Wildlife Habitat and Water Quality Enhancement Opportunities at Castlewood Country Club

SEPTEMBER 2020

PREPARED BY
San Francisco Estuary Institute
H.T. Harvey & Associates

IN PARTNERSHIP WITH
Alameda County Flood Control and Water Conservation District, Zone 7

FUNDED BY
San Francisco Bay Water Quality Improvement Fund, EPA Region IX

A PRODUCT OF **PREPARING FOR THE STORM**

FINAL ZONE 7
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ABOVE: ARROYO DE LA LAGUNA. BELOW: CASTLEWOOD'S VALLEY GOLF COURSE LOOKING SOUTHWEST • PHOTOS BY SFEI

Introduction

PROJECT OVERVIEW

Meeting human and ecological needs within San Francisco Bay's watersheds is increasingly challenged by flooding, water quality degradation, and habitat loss, exacerbated by intensified urbanization and climate change. Addressing these challenges requires implementing multi-benefit strategies through new partnerships and increased coordination across the region's diverse landscapes. Actions to improve water quality and enhance habitat for biodiversity in our highly developed and managed landscapes can help the region as a whole to build resilience to withstand current pressures and future change. The EPA-funded project, "Preparing for the Storm," aims to address these challenges at the site- and landscape-scale through studies and implementation projects in the Livermore-Amador Valley (hereafter "Valley"). As part of this larger project, this technical report presents a synthesis of water quality and habitat improvement opportunities for a golf course of Castlewood Country Club (hereafter "Castlewood").

The location of Castlewood yields substantial opportunities to contribute to improving resilience within the region. Uniquely positioned between two large upland open spaces, Castlewood is a rare greenspace linking these two areas. Castlewood borders the Arroyo de la Laguna (hereafter "ADLL"), which is the main channel draining the Valley and a riparian corridor allowing wildlife movement. It is currently experiencing substantial changes to its channel morphology, namely incision and widening, leading to bank erosion and bank failures, causing loss of property in some instances (Bigelow et al., 2008). Furthermore, the implications of further development upstream and climate change (e.g., water quality degradation, habitat alteration, and increased extreme floods and droughts) amplify the importance of enhancing conditions at Castlewood.

The trend in the golf industry toward sustainable practices reflects member interests as well as potential for reducing costs (Mickey, 2017). In recent years, Castlewood has worked on sustainability measures, such as reducing area under irrigation, replacing non-native trees with native trees, and planning future transitions of out-of-play landscaping to native vegetation. There is also interest in achieving recognition for their efforts as environmental stewards.

The recommended strategies in this report are intended to support Castlewood in making informed management decisions that will improve the ability of Castlewood's Valley Course to protect water quality and enhance habitat for native wildlife. Of course, habitat and water quality are not mutually exclusive; improvements in one will often result in improvements in the other. The contents of this report include:

- An examination of the existing resources and management practices related to habitat for native species, water quality, and water conservation,
- Identification of opportunities to enhance habitat, protect water quality, and conduct outreach and education, and
- Descriptions of recommended strategies to address these opportunities.

The recommended strategies described within this report draw upon principles and guidance from the current science, best management practices, as well as certification standards for the Audubon Cooperative Sanctuary Program (ACSP):

- Urban Biodiversity Framework: The current body of scientific literature on features of the urban landscape that support biodiversity has been summarized as an urban biodiversity framework. The framework consists of seven key elements of urban landscapes that contribute to biodiversity support (see Appendix A; Spotswood et al., 2019).
- California Golf Course Superintendents Association (CGCSA) Best Management Practices: The CGCSA published a Best Management Practices Guide that comprehensively details strategies to improve irrigation practices, surface water management, integrated pest management, and more (CGCSA, 2020). The guide also directs readers to various resources for additional expert and region-specific information.
- Audubon Cooperative Sanctuary Program (ACSP) for Golf Courses: The ACSP provides information on environmental stewardship and recognizes environmentally sustainable golf course management through a certification program. Standards for certification span the topics of environmental planning, wildlife and habitat management, fertilizer and pesticide use reduction and safety, water conservation, water quality management, and outreach and education (Audubon International, 2013).

STUDY AREA

Castlewood Country Club owns and operates two golf courses, the aptly named Hill Course and Valley Course. The Hill Course is situated along the eastern slope of Pleasanton Ridge. The 125-acre Valley Course is positioned below at the base of the Valley, in a narrow corridor between Interstate 680 (hereafter "I-680") and ADLL (Figure 1). Beyond residential areas in the immediate vicinity, large protected areas of regional parklands lie to the west along Pleasanton Ridge, and open hill land lies to the east. Most of the western edge of the course is bounded by an approximately 1.1-mile reach of ADLL, which is a tributary of Alameda Creek, the largest local watershed draining to San Francisco Bay. At its northern end, the course is bordered by 2,400 feet of a tributary to ADLL called Line B.2.1. The course also contains 570 feet of Happy Valley Creek, which drains into ADLL. Although this study is focused solely on the Valley Course, many of the strategies in this report could be considered for the Hill Course as well.

LANDSCAPE CONTEXT

Lying in the rain shadow of the East Bay hills, the Valley receives less rainfall than many locations in the Bay Area. Precipitation is highly variable from year to year, with a long-term annual average of 15 inches. Characteristic of Mediterranean-type climates with cold wet winters and warm dry summers, nearly all precipitation occurs between the months of October and May, often arriving in just a few major storm events that can sometimes cause substantial flooding throughout the Valley. Under climate change, increasing precipitation extremes as well as prolonged dry seasons and more frequent and extreme droughts are expected (Ackerly, 2018).

Historically, the broad and braided Arroyo Mocho and Arroyo Valle channels flowed east to west across the Valley, losing definition and sinking into the alluvium before reaching the Pleasanton

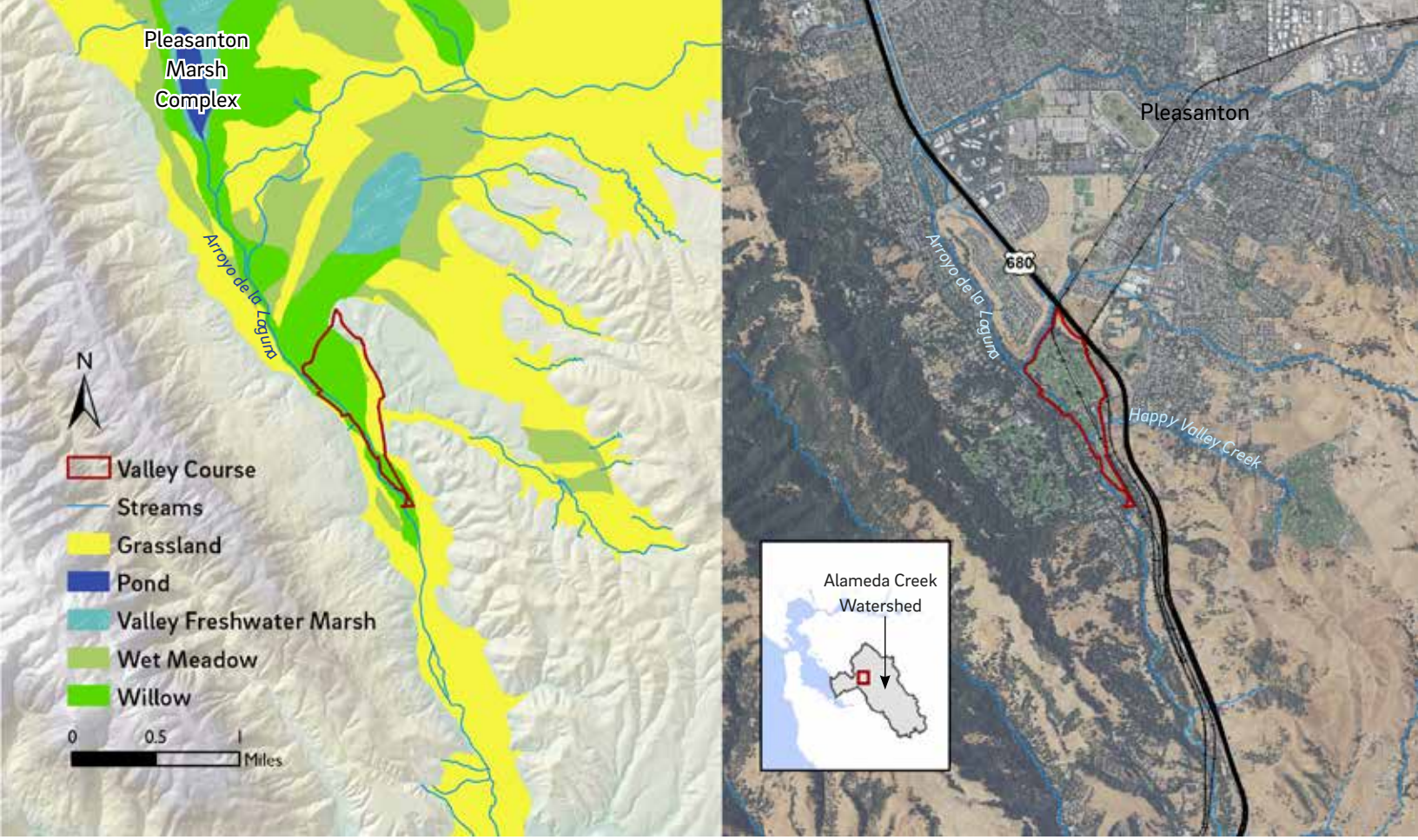


Figure 1. Study Location. The Castlewood Country Club is located in the downstream end of Livermore-Amador Valley, which historically contained a major marsh complex (left). The location of the Valley Course was historically occupied primarily by willow-dominated habitat. The wet meadows and marshes were drained and the land was developed into what is now Pleasanton (right).

Marsh Complex, a large wetland in the vicinity of present-day Pleasanton (Beagle et al., 2014; Figure 1). In contrast, the smaller streams draining the northern watersheds were typically single thread, and lost definition as they flowed out into the Valley. In total, the Valley contained 19,600 acres of seasonal wetland habitat, 600 acres of perennial wetland habitat, and 2,000 acres of willow thicket or swamp (Stanford et al., 2013). In addition to the Marsh Complex, the Valley supported large areas of grassland habitat across the Valley floor, with only a few small oak groves that were characteristic of other valleys in the Bay Area. Downstream of the Pleasanton Marsh Complex, the Valley Course area was historically dominated by willow thicket or swamp associated with ADLL.

Currently, the Valley is home to approximately 270,000 people in the cities of Livermore, Pleasanton, Dublin, and San Ramon (EcoAtlas, 2018). Most of the Valley is urbanized residential and commercial areas. Most channels in the Valley floor today are channelized trapezoidal flood control channels, such as in the location of the historical marsh complex. Many channels, including ADLL, have experienced historic channel incision, leading to chronic bank failures while also effectively disconnecting stream systems from adjacent floodplains and riparian areas. The Del Valle dam was constructed in 1968 on the Arroyo Valle channel, and now regulates flow from approximately 36% of the ADLL watershed. Together, these physical alterations created conditions appropriate for drier habitat types, such as oak woodland/savanna, grassland and riparian forest along the ADLL banks, compared to the wet willow thickets that once dominated the area.

