv).

A floodplain management plan sets the course for reducing the risk to life and property associated with flooding (FMP, p. 2-3). The plan is developed in order to achieve all below:

- Ensuring that all possible floodplain management activities are reviewed and implemented so that local problems are addressed by the most appropriate and efficient solutions.
- Ensuring that floodplain management activities are coordinated with one another and with other community goals and activities, preventing conflicts and reducing the cost of implementing each individual activity.
- Coordinating local floodplain management activities with federal, state and regional programs.
- Educating residents on the flooding hazard, loss reduction measures, and the natural and beneficial functions of floodplains.
- Building public and political support for mitigation projects.
- Fulfilling planning requirements for obtaining state or federal assistance.
- Facilitating the implementation of floodplain management (FMP, p. 2-3).

The City of Los Angeles 2020 Floodplain Management Plan identifies 78 hazard mitigation actions in order to meet the above objectives (FMP, p. xvi). The Floodplain Management Plan develops measures to mitigate potential flood problems throughout the region. These measures serve the purpose of reducing and preventing loss of life, personal injury, and property damage that can result from flooding. The Plan measures consist of strategies such as planning, policy changes, programs, projects, and other activities to mitigate the impacts of floods (FMP, p. 1-1).

OBJECTIVES

The study's objectives are defined as:

1. Provide, improve and maintain flood protection.
2. Use the best available data, science and technologies to improve understanding of the locations and potential impacts of flood hazards, the vulnerability of building types and community development patterns, and the measures needed to protect life and safety.
3. Minimize the impacts of flood hazards on current and future land uses through implementation of appropriate codes, standards, and ordinances.
4. Retrofit, purchase, and relocate structures that are in flood hazard areas, especially those known to be repetitively damaged.
5. Maintain or enhance early warning emergency response systems, evacuation procedures, training and equipment.
6. Increase resilience and continuity of operations of critical facilities and infrastructure.
7. Pursue effective and efficient approaches to reducing stormwater runoff, protecting water quality and water resources.

8. Increase public awareness of existing flood risks and the means to reduce these risks by conducting educational and outreach programs.
9. Encourage and support leadership within the private sector, nonprofit agencies and community-based organizations to promote and implement local floodplain management activities.
10. Anticipate and minimize effects of climate change on flood risk.
11. Minimize adverse impacts from flood risk on vulnerable communities (FMP, p. xviii).

In order to achieve these objections, the plan adheres to mitigation actions. These mitigation actions are defined as "*activities designed to reduce or eliminate losses resulting from the impacts of flooding*" (FMP, p. xix). The action plan is a key component of the Floodplain Management Plan. The mitigation strategy and action plan is how Los Angeles can stay on course to become and remain flood disaster-resilient.

BACKGROUND

Most of Los Angeles is built within floodplains and mountains or near the ocean (FMP, p. 3-1). Its climate is characterized by warm, dry summers and cool, wet winters. Temperature and precipitation vary considerably with elevation, topography, and distance from the Pacific Ocean (FMP,p. 3-4). A storm producing moderate rainfall on the coast (1 inch during a 24-hour period) may produce very heavy rainfall in the mountains (10 to 20 inches during the same 24-hour period). According to the report, "*all citizens and businesses of the City of Los Angeles are the ultimate beneficiaries of the FMP2020". The City of Los Angeles has participated in the CRS (community rating system) since 1991. The principal activities of the CRS have had to do with floodplain management planning and implementation. In November 2001, the City adopted its first floodplain management plan; this plan identified flood-prone areas and established goals to reduce flood related hazards to "protect the natural and beneficial functions of the City's floodplains*" (FMP, p. 1-1). The floodplain management plan requires the participation and accountability of stakeholders on all levels – private property owners, business, industry, and local, state and federal government.

The FMP2020 was developed to meet the following objectives:

1. Comply with local, state and federal requirements for floodplain management planning.
2. Meet requirements allowing the City of Los Angeles to enhance its CRS classification.
3. Coordinate existing plans and programs to fund and implement high-priority floodplain management measures.
4. Create a linkage between the FMP2020 and established plans of the City of Los Angeles so that they can work together in achieving successful mitigation (FMP, p. 1-3).

METHODOLOGY

The methodology used for this study included a six phase comprehensive risk assessment as well as a plan development methodology (FMP, p. 2-1). The process consisted of planning, committees, collaborating with other agencies, public meetings, and outreach (FMP, p. xvi-xvii).

The Flood Hazard Risk Assessment involves the process of measuring possible loss of life, personal injury, economic injury, and property damage resulting from natural hazards such as flooding. It helps with establishing early response priorities by identifying potential hazards and vulnerable assets. This plan's risk assessment used available data, science and technology, along with tools that included GIS and FEMA's risk assessment platform, Hazus-MH. Hazus-MH is a program that includes extensive inventory data and uses multiple models to estimate potential losses from natural disasters. The Hazus-MH program maps hazard areas and estimates damage and economic losses for buildings and infrastructure (FMP, p. 3-2).

Some key findings from the risk assessment of this plan included:

LITERATURE REVIEW

- There were 15 flood events in Los Angeles County (including the City of Los Angeles) that caused sufficient damage to trigger a presidential disaster declaration from 1969 through 2018.
- The City of Los Angeles includes over 16,000 acres of mapped floodplain for recurrence intervals up to the 500-year flood event that encompasses over 30,000 structures, most of which are residential (FMP, p. 3-2).

The Community Rating System is a program within the National Flood Insurance Program that encourages floodplain management activities that fulfill the program goals of reducing flood losses, facilitating accurate insurance rating and promoting awareness of flood insurance. The activities are in four categories: 1. Public information; 2. Mapping and regulations 3. Flood damage reduction; and 4. Flood preparedness. The City of Los Angeles has participated in the rating system program since 1991 and has a Class 7 rating; this means that "citizens who live in a 100-year floodplain can receive up to a 15-percent discount on their flood insurance; outside the 100-year floodplain they receive a 5-percent discount" (FMP, p. xvi). To maintain or improve its rating, the City of Los Angeles must go through recertification annually and a re-verification every five years (FMP, p. xvi).

DISCUSSION

Plan implementation will be the proof of the Floodplain Management Plan's effectiveness. Its action items must be incorporated into existing local plans and policies. The plan's action items and programming provide a framework for activities that the City of Los Angeles can put into progress over the next five years. The established goals and objectives prioritize mitigation actions to be implemented through existing programming and policies. The City of Los Angeles Department of Public Works Bureau of Engineering will oversee the FMP2020 implementation, although the implementation and evaluation will be a shared responsibility among identified lead agencies in the mitigation action plan (FMP, p. 15-1).

The annual progress report will involve evaluation of the plan and implementation by a steering committee that will rate the progress of the action plan during a year-long performance period (FMP, p. 15-2). The review will include the below:

- Summary of any flood hazard events that occurred during the performance period and the impact these events had on the City of Los Angeles
- Review of mitigation success stories
- Review of continuing public involvement Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or actions that involve floodplain management (FMP, p. 15-2).

CONCLUSION

The City of Los Angeles will utilize the Floodplain Management Plan to prevent loss of life and property damage, taking measures to mitigate the impacts of flooding to the city. The plan is intended to be updated on a five year cycle from the date of its adoption. It is possible for the five year cycle to be accelerated due to flood-related disasters that impact the city of Los Angeles and flooding that causes losses of life. The plan will be updated through its steering committee and a hazard risk assessment will be reviewed and updated using available data and technologies (FMP, p. 15-2). The plan will continue to utilize public involvement and other planning mechanisms to make as efficient as possible.

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2. METHODS AND RESULTS

Figure 21: Origin of the Los Angeles River in Canoga Park, Los Angeles. 2014. (By Craig Dietrich).

2.1 METHODOLGY - LAND USE CONFLICT IDENTIFICATION

To identify opportunities for naturalizing the Los Angeles River, we took a multidimensional approach that integrates environmental design, planning, policy, and community values for our initial round of site analysis.

LUCIS

Land Use Conflict Identification Strategy (LUCIS) tool was used to identify and evaluate the potential land use conflicts that may arise in a given site. It was developed by Dr. Maarten Kappelle, a researcher at the International Institute for Geo-Information Science and Earth Observation (ITC) in the Netherlands. LUCIS provided a basis for a science-policy dialogue on translating the needs of stormwater capture and storage with creating sustainable natural and built environments (Carr and Zwick). As a tool for policy, LUCIS provides an understanding of conflicts to be managed, identifying where resources should be placed for efficient and effective action. It involves mapping different land uses and identifying areas where potential conflicts may arise based on factors of ecology, flood mitigation, and social economics. The model evaluates the potential impact of these conflicts on the area's ecological, social, and economic systems and provides guidance on how to mitigate or manage them.

Figure 22: How the LUCIS method guided our research of the Los Angeles River.

The LUCIS model consists of six steps that identify and evaluate potential land use conflicts in a given area. These steps help create a GIS model that demonstrates how relevant criteria interact. The result is a suitability map that illustrates opportunities to achieve objectives.

When applying this model to land use within the vicinity of the Los Angeles River, we needed to define our Statement of Intent. Our class took a multifaceted approach to the river, with some students looking into ecological restoration and some exploring stormwater retention.

The suitability process was about analyzing relationships between features and identifying existing patterns. It was important to find the best way to spatially represent each feature. During the suitability mapping process, the collected data was combined and weights were applied according to the relative importance each feature had in satisfying the objectives (Carr and Zwick) .

METHODOLGY - LAND USE CONFLICT IDENTIFICATION

GOAL 1: ECOLOGY AND NATIVE BIODIVERSITY

1. Identify lands important for protecting native focal species

1.2 Identify areas important for protecting wide-range species & habitats.

Figures 23-25 show multiple copies of the Los Angeles River overlaid with data relevant to the goal at hand. Figure 23 illustrates the need for ecological protection. The lower three maps identify the concentration of certain species. Each species was weighted to reflect its value to the suitability goal. The answer to the question: "Which areas of the Los Angeles River are most in need of ecological protection?" is shown in the top map of Figure 23. Here the weighted data from the lower maps is combined to provide a clear answer. These maps can help decision makers to understand the potential impacts of different land use scenarios on native biodiversity and guide the development of conflict management.

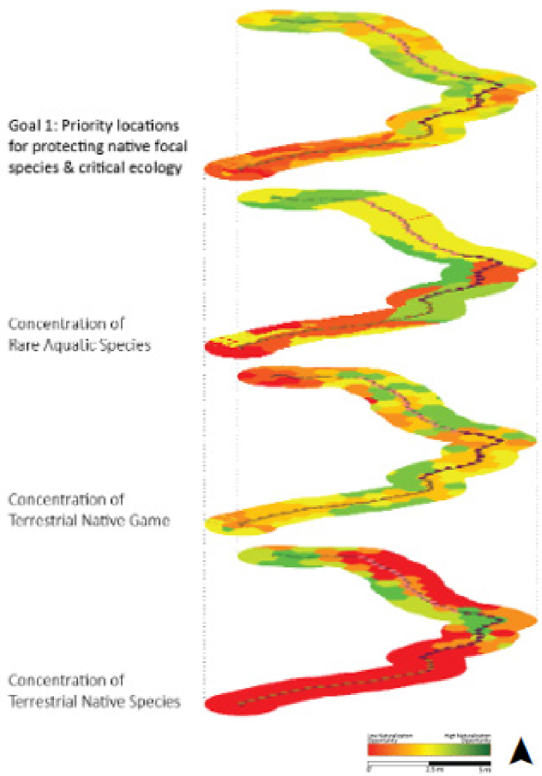

Figure 23: Areas of the river most in need of ecological protection.

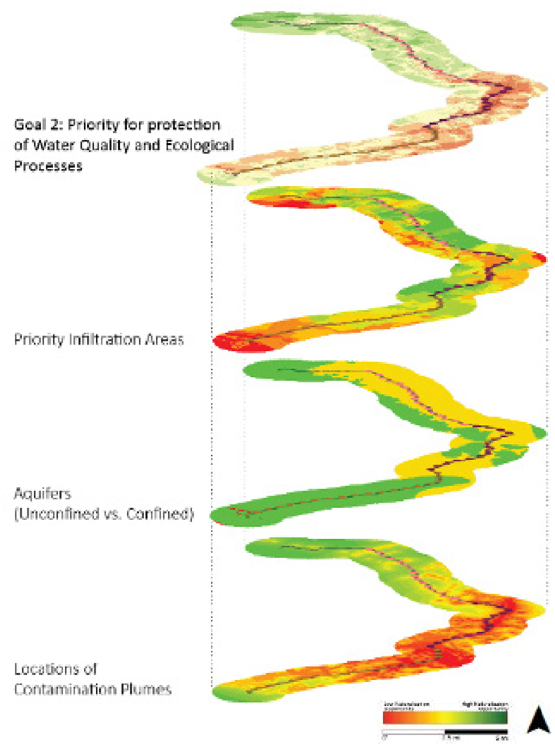

Figure 24: Areas of the river where water quality is threatened.

Following the same procedure, we evaluated again for water quality, paying particular attention to contamination plumes, areas important for protecting groundwater resources, land along the river that would benefit from increased infiltration and absorption, and areas important for protecting surface water bodies.

GOAL 2: PROTECTION OF WATER QUALITY

2.1 Identify lands away from contamination plumes

2.2 Identify areas important for protecting groundwater resources

2.3 Identify lands along the river that would benefit from increased infiltration and absorption

2.4 Identify areas important for protecting surface water bodies

GOAL 3: CLIMATE IMPACTS

A final model was created to evaluate for climate impacts, i.e., pollution. We looked for areas with high pollution burdens that negatively impact ecosystems.

METHODOLGY - LAND USE CONFLICT IDENTIFICATION

3.1 Identify areas with high pollution burden that may negatively impact ecosystems and wildlife habitats.

- Clean-Up sites
- Groundwater Threats
- Hazardous Waste
- Impaired Water Bodies
- Solid Waste/Facilities

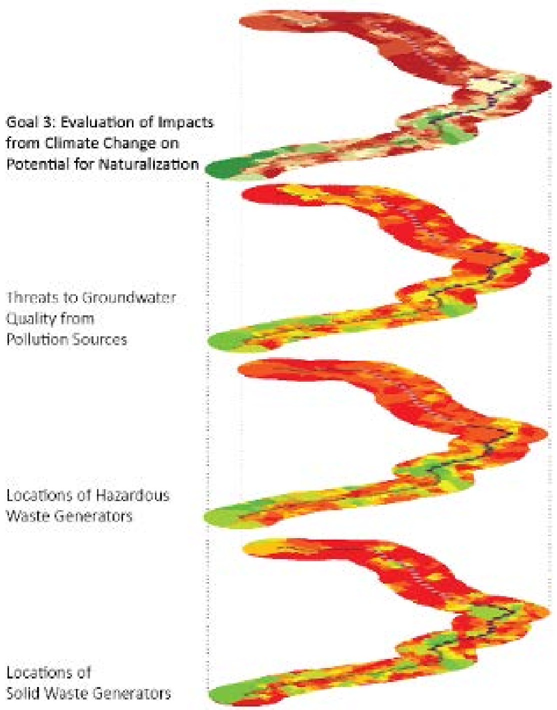

Figure 25: Areas of the river with the highest pollution.

IMAGEABILITY

Parallel to the LUCIS mapping, the studio generated a series of subjective site analysis diagrams inspired by Kevin Lynch (1960). In these maps, we identified landmarks, paths, districts, nodes, and edges of the river's influence on the surrounding community.

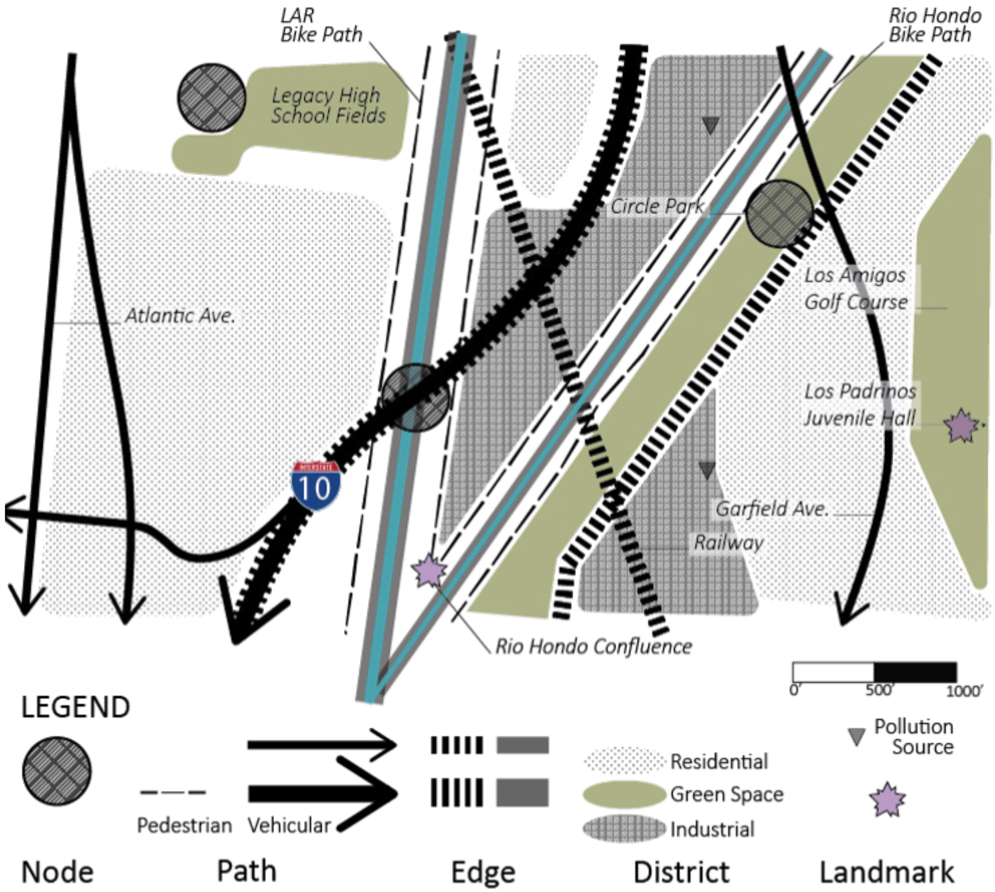

Figure 26: Imageability mapping of the confluence the Rio Hondo.

MITIGATING THE HYDROLOGICAL IMPACTS OF NATURALIZATION

Re-vegetating the river will reduce the channel capacity, thus increase flood risk to adjacent communities. Our literature review failed to identify any studies that quantified this increased risk as the channel is already undersized. As the status quo consensus is that naturalizing the river is unfeasible, there have been no studies looking at how to mitigate this flood risk to enable naturalizing the river before this report.

HYDROLOGY MODELING PROCESS

1. Compiled river channel geometry and existing capacity into a spreadsheet model
2. Measured existing vegetation and obstructions in the Glendale Narrows.
3. Extrapolated vegetated channel capacity for the entire river using the average percent the Glendale Narrows is obstructed.
4. Reviewed storm data to define the duration of peak flow during storm events
5. Modeled existing capacity versus vegetated capacity to define the required retention volume needed to minimize flood risks of naturalized river for 1% (100-year) Storm, 0.5% (200-year) Storm, and 0.2% (500-year) Storms.

CHANNEL GEOMETRY AND EXISTING CAPACITY TABULATION

Data for our model was tabulated from existing hydrological studies included the 2020 LA River Master Plan (LARMP), US Army Corp of Engineers HEC-RAS models and Los Angeles River Letter of Map Revision (2017), and other publicly available data.

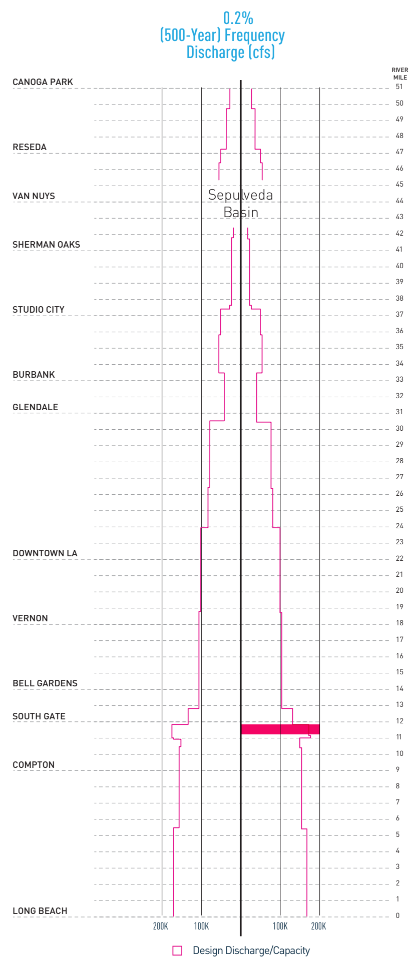

Figure 27: Scaling the River's design capacity from the LA River Master Plan chart.

Data from the LA River Master Plan was extracted from their high resolution (vector) 'Rulers' by scaled measurements in Adobe Illustrator (Figure 27). The scale was 0.6504 inches from the center line = 100,000 cfs. Where the measured Capacity Factor (in inches) X 0.6504 X 100,000 cfs = Design Capacity. Results were reported as 2 significant digits using this formula:

```
=ROUND([data cell],[sig digit cell]-
  (1+INT(LOG10(ABS([data cell])))))
```

Where [data cell] is a dynamic link to the raw value in the adjacent cell, and [sig digit cell] is a fixed linked to the cell at the top of the sheet indicating how many significant digits to display).

River Mile	LAR Master Plan Designation	Design Capacity Factor (from Ruler)	Design Capacity (Measured) LARMP 0.6504	2 Sig Digits Design Capacity (LARMP) cfs
51	51.0 River Origin Park	0.1652	25,400	25,000
	50.9 Canoga Park High School	0.1652	25,400	25,000
	50.6 Canoga Park River Park	0.1652	25,400	25,000
50		0.1652	25,400	25,000
49	48.9 Pierce College Connector	0.2198	33,795	34,000
48	47.8 LA River Valley Bikeway and Greenway	0.2198	33,795	34,000
47	47.5 Southern Aliso Green Network	0.2198	33,795	34,000
	47.4 Aliso Creek Confluence Park / Reseda River Loop	0.3037	46,694	47,000

Figure 28: Screenshot of Design Capacity measurements and calculations in LAR Flow Model. See Appendix C.

NATURALIZATION FLOW ESTIMATION

To estimate potential flow reduction from naturalizing the entire river, we measuring vegetation and dry land within the river channel at transects (n=24) in the Glendale Narrows using Google Maps satellite imagery.

All transects have trapezoidal channels, where

```
Channel Cross Section Area = Channel Depth  X
        (Top Width + Bottom Width) / 2
```

Channel geometry was extracted from the LA River Master Plan and other sources. Channel obstructions area were calculated as:

```
Tall Vegetation = Measured Width x Channel Depth

Low Vegetation = Measured Width x 3 foot Height

Sand Bars/Rocks = Measured Width x 1 foot Height
```

Where obstruction heights are the elevation above the channel bottom/water surface. Obstruction heights for transects 1-18 are based on observations made while on foot, while Transect 19-24 were made while kayaking 1.5 miles through the Elysian Valley Recreation Zone on September 19th, 2022 with LA River Kayak Safari.

For each transect, the percent obstructed was calculated by adding up the obstruction area / channel cross section area. The average percentage obstructed was then calculated to use in the model.

See Appendix A for the data. The original map can be viewed at: https://www.google.com/maps/d/edit?mid=135ROSN4euasENOCOXQbSWC6TjDSPHQc&usp=sharing.

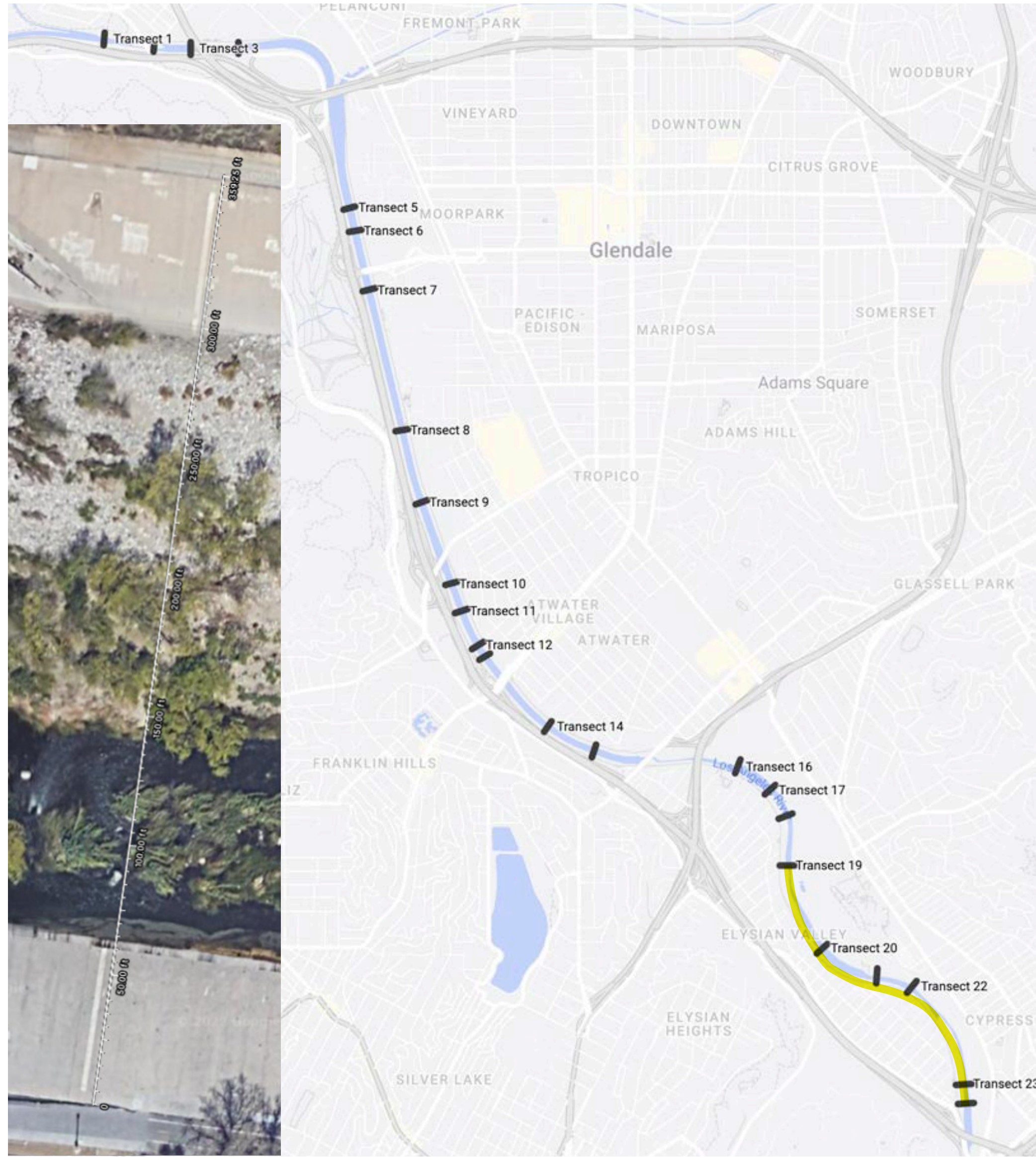

Figure 29: Location of transects used to model the impact of naturalizing Los Angeles River. Kayaked portion is highlighted in yellow.

NATURALIZATION FLOW CAPACITY

The average obstruction percentage from the Glendale Narrows was used to model the impact on naturalization on the flow capacity of the entire river, where

```
Naturalized Flow Capacity (NFC) =
Design Capacity * Obstruction Percentage
```

PEAK STORM FLOWS

Peak storm flows along the entire river were tabulated by scaling the LA River Master Plan Rulers for 1% (100-Year) Frequency, 0.5% (200-Year) Frequency Discharge, and 0.2% (500-Year) Frequency events. Ruler factor scale was 0.6024 inches from the center line = 100,000 cfs. Where the measured discharge (in inches) X 0.6024 X 100,000 cfs = event peak flow.

