RESILIENT LANDSCAPE VISION for Upper Penitencia Creek

SFEI AQUATIC SCIENCE CENTER

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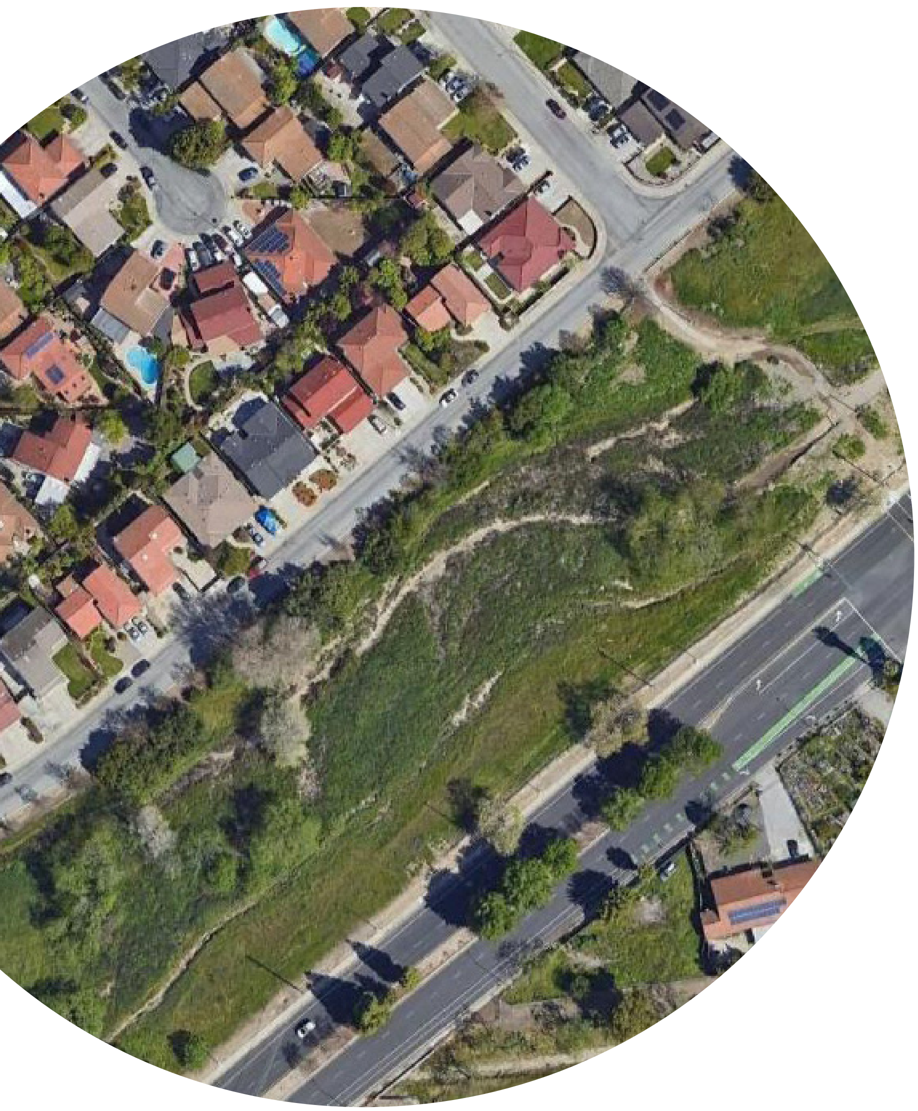

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DISCLAIMER:

This report explores the potential for integrating ecological functions into flood risk and water supply management along Upper Penitencia Creek. It presents an initial vision for how ecological elements could contribute to flood management objectives, based on a broad-scale analysis, two one-day workshops of local and regional experts, and a series of charrettes held by the Santa Clara Valley Water District. This landscape vision is not intended to be implemented as is, but rather adapted and applied through future projects and analysis.

CONTENTS

Overview

This report proposes a new multi-benefit approach to flood management along Upper Penitencia Creek. Recognizing the creek's complex history, land use, and challenges, this report explores a suite of actions that could help meet flood management objectives while improving ecosystem functioning, expanding recreational opportunities, and supporting water supply needs.

The San Francisco Estuary Institute-Aquatic Science Center (SFEI-ASC) and the Santa Clara Valley Water District (District) worked with technical advisors and a group of local stakeholders to explore a range of multi-benefit management opportunities along Upper Penitencia Creek, culminating in this Resilient Landscape Vision. The vision focuses on ways to expand flow conveyance and flood water storage from the Coyote Creek confluence upstream to the Dorel Drive bridge in a manner that works with the existing landscape features and supports habitats for native species. The management measures described here fall into two main categories:

- **In-channel improvements & riparian enhancements** includes floodplain excavation, setting back levees, and managing vegetation in modified channel-floodplain areas to better support native wildlife
- **Multi-benefit off-channel detention** includes creating high-flow floodplain basins that have multiple uses (e.g., sports fields and flood detention) and provide habitat features to support native wildlife

Additional management measures related to modifying flow and sediment delivery from the upper watershed are also discussed.

The next steps for implementing the vision measures include developing design alternatives, conducting feasibility analyses, continued collaboration with local stakeholders who own and manage land along the creek, and garnering regulatory agency support. Although situated in a highly developed landscape, the Upper Penitencia Creek channel-floodplain corridor retains a considerable amount of open space that provides opportunities for multi-benefit flood management. This Vision can be used as guidance in similar landscapes around the region, where managers are seeking to implement a nature-based approach to flood management that leverages existing open space features and benefits both people and wildlife.

SYCAMORE AND OAKS ALONG UPPER PENITENCIA CREEK

Introduction

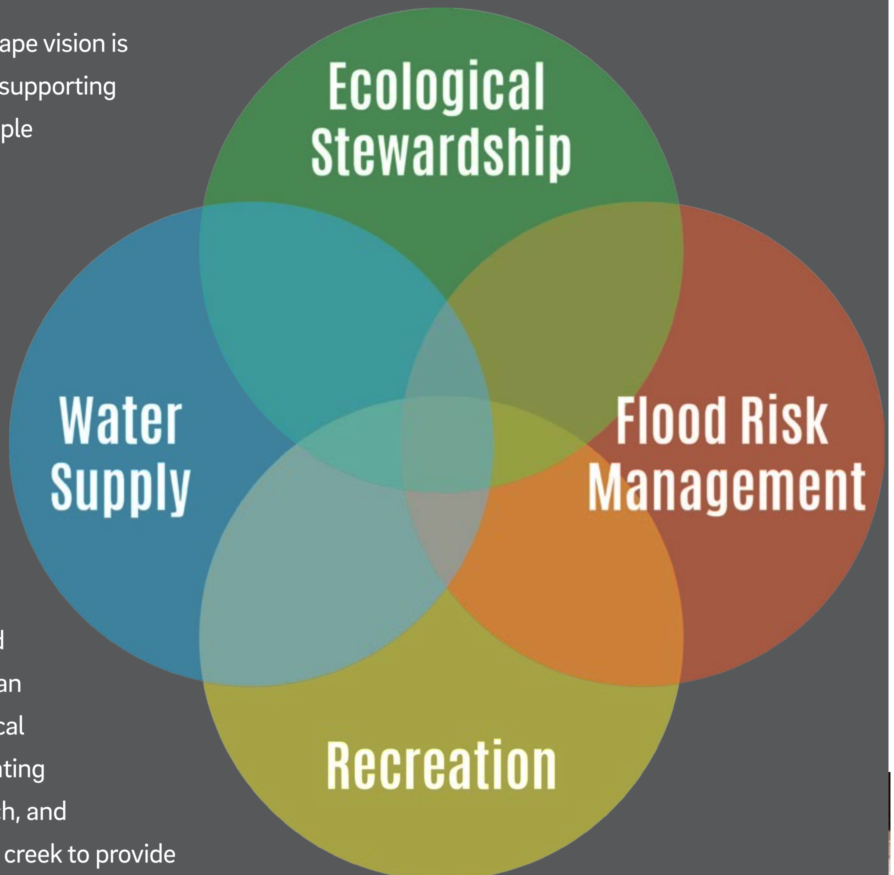
As vital flood infrastructure ages and flood systems are redesigned, there are new opportunities to incorporate additional benefits, such as ecological health, into flood risk management. Well-designed infrastructure that supports functioning ecological systems can confer resilience to climate change, protect adjacent development, and sustain native plants and animals. The recommendations, measures, and landscape concepts described in this document together present a vision for Upper Penitencia Creek that supports and restores natural processes and expands recreational values, while improving aspects of flood risk management.

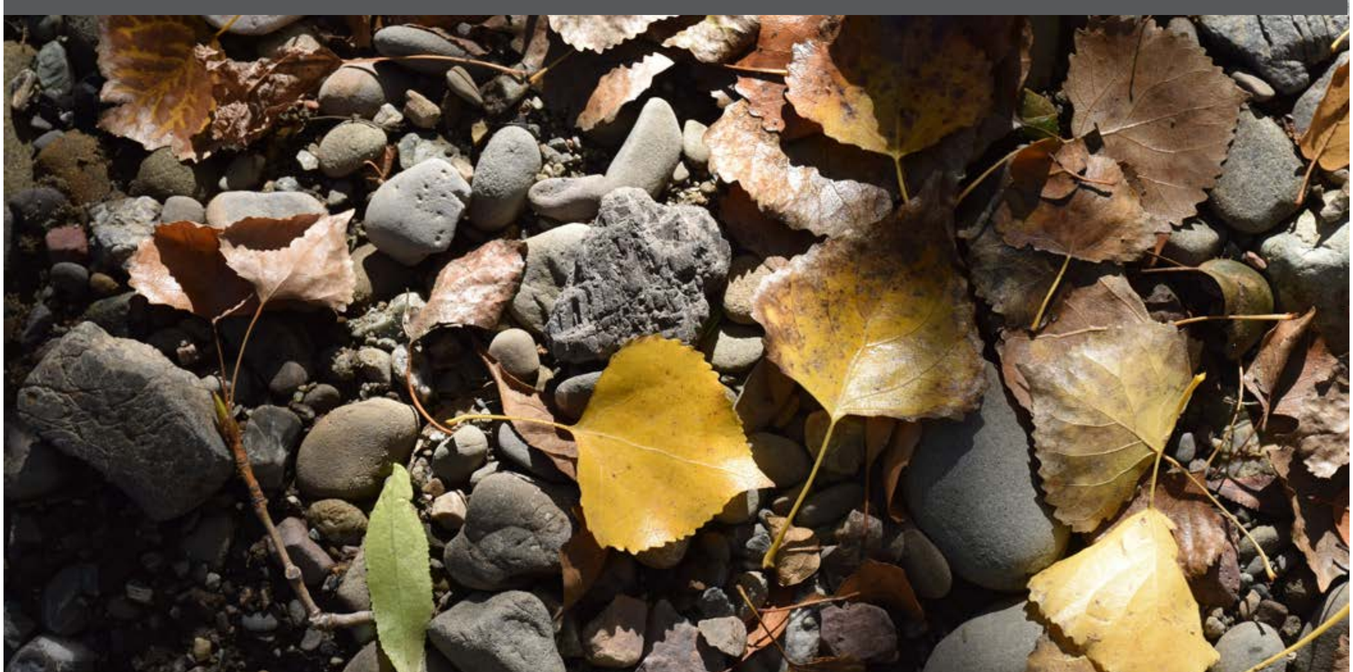
The District recently initiated the Upper Penitencia Creek Natural Flood Protection Project, with a main goal being the prevention of flood damage and shutdowns to utility and transportation infrastructure that have historically occurred along the creek, particularly in its downstream reaches near the confluence with Coyote Creek. This effort is occurring in the context of the District's One Water initiative, which seeks to integrate water supply, flood protection, and stream stewardship at the watershed-scale. This effort includes the City of San José and the County of Santa Clara, who, together with the District, form a "Tri-Party Agreement" that includes provisions for managing lands jointly within and surrounding the creek. The District and its partners who own and operate land along the creek are seeking a management approach for the creek that meets flood management goals in a manner that is resilient to changing land use and climatic conditions, while providing additional benefits beyond flood risk management, including maintaining water supply, supporting ecological processes and functions, and creating recreational opportunities.

SFEI-ASC, in collaboration with the District, led the development of this landscape vision. The process for developing the vision had four main elements. First, SFEI-ASC built a baseline understanding of historical and contemporary geomorphic and ecological conditions, and considered these in the context of future climatic conditions and watershed management approaches. Second, a workshop was convened that included presentations by SFEI-ASC scientists on the historical and contemporary characteristics of Upper Penitencia Creek and its surrounding landscape, and by District engineers and planners on key creek management considerations. The goal of the workshop was to recruit advice and input from an expert panel of science advisers, the Science Advisory Hub, on ways to incorporate support for ecosystem function into new flood risk management approaches. The workshop discussion focused primarily on the creek and floodplain from the confluence with Coyote Creek upstream to the Dorel Drive bridge, but changes to land management in the upper watershed were also discussed. Third, the District led a series of design charrettes with Tri-Party Agreement partners that further developed many of the management concepts put forth during the Science Advisory Hub workshop. Finally, the Science Advisory Hub reviewed and helped refine the management concepts that came from the design charrettes. These concepts make up the landscape vision shown in this report.

PROJECT PURPOSE

This Upper Penitencia Creek landscape vision is intended to serve as a roadmap for supporting ecosystem functions to benefit people and wildlife. It is intended to assist the District, its partners, and other regional stakeholders in planning adaptation approaches to ecological stewardship, flood risk management, recreation, and water supply for Upper Penitencia Creek during the coming decades. The District is seeking to develop a new management approach in coordination with local partners who own and operate land adjacent to the creek (e.g., City of San José, County of Santa Clara, and local school districts), explicitly incorporating the partners' goals into the approach, and managing the areas adjacent to the creek to provide multiple benefits.



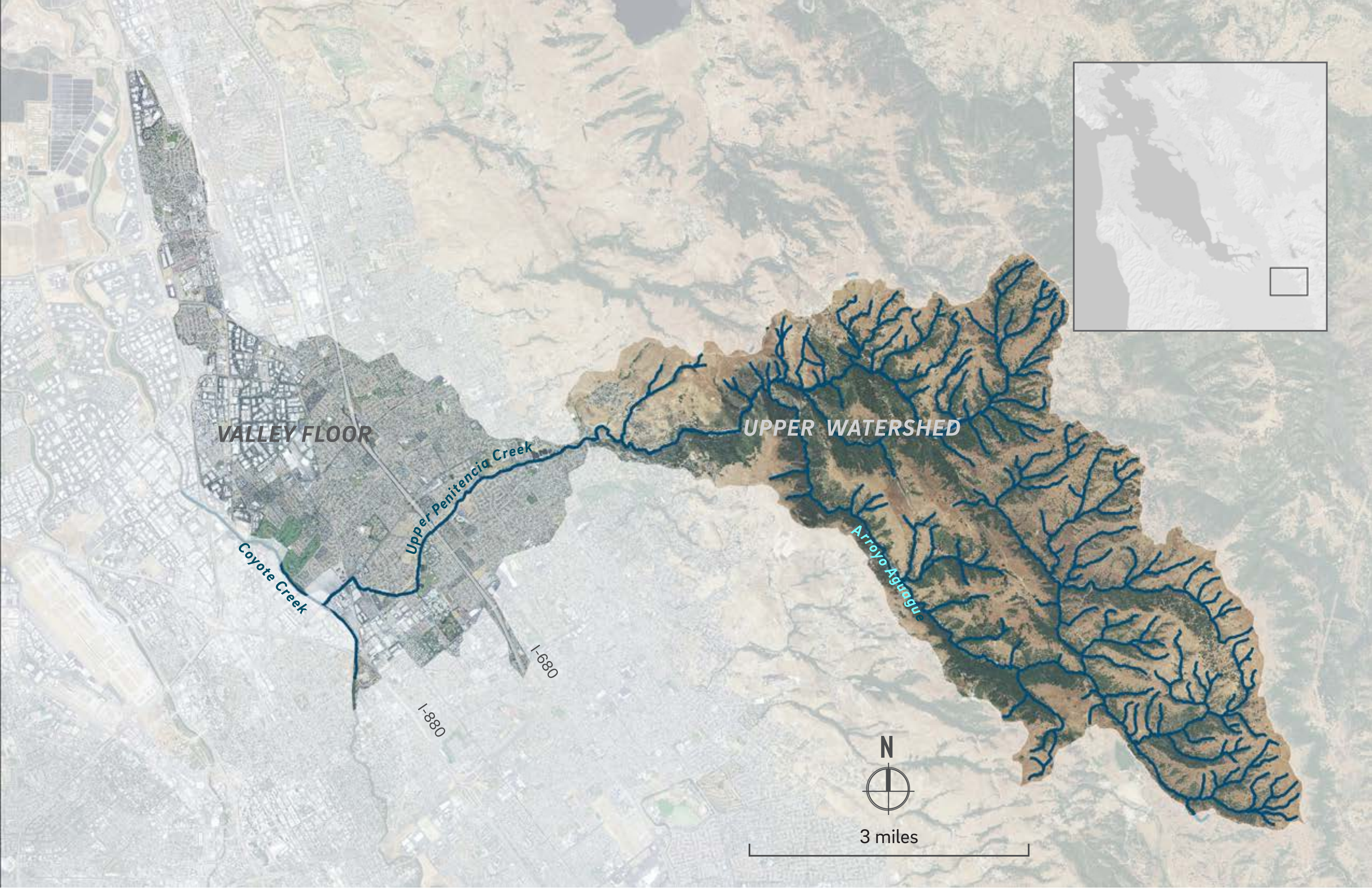

COTTONWOOD LEAVES, UPPER PENITENCIA CREEK

Upper Penitencia Creek
Natural Flood Protection Project

Upper Penitencia Creek originates in the Diablo Range, then flows across its alluvial fan for approximately four miles through northeastern San José before emptying into Coyote Creek. Over the past 200 years, the watershed has undergone considerable changes, including conversion of much of the valley floor to urban and suburban uses. Despite this, substantial areas of open spaces and park lands flank the creek corridor.