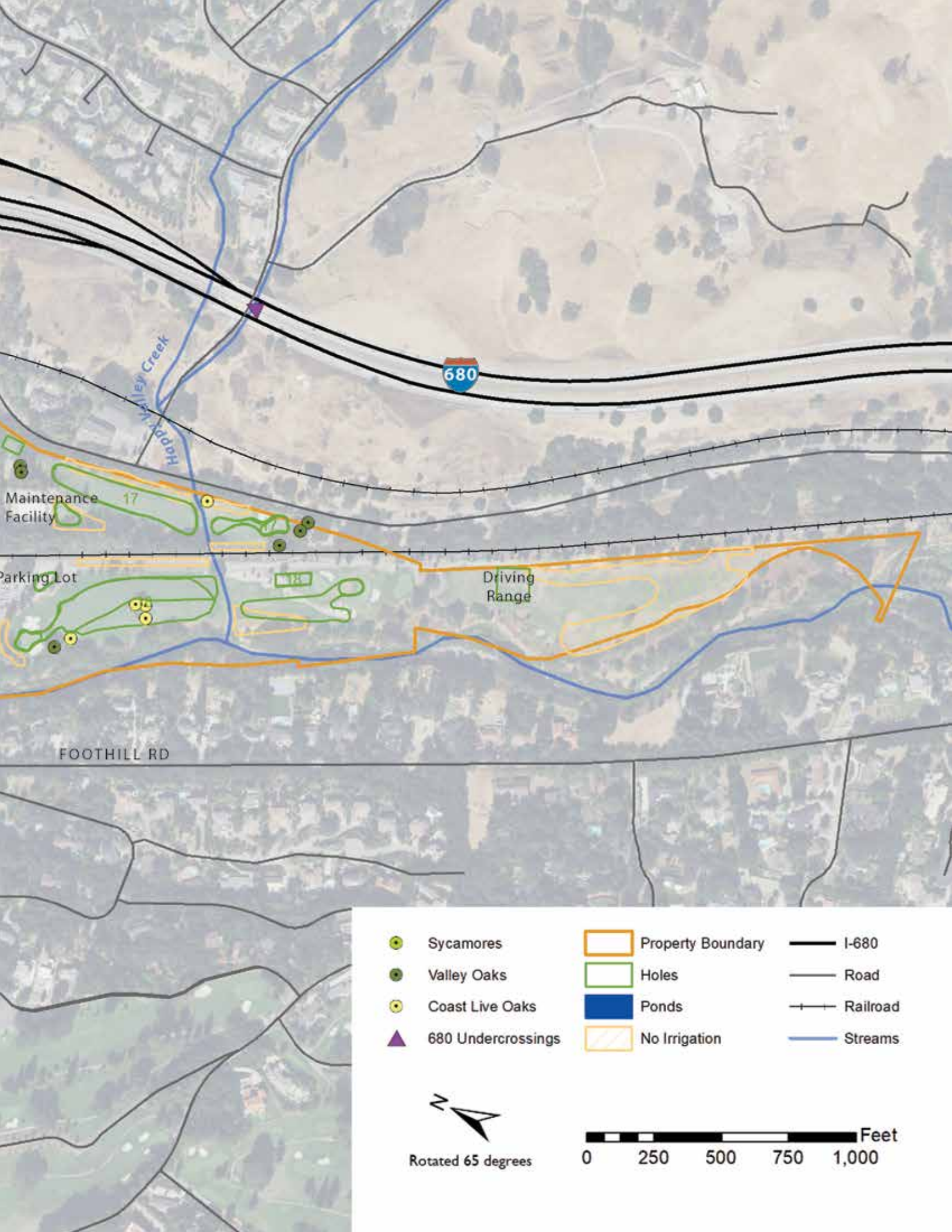
SUMMARY OF CURRENT CONDITIONS AND RECOMMENDATIONS AT CASTLEWOOD

As more and more land is developed, habitat for native species becomes fragmented and lost. Bordering the City of Pleasanton and between large undeveloped open spaces to the east and west, the Valley Course presents an opportunity to enhance wildlife habitat and movement. Currently, the Valley Course features some key resources for wildlife (Figure 2), that can be enhanced to improve habitat quality and wildlife connectivity. The course currently supports more than forty valley oaks and ten coast live oaks, and 92% of trees surveyed in 2006 were native species (Hort Science, Inc., 2006). Approximately 16.9 acres were removed from irrigation in 2015 during a prolonged drought to conserve water. These out-of-play, no-irrigation zones present opportunities for installing native, drought-tolerant species to increase habitat value (Figure 3). There are also opportunities to enhance habitat around three ponds and in the riparian corridors associated with ADLL, Line B.2.1 and Happy Valley Creek. A project currently being designed for ADLL's left bank along Hole 18 includes laying back a portion of the retreating bank to address bank erosion and safety concerns. It also presents an opportunity to provide enhanced riparian habitat and adjacent buffer areas by following a recommended planting palette and strategically placing additional trees. Conversion of particular areas to native plant dominated landscaping and riparian habitat enhancement, in conjunction with installing special resources for wildlife and adopting other wildlife-friendly management practices, could improve the ability of the Valley Course to support local biodiversity. These strategies are discussed in further detail in the "Natural Habitat and Wildlife Connectivity Enhancement" section.

In relation to water quality, there are a number of fertilizer and pesticide products in use for turf maintenance. The type of product, as well as the amount, timing and location of application, can significantly affect the potential for these products to enter adjacent water bodies and affect water quality. A vegetative buffer in the transition from turf to water bodies can help filter runoff to improve water quality downstream and in the ponds. Many of the habitat enhancements can also help protect water quality. Through the development of rigorous record-keeping systems for fertilizer and pesticide use and irrigation, evaluation and selection of products with minimal negative ecosystem impacts, and the creation of a water sampling program, Castlewood can improve its ability to make informed decisions that reduce total fertilizer and pesticide use and protect water quality. These strategies and more are discussed in further detail in the "Turf Management" section.

RIPARIAN VEGETATION ALONG THE EDGE OF CASTLEWOOD'S VALLEY COURSE • PHOTO BY SFEI

Figure 2. Existing conditions at the Valley Course of the Castlewood Country Club. The Valley Course contains features supporting native wildlife and water quality, including: native trees (e.g., valley oaks, coast live oaks, and sycamores), ponds, riparian vegetation along Arroyo de la Laguna, freeway undercrossings, and no-irrigation zones.


680
Hopper Valley Creek
Maintenance Facility
17
Parking Lot
Driving Range
FOOTHILL RD
Sycamores
Valley Oaks
Coast Live Oaks
680 Undercrossings
Property Boundary
Holes
Ponds
No Irrigation
I-680
Road
Railroad
Streams
N
Rotated 65 degrees
Feet
0
250
500
750
1,000

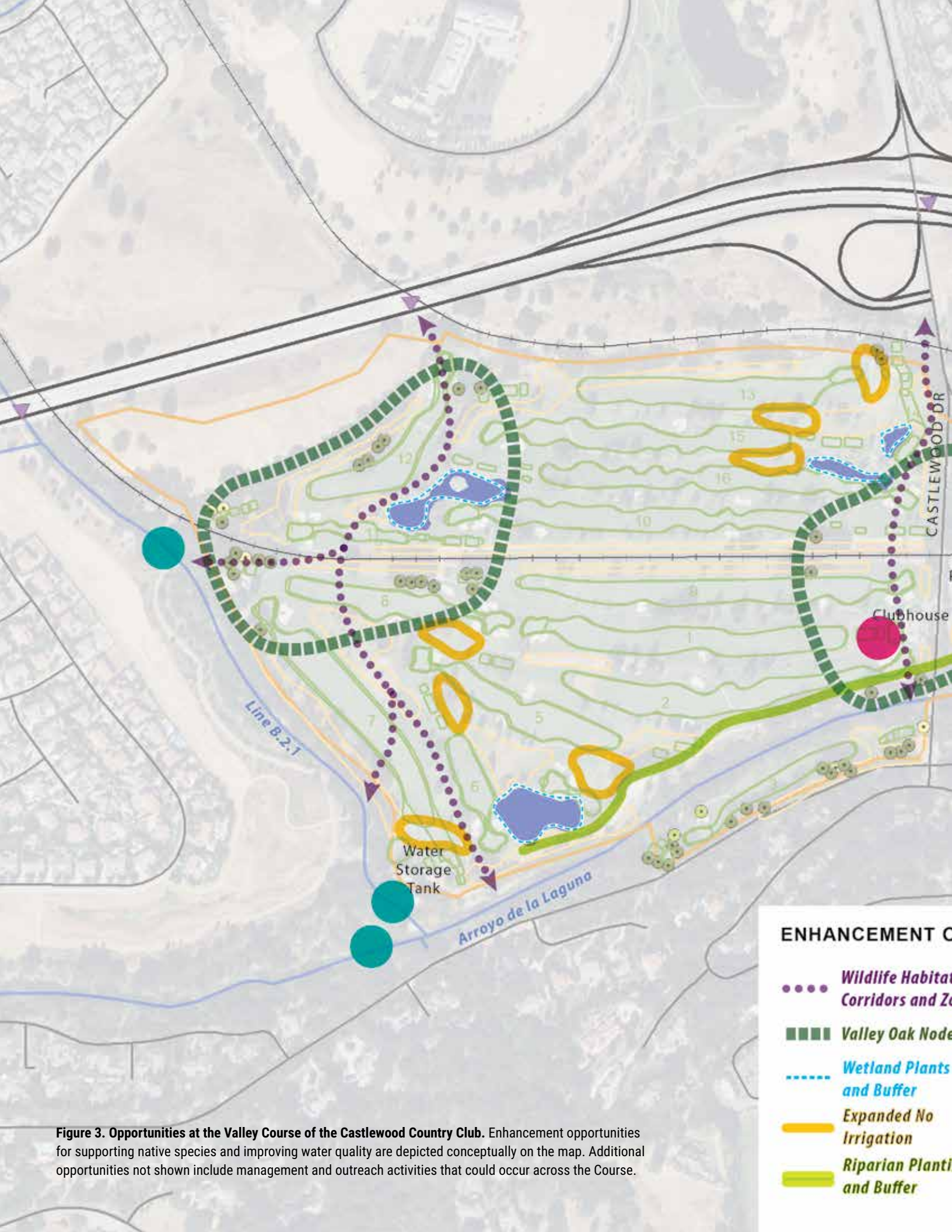
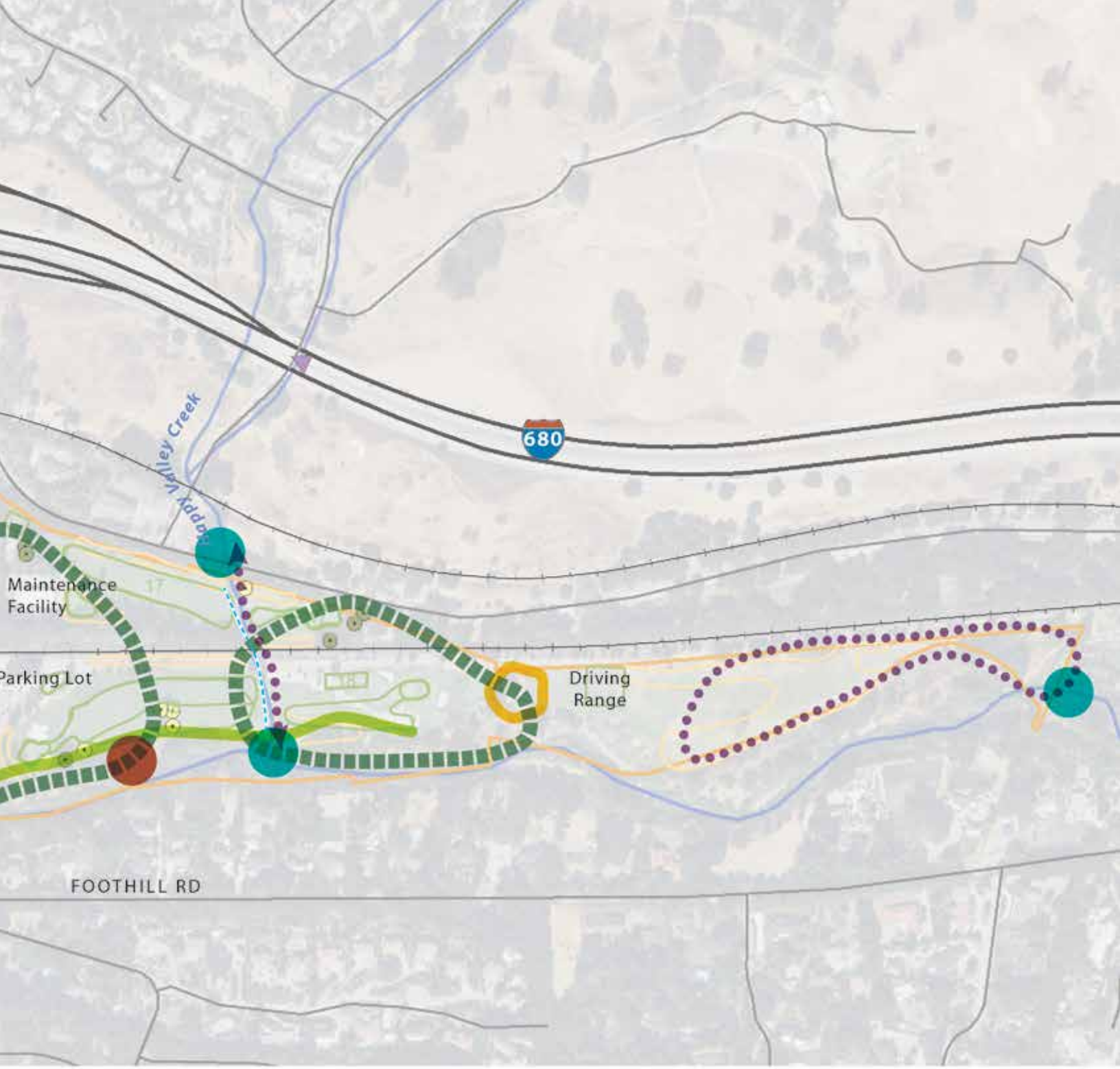


Figure 3. Opportunities at the Valley Course of the Castlewood Country Club. Enhancement opportunities for supporting native species and improving water quality are depicted conceptually on the map. Additional opportunities not shown include management and outreach activities that could occur across the Course.