NATURALIZATION MITIGATION VOLUME

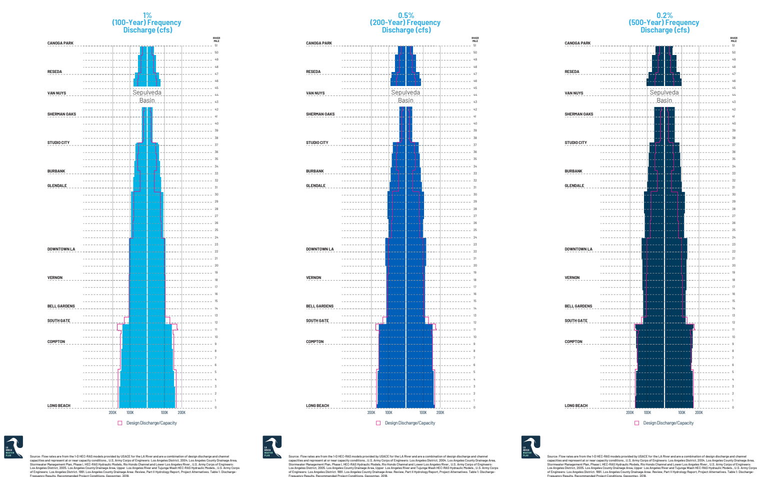

Figure 30: Peak flows 'Rulers' for 1%, 0.5% and 0.2% storm events from LA River Master Plan, source of data used in this study.

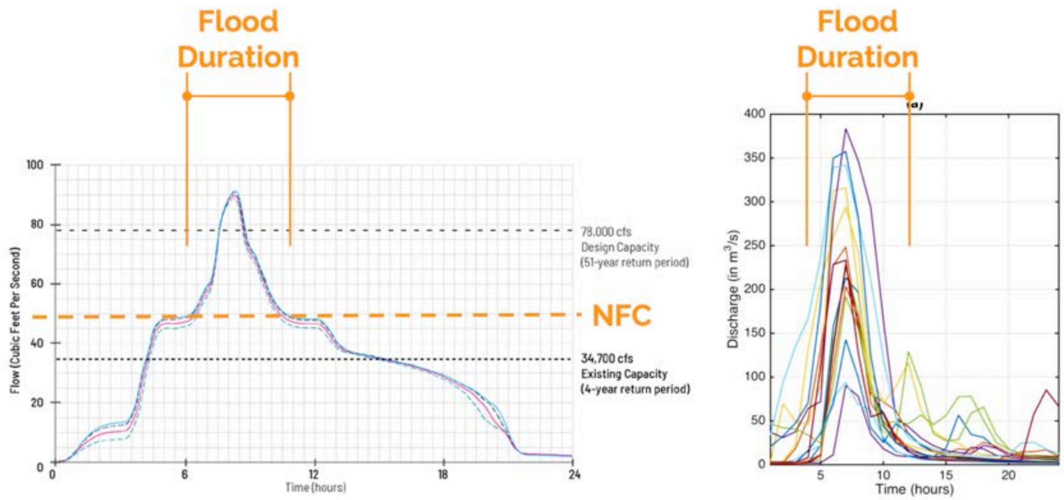

Figure 31: Flood duration where NFC = Naturalized Flow Capacity. Left is a hydrograph from LA River Master Plan, right is from Lassche.

To figure out the duration of peak flows above flood stage for the LA River, hydrographs published in the LARMP (2020), Lassche (2016), and others were graphically analyzed to define the average duration of peak flow (T) during storm events where flows exceeded the NFC.

Volume of water during storm events that exceeded then NFC, thus would need to be diverted into retention/infiltration (R/I) facilities to avoid flooding was calculate for each reach of the river by in the model

```
R/I volume (ft^3) = (Peak Storm Flow - NFC) * Peak Flow Duration
```

Additionally, the Peak Storm Flow's percentage of NFC was calculated, and R/I volumes were rounded to two significant digits.

For this report and presentation purposes, R/I volumes were converted from cubic feet into Acre-Feet, where one acre-foot = 43,560 cubic feet.

METHODOLOGY - MITIGATION

SITES FOR RETENTION AND INFILTRATION

A 2.5 mile buffer (matching the buffer used for the LUCIS analysis) was drawn on Google Maps (Figure 27) using the measurement and line tool. Net buffer area was determined by tracing areas of the buffer outside the Los Angeles River Watershed (City of Los Angeles Geohub). Areas falling outside the watershed were separately measured and subcontracted from the gross buffer area (shown in gray in Figure 32).

Area of the buffer within and outside the watershed were recorded in square miles, then converted to acres in Google Sheets, then reported as 2 significant digits.

MAPPING SUITABLE LAND FOR RETENTION AND INFILTRATION

Land suitable for detention and infiltration were identified using satellite imagery and topographic data, then traced on Google Maps into separate layers for each land-use: Parks (including trails and wide vegetated median strips), Golf Courses, Equestrian Facilities, School Yards, Railroad and Power Right of Ways (ROW), Parking Lots, and Vacant Land. Existing infiltration and retention basins (such as the Sepulveda Basin and Rio Hondo Spreading Grounds) were excluded from this inventory.

Areas for each parcel was recorded as acres to 2 significant digits in the item description, then downloaded as .csv file and tabulated into a Google Spreadsheet file to calculate the total available area. Totals for each land-use were then reported to 2 significant digits.

For Parks (N=100) and Schools (N=245) within the buffer/LA River Watershed, there were just too many to digitize, so the average site size was calculated based from a random digitized sample (parks n=40, schools n=46) and used estimate the total areas these land-uses.

Schools were additionally categorized as elementary schools, middle schools/junior highs, high schools, and adult education/community college/administrative facilities. Locations or adjacent schools housing multiple grade level categories were tabulated under the highest grade.

Inventory of schools includes both public and private academies. Net area of the school yards was calculated by tracing a simplified perimeter around the buildings to capture the larger open spaces, so reported areas for each school and the tally is estimated as 10 to 20% smaller than a more precise survey might provide.

Gross areas of Railroad and Power Transmission Right of Ways (ROW) includes cross streets, but not bridges over highways or the river.

Figure 32: Los Angeles River Watershed and the 2.5 mile buffer, with areas outside the watershed are indicated in dark gray

METHODOLOGY - MITIGATION

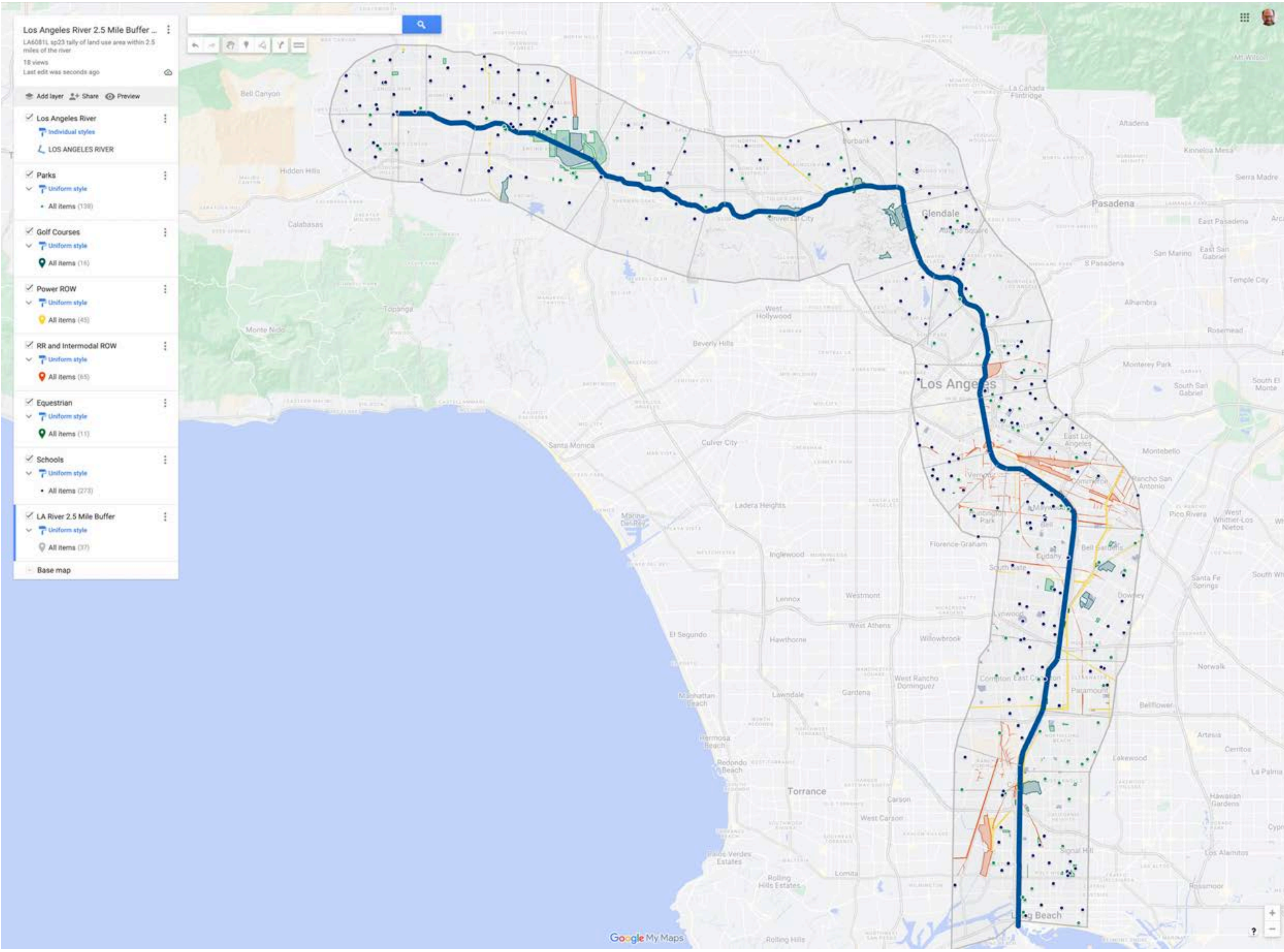

Figure 33: Screenshot of Google Map Retention Suitable Land Use Inventory with location of the suitable parcels. https://www.google.com/maps/d/u/0/edit?mid=1PphMrqIOjcxQCIWV-34RtkJwbtAdYDA&usp=sharing.

METHODOLOGY - DESIGN

PILOT STUDY SITE SELECTION

Based on individually defined project goals determined by our interests, we each identified and evaluating at least 3 potential sites that would be suitable for a pilot site design. Once the initial selection of sites were identified, we collectively refined the set of sites to avoid duplication or overlapping sites, to ensure they were distributed geographically along the entire river, and that major land uses/typologies (golf courses, residential neighborhoods, local and regional parks, commercial, industrial, rail/power right of way, et cetera) along the river were represented.

The final selection of the pilot study sites was made after we discussed the alternative sites with project advisors.

see: https://www.google.com/maps/d/edit?mid=19bQQuH3bI7WOIJOUlRVuORLM_sIJ8sM&usp=sharing

DEFINING DESIGN PARAMETERS

CASE STUDIES

Based on our self-defined primary pilot project goals (retention or naturalization), we identified and researched case studies with similar site conditions and performance goals. These case studies and the guidance of our faculty advisor defined the design typologies, strategies & tactics that were utilized for our pilot site designs.

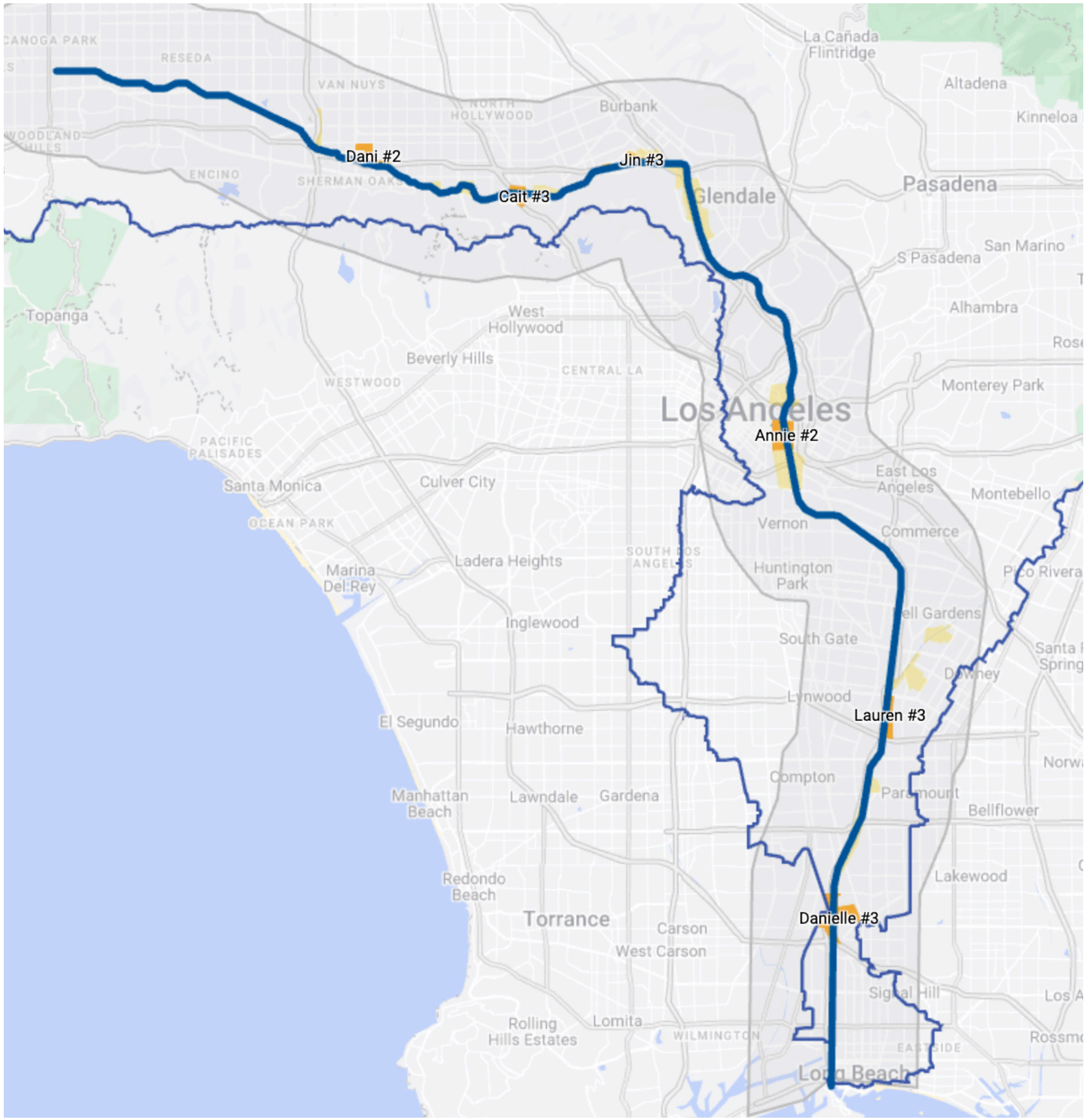

Figure 34: Concept Design site selection: Preliminary site options (yellow), and Final sites (orange).

2.2 RESULTS - LUCIS

LUCIS

We combined the data from each of our three ecological goals to determine the conflict relationships between stakeholders based on the preference for each stakeholder. This semester we only applied the LUCIS strategy to the goals within the Natural Environment to demonstrate the power of the methodology to inform naturalization policy.

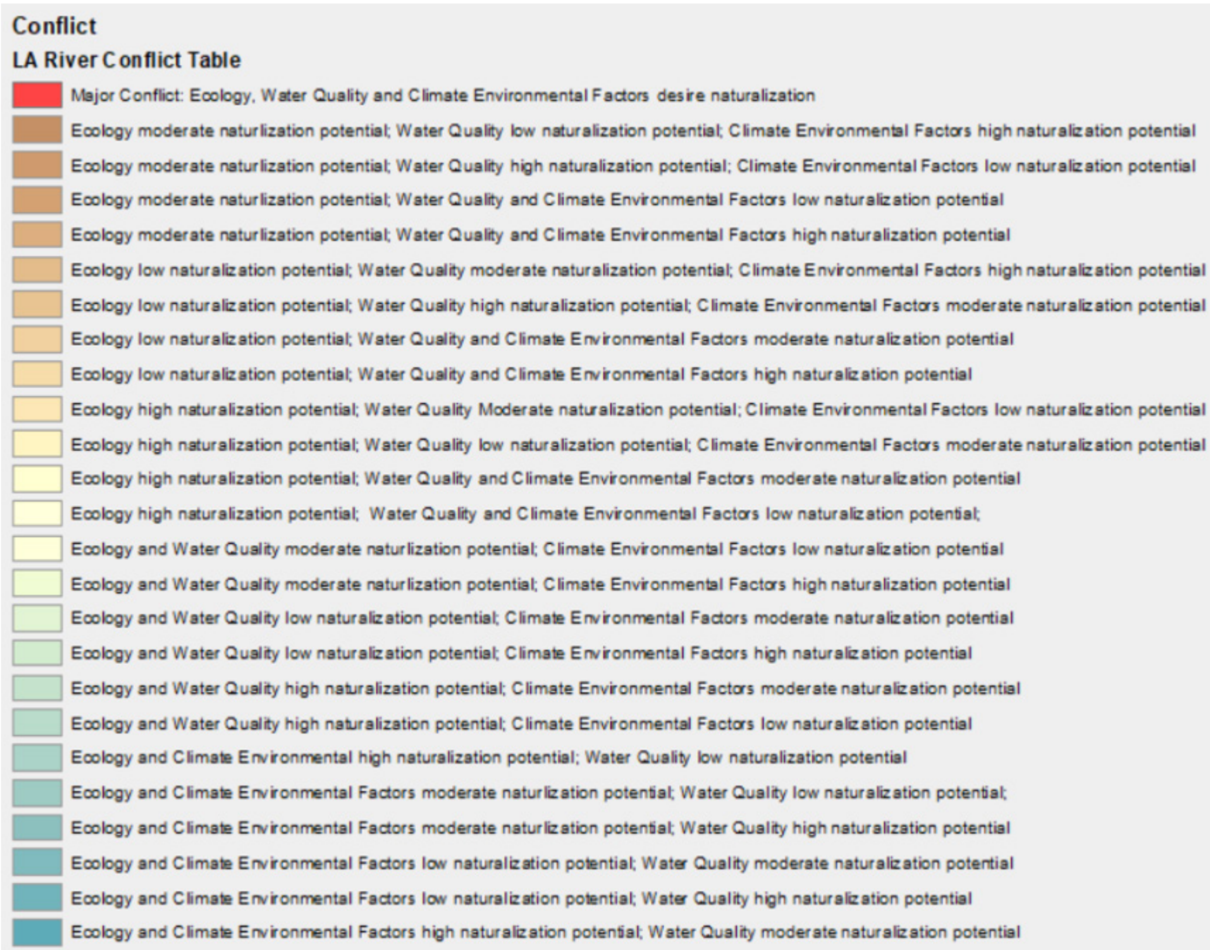

Figure 35: Los Angeles River Land Use conflict table/legend for maps.

Figure 35 illustrates the conflict value between the individual goals that were explored. We completed our analysis at the quarter-acre scale, resulting in a conflict value assigned to each pixel.

The conflict value identifies naturalization challenges and opportunities within the context of water capture and storage. Each digit in the conflict value represents the preference or opportunity of the goal to satisfy its desired outcome. Preference value 1 reflects high opportunity, 2 reflects moderate opportunity, and 3 represents low opportunity (LUCIS). These preference values guide where to naturalize in a way that balances hydrological and environmental needs. The conflict maps shown in Figures 32-34 exclude the existing naturalized areas. The red color stands for the highest opportunity to be naturalized.

Figure 36: Ecological conflicts within the Upper LA River.

RESULTS - LUCIS & HYDROLOGY

We now have the ability to take the hydrology capacity values and develop scenarios that illustrate the distribution and impacts of water across the natural and built environments. The allocation model is based on comparing different land use preferences and determining areas of possible future land use conflict.

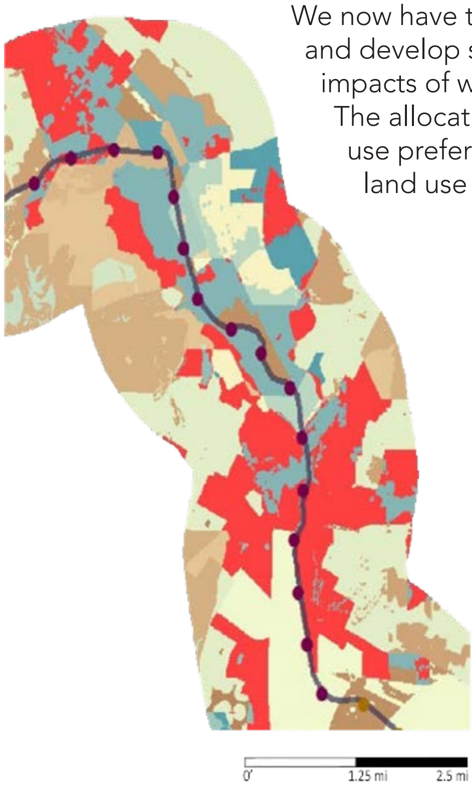

Figure 37: Ecological conflicts within The Narrows (mid Los Angeles River).

The strategy we have applied to this project examines where emphasis should be put for efficient and effective action and identifies who needs to be brought to the table to achieve collective impacts across multiple policy domains. From those discussions, allocation priorities can be determined.

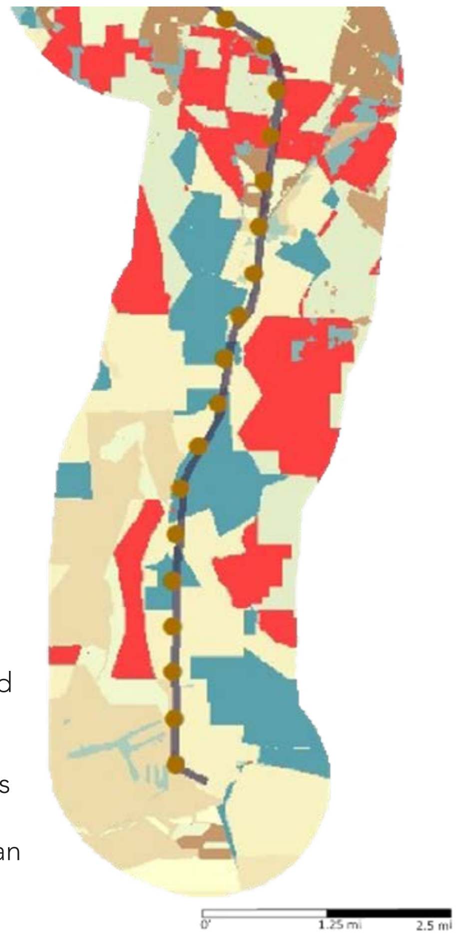

Figure 38: Conflicts within the lower Los Angeles River.

NATURALIZED CHANNEL CAPACITY

Average Channel Obstruction in the 24 transects of the Glendale Narrows was 30.1% (st. dev. 0.090, n=24). To model the Naturalized Flow Capacity (NFC) for the entire river, we used a value of 70% Design Capacity.

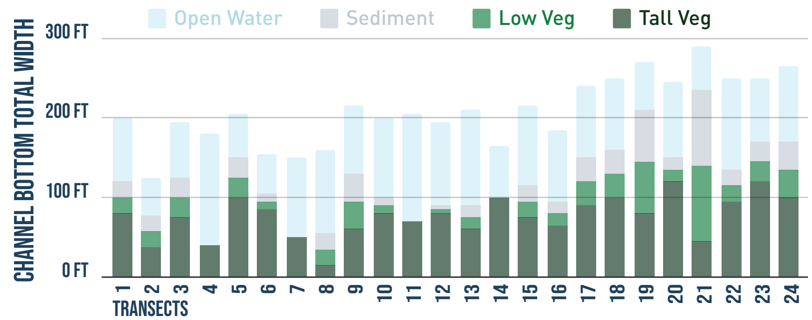

Figure 39: Amount of vegetation and surface conditions per transect in Glendale Narrows based on satellite imagery circa Fall 2022. See Appendix B for the data.

PEAK STORM FLOWS

1%, 0.5%, and 0.2% storm events were modeled, with the 500-year return event used as our design storm. In this scenario, the Upper LAR near the confluence of Tejunga Wash (river mile 42) was nearly at 500% of capacity with 59,000 cfs and only 12,000 cfs NFC. Further downstream at Headworks Park (river mile 33), the peak storm flow was 98,000 cfs, with 27,000 cfs NFC, the greater flow requiring 34,000 acre feet of retention to avoid exceeding the NFC.

RESULTS - HYDROLOGY

12-HOUR NATURALIZATION MITIGATION VOLUME

The minimum threshold for naturalization new reaches of the Los Angeles river is the construction of 4,000 acre-feet of retention capacity, when the concrete bottom along 0.2 miles in South Gate (river mile 12.7 to 12.9) can safely be removed.

- Build out of 28,000 acre-feet of storage allows 50% of the length to be naturalized.
- 70% of the river can be naturalized when 30,000 acre-feet of storage is available.
- 34,000 acre-feet of new retention and infiltration capacity enables naturalizing 99% of the river.

100% naturalization require 37,000 acre feet for the most constrained reach at Burbank Western Green Network (river mile 31.9) where the 0.2% storm flow exceeds the NFC by 73,000 cfs.

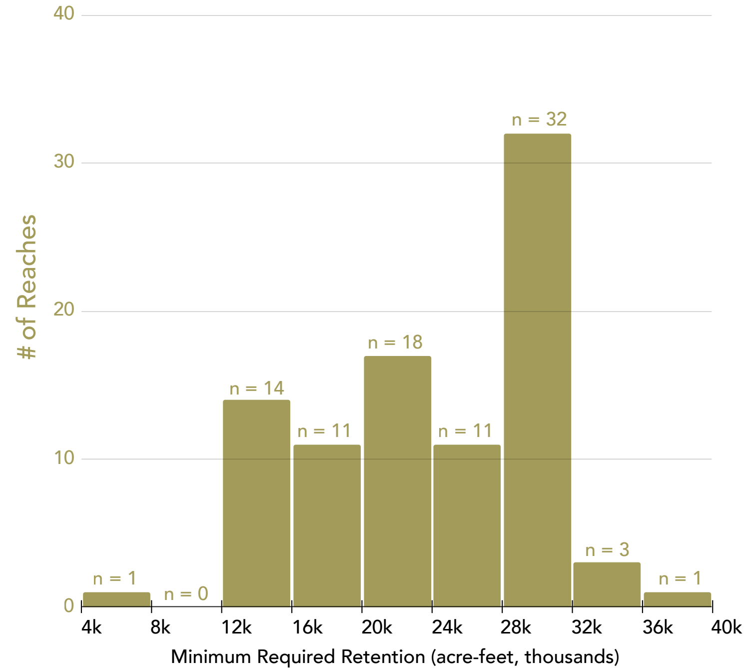

Figure 41: Distribution of required retention to mitigate flooding during a 500-year Storm

POTENTIAL NATURALIZATION

RETENTION CAPACITY BUILD-OUT	UPPER LAR * miles	MIDDLE LAR * miles	LOWER LAR miles	TOTAL miles
7,000 ACRE-FEET	0	0	0.2	0.2
14,000 ACRE-FEET	1.2	0	0.2	1.4
21,000 ACRE-FEET	2.4	3.3	2.3	8.0
28,000 ACRE-FEET	8.7	9.2	6.7	24.6
35,000 ACRE-FEET	18	16.4	14.1	48.5

Figure 40: Potential length of naturalization possible as retention capacity is created. Tally does not exclude bridges, flow control structures, or other situations where naturalization isn't feasible.

* Existing soft bottom reaches are included in tally.

IMPLEMENTATION OF NATURALIZATION

We evaluated multiple parameters using LUCIS, such as demographics, environmental justice, limited access to parks, and more, but the results were inconclusive as most communities along the lower river are under-served, while the upper river flows through higher socio-economic status communities with significant park access.

Alternatively, we evaluated naturalizing highly visible locations, such as where the river is visible from freeways and major arterial streets, as a means to strategically increase the political capital for continued/increased project funding. Proximity to bridges, other infrastructural constraints, and the poor habitat quality from the excessive disturbance of the highways limited the utility of this approach.

Based on the calculated NFC, we modeled the retention required to avoid flooding in a 0.2% (500 year) storm event, and discovered the feasibility of naturalizing each reach depending on available retention capacity (figures 41 and 42).