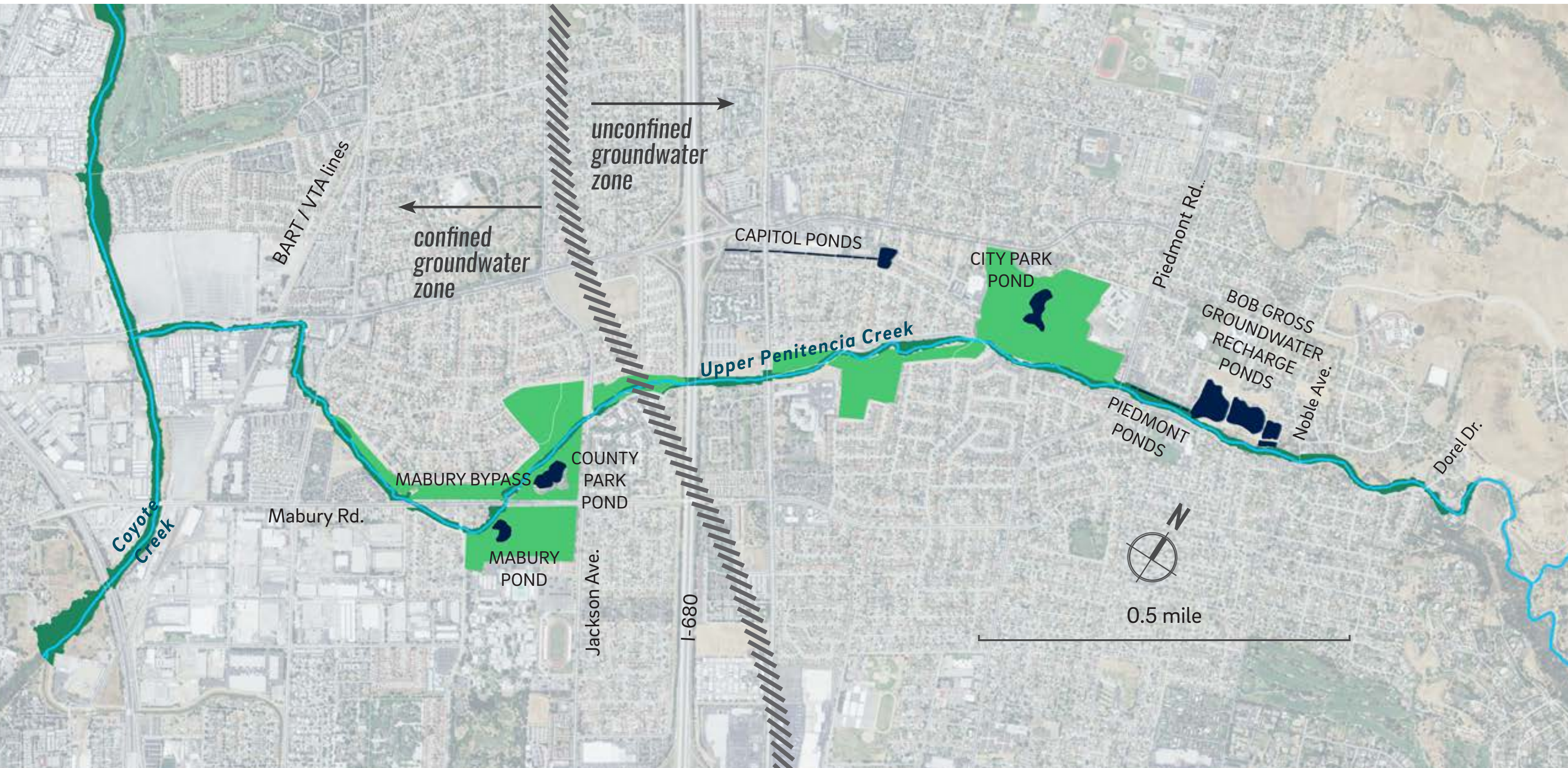
Upper Penitencia Creek can flood a large area that extends north toward Berryessa Creek and Lower Penitencia Creek in Milpitas, affecting approximately 9,000 land parcels along with critical utility, transportation, and water supply infrastructure. Since the 1950s, the creek has flooded several times, with the largest flood occurring in 1958. This, and other significant floods in the 1970s, 1980s, and 1990s, caused major damage and cost millions of dollars in repairs, as well as in lost revenue for affected residents and businesses. Following recent floods, traditional flood management engineering approaches were rejected by the community, and were inconsistent with District natural flood protection guidance. The District decided to develop a new approach to flood management along the creek that provides the necessary level of flood protection in a manner that reduces maintenance costs and provides multiple benefits to people and wildlife.

In 2014, the District initiated the Upper Penitencia Creek Natural Flood Protection Project. The project focuses on preserving open land and improving flood protection along the 4.2-mile creek corridor from the Coyote Creek confluence upstream to the Dorel Drive Bridge. The overall project approach is to preserve the natural creek channel as much as possible and have adjacent open space and recreational areas act as temporary flood storage areas to help prevent floodwaters from entering surrounding neighborhoods and commercial areas. Implementing this approach will require channel and floodplain modifications to help capture flood flows as well as modification to water supply infrastructure and other floodplain infrastructure elements that will need flood protection. The project planning is expected to be completed by 2019 and construction is expected to be completed by 2026, with funding coming primarily from the District's Safe, Clean Water and Natural Flood Protection programs. Project partners include the City of San José and Santa Clara County.



Upper Penitencia Creek's Upper Watershed and Lower Watershed on the Valley Floor. *Upper Penitencia Creek's upper watershed area is 24 mi². After exiting a narrow canyon, the creek flows through a mostly urbanized valley floor to its confluence with Coyote Creek.*

Upper Penitencia Creek *is unique in the region for having a high proportion of public and open space along its course (shown in green). The upper portion of its alluvial fan is located in an unconfined groundwater zone, which allows for surface waters to recharge the groundwater aquifer.*



OPPORTUNITIES AND CHALLENGES

An array of opportunities and challenges for managing ecological resources, flood risk, recreation, and water supply exist in the Upper Penitencia Creek area:

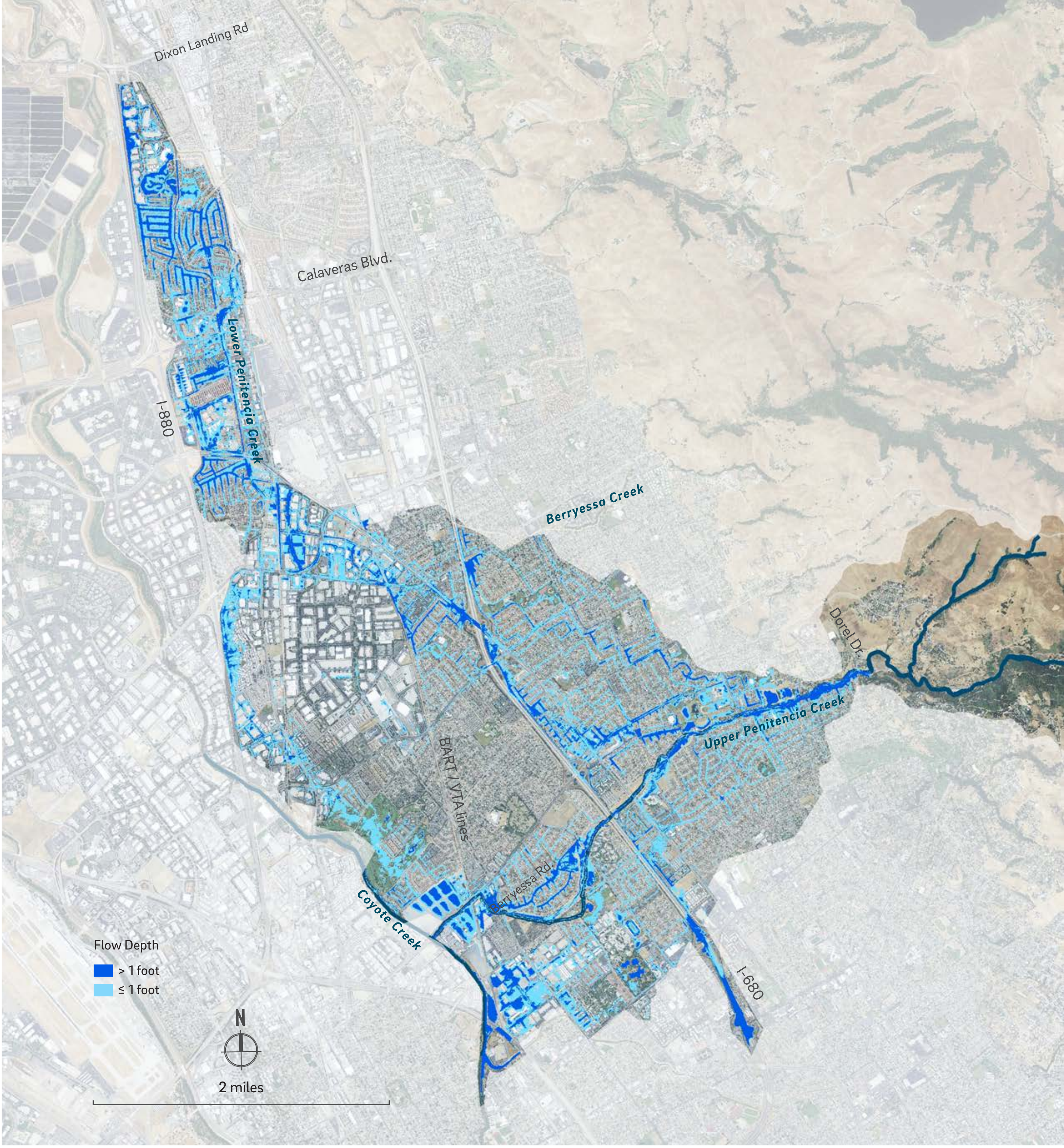
OPPORTUNITIES

- Improve flood management for parcels by integrating flood risk management in public open spaces.
- Enhancements to riparian and aquatic habitats.
- Improved in-channel sediment transport and reduction of maintenance requirements and costs associated with excess sediment.
- Improvements to water quality associated with increased floodwater storage and filtration in expanded flood detention basins.
- Recreation improvements consistent with the City of San José and Santa Clara County Park master plans, including completing the long-planned trail and linear park along Upper Penitencia Creek.

CHALLENGES

- Providing up to 100-year flood (or 1% flood) protection for over 9,000 parcels containing homes, schools and businesses. Under current conditions, the 100-year flood is expected to inundate approximately 1,400 acres from Coyote Creek upstream to Dorel Drive, affecting transportation, utility, and water supply infrastructure within the creek and adjacent floodplain.
- Protecting habitat for aquatic and terrestrial wildlife species (e.g., steelhead trout, Pacific lamprey, migratory and nesting birds).
- Risk of increasing flood flows, sediment deposition, and scour due to climate change.
- Meeting local water need by continuing to infiltrate water through recharge ponds and the channel bed.
- Maintaining public access to open space areas.

HIGH FLOWS IN UPPER PENITENCIA CREEK IN COMMODORE PARK, COURTESY OF SANTA CLARA VALLEY WATER DISTRICT



Modeled Upper Penitencia Creek Flow Contribution to Flooding on the Valley Floor. *Modeling shows the flooding extent in the urbanized valley floor (blue) around Upper Penitencia Creek for a 100-year flood event. Modeling results courtesy of the Santa Clara Valley Water District.*

One Water

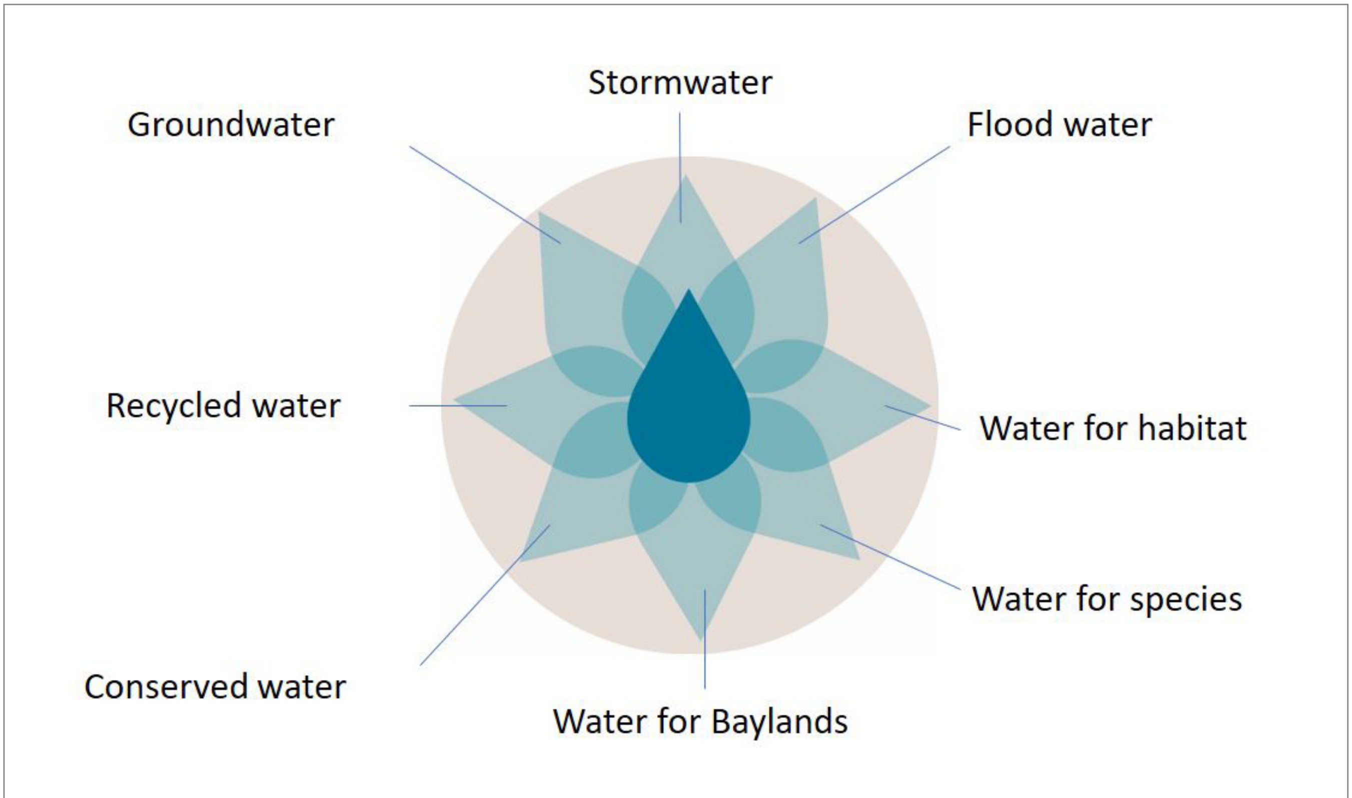
The District is responsible for providing clean, safe drinking water, flood protection, and stream stewardship for a service area that covers 1,300 square miles with 1.9 million residents in 15 major cities. The District imports approximately 40% of the county's water supply. Those imports, along with local surface water, are delivered to drinking water treatment plants and used for groundwater recharge in creeks and recharge ponds. Additional supplies in the county include natural groundwater recharge, recycled water delivered by water retailers, and San Francisco Public Utilities Commission deliveries. The District is also charged with managing flood risk to homes, businesses, and transportation networks. In many areas throughout the County, the District maintains levees and removes accumulated sediment to help ensure floodwaters remain in the channel. With regard to stream stewardship, the District is responsible for protecting the more than 800 miles of creeks that wind through the County. This includes supporting steelhead trout (*Oncorhynchus mykiss*) and other native aquatic species, which can often be complex and difficult to coordinate with flood protection and water supply needs.

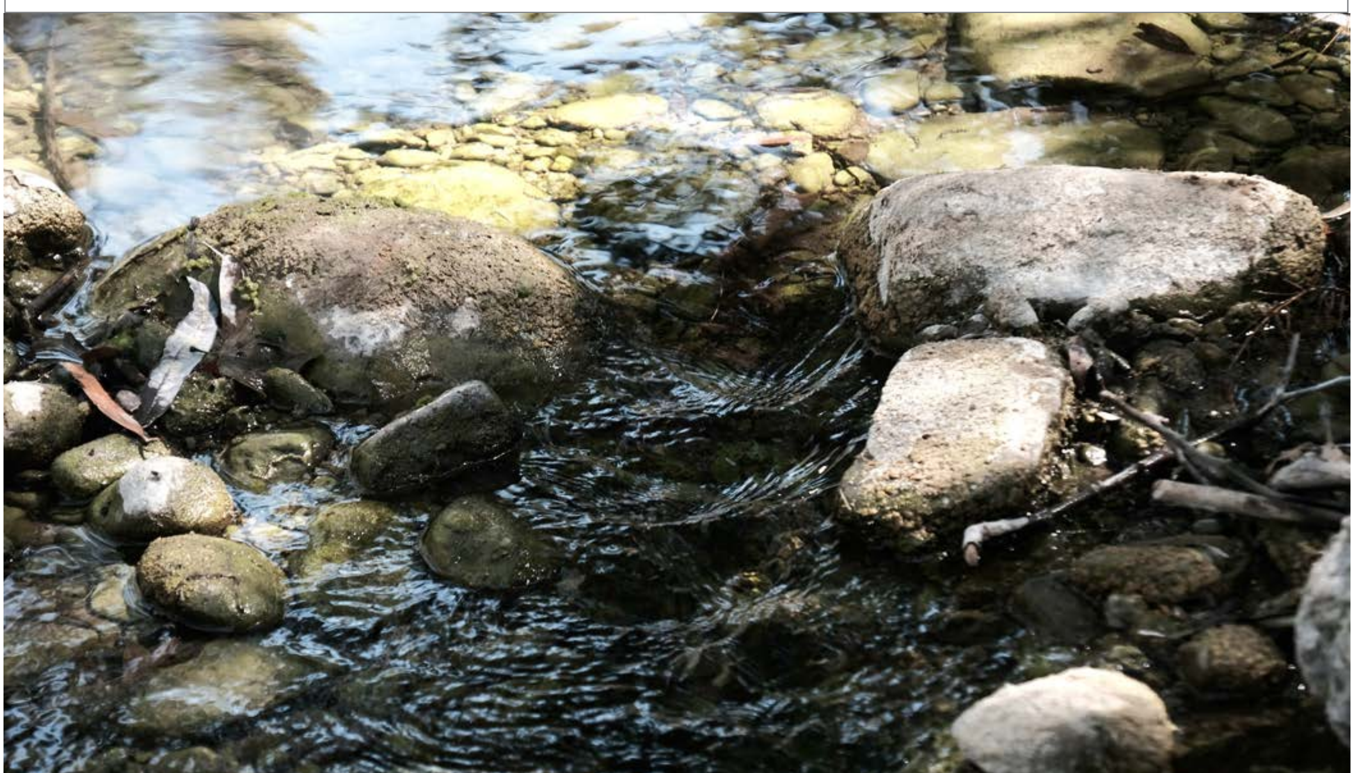
The District recognizes the need for a new approach to water resource management that is more sustainable, effective, efficient, and operates within a multi-decade planning horizon. The One Water Plan is a new long-term District initiative that seeks to integrate stream stewardship, flood management, and water supply at the watershed scale. The approach looks to build upon current master planning efforts and consider new planning elements, seek water management across institutional programs, and manage water resources in a multi-benefit, holistic way.