OPPORTUNITIES

- *ones*
- *es*
- *ng*
- *Water Quality Sampling*
- *Pollinator Garden*
- *Bank Setback Project*

- Sycamores
- Valley Oaks
- Coast Live Oaks
- 680 Undercrossings
- Property Boundary
- Holes
- Ponds
- No Irrigation
- I-680
- Road
- Railroad
- Streams

N

Rotated 65 degrees

0 250 500 750 1,000 Feet

ABOVE: POND WITH CALIFORNIA SYCAMORES ALONG ARROYO DE LA LAGUNA. BELOW: LANDSCAPING AREA WITH NON-NATIVE ORNAMENTAL PLANTS • PHOTOS BY SFEI

1 Natural Habitat and Wildlife Connectivity

Conversion of land for development causes loss and fragmentation of natural habitats, contributing to declines in biodiversity worldwide (IPBES, 2019). While relatively large areas of undeveloped land have been protected by various entities in the Bay Area and provide habitat for local wildlife, most of the region's natural valley floor and riparian habitats have been lost or substantially altered. While some species have adapted well to urbanization, most native species populations are in decline and some have gone extinct. Climate change places additional pressures on native biodiversity, such as increasing floods, longer droughts, and extreme heat, which can change seasonal life history cues and species ranges. In this context, there is an ever growing need for urban planners, developers, and managers to better support ecosystem functions and biodiversity within human-dominated landscapes.

A number of considerations are important for supporting biodiversity within urban landscapes, including the size of habitat patches, connectivity between patches, and special resources (Spotswood et al., 2019). Larger patches of habitat can support more species and larger populations. Streams and wetlands and their adjacent riparian habitats are particularly important for supporting ecosystem diversity and productivity and therefore deserve particular attention in urban landscapes.

Connectivity of habitats across the landscape allows species to move between nesting and foraging habitat, migrate longer distances for breeding, and thereby maintain genetic diversity within populations. Research has shown that wildlife tend to move across the urban landscape through connections – either linear habitat corridors or "stepping stones" of habitat patches – such as greenways and riparian corridors. The tolerance or ability to move across an urbanized landscape varies between species. In the urban landscape, there are numerous barriers to movement, including roads, freeways, and fences. Undercrossings, overpasses, and gaps in fencing or other obstructions like a highway median can facilitate the movement of wildlife across these barriers.

A golf course presents a unique opportunity to provide habitat and increase connectivity across the landscape. Although these landscapes are highly managed and novel habitats, golf courses can function as rare greenspaces in developed areas where wildlife can use the water features, trees, and natural out-of-play areas. Landscaping and management choices relating to these resources are particularly relevant for supporting wildlife.

By making wildlife habitat improvements on the Valley Course, Castlewood can contribute to regional wildlife conservation goals (see Figure 3). The course lies within the area of the East Alameda County Conservation Strategy (hereafter "Conservation Strategy") (ICF 2010). Among the target species for conservation effort are the Alameda whipsnake (*Masticophis lateralis*), California red-legged frog (*Rana draytonii*), and steelhead trout (*Oncorhynchus mykiss*), all of which have been observed within 5 miles of the course, according to the California Natural Diversity Database (2019). Some observations in the database are old, as steelhead trout have not been present for over 50 years in Alameda Creek, into which ADLL drains; however, two decades of restoration efforts on Alameda Creek and its tributaries may soon restore access for steelhead trout to more of the Alameda Creek watershed downstream of Castlewood (Alameda Creek Alliance, 2019). Along Arroyo de la Laguna (ADLL), the Conservation Strategy also calls for restoration of riparian woodlands and protection of remaining sycamore alluvial woodland, a habitat type that is imperiled in the state of California, and that occurs in the watershed.

VIEW OF CASTLEWOOD'S VALLEY COURSE LOOKING NORTHWEST • PHOTO BY SFEI

CURRENT CONDITIONS

The Valley Course is uniquely positioned between large open spaces (Figure 4). These include the East Bay Regional Parks Pleasanton Ridge Regional Park (9,090 acres) and the City of Pleasanton Augustin Bernal Park (237 acres) to the west and rangeland to the south and east. The riparian corridors of ADLL and its tributaries provide wildlife pathways to travel throughout the watershed.

Human transportation corridors tend to be major barriers to wildlife movement. Immediately adjacent to Castlewood is Interstate 680, a heavily used route that sees over 250,000 vehicles per day on average (CalTrans 2017). The stretch of I-680 that parallels Castlewood has four under-crossings where wildlife could move across the highway. The four under-crossings likely vary in the level of actual use, due to their differences in size, type of substrate, and presence of roads. To the west of ADLL, traffic on Foothill Road poses another barrier. In addition, a railroad bisects the course lengthwise, and a second line (not currently functioning) parallels the course's western boundary.

The absence of fencing around the Valley Course's perimeter is a benefit as it should allow wildlife movement across the property, including access to ADLL. However, the highly managed, non-native dominated landscape of Castlewood likely deters regular use by the numerous wildlife species known to occur in the surrounding area. The wide expanse of open turf, lacking in shrubs or tall herbaceous plants, does not provide the type of protective cover that many wildlife species utilize to navigate through developed areas and is likely a deterrent for many species. In addition, the regular human activity on a golf course likely discourages visits from wildlife.

The course includes several notable features that provide habitat value. Native trees made up 92% of the trees surveyed (palm trees were not included) (Hort Science, Inc., 2006), a percentage that exceeds the ACSP standard of at least 80% native species in landscaping, although the composition has changed since 2006 and needs to be updated. The surveyed trees included 47 valley oaks, 2 sycamores, and 10 coast live oaks according to the 2006 tree survey (Hort Science, Inc., 2006). The course has three ponds that are filled with well water. One pond serves as the reservoir for irrigation, while the other two are ornamental. In all three, aquatic plants are manually removed and a pigment called Black Onyx is used to control aquatic plant growth by reducing sunlight penetration into the water. The northeast pond is stocked with fish, including bluegill, bass and catfish, for an annual fishing derby. All ponds on the course are surrounded by an approximately 3-foot buffer of thicker rough of non-native turfgrass, which provide little habitat value for wildlife.

Regardless of the challenges described above, several species have been observed on the Valley Course, indicating that habitat enhancement measures could result in substantial benefits to wildlife including overall improvement to connectivity between adjacent open spaces. Several mammal species have been observed by staff, including bobcat *(Lynx rufus),* mule deer *(Odocoileus hemionus)* and, on one occasion, mountain lion *(Puma concolor).* A variety of bird species use the oak trees and water resources on the course, including acorn woodpecker *(Melanerpes formicivorus),* great blue heron *(Ardea herodias),* great egret *(Ardea alba),* double-crested cormorant *(Phalacrocorax auritus),* bufflehead *(Bucephala albeola),* mallard *(Anas platyrhynchos)*, and Canada geese *(Branta canadensis).*

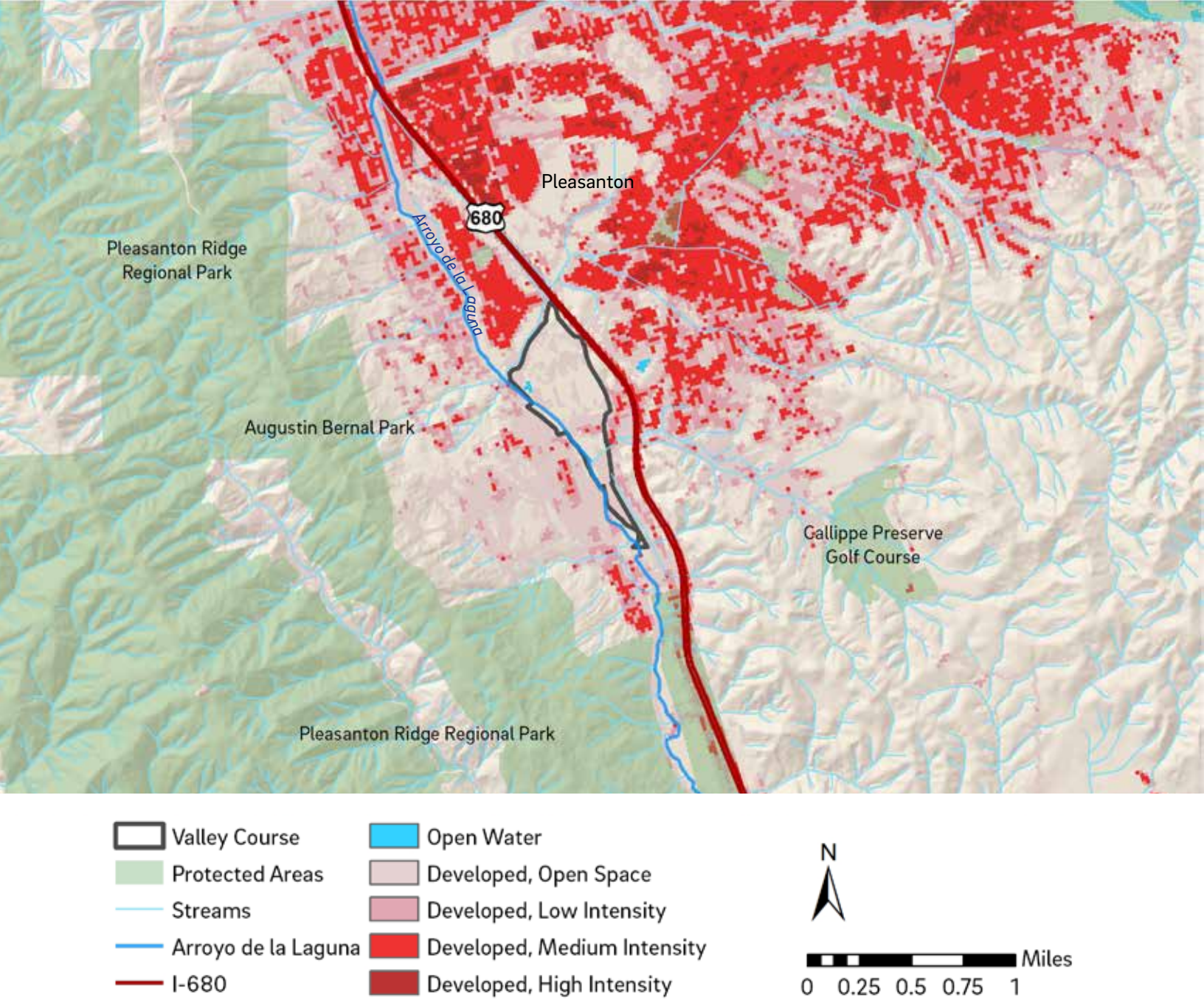


Figure 4. Regional Connectivity for Wildlife Movement.

RECOMMENDED STRATEGIES

Wildlife will be able to more easily use and cross the Valley Course through a number of actions to improve habitat and management changes. While the expansion of native habitat is limited by in-play areas, existing features and out-of-play areas can provide corridors and stepping stones of habitat across the course. With a long-term vision of a few key corridors across the course, each additional, strategically placed tree or native habitat zone can support wildlife mobility and use of the course. The following recommended actions could help prepare Castlewood for ACSP certification and in general improve their environmental stewardship (see Figure 3).