RESULTS - HYDROLOGY

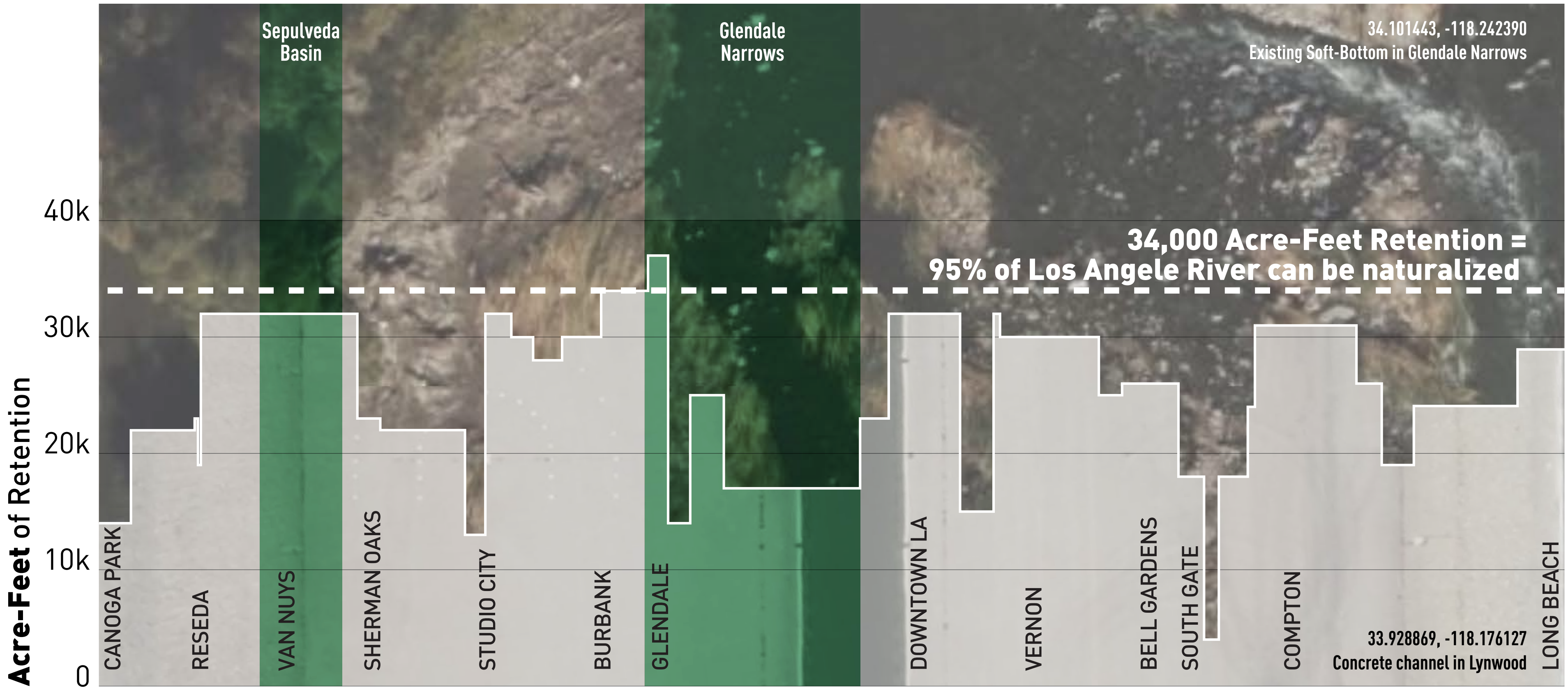

Figure 42: Minimum retention capacity needed to naturalize each reach of the river to avoid flooding during a 0.2% (500-year) storm. Satellite imagery from Bing.

RESULTS - POTENTIAL RETENTION

CONCEPT SITE DESIGN RETENTION VOLUMES

See Section 4 for the concept designs.

Projects encompass 1,200 acres adjacent to the river and provide 1,600 acre-feet of retention. Students deployed a variety of site specific retention solutions on 120 acres of their sites: bioswales, basins, cisterns, dry wells, inflatable water bladders, tanks (above ground), and wet ponds.

PILOT SITE LOCATION	PRIMARY LAND USE(S)	GROSS PROJECT AREA	NET AREA WITH RETENTION	TOTAL AREA OF RETENTION	RETENTION DEPTH	RETENTION CAPACITY	NET RETENTION PER ACRE	RETENTION AREA/ GROSS AREA
	Acres	Acres	Acres	Acres	Feet	= Retention Area X Depth	Acre-Feet	
4.1 SHERMAN OAKS	Park (66 ac)	100	66	20	8	**160** a-f	0.33 a-f	20%
4.4 NORTH HOLLYWOOD	Park (22 ac)	250	22	10	15	**150** a-f	0.15 a-f	4%
4.3 BURBANK	Park (30 ac) + Equestrian (85 ac)	115	85	40	20	**800** a-f	0.14 a-f	35%
4.6 DTLA	Industrial (90 ac) + Naturalized River	250	n/a	n/a	n/a	n/a	n/a	n/a
4.2 SOUTH GATE	Park (50 ac) + Infrastructure (20 ac) + Equestrian (8 ac)	165	75	34	12	**408** a-f	0.16 a-f	20%
4.5 LONG BEACH	Park (20 ac) + Golf (2 ac) + Equestrian (10 ac) + Infrastructure (200 ac)	350	22	16	5	**80** a-f	0.14 a-f	5%
TOTAL		**1,230**	**270**	**120**		**1,600 A-F**		
AVERAGE (N=5)		205	54	24	12	320 a-f	0.18 a-f	17%
ST. DEV		96	30	13	6	296 a-f	0.08 a-f	0.13

Figure 43: Summary of Pilot Site Designs arranged by geographically. Results from 4.4 DTLA are not included in the analysis as it didn't distinguish between retention provided outside the channel and within the proposed naturalized river.

RESULTS - POTENTIAL FOR RETENTION

AVAILABLE LAND FOR RETENTION WITHIN 2.5-MILES OF THE RIVER

Within 2.5 miles of the river in the watershed, are 9,300 acres (6.7% of the net urbanized area of 216.5 square miles) where creating additional retention/infiltration capacity is potentially feasible.

POTENTIAL RETENTION CAPACITY WITHIN 2.5-MILES OF THE RIVER

The 9,300 acres have the capacity to provide 1,900 acre-feet to 39,000 acre-feet of retention based on the range of retention intensity developed in the conceptual site designs. The lower range is calculated from 9,300 acres x net average retention of 0.18 acre-feet/acre.

See Appendix D for a detailed summary of the data.

			POTENTIAL RETENTION PER PILOT DESIGNS			
	SUITABLE AREA	NET AREA OF 2.5 MILE BUFFER	MINIMUM		AVERAGE	MAXIMUM
	Acres	216.5 mi^2 total	4% of Area 5ft deep	4% of Area 12ft deep	17% of Area 12ft deep	35% of Area 12ft deep
PARKS AND RECREATION LAND	4,100	3.0%	820 A-F	2,000 A-F	8,400 A-F	17,000 A-F
SCHOOL YARDS	1,800	1.3%	360 A-F	850 A-F	3,600 A-F	7,400 A-F
INFRASTRUCTURE AND INDUSTRIAL LAND	3,400	2.5%	690 A-F	1,700 A-F	7,000 A-F	14,000 A-F
TOTAL	9,300	6.8%	1,900 A-F	4,500 A-F	19,000 A-F	39,000 A-F

Figure 44: Potential retention capacity and summary of suitable land inventory (within 2.5 miles of the Los Angeles River). See: https://docs.google.com/spreadsheets/d/1rgdd10A3x16zq10GxAIlD2oyyl49ROilZ8Oue5j8EjI/edit?

3. TYPOLOGIES, PRECEDENTS, STRATEGIES & TACTICS

Figure 45: Los Angeles River in the Sepulveda Basin Recreation Area. September 2022. iPhone, 3.99mm f/1.8, 1/736 seconds

3.1 TYPOLOGIES

NATURALIZATION

The Rhône River Banks in Lyon, France are one of many potential design typologies for the naturalization of an urban river. The Rhone River's east bank underwent a transformation converting former ports from a riverside car park to public spaces with varied programming. The project was designed by landscape architects from IN SITU Architectes Paysagistes and the architect Françoise-Hélène Jourda (Land8).

The river bank project began construction in 2005 and, due to its focus on the removal of concrete and the incorporation of vegetation, serves as a model for what possible design strategies and tactics can be utilized for the studio's site designs along the Los Angeles River (Land8). The design typology includes riparian habitat restoration within the stream, on its banks, and channel walls through bioretention. Bioswales and native vegetation on both sides of the walking and bicycle paths as well as trees on the upper street level promenades offer wind protection and flood control, and also allows for recreational opportunities and space for community events and markets.

The site allows for reconnection to nature with access to riverside public space along the Rhône and attracts cyclists as it is part of the Vélo-route Léman-Mer, a European cycle path, which runs from Lake Geneva to the Mediterranean coast (Land8).

The design parameters developed for consideration in the naturalization of sites along the Los Angeles River include the following:

- Stormwater management
- Riparian management along river corridor
- Habitat restoration (in & near stream)
- Bank stabilization
- Channel reconfiguration, removal, retrofitting
- Water quality
- Recreation
- Education

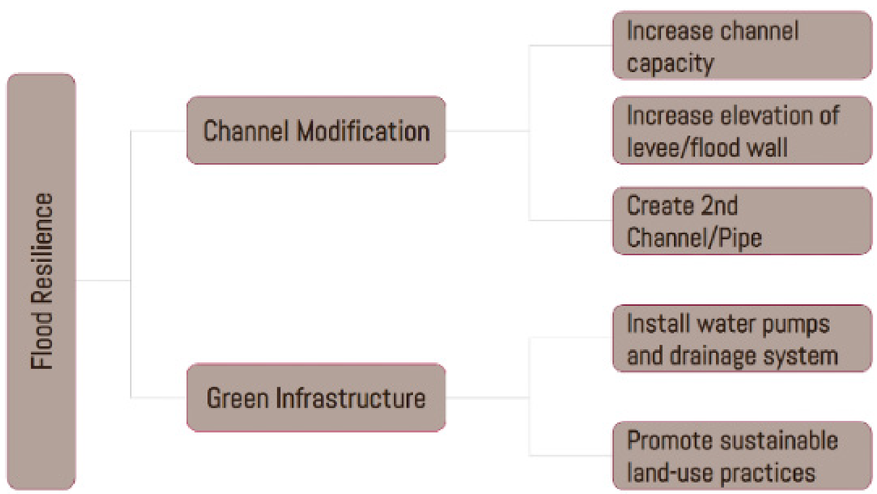

Figure 46: Methods of flood resilience.

FLOOD RESILIENCE

The Los Angeles River is prone to flooding due to a combination of natural and human factors. The river runs through a highly urbanized area that has altered its natural course and drainage patterns. It is a highly engineered river system that was designed to control flooding and manage stormwater runoff (LAR, nd). Much of the river has been channelized and paved with concrete, which limits the amount of water that can be absorbed into the ground and increases runoff during heavy rains (Wells 2023). The river's capacity is overwhelmed particularly during the winter month. Climate change has also been contributing to an increase in extreme weather events. While, during periods of heavy rainfall or when there is a high volume of water entering the river system, it still floods.

There are multiple reasons that cause the Los Angeles River to flood. The most common reason for the Los Angeles River to flood is intense rainfall due to climate change (Wells). During periods of heavy rain, weather like early Jan this year, Los Angeles received 0.8 to 5.4 inches of rainfall (LA Times). The river can quickly fill up and overflow its banks.

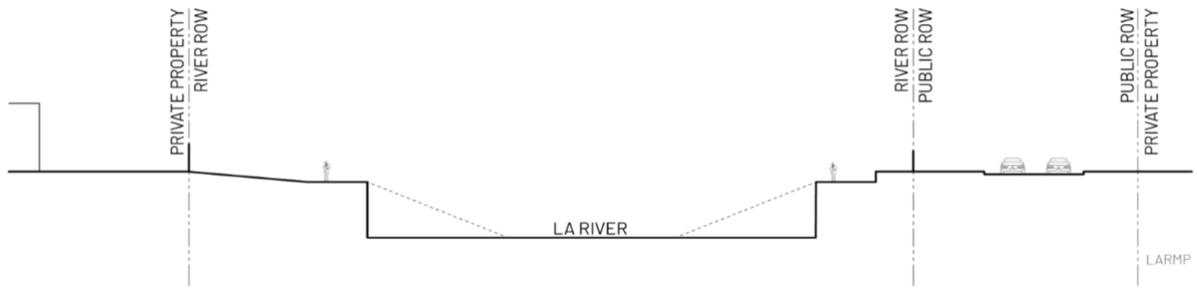

Figure 47: Physical modifications to the river channel, such as widening the channel, can help reduce the risk of flooding and increase the capacity of the channel to carry water during high-flow events. (LA River Master Plan, 2020).

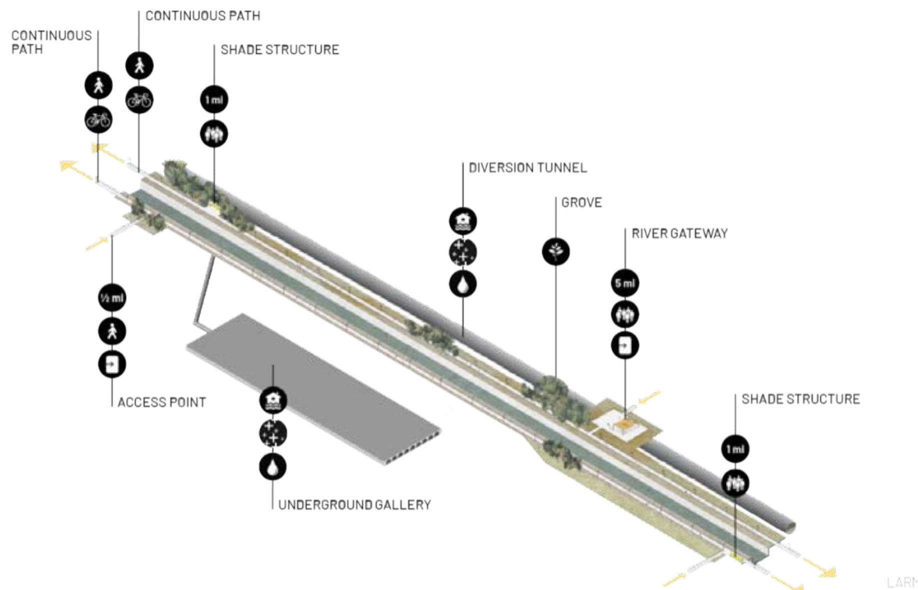

Figure 48: Concrete channel. (LA River Master Plan, 2020).

TYPOLOGIES

Almost the entire alignment of the river is paved in concrete as part of channelization efforts to control flooding. The channel acts as a water freeway, flushing rain and runoff away from development and into the ocean.

Preventing floods in the Los Angeles River requires a multi-faceted approach that addresses the physical and non-physical factors contributing to flooding. Some types of measures that could be used to prevent flooding align with the Los Angeles River. These measures can be classified into channel modification and green infrastructure measures. Increasing levee elevation and flood wall are types of common strategies used to prevent flooding. The design should consider the flow rate and volume of water during high water events, and the soil, geological conditions, and the expected lifespan of the structure (LAR, 2014). A bypass channel that diverts water flow to a specific area. It provides an alternate path for the water to flow, reducing the pressure on the main channel and reducing the risk of flooding (Sharp).

It is important to understand that channel modification is just one component of a comprehensive flood management strategy. Other measures, such as storm water management, land use management are also necessary to effectively prevent flooding. Implementing green infrastructure such as permeable pavements, and rain gardens can reduce runoff and increase the ability to absorb water. These solutions can also provide other benefits such as reduced heat island effects, improved air quality and increased gathering places.

RETENTION

Water retention typologies can be classified under two different branches: scale and exposure. Exposed retention methods are vulnerable to water loss by evaporation. Examples of small-scale exposed methods include bioswales/rain gardens and flow-through planters. Each of these methods requires the addition of a storage method, whereas the small-scale enclosed option – rain barrels – are storage-inclusive.

On the large scale, water retention can be achieved through reservoirs/retention ponds (permanent storage), detention ponds (temporary storage), and porous paving, which often comes in the form of green parking lots. These are all exposed retention methods, although only porous paving requires the addition of storage. Large-scale enclosed methods of water retention include cisterns (generally underground) and water towers.

3.2 CASE STUDIES

NATURALIZATION

KALLANG RIVER BISHAN PARK

Figure 49: Kallang River Bishan Park.

While the Kallang River Bishan Park in Singapore may have a different climate than what is common for the Southern California region, the project nevertheless serves as a precedent for the redesigning of a riverfront that, similarly to the Los Angeles River, re-evaluated the installment of concrete drains and canals built to alleviate widespread flooding (Schofield). The project was designed by Atelier Dreiseitl and covered 153 acres of park space as well as 2 miles of the 6.2 mile-long river that flows through the center of the island (Holmes, 2015). The project incorporated river restoration, open space, and park space. The Bishan Park was completed in 2012 and had a $60 million dollar budget (Schofield).

Approximately 1.6 miles of concrete drainage channel has been restored into a natural river that meanders through the park. The redesign is based on a floodplain concept to accommodate the dynamic process of a river system and its fluctuating water levels (Holmes, 2012). The natural riverbed, filled with rocks and pools, helps to slow down the velocity of the river and prevent large amounts of particles from flowing downstream. Access to the riverfront offers opportunities for connection to nature for the 3 million annual park visitors – and the project has seen a 30% increase in the park's biodiversity (Holmes, 2012).

Figure 50: Tujunga Wash.

TUJUNGA WASH GREENWAY & STREAM RESTORATION

The Tujunga Wash is a 13 mile stream and tributary of the Los Angeles River. As a project located near and along the River, it serves as a fitting precedent for this study. 1.2 miles of inaccessible land along the concrete box channel of the Tujunga Wash has been transformed into a greenway to create habitat and restore natural stream functions along the stream bank for flood control. The greenway stream is fed with water from a gravity-fed pipe diverted from the flood control channel that is 2 miles upstream which allows for natural filtration and infiltration after rain events (LPS, 2018).

The project was completed in 2007 by the Mountains Recreation & Conservation Authority. The project focus was adding native plantings along both banks of the concrete wash to support the goal of reintroducing riparian habitat along the stream (LPS, 2018). The site includes recreational pathways for walking and biking on both sides of the stream banks, seating areas, rest area amenities, and educational signage (RPOSD). The project has increased the ratio of park space for residents, adding more open community space, and added native vegetation to reduce irrigation costs and help with urban heat island effect in urban areas such as this (LPS, 2018). The greenway offers a tranquil green space for wildlife habitat and humans alike.

CASE STUDIES

OLD COLLIER GOLF CLUB

Figure 51: Site plan of Old Collier Golf Club.

The Old Collier Golf Club in Naples, Florida serves as another interesting example for design strategy possibilities along the Los Angeles River. This project is recognized as a prime example in environmental planning for new and underdeveloped golf courses. The design for the landscape provides multiple advantages for both golfers and wildlife.

The design enables the course to operate as a nature and wildlife preserve, protecting over 53 acres of mangrove and wetland habitat bordering the Cocohatchee River and establishing 109 acres of land as interconnected native uplands scrub to support vulnerable species in the region. The site also retains on-site rainfall with 11 water management lakes that also provide biofiltration of runoff from the nearby neighborhoods for a 25-year storm event.

The use of salt-tolerant native vegetation reduces the need for irrigation, nutrient runoff, and maintenance of the course turf. This project pioneered the "tee-to-green" use of two types of seashore grass that can be irrigated with brackish water and can survive without traditional golf course chemicals while still providing a good surface for golf.

SYDNEY PARK WATER RE-USE PROJECT

A case study examined to inform the design of sections along the Los Angeles River is the Sydney Park Water Re-use Project located in St. Peters, an inner city suburb of Sydney, Australia. This project is part of a city-wide plan to drought-proof its water supply and reduce its reliance on potable water. The park was redesigned to treat and store stormwater and circulate it for re-use within the park, irrigating lawns, sports turfs and for various other purposes around the park.

This project invested in a stormwater treatment system that has the ability to harvest 690 acre feet of runoff. Furthermore, it utilizes that runoff to restore and sustain wetland habitat areas, storing water in constructed wetland bioretention ponds that are filtered and cleaned by over 150 indigenous plant species. This project also acts as a model for engaging the public and offering a beautiful community space with paths, lookouts, boardwalks, and bridges.

CASE STUDIES

CHEONGGYECHEON

Figure 52: Cheonggyecheon River.

The Cheonggyecheon River in South Korea is as near an "official" source of inspiration for the Los Angeles River as you can get. In 2006, the mayor of Los Angeles visited Korea to see the Cheonggyecheon restoration project and to get ideas for how the Los Angeles River could be improved. Cheonggyecheon flows 6.8 miles west to east through downtown Seoul before it meets Jungnangcheon, which further connects to the Han River and eventually empties into the Yellow Sea. Jung Gu – the district in which Cheonggyecheon is located – has a population of over 10 million people.

In the 1960s, the river was covered with concrete and an elevated highway constructed above it. A project was begun in 2003 to remove the highway and restore the river. This was a major undertaking, as the highway had to be removed and years of neglect and development had left the stream nearly dry.

The completed restoration project was opened to the public in 2005 with a price tag of $25.6 million. The design has three sections: history, culture, and nature. More than 100 acre feet of water per day feed the Cheonggyecheon from three sources: groundwater, the Han River, and water processed at the Jungnang Sewage Treatment Plant. A total of 22 new bridges were constructed to provide access for pedestrians and cars. Public access to the river was an important consideration in the planning process.

During construction, 100 percent of the scrap iron and steel used for construction was recycled. Over 90 percent of the waste concrete and asphalt was reused. Efforts were made to reduce the urban heat island effect, vehicle volume, and air pollution, while increasing the numbers of pedestrians and users of public transit. There was originally fierce opposition and protests from nearby vendors and business owners who depended on the area for their livelihoods. However, the number of visitors to Cheonggyecheon River has surpassed 50 million, and community members have been generally happy about the improvements they have seen.

FLOOD RESILIENCE

BUFFALO BAYOU PARK

Figure 53: Buffalo Bayou Park.

Buffalo Bayou Park is in Houston Texas. It is a 160-acre urban park that underwent a major renovation project in 2015 (LPS, 2001). The park suffered from extreme weather and transformed into a vibrant green space that provides a variety of recreational, educational, and cultural opportunities for visitors. One of the main goals of the project was to improve the park's resilience to flooding (LPS, 2001). The city of Huston is prone to severe weather conditions including hurricanes and intense rainfall, which could cause the Buffalo Bayou to overflow its banks and flood nearby communities.

To address this issue, the project included the installation of a series of underground detention basins and floodgates that can be closed during heavy rain events to protect

CASE STUDIES

the park and surrounding areas from flooding. Floodgates were installed at key locations along the park to prevent high water from entering the park and cause damage. It is designed to hold back water during periods of high flow and to release it slowly over time to prevent downstream flooding.

In addition to the flood mitigation measures, the park's renovation also includes a variety of green infrastructure features, such as rain gardens and bioswale, which help to capture and treat stormwater runoff. This design also provides additional ecological and recreational benefits. The park soils were amended to increase the ability to absorb water, and the park's lawn areas were graded to promote infiltration and reduce runoff. Permeable paving was used throughout the park to allow for water to penetrate the surface, reduce runoff and minimize the risk of downstream flooding. The park preserves a portion of the natural floodplain of the Buffalo Bayou. The area is specialized to temporarily store floodwaters and reduce the risk of downstream flooding (LPS, 2001).

RETENTION

WATER SQUARE

Figure 54: Benthemplein Water Square, Rotterdam.

Ninety percent of the city of Rotterdam is below sea level, which means Dutch engineers have gotten very creative when it comes to managing stormwater. Water Square (Dutch: Benthemplein) is, at first glance, a simple plaza. But through clever engineering, designer De Urbanisten created a space that can hold 1.5 acre feet of water. The site is a mere two acres in size and sits in a transitional area of the city, wedged between historic housing, modern commercial buildings, and a school.

Built in 2013 for $4.8 million, Water Square is composed of two visible basins for immediate water collection and a third underground reservoir that can be manually opened as needed. During dry times, the main square functions as a theater, meeting place, and sports court. Large gutters installed to guide water into the squares function as intentional skateboard ramps.

CASE STUDIES

CHULALONGKORN CENTENNIAL PARK

Figure 55: The water features of Centennial Park, Bangkok.

Bangkok used to be a city of canals, but thanks to commercial development, most of those canals have been concretized or filled in, leading to frequent flooding in the city. And while the sea level is rising, the city of Bangkok - which sits on a river bed - is sinking, compounding the problems already caused by climate change.

Centennial Park is located on the campus of Chulongkorn University in Bangkok. It sits on an 11-acre site and was built in 2017 for a cost of $4.8 million. Designed by Kotchakorn Voraakhom, the park is a sponge that can hold up to 3 acre feet gallons of water at one time. The park was designed on a 3% slope to utilize gravity to guide water from on-site museum's green roof to the park's retention pond. The green roof also connects to a storage tank that can hold up to 0.8 acre feet of water. This water is saved and used for irrigation during the city's dry season. A fun feature of the park is a set of stationary bikes that visibly aerate the retention pond when ridden.

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4. CONCEPTUAL SITE DESIGNS

Figure 56: Map locating each Conceptual Site Design

4.1 Sherman Oaks

Conceptual Design - North Hollywood

Conceptual Design - Burbank

Conceptual Design - Downtown Los Angeles

4.2 South Gate

Conceptual Design - Long Beach

4.1 CONCEPT DESIGN: SHERMAN OAKS

DANI BEHR

TAPWATER PARK

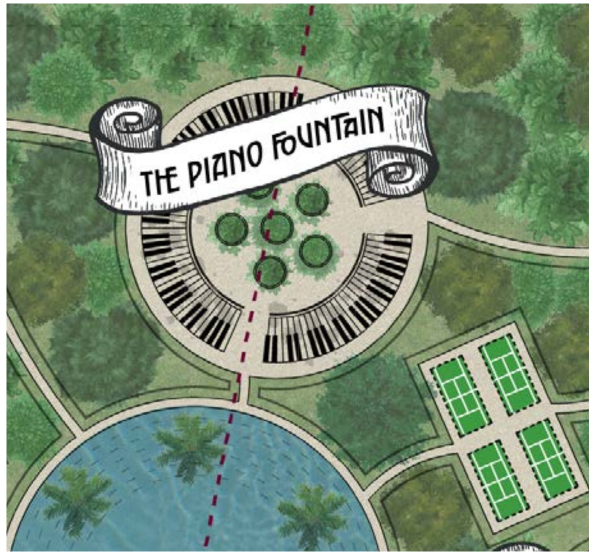
INTRODUCTION

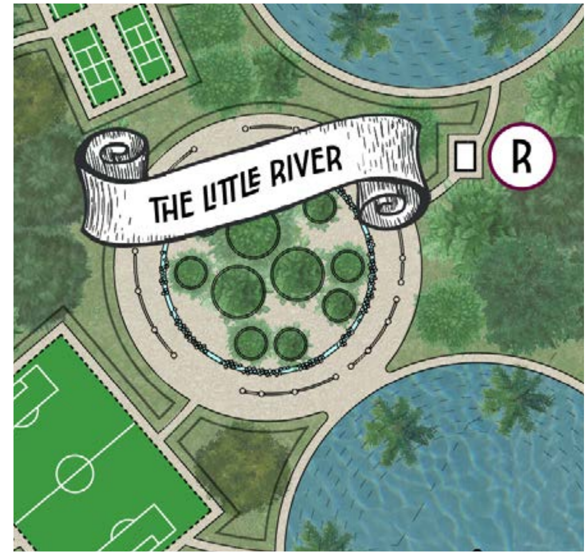
The dual purposes of Tapwater Park are to collect and celebrate water in a region where the resource has historically been insecure. The site is a conduit to the aquifer below, where water can be stored securely and indefinitly until needed.

Well above the aquifer, visitors rest on concrete benches, serenaded by a vivacious brook. A massive umbrella-like structure rises above the tree line, its translucent roof allowing sunlight to shine on ferns growing from its core. Water streams from the top of the umbrella, falling down the domed rooftop before raining off the edges. The 360-degree curtain of rain falls into a channel drain, to be recycled for the next shower (which will occur in exactly 10 minutes during park hours).

The final water feature of this enchantingly wet space is the Piano Fountain, where water and music dance and play. A ring of piano keys is painted on the ground, and while music plays over speakers, invisible hands send water flinging from keys with every note. Water arcs towards the grate in the center of the circle, where cool visitors try to guess which keys the invisible giant will play next.

Welcome, to Tapwater Park.