Through close collaboration with community groups, stakeholders, and science advisors, the District has developed the Plan by starting with a central vision to manage water holistically to benefit people and wildlife, under which are nested, integrated high level goals that address water, people, and ecosystems, and objectives that bring definition to the goals. Progress towards meeting the Plan's objectives will be assessed by tracking movement toward target values for objective-specific metrics (e.g., acres of wetland, volume of stored groundwater). The District will then prioritize and rank potential projects and programs based on the degree to which they can move One Water metrics toward their established target values. The District has completed a draft One Water Framework that provides a countywide overview for several metrics appropriate for tracking at the county scale.

The District is working to have watershed-specific plans (with watershed-specific target values) for the five major watersheds throughout the county (Coyote, Guadalupe, West Valley, Lower Peninsula, and Pajaro) completed by 2020. This vision contributes to achieving One Water goals for the Coyote Creek watershed by providing guiding principles and identifying multi-benefit landscape concepts within Upper Penitencia Creek.

More information about the Santa Clara Valley Water District One Water Plan can be found at https://www.valleywater.org/your-water/one-water-plan.





ONE WATER LOGO, COURTESY SANTA CLARA VALLEY WATER DISTRICT (ABOVE); WATER FLOWING IN UPPER PENITENCIA CREEK (BELOW)

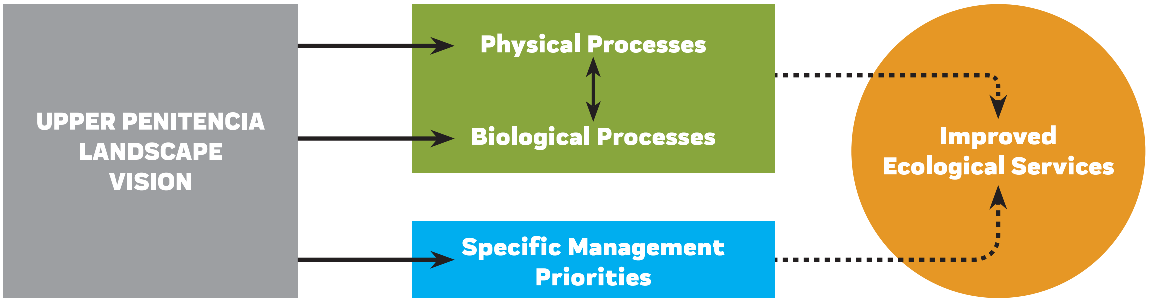
The Process for Developing a Landscape Vision

A science-based collaborative process was employed to develop a landscape vision for Upper Penitencia Creek that provides multiple benefits in addition to flood management. This "resilient landscape" approach has been successfully applied for flood control projects throughout the region (e.g., in Novato, Walnut, and Calabazas and San Tomas Aquino Creeks).

Step 1
Pre-Workshop

Understanding landscape functioning

Developing a management approach that can support a resilient landscape requires an understanding of how landscape-scale functions and processes contribute to ecological services for people and wildlife. In 2012, SFEI-ASC researched and documented the historical landscape of Upper Penitencia Creek (Beller et al. 2012), documenting mid-19th century habitat conditions along the creek corridor as well as in surrounding uplands. Other studies provide information on current landscape processes, including assessments of creek geomorphology and ecology (e.g., DeJager and Martel 2006; Stillwater Sciences 2006; Jordan et al. 2009, 2010; EOA and SFEI 2011), and ecological functioning for fish (CDFW and SJSU 2013; Stillwater Sciences 2006; SCVURPPP 2014, 2015, 2017). SFEI-ASC used these to develop an understanding of historical and modern landscape functioning.



CONCEPTUAL MODEL OF UPPER PENITENCIA LANDSCAPE VISION

Step 2
At Workshop

Workshop

In March 2017, the District and SFEI-ASC convened a workshop to solicit ideas from a Science Advisory Hub, a group of regional and local experts, regarding recommendations, general measures, and multi-benefit concepts for Upper Penitencia Creek that support flood risk and water management, habitat restoration, and recreational amenities under changing future conditions. The Hub members were Andy Collison (fluvial geomorphologist, ESA), Lorraine Flint (hydrogeologist, USGS), Robert Leidy (fisheries biologist, USEPA), Bruce Orr (riparian ecologist, Stillwater Sciences), and Steve Rottenborn (wildlife biologist, HT Harvey). Caitlin Sweeney (SFEP) moderated the workshop. Participants included representatives from local organizations as well as state and federal

DEVELOPING A LANDSCAPE VISION THROUGH WORKSHOPS AND FIELD VISITS

regulatory agencies responsible for permitting projects. Participants and Hub members asked critical questions that helped shape the landscape vision under development.

The workshop included presentations by District engineers and planners, as well as SFEI-ASC scientists, with information on the historical and contemporary ecological, hydrologic, geomorphologic, and recreational conditions along and adjacent to Upper Penitencia Creek. A moderated discussion then focused on gathering short- and long-term management directions put forth by the Hub. Recommendations from the Hub members for improving the resiliency of the Upper Penitencia Creek landscape to changing conditions were then grouped into categories. Each category contains several general management recommendations that focus on supporting physical and ecological processes along Upper Penitencia Creek (See "Recommendations from the Science Advisory Hub," below).

Step 3
Post-Workshop

Landscape Concept Design Charrettes and Second Hub Workshop

During the spring of 2018 , the District led a series of design charrettes with internal staff and local partners to identify specific actions—the landscape concepts—informed by the May 2017 workshop findings that achieve multi-benefit goals for the creek. Charrette participants included staff from the City of San José, Santa Clara County, and experts from multiple departments within the District. The landscape concepts generated in the charrettes were then the focus of a second Science Advisory Hub workshop, during which the Hub members were able to review the suite of concepts and help refine them as appropriate.

Step 4
Vision

Developing the Landscape Vision

Following the second Hub workshop, the suite of multi-benefit landscape concepts were combined into an overall landscape vision that includes the project reach from the Coyote Creek confluence to Dorel Drive, and the upper watershed. The concepts were grouped into two types (called 'measures') that cover different approaches for improving flood protection in a manner that supports and augments wildlife habitat and recreational uses, and does not negatively impact water supply operations.

The landscape vision was informed not only by the current management priorities of flood protection, water supply, recreational uses, and habitat enhancement, but also by an understanding of the underlying processes that have created the conditions in the current creek system today. By supporting and working with these physical and ecological processes, future management can have a more resilient and lasting effect.

Step 1
Pre-Workshop

Landscape Change Analysis

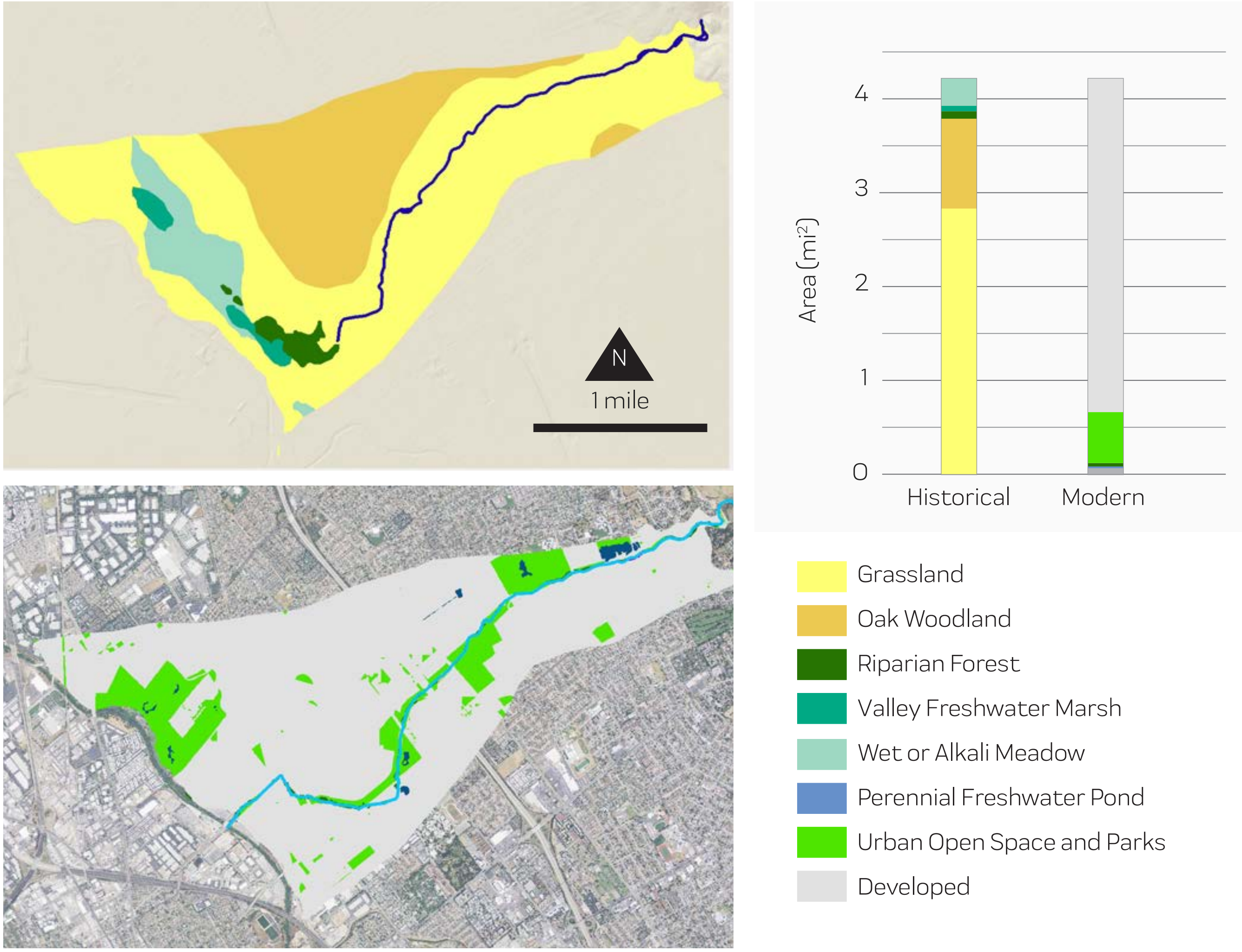
The Upper Penitencia Creek historical landscape included extensive wetland and riparian areas embedded within oak savanna and grassland. The creek corridor was likely vegetated with sycamores and oaks grading into the surrounding uplands. Over the past 200 years, the geomorphology, hydrology, and habitat of Upper Penitencia Creek have been significantly altered. This section describes key features of the historical landscape, and compares historical and contemporary conditions.

Landscape parameters were selected to evaluate the extent of change and habitat loss since the middle of the 19th century. The parameters address changes in land cover, riparian condition, wildlife use, stream flow, groundwater, channel planform, and sediment transport. Changes in these parameters have implications for flooding and erosion dynamics, as well as for the habitats that support a range of wildlife that utilize Upper Penitencia Creek and its adjacent floodplain.

LAND COVER TYPES

Historical: In the early 1800s, the floodplain along the creek hosted a mix of habitat types, including sycamore alluvial woodland, oak woodland, and oak savanna/grassland. The upper reaches of the channel on the valley floor supported an abundance of California sycamore trees (*Platanus racemosa*), which favor areas with intermittent hydrology. California sycamores were once extensive in Santa Clara County, but are now a rare cover type (Keeler-Wolf et al. 1996, Sawyer et al. 2009). The creek emptied into a wet meadow/seasonal freshwater wetland adjacent to Coyote Creek, which then drained to Lower Penitencia Creek in the wet season (Beller et al. 2012).

Modern: The greatest changes in land cover have been the conversion of grassland, oak woodland, and wetlands first to agricultural, then to urban uses. Currently, 75% of the valley floor adjacent to the creek is urbanized. Mixed riparian vegetation along the creek banks is more dense than historically, and stands of sycamore trees persist along some portions of the creek. The extensive wetland and willow thicket area adjacent to the natural levee of Coyote Creek has been converted to urban uses; in some cases, this area is completely paved over, though a golf course now occupies the northern area of this former wetland complex. Despite these changes, the riparian corridor along Upper Penitencia Creek has extensive areas of parkland and open space unique in the region, that not only provides recreational opportunities for people, but also supports a host of wildlife, including one of the more significant runs of steelhead in the South Bay (Leidy et al. 2005).



Historical and Modern Land Cover Types. *Land cover has changed considerably between historical (early 19th c.) and modern (early 21st c.) time periods, with greatest reductions in grassland, oak woodland and wetland habitat types.*

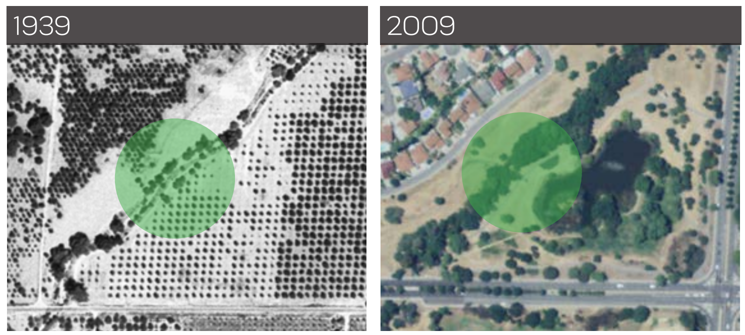
MIXED RIPARIAN CORRIDOR ALONG UPPER PENITENCIA CREEK

RIPARIAN VEGETATION

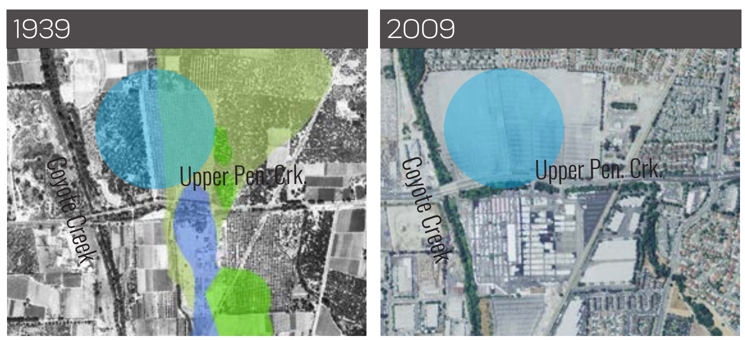
Historical: Historical canopy composition on the valley floor was likely dominated by California sycamore in the upper reaches, and may have graded into an oak-dominated canopy near present-day Mabury Road, before finally transitioning into willow grove in the downstream-most reaches (Beller et al. 2012, DeJager and Martel 2006). Intermittent streamflow conditions in the upper reaches, as well as Native American land management, may have kept tree density low.

Upper Reach. *Riparian vegetation is generally more dense than historically, as shown in historical aerial photographs and indicated by historical data.*

Modern: Due to changes in dry-season hydrology that have created wetter conditions year-round, and to changes in land management practices such as fire suppression and the removal of grazing and farming pressure, riparian vegetation density and width have changed considerably (DeJager and Martel 2006, Grossinger et al. 2006). In the upper reaches of the valley floor, tree canopy is wider and denser than during the agricultural era (ca. 1880s-1960s), although urban development has generally left the floodplains more confined. In the historical willow grove and wet meadow areas, the creek has been channelized and riparian canopy is now much narrower than historically.



Middle Reach. *Riparian canopy width is greater in some areas, but floodplains are more confined.*



Lower, Wetland Reach. *Riparian width and density is likely much reduced from the 1850s; colored areas on 1939 aerial indicate historical wetland areas.*

Riparian canopy composition remains mostly native, with non-native species comprising little cover. Notably, California sycamores are still present, and are even dominant in and around the channel, especially upstream of Capitol Avenue (DeJager and Martel 2006). However, they are not considered an example of the classic open park-like stands that once graced the nearby drainages of the Coyote Valley. Due to their tolerance of drought and requirement for flashy hydrology for reproduction, they may prove resilient to future climate changes expected for the Santa Clara Valley. The sycamores present today are generally large, mature trees similar to those recorded in early General Land Office records (field observation 2017; Beller et al. 2012), indicating that the population may not be reproducing, potentially due to changes in hydrological patterns, or perhaps due to competition for light and resources within the relatively dense canopy of the modern channel.