Conduct plant surveys on a regular basis

Regularly conducted plant surveys (e.g., every 2-3 years) can help staff monitor the successful establishment of plants in out-of-play landscaping and keep track of plants that unintentionally seed in and establish. Surveys will reveal the proportions of native and non-native plants on the property and identify any invasive species that should be carefully managed or eliminated. This includes conducting a tree inventory to update the 2006 tree inventory. Tree surveys can occur at less-frequent intervals (e.g., every 5-10 years) than plant surveys given tree longevity.

Create habitat corridors and zones

Creating habitat corridors that link together existing and future habitat patches across the course can facilitate movement across the course, and connect points where wildlife can feasibly cross under I-680. Habitat creation and enhancement measures as described later in this section could be implemented to create the following three corridors, listed from north to south on the course:

Across the northeast ornamental pond and irrigation pond: This corridor follows stepping stones of habitat including the northeast ornamental pond, irrigation pond, a stand of valley oaks, and at least one no-irrigation zone which could be converted to native habitat. Wildlife, such as bobcats and deer, may use this corridor to avoid more heavily trafficked areas.

Parallel to Castlewood Drive to the north: This corridor provides natural cover parallel to Castlewood Drive, which enables animals to stay off of the busy two-lane road. It would pass through the suggested native pollinator garden and one valley oak node, as described below.

Along Happy Valley Creek: This corridor consists of shorter, herbaceous vegetation, and would primarily be helpful to birds, amphibians and insects.

In addition, Castlewood could designate the area south of the driving range as a special habitat zone. This is one of the least used areas of the course, and therefore may be used by wildlife species that are the most averse to human disturbance, such as mountain lions. As habitat enhancements may not interrupt play as much as elsewhere on the Valley Course, this special habitat zone is an opportunity to utilize more robust native planting efforts, provide high quality foraging and cover for birds, reptiles and mammals. Doing so will better connect available habitat on the course to the larger existing open space to the south.

Restore and enhance natural habitats

Natural habitat restoration and enhancement actions should support native species and persist with minimal maintenance over time. Increasing native vegetation can provide filtering capacity to improve water quality within the ponds and streams, resulting in higher quality habitat for aquatic wildlife. Given the local climate, native ecosystems, and current conditions, there are five target habitat types for the Valley Course.

Drought-tolerant scrub

Drought-tolerant scrub is a semi-arid shrub dominated habitat, often with an understory of native grasses and forbs. Once established, it is extremely drought tolerant and provides valuable habitat for a wide variety of wildlife including reptiles, amphibians, mammals, and many migratory birds. The no-irrigation, out-of-play zones of the Valley Course, where oak woodland is not feasible due to vegetation height restrictions, are ideal for conversion to drought-tolerant scrub habitat. These zones are widely distributed on the course, and can be used as part of the recommended corridors for wildlife movement.

Many pollinator friendly plants are included in the drought-tolerant scrub palette (Appendix D Table 1). Conversion of no-irrigation zones to this habitat type will support hummingbirds and insect pollinators – including bees, beetles, butterflies and moths – that play a critical role in the survival of ecosystems and success of agriculture (Vanbergen and The Insect Pollinators Initiative, 2013). For high accessibility, a dedicated pollinator garden could be installed adjacent to the clubhouse (Figure 3; see the "Outreach and Education" section for further details). Insect pollinator species are particularly vulnerable to pesticides sprayed on or near their host plants, especially the group of insecticides known as neonicotinoids (see the "Turf Management" section for further details).

Valley oak woodland

Valley oaks (*Quercus lobata*) are native to the region, and are large, iconic and long-lived trees. Common to valleys of the Bay Area, they are suitable for the conditions currently found at Castlewood. Oak woodlands provide a variety of resources for wildlife. Valley oaks provide important stopover habitat for migratory songbirds (Greco and Airola, 2018). Restoring valley oak woodland on the Valley Course would support the population of acorn woodpeckers (*Melanerpes formicivorus*) that are present year-round. Coast live oaks (*Quercus agrifolia*) are valuable for nesting white-tailed kites (*Elanus leucurus*), which prefer to hide their nests high in the tree top. Planting groups of additional valley oaks, coast live oaks, and other oak woodland associate species can help reestablish ecosystem functions of valley oak woodlands. Not only does this support wildlife, but these large, long-lived trees can provide shade for golfers.

Enhancement of oak woodland habitat could be centered around two or three existing stands of valley oaks (Figure 3). To support pollination and benefits to wildlife, a stand of oaks, or an oak node, should be approximately 1,000 feet in diameter (15–20 acres) and contain > 20 oak trees (Spotswood et al., 2017). Given space limitations on the property, only one or two nodes may be feasible. Following a planting palette of oak woodland species (Appendix D, Table 2), valley oaks, coast live oaks and other associate species could be used when replacing non-native trees and new trees could be placed strategically at these oak nodes where play would not be impeded. Additionally, maintenance of trees and shrubs can be planned around bird nesting season, avoiding trimming while nests are in use, to ensure that young birds can fully fledge to adulthood.

A LARGE MATURE VALLEY OAK AT CASTLEWOOD'S VALLEY COURSE • PHOTO BY SFEI

Riparian habitats

Riparian areas are defined as transitional areas between aquatic and terrestrial environments. Under natural conditions, they are complex habitats offering rare and valuable habitat through the dry summer months and during drought. This habitat is important to fish and wildlife for many reasons, including providing diverse habitat for foraging, nesting, and shelter, serving as migration corridors, maintaining cooler water temperatures through shading, as well as protecting water quality by filtering nutrients and contaminants.

For the ADLL riparian corridor, additional woody riparian plants could improve habitat structure as well as help protect the bank from erosion where vegetation is currently sparse (Appendix D, Table 3). A project currently being designed for the Valley course along Hole 18 includes laying back a portion of the retreating bank to address bank erosion and safety concerns. It also presents an opportunity to provide enhanced riparian habitat and adjacent buffer areas by following the planting palette and using strategic placement of additional trees. An iconic riparian tree in this region is the California sycamore (*Platanus racemosa*), which Castlewood could consider in its planting palette. Staff should ensure that the nursery provides the native California sycamore for its habitat value and contribution to ecological integrity, and not the London plane tree, a non-native sycamore (*Platanus hispanica*). The existing riparian corridor is generally quite narrow, with turf extending nearly to the top of the channel bank. Planting riparian vegetation where feasible and creating a wider un-mowed and non-irrigated buffer along the riparian corridor can support wildlife (e.g., nesting turtles) as well as filter runoff and improve water quality. The target buffer width should be 20 feet wherever possible.

Happy Valley Creek is a small seasonal creek that flow intermittently. For the Happy Valley Creek riparian corridor, play for Hole 17 crosses over the creek, and therefore the addition of trees is not considered feasible. Habitat enhancements could include low growing, native herbaceous plants and shrubs along a no-mow and no-irrigation zone approximately 10 feet on either side of the creek. This would also help deter players from crossing these areas and causing undue disturbances.

Aquatic and wetland habitat

Aquatic and wetland habitats are rare but important to native California ecosystems, providing habitat for many threatened and endangered plant and wildlife species, as well as also being essential to many more common species. Historical and continued loss and degradation of aquatic and wetland habitats makes them an important focus of conservation and restoration efforts. In addition to providing important wildlife habitat, wetlands are also important for assimilating nutrients and protecting water quality. They can also be aesthetically pleasing to humans and are often bird watching hotspots.

Altering the existing management protocol to allow installation and establishment of native wetland vegetation in sections of the ponds can increase habitat value for an array of invertebrates, amphibians, fish, and birds. Maintaining at least one of the ponds for wildlife is recommended and

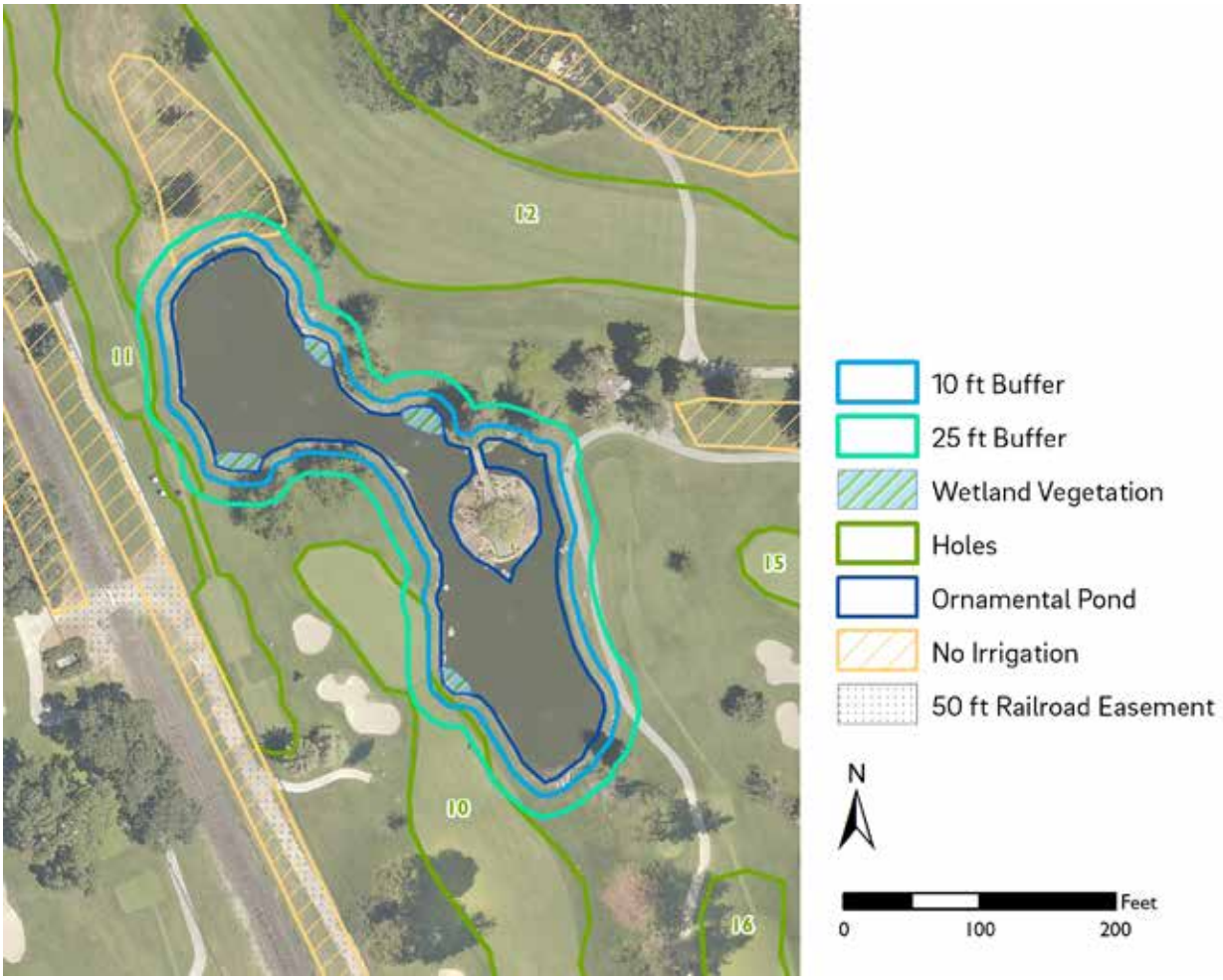


Figure 5. The northeast ornamental pond as the water resource for wildlife. The northeast pond can be enhanced as habitat through plantings of wetland vegetation in the small coves and shoreline vegetation in patches on the perimeter. A 10-foot buffer should be designated as a no-spray zone, and a 25-foot buffer of thicker vegetation wherever possible will provide habitat and aid water infiltration.

a requirement of the Audubon Cooperative Sanctuary Program (ACSP; Audubon International 2013) (Figure 5). The northeast ornamental pond is recommended given the observed wildlife activity in the northeast section of the property, including visits by bobcats, deer, and various waterbirds (e.g., herons, egrets, and cormorants). However, the stocked fish limit the success of native aquatic species.

The transition area along all pond perimeters is valuable habitat for invertebrates, amphibians, water birds, and small mammals. Removing the non-native turf from the pond edges and replacing it with native forbs and graminoids would increase the habitat value (Appendix D, Table 4). Additional trees on the shoreline could be strategically placed to provide shade for cooler water temperatures for aquatic species, lower algae production, and reduced evaporation from the pond. In the rough around the course, the use of native grasses, sedges, and rushes would improve habitat value and water filtration around the course and reduce the amount of irrigation and maintenance needed compared to the current vegetation (Appendix D, Table 5).