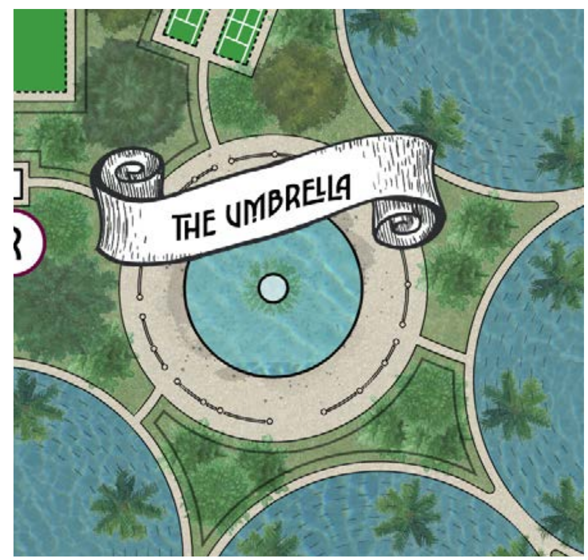


Figure 57: The water features at Tapwater Park.

4.1 SHERMAN OAKS

DESIGN GOALS

The goal of Tapwater Park is to retain and return as much water to the underlying aquifer as possible. This is achieved through the following means:

1. Infiltration Ponds
2. Dry Wells
3. Storm Mode (full park retention)
4. Drain Interception

The park includes 8 circular infiltration ponds, each 400 feet wide, 6 feet deep, and capable of holding over 0.2 acre feet of water. Ponds are lined with gravel, and obstructions to the flow of water are limited to riparian trees and recreational equipment that can withstand flooding.

At the center of each pond, there is a dry well that skims the top of the floodwaters. The water that enters these wells drops 100 feet down, relying on infiltration to cross the remaining 75 feet to the aquifer. Once water has reached the aquifer, it can be safely stored until it is needed, at which point, the water will be withdrawn through a traditional well. Testing of this water would be necessary to ensure its quality, and additional treatment may be needed before the water is ready for the tap.

Beyond the infiltration ponds, the rest of the park is designed to work like a sponge. Vast plantings of trees create a network of roots that hold and direct water downward. the parking lot and paths are paved with porous pavers that allow water through, rather than holding it on the surface or draining it into the nearby Los Angeles River.

Figure 58: A demonstration of porous concrete pavers with water draining through.

STORM MODE

In "Storm Mode", the park closes to visitors and measures are taken to protect anything that can't withstand a flood (restrooms, maintenance yard, etc.). A two-foot berm surrounds the entire park, creating a single enormous container for retaining water during periods of peak precipitation.

Between dry wells, infiltration ponds, and porous paving, all of the water that enters the park will eventually reach the aquifer. The previous fate of the water would have been draining into the Los Angeles River, which shunts water wastefully into the ocean.

While Tapwater Park does not connect directly to the Los Angeles River, it does lift a heavy burden from the concretized channel by intercepting drains that previously dumped water - mostly urban runoff - into the river.

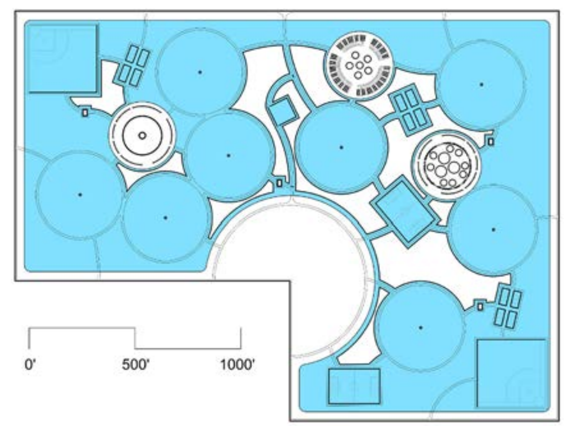


Figure 59: The park at retention capacity, showing areas design to flood in blue.

4.1 SHERMAN OAKS

SITE ANALYSIS

The site is located in Sherman Oaks, California, bounded to the north by the vast Magnolia Blvd., and to the east and west by Hazeltine Ave. and Van Nuys Blvd., respectively. The 101 freeway and the Los Angeles River flow a few blocks to the south. Most of the site is occupied by the Van Nuys Sherman Oaks Recreation Center, with the remaining space dedicated to low-density commercial (small stripmalls, auto repair, dentist offices) and residential, both single- and multi-family.

The park contains 11 baseball fields, all planted with yellowing turf. The baseball fields are single-purpose, serving those who play baseball but no one else. Trees and shade are sparse, and there is almost no shrubbery between the turf and trees.

Other features of the park include 8 tennis courts, 3 soccer fields, 2 handball courts, 4 basketball courts, 6 small parking lots, and an outdoor pool. The pool is operated by the City of Los Angeles Department of Parks and Recreation and is open year-round. Elevation declines gently across the site from northwest to southeast. There are views of the Hollywood Hills to the south.

Figure 60: The site of the proposed park.

Figure 61: Representative images of the existing site, showing the Van Nuys Sherman Oaks Recreation Center. Note the scarcity of trees, the open skyline, and the omnipresence of yellowing turf.

4.1 SHERMAN OAKS

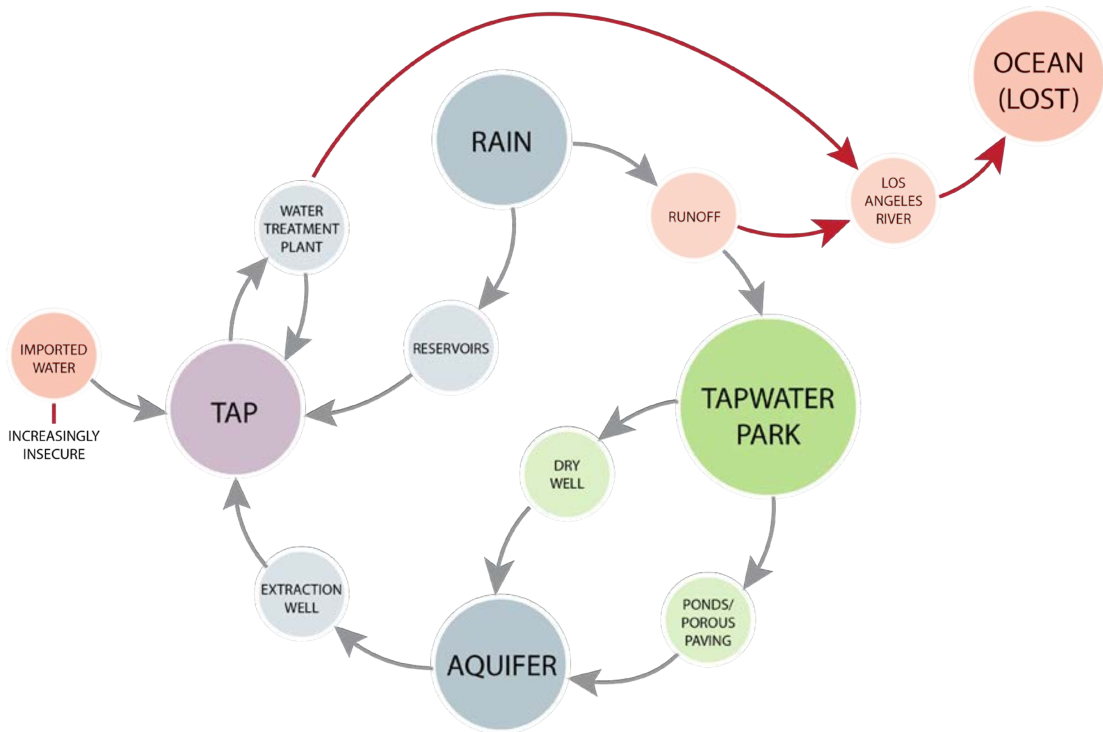


Figure 62: How Tapwater Park fits into the existing urban water cycle, intercepting runoff that would otherwise go into the Los Angeles River and be lost to the ocean.

AQUIFER RECHARGE

All water that enters the Los Angeles River water that the city desperately needs for drinking, bathing, laundry, and irrigation -will ultimately be lost to the ocean, which is in turn negatively affected by the polluted runoff. This is the sacrifice made by the Army Corp of Engineers on behalf of the people of Los Angeles, a sacrifice that perhaps should never have been made, but now that we have a concrete riverbed, we can't easily be rid of it.

The best thing we can do is keep water out of it and store the water where it can eventually be used. Cisterns are adequate for this purpose, although they generally require moving massive amounts of earth to put them underground, or they sit like squat warehouses on the soil surface and water must be pumped into them. Most importantly, cisterns have finite storage capacities, whereas the San Fernando Aquifer can hold 3.7 million acre feet of water (California's Groundwater, Bulletin 118). The aquifer is sheltered from contamination by the hundreds of feet of rock, soil, and gravel that water must pass through to get there - a natural filter that cleans water effectively enough (quality tests pending) to send it through a tap. The water in the aquifer is not subject to heat or evaporation, and unlike with cisterns, there is no chance of leaking or reaching capacity. In fact, "groundwater levels in the San Fernando Basin have undergone a general decline during recent years" (Upper Los Angeles River Area Watermaster).

Evaporation is a concern with infiltration ponds, although given the predictable seasonality of rain in Los Angeles (i.e., we reliably get rain during the winter and almost never in the summer), the risk is limited due to wintertime's low temperatures and high humidity. Dry wells mitigate the risk of evaporation by shunting water below ground, short-cutting it towards the aquifer. Water moving through dry wells reaches the aquifer faster than water that must infiltrate from above ground. The biggest maintenance risk with dry wells is clogging, which is mitigated by a design that takes water from the top of the ponds, allowing trash and debris to sink to the bottom, as well as grates that catch debris before it can enter the wells.

In order to utilize the park's full retention capabilities, the space would need to be

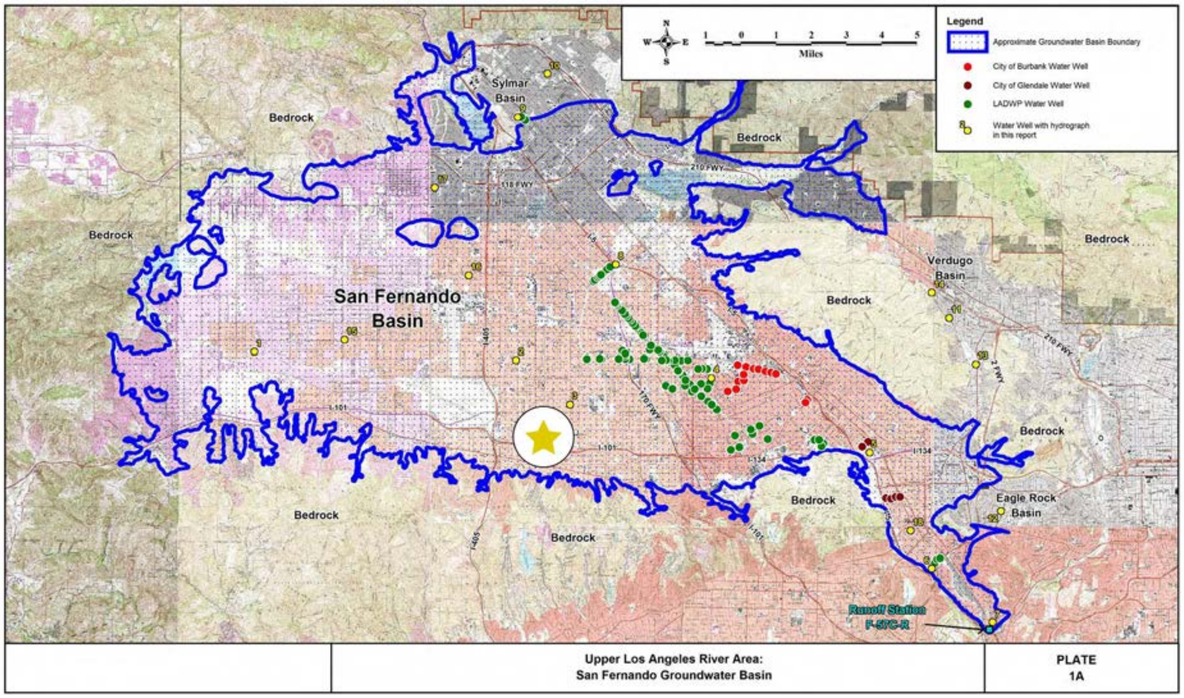


Figure 63: The San Fernando Aquifer is located directly below the site of the proposed park (gold star).

closed to pedestrians before storm events. Gates at entrances would be locked and buildings would be sealed against floodwaters. The park's three water features are situated above the flood zone, but their operation would cease during storms since there would be no one there to enjoy them. The park's two-foot berms create a total retention capacity of 16.9 acre feet, keeping all of that water out of the river and the ocean and putting it into the aquifer, where it can be utilized later.

4.1 SHERMAN OAKS

ECOLOGICAL BENEFITS

The primary ecological benefit of the park is the addition of a veritable forest of trees. Rings of California Fan Palms adorn the infiltration ponds, trunks rising like columns toward the sky. Riparian species like cottonwood and sycamore grow in floodable areas, while drought-tolerant ironwoods and junipers populate the perimeter berm and raised beds. The benefits of trees include shade and cooling, habitat, carbon sequestration, erosion control, and soil retention.

Among the trees in the raised beds and along pedestrian pathways, shrubs and flowering perennials provide color and additional habitat for birds and insects. The plant palette should focus on evergreens and self-sowing annuals, like the Matilija Poppy, to limit the amount of re-planting that will need to be done on a yearly basis.

Another major ecological benefit is the re-use of existing materials on site. The soil that is dug for dry wells and infiltration ponds will be mounded and used to create the perimeter berm as well as the raised beds that fill the spaces between ponds. Concrete broken from the existing parking lots will be re-purposed as urbanite and used to build retaining walls. Keeping these materials on site during construction will limit how much fuel must be spent hauling trash away and how much new material will need to be procured.

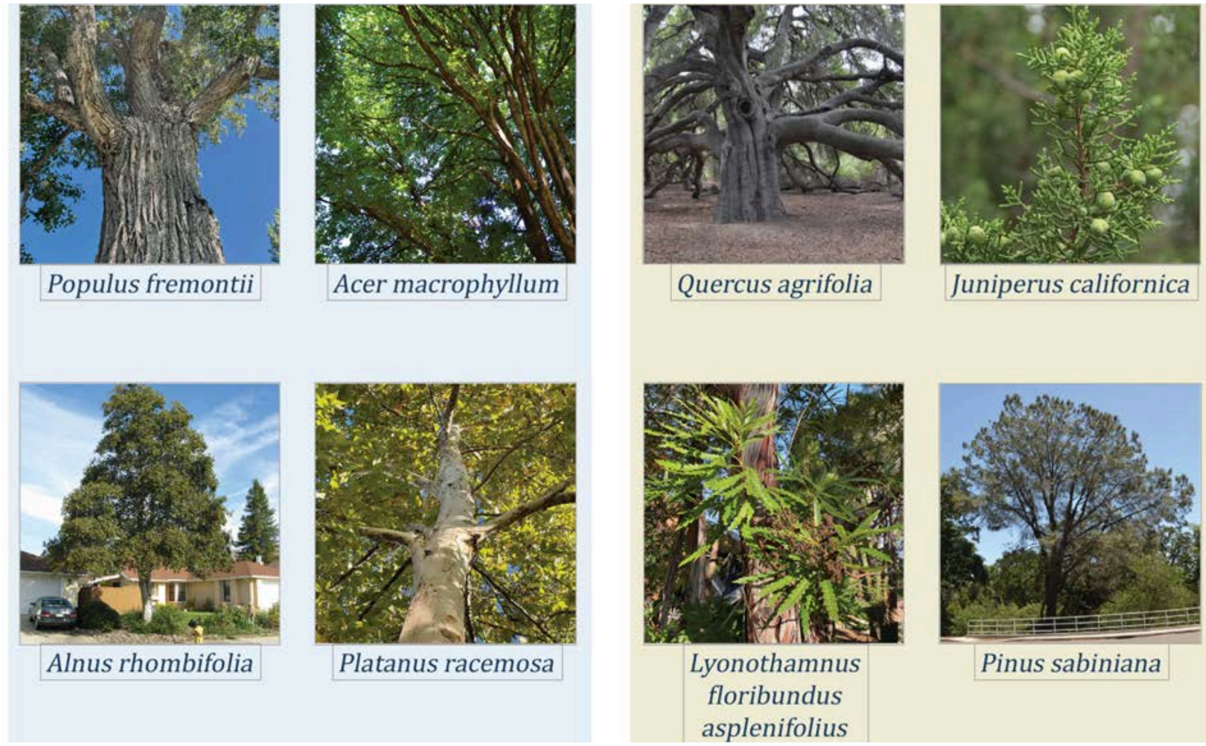


Figure 64: Tapwater Park's tree palette; left: riparian trees for areas of the park designed to flood; right: drought-tolerant trees for areas of the park designed to remain dry.

COMMUNITY BENEFITS

For the surrounding community, Tapwater Park would provide 95 acres (the current park is 67 acres) of public park land for leisure and recreation. Athletic opportunities include 2 baseball fields, 2 soccer fields, and 12 tennis/pickleball courts. The park features restrooms at four locations and ample shade and seating to keep visitors cool during summer months.

Figure 65: An example of porous paving: urbanite and gravel.

4.1 SHERMAN OAKS

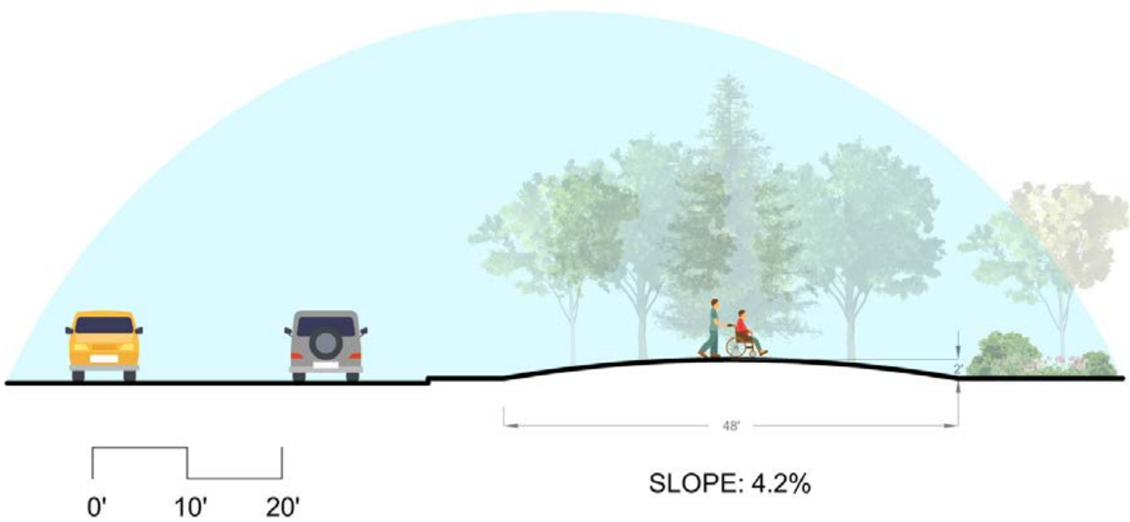


Figure 66: A section showing the water-retaining berm that surrounds the park. While entrance paths cross this berm, slopes have been calculated so that paths remain ADA-accessible.

The community would face two losses if Tapwater Park were built: the loss of some residential and commercial space through eminent domain, and the loss of 9 baseball fields. Figure 61 shows the abundance of alternative ball fields.

The loss of residential and commercial space is necessary in order to expand the bounds of the existing park north to Magnolia Blvd. and west to Van Nuys Blvd. Without this additional space, the park's retention capacity would be diminished by almost 40%.

VISITOR POV

Access Tapwater Park has seven entrances, distributed roughly equally in the cardinal directions. The main entrances are on Magnolia Blvd. and through the central parking lot. Rather than the six existing small parking lots, this centralized lot improves accessibility and provides 20% more space for vehicles than the current parking lots combined.

Visitors follow 10-foot wide paths that skirt the gigantic infiltration ponds, providing views of water in the winter and dry space for recreation in the summer. Between the ponds, urbanite retaining walls hold up shade-bearing trees and provide a sense of enclosure and escape from the surrounding city. Seating at regular intervals give visitors a chance to stop and take in their surroundings.

After a game of soccer or pickleball, visitors might wander toward one of the park's three water features: the artificial brook that babbles through a shady platform, the musical piano fountain where children splash and shout as water arcs from the keys of a giant, circular piano, or the enormous umbrella that shelters visitors from regularly-timed rain showers. Opportunities to stay cool and celebrate Los Angeles' hydrological independence abound.

Figure 67: While the design of Tapwater Park reduces the number of baseball fields on site from 11 to 2, there are a total of 41 alternative ball fields within 5 miles of the park.

4.1 SHERMAN OAKS

To ensure access for visitors with mobility concerns, no path in the park is sloped more than 5%, including the paths over the berms that make the whole space floodable. Turfstone is filled with gravel and swept daily to ensure there are no obstructions to wheelchair access. Restrooms are also ADA-compliant, and curbs in the parking lot are replaced with bollards, allowing a level transition from parking lot to the wide pedestrian pathway that surrounds it. Visitors who come just to walk can choose from a wide network of paths or take a lap around the two-mile trail marked on the pavement.

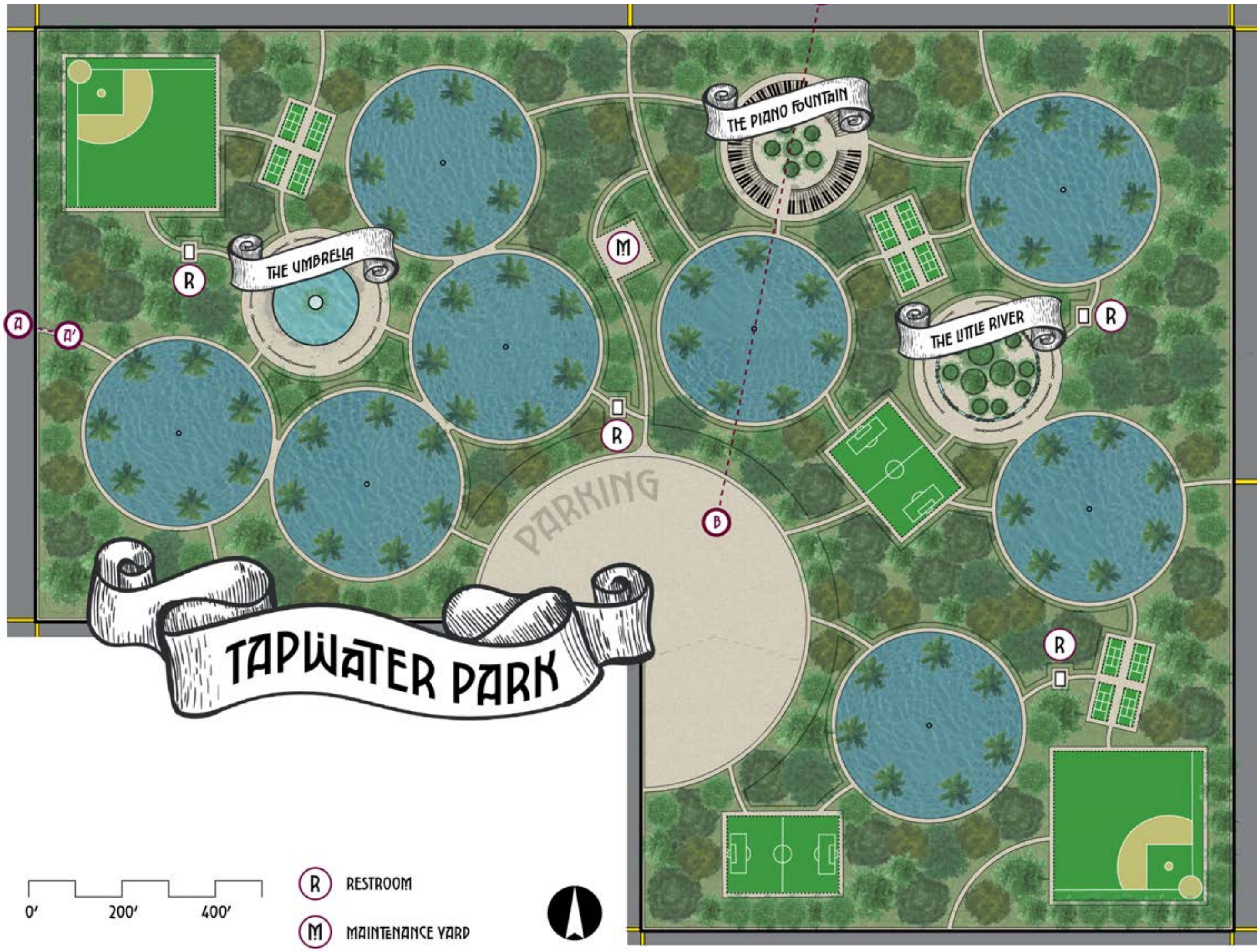


Figure 68: A visitors'-map-style site plan for Tapwater Park.

4.2 CONCEPTUAL DESIGN: SOUTH GATE

LAUREN DEMOTT

Figure 69: Rendering of the redesigned Hollydale Park in South Gate.

4.2 SOUTH GATE

Figure 70: Current South Gate Hollydale Park Site.

OVERVIEW

Size: 65 Acres

Location: South Gate / Hollydale Park

Current Use: Park / Power Easement Land

GOALS

1. Retain as much water as possible
2. Utilize power easement land
3. Multi-use, functional but fun

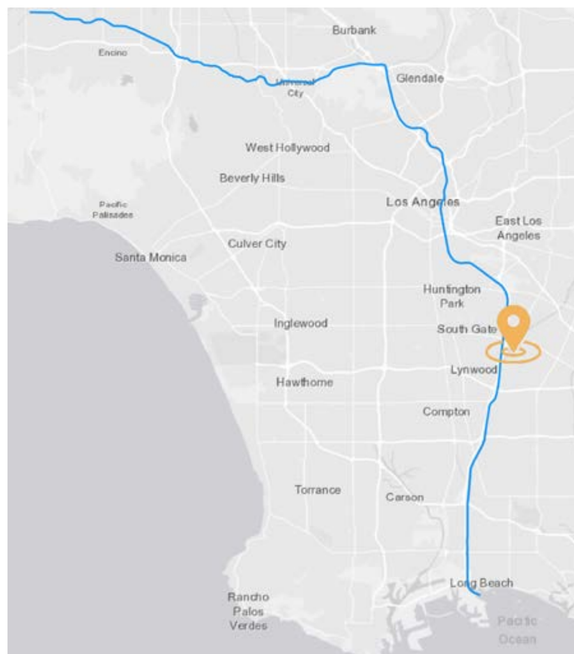


Figure 71: Location Map.

Figure 72: Conceptual Site Plan.

4.2 SOUTH GATE

Figure 73: Detailed Schematic Plan.

MAP LEGEND

1. LOS ANGELES RIVER
2. WATER BOUNCER
3. SPORT COURTS
4. DOG PARK
5. POWER TOWER
6. PEDESTRIAN BRIDGE / LOOKOUT
7. PARKING LOT

- PROPOSED TREES
- EXISTING TREES

NOTE: ALL SPORTS COURTS WILL BE BUILT ON UNDERGROUND CISTERNS

Figure 74: Index Map.

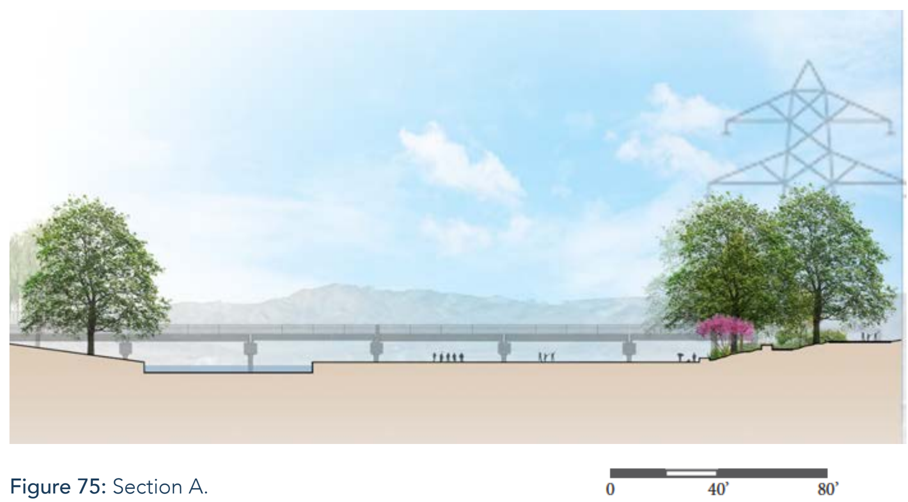


Figure 75: Section A.

4.2 SOUTH GATE

FOREVER YOUNG

Ever wanted to jump on a water bed or walk across a pool cover? With the water bouncer you can act on your intrusive thoughts and experience something truly unique. Storm water will be filtered from large sediments before entering the bouncer. The bouncer will be a military grade water bladder to make sure the structure is strong.