WILDLIFE CONNECTIVITY

Historical: The complex mosaic of historical landscape features supported habitats for terrestrial and aquatic species that were able to forage, shelter, reproduce, and disperse along Upper Penitencia Creek between the Diablo Range to Coyote Creek, and eventually to the Bay. Flood flows delivered fine and coarse sediment that helped maintain in-channel and floodplain habitats on the alluvial fan for a host of mammals, birds, and fishes (Beller et al. 2012). Wet season flooding that connected Upper Penitencia Creek to Lower Penitencia Creek allowed fishes to access bottomland floodplain and freshwater marsh habitats, and established a seasonal migration corridor from Upper Penitencia Creek to Lower Penitencia Creek and eventually to the Bay. In addition to instream connectivity, the ecotone between riparian and oak savanna habitats likely hosted a rich diversity of species, including terrestrial species that were able to freely access the riparian area from uplands, and to use the riparian corridor for movement and resources.

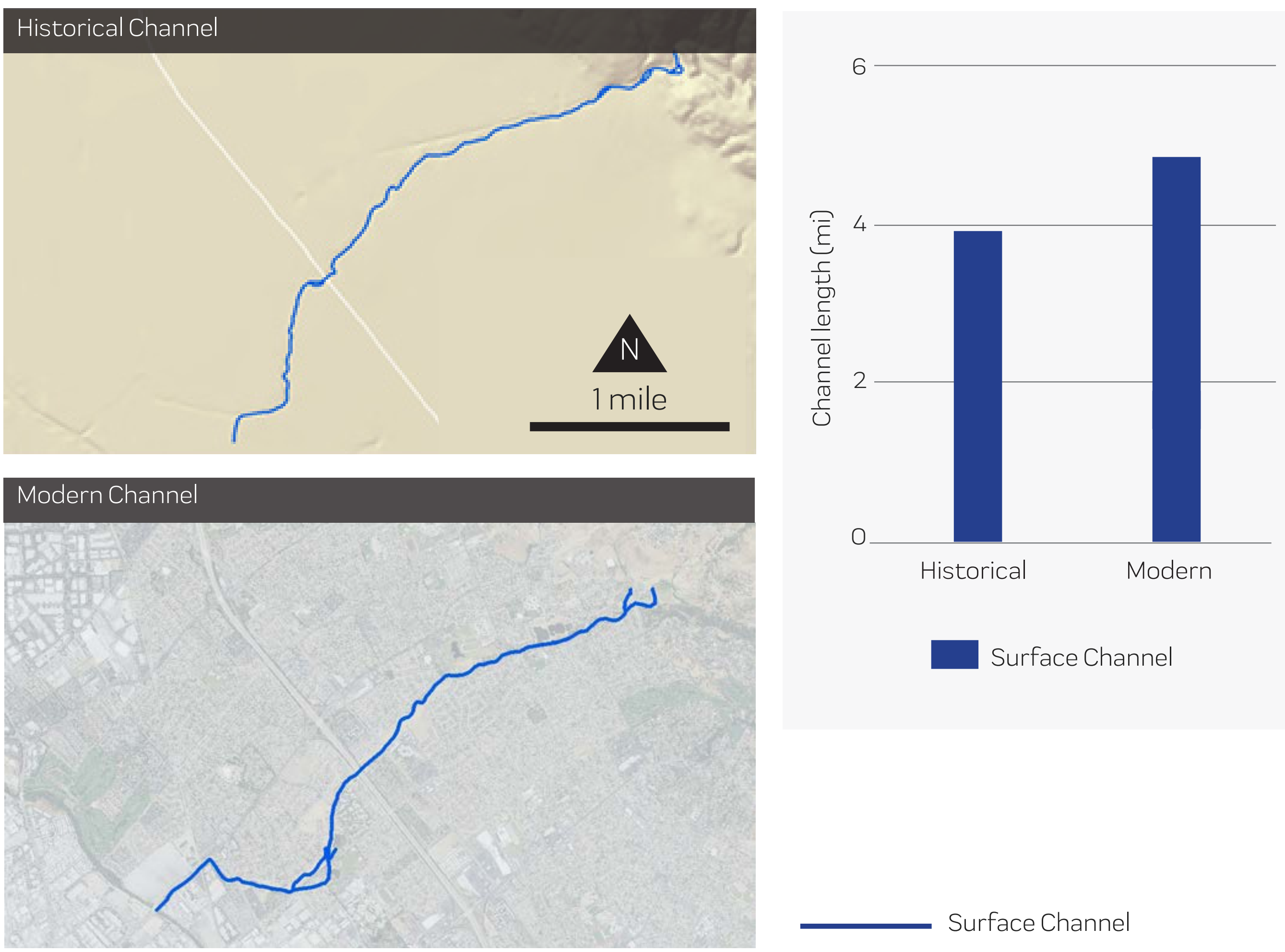
Modern: Upper Penitencia Creek is still an important place for wildlife in the South Bay, retaining many ecological characteristics that are relatively unique in Santa Clara Valley. The creek is critical habitat for one of the more significant remaining steelhead populations in the Bay Area, providing a relatively continuous riparian corridor along one of the shortest routes to spawning areas in the South Bay (Leidy et al. 2005; Stillwater Sciences 2006; Leidy 2007; Winzler and Kelly 2011). The creek also provides habitat for other native aquatic species, including Pacific lamprey (*Entosphenus tridentatus*) and Sacramento sucker (*Catostomus occidentalis*) (CDFG 2009; CDFW and SJSU 2013). In addition, public open spaces and natural areas along the creek provide important habitat for native plants, amphibians, reptiles, fishes, birds, and invertebrates, and provide a pathway between the Diablo Range and the Santa Clara Valley for a variety of mammals and birds such as bobcat (*Felis rufus*) and oak titmouse (*Baeolophus inornatus*). Enhancements along Upper Penitencia and Coyote Creeks could potentially promote wildlife movement along Coyote Creek to the Bay (Bay Area Open Space Council 2011). Management actions that support and sustain a diversity of habitat conditions within and adjacent to the creek could help support wildlife populations into the future.

BOBCAT, OAK TITMOUSE, AND PACIFIC LAMPREY. LEFT TO RIGHT, PHOTOS BY DON DELEON, BECKY MATSUBARA, AND USFWS (CREATIVE COMMONS)

CHANNEL PLANFORM

Historical: In the early to mid-1800s, Upper Penitencia Creek was a relatively low sinuosity, single-threaded channel along the four miles from where it flowed out of its canyon and onto a cone of sediment, the alluvial fan. Downstream, it drained into the extensive wet meadow/seasonal freshwater wetland that connected Upper and Lower Penitencia Creeks. Local sinuosity was the highest just downstream of the canyon at the top of the alluvial fan, which also had a few sections where side channels were present (Hermann 1902, shown in Beller et al. 2012).

Modern: The current planform is similar to historical conditions, but with a few significant changes. The side channels that existed just downstream of the canyon were filled in sometime in the early 20th century to increase land available for agriculture and then development. To make way for the building of Interstate 680, a short section of channel was moved approximately 200 ft to the north in the 1970s (DeJager and Martel 2006). A permanent connection to Coyote Creek that was established in the mid-1800s created a very straight reach that added approximately 0.5 miles to the total channel length. Similarly, the Mabury bypass, which captures flow during large flood events, also added approximately 0.5 miles to the total channel length.



Historical and Modern Channel Planform. *The overall channel planform has remained relatively unchanged between historical (mid-19th c.) and modern (early 21st c.) time periods, with the mainstem channel length increasing by approximately 1 mile.*

LARGE COBBLES IN THE DRY STREAM BED, UPPER PENITENCIA CREEK

SEDIMENT TRANSPORT

Historical: Flood flows from the upstream watershed would bring sediment that spread out over the alluvial fan and built it over time. A distributary channel network transported sediment from the upper watershed downstream toward the toe of the fan along Coyote Creek, with coarser sediment being deposited in the upper reaches near the head of the fan, and finer sediment deposited in the lower reaches downstream. Flood hydraulics and sediment transport dynamics resulted in rather shallow mainstem and distributary channels, with relatively high width-to-depth ratios, that frequently moved across the fan and flooded surrounding areas during modest storm events.

Modern: In contrast to many sediment-starved streams in the region, coarse and fine sediment is still transported along the mainstem channel and out to Coyote Creek. Overall, the channel bed is stable to aggradational (with excess sediment deposition) from the Bob Gross Ponds downstream to the King Road bridge (Jordan et al. 2010) and incised in the lowest reach at the Coyote Creek confluence. Considerable aggradation has been documented recently in reaches around Capitol Avenue, where elevations had previoiusly dropped by approximately 3 ft due to valley-wide subsidence (Jordan et al. 2009). Coarse sediment transported along the channel in the wet season now gets trapped under bridges and culverts, causing some localized flooding issues and impediments to fish and wildlife passage (Stillwater Sciences 2006). Deposition of Upper Penitencia Creek sediment in Coyote Creek at the confluence can decrease flow capacity, contributing to flooding issues in Coyote Creek.

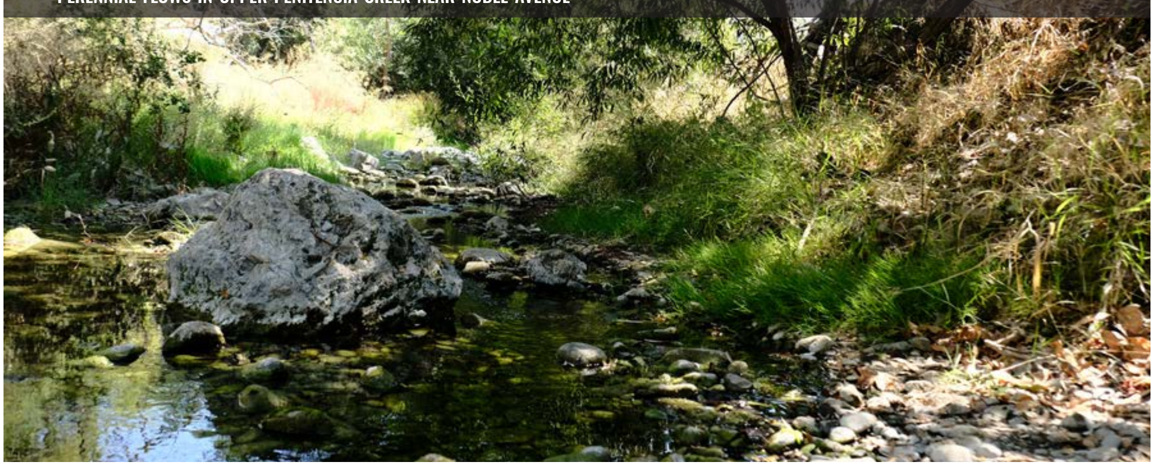
STREAM FLOW PATTERNS

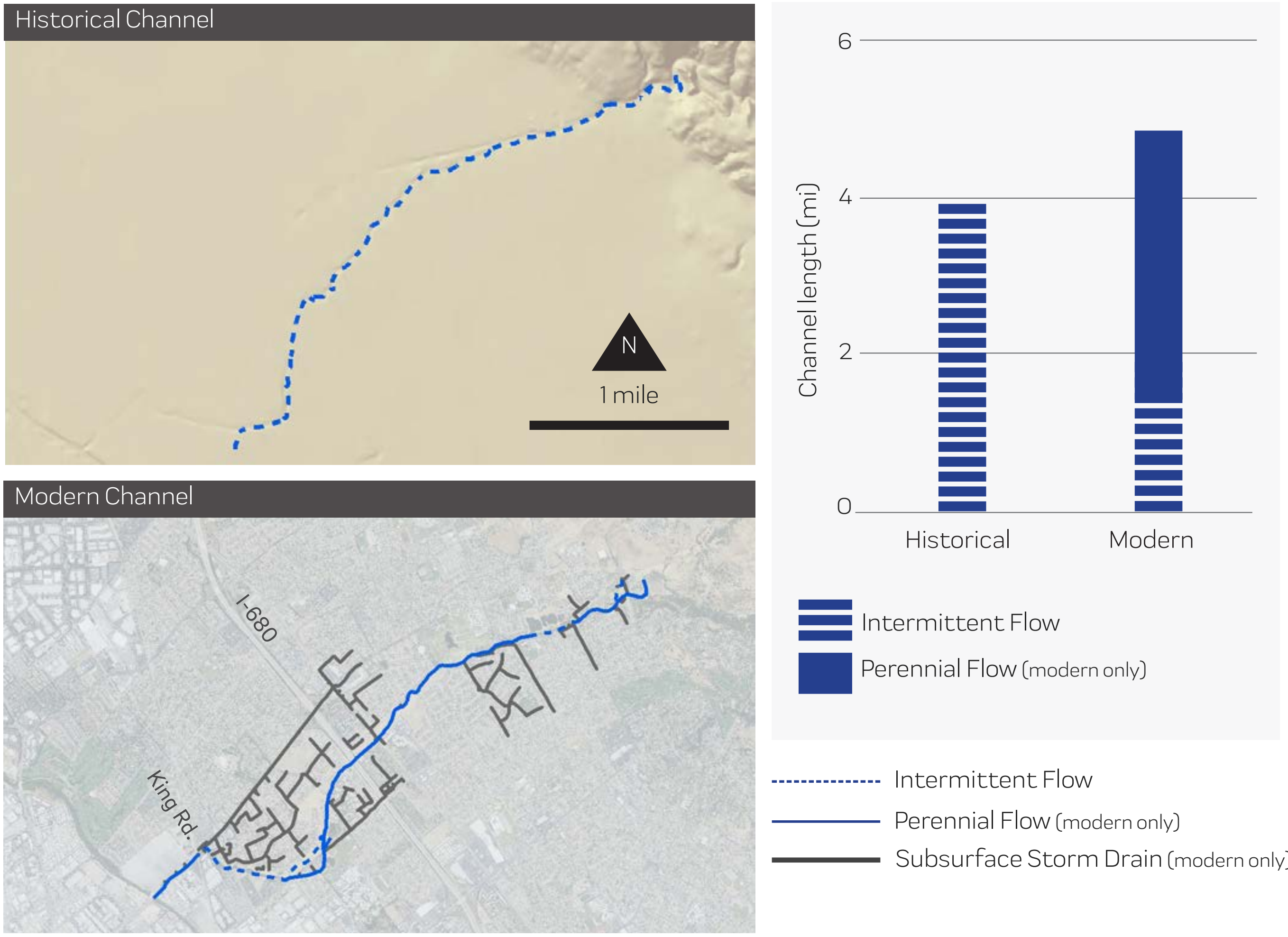
Historical: The creek on the valley floor likely had intermittent flow (wet during most winters, dry during most summers) along its entire length (Beller et al. 2012). Flood flows coming from the upper watershed would spread out across the alluvial fan in the upper reaches of the valley floor. In the lower reaches of the valley floor, a natural levee along Coyote Creek directed flows northward into the extensive wet meadow/freshwater wetland complex connecting Upper and Lower Penitencia Creeks. During larger flood events, flows would also enter directly into Coyote Creek. Over geologic time, the creek's mainstem channel changed course many times as it migrated across the alluvial fan, directing flood waters and sediments towards both the north and south.

Modern: The permanent connection into Coyote Creek was established to promote flood water drainage and increase the amount of arable land around the creek (Beller et al. 2012). The extensive storm drain network that now serves the surrounding urbanized landscape has reduced the creek's historical drainage area by approximately 30% by diverting runoff to adjacent creeks. This has resulted in an estimated 10% decrease in peak storm discharge compared to historical conditions (Jordan et al. 2010). Earthen berms along lower reaches between Interstate 680 and King Road help keep modest flood flows in the channel. During large flood events, flood waters still leave the channel at several "breakout" locations and flow across the fan to the north as they did historically. The downstream-most reach at the Coyote Creek confluence often floods when both Upper Penitencia Creek and Coyote Creek are at flood stage.

Most of the upper reaches on the alluvial fan now have perennial flow (year-round flow) in most years due to releases of imported water for groundwater recharge, which is discharged to the creek bed once natural flows have ceased for the season. Imported water is diverted at the Mabury diversion, and the middle section of the channel on the valley floor remains intermittent. Imported water may introduce fish from outside the local system (Stillwater Sciences 2006), and can introduce warmer temperature flows, which likely support a different assemblage of warm-water fishes than an intermittent stream would host (SFEI-ASC 2008). Additionally, the shift to perennial flows during most years has likely had a large effect on riparian vegetation, increasing the density of vegetation along the stream banks and shifting tree species composition (DeJager and Martel 2006).

PERENNIAL FLOWS IN UPPER PENITENCIA CREEK NEAR NOBLE AVENUE





Historical and Modern Stream Flow Patterns. *Much of Upper Penitencia Creek now has perennial flow during most years, though areas in the middle reaches still have intermittent flows. Storm drains now carry runoff directly to the creek.*

GROUNDWATER

Historical: Flood flows spreading out over the upper portion of the alluvial fan would infiltrate into highly permeable soils and recharge the underlying groundwater basin. Dry season flows coming from the canyon upstream would infiltrate directly into the channel bed and also contribute to groundwater recharge. The lower portion of the fan has a low-permeability confining clay layer near the ground surface that limited surface water infiltration into the underlying aquifer and kept surface soils moist, resulting in the creation of the wet meadow/freshwater marsh complex that connected Upper Penitencia and Lower Penitencia Creeks (Beller et al. 2012).

Modern: The development of the land adjacent to the creek in the upper portion of the fan has caused a decrease in the amount of flood waters infiltrated into the underlying groundwater basin. Since the 1960s, the District has been importing water from the State Water Project, adding Central Valley Project water in the 1980s. Imported water is stored in the underlying aquifer for water supply via surface water infiltration in the Bob Gross Groundwater Recharge Ponds and then by percolation into the stream bed. As natural stream flow recedes, imported water is released for infiltration into the creek bed from the ponds downstream to the Mabury Road bridge.

Step 1
Pre-Workshop

Future Drivers

The factors affecting flooding within Upper Penitencia Creek, as well the drivers of physical and ecological processes within and adjacent to the creek, are dynamic. Regional climatic changes coupled with continued changes in physical landscape characteristics and processes have the potential to cause serious infrastructure damage during storm events and result in costly maintenance. Here, we consider several features and processes that are expected to change in the coming decades and their possible effects on flood flows and channel conditions.