The planting palette for wetland vegetation (Appendix D, Table 6) was developed with consideration for management concern regarding potential damage by plants to the PVC lining of the pond. The pond coves are suitable for wetland vegetation, such as tule *(Schoenoplectus acutus),* and shoreline vegetation could be arranged in patches to allow access to the water for the Castlewood Father's Day Fishing Derby. Also, at depths greater than 3 feet, plant growth will be limited, keeping maintenance requirements minimal.

RIPARIAN VEGETATION BUFFER AT A SIERRA NEVADA GOLF COURSE • PHOTO BY SFEI

EXAMPLE OF DOWNED RIPARIAN WOOD AT CASTLEWOOD • PHOTO BY SFEI

CALIFORNIA TIGER SALAMANDER • COURTESY OF CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

COMMON YELLOWTHROAT IN TULE • COURTESY CC 2.0, PHOTO BY TRACIE HALL

LEFT, GREAT BLUE HERON AT TILDEN PARK, RIGHT, BOBCAT AT EL SOBRANTE RIDGE • COURTESY CC 2.0, PHOTOS BY BECKY MATSUBARA

Provide special resources for wildlife

Special resources are defined as habitat features required for species life history requirements and are therefore important for supporting overall biodiversity (SFEI, 2019). Wetland, riparian and aquatic habitats are considered to be special resources for native species, and are particularly important given California's Mediterranean-type climate with long summer dry periods and drought. The three ponds, ADLL, and Happy Valley Creek are therefore considered to be special resources within and adjacent to the Valley course.

Certain habitat features or elements can be introduced to increase the value of the habitat. To support amphibians and turtles, basking rocks or logs within the ponds could be added. Leaving dead trees or snags (where doing so will not create a safety hazard) can offer high value habitat features for nesting birds as well as foraging for insectivorous birds (Mizejewski, 2019.). On the ground, logs, sticks and leaves provide essential habitat for animals such as turtles and salamanders. The California tiger salamander (*Ambystoma californiense*) is threatened and has been observed within five miles of the Valley Course (CNDDB, 2019). Such features should occur within native habitat areas and can be placed strategically to not detract from the overall aesthetic of the course.

Supplementing the habitat with artificial special resources, can re-establish habitat elements not currently present on the course. Nest boxes are a popular supplemental structure for wildlife. Where snags are removed, natural cavities for nesting are lacking (Mizejewski, 2019). The specifications for design vary for each intended species, and local species that may use nest boxes include western bluebird *(Sialia mexicana),* tree swallows *(Tachycineta bicolor),* and several species of bat. In general, these should be placed away from highly-trafficked areas. Humans benefits include increased bird watching opportunities and reduced populations of insect pests (e.g., mosquitos; Glassey and Farlik, 2009).

Artificial raptor perches could provide crucial resources for hawks and eagles in places where snags have been removed. Attracting raptors to the area could help to control the ground squirrel population and turf issues they cause. However, perches should not be introduced until anticoagulant rodenticide use is completely eliminated from use on the course and the surrounding area, as it can cause serious illness and death in raptors and other predators that eat rodents that have ingested the poison.

Monitor wildlife

A consistent record of wildlife observations is useful for decision making. A better understanding of which species are present, when, and where on the course can enable Castlewood to make informed decisions that minimize risk to wildlife. Such decisions may include which fertilizers and pesticides to use, when to apply products, where habitat features could be added, or where to place future development.

Prior to any habitat enhancements, it is important to establish a baseline, against which to assess the impacts to wildlife – positive, negative and neutral – of any future changes in management. A BioBlitz is a popular event that could be used to establish a baseline of observations of wildlife and plants (see "Outreach and Education" section for more details). A partner organization (e.g., a local environmental organization or consulting firm) could also help conduct a survey of at least the northeast ornamental pond, or all three ponds, both to establish a baseline before habitat enhancements and to re-survey in subsequent years. Furthermore, the use of camera traps could help monitor for wildlife that use the highway underpasses or visit the course at night.

A WILDLIFE CAMERA FOR MONITORING USE OF HABITAT AREAS • PHOTO COURTESY OF PIXABAY, HARRY STUEBER

Related ACSP Standards

- Maintain nesting boxes or other structures to enhance nesting sites for birds or bats.
- Connect wildlife habitat areas to facilitate wildlife movement through the property.
- Establish and maintain at least 80% of the landscaped trees, shrubs, and flowers, excluding turfgrass, with plants that are indigenous to the native plant community of the ecological region of the property.
- Naturalize at least 50% of out-of-play shorelines with emergent-aquatic and shoreline plants.
- Maintain natural wildlife habitat in at least 50% of all unused or minimally used potions of the property.

Related California GCSA BMPs

- Retain riparian buffers along waterways to protect water quality and provide food, nesting sites, and cover for wildlife.
- Remove nuisance and exotic/invasive plants and replace them with native species.
- Properly designed ponds with narrow edge vegetation are more resistant to problems than those with highly maintained turf immediately adjacent to the pond edge.

Related Urban Biodiversity Framework Elements

- Connections: Features in the urban landscape that facilitate the movement of plants and animals.
- Native Plant Vegetation: Plant species long evolved in a specific geography (including nearby species that may be appropriate in the near future, given anticipated range shifts with climate change).
- Habitat Diversity: The type, number, and spatial distribution of habitat types within an urban area. Together, mosaics of habitats create diversity in habitat types at the landscape scale.
- Special Resources: Unique habitat features necessary to support species' life history requirements, including large trees, wetlands, streams, and rivers.
- Management: Human activities and planning that promote positive biodiversity outcomes.

MORE INFORMATION: INSTALL AND MAINTAIN HABITATS

Successfully establishing native habitats requires identifying plant palettes that are appropriate for the site specific conditions (i.e., soils, hydrology, microclimate, land management, etc.). Once established, care and maintenance should be lower than non-native plants and landscaping. Habitats should be installed by a restoration contractor familiar with native plants.

Site preparation

For a given site, all non-native species, including turf and woody species (where appropriate) should be removed. The removal of invasive plant species should be thorough and include as much root material as possible to prevent resprouting. Invasive species are listed by the California Invasive Plant Council (Cal-IPC) and include Bermuda grass (*Cynodon dactylon*), a species observed across the golf course. If any herbicides are used in conjunction with physical control methods, the herbicide type and application method should be in accordance with recommendations from a licensed Agricultural Pest Control Advisor and approved for use adjacent to aquatic environments by the U.S. Environmental Protection Agency.

Irrigation

Temporary irrigation should be installed in all locations that are not already in close proximity to water or will be regularly irrigated during golf course maintenance (i.e., riparian, drought-tolerant scrub, oak woodland, and pollinator garden habitats). Prior to planting, irrigation lines should be installed in trenches with on-grade bubblers to limit visibility and provide efficient irrigation to each plant.

Installed plants should be irrigated during the first three years after installation or potentially longer if drought conditions occur. Irrigation should be provided in a way that allows deep infiltration to facilitate deep root establishment. This will improve the long term self-sustainability of the plants. Initially, during the first dry season (approximately April–September) approximately 10 gallons of water should be applied to each plant every 14 days. The irrigation frequency should be gradually reduced during the first three years to allow plant acclimation to the natural climate of the site. Additionally, plants should not be overwatered, as many California native plants are adapted to dry conditions and overwatering may result in high mortality when the temporary irrigation system is removed. The installed plants should be monitored by a qualified biologist so that the irrigation regime can be altered as necessary.

Plant installation

Appendix D provides the plant palettes and spacing for each habitat type. Plants should be installed around the first rain in order to allow the plants to become established with rainfall. Planting holes should be dug to 3 times the width and 2 times the depth of nursery stock containers, then backfilled. Nursery stock should be installed such that the top of the rootball is between 0 and 0.25 inches above ground level. Irrigation basins should be created by making a 2 foot diameter and 4 inch tall by 4 inch wide berm around each installed plant to reduce

runoff and increase deep soil infiltration. Coarse woodchip mulch should be spread within each irrigation basin to a minimum depth of 3 inches. The mulch will serve to control weeds and reduce soil moisture loss. Mulch should be installed so that there is a 2-3 inch gap around the plant stem to prevent stem rot. Mulch should not be installed outside of irrigation basins unless it is necessary to combat the growth of invasive species, such as Bermuda grass. It is recommended that plants susceptible to deer browse are caged until they become established or grow to a point where deer browse can be avoided (e.g. greater than 6 feet tall for valley oaks). If caging is not feasible, plants less susceptible to browsing can be selected (see Appendix D).

Seeding

Native grass and forb seed mixes should be of Alameda County origin to maintain native adaptation and genetics. The soil should be raked in two directions prior to broadcasting seed to improve seed-soil contact. Seeding rates should be assessed by a qualified biologist to ensure enough seed is being applied in an area, but should be between 15-30 pounds per acre depending on the mix of species being used. A "belly grinder" manual type seeder or hand seeding should be used to broadcast seed. The seed should be broadcast between September 15 and October 15. Seed may need to be broadcast in multiple years to establish a native dominated herbaceous layer and persistent seedbank.

Weed and invasive plant control

Weedy and invasive plant species removal should be implemented within and around the irrigation basins during the first three years of plant establishment and on an ongoing, as needed basis to maintain a native dominated and visually appealing landscape. All non-native plants within irrigation basins should be hand-pulled to limit competition with the installed native plants. Outside of irrigation basins, non-native plants can be maintained via string-trimming. However, special care should be taken to avoid native plants. If native forbs are observed in certain areas, string-trimming of these areas should be postponed until after these plants have set seed.

Invasive, non-native plant species, both herbaceous and woody, are typically a significant obstacle to native habitat establishment. Therefore, invasive plant species (plants rated by Cal-IPC as "high" or "moderate") should be actively monitored and controlled as necessary to minimize the possibility of invasion on an ongoing basis.

Dead plant replacement

All dead plants should be replaced in the first three years. Dead plants should be replaced with the same species, or a native species that is observed to be performing well in the immediate area. After the first three years, dead plants should be replaced on an as needed basis as installed plants may be providing adequate cover and habitat value, such that replacement plants may not be necessary.

ABOVE: A VIEW OF THE NORTHEAST ORNAMENTAL POND. BELOW: A VIEW OF CASTLEWOOD'S VALLEY COURSE • PHOTOS BY SFEI

2 Turf Management

Pesticides and fertilizers can have deleterious effects upon people, water quality, terrestrial and aquatic wildlife, and overall ecosystem health. The type of product and the amount, timing, and location of use and other best management practices can all have substantial impacts on how those products might run off the site or infiltrate. Effects can include diminished water quality in adjacent water bodies and hazards to non-target wildlife and human health. Certain products can negatively impact pollinating insects and bird species that utilize the golf course at or near to the application site, as well as wildlife species, such as deer, that browse on plants that are uptaking the products.

Golf course superintendents must balance the amount of irrigation and the variety of products used to keep the turf at peak playability, yet keep costs down and avoid unintended consequences of excess irrigation or product application. The amount of water used to irrigate golf courses is high and is typically one of the largest costs. Innovative ways to reduce the total amount of irrigation — whether it be timing or location of irrigation, utilization of better irrigation technologies, or transitions in plant species — can have significant positive impacts. Water usage is also a factor in the transport and fate of applied pesticides. Excessive irrigation produces more runoff, moving products away from their intended location, sometimes before their intended effect can take place. The California Golf Course Superintendents Association (CGCSA, 2020) outlined best management practices for determining optimal timing of irrigation that both supports the growth of quality turf and avoids producing excess runoff from the course.

Golfers have come to expect impeccably manicured courses. This level of management, along with the overall area of turf at most courses, requires large amounts of water, fertilizer and pesticides annually. However, a number of efforts have provided alternative strategies, including the Audubon Cooperative Sanctuary Program (ACSP; Audubon International, 2013) and CGCSA BMPs to improve water quality and conservation. By implementing some or all of these changes, Castlewood could reduce potential impacts to water quality in ADLL and Alameda Creek downstream. They would also support regional goals outlined in the East Alameda County Conservation Strategy (ICF International, 2010), including managing site runoff and transport characteristics, enhancing soil infiltration capacity, and restoring riparian vegetation communities.