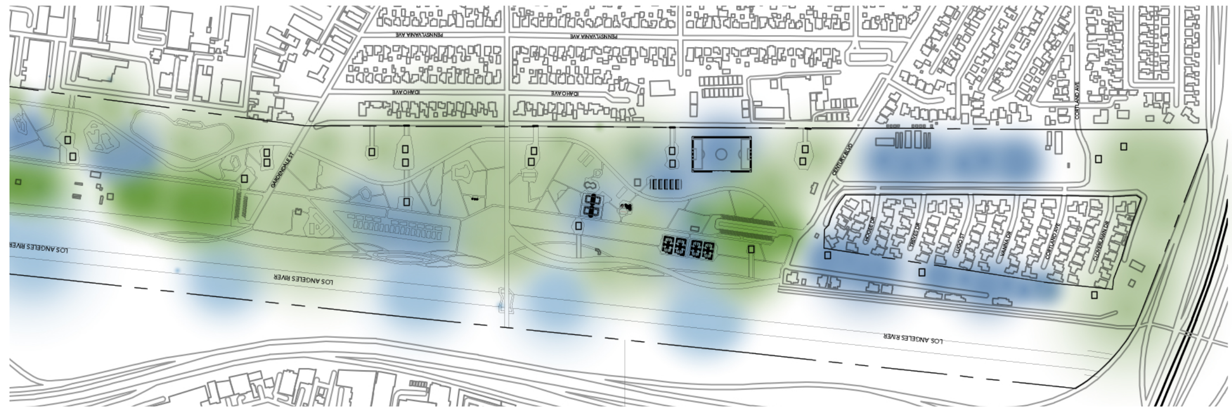


Figure 76: Water Diagram.

0 600' 1200' N

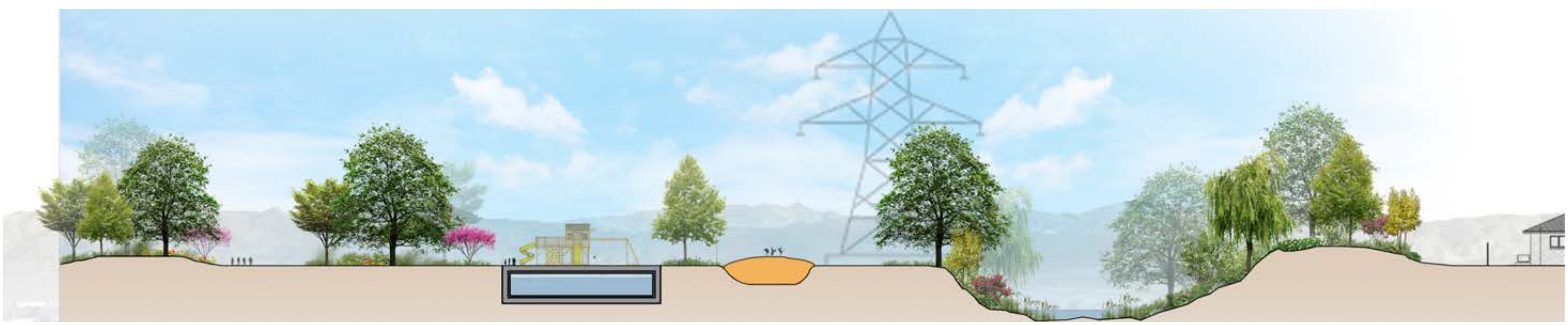


Figure 77: Section A Continued.

0 40' 80'

4.2 SOUTH GATE

Figure 78: Detailed schematic plan.

INDEX MAP (NTS)

MAP LEGEND

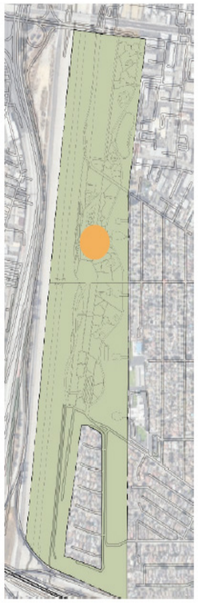
1. LOS ANGELES RIVER
2. WATER BOUNCER
3. LA COUNTY WATER DISTRICT
4. COMMUNITY GARDEN
5. POWER TOWER
6. PEDESTRIAN BRIDGE / LOOKOUT
7. PARKING LOT

PROPOSED TREES

EXISTING TREES

NOTE: COMMUNITY GARDEN WILL BE BUILT ON UNDERGROUND CISTERNS

4.2 SOUTH GATE



INDEX MAP (NTS)

Figure 79: Typical Terraced Bioswale.

4.3 CONCEPT DESIGN: BURBANK

JIN ZHANG

INTRODUCTION

The site is chosen based on the Hydraulics Report Flood Plan Management Service Special Study. It is located in the upper Los Angeles River between Freeway 5 to 134, mile markers 33 to 31 with three separate sites including Disney Retention, Los Angeles Equestrian Center, and Bette Davis Park sum of a total of 115 acres. Rising temperatures impact the Earth's water cycle, not only resulting in more frequent and intense storms but also contributing to drying over some land areas (NASA). Patterns in intensity rainfall and duration have challenged the existing flood management and capacity. In 2023, according to the research (Pezzetti), Los Angeles airport shows the county observed 15.65 inches of rain, more than double the 6.98 inches usually recorded by mid-March.

SITE ANALYSIS

Burbank City is a thriving entertainment industry, with several major media and entertainment companies including Warners Bros, Walt Disney Studios, and NBC Universal. The 115-acre three sites are located in the city of Burbank with flood resilience purpose selection. It comes with high-intensity land cover, surrounded by multi-residential (See Figure 75).

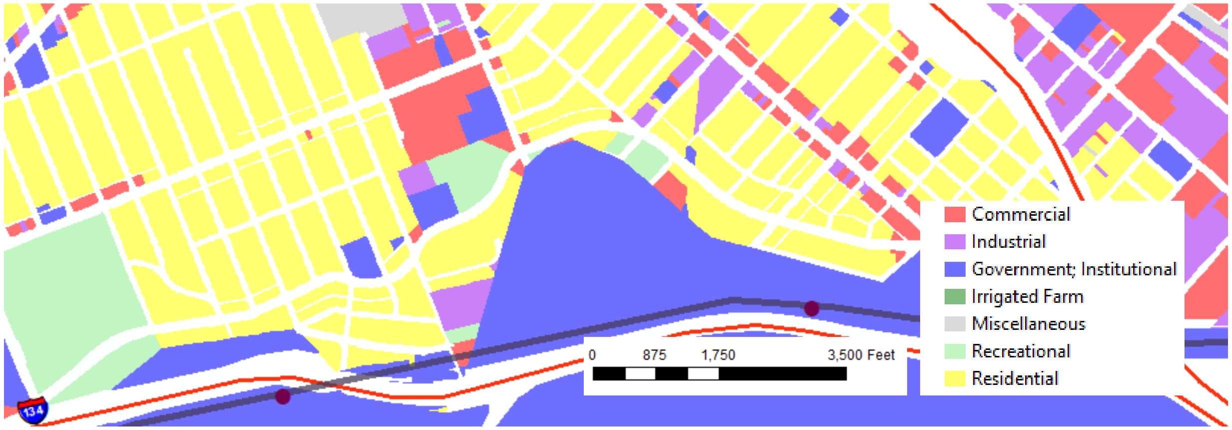


Figure 80: Land use map of the surrounding neighborhood.

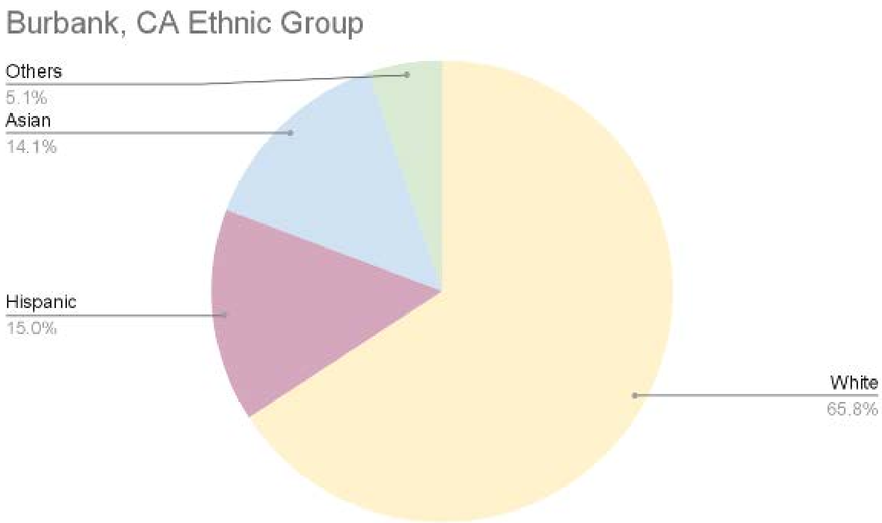


Figure 81: Burbank, CA Ethnic Group Data.

In 2021, Burbank, CA has a population of 103,000 with a median age of 39.6 and a median household income of $82,246 with a poverty rate of 12.42% (U.S. Census). It relies on the largest source of property tax revenue. The 5 largest ethnic groups are White, Hispanic, Asian, and others (See Figure 76).

4.3 BURBANK

The channel is the soft bottom, and the structure is trapezoidal with an approximate width of the top channel of 300 feet The slope of the channel is 0.4% and the concrete type is earthen. The geology of the site is alluvium. The Los Angeles Equestrian Center and Disney Retention Park reach to higher infiltration rate of stormwater (See Figure 77). When rainfall hits on impervious surfaces such as roads and parking lots, it could increase the risk of excess runoff that cause flooding and erosion. A higher infiltration rate is desirable for sustainable stormwater management. And the alluvium on the site could benefit from stormwater infiltration. It refers to loose sediment or soil that has been deposited by water. When stormwater runoff directly from alluvial soils, it can be naturally infiltrated and purified by the soil's purpose structure.

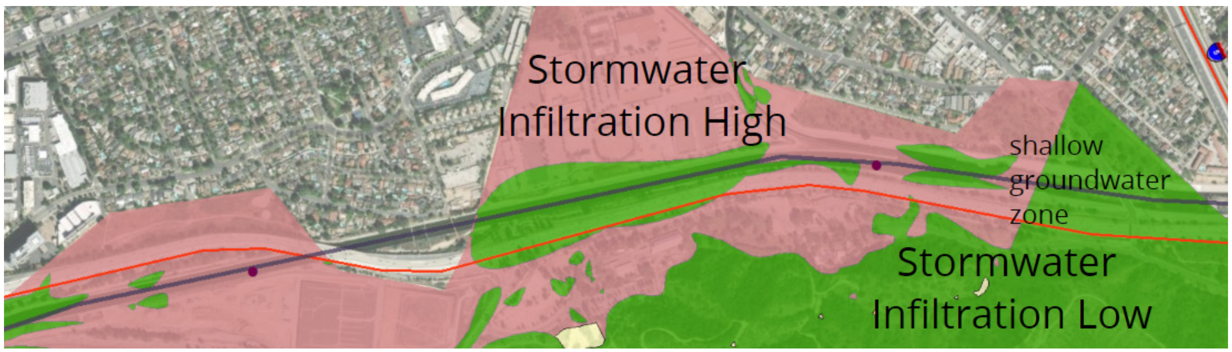


Figure 82: Stormwater capture infiltration rate by ArcGIS.

The Burbank Western Channel was constructed in the 1940s serves as a tributary to the Los Angeles River. The channel is approximately 1.5 miles long. It helps to recharge groundwater supplies by allowing water to infiltrate into the soil (See Figure 78).

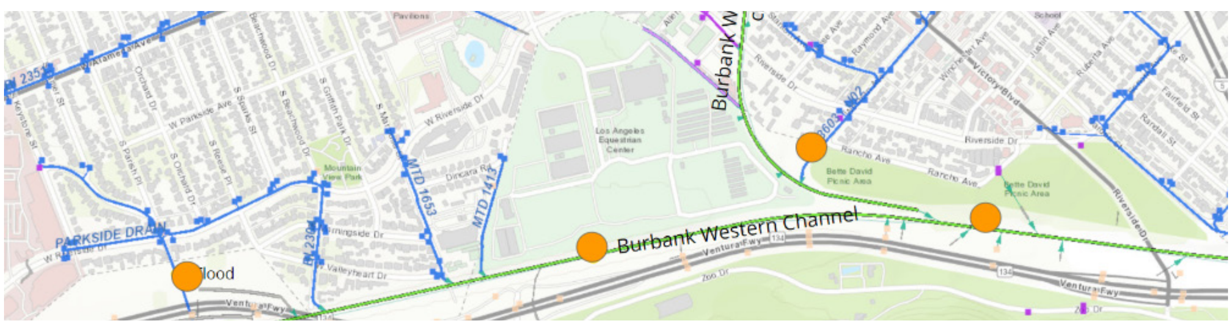


Figure 83: Public Works Los Angeles County Storm Drain System.

DESIGN GOAL

The overall goal for comprehensive site design is enhancing the natural flow of the river and reducing the risk of flooding downstream. It is concentrated into three sections, the Disney retention park would be focused on the multiple loop circulation that benefits for both habitats and the equestrian center. The Los Angeles Equestrian Center would concentrate on building concrete cistern underground to capture water. And Bette Davis Park is a multi-functional park that not only contributes to the surrounding neighborhood but also mitigates and reduces the flood risk of the Los Angeles River. Design strategies would be included:

- Increase the flood storage capacity
- Improve the channel's ability to withstand stormwater velocity
- Build a rainwater harvesting system
- Create nature features
- Design elevated promenade

4.3 BURBANK

DISNEY RETENTION PARK DESIGN

The project site is situated in a Mediterranean ecosystem that is globally rare, comprising merely 2% of the earth's land surface, but accounts for 20% of all documented plant species. One of the objectives is to restore ecosystems that encompass riparian and freshwater marsh habitats. Three significant interconnected ponds will be utilized to collect the inflow from the streets.

The major inflow will be directed to S Parish Pl where it will be captured in the connected detention ponds. If the capacity of the detention pond is reached, the excess inflow will overflow into the primary drainage channel. Additionally, alternative ponds will be in place to capture inflow from the streets, and once their capacity is net, the inflow will overflow to the main drainage channels.

Figure 84: Disney Retention Park Conceptual Plan.

Meanwhile, the site drainage will be managed by the primary drainage channels on the southern side. The vegetation in the riparian zone is composed of plant species adapted to the wet and dynamic environment such as Schoenoplectus californicus, California bulrush. It is designed for the protection and conservation of biodiversity and provides valuable ecosystem services such as water filtration, erosion control, and carbon sequestration.

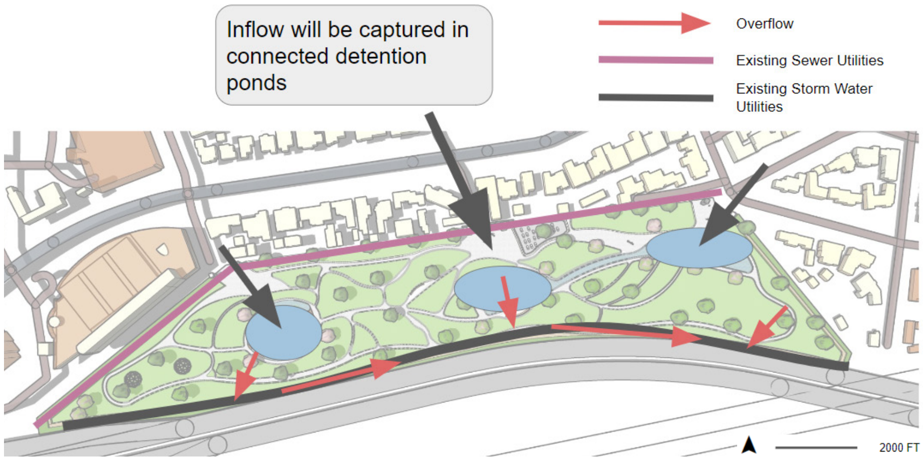


Figure 85: Water Flow Direction.

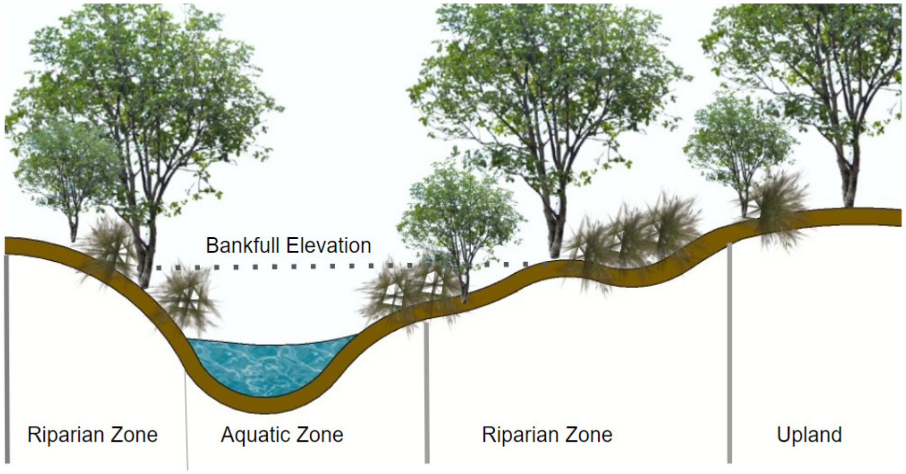


Figure 86: Riparian Zone.

4.3 BURBANK

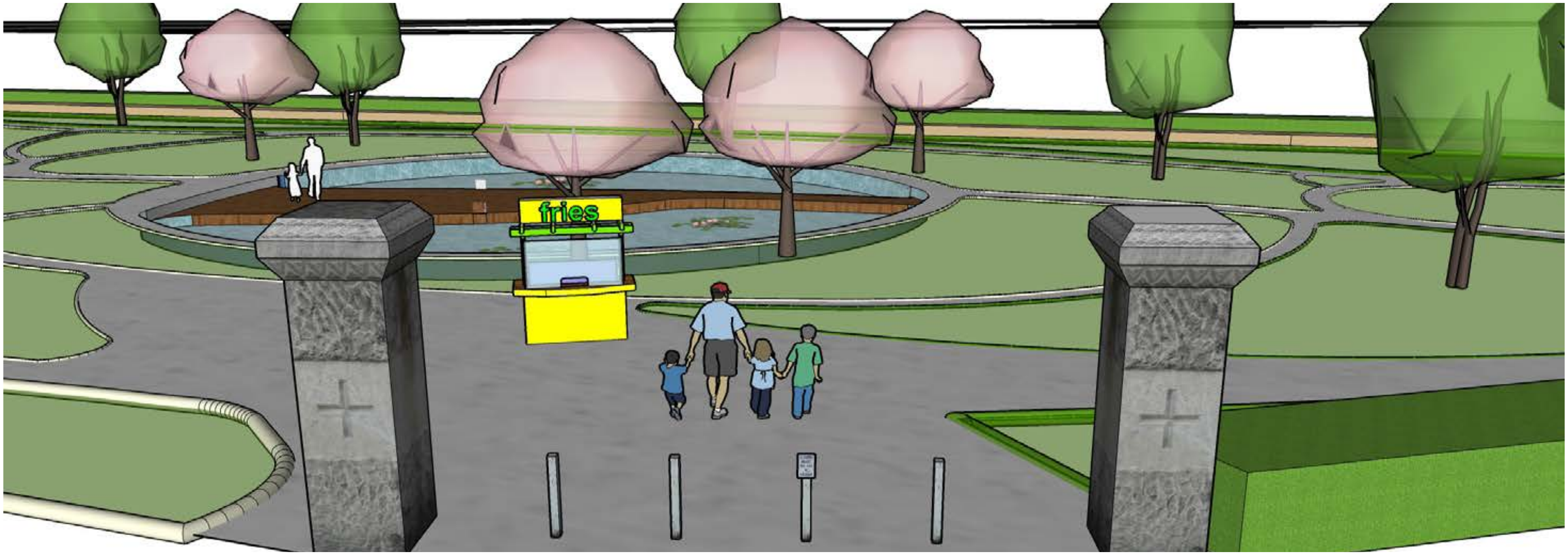


Figure 87: Perspective View.

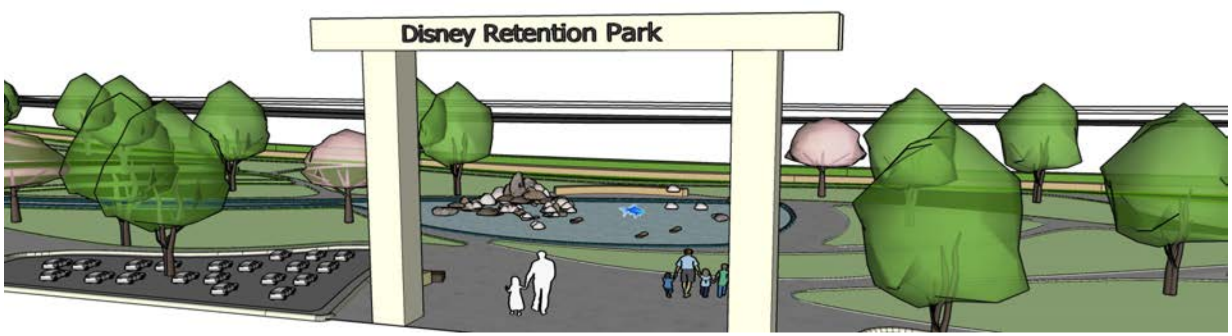


Figure 88: Perspective View.

In addition to providing effective water flow guidance, the site is also designed to incorporate multiple loop circulation. This includes dedicated lanes for bike riding, horse riding amenities, and elevated pedestrian walkways that please a safe and pleasant experience for all communities. The five feet loops are carefully planned to ensure maximum accessibility, ease of movement, and comfort. Visitors would be able to explore and enjoy the sites while enjoying the natural surrounding. Each circulation offers endless opportunities for recreation and relaxation, making the site an ideal destination for people of all ages and interests.

4.3 BURBANK

THE LOS ANGELES EQUESTRIAN CENTER

As a result of the limitation surrounding the site, the design will majorly focus on implementing flood control. Multiple cisterns will be placed to capture and retain water runoff from the surrounding area.

The calculator of the watershed retention capacity was based on the dimensions of the bioretention technique, which were designed to maximize water retention and minimize the risk of flooding. The site will feature four underground cisterns, each with a depth of 20 feet and a capacity to hold roundly 1.1 acre feet of water. The cistern will be strategically located to capture runoff from the surrounding areas and store it for the hardness weather.

BETTE DAVIS PARK DESIGN

Bette Davis Park is an example of sustainable design that involves innovative features to address flood control, habitat restoration, and recreational opportunities for communities. One of the key design elements is the riverfront flood control steps. These provide flood control and creates an attractive visual feature that enhances the park's overall aesthetic appeal. Additionally, the park features a habitat island to enhance the existing soft-bottom habitat and provide excellent opportunities for communities to enjoy the view of the riverfront while restoring the habitat for multiple species.

Another important feature of the park is the research center, which is built 10 feet above the river and allows both researchers and communities to study the ecosystem. It also provides a view of the river and Griffith Park. Additionally, it allows researchers to easily access the water for quality sampling tests.

In addition to these features, the park retains existing walking trails that connect to the Los Angeles Equestrian Center. The promenade along the Los Angeles River edge is designed with multiple-loop circulation that creates a flood control buffer while providing a scenic and enjoyable experience for communities. Furthermore, streets along the edges of the park are designed with green infrastructure, managing stormwater runoff and reducing the risk of flooding in urban areas. The approach involves integration of vegetated areas, such as bioswales that slowly infiltrate the soil and recharge groundwater supplies. Overall, the design for Bette Davis Park is multi-beneficial for the environment, wildlife, and communities alike.

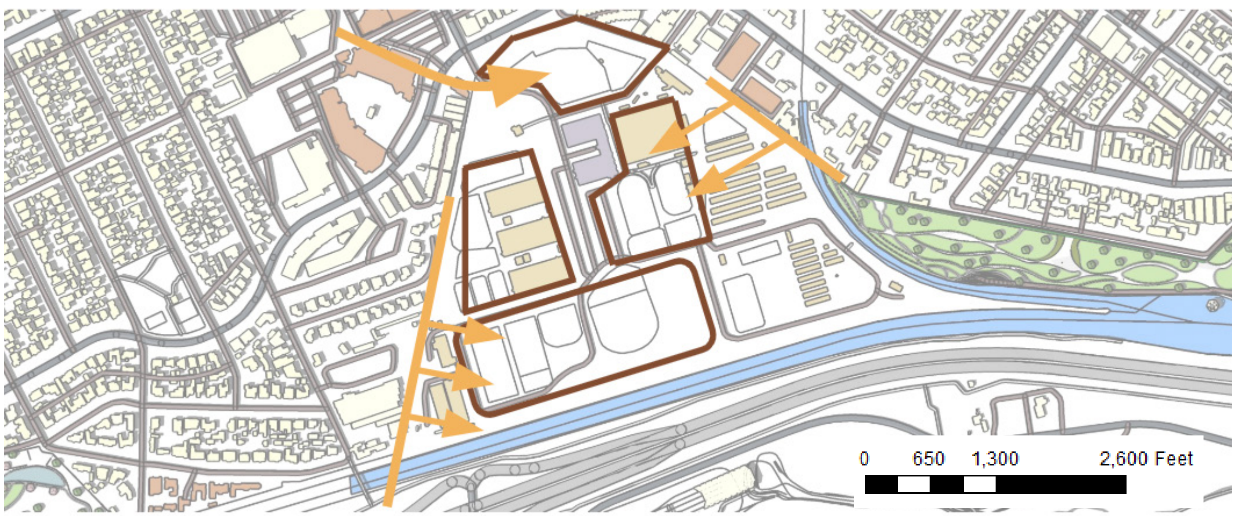


Figure 89: Los Angeles Equestrian Cistern Basin Conceptual Map.

4.3 BURBANK

Figure 90: Bette Davis Park concept plan.

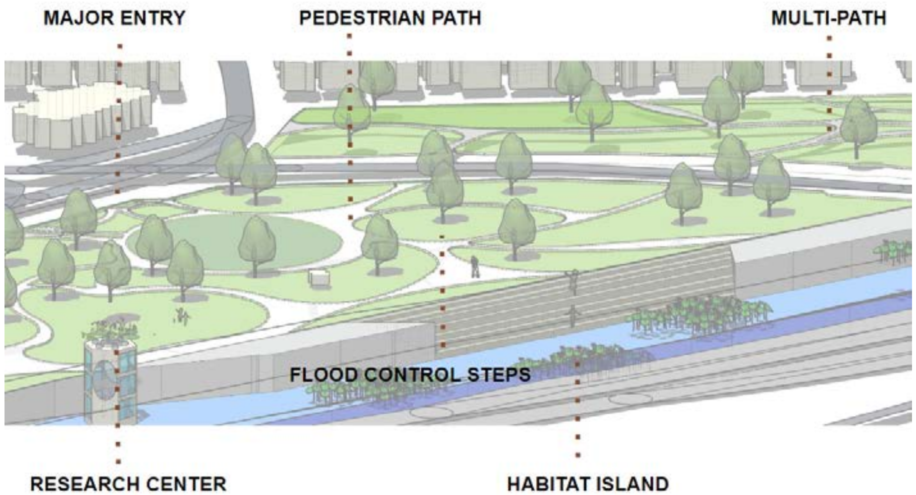


Figure 91: Bette Davis Park features.

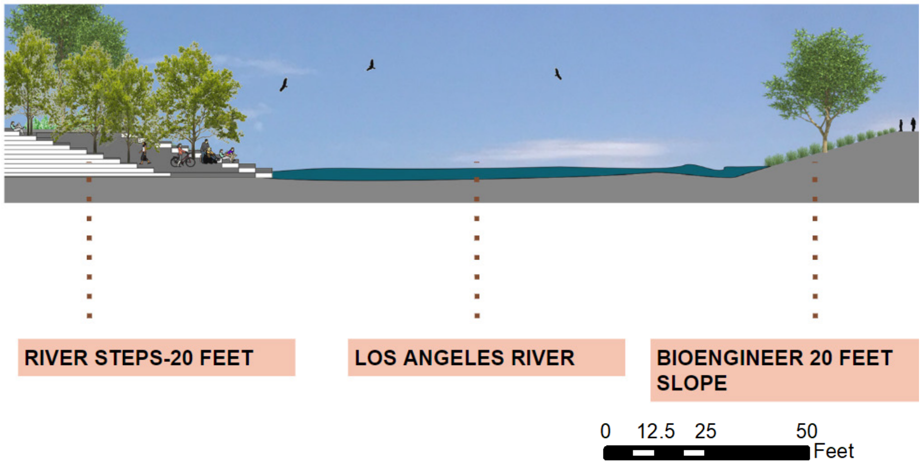


Figure 92: Bette Davis Park river front section.