CLIMATE CHANGE

Climate change will likely affect the frequency and intensity of storm events, leading to changes in flooding, sediment transport, and erosion dynamics. Over the past century, the frequency and magnitude of extreme precipitation events in the San Francisco Bay region have increased significantly (Russo et al. 2013), with wintertime extreme precipitation events increasing by over 20% between 2001 and 2013 (Prein et al. 2017). Future projections for the region suggest that continued climate change could result in more years with intense storms, causing an increase in flood risk during midwinter months (Dettinger 2011, Flint and Flint 2012, Swain et al. 2018). More large flood events would cause increased channel erosion, an increase in sediment delivery to Upper Penitencia Creek and downstream to Coyote Creek, and could cause an overall increase in storm-related damage to infrastructure within and adjacent to the channel. This could also have negative impacts on winter refuge from high storm flows for steelhead, lamprey, and other aquatic species that overwinter in Upper Penitencia Creek.

Along with changes to precipitation dynamics, climate change is expected to bring higher air temperature, which will affect vegetation conditions that, in turn, will impact flow and sediment dynamics. Recent climate modeling for the region suggests that, regardless of the carbon emission scenario considered, the annual maximum air temperature in the latter half of this century will be at least around 0.5 ºC (0.9 ºF) higher than the latter half of the 20th century (Weiss et al. 2013). Climate models also agree that summers in the region will be longer and drier in the future than in the past, with potential evapotranspiration and associated deficit in soil moisture for plants predicted to increase up to 30% in some areas by the end of this century (Flint & Flint 2012). These temperature changes could cause an overall increase in wildfire risk and a shift to smaller, more sparse vegetation assemblages, further increasing runoff and sediment delivery during future wintertime storm events. In addition, increased summertime air temperatures would lead to increased water temperatures, which could decrease habitat quality for rearing steelhead, lamprey, and other native fishes.

WATERSHED MANAGEMENT

Land management may also have a big effect on future flow and sediment dynamics in Upper Penitencia. For example, management decisions for the properties in the upper watershed could have direct impacts on channel conditions in downstream reaches. Climate change impacts to flood flows and sediment delivery could be exacerbated by shifts in vegetation type, impervious area, and land use type (e.g., shifts from managed forest to open rangeland). Conversely, implementing more green infrastructure (GI) and low impact development (LID) features along the developed portion of the creek would increase infiltration and help offset increases in runoff from upstream due to land use changes and climate change impacts. The District and the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) are in the process of developing a Storm Water Resource Plan that will include identification of GI projects adjacent to Upper Penitencia Creek that can help decrease runoff.

In addition to land management decisions, water management strategies can also play a role in future channel conditions. Increased dry season evapotranspiration associated with climate change, combined with a projected population increase in the area, may result in the need to infiltrate more water into the groundwater basin below Upper Penitencia Creek. This could require building new on- and off-channel infrastructure that would need to be protected from flooding, which could cause changes in local flood hydraulics that lead to the need for additional flood protection in downstream reaches.

NEW CHANNEL FORMATION DURING 2017 FLOODS IN THE MABURY BYPASS

Step 2
At Workshop

Recommendations from the Science Advisory Hub

The recommendations presented here focus on long-term, holistic landscape management actions within the Upper Penitencia Creek watershed that benefit people and wildlife, and those that will enhance resilience to changing climatic conditions. These recommendations were brought forward by the Science Advisory Hub during the March 2017 workshop, and were informed by presentations and discussions at that workshop. The physical processes and ecological functions the Hub identified cross property and jurisdictional boundaries, so implementing actions that address these recommendations will require coordination among many parties. Some of the recommendations below relate to on-the-ground infrastructure, while others call for planning and coordination among partners and stakeholders.

SUPPORT PHYSICAL DRIVERS OF ECOLOGICAL FUNCTION

Management actions should work with natural physical processes, such as sediment transport and groundwater recharge, which in turn support key ecological functions such as persistence of healthy food webs.

SEDIMENT DEPOSIT AT BART / VTA RESTORATION AREA

Focus on the watershed scale when considering sediment management. Managing the supply of fine and coarse sediment to the channel impacts flood management as well as in-channel habitat. For example, decreasing the total sediment supply can help maintain flood flow capacity in some reaches, but may also decrease the quality of spawning and rearing habitat for native steelhead. Therefore, both coarse and fine sediment should be considered when developing a watershed-scale sediment management plan that addresses multiple objectives, as well as when developing and assessing specific projects. Example approaches could include replacing bridge culverts with bridge spans that allow sediment to move more freely, or analyzing grazing and road patterns in the upper watershed for effects on fine sediments.

Manage imported water to be more ecologically beneficial. The State Water Project and Central Valley Project water supply can be unpredictable from year to year, and may change considerably in the future. The supply is very dependent on the amount of wintertime precipitation, and operations lie mostly outside the control of the District. Currently, a portion of the creek bed is used as a recharge facility during summer months, which has effects on instream water quality and biota, such as allowing persistence of non-native warm-water fish (SCVURPPP 2017). Flows could be released in a manner that better supports native fish and riparian vegetation while still meeting local water supply needs.

Support habitat for native wildlife. The District and its partners have the opportunity to take an integrated ecosystem perspective that can balance wildlife, flood risk management, and recreation in the Upper Penitencia Creek corridor. Using an understanding of historical, contemporary, and projected future conditions as a guide, they can use management techniques that support natural streamflow and sediment transport and enhance habitat for native plants and animals.

STEELHEAD TROUT (*ONCORHYNCHUS MYKISS*)

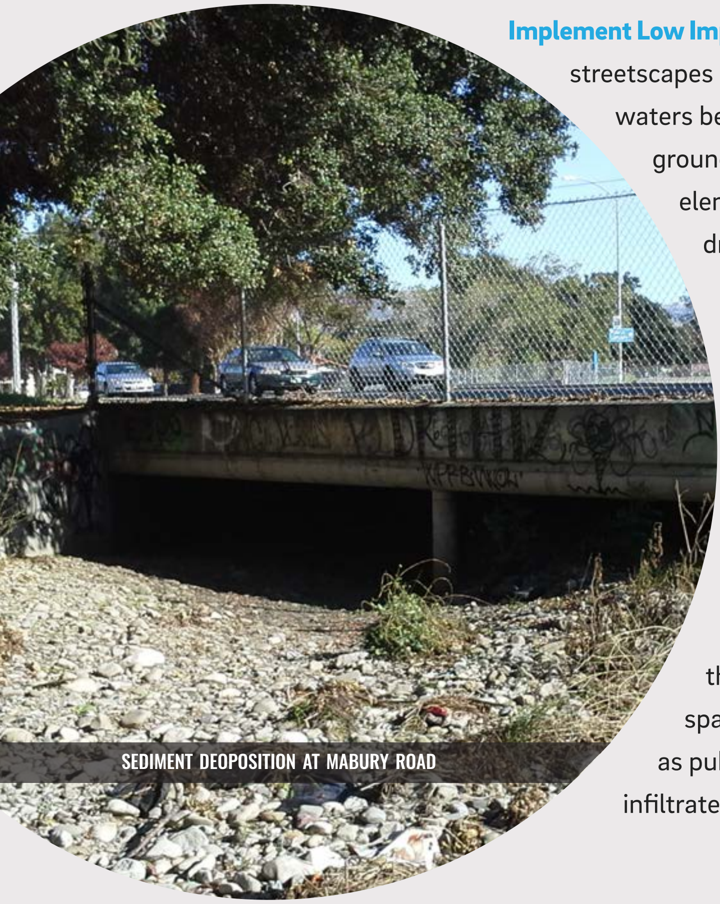
Enhance wildlife habitat patches and connectivity with corridors and nodes. Functional connectivity for wildlife can be enhanced with a combination of 'nodes,' larger areas that can support a variety of habitat functions for wildlife, and narrower wildlife-friendly riparian corridors that provide connectivity between nodes. Together, the nodes and connecting riparian habitat support greater species diversity and resilience to climate change (Koen et al. 2014; Heller and Zavaleta 2009). Management actions within nodes could include replacing non-native trees with natives such as oaks, willows and sycamores, expanding wooded areas, planting more multi-layered vegetation, and making room for wildlife by moving trails away from sensitive areas.

Enhance steelhead habitat. There are opportunities to improve creek flow and sediment management to benefit steelhead. For example, Cherry Flat Reservoir releases could be modified to help with improving dry season water temperatures in the creek's bedrock reaches, thereby benefiting rearing steelhead as well as other native fish species. This could be an important way to buffer predicted future increases in summertime air temperatures and associated stream water temperatures.

Enhance urban ecology. Sycamores, oaks, and other native trees and shrubs could be planted in the urban areas adjacent to the creek. In addition to aesthetic enhancements and reinforcing a connection to a local 'sense of place,' such plantings would expand feeding and migration habitat for native wildlife such as birds (e.g., Acorn woodpecker (*Melanerpes formicivorus*)) and mammals (e.g., bats). This could include drought-tolerant plantings in parks and other public open space areas. Planting of drought-tolerant native species in yards and gardens of private residences could be incentivized through education, subsidies, and rebate programs.

MANAGE FLOOD RISK AND SEEK OPPORTUNITIES FOR FLOODPLAIN ENHANCEMENTS

It may be possible for the District and its partners to create and support landscape configurations that enhance both flood protection and habitats in the Upper Penitencia watershed.



SEDIMENT DEOPOSITION AT MABURY ROAD

Implement Low Impact Development (LID). Incorporating LID elements into streetscapes and other urban developments would slow, sink, and filter surface waters before entry into the river and stormwater systems, help recharge groundwater, and provide neighborhood and habitat amenities. LID elements that should be considered include rain gardens, vegetated drainage swales, and permeable pavement.

Consider variable riparian widths. The widths of riparian areas protected from development encroachment could be determined based on desired riparian function, such as surface water filtration, stream shading, and terrestrial and aquatic habitat. There are tools that can be used to help the District and its partners to determine riparian functional width along the creek (e.g., the Riparian Zone Estimator Tool (RipZET)).

Expand flood storage capacity. Current flood storage capacity along the creek could be expanded by utilizing the area of existing open space next to the creek that regularly floods. Open space areas such as public parks and school athletic fields could be configured to capture, infiltrate, and release wintertime flood flows.

BOB GROSS GROUNDWATER RECHARGE PONDS ARE DRY IN THE SUMMER MONTHS AND ARE PERIODICALLY DRAWN DOWN FOR MAINTENANCE

ENVISION AND PREPARE FOR FUTURE CONDITIONS

For the San Francisco Bay Area, climate models suggest that in 50 years, there is likely to be an increase in precipitation variability and large storm event frequency (Flint and Flint 2012). Multi-benefit management strategies need to account for this uncertainty in the Santa Clara Valley water future.

Conduct scenario planning. Use models to assess runoff, flow discharge, flow stage and velocity, and sediment transport for a suite of management scenarios and climate predictions. The output can be used to spark discussions among stakeholders regarding the range of options that meet management objectives and promote landscape resilience. Engaging local stakeholders early in scenario planning can reveal project feasibility, cost and benefit tradeoffs, and optimize ecological and economic outcomes (Lester et al. 2013).

STUDENTS WALKING IN PENITENCIA CREEK PARK

Invest in LID. In addition to helping filter runoff and recharge groundwater, LID elements can slow runoff and help delay the time to reach peak storm discharge (i.e., decrease storm 'flashiness'), which would help maintain overall channel stability and prevent excess erosion.

Step 2
At Workshop

KEY MANAGEMENT CONSIDERATIONS
for Project Reaches

OVERVIEW

Reach 1

At the confluence with Coyote Creek, the lower portion of the reach forms a series of pools and riffles within a confined channel that flows through an area that is almost entirely paved. Flow is perennial near the confluence and intermittent in the upper section of the reach, which has recently been restored.

Reaches 2 & 3

These reaches include road crossings that affect sediment and flow at King, Mabury, Jackson, and Capitol Roads, and Highway 680. The Mabury bypass channel and gaging weir are located here. County and Mabury Parks attract picnickers and walkers. This reach dries in the summer until flows of imported water are released for groundwater recharge.

KEY CONSIDERATIONS

Reach 1

- Infrastructure includes BART/VTA station, and road crossings.
- The channel downstream of the BART/VTA station and mitigation area is confined by Berryessa Road to the north and pavement to the south, and has experienced flooding and water quality issues.
- Redevelopment of the paved flea market area is zoned for mixed commercial and residential uses.
- The confluence with Coyote Creek is currently narrow and confined by road infrastructure, which poses a barrier to flows and terrestrial wildlife movement.

Reaches 2 & 3

- Weirs near Mabury Road currently divert high flows into a bypass channel.
- The creek enters an area overlying a confined groundwater aquifer, the "confined zone," downstream of Jackson Avenue. Flows within this lower zone do not recharge the aquifer.
- Coarse sediment builds up under road crossings and is periodically removed to maintain channel capacity.
- Several uncertified levees or earthen berms confine flows.
- Open spaces and park lands provide opportunities for floodplain restoration.
- Creek areas and parks provide camping areas for homeless people.
- Historical floods have affected the suburban areas surrounding the creek.

Reaches 4 & 5

These reaches contain two schools, a nature center, and Penitencia Creek Park. Helmsley, Capitol, and Penitencia Park Ponds are located here. Several roads and driveways cross over the creek within these reaches, including at Capitol Avenue, Viceroy Way, and Piedmont Road. Located in the unconfined groundwater zone, these reaches dry down in the summer until flows are released for groundwater recharge.

- Roads and driveways constrict flows of water and sediment.
- Open spaces in these reaches include Penitencia Park, and County lands east of East Side Union High School District offices.
- An underground canal conveys water from Penitencia Ponds to Helmsley and Capitol Ponds.
- Riparian corridor supports habitat for fish and other wildlife, as well as aesthetic value.
- A gaging station is located just downstream of Piedmont Road.
- Single and multi-family residences are the main developments in these reaches.
- Historical flooding has affected Capitol Avenue, Penitencia Creek Road, and Viceroy Way.

Reaches 6 & 7

These reaches, located in the unconfined groundwater zone, generally flow perennially upstream of Noble Drive and host a high concentration of California sycamores. These reaches contain critical water supply infrastructure. Roads cross the creek at Noble Avenue, Dorel Drive, and along private roadways.

- South Bay Aqueduct flows augment groundwater, entering the creek through a screened inlet from Bob Gross Pond 1.
- Overflow from Bob Gross Pond 3 occasionally enters the creek, affecting water quality and increasing temperature; non-native species introductions are possible because it is unscreened. Floodwaters from the creek can back up into the pond.
- At Noble Avenue, a flow diversion canal connected to the Bob Gross Ponds is no longer operating. A non-functional fish ladder at the diversion is collecting sediment. A gaging weir records high and low flows.
- Historical flooding has affected neighborhoods along Penitencia Creek Road.

Upper Reaches

The upper watershed of Upper Penitencia Creek mainly drains rangeland, with sparse development. Current land use is primarily cattle grazing, with recreational opportunities for hiking and walking.

- Cherry Flat Reservoir captures flow from only a small portion of the watershed, while Arroyo Aguague has natural flow and sediment transport downstream to Upper Penitencia Creek.
- Alum Rock Park attracts visitors.
- Waterfalls in Alum Rock Park form a natural barrier to fish migration.
- Native sycamores form an important portion of the riparian community in the lower segments of these reaches.

GRASSLAND AND MIXED RIPARIAN FOREST IN THE MABURY BYPASS AREA, UPPER PENITENCIA CREEK

Step 3
Post-Workshop

Multi-benefit Landscape Vision

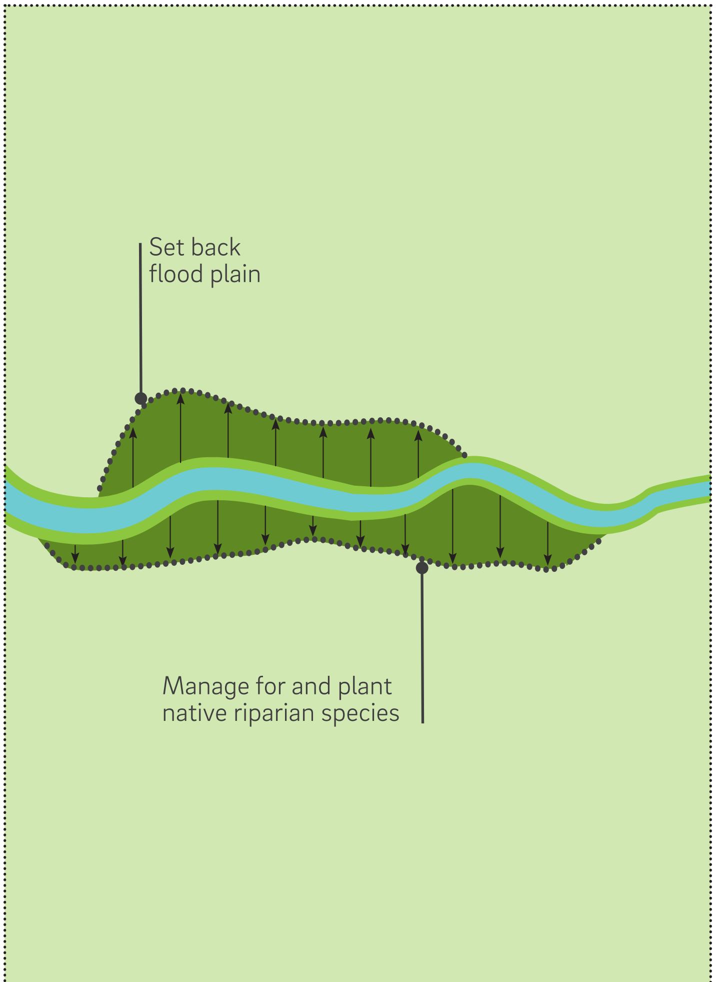
for Upper Penitencia Creek

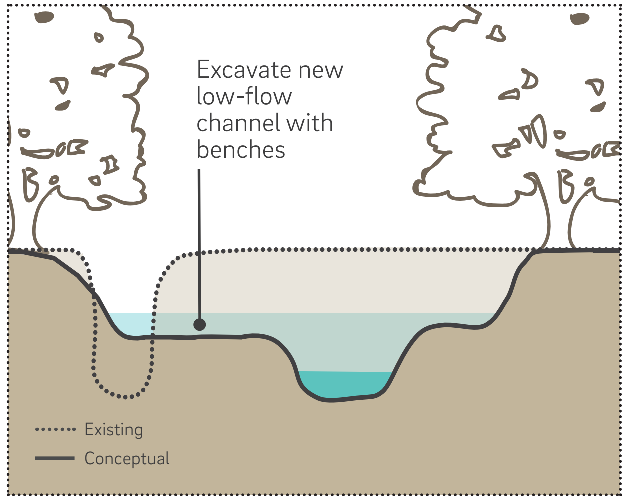
The concepts presented here were brought forward through the District-led charrette brainstorming sessions, and were reviewed during the second Science Advisory Hub workshop. They are meant to address flood management needs for Upper Penitencia Creek while helping fulfill a holistic landscape vision guided by the Hub recommendations. The concepts focus on the creek corridor and take into account the key constraints presented earlier. Additional considerations for potential actions and management in Upper Penitencia's upper watershed are also presented.