CURRENT CONDITIONS

Although the Castlewood is just a small part of a much larger urbanized watershed, management of each component of the urban landscape will have an impact on downstream water quality. The western boundary of Castlewood's Valley Course is the ADLL, which is a tributary to Alameda Creek, the largest local watershed draining to San Francisco Bay. Further downstream, flow from Alameda Creek is diverted and infiltrated by the Alameda County Water District; Alameda Creek accounts for approximately 40% of the District's municipal supply. Because Castlewood's runoff drains directly to ADLL, on-site management practices related to irrigation, fertilizer application and pesticide application can have significant localized and regional effects upon water quality and wildlife.

ADLL is responding to significant changes in water and sediment delivery from the watershed, resulting in channel incision and bank erosion. Also, ADLL is classified as an impaired water body on the 303d list for the insecticide diazinon, which currently has an approved total maximum daily load (TMDL) and tends to enter ADLL from urban runoff and storm sewers (State Water Resources Control Board, 2017). Exposure to diazinon through ingestion, skin contact, or inhalation affects the nervous system of insects, people, and pets (Harper et al., 2009). Despite extensive sampling across the ADLL watershed for water quality by many agencies and organizations, and for turbidity by SFEI (Gilbreath and McKee, 2008), very little is known about water quality in the reach surrounding Castlewood, as only limited sampling has occurred according to records in the California Environmental Data Exchange Network (2019).

Chemical use and water quality

Chemicals, fuel and equipment are stored in the maintenance area to the south of Castlewood Drive (see Figure 2). Maintenance staff are properly trained in the application, handling and storage of products used on the course. Currently, Castlewood applies products on the following approximate schedule. For greens across the course, fertilizer and fungicide are applied on a two week rotation from April 1st to September 30th, and monthly from October 1st to March 31st. For tees, fairways, roughs and other landscape areas, fertilizer is applied in April, June, August and October, and coincides with the aeration schedule and days that the course is closed. In addition, Castlewood uses a pigment called Black Onyx in the ponds to reduce sunlight penetration into the water to control the growth of aquatic plants.

Although Castlewood is conscious of avoiding water quality degradation of ponds and streams on the course, current conditions could be enhanced with regard to naturalized shorelines and vegetative buffers. Currently, none of the shorelines of the three ponds on the course are naturalized; instead, each pond has an approximately 3-foot wide buffer of thicker rough. For most of the boundary between the course and ADLL, the turf extends up to or very near to the top of bank. However, a greater area of buffer exists between the course and the Line B.2.1 top of bank, largely because of the need for maintenance access along the riparian corridor. The current conditions along each of these shorelines/creek banks show that the current vegetation likely provides minimal filtration benefit.

In addition, Castlewood conducts soil tests and plant tissue tests quarterly at a number of locations across the course for the purpose of determining deficiencies in soil nutrients and making decisions about the appropriate type and amount of fertilizer to apply. These tests can also help inform the selection of plant species and cultivars for new or replacement installations, by identifying troublesome varieties and favoring varieties that are more pest-resistant or stress-tolerant for use.

Castlewood currently uses treatments for at least two animal species considered to be pests: nematodes and ground squirrels. Nematodes are treated by Castlewood with pesticide application directly to the turf. For ground squirrels, a total of 12 bait stations are installed along the course perimeter. The bait contains anticoagulant rodenticide.

Irrigation and water conservation

Within the Livermore-Amador Valley, the Valley Course is situated on the fairly flat valley floor, and Happy Valley Creek, precipitation, and pumped groundwater for irrigation are the few discrete sources of water entering the course. Although the largest floods bring water stages near the top of the

banks of ADLL, channel incision has thus far kept flood waters from spilling over onto the course. Line B.2.1 forms the northern boundary of the course and enters ADLL at the northwest corner of the course. Runoff from adjacent hillslopes to the east carry water onto the course, but that runoff is not channelized. Runoff from Interstate 680 does enter the property during periods of heavy precipitation.

Surface water on the course either directly infiltrates into the ground, or drains into Happy Valley Creek, ADLL, the three ponds, or a ditch that parallels Castlewood Drive. While the ponds are equipped to drain into ADLL, this capability is never used by staff. ADLL ultimately provides the drainage for the entire course.

The water supply for the Valley Course comes from four on-site groundwater wells, as well as water from the City of Pleasanton. Because of high boron concentrations in the well water, the course must carefully manage the irrigation system, and thus they blend well water with City water to reduce negative impacts of the boron on the turf. The greens are watered exclusively with City of Pleasanton water due to the water quality issues.

Castlewood has a state of the art irrigation system that includes an on-site weather station, programmable logic controller (PLC) panels, and separate irrigation for greens versus fairways and rough to allow for specific watering needs. A handful of soil moisture monitors also informs decisions about irrigation timing and spatial variability across the course. Irrigation currently happens weekly, and product application is timed to correspond to the watering.

In response to the extended drought (2011-2015), Castlewood eliminated 300 sprinkler heads in 2014, thus effectively shifting about 16.9 acres out of irrigation and saving 10 million gallons of water annually. With the exception of some hand-watering during the day, irrigation occurs overnight, and meets all water restriction goals. Castlewood has a drought management plan that includes areas to remove from irrigation in the future if necessary, in addition to the current no-irrigation zones.

ARROYO DE LA LAGUNA • PHOTO BY SFEI

IRRIGATION POND • PHOTO BY SFEI

RECOMMENDED STRATEGIES

First and foremost, to prevent hazards and negative effects associated with product use, Castlewood Country Club must stay current and compliant on all present and future local, county, state, and OSHA guidance, ordinances and laws regarding chemical storage, spill prevention and use. In addition, Castlewood currently implements a number of strategies and is considering additional strategies to reduce chemical use, improve water quality, and conserve water, while maintaining playable conditions and supplying water for the ponds. As new strategies are implemented, new opportunities or needs may become apparent. For example, if water quality testing points to the need to improve the management of particular applications of fertilizers or pesticides, water quality targets and strategies to achieve those targets should be developed. The following actions are recommended for their potential to prepare Castlewood for ACSP certification and in general improve their environmental stewardship and water supply.

Establish rigorous recordkeeping

As part of ACSP certification, Castlewood should build upon their current record keeping practices and establish rigorous electronic record keeping protocols for irrigation, turf maintenance, fertilizer, and pesticide use. A standardized protocol could include the use of field data sheets that include observations, measurements, product applications, outcomes, and control information. These data sheets can then be compiled to create electronic weekly, monthly or annual summaries. The following data should be collected and recorded:

- Amount of fertilizer used (lbs/acre) per season, broken into nitrogen (N), phosphorus (P), and potassium (K)
- Amount, type, rate and location of pesticide applied
- Location, timing and species of plant disease, insect outbreaks and pest infestations
- Treatments employed and effectiveness
- Irrigation (rate, duration, frequency)
- Mowing frequency (height, frequency, clippings collected)
- Aerification frequency (greens, tees, fairways, roughs)
- Top dress frequency (greens, tees, fairways, roughs)
- Dethatching frequency (greens, tees, fairways, roughs)
- Any other turf maintenance practice in use by Castlewood

Analysis of these records, combined with visual inspections and regular soil testing, may reveal spatial or temporal patterns. These patterns could reveal areas that could receive less irrigation or product without reductions in turf health, playability, or aesthetics.

VIEWS OF CASTLEWOOD'S VALLEY COURSE • PHOTOS BY SFEI

Develop an Integrated Pest Management program

The CGCSA advocates for the use of an integrated pest management program for golf courses. The University of California Statewide Integrated Pest Management (UC IPM) Program states:

"IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment."

The UC IPM provides tools and resources that can enable Castlewood to develop an appropriate IPM program for the Valley Course. For example, Castlewood should evaluate and adjust their application of fertilizers and pesticides to ensure compliance with an IPM approach. With an IPM approach, golf courses are encouraged to focus on a curative treatment approach to specific pest issues, rather than a preventative approach, so that less product is used overall, pest resistance is prevented, and negative environmental impacts are reduced.

Develop a nutrient management plan

Castlewood should create a nutrient management plan, which measures the inputs and outputs of nutrients to the golf course, and compares those values to the nutrients needed by turf and other vegetation. These plans take into account the different soil types, nutrient data from soil testing on those types, the amount of irrigation, nutrient data from testing the irrigation sources, the various turf species present across the course, mowing heights, clipping removal, and amount of traffic/damage to the turf. The plan allows for tracking of the nutrient requirements and presents a strategy for the optimal timing, amount and type of fertilizer applied to maintain turfgrass health. One potential outcome of a nutrient management plan is a careful assessment of current fertilizer use, benefits and drawbacks of fertilizer use, and a chance to make informed decisions about continued use patterns.

Establish a water quality testing program

Maintaining good water quality of water bodies on and adjacent to the course is an essential part of environmental stewardship. Impacts from golf courses can include chemical pollutants, excess sediment due to erosion, increased water temperature, excess water withdrawals, and oxygen depletion. However, many BMPs can help maintain water quality on the course and as it exits the course. Establishing and maintaining a record of observations and sampled data will permit analyses of spatial and temporal patterns of water quality issues, which will help inform future improved usage of fertilizers and pesticides or implementation of BMPs.

A regular water quality sampling program is required to meet the ACSP certification standards. To establish a baseline, at a minimum, ACSP requires data to be collected quarterly (spring, summer, fall, winter) for a total of two years. Following this baseline period, sampling can be reduced to twice a year (winter and summer). However, additional monthly sampling (analyzing a subset of the quarterly analytes) is recommended because, with only four samples per year, the seasonal variation

will overwhelm any trends in the analysis (Blankinship and Associates, 2006). The goal of this simple sampling program is to identify any major concentration-based water quality challenges associated with the golf course. Any challenges that are identified would provide the impetus for changing management on the course (e.g., type, amount or timing of product application, or timing, amount or rate of irrigation) to cause an improvement in the trend of future water quality measurements. If the initial water quality sampling program does indicate a water quality concern, then perhaps a more detailed sampling program could be developed and utilized to provide data support and monitoring for more nuanced management modifications.

A total of nine sample locations are recommended, so as to collect samples upstream and downstream of all water bodies that enter/exit the property and the ponds on the property, as per ACSP guidance. Sample locations should include:

- ADLL at the upstream property boundary
- ADLL at the downstream property boundary
- Happy Valley Creek at the upstream property boundary
- Happy Valley Creek at the downstream property boundary
- Line B.2.1 at the upstream property boundary
- Line B.2.1 at the downstream property boundary
- Each of the three ponds

Every month, data should be collected from the nine locations, using field water quality electrode probes, test strips (typically less precise than probes), and field meters. These analytes will include:

- Total Ammonia (mg/L) (electrodes or test strips)
- Total Nitrate (mg/L) (electrodes or test strips)
- Total inorganic N (mg/L) (calculated as the sum of ammonia and nitrate)
- Phosphate (mg/L) (electrodes or test strips)
- Temperature (degrees C) (YSI multiprobe meter)
- Specific conductivity (us/cm) (YSI multiprobe meter)
- Dissolved oxygen (mg/L) (YSI multiprobe meter)
- pH (YSI multiprobe meter)
- Turbidity (NTUs) (HACH turbidity meter)
- Alkalinity (test strips)

In addition to monthly field-based sampling, to meet the ASCP requirements, additional samples should be collected during storm events to be analyzed by an accredited laboratory. These samples can be grab samples; however, if an environmental organization or contractor is utilized to do the sampling, the winter and spring samples should be flow-integrated samples that integrate water from an entire storm event. Winter and spring samples should be collected during a rain event that is forecast for at least 0.5 inches of rain over a 6 hour period. Ideally these samples would be collected

VIEW OF CASTLEWOOD'S VALLEY COURSE NORTHEAST ORNAMENTAL POND • PHOTO BY SFEI

during the rising limb of the hydrograph, or during the first hour or two of the rain event, so as to be capturing the initial flush off of the landscape. These samples should be analyzed for:

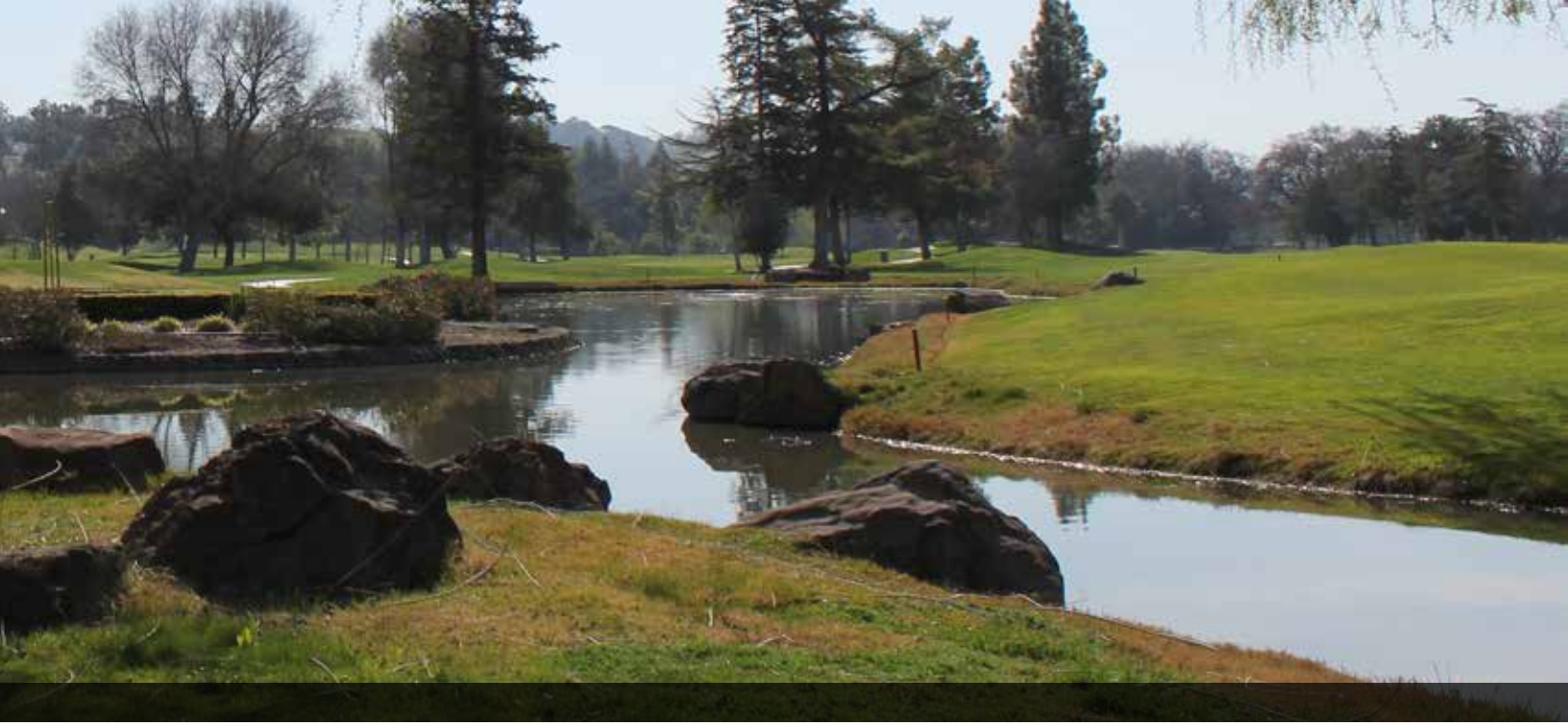
- Heavy metals
- Nutrients: dissolved and particulate (Ammonia mg/L, Total N mg/L, Phosphate (mg/L)
- Total dissolved solids
- Could consider monitoring for specific pesticides (the type(s) utilized on the course, but these samples are typically expensive to analyze)

In addition, consider testing the water supply (wells and City of Pleasanton water) at least once a year to monitor for potential problems. With regular monitoring, it is possible to make adjustments as needed to the mixture between well water and the municipal supply to account for any fluctuations to boron or nutrient concentrations in the water.

Finally to complement sampling, visual observations of water quality are also highly important within a larger monitoring program. For instance, visual observation of algae growth, which indicates an increase in nutrient concentrations, can trigger appropriate responses while the issue is still a smaller, more manageable size. Maintenance staff could make regular observations during scheduled weekly maintenance and record the data in a data log.

Regularly test soil conditions

To qualify for ACSP certification, Castlewood should continue the regular quarterly soil testing program, and map the locations where soil and plant tissue samples are taken. As the data record grows over time, Castlewood should be able to strengthen the link between the soil test results, the product application decisions, and measured outcomes. The data allows for analysis across time and space to continually provide the insight to make informed decisions to better target and time applications to be most effective.



Also, soil samples are essential to diagnose nematode abundance in the soil causing wilting and thinning, as these above-ground symptoms are not sufficient because a variety of issues can trigger these symptoms (Wick, 2012).

Select products with minimal negative environmental impacts

Castlewood should conduct a thorough review of all products in current use and considered for future use. In a re-evaluation of pest control measures, Castlewood should assess and consider the environmental impact of each product, including leaching and runoff potential, toxicity to non-target organisms, soil absorption capacity, pesticide persistence, water solubility, and the effects on soil microorganisms. When considering fertilizer products, the benefits of choosing organic versus inorganic should be studied (Blankinship and Associates, 2006). Each product has its own functional pathway and outcomes, both intentional and unintentional. For any given product, it is possible that there is a more environmentally friendly alternative available that is equally as effective (e.g., a slow-release version of a product).

A variety of products are currently in use at Castlewood (Table 1). The active ingredients of current and future potential products should be assessed in terms of the risks they pose to the environment according to the best available science. Many products have deleterious effects on wildlife and overall ecosystem health, causing significant harm or death to non-target species. For example, anticoagulant rodenticides can bioaccumulate up the food chain, causing illness and death for larger predators such as cougars, foxes, owls and eagles. These products should be completely eliminated from use on the course. Castlewood should consider effective alternatives to anticoagulant rodenticides, such as live trapping of ground squirrels, to avoid negative impacts to non-target wildlife populations.

Also, pollinator species such as bees and birds are vulnerable to pesticides and fertilizers sprayed on their host plants, and are especially vulnerable to insecticides containing neonicotinoid chemicals

Table 1. A variety of products that are currently in use by Castlewood.

Product Type	Product Name	Active Ingredient
Anticoagulant rodenticide	-	-
Fertilizer	-	Ammonium Sulfate
Fertilizer	-	Calcium Nitrate
Fertilizer	-	Potassium Nitrate
Fertilizer	-	Ferrous Sulfate
Fertilizer	-	Sulfate of Potash
Fertilizer	-	Calcium / Gypsum
Fungicide	Banner Maxx	Propiconazole
Fungicide	Secure Action	Acibenzolar-S-methyl, Fluazinam
Fungicide	Daconil Action	Chlorothalonil, Acibenzolar-S-methyl
Fungicide	Instrata	Chlorothalonil, Fludioxonil, Propiconazole
Fungicide	Appear II	Potassium Phosphite
Fungicide	Medallion SC	Fludioxonil
Fungicide	Velista	Penthiopyrad
Fungicide	Heritage Action	Acibenzolar-S-methyl, Azoxystrobin
Fungicide	Briskway	Azoxystrobin, Difenoconazole
Fungicide	Subdue Maxx	Mefenoxam
Fungicide	Interface	Iprodione, Trifloxystrobin
Fungicide	Chipco 26Gt	Iprodione
Insecticide	Acelepryn	Chlorantraniliprole
Insecticide	Merit	Imidacloprid
Insecticide	Indemnify	Fluopyram

(Hopwood and Shepherd, 2012). Practices such as no-spray zones, reducing use of pesticides, and strategies that minimize movement of pesticides can help to protect habitat from pesticide contamination (Xerces Society, 2016). The use of any products containing neonicotinoids should be discontinued, such as the insecticide Merit which is currently in use (Table 1). However, other products that do not contain neonicotinoids can also be harmful; for example, the active ingredient chlorothalonil in the products Daconil Action and Instrata has a high hazard rating for human health, aquatic wildlife and honeybees, according to UC IPM (2019). To review current and future products, information can be found in the National Pesticide Information Center (http://npic.orst.edu/) and UC IPM's pesticide active ingredients database (http://ipm.ucanr.edu/PMG/menu.pesticides.php).

Enact best management practices to maintain water quality

A number of best management practices can be employed on golf courses to prevent deleterious effects upon water quality (e.g., from nutrients or pesticides) due to normal course operation (CGCSA, 2020; Blankinship and Associates, 2006). Although the potential list is long, some are relatively simple yet provide large benefits. For example, along shorelines and creek banks wherever possible without interfering with play, creating a 20-foot wide buffer of at least 3-inch tall turf or natural vegetation (see the "Natural Habtiat and Wildlife Connectivity" section) can provide turf runoff

filtration benefits. However, in some specific locations, for instance in areas with concentrated surface water flow, a mechanical filter, such as those utilized in green infrastructure to capture sediment-bound contaminants or to filter water through filtering agents or membranes, might be more effective than vegetative filtration. Also, when mowing in areas adjacent to ponds, collecting clippings can prevent them from entering the pond, where they will decompose, increase nutrient concentration, and decrease dissolved oxygen concentrations, potentially leading to algal blooms and fish die-offs. If ponds develop algae blooms, aeration, nutrient reduction, bio-filters, vegetation management or bio-controls, rather than chemical control should be considered. Finally, a contained maintenance equipment wash off area should be designated, with drainage to an appropriate area.

Monitor, record and modify irrigation practices

There are many opportunities for Castlewood to enhance and improve their irrigation practices. This includes improving water conservation by eliminating all non-target watering on the course. These actions can also help the course save money, increase pump longevity and reduce maintenance costs, and sustain local groundwater levels.

First, good record keeping is essential to both ACSP certification and continual improvements to water conservation. Castlewood should carefully document watering volume and timing on a daily and monthly basis, and set targets for yearly improvement. With more detailed records of water usage, it will be possible to identify opportunities and inform decisions for maximum irrigation efficiency and minimal waste. For example, the records would allow for an analysis of different irrigation volumes needed for different areas of the course.

Second, Castlewood can make improvements to the decision-making process for when, where, and how much water is applied to the course. Rather than using a fixed schedule, irrigation decisions could be based upon estimates of evaporative losses, soil moisture and weather. For example, the records would allow for an analysis on the timing of irrigation to be conducted to see if watering during other times can reduce evaporative losses. See the California Department of Water Resources' California Irrigation Management Information System (https://cimis.water.ca.gov) or the UC IPM's Guide to Healthy Lawns (http://ipm.ucanr.edu/TOOLS/TURF/MAINTAIN/irrsched.html) for additional information and resources. In addition, Castlewood should also continue to conduct soil infiltration tests across the course, to ensure that the irrigation application rate does not exceed the infiltration rate. Test results should inform modifications to the irrigation timing and rate.

Third, whenever possible, continual updates to the irrigation system with new, more efficient technologies will improve water conservation over time. Irrigation decisions will be easier to implement with the entire course equipped with sprinkler heads that can be controlled remotely, and that operate using soil moisture sensors, estimates of evapotranspiration, and the course's weather station data. In addition, flow meters should be included so that water use can be accurately monitored and recorded. The use of specialized part-circle sprinkler heads can help ensure that water is not lost to parking lots, cart paths, out-of-play areas, ponds or riparian areas. Manual quick-coupler valves on all greens, tees and bunkers can allow for hand-watering as needed. Drip irrigation would supply water directly to individual plants during establishment in the native habitat landscape areas.

Develop a drought management plan and a water budget

Situated in a drought-prone climate, it would be prudent for Castlewood to prepare a drought management plan, in the event of another multi-year drought that reduces the water availability for irrigation of the course. The plan could set priorities for what areas would continue to receive irrigation, and other areas where reduction or elimination of irrigation could occur, allowing areas (e.g., some fairways) to be played dry or taken out of play (see CGCSA, 2020 for additional resources). As an initial starting place, Figure 3 highlights areas of the course that could be considered for temporary (or permanent) removal from irrigation and potential conversion to habitat areas. As part of the development of the drought management plan, the superintendent, maintenance staff and member committee should carefully consider each of these potential areas, and make decisions based upon maintaining playability, maintenance concerns and aesthetics.