4.3 BURBANK

CONCLUSION

Overall, the three sites are characterized by a diverse range of habitats, with a majority of the area covered by wetland, riparian, and transitional habitats. The wetland habitat is predominantly covered with water and is home to various aquatic plants, fishes, and birds. This habitat is crucial for maintaining the ecological balance of the area and acts as a natural filter for pollution.

Figure 93: Bette Davis Park river front perspective.

The riparian habitat refers to the area of land that is adjacent to a river. It is characterized by the presence of trees and other vegetation, which provides shade and habitat for a wide species. It maintains the quality of water in the river and helps to prevent soil erosion and filter out pollutants. The transactional habitat will plant in between two different types of wetland and riparian. It provides a transition zone for species to move as well as a pedestrian pathway. In conclusion, these three habitats enhance the health and well-being of both communities and wildlife.

Figure 94: Bette Davis Park river elevated promenade perspective.

4.4 CONCEPT DESIGN: NORTH HOLLYWOOD

CAITLIN KELLER

INTRODUCTION

The site selected for the studio project is located in the upper Los Angeles River between river miles 35.5 and 36.5 in the North Hollywood area. The site is surrounded by residential, commercial, and industrial development, and within close proximity to Universal Studios. The selected site area includes two parks located on both north and south sides of the river, and located just east of the 101 Freeway. The site selected for revitalizing this area of the Los Angeles River is a total of 256 acres. The river channel in this area is concrete lined and rectangular, with a width of roughly 130 feet and a slope of 0.6%. The historical vegetation in this area is coastal sagebrush and the climate is hot-summer Mediterranean.

Figure 95: Site images showing current river conditions.

SITE ANALYSIS

The site selection for this project includes 8 design areas: 1. Rio Vista Elementary; 2.Tujunga Wash; 3. Weddington Recreation; 4. The Los Angeles River; 5. Residential Area; 6. South Weddington Park; 7. Metro Station; and 8. Universal Studios. These 8 areas will incorporate the design goals for this project by improving biodiversity, providing habitat enhancement, and linking wildlife and native plant corridors, while improving flood control.

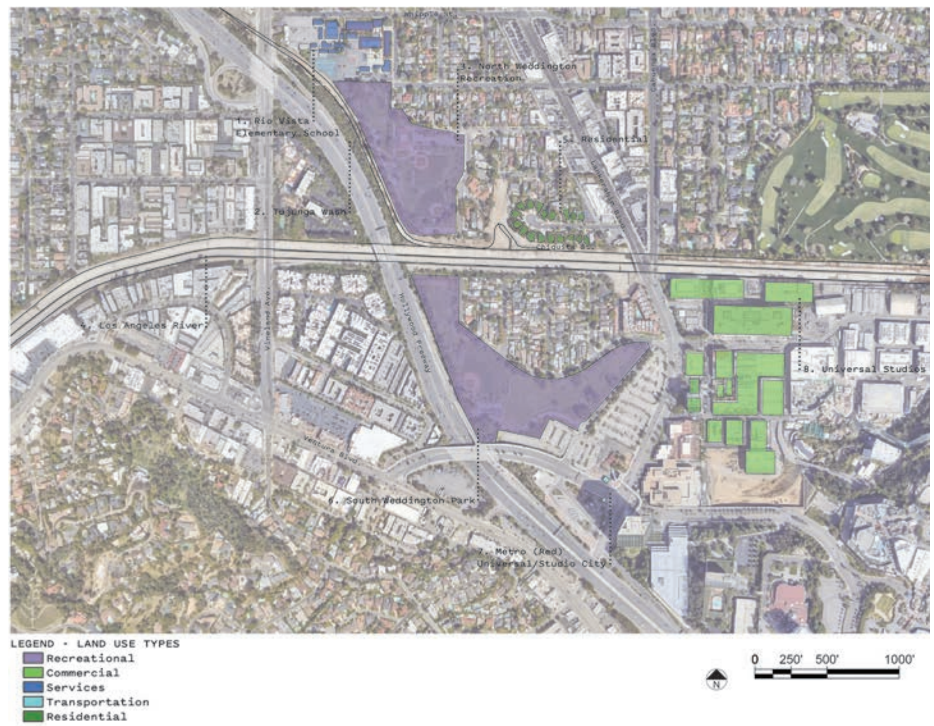


Figure 96: Site design areas and land use types.

4.4 NORTH HOLLYWOOD

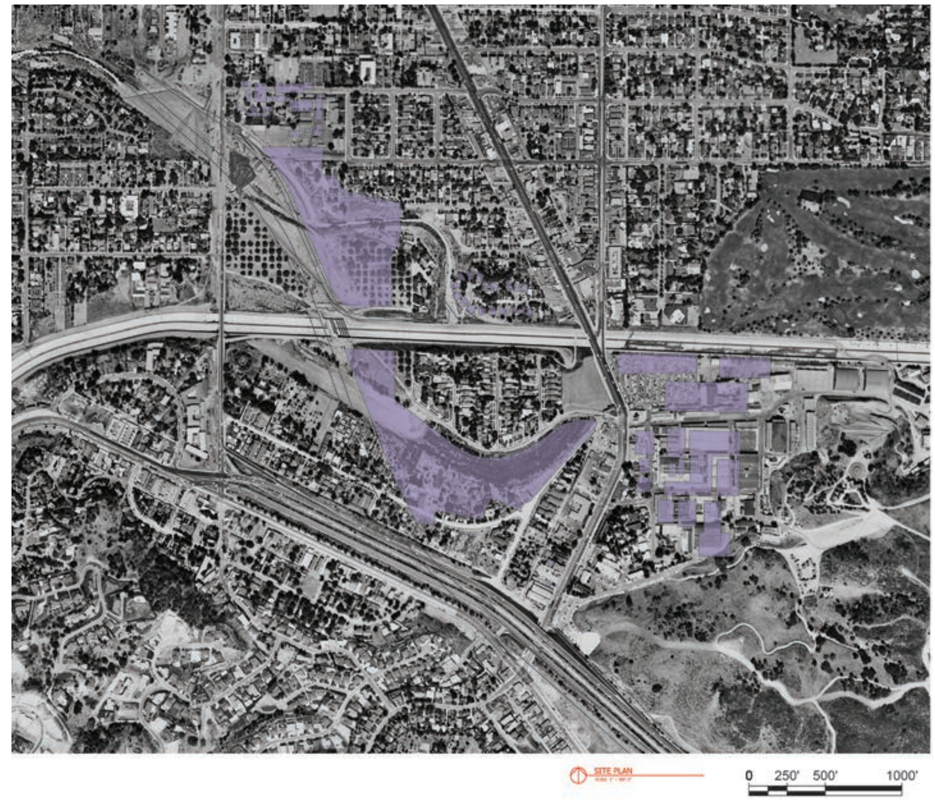


Figure 97: Historical aerial image from 1938 and 1956.

Site context for this project that is helpful in the design process includes reviewing historical aerial imagery of the site. The aerial images provided for review are from 1938 and 1956. The historical image from 1938 shows the area before the channelization of the Los Angeles River and of the Tujunga Wash. From this image, one can see the natural shape of both the river and the Tujunga Wash. In the historical image from 1956, the channelization had already occurred. The image from 1956 shows the area before the development of the Hollywood Freeway, also known as the 101 Freeway, and shows the Tujunga Wash before channelization, running between what is now Weddington Recreation and a residential area. The original 10-mile Hollywood Freeway opened in 1954 and ended just north of the Cahuenga Pass, which is located about 5 miles south of Wedding Park South. The Tujunga Wash runs parallel to the 101 Freeway and enters the Los Angeles River at North Weddington Recreation Center. The wash was channelized along with the river for flood control by the U.S. Army Corps of Engineers in the 1950s.

4.4 NORTH HOLLYWOOD

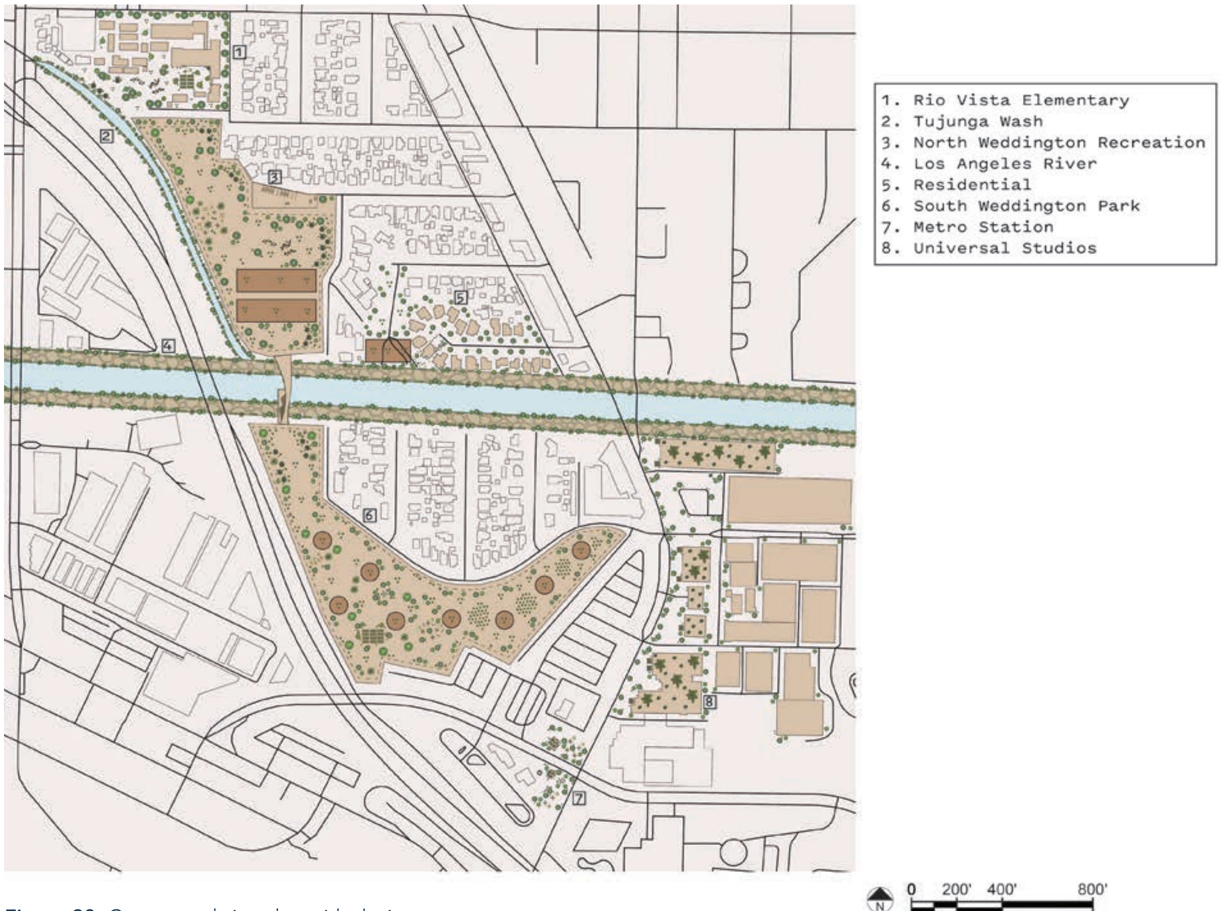


Figure 98: Conceptual site plan with design areas.

PROJECT GOALS

The project goals for revitalizing this portion of the Los Angeles River and its surrounding area are: 1. Restore and create habitat for plants and animals; 2. Connect and create new green corridors through urban areas; 3. Reduce flood risks. The strategies and tactics used for achieving these project goals include: Redesigning or developing supplemental designs of the river, riverbanks, and areas surrounding the river; recommended planting palettes and plans for design areas; design typologies such as bioswales and other bioretention techniques such as underground basins and cisterns. Design strategies involve working with existing conditions as well as removing the concrete that is on the bottom of the river and that is covering the river; this would allow the river in this area to be soft-bottomed and in a more natural shape. Some factors to consider in the design process are: Community use and community engagement, climate change, seasonal rain patterns, historical vegetation and wildlife, as well as existing vegetation and wildlife.

CONCEPTUAL DESIGN

The overall site design's programming that can be found within each area includes native and drought tolerant plantings, shade, seating areas, rainwater catchment, permeable paths, educational gardens, and natural materials. Programming will reflect the project goals of restoring and creating new habitat, connecting green corridors and reducing flood risk. The Rio Vista Elementary School and the parks within the site boundaries will incorporate natural play structures, shaded areas, open space, and opportunity for discovery, learning, and play. The riverfront design concept will include native plantings, bioswales, seating areas, recreational pathways, and a pedestrian bridge with a lookout platform and native plantings in the format of a "pollinator highway." The metro station and Universal Studios conceptual site designs feature tree canopy for shade

4.4 NORTH HOLLYWOOD

and planters with native plantings, offering opportunities for connecting green corridors in the area and cooling areas that experience urban heat island effect.

The predominant plant communities within the selected site area are Coastal Sage Scrub and Southern Oak Woodland. These plant communities often overlap. The Coastal Sage Scrub plant community is unique to Mediterranean climates and common throughout Los Angeles. Coastal Sage Scrub is often referred to as “soft chaparral” with most plants featuring soft gray-green foliage and shallow root systems. These plants will go dormant in the summer to survive dry conditions. Southern Oak Woodland plant communities are typically found on valley floors, fault-lines, foothills, and mesas. Southern Oak Woodland plant communities feature oak trees with understories of grasslands or coastal sage scrub plants. Most of the plants that are considered to be Southern Oak Woodland are woody vegetation. When it comes to the riverfront and its riverbanks, the plant communities within the selected site area would be Riparian or Riparian Woodland. Riparian plant communities are always near a water source, found along any river, stream, or waterway. Riparian plants are generally more water-thirsty than others found in the Southern California plant communities. These plant communities can be thick in vegetation and provide food and shelter for local wildlife.

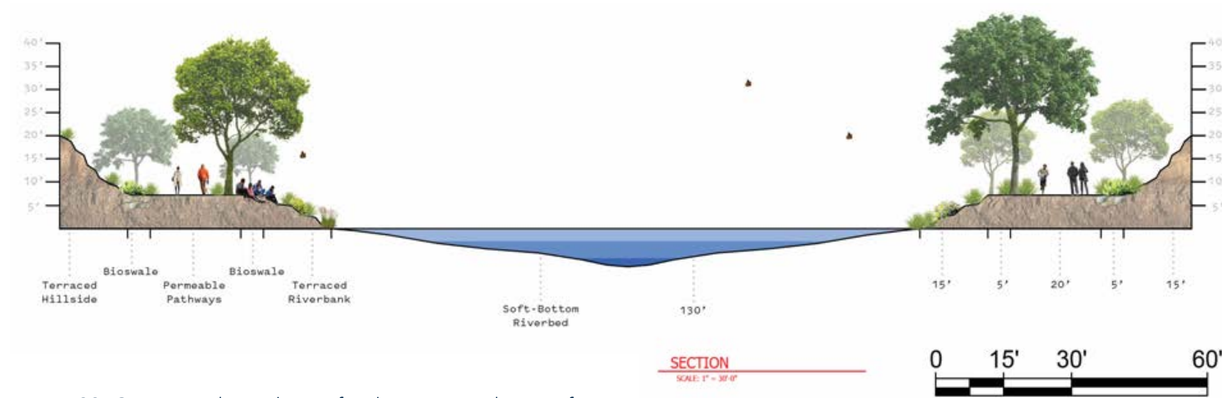


Figure 99: Conceptual site design for the Los Angeles riverfront.

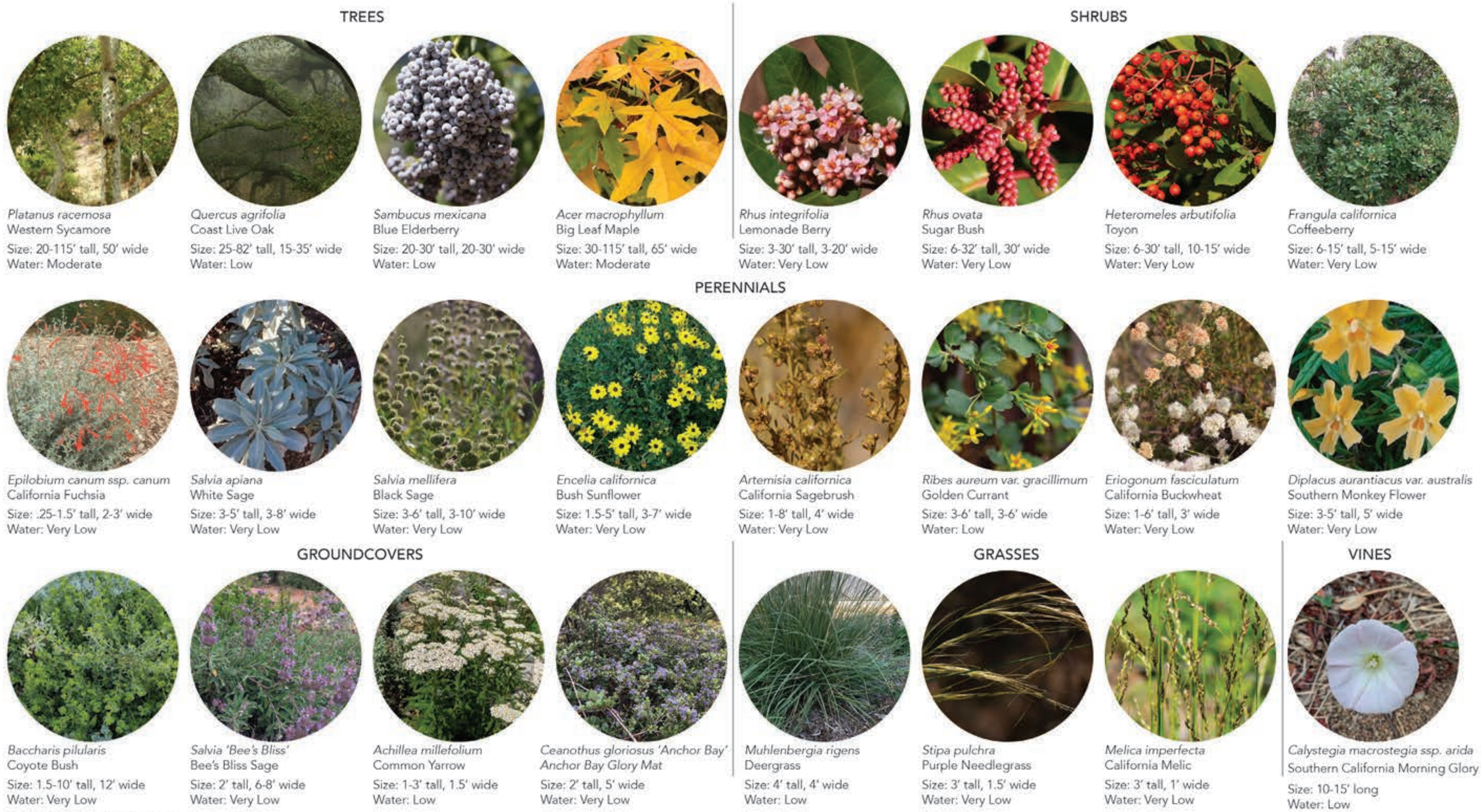
Figure 100: Conceptual site design for South Weddington Park.

The predominant plant communities within the selected site area are Coastal Sage Scrub and Southern Oak Woodland. These plant communities often overlap. The Coastal Sage Scrub plant community is unique to Mediterranean climates and common throughout Los Angeles. Coastal Sage Scrub is often referred to as “soft chaparral” with most plants featuring soft gray-green foliage and shallow root systems. These plants will go dormant in the summer to survive dry conditions. Southern Oak Woodland plant communities are typically found on valley floors, fault-lines, foothills, and mesas. Southern Oak Woodland plant communities feature oak trees with

4.4 NORTH HOLLYWOOD

RESTORATION PLANT PALETTE

COASTAL SAGE SCRUB + SOUTHERN OAK WOODLAND



Source: Theodore Payne.

Figure 101: Plant palette featuring Coastal Sage Scrub and Southern Oak Woodland plant communities.

understories of grasslands or coastal sage scrub plants. Most of the plants that are considered to be Southern Oak Woodland are woody vegetation. When it comes to the riverfront and its riverbanks, the plant communities within the selected site area would be Riparian or Riparian Woodland. Riparian plant communities are always near a water source, found along any river, stream, or waterway. Riparian plants are generally more water-thirsty than others found in the Southern California plant communities. These plant communities can be thick in vegetation and provide food and shelter for local wildlife.

Planting palettes for residential areas within this selected site area would mix plants from both the Coastal Sage Scrub and Southern Oak Woodland plant communities and include examples of trees, shrubs, perennials, groundcovers, grasses, and vines. The plants featured in the palette would be drought tolerant, easy maintenance, affordable, and accessible at local native plant nurseries. These plant palettes would be distributed to local neighborhood residents and businesses to encourage native landscapes that are appropriate for the region and climate of the area. One or two native and water-wise educational gardens with signage installed at residences within close proximity to the river and within the project boundaries would be an opportunity to provide incentive for other residents in the neighborhood to follow suit.

WATERSHED RETENTION CAPACITY

For the selected site's conceptual design, bioretention techniques such as bioswales, cisterns, and basins were included to improve flood control. These methods are primarily implemented in the parks located both north and south of the river as well as along the riverfront itself. The watershed retention capacity was calculated from the dimensions of the bioretention techniques used. Two rectangular underground basins are proposed for the park located north of the river. Each basin would be 350 feet long, 100 feet wide, and 10 feet deep. These basins would hold a volume of 8 acre feet of water each. One rectangular underground basin is proposed for the Aqua Vista D.D.A. This basin would be 200 feet long, 100 feet wide, and 10 feet deep, and would hold 4.6 acre feet of water. Seven round underground cisterns are proposed for the park south of the river. Each tank would be 80 feet in diameter by 10 feet deep. These cisterns would hold a volume of roughly 1.1 acre feet of water each. Bioswales are proposed to be dispersed alongside the riverfront recreational pathways on both sides of the river. The bioswales would be 20 feet long, 5 feet wide, and 3 feet deep. There would be an estimated 40 bioswales total with 20 bioswales developed on each side of the river.

4.5 CONCEPT DESIGN: LONG BEACH

DANIELLE LEWIS

INTRODUCTION

This site is located at river mile 5 near Del Amo Blvd. and the 405 freeway in Long Beach. This area encompasses the Los Cerritos neighborhood, Virginia Country Club golf course and Scherer Park to the east of the river and the Dominguez Gap spreading grounds and underutilized land along the 710 freeway to the west.

HISTORICAL CONTEXT

The Tongva are the original inhabitants of this area and adapted to the river having periods of dry and flood seasons. From the late 1700's to the 1860's the site which is now the Virginia Country Club golf course and neighborhood operated as a cattle and sheep ranch called the Rancho Los Cerritos. It's location came about from a series of land deals and due to it's proximity to the historic Los Angeles River path. The map from 1896 on the left shows the original path of the Los Angeles River.

By 1942, as shown on the map to the left, much of the land from the Rancho had been sold off to individuals and the golf course to pay for repairs of the adobe structure which is now a historic site. The streams meeting up with the river had been redirected and channelized via a concrete channel running directly north of the golf course (Rancho Los Cerritos Historic Site).

Figure 102: Historic channel of the Los Angeles River on 1896 (top) and 1942 (bottom) USGS Topographic Maps.

4.5 LONG BEACH

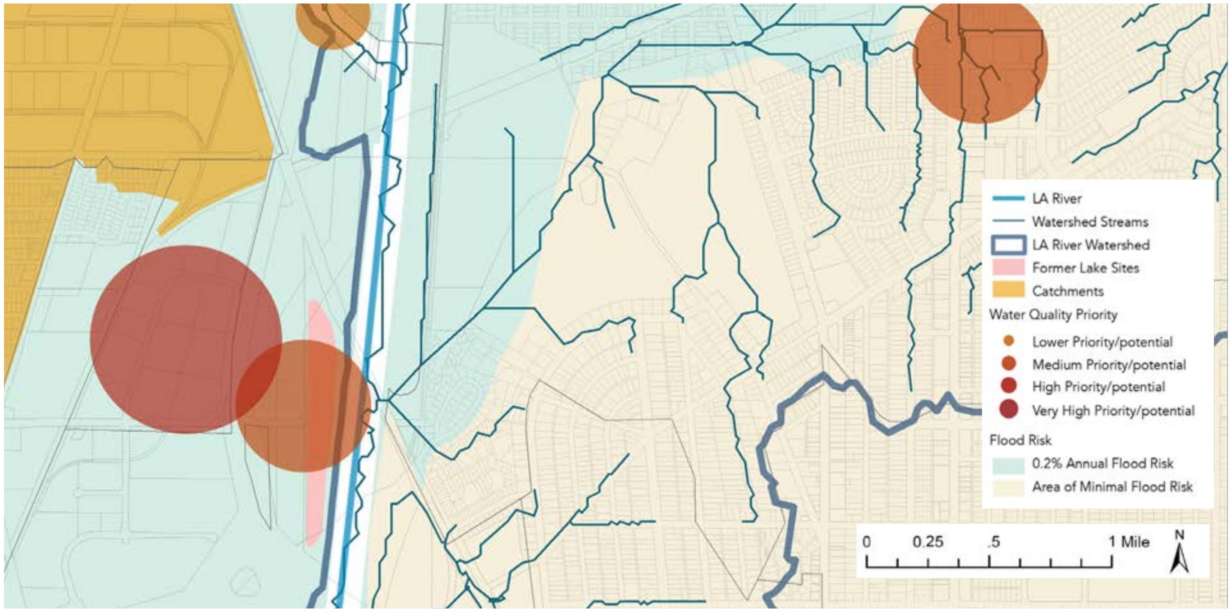


Figure 103: Water Quality and Flood Risk in the Lower LA River.

DEMOGRAPHICS

The current land surrounding the site is primarily industrial and residential with some recreational and miscellaneous use. The east and west sides of the river represent drastically different socio-economic groups. The Los Cerritos neighborhood, with its large, private golf course is affluent and has above moderate median income scores and a low vulnerability to climate change. In contrast, the area to the west of the river is highly vulnerable to climate change, has a high need for improving water quality, and 55% of residents are considered low income. Redesigning the river for these two distinct communities creates an interesting challenge and provides an opportunity to address a variety of community and environmental needs.

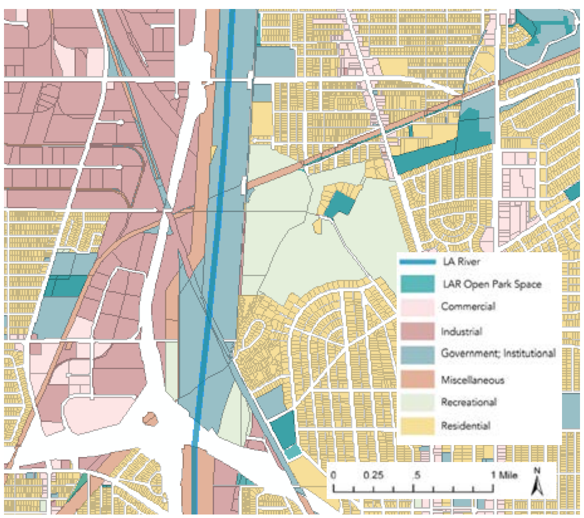


Figure 104: Land Use.

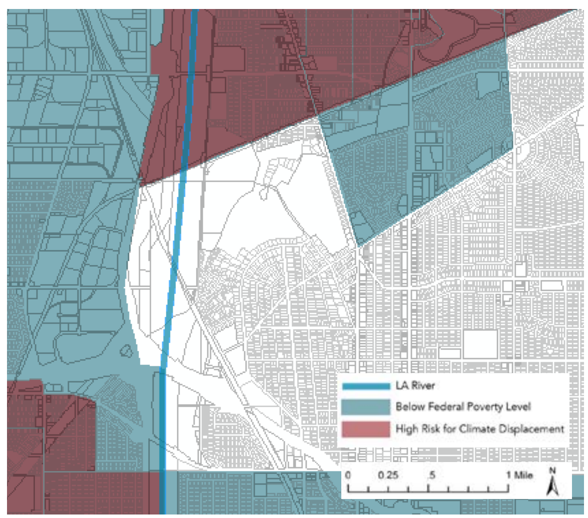


Figure 105: Income & Displacement.