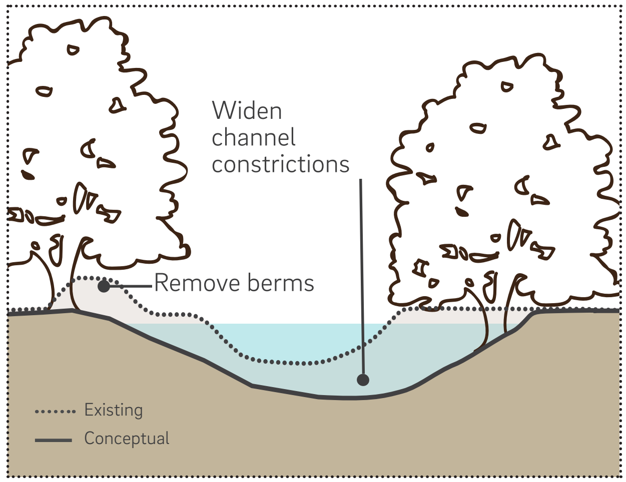
The concepts fall into two major types of landscape measures, with opportunities to pursue some of them in multiple places along the Upper Penitencia Creek corridor. The riparian enhancement measures include various new configurations for the creek channel, including levee and berm setbacks, excavation of flood benches, and vegetation management to benefit wildlife. Measures for expanding flood storage capacity include detention basins that can serve recreational purposes when these features are not inundated.

Pursuing any of the concepts will require a collaborative decision-making process with Tri-Party partners and local landowners, and the benefits they would convey to flood risk management, habitat improvement, recreational opportunities, and water supply will need a thorough analysis.

LANDSCAPE MEASURE: RIPARIAN SETBACKS AND ENHANCEMENTS







Description

Expand Floodplain

- Excavate flood benches
- Set back levees

Enhance Riparian Habitat

- Create or improve willow, sycamore, oak savanna habitats; incorporate a shrub layer
- Manage non-native species such as eucalyptus

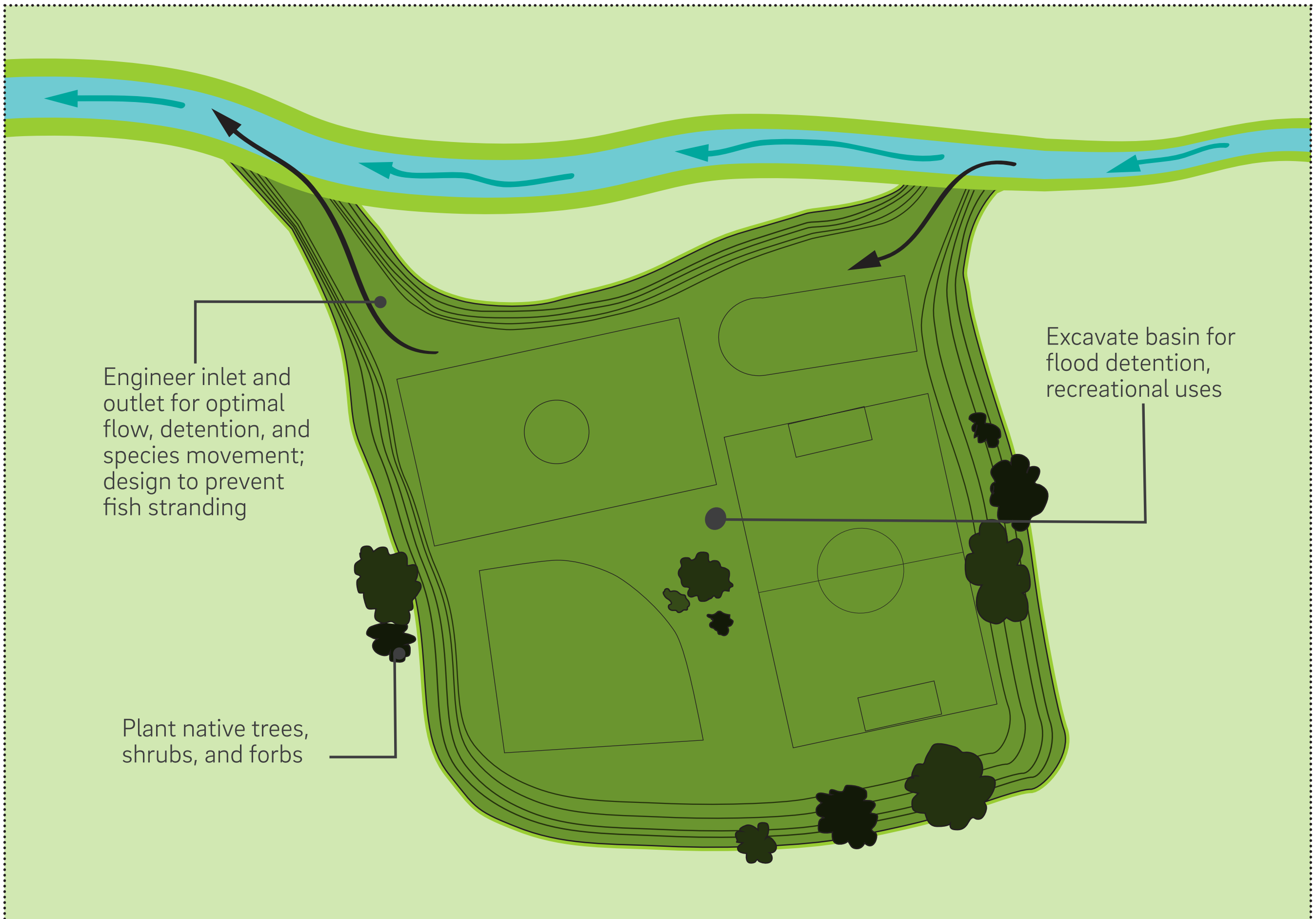
Enhance Recreation

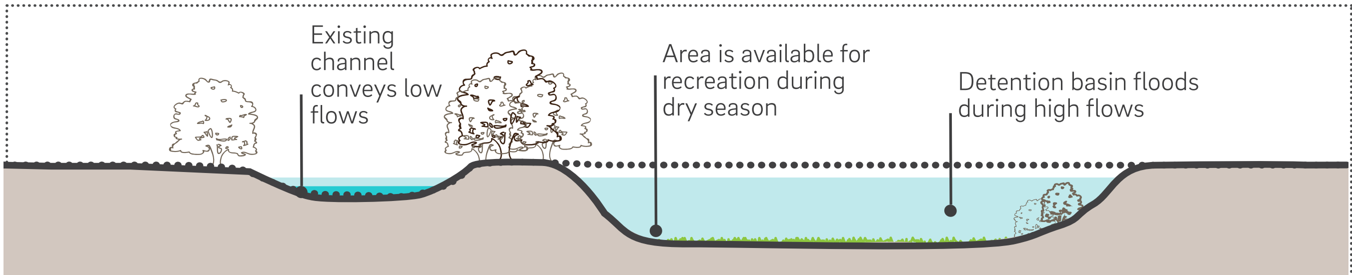
- Complete trail system and provide informational signage

Key Benefits

- Utilizes open spaces for flood protection
- Allows greater infiltration of flood flows
- Preserves and enhances riparian functions and wildlife habitat
- Preserves and enhances recreational uses
- Enhances sediment movement to benefit fish rearing habitat, and provides high-flow refuge habitat

LANDSCAPE MEASURE: MULTI-BENEFIT OFF-CHANNEL DETENTION





Description

Create Basin

- Create basin below existing grade, with engineered side slopes
- Provide recreational oppotunities, such as sports fields

Enhance Habitat

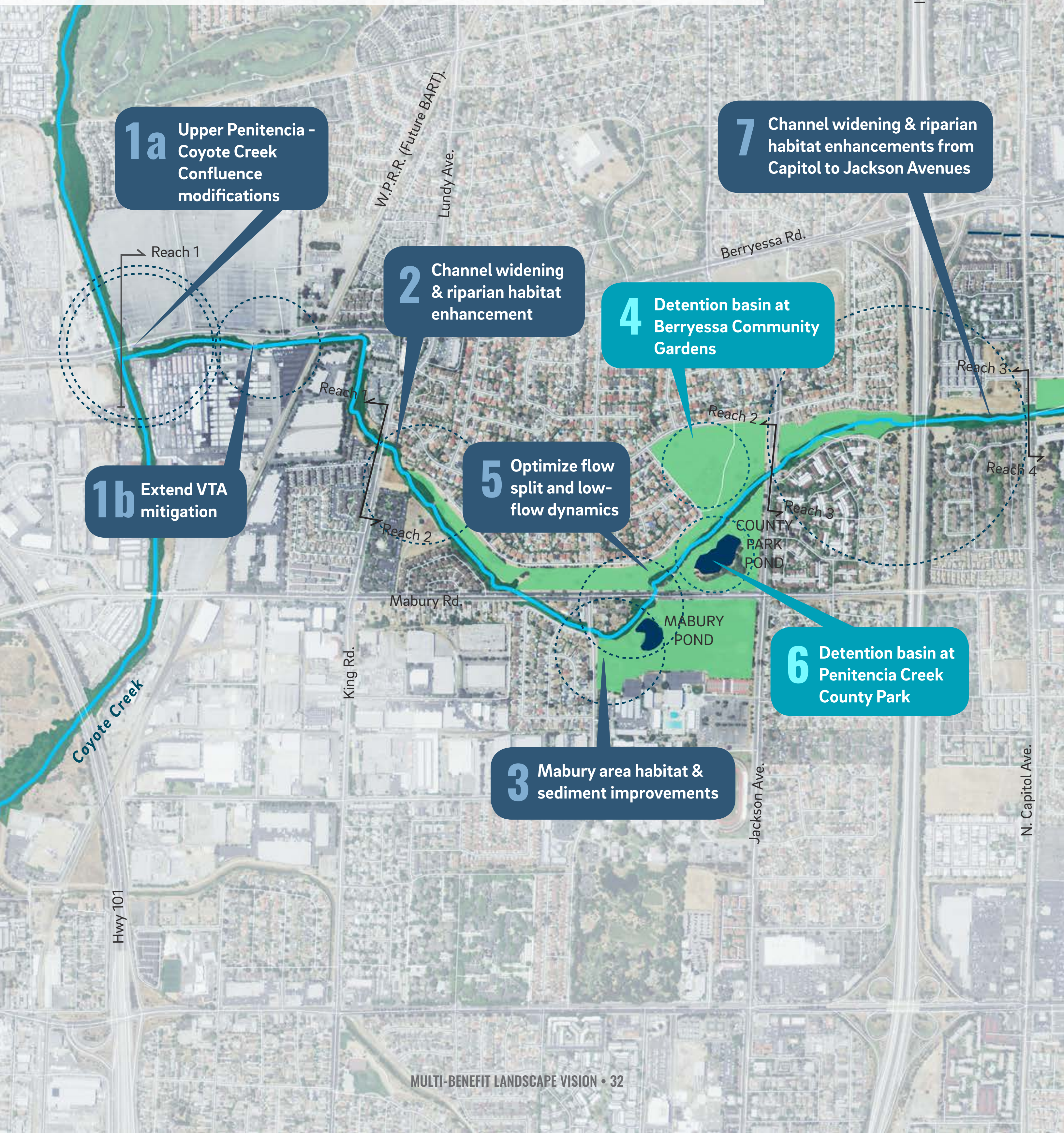
- Plant native trees and shrubs where possible
- Manage non-native species

Key Benefits

- Reduces flookd risk
- Provides temporary flood storage and infiltration
- Provides opportunity to create a sports field amenity for the school and community
- Enhances habitat within basin

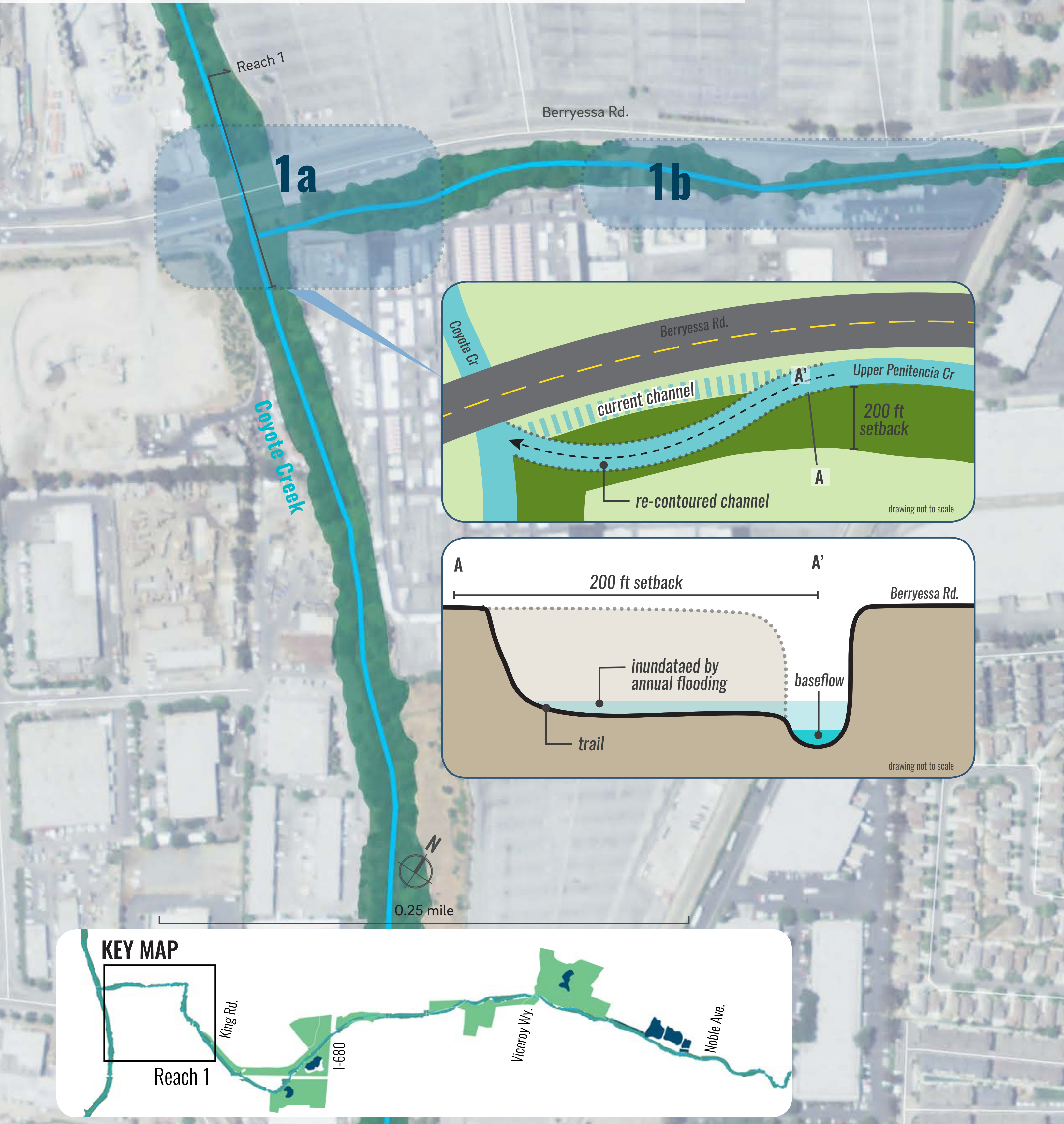
Step 4
Vision

OVERVIEW of LANDSCAPE VISION CONCEPTS




9 Channel widening & riparian habitat enhancement between Piedmont Avenue and Viceroy Way
CAPITOL PONDS
HELMSLEY POND
10 Detention basin at Penitencia Creek Park
PENITENCIA CREEK PARK
Reach 4
Reach 5
Piedmont Rd.
12 Water supply preservation
Reach 6
BOB GROSS PONDS
PIEDMONT PONDS
13 Detention basins
Upper Penitencia Creek
Reach 5
Reach 6
Noble Ave.
Reach 7
Dorel Dr.
Penitencia Creek Road
Reach 7
8 Sports field and detention basin at Santa Clara County property
11 Detention basin at Piedmont
Toyon Ave.
Upper Reaches
N. White Rd.
14 Channel widening & riparian habitat enhancement
15 Connect Alum Rock Park and Penitencia Creek Trails
N
Legend
Riparian enhancements and in-channel improvements
Multi-benefit off-channel detention
Water supply preservation
Recreation enhancement

Concepts for Reach 1



1a Confluence modifications:
Redesign channel at confluence with Coyote Creek

Channel Modifications

Widen the channel within a ~200 ft setback area, incorporating a more sinuous, compound channel form, incorporating a low-flow channel and high-flow bench; remove in-channel concrete and fill to provide enhanced flood protection to proposed development near the confluence with Coyote Creek. Investigate possibility of rebuilding bridge over Coyote Creek just downstream of confluence to improve flow and sediment transport capacity.

Stream Habitat Improvements

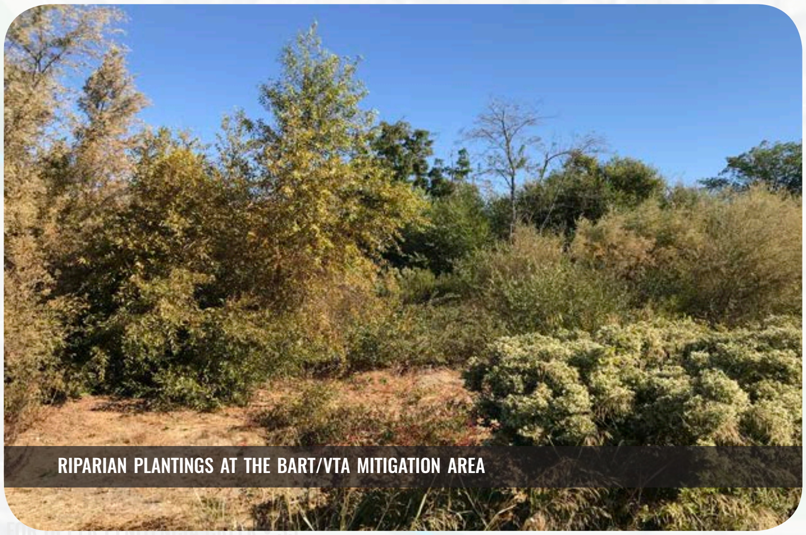
Within the confluence setback area, create or improve perennial stream habitat with native willows, sycamores and oaks, including a shrub layer; manage non-native species such as eucalyptus (*Eucalyptus globulus*) and giant reed (*Arundo donax*) to provide improvements in connectivity for sediments, water flow, and wildlife between Upper Penitencia and Coyote Creeks. Provide instream structures, e.g., large woody debris, to improve fish habitat.

Pedestrian Trail Extension

Connect Coyote Creek and Upper Penitencia Creek trails within setback area to provide enhanced recreational opportunities. Consider limiting trail to one side of creek to provide wildlife corridor on the opposite side.

1b Extend habitat improvements:
Extend stream mitigation design

Modeled on the successful upstream BART / VTA mitigation, continue channel improvements to downstream areas, including incorporation of riparian setbacks, native plantings, invasive plant management, and sediment management to enhance habitat and water quality.



RIPARIAN PLANTINGS AT THE BART/VTA MITIGATION AREA

Concepts for Reach 2

2 Channel widening and riparian habitat enhancements

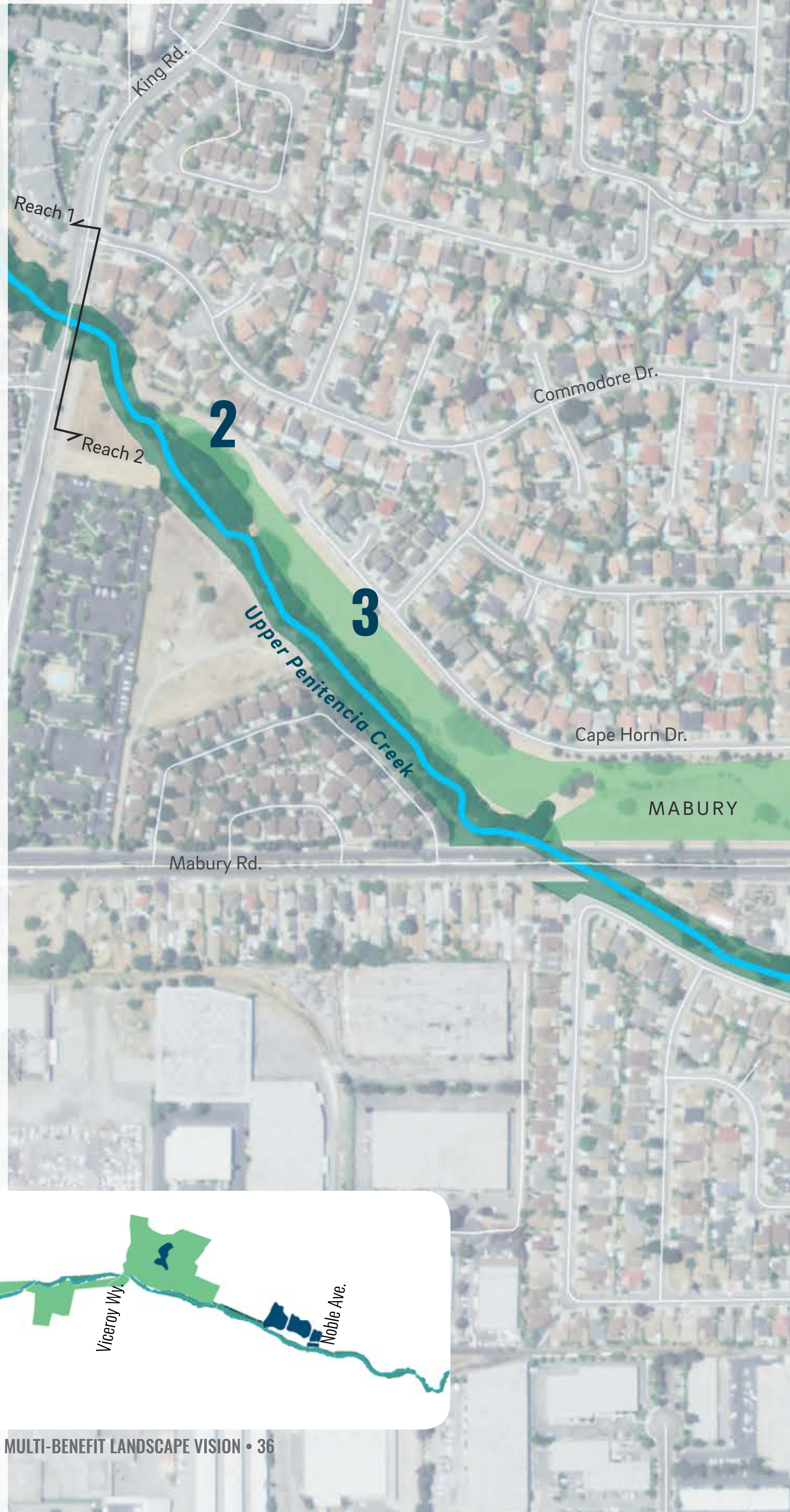
Channel widening
To address sediment aggradation in this reach, expand floodplain area within a wider setback and consider expanding openings under bridges (including partnering with the City of San José on redevelopment of King Rd bridge). These actions would improve flow and sediment transport during flood events, improve passage for migrating steelhead and other fish, and enhance in-channel terrestrial wildlife migration and dispersal.

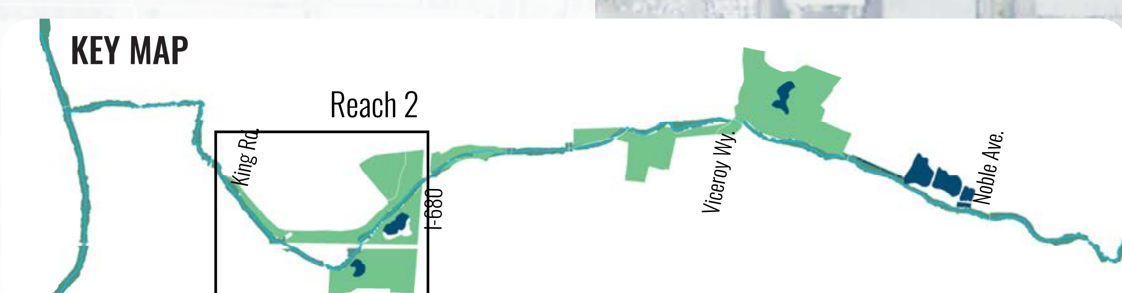
Near-channel vegetation enhancement
Improvements to the riparian zone should include enhancement of sycamore habitat and additions to the shrub layer, with benefits to terrestrial and aquatic wildlife. These improvements should take place in the context of managing vegetation for flood conveyance.

3 Mabury area habitat and sediment improvements

Promote California sycamore cover
Within open spaces between King Road and Jackson Avenue, increase proportion of native canopy and understory cover within the riparian zone to promote native wildlife diversity and improve wildlife habitat. Plant California sycamores and native shrubs such as elderberry and coyote brush as part of this effort.

Design sediment management strategy
Implement a strategy that focuses on local sediment reuse instead of hauling sediment elsewhere to decrease sediment disposal costs and increase sediment available for local in-channel habitat restoration and maintenance.





4 & 6 Multi-use flood detention basins

Flood detention basins could be engineered to work together, filling and draining sequentially as flood stages rise and fall. Potential fish stranding as floods recede can be addressed by designing a connection that allows for proper drawdown sequence from basins, and proper connection of basins to the channel.

Berryessa Community Gardens

Working with partners and landowners, engineer a flood detention basin that also serves desired recreational uses.

Penitencia Creek County Park

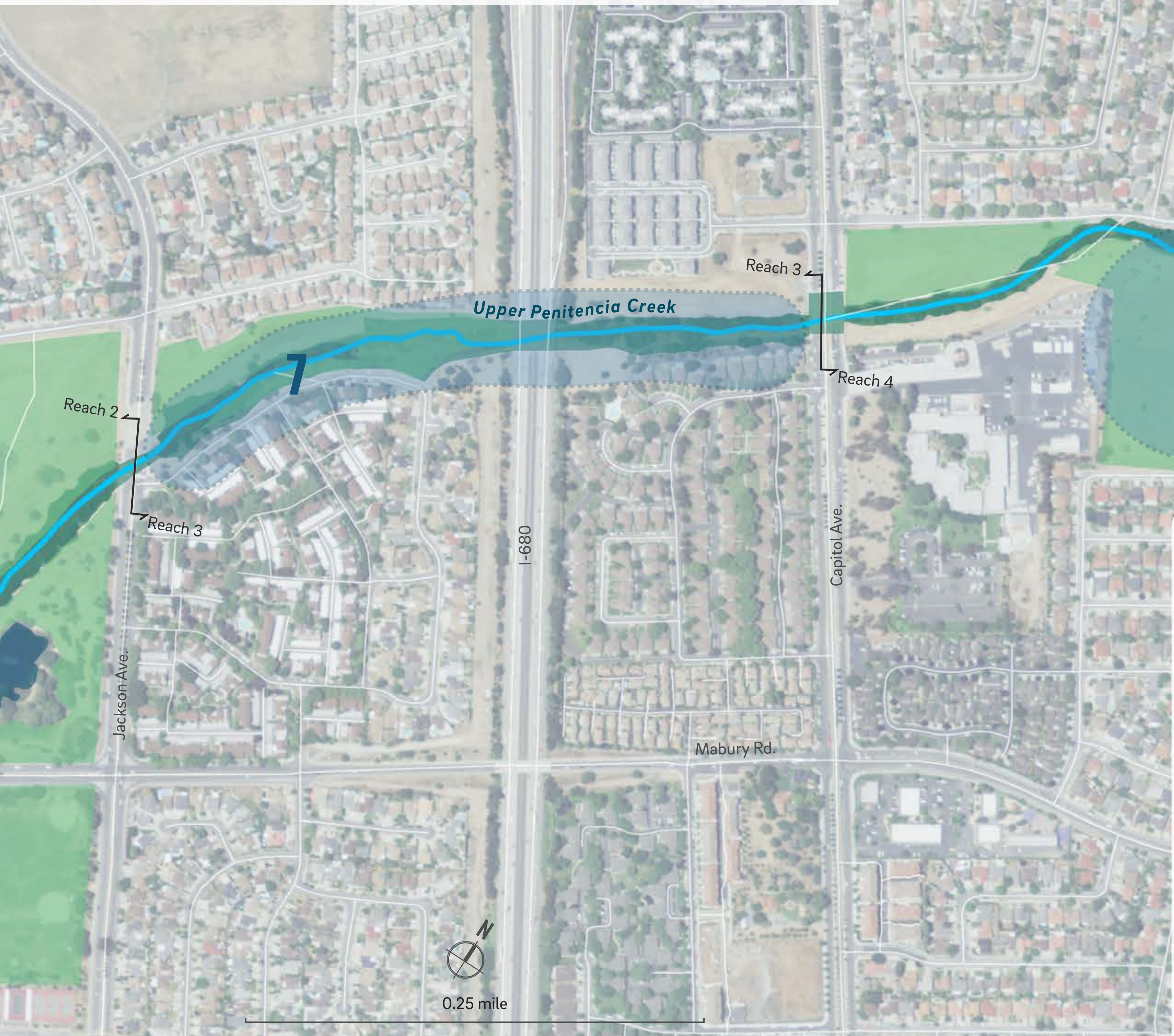
Lower floodplain around the existing pond to increase flood detention capacity, improve the connective pipe that fills this pond, and provide a sediment settling basin. Construct berm surrounding the park boundary to provide flood protection to the surrounding area.

5 Optimize flow split and low-flow dynamics

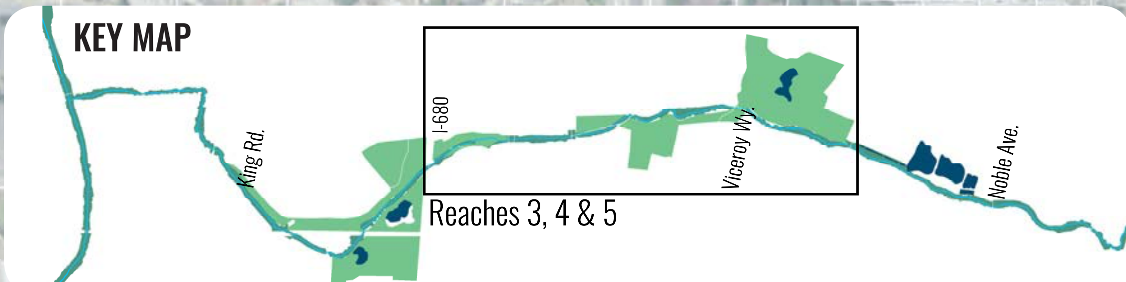
Flow split and low-flow dynamics

This reach accumulates sediment and has an engineered weir separating Upper Penitencia Creek from the Mabury Bypass (which currently serves as a secondary, high-flow channel). Establishing a low-flow connection from the Creek to the Bypass and planting riparian vegetation along both channels could improve dry season aquatic habitat conditions and increase riparian habitat for native wildlife. Earthen berms that prevent flows from entering the open space area south of Mabury Road, and that cause the channels to fill with sediment could be removed to improve flow conditions through the reach. Consider different designs for the channel split to increase flood conveyance. Redesign flow conveyance of imported water to Mabury Pond.

Concepts for Reaches 3, 4 & 5



KEY MAP



7 & 9 Channel widening and riparian habitat enhancements

From Capitol to Jackson Avenue

Reconfigure channel and adjacent floodplain so that floodplain is inundated under modest flood events (e.g., 5-year flood event), decreasing downstream flood impacts and increasing refuge habitat for fish during flood events. Create wider channel with flood benches; place large woody debris and cobble/boulder features within the channel near Highway 680 underpass to increase velocity refuge and cover habitat for steelhead and other fish as well as increasing sediment deposition and overall habitat complexity.

Between Piedmont Road and Viceroy Way

Create levee setbacks and explore channel configurations that include benches and low-flow channels to improve flood capacity; manage non-native species and promote native oak and sycamore communities to promote native wildlife.

8, 10, 11 Create multi-use flood detention basins

Flood detention basins could be engineered to work together, filling and draining sequentially as flood stages rise and fall. Potential fish stranding as floods recede can be addressed by connecting basins to the channel.

Santa Clara County Property

Working with partners and landowners, engineer a flood detention basin to increase flood retention that also includes recreational uses like a collection of sports fields. Lower the floodplain elevation and use the public trail to move flood waters to the basin. Native trees and shrubs can be incorporated into edge plantings. Optimize flow to and from the site so inundation only occurs during certain flood intensities, and so that flood waters recede reasonably quickly.

Penitencia Creek Park

Build a flood detention basin to provide temporary storage during high-intensity flood events, and preserve or re-create trail system that serves desired recreational uses; consider adding sports fields to this area. Vegetate with native trees and shrubs where appropriate.

Piedmont Basin

Further excavate a natural basin south of Piedmont Middle School for flood detention, and investigate infiltration capacity of this area. Consider this area for sports fields or riparian vegetation enhancement.

Concepts for Reaches 6 & 7

12 Flood storage enhancement and water supply mitigation at Bob Gross Ponds

Recontour the area south of the existing Bob Gross Ponds to serve as a new detention basin separate from the existing ponds in order to increase flood storage capacity. As mitigation for water supply impacts, investigate whether expanding the ponds to the north to retain recharge capacity is feasible from geotechnical, engineering, landowner, and partnership perspectives. New features should be planted with native trees and shrubs, and drainage of the basins should be designed to prevent fish stranding.