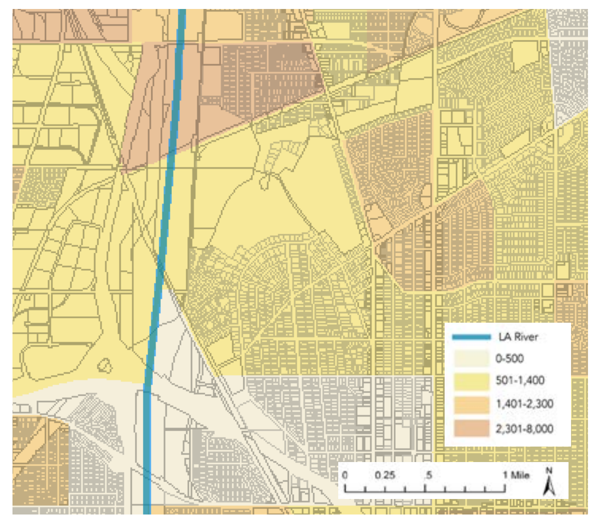


Figure 106: Population Density.

4.5 LONG BEACH

SPATIAL DESIGN

The concept of this site design derives inspiration from the historic stream path that once meandered through what is now the Virginia Country Club golf course. Today that stream is a flood channel running alongside the north of Scherer Park and the golf course before meeting up with the Los Angeles River.

This pilot design plan is split into three phases which are based on their feasibility. Feasibility was determined by the complexity of implementation, land ownership and jurisdiction, and the sheer scale of the project.

Phase 1 includes the redesign of Scherer Park which was determined the most feasible. It would be relatively simple to implement the design elements in terms of land use, jurisdictional support, project scale, and community impact. Phase 2 focuses on the Virginia Country Club golf course. Though the actual design proposals would be simple to develop, the difficulty with a project at this location lies in getting the support of the private entity and club-members. Phase 3, the largest phase of the project, is the naturalization of the Los Angeles River channel. This has the most potential obstacles regarding land ownership. Several parcels of land around the Metro Blue Line maintenance yard and 710 freeway would need to be acquired simultaneously for this project to be possible.

Figure 107: Conceptual Lower Los Angels River Plan.

4.5 LONG BEACH

PHASE 1: SCHERER PARK

Scherer Park, at approximately 20 acres is currently a mostly grass-covered park with a duck pond, dog park, tennis and sports courts, and walking paths. This park has great potential for being able to provide a greater environmental benefit than it currently does through stream re-naturalization, restoration of the wetlands and riparian habitats, retention of water during flood events, and the provision of functional recreation space for the community.

The current concrete channel to the north would be redirected through the park as an open,natural stream and a bioswale filtration device placed where the stream enters the park to mitigate pollutants. Additional features of the site are two retention basins capable of retaining about 3.4 acre feet of water in the wet season, a park playground designed for both wet and dry season play, permeable walking paths, and spaces of drought-tolerant native California grasses.

Plants selected for this site include the Black Cottonwood to create a natural irrigation system as it pulls water thought the ground by its roots and Western Sycamore to provide shade. Other plants include plants from the riparian plant community which aids in habitat restoration and that can tolerate periods of drought and flooding.

Figure 108: Scherer Park Conceptual Plan.




Figure 109: *Populus trichocarpa* (Black Cottonwood), *Platanus racemosa* (Western Sycamore), *Solidago californica* (California Goldenrod), *Muhlenbergia rigens* (Deer Grass).

4.5 LONG BEACH

Figure 110: Virginia Country Club Golf Course Conceptual Plan.

Figure 111: *Morelia californica* (Pacific Wax Myrtle), *Carex divulsa* (Berkley Sedge), *Juncus effusus* (Soft Rush), *Carex praegracilis* (Clustered Field Sedge) .

PHASE 2: VIRGINIA COUNTRY CLUB GOLF COURSE

The naturalized channel from Scherer Park could be directed under Long Beach Boulevard and resurface on the northern area of the golf course, which offers an opportunity for grassland and wetland restoration. The site plan indicates a design proposal of natural streams running between greens and connecting to several retention basins. The first basin is the current water body on the course but with implementations to make it a natural retention pond and restore the habitat. The installation of two basins totaling only 2 acres of the 175 acre golf course could retain about 10.3 acre feet of water, reducing the already low flood risk of this area even further.

Another significant impact a redesigned course could have is habitat connectivity. Planting black cottonwood and pacific wax myrtle trees can assist with building natural irrigation throughout the course, carbon sequestration, and shade. Plants like Berkley sedge and soft rush aid in riparian habitat creation and tolerate periods of inundation following storm events. Another approach to making the course more environmentally beneficial is converting the less frequently played-on areas to native grasslands. Converting just areas surrounding the golf greens, more than 60% of the course could be restored to native plants without impacting the current play flow.

4.5 LONG BEACH

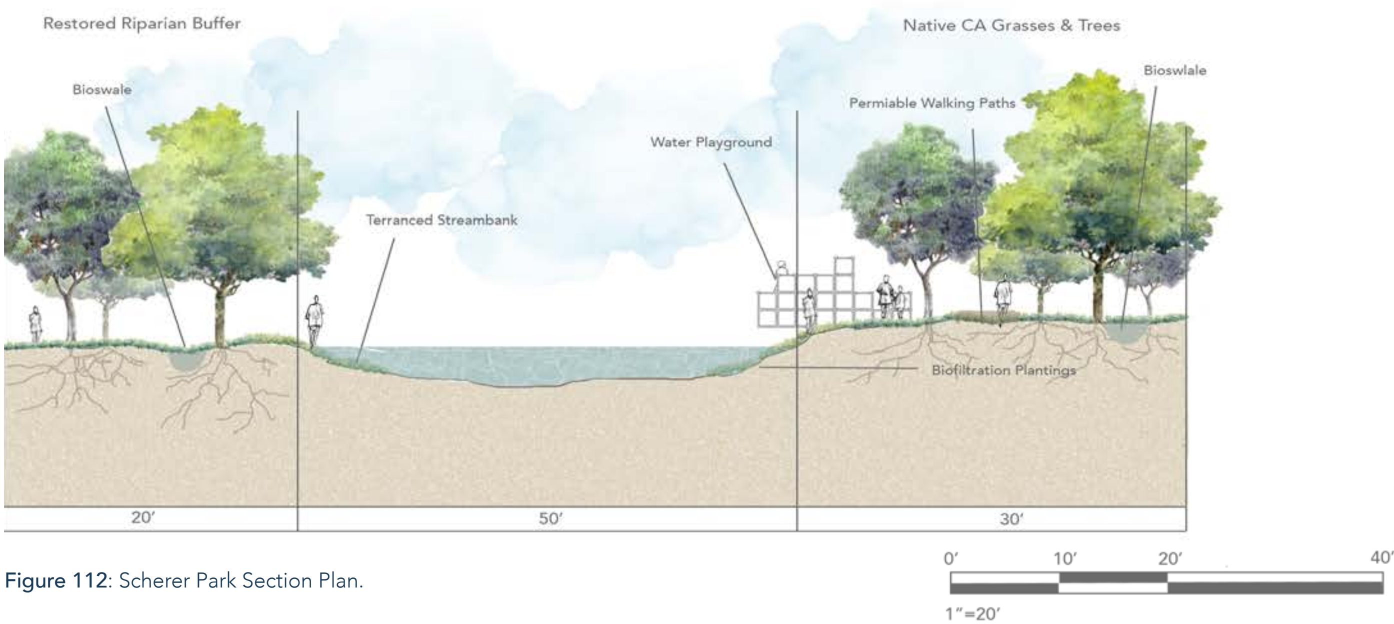


Figure 112: Scherer Park Section Plan.

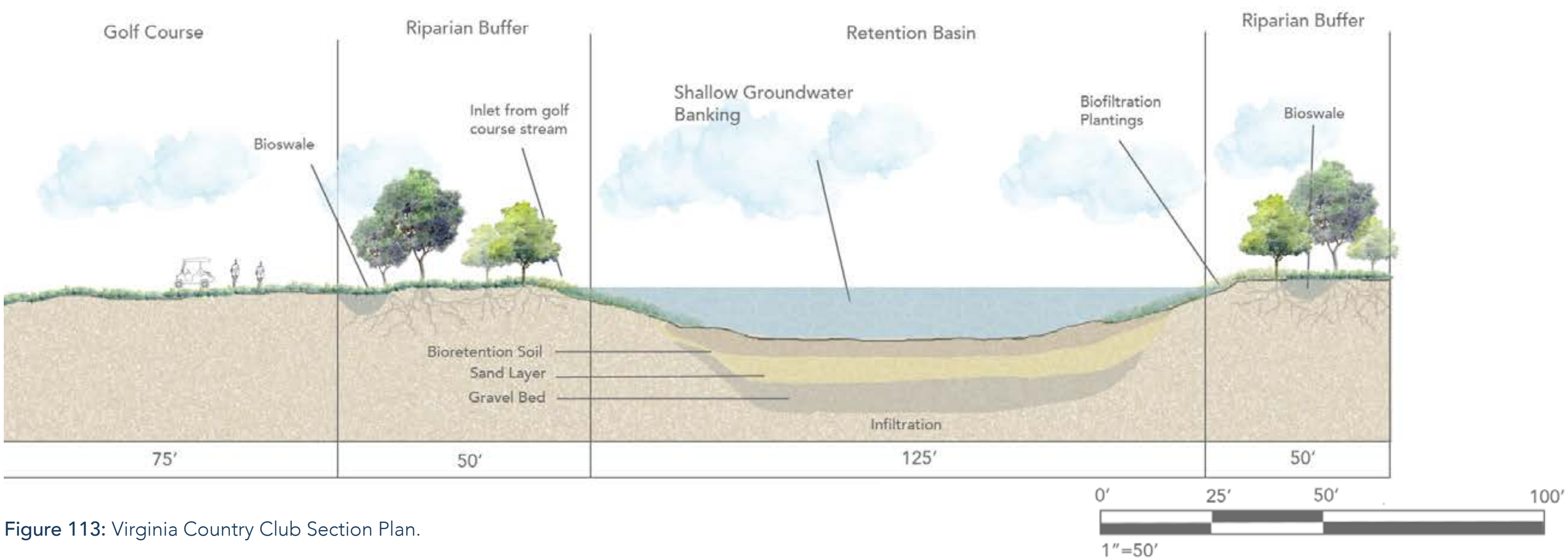


Figure 113: Virginia Country Club Section Plan.

4.5 LONG BEACH

PHASE 3: RIVER CHANNEL

The third phase entails the redesign of the Los Angeles River channel. The runoff from the naturalized stream would be collected in a bioswale and filter through an extension of the Dominguez gap wetlands, removing additional pollutants though the natural wetlands ecosystem. Across the river from the golf course, south of the Compton confluence, is land owned by the County of Los Angeles that is currently industrial storage. Acquisition of this parcel, and parcels like it, offers the opportunity for feasible in-channel river restoration. Considering the low flood risk of this area and the added retention from stream enhancements along the park, golf course, and acquired former parking lot, the concrete from this section of the river could be removed and the channel widened from 300 to 600 feet to restore the natural riverbanks and riparian ecosystem. This additionally would expand the active flood plain by 100-200 feet in wet seasons.

Further south along the west side of the river the Dominguez Gap spreading grounds aids in water capture. This site is located next to an equestrian center. Both locations are prime for environmentally resilient adaptations though water capture and native plant integration. Removing the concrete and naturalizing the river in this area is feasible and provides continuous green space for habitat restoration, heat and carbon sequestration, and social benefits to nearby residents.

Figure 114: *Salix lasiolepis* (Arroyo Willow), *Encelia californica* (CA Bush Sunflower), *Eriogonum faciculatum* (CA Buckwheat), *Artemisia californica* (CA Sagebrush).

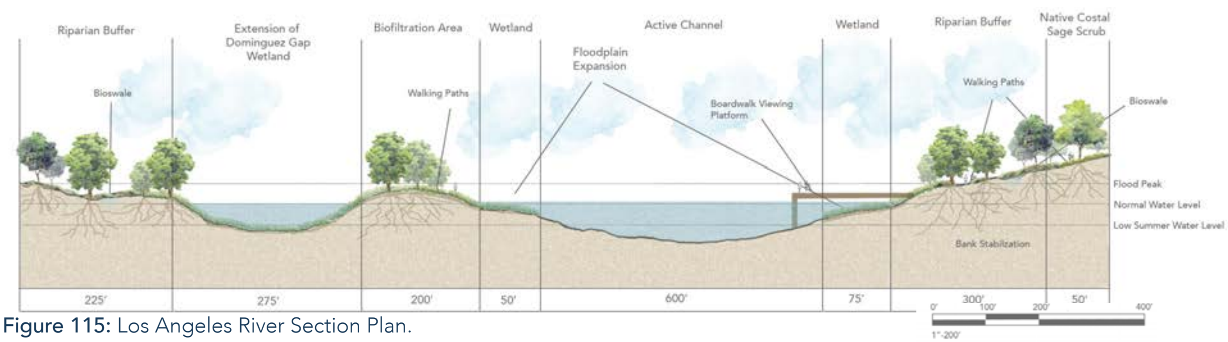


Figure 115: Los Angeles River Section Plan.

Figure 116: Los Angeles River Conceptual Plan.

4.6 CONCEPT DESIGN: DOWNTOWN LOS ANGELES

ANNIE WOON YUN

INTRODUCTION

The design project site is in downtown Los Angeles at mile 21 of the Los Angeles River. This area has stable flood resilience, but the ecosystem is vulnerable due to water and air pollution. The presence of rivers and train trails has divided the local community, making it challenging to visit and enjoy the area, despite its numerous attractions such as art museums, galleries, Chinatowns, and Japanese towns. The neighborhood includes Aliso Village, the Art District, and Pico Gardens are incorporation the design themes respecting their own cultures and characteristics.

When comparing the historical map from 1899 to the present map, the shape of the area has not changed significantly. The 2023 context map of the area depicts a heavy industrial zone, power transmission corridor, and metro areas.

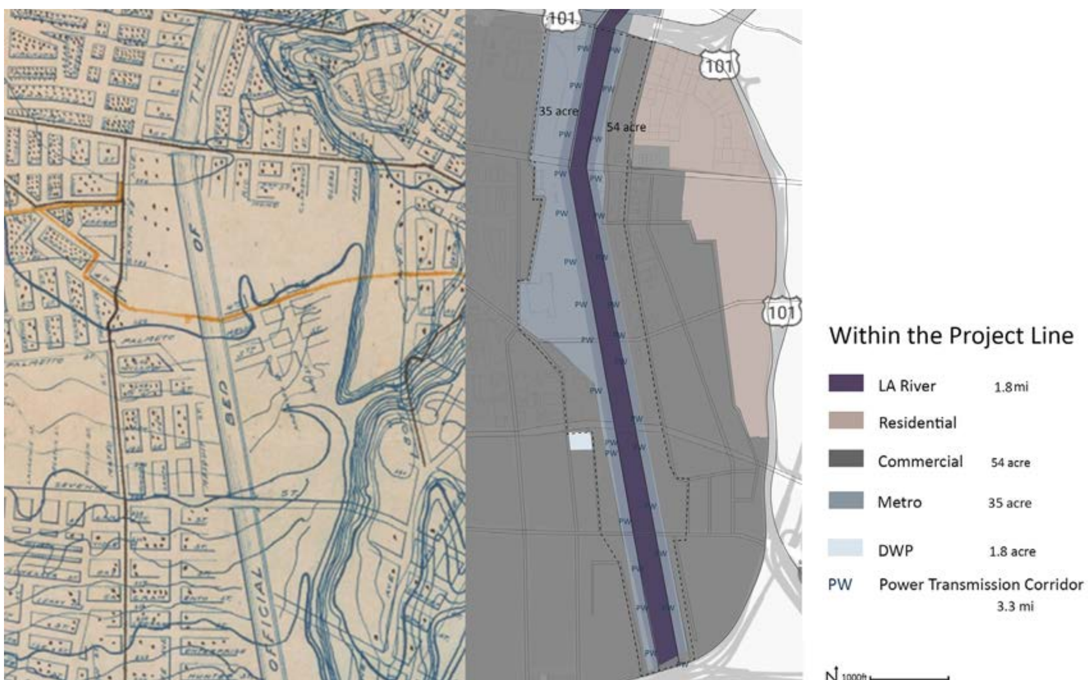


Figure 117: 1899 Contour map of the city of Los Angeles CA No 4-frank H. Olmsted and 2023 context map.

Figure 118: Downtown Los Angeles River Conceptual Plan.

4.6 DOWNTOWN LOS ANGELES

CONCEPTUAL DESIGN

The most crucial aspect of this design is to improve the environment and benefit the community by promoting the naturalization of rivers without disrupting the existing infrastructure. Since naturalization of the river can interfere with flood management, the design includes expanding the area from 220-280 feet to 500-560 feet by incorporating a softer surface that intersects with the concrete floor. The power transmission tower will be relocated to the outskirts of the design site, facilitating the construction of the new river.

The new train corridor is designed to maintain a 1% slope by securing more than 1000 feet of entrance and exit areas before the 101 Freeway and after 7th Street, respectively. It is also designed to accommodate three railroads, ensuring its functionality. Rail infrastructure, such a Union Pacific and Yards, will be relocated to the San Fernando Valley.

The process could allow for the creation of a new design site spanning 213 acres. The new venue will feature three pedestrian bridges that connect communities and encourage walking. Among them, the new pedestrian bridge between 1st and 4th streets will provide facilities to enjoy the virtual Los Angeles River, allowing people to learn about and experience the river even during the dry season. Additionally, the design includes an amphitheater with a viewpoint, new sports and playgrounds a mist park designed for hot summers, designated spaces for roller blades, scooters, and inline skates, repurposed historic railways transformed into rail bikes, climbing spaces offering views of the city and river, graffiti wall parks for street artiest, and California plant and cactus parks for water-smart garden suggestions.

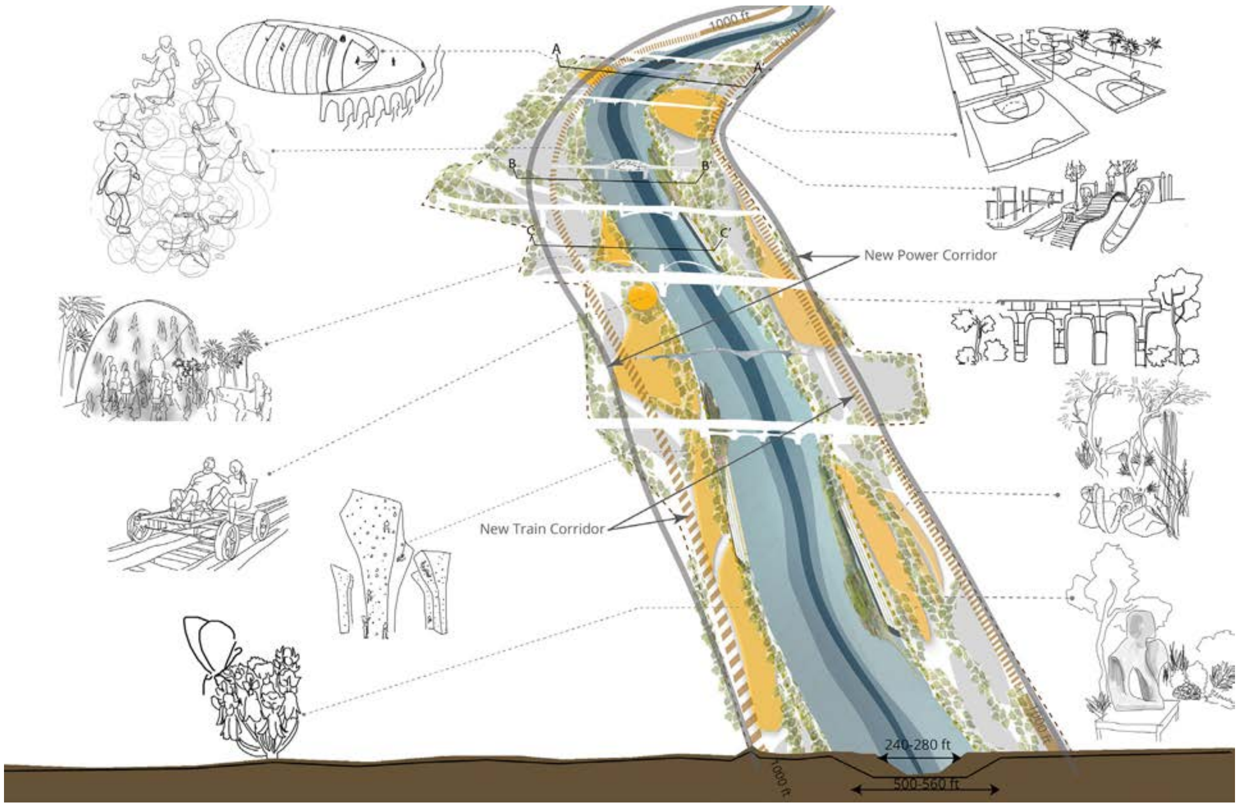


Figure 119: Downtown Los Angeles River Conceptual Plan.

4.6 DOWNTOWN LOS ANGELES

Figure 120: Amphitheater yard area about 54 acre included naturalized river and shows the location of the site. Rendering shows the dry season of the soft river bottom.

4.6 DOWNTOWN LOS ANGELES

Figure 121: Section drawing of an amphitheater yard area with present picture for comparison with the new design and the location of the new train and power transmission corridor. A rendering shows the wet season with the night life in the city.

4.6 DOWNTOWN LOS ANGELES

Figure 122: Pedestrian walkway with the virtual river area in a dome in new design of 128 acre included naturalized river and shows the location of the site. A rendering shows soft river bottom river with layers of new pathways to enjoy the dry season as well.

4.6 DOWNTOWN LOS ANGELES

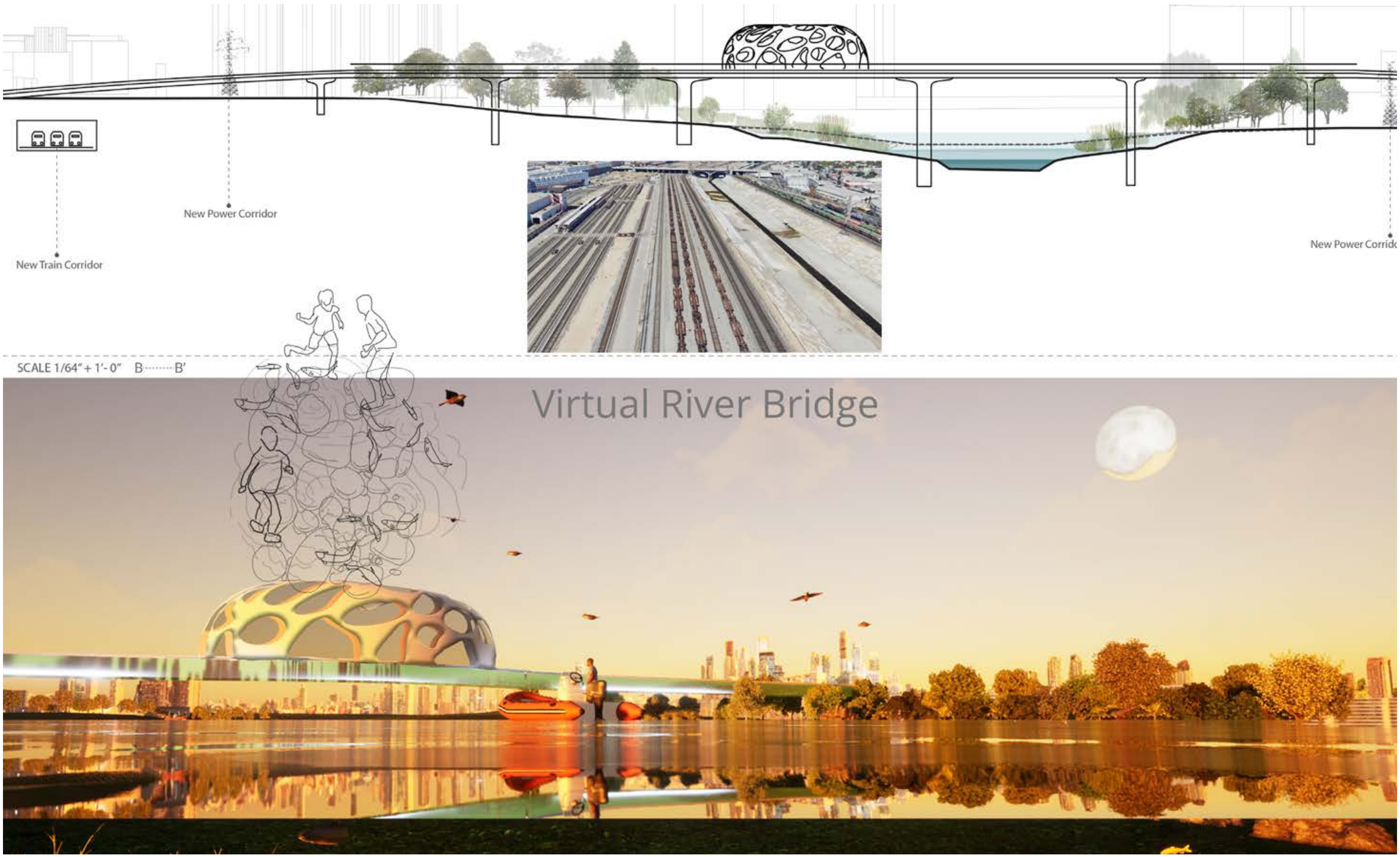


Figure 123: Section rendering of the location of the new train and power transmission corridor. A rendering shows the wet season welcoming new species to the river. The scribble line drawing shows the idea of a virtual river in a dome.

4.6 DOWNTOWN LOS ANGELES

Figure 124: New design site of 31 acre. A rendering shows a scene at the mist park for the hot summer night.

4.6 DOWNTOWN LOS ANGELES

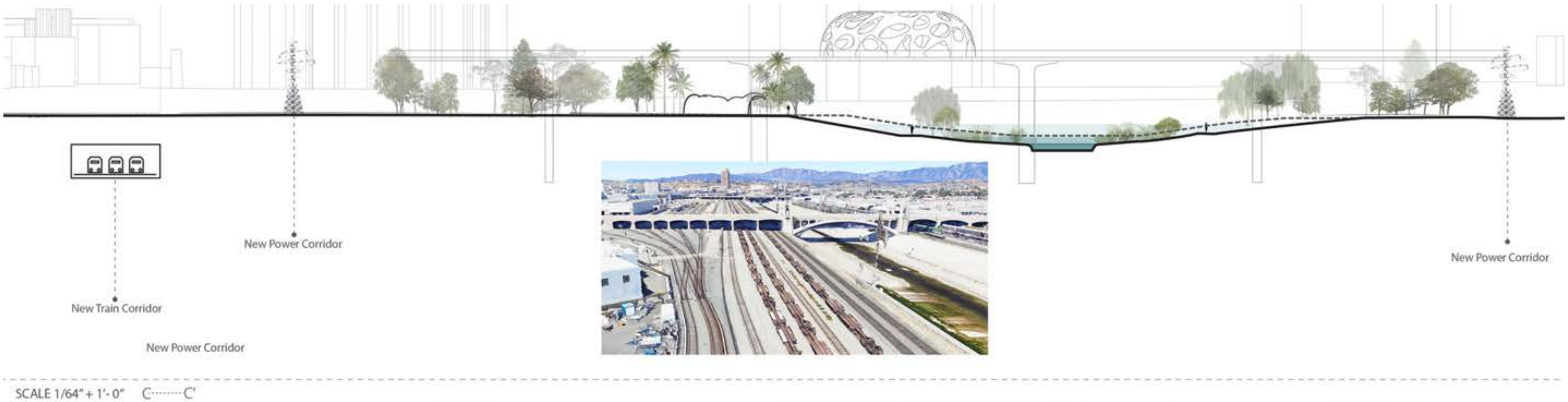


Figure 125: Section drawing the new train and power transmission corridor. A rendering shows soft river bottom river with new pathways to enjoy the dry season as well beside the mist park.

4.6 DOWNTOWN LOS ANGELES

Figure 126: Rendering of the planting concept.

CHALLENGES

The most significant challenge in the design process is land ownership. Firstly, to naturalize a significant portion of land connected to the metro, various situations arise due to previous issues. Questions such as which site to relocate to, and how to obtain the substantial amount of funding required for relocation and underground railway access, need to be addressed. There are numerous challenges that must be tackled. Additionally, there are difficulties in relocating individually owned industrial complexes and offices, including addressing individual requirements and reducing the understanding gap between cities and individuals.