13 Bob Gross Ponds area habitat improvements

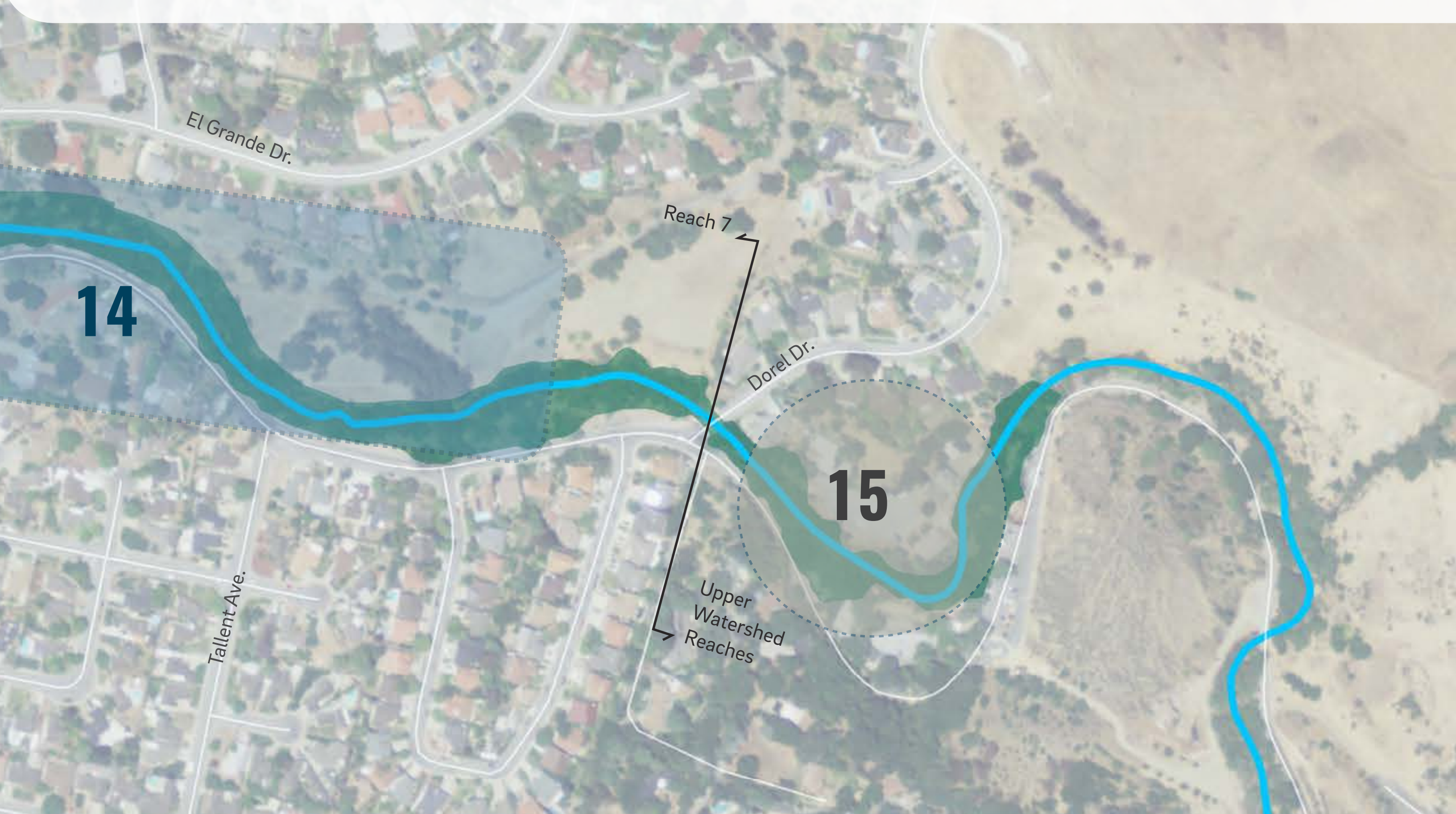
Along approximately half a mile, expand channel width and excavate a lower-flow channel, designing a flood bench to flood at the 10-year storm interval. This flood bench can be planted with native species, and vegetation in the surrounding area can be managed to promote native species. Monitoring of the channel for fish and wildlife use will be important as the channel evolves through flood events.

14 Channel widening and riparian habitat enhancements

Restore the stream to a riffle-pool configuration by removing an inoperable concrete fish ladder, and widen the stream channel by removing a berm that separates the unused Noble diversion canal from the stream to benefit native fish. Investigate increasing the flow and sediment transport capacity of an aging bridge at Noble Avenue, working with partners and landowners.

15 Connect Alum Rock Park and Penitencia Creek Trails

Connect the last remaining section of the Penitencia Creek Trail to Alum Rock Park upstream of Dorel Drive to provide pedestrians with continuous access from Coyote Creek to the park. Preserve and maintain native vegetation, while managing non-natives to benefit terrestrial and aquatic wildlife.



MEASURES to consider for the **UPPER WATERSHED**

In the upper watershed, upstream of Reach 7, there is the potential to modify the delivery of flow and sediment to downstream reaches in a manner that benefits flood risk management and habitat conditions under a changing climate. Here we present a few examples of management measures in the upper watershed that should be further explored.

High-flow management

There are several options for decreasing flood flows from the upper watershed that should be considered in conjunction with the concepts shown earlier for Reaches 1 through 7. Working with partners who own and operate land in the upper watershed to convert open grassland areas back to forests would increase rainwater infiltration into the soil and help decrease flows for modest flood events. In-channel and floodplain storage of flood flows could be enhanced through the strategic placement of large woody debris (LWD) to slow down flow, and through improving channel-floodplain connectivity to get flood flows onto floodplains (e.g., at the downstream end of Alum Rock Park). Slowing flow through LWD placement could also provide benefits for steelhead. For example, LWD installation has been recommended in Alum Rock Park to slow high flows for improving steelhead passage conditions (Balance Hydrologics 2018). In addition, there could be opportunities to install in-channel structures designed to impede flows above a given discharge and decrease peak flood flows downstream. This type of approach to high-flow management is being considered elsewhere in the Bay Area (e.g., Mount Diablo Creek).

Sediment management

As discussed earlier, climate change could cause a shift in vegetation assemblages and an increase in large storm frequency, which combined could increase sediment delivery from the upper watershed to downstream reaches. As with high-flow management, options for managing future sediment supply from the upper watershed include changes to land use and channel-floodplain characteristics. Establishing more forested areas in the upper watershed could decrease rates of hillside erosion and sediment production, particularly along road cuts and in areas with erosive underlying geology (Stillwater Sciences 2008). Installing LWD to slow flow in upper watershed reaches could also decrease bedload transport rates, thereby causing localized in-channel coarse sediment deposition. Increasing channel-floodplain connectivity during high flows could increase the amount of fine sediment delivered to and deposited on upper watershed floodplain areas, which in turn could help modulate fine sediment delivery to reaches downstream.

Reservoir operation

Currently, Arroyo Aguague supplies perennial flows to Reach 7 during most years. Releases from Cherry Flat Reservoir, owned by the City of San José and located on Upper Penitencia Creek approximately 2 miles upstream of the confluence with Arroyo Aguague, have historically augmented flows through Alum Rock Park and kept dry season creek water temperature cooler, especially in drought years (SCVHP 2012). The operation of the reservoir should be revisited for improved aquatic habitat support, including options for mimicking a more natural hydrograph. Options for reservoir dredging to increase water storage should also be explored. More storage would increase the volume of cool water available for augmenting flows in the summer, which are expected to be longer and hotter in the future due to climate change. In addition, dam removal options should also be considered, since the capacity of this reservoir is relatively small and it therefore does not provide much flood risk management benefit.

Known Constraints and Uncertainties

The landscape vision presented in this report explores flood and water supply management, human recreational, and ecological benefits associated with modifications to the Upper Penitencia Creek corridor. Implementation of any of these concepts will need to include consideration of a number of common constraints, including:

PROPERTY ACCESS AND OWNERSHIP

In many cases, implementing the concepts presented in this landscape vision would require changes in lands that are currently private property, or operate under legal provisions that dictate certain land uses, including the provisions within the Tri-Party Agreement. Coordination with and agreement among property owners for both implementation and maintenance of current or future infrastructure will be essential to implementing any multi-benefit concept.

CLIMATE CHANGE

Current climate change predictions forecast a future with higher air and water temperatures, a higher frequency of intense storm events, more intense periods of drought, and increases in wildfire potential. Together, these factors could affect sedimentation and erosion patterns, vegetation condition and composition, as well as humans and wildlife in unpredictable ways. Increased coordination and cooperation will be needed to face these challenges.

REGULATORY CONSIDERATIONS

Consultation with permitting agencies will be essential to the development and implementation of concepts that the District and its partners wish to pursue, and appropriate permits will need to be sought. This includes early coordination with staff at the California Department of Fish and Wildlife, the San Francisco Bay Regional Water Quality Control Board, the US Army Corps of Engineers, and the National Marine Fisheries Service. Measures related to channel widening and modification and the building of flood retention basins will be especially relevant to these agencies given the high value of the creek's habitat to steelhead and other native fishes.

INFRASTRUCTURE MODIFICATIONS

Some of the concepts include redesign of in-channel or other infrastructure, including potential redesign of bridges, culverts, or dams. The effects of the modifications of such infrastructure will need to be a part of engineering analyses, and their feasibility will depend on the age, type, and ownership of the affected infrastructure.

GROUNDWATER RECHARGE

As part of the District's mandate to supply water and sustainably manage groundwater (per the District Act and Sustainable Groundwater Management Act or SGMA), potential impacts on groundwater recharge operations would have to be thoroughly investigated to ensure that water supply is preserved. Proposed concepts that affect the function of the Bob Gross Ponds, or concepts that would change the delivery of water within the stream channel would need to be analyzed in-depth for their effects on the quantity and quality of surface water infiltrated into the groundwater basin for potable water use.

PUBLIC USES OF PARKLANDS AND CREEK CORRIDOR

Parklands and open spaces along Upper Penitencia Creek currently support a wide variety of activities for the public, including walking, biking, picnicking, the enjoyment of nature, community gardening, and use for sporting events. The open spaces are also used by people without other means of housing, and there are several homeless encampments within the creek corridor. Changes to the use patterns and configurations of the parklands and creek areas will require early communication with current and potential future users of these open spaces.

INTEGRATION WITH EXISTING PLANS

For many concepts within this landscape vision to be achieved, they will need to abide by the provisions of the existing Tri-Party Agreement between the District, the City of San José, and the County of Santa Clara. Significantly, redevelopment of the confluence area near the new Berryessa BART station is in the planning phase and is highly relevant to the concepts proposed for this area. Enhancements in Upper Penitencia Creek could contribute to achieving the Valley Habitat Authority's (VHA) conservation strategy for urban creeks; coordination with the VHA could benefit projects from design through permitting, to implementation phases. Additionally, plans for Upper Penitencia need to be integrated with upcoming planning for flood protection and habitat improvements along Coyote Creek, as well as the 2016 Groundwater Management Plan that was submitted for SGMA compliance and describes the need to preserve existing groundwater recharge.

ENVIRONMENTAL OUTCOMES

In addition to the above known constraints, it is important to recognize the unpredictability of the results of management actions. Even after the removal of a stressor (e.g., channel constriction), there is no guarantee that the system will return to conditions present before the stressor was introduced. This is due not only to the presence of factors other than the management action that also affect the stressor, but also because changes in the system that happen in tandem with or after the onset of the stressor can 'move' the system into a new baseline condition. Therefore an adaptive management process, in which changes are monitored to guide adjustments, is essential.

Moving Forward

The intention of this landscape vision is to provide the District, its partners, and adjacent landowners with an articulation of a potential future for management of the Upper Penitencia Creek that integrates support for natural processes with enhancements in flood risk management. The vision is intended to complement existing restoration and management plans in the vicinity by providing a perspective that incorporates a larger-than-usual view in space and time. Some of the concepts presented here cross jurisdictional boundaries and would require concerted and coordinated efforts among people living and working along Upper Penitencia Creek. Additionally, actions undertaken in Upper Penitencia can affect, or be affected by, events and management in nearby areas. The challenges of coordinating infrastructure and restoration projects can be outweighed by the synergistic benefits that such collaboration can yield, including improved habitat conditions, better near-term flood protection, and reduced implementation costs.

Translating the concepts presented in this document into management actions will be a complex effort, requiring a prioritization of potential projects, detailed technical analyses, and effective coordination among stakeholders. Implementation of projects that help achieve components articulated here could be implemented in phases as financial considerations, site constraints, and dependence on prior management and infrastructure decisions allow.

BUILD ON EXISTING PARTNERSHIPS

Strong local and regional partnerships will be the mainstay of successful implementation of projects that reach toward a multi-benefit vision for Upper Penitencia Creek. The existing Tri-Party Agreement among the County of Santa Clara, the City of San José, and the District, which encourages use of the creek corridor for recreation, water conservation, and flood management is one venue where partners can come together to continue developing a regional, shared vision. Additionally, the District and SCVURPPP are in partnership for the development of a Storm Water Resource Plan that, working with stakeholders, seeks to implement multi-benefit green infrastructure projects. The dialogue should also be expanded to include additional planning entities as well as local landowners so that

WALKERS ENJOY PENITENCIA CREEK PARK

everyone who enjoys living and working along Upper Penitencia can help identify priorities and synergies between infrastructure maintenance and improvement and ecosystem enhancement and restoration.

CONDUCT DETAILED ANALYSES

The concepts that make up the landscape vision will be assessed and refined through analyses focused on cost and impacts to flood risk, water supply, and ecosystem functioning. The concepts will be assessed using a benefit-cost analysis for a range of concept alternatives (e.g., volume of excavation for a detention pond or recontoured channel). The benefit-cost analysis can also be used to help identify which concepts to prioritize in the near-term. In addition, understanding the impacts to flooding, water supply, and habitat conditions associated with the concepts will require more detailed technical analysis, including hydraulic and sediment transport modeling, water quality modeling, and habitat assessments. As part of project alternatives and feasibility analyses, the District will be assessing the anticipated short- and long-term impact of these concepts on flood stages, flood flow velocities, sediment transport and deposition dynamics, biological resources, as well as for public use and recreation, within Upper Penitencia Creek and in Coyote Creek downstream.

CONTINUE WORKING TOWARDS A MORE RESILIENT LANDSCAPE

The vision focuses on concepts in or directly adjacent to the creek that are within the purview of the District or other Tri-Party Agreement partners. Future long-term landscape planning should include multi-benefit management actions in areas outside the immediate vicinity of the creek corridor that lead to a more functional and resilient landscape under changing climatic conditions. The Science Advisory Hub recommendations above give detailed guidance on the types of actions that the District and its partners can incorporate into long-term, multi-benefit planning initiatives such as One Water and the Storm Water Resource Plan.

BOB GROSS GROUNDWATER RECHARGE POND WHEN FULL

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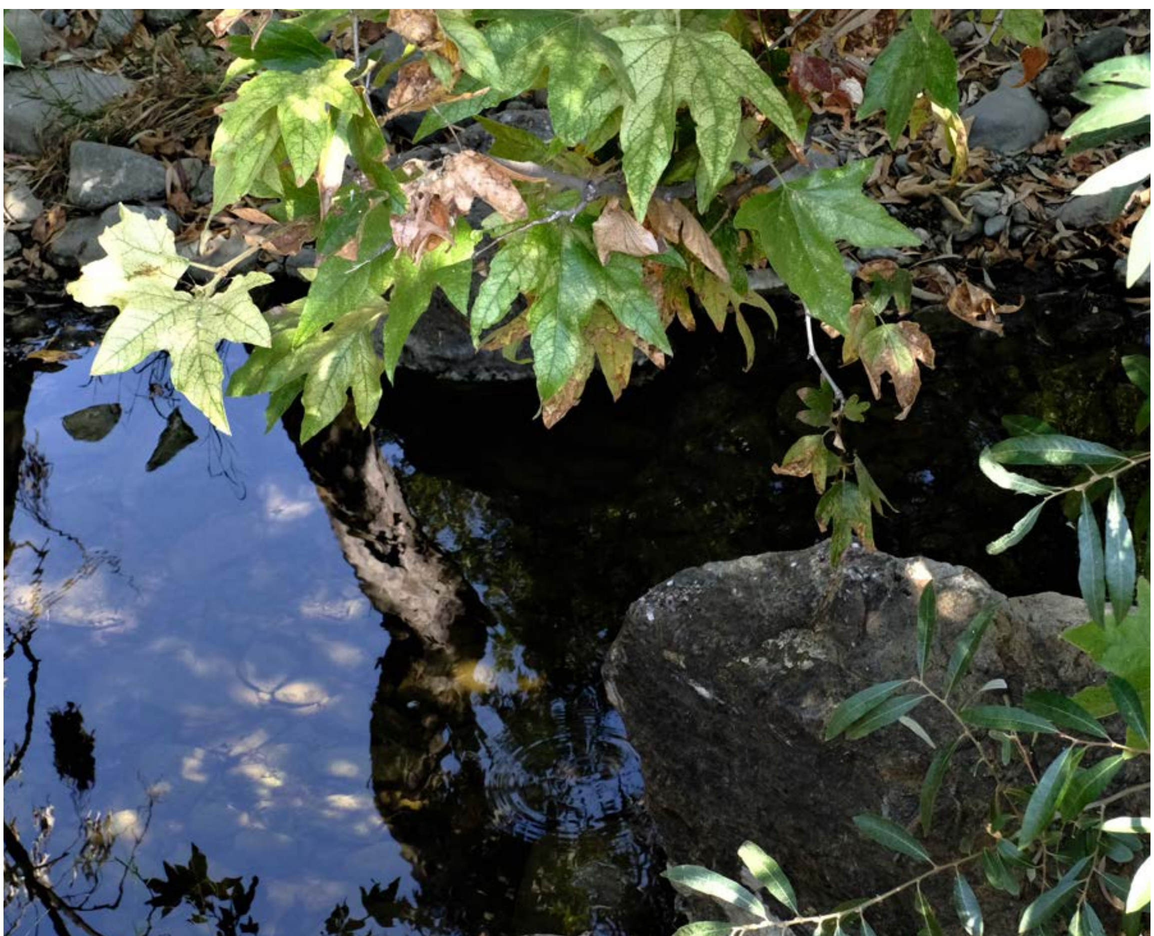

SYCAMORE AND WILLOW SURROUND A PERENNIAL POOL IN UPPER PENITENCIA CREEK

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SYCAMORE TREE, UPPER PENITENCIA CREEK

This report proposes a new multi-benefit approach to flood management along Upper Penitencia Creek. Recognizing the creek's complex history, land use, and challenges, this report explores a suite of actions that could help meet flood management objectives while improving ecosystem functioning, expanding recreational opportunities, and supporting water supply needs.

The San Francisco Estuary Institute-Aquatic Science Center and the Santa Clara Valley Water District worked with technical advisors and a group of local stakeholders to explore a range of multi-benefit management opportunities along Upper Penitencia Creek, culminating in this Resilient Landscape Vision. The vision focuses on ways to expand flow conveyance and flood water storage in a manner that works with the existing landscape features and supports habitats for native species.