5. CONCLUSION

Figure 127: Hansen Dam and Wildlife Preserve on the Tujunga Wash, northern San Fernando Valley, Los Angeles. 2022-09-19

CONCLUSION

ANNIE WOON YUN

Operating a dedicated department for park management and programs to facilitate coordination between civil society and schools is important. For example, allowing students to work as volunteers at the parks and river maintenance tasks to accumulate the volunteer credits needed for college application. Additionally, considering opportunities for hob creation through park maintenance employment for college students residing in provided accommodations. These specific programs will provide young generations with various tasks, experiences, and memories, ensuring sustained interest and understanding of Los Angeles river. Advisably, promoting communication and managing the promotion and maintenance of the Los Angeles River area through diverse benefits and program development.

To enhance accessibility to this area, it is necessary to prioritize the utilization of public transportation and establish residential areas in its vicinity. To achieve this, converting industrial and commercial zones into residential areas and revising city zoning regulations will be essential, allowing for convenient pedestrian and public transportation access to the river. By implementing these measures, we can revitalize the area, creating a safer living environment and providing opportunities to enjoy the river.

POLICY RECOMMENDATIONS

Policy recommendations for this project include encouragement to utilize green infrastructure and solar energy throughout the design process, when necessary. All designs should incorporate local materials, when necessary, implement bioswales as well as other bioretention techniques, and permeable paving. Businesses and high rise buildings in the area should consider installing planter boxes and planting trees to provide shade and cooler temperatures. A diverse planting palette of California native plants appropriate for this area is advised to promote biodiversity, support the local wildlife habitat, and minimize irrigation requirements. These policy recommendations would support a healthy urban riverfront and its habitants – humans, animals and plants alike – for years to come.

CONCLUSION

This studio project offered the opportunity to delve into the historical context and existing conditions of the Los Angeles River and re-imagine a river that is restored and revitalized. Reclamation of channelized segments of the concrete bottomed river would provide restoration and the creation of habitat for plants and animals, connect green corridors through urban areas surrounding the river, and reduce flood risk by way of various bioretention techniques. Programming within the project designs incorporate the use of native vegetation that would support local wildlife as well as decrease water use. Shade with dense tree canopy, seating areas for resting and gathering, and permeable pathways are also design elements featured in the overall project designs. The project areas selected along the Los Angeles River incorporate thoughtful designs to support a thriving ecosystem, a beautiful place to visit, and reduction of flood risk while helping to improve water and air quality. The pilot projects presented within this report propose what's possible – by way of tactics and strategies – to show how areas along the river can be restored and revitalized for a better Los Angeles.

CONCLUSION

DISCUSSION

DANI BEHR

With a well-placed drainpipe, Tapwater Park could collect water year-round from the river via the Tillman Water Reclamation Plant. Currently, an overwhelming 3 acre feet of water are treated here daily, and all of this water is dumped into Los Angeles River and ultimately lost to the sea. There are minor benefits to keeping the river "wet" even in summer – recreational opportunities like kayaking, the growth of riparian plant species in the soft-bottomed Glendale Narrows, and the possibility that displaced animal species like Steelhead Trout might be able to use the river to return to their spawning grounds. Unfortunately, compared to the water insecurity of 11 million people, the trout and kayaks may not rate. I would strongly recommend returning as much water as possible to the aquifer, even at the expense of threatened species and aquatic recreation.

JIN ZHANG

One of the challenges to designing a flood control park is to ensure the park effectively controls flooding while also providing recreational and ecological benefits. This requires careful consideration of the site's topography, hydrology, and ecological characteristics. In addition, the design of the park has to consider the impact of human activities on the natural environment. High-traffic visitors could negatively affect the park's ecosystem and wildlife. The educational program is one of the factors that could minimize the impact of human activities on the park's natural environment. Furthermore, the community has limited agency and influence over the design and development of the site. The community is not seen the site design as a partner in the planning process, which could results in a design that does not fully address the needs of the community or the site is met with resistance and opposition from local residents.

CAITLIN KELLER

This studio project offered the opportunity to delve into the historical context and existing conditions of the Los Angeles River and re-imagine a river that is restored and revitalized. The site selection for my design project is located in the upper portion of the river and is roughly 250 acres. The site includes 8 design areas, and features a mix of residential, commercial and industrial development. These 8 areas incorporate design goals by improving biodiversity, providing habitat enhancement, and linking wildlife and native plant corridors, while improving flood control. Design strategies involve working with existing conditions in the area and removing the concrete that is on the bottom of the river and that is also covering the river. The soft bottomed river would not only give the river a more natural shape, it would also support wildlife and increase biodiversity.

DANIELLE LEWIS

The Los Angeles River presents an unique problem. Flood risk needs to be considered, but so does the future of the climate of Los Angeles. This pilot design for the lower Los Angeles River addresses flood risk and creates drought resiliency in dry periods via the recharge of groundwater as well as the collection and storage of water to be used when needed. Implementations like stormwater capture and storage, ecosystem and habitat restoration, and better use of urban spaces are more necessary than ever as the world and the Los Angeles Basin becomes increasingly at risk of climate change disasters. We are now in an era where the attitude of "if it isn't broken, don't fix it" does not and cannot apply. Considering future projections, we are directly headed for the Los Angeles water system as we know it to break. This plan demonstrates how utilizing a variety of types of land and tactics aids in a larger goal of river and environmental restoration that benefits the environment, the community, and the future of Los Angeles.

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6. BACK MATTER

Figure 128: Floodwaters raging down the Los Angeles River on March 2, 1938, taken from North Figueroa Street bridge. (Los Angeles Times)

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6.2 LIST OF FIGURES

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APPENDIX A - VEGETATION MEASUREMENTS IN ELYSIAN VALLEY

TRANSECT	START (LAT/LON)	END (LAT/LON)	LOCATION NAME	CHANNEL TOP	CHANNEL BOTTOM	CHANNEL DEPTH	CHANNEL CROSS AREA	TALL VEG WIDTH	LOW VEG WIDTH	BARE SAND/ ROCK WIDTH	OPEN WATER WIDTH	PERCENT OBSTRUCTED	STATISTICS
1	-118.2975806 34.1570278	-118.297696 34.1562088	Bette Davis Park	300	180	20	4,800	80	20	0	80	34.6%	
2	-118.2936797 34.1557497	-118.2935523 34.1565565	Riverside Drive	300	180	20	4,800	38	20	75	48	18.4%	
3	-118.2906784 34.156425	-118.2906704 34.1556027	Glendale Narrows Riverwalk	300	180	20	4,800	75	25	10	70	33.0%	
4	-118.2867775 34.1556308	-118.286811 34.1564531	Glendale Narrows Riverwalk	300	180	30	7,200	40	0	0	140	16.7%	
5	-118.2783043 34.1452175	118.2773119 34.1454218		300	180	16	3,840	100	25	0	55	43.6%	
6	-118.2778489 34.1436737	118.2768619 34.1438491		300	180	16	3,840	85	10	35	50	37.1%	
7	-118.2767136 34.1397309	-118.2757453 34.1399285	Colorado St	300	180	16	3,840	50	0	30	100	21.6%	
8	-118.2740592 34.1303216	-118.2730749 34.1305215	N. Atwater Ped Bridge	300	200	20	5,000	15	20	60	105	8.4%	
9	-118.2715297 34.1257274	-118.2724711 34.1254499		300	200	20	5,000	60	35	20	85	26.5%	**AVERAGE OBSTRUCTED**
10	-118.2691162 34.1202808	-118.2700711 34.1200166		300	200	20	5,000	80	10	10	100	32.8%	30.1%
11	-118.2692492 34.1182017	-118.2682622 34.118517		325	205	20	5,300	70	0	0	135	26.4%	**STANDARD DEVIATION**
12	-118.2679182 34.1158136	-118.2669661 34.1162688	Sunnynook Ped Bridge	335	215	20	5,500	80	5	25	105	29.8%	0.090
13	-118.2673209 34.115071	-118.2664117 34.1155174	Sunnynook Ped Bridge	335	215	20	5,500	60	15	20	120	23.0%	**MAX**
14	-118.2620668 34.1102622	-118.2614284 34.1109262		300	180	20	4,800	100	0	15	65	42.0%	43.6%
15	-118.2581678 34.1085489	-118.2578406 34.1093772		315	195	20	5,100	75	20	0	100	30.6%	**MIN**
16	-118.2466604 34.1074826	-118.2461669 34.1083754		350	230	20	5,800	65	15	60	90	24.2%	8.4%
17	-118.244206 34.1060406	-118.2433209 34.1066625		350	240	20	5,900	90	30	30	90	32.5%	
18	-118.2430669 34.1044021	-118.2419538 34.1047508		350	230	20	5,800	100	30	10	90	36.2%	
19	-118.2418328 34.1013177	-118.2429888 34.1013177	Taylor Yard	350	220	25	7,125	80	65	15	60	31.0%	
20	-118.2400341 34.0954079	-118.2391624 34.0960253	Taylor Yard	350	230	25	7,250	120	15	0	95	42.0%	
21	-118.2352428 34.0933953	-118.235106 34.0943771	Taylor Yard Bridge	350	230	25	7,250	45	95	35	55	19.9%	
22	-118.2326764 34.092769	-118.2319844 34.0935619		350	230	25	7,250	95	20	0	115	33.6%	
23	-118.2275041 34.0866567	-118.2287299 34.0865856	kayak haul-out	350	230	25	7,250	120	25	5	80	42.5%	
24	-118.2273485 34.0853646	-118.2285984 34.0852735		350	230	25	7,250	100	35	0	95	35.9%	

APPENDIX B - ANALYSIS OF NATURALIZED STORM FLOWS

LOCATION		1% (100-YEAR) STORM				0.5% (200-YEAR) STORM				0.2% (500-YEAR) STORM			
		STORM FLOW	FLOW % CHANNEL CAPACITY	FLOW IN EXCESS OF CAPACITY	12-HOUR R/I VOLUME	STORM FLOW	FLOW % CHANNEL CAPACITY	FLOW IN EXCESS OF CAPACITY	12-HOUR R/I VOLUME	STORM FLOW	FLOW % CHANNEL CAPACITY	FLOW IN EXCESS OF CAPACITY	12-HOUR R/I VOLUME
River Mile(s)		cfs	%	cfs	acre-feet	cfs	%	cfs	acre-feet	cfs	%	cfs	acre-feet
UPPER LA RIVER	**N = 28**												
46.5 to 46.8	**MAXIMUM**	74,000	279%	48,000	23,000	88,000	332%	61,000	30,000	98,000	498%	69,000	**34,000**
	AVERAGE	50,000	202%	24,000	12,000	63,000	248%	37,000	18,000	75,000	304%	49,000	24,000
50.6 to 51.0	**MINIMUM**	32,000	100%	-210	-110	37,000	115%	4,900	2,500	46,000	184%	27,000	13,000
	ST.DEV	17,000	44%	12,000	6,100	22,000	41%	15,000	7,300	20,000	73%	14,000	7,300
MIDDLE LA RIVER	**N = 34**												
21.1 to 23.5	**MAXIMUM**	110,000	309%	55,000	28,000	120,000	350%	66,000	32,000	130,000	376%	73,000	37,000
	AVERAGE	96,000	177%	40,000	20,000	110,000	195%	49,471	25,000	110,000	211%	58,000	29,000
32.8	**MINIMUM**	82,000	145%	29,000	14,000	88,000	156%	36,000	18,000	95,000	148%	31,000	15,000
	ST.DEV	12,000	35%	6,800	2,500	10,000	42%	8,258	4,000	13,000	45%	9,500	4,600
LOWER LA RIVER	**N = 28**												
0 to 1.6	**MAXIMUM**	160,000	162%	52,000	25,000	160,000	164%	62,000	30,000	170,000	177%	62,000	30,000
	AVERAGE	140,000	141%	41,000	20,000	150,000	149%	48,000	23,000	150,000	152%	51,000	25,000
12.0 to 14.1	**MINIMUM**	110,000	98%	-1,800	-920	110,000	98%	-1,800	-920	120,000	107%	8,200	4,100
	ST.DEV	19,000	12%	11,000	5,500	21,000	15%	15,000	7,100	18,000	15%	12,000	6,100

Notes:

All quantities are rounded to two significant digits.

Sources: LA River Master Plan (2020), Navigate LA, Los Angeles River Metals Appendix A

Full data set can be explored at:
https://docs.google.com/spreadsheets/d/1soF2grUJBPtCgw9IQeHXuRNcfrzOoL3EouxpkwfylUw/edit?usp=sharing

APPENDIX C - NATURALIZED FLOW CAPACITY AND RETENTION VOLUME

RIVER MILE	LA RIVER MASTER PLAN DESIGNATION / REACH	NATURALIZED FLOW CAPACITY cfs	0.2% STORM FLOW cfs	0.2% STORM FLOW %	FLOW IN EXCESS OF NFC cfs	0.2% STORM 12-HOUR VOLUME acre-feet	COMMENTS
UPPER LOS ANGELES RIVER							
51	51.0 River Origin Park	17,000	46,000	264%	29,000	14,000	
	50.9 Canoga Park High School	17,000	46,000	264%	29,000	14,000	
	50.6 Canoga Park River Park	17,000	46,000	264%	29,000	14,000	
50	50.0 Reservoir Loop	17,000	46,000	264%	29,000	14,000	
49	48.9 Pierce College Connector	24,000	67,000	283%	43,000	22,000	
48	47.8 LA River Valley Bikeway and Greenway	24,000	67,000	283%	43,000	22,000	
47	47.5 Southern Aliso Green Network	24,000	71,000	300%	47,000	23,000	
	47.4 Aliso Creek Confluence Park / Reseda River Loop	33,000	71,000	217%	38,000	19,000	
46	46.8 Reseda Expansion	36,000	98,000	276%	63,000	32,000	
	46.5 Caballero Creek Confluence Park	36,000	98,000	276%	63,000	32,000	
45	6300 Balboa Blvd (parking) River Bike Path	36,000	98,000	276%	63,000	32,000	
44	44.0 Sepulveda Basin	36,000	98,000	276%	63,000	32,000	
43	Sepulveda Dam	36,000	98,000	276%	63,000	32,000	
	Tujunga Wash Greenway @ Victory Plaza	36,000	98,000	276%	63,000	32,000	
42	Van Nuys	12,000	59,000	498%	47,000	23,000	
41	41.2 Hazeltine River Edge Park	15,000	59,000	403%	44,000	22,000	Sherman Oaks Pilot Site Design RM40.86 - 41.41
40	40.9 Hazeltine Avenue	15,000	59,000	403%	44,000	22,000	
	40.8 Van Nuys Blvd	15,000	59,000	403%	44,000	22,000	
39	39.4 West of Coldwater	15,000	59,000	403%	44,000	22,000	
38	38.8 Zev Yaroslavski Greenway Park	15,000	59,000	403%	44,000	22,000	
	38.2 Upstream from Tujunga Confluence	32,000	59,000	184%	27,000	13,000	
37	37.6 Tujunga Wash Confluence Park	32,000	59,000	184%	27,000	13,000	

APPENDIX C - NATURALIZED FLOW CAPACITY AND RETENTION VOLUME

RIVER MILE	LA RIVER MASTER PLAN DESIGNATION / REACH	NATURALIZED FLOW CAPACITY cfs	0.2% STORM FLOW cfs	0.2% STORM FLOW %	FLOW IN EXCESS OF NFC cfs	0.2% STORM 12-HOUR VOLUME acre-feet	COMMENTS
	37.5 Tujunga Wash Path	32,000	98,000	305%	66,000	32,000	
36	36.02 N/S Weddington Park	32,000	91,000	283%	59,000	30,000	North Hollywood Pilot Site Design RM 35.76 - 36.02
35	35.9 101 Freeway Crossing	35,000	91,000	260%	56,000	28,000	
34	34.9 LA River Valley Bikeway and Greenway	35,000	95,000	273%	60,000	30,000	
33	33.5 Sennett Creek	27,000	95,000	359%	69,000	34,000	
	33.0 Headworks Park	27,000	95,000	359%	69,000	34,000	Burbank Pilot Site Design RM 32.0 - 33.3
MIDDLE LOS ANGELES RIVER							
32	32.8 Headworks Connector	27,000	95,000	358%	68,000	34,000	
31	31.9 Burbank Western Green Network	27,000	100,000	376%	73,000	37,000	
	31.2 Bette Davis Picnic Area	*71,000*	100,000	140%	29,000	14,000	
	31.0 Glendale Riverwalk Non-Motorized Bridge	*71,000*	100,000	140%	29,000	14,000	
30	30.9 Ferraro Fields Side Channel	*71,000*	100,000	140%	29,000	14,000	
	30.8 Glendale Narrows Riverwalk	*71,000*	100,000	140%	29,000	14,000	
	30.6 Verdugo Wash Confluence Park	*71,000*	100,000	140%	29,000	14,000	
	30.5 River Glen Wetlands (ARBOR)	*71,000*	100,000	140%	29,000	14,000	
	30.4 River Glen Wetlands (ULART)	*71,000*	100,000	140%	29,000	14,000	
29	29.5 Atwater Village East Bank Riverwalk	*71,000*	120,000	168%	49,000	25,000	
28	29.3 Central Service Yard	*71,000*	120,000	168%	49,000	25,000	
26	26.2 G1 Bowtie	*71,000*	120,000	168%	49,000	25,000	
25	25.6 G2 Taylor Yard	*71,000*	120,000	168%	49,000	25,000	
	25.3 Dorris Place Sanitation Yard	*76,000*	110,000	146%	34,000	17,000	
	25.2 Taylor Yard Non-Motorized Bridge	*76,000*	110,000	146%	34,000	17,000	
24	24.5 Oso Park	*76,000*	110,000	146%	34,000	17,000	

APPENDIX C - NATURALIZED FLOW CAPACITY AND RETENTION VOLUME

RIVER MILE	LA RIVER MASTER PLAN DESIGNATION / REACH	NATURALIZED FLOW CAPACITY cfs	0.2% STORM FLOW cfs	0.2% STORM FLOW %	FLOW IN EXCESS OF NFC cfs	0.2% STORM 12-HOUR VOLUME acre-feet	COMMENTS
	24.5 Metro LA River Path	76,000	110,000	146%	34,000	17,000	
	24.1 Arroyo Seco Confluence	76,000	110,000	146%	34,000	17,000	
	24 Arroyo Seco Greenway	64,000	110,000	171%	46,000	23,000	
23	23.5 Bending The River Back Into The City	64,000	110,000	171%	46,000	23,000	
	23.2 Main Street Terrace	64,000	110,000	171%	46,000	23,000	
22	22.6 Piggyback Yard	64,000	130,000	202%	66,000	32,000	
21	21.6 Downtown Train Yard	64,000	130,000	202%	66,000	32,000	DTLA Pilot Site Design RM 21.1 - 21.8
	21.5 First Street to Sixth Street River Loop	64,000	130,000	202%	66,000	32,000	
	21.1 6th Street Viaduct	64,000	130,000	202%	66,000	32,000	
20		64,000	130,000	202%	66,000	32,000	
19	19.9 East Washington Blvd	64,000	130,000	202%	66,000	32,000	
	Northeast of LA River	64,000	95,000	148%	31,000	15,000	
18	18.2 West Santa Ana Branch Bikeway	64,000	130,000	202%	66,000	32,000	
17	District Blvd & Gifford Avenue	68,000	130,000	192%	62,000	30,000	
16	16.2 Upper Segment Multiuse Easement and Atlantic Blvd Area	68,000	130,000	192%	62,000	30,000	
15	15.8 Maywood Park Bend	68,000	130,000	192%	62,000	30,000	
	15.3 Rail to River Corridor: Randolph Street	68,000	120,000	177%	52,000	25,000	
LOWER LOS ANGELES RIVER							
14	14.1 Clara Street	68,000	120,000	177%	52,000	26,000	
13	13.9 Cudahy River Park	68,000	120,000	177%	52,000	26,000	
	13.5 U.P.R.R. Spur Line	84,000	120,000	143%	36,000	18,000	
12	12.9 Firestone Blvd	84,000	120,000	143%	36,000	18,000	
	12.7 South Gate Orchard	110,000	120,000	107%	8,200	4,000	

APPENDIX C - NATURALIZED FLOW CAPACITY AND RETENTION VOLUME

RIVER MILE	LA RIVER MASTER PLAN DESIGNATION / REACH	NATURALIZED FLOW CAPACITY cfs	0.2% STORM FLOW cfs	0.2% STORM FLOW %	FLOW IN EXCESS OF NFC cfs	0.2% STORM 12-HOUR VOLUME acre-feet	COMMENTS
	12.0 Parque Dos Rios	84,000	120,000	143%	36,000	18,000	
11	11.9 I-710 Corridor Bike Path Project: Western LA River Levee Bike Path	110,000	160,000	143%	48,000	24,000	
	11.8 Rio Hondo Confluence	98,000	160,000	164%	62,000	31,000	South Gate Pilot Site Design RM 10.5 - 11.8
	11.7 SELA Cultural Center	98,000	160,000	164%	62,000	31,000	
10	10.5 Highway 105	98,000	160,000	164%	62,000	31,000	
	10.4 1-710 Corridor Bike Path Project: Terminal Island to Rio Hondo	98,000	160,000	164%	62,000	31,000	
	10.2 E. Rosecrans Ave	98,000	160,000	164%	62,000	31,000	
9	9.4 I-710 Corridor Bike Path Project: Compton Blvd	98,000	160,000	164%	62,000	31,000	
8	8.1 Connectivity Corridor	98,000	160,000	164%	62,000	31,000	
7	7.2 Middle Segment Multiuse Easement and Crossover	98,000	160,000	164%	62,000	31,000	
6	6.3 Sutter Bend at Del Amo Blvd	98,000	150,000	153%	52,000	26,000	
5	5.5 Compton Creek Confluence Area + Dominguez Gap Wetlands	110,000	150,000	134%	38,000	19,000	Long Beach Pilot Site Design RM 4.5 - 5.7
	5.1 W 47th Street/ Rancho Los Cerritos	110,000	160,000	143%	48,000	24,000	
4	4.4 Wrigley Heights River Park	110,000	160,000	143%	48,000	24,000	
3	3.7 W 28th St to 405 Freeway	110,000	160,000	143%	48,000	24,000	
2	2.9 Willow Street	110,000	160,000	143%	48,000	24,000	
1	1.7 Middle Long Beach	110,000	160,000	143%	48,000	24,000	
	1.6 South of Willow Street	110,000	170,000	152%	58,000	29,000	
0	0.9 Long Beach Municipal Urban Stormwater Treatment	110,000	170,000	152%	58,000	29,000	
	0.7 Shoemaker Bridge Replacement	110,000	170,000	152%	58,000	29,000	
	0.6 Cesar Chavez Park	110,000	170,000	152%	58,000	29,000	
PACIFIC OCEAN							

APPENDIX D - LAND SUITABLE FOR RETENTION

LAND USE	COMMENTS	MEASURED & ESTIMATED AREA Acres	NET AREA OF 2.5 MILE BUFFER 216.5 mi^2	# PARCELS N=	SAMPLE n=	AVERAGE AREA Acres	STANDARD DEVIATION	RETENTION CAPACITY Acre-Feet
PARKS AND RECREATION								
GOLF	Gross area measured	**1500**	1.1%	15	15	100	91	
SMALL AND MEDIUM PARKS	Net open area estimated	**880**	0.64%	100	40	9	13	
LARGE PARKS	Net area excluding steep terrain and golf facilities	**670**	0.48%	13	4	170	13	
SPORTS PARKS	Gross area estimated	**900**	0.65%	27	9	33	55	
EQUESTRIAN FACILITIES	Gross area measured	**150**	0.11%	11	11	14	23	
SCHOOL YARDS			1.3%	246	47			
ELEMENTARY SCHOOLS	Net open area estimated	**560**	0.41%	140	23	4	2.5	
MIDDLE SCHOOLS	Net open area estimated	**430**	0.31%	33	12	23	8.6	
HIGH SCHOOLS	Net open area estimated	**780**	0.56%	64	12	91	5.9	
INFRASTRUCTURE								
POWER TRANSMISSION & SUBSTATIONS	Gross area measured	**1,000**	0.75%	46	46	28	57	
RAILROAD ROW AND LOGISTICS FACILITIES	Gross area measured	**2,400**	1.7%	62	62	30	72	
TOTAL	2.5 mile buffer in LAR watershed = 140,000 acres	**9,300**	**6.7%**					

Notes:

All values are rounded to two significant digits.

Suitable locations are identified and measured: https://www.google.com/maps/d/edit?mid=1PphMrqIOjcxQCIWV-34RtkJwbtAdYDA

Original data set: https://docs.google.com/spreadsheets/d/1rgdd10A3x16zq10GxAIlD2oyyl49ROiIZ8Oue5j8EjI/edit?

COLOPHON

TITLE: BEBAS NEUE 72 PT

PAGE HEADERS: BEBAS NEUE 30PT

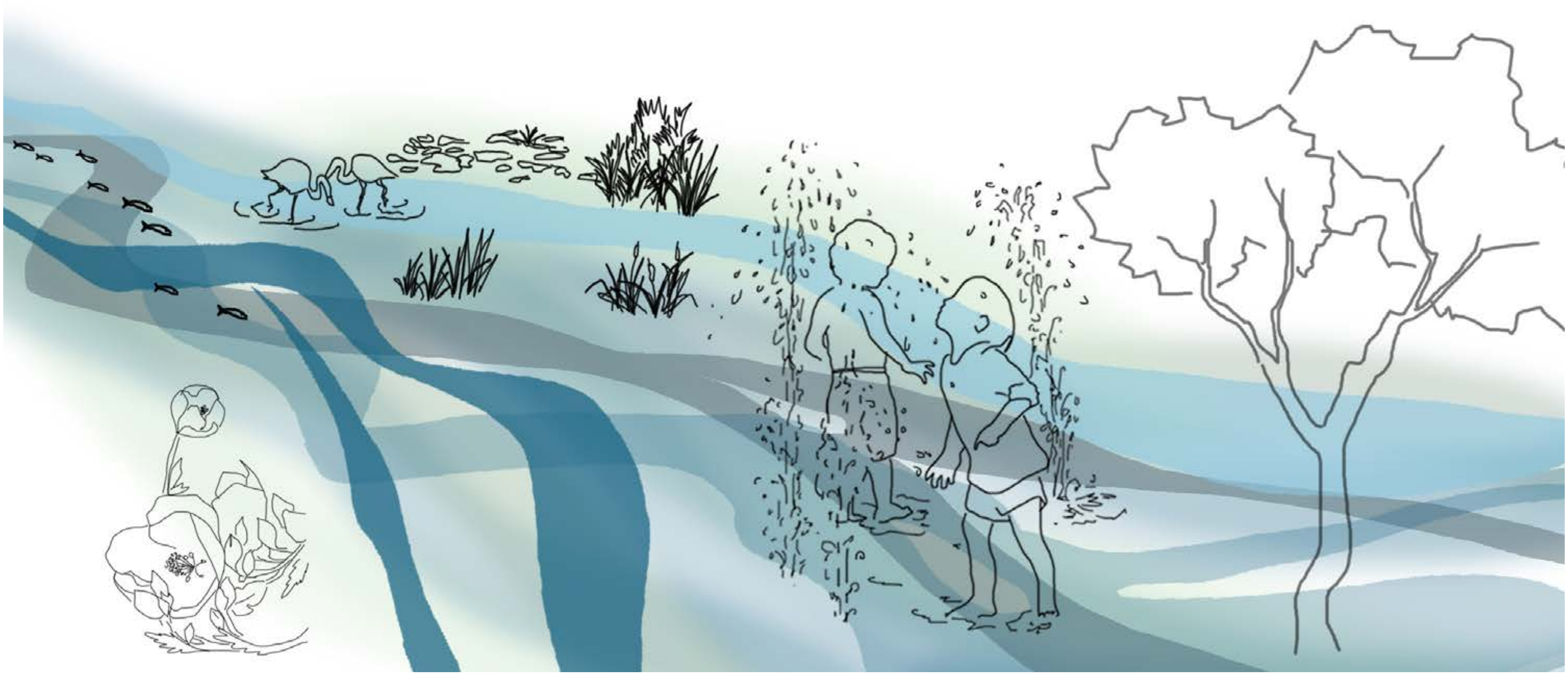
SUBHEADER 1: BEBAS NEUE 16PT

SUBHEADER 2: BEBAS NEUE 12PT

Body Text: Avenir Light 10.5pt

FOOTER: AVENIR LIGHT 10PT

Captions: Avenir Light 8pt



MASTER OF LANDSCAPE ARCHITECTURE CAPSTONE PROJECT
MAY 2023
DEPARTMENT OF LANDSCAPE ARCHITECTURE
CALIFORNIA STATE POLYTECHNIC UNIVERSITY OF POMONA