Castlewood should also consider preparing a water budget, or an accounting of the water that enters and exits the golf course. The budget should include precipitation, irrigation, storage, evapotranspiration, surface runoff and infiltration/groundwater flow. In doing so, the budget would allow for assessment of the current irrigation practices and identification of opportunities to increase efficiency (for additional information, see California Department of Water Resources' California Irrigation Management Information System https://cimis.water.ca.gov/ or US Environmental Protection Agency's Water Budget Data Finder https://www.epa.gov/watersense/water-budget-data-finder). For example, the budget could highlight seasonal variability in the fate of irrigation that is applied, or it could highlight efficiencies relating to the source of irrigation water. Many municipalities now distribute recycled water ("grey water"), to use for landscaping that does not require potable water. The City of Pleasanton began installation of a recycled water system in 2016; however, it currently only distributes water to properties north of the golf course. Castlewood could reach out to the City to inquire about expansion plans and the future potential for delivering water

to the course. Turf does not require potable water, and its use at Castlewood could be an excellent demonstration of recycling and responsible water usage for the region.

Both of these actions encourage additional inspection of water usage across the course, and are designed to illustrate potential modifications or innovations that can increase water conservation. For instance, while there is already a difference in watering methods between tees, fairways, and greens, Castlewood could assess whether further differentiation could reduce overall water use while still upholding the quality of these in-play areas. Additionally, Castlewood could explore if a demonstration project that captures roof runoff from the clubhouse could be used to irrigate new pollinator gardens while also providing member education.

Modify turf composition and maintenance

An effective method of reducing water use is to reduce demand for water. If turf ever needs to be replaced, Castlewood could consider replacing the non-native Bermuda grass with a species of grass that would provide the characteristics desired of turf, yet require less irrigation. For example, red fescue (*Festuca rubra*) is a native, drought-tolerant species of grass. It grows in a turf-like form, and would be an adequate substitute wherever possible to install.

As golfers walk on the course, the soil surface gets compacted, which impedes water infiltration. If appropriate, Castlewood could consider slicing and spiking practices to reduce surface compaction and promote water infiltration.

Monitor for erosion

The course itself has very little erosion potential; however, the stretch of the Valley Course to the south of Castlewood Drive should be actively monitored, as it poses a safety hazard to golfers and risk to the playable area. Zone 7 is highly aware of this issue, and maintaining a connection with Zone 7 would be beneficial to both parties.

Related ACSP Standards

Chemical Use

- Select pest-resistant stress-tolerant plant species, suited to climate, soil, growing conditions.
- Regular soil testing to make decisions regarding fertilizer applications.
- Consider the environmental impact of pest control measures, e.g., leaching and runoff potential, toxicity to non-target organisms, soil absorption capacity, pesticide persistence, water solubility, effects on soil microorganisms.
- Keep records of where disease or insect outbreaks first occur, the treatments employed and their effectiveness.

Water Conservation

- Eliminate all non-target watering.
- Avoid running irrigation system at peak evapotranspiration times.
- Incorporate evapotranspiration rates or weather data into daily irrigation decisions.
- Keep records of daily water use, tally monthly usage, and set targets for yearly improvement.

Water quality management

- Identify the specific watershed in which the property is located, including where wastewater and runoff go after leaving the property.
- Employ environmentally-sensitive plant management techniques within 25 feet of all water bodies and well heads to minimize nutrient and chemical inputs.
- Raise mowing heights along in-play shorelines to slow and filter runoff.
- Reduce potential for nutrient loading into water bodies.
- Reduce/eliminate the need for chemical algae control in ponds through aeration, nutrient reduction, bio-filters, vegetation management, and/or bio-controls.
- Keep records of monitoring activities (including visual monitoring for water quality problems like algae, erosion, weed growth, fish kills, sediment buildup), results, and control measures taken if needed.
- Establish baseline data for representative water bodies and water sources that may be adversely affected by golf course operations.

Related California GCSA BMPs

- When mowing the lake edge, collect or direct clippings away from the water to areas where runoff will not bring the clippings into the lake or pond.
- Minimize the unintentional introduction of fertilizers and pesticides into ponds by creating a minimum 10 foot buffer around the pond perimeter. Many pesticides list a greater distance; always follow the label.

VIEW OF CASTLEWOOD'S VALLEY COURSE AND THE RAILROAD THAT PASSES THROUGH • PHOTO BY SFEI

- The use of vegetative buffers may reduce pesticide and fertilizer runoff into ponds.
- Implement an integrated pest management program.
- Minimize or eliminate any pest management that may result in adverse impacts to non-target animals.
- Record and map disease outbreaks and identify trends that can help guide future treatments. Consider changing manageable conditions in susceptible areas to reduce disease outbreaks.
- Consider the use of low toxicity repellants, such as garlic, putrescent whole egg solids, and capsaicin, to prevent or evict vertebrate pests when appropriate.
- In general, be aware of county, state, and federal laws pertaining to vertebrate pest management. Due to declining populations or genetic diversity, actions taken against specific animals (e.g., coyotes, mountain lions) may be limited. Please contact the resources mentioned at the beginning of this section for more information.
- Use resources such as the UC IPM Program to diagnose problems with turf and manage turf pests.
- California requires that if pesticides are used, a monthly Pesticide Use Report (PUR) be submitted to the County Agriculture Commissioner (CAC). Refer to Chapter 8: Pesticide Management for more information.

Related Urban Biodiversity Framework Elements

- Management: Human activities and planning that promote biodiversity supportive outcomes.

SWALLOWS USING NEST BOXES, SOUTH BAY • COURTESY OF CC 2.0, PHOTOS BY DON DEBOLD

A BIOBLITZ EVENT AT GOLDEN GATE PARK • COURTESY OF CC 2.0, PHOTO BY NERDS FOR NATURE

GREAT BLUE HERON AT CASTLEWOOD • PHOTO BY SFEI

3 Outreach and Education

Promoting outreach and education can provide various benefits to Castlewood's board, membership, and guests, while at the same time benefiting local wildlife through certain activities and citizen science. Its value is recognized by Audubon Cooperative Sanctuary Program (ACSP), which requires a plan for outreach and education (Audubon International, 2013). When people increase their daily observation of urban wildlife at a focal location, such as a bird feeder, they experience more relaxation and more feelings of connection to nature (Cox and Gaston, 2016). The well-being benefits are speculated to be even greater if a person possesses greater knowledge of different wildlife species (Cox and Gaston, 2015). Furthermore, volunteer participants in environmental stewardship programs report improvement in their well-being, citing the social aspect and learning about the environment as beneficial drivers (Molsher and Townsend, 2016).

Public interest in sustainability is on the rise. The implementation of better environmental management practices as described in this report can support the triple bottom line of sustainability for Castlewood: environmentally, economically, and socially. Sharing the story of environmental stewardship and motivation with the board, membership, guests, and neighbors has an important place in public relations. Castlewood's consideration and implementation of local improvements supports the community's health and well-being by contributing to regional biodiversity and water quality.

Furthermore, by hosting environmental stewardship events, Castlewood can start to build a volunteer base that can assist in activities, such as maintaining native vegetation landscaping and installing nest boxes for wildlife, potentially saving time for staff. Castlewood can use help from volunteers to jumpstart the wildlife observation database, which not only is required for ACSP certification but also can help inform future management decisions. An effective example is a BioBlitz, an engaging event where participants are challenged to record as many wildlife observations as possible and identify each animal to species. This event can be used to establish a baseline prior to any habitat enhancements, then repeated to assess changes in biodiversity on the course resulting from those enhancements.

A TREE PLANTED AT THE TOP OF THE BANK OF ARROYO DE LA LAGUNA • PHOTO BY SFEI

CURRENT CONDITIONS

Castlewood distributes information through an e-newsletter called "News from the Bunker" and a Club newsletter called "The Forecaster." Castlewood also maintains communications with the neighboring Homeowners Association.

In terms of events, Castlewood has hosted at least one nature walk for the employees of a company in Pleasanton. This type of activity requires relatively little effort, and could easily be expanded for other nearby companies or organizations. Castlewood annually hosts the Father's Day Fishing Derby, a family friendly event centered around the northeast ornamental pond, which is regularly stocked with bluegill, bass and catfish.

RECOMMENDED STRATEGIES

Assemble a Resource Advisory Group

For ACSP certification, a Resource Advisory Group is required (Audubon International, 2013). This group should consist of representatives of the country club as well as representatives across stakeholder groups, such as local community members and experts in ecology and water quality. The Resource Advisory Group should total between five and twelve members. Typically, the golf course superintendent chairs the group. The purpose of the group is to help guide environmental projects and educational efforts. The members of the group can change, but the group itself must be a permanent entity.

EXAMPLE OF INTERPRETIVE SIGN AT MAMMOTH LAKES • PHOTO COURTESY CC 2.0, BY KEN LUND

Install interpretive signs

Interpretive signs are a great way for visitors to learn along the way as they enjoy the course. After the cost of manufacture and installation, the maintenance of these signs poses a minimal cost. The signs can be small and non-intrusive to play, and help generate the recognition Castlewood deserves for becoming better environmental stewards. A larger sign giving an overview of the environmental management plan and anticipation of future certification from Audubon can be featured in the clubhouse. Interpretive signs can help visitors recognize the intent and value of natural habitat areas, and thereby reduce potential negative perceptions toward the different aesthetic of those areas.

Good opportunity locations for interpretive signs include:

- Benches where visitors can learn about Castlewood's environmental management practices as they rest,
- Landscaped areas that feature native species, reduce water usage, or provide water filtration,
- Along the cart path near stands of valley oaks,
- Ponds where a no-spray zone and a vegetative buffer have been implemented and native plants enhance the shoreline habitat, and
- Next to the bank setback project.

Another opportunity that leverages interpretive signs to educate visitors is a pollinator garden. An existing no-irrigation zone next to the clubhouse could be converted to drought-tolerant scrub, a habitat type that is highly supportive of insect pollinators as well as hummingbirds. This location would ensure high accessibility of the pollinator garden, and the interpretive signs could provide the species names of the plants, describe the drought-tolerant natural landscaping, and explain the many benefits of pollinators to sustaining ecosystems. Establishing a pollinator garden may also inspire visitors to consider such improvements for their own gardens.

Leverage partnerships to host community events

There are numerous ways to involve the community in Castlewood's environmental stewardship program. Community events could be planned to coincide with regular maintenance days, when the Valley Course and driving range are closed to play. The event and maintenance could be coordinated to prioritize the safety of event participants and also minimize interference to maintenance.

To effectively carry out education and outreach programs, Castlewood could benefit from building partnerships with other local organizations that already have necessary expertise and experience. Partnering with local biologists, bird-watchers, conservationists, and others would provide support for hosting an event. It could also build new connections to the community, heighten visibility of Castlewood's efforts to be better environmental stewards, and garner recognition as a supporter of environmental conservation. Potential partners near Castlewood include Ohlone Audubon Society (**ohloneaudubon.org**), Tri-Valley Conservancy (trivalleyconservancy.org), East Bay Regional Park District (ebparks.org), Livermore Area Park and Recreation District (larpd.org), Alameda Creek Alliance (alamedacreek.org), Living Arroyos (livingarroyos.org), Xerces Society (xerces.org), California Bluebird Recovery Program (cbrp.org) and California Native Plant Society (cnps.org).

There are numerous types of community events, and events that Castlewood already hosts for which the educational component could be enhanced. For example, for the Father's Day Fishing Derby, members could bring their families to the ornamental pond, where a local biologist or environmental educator could provide kid-friendly, interactive lessons on aquatic habitat and food webs. Guests could learn about the importance of ponds for birds, amphibians and turtles in a drought-prone ecosystem.

Another type of event is a nature walk, where a local expert can lead guests along the cart paths to visit the drought-tolerant, native landscape areas and the riparian habitat of ADLL. Some walks could have a special focus, like bird-watching or pollinators. Castlewood could host such an event specifically for neighboring property owners to build relationships and create more open lines of communication. For a self-guided option, visitors could be supplied with a map of various habitat features and the interpretive signs, as well as a species checklist, derived from the records of wildlife observed on the course.

A popular and effective community event is a BioBlitz. Participants of all ages are invited to search for the many species that inhabit and use the course and are challenged to record as many observations as possible. This could help support the ACSP certification requirement to have an ongoing record of wildlife observed on the course. Co-hosting the event with a partner that will act as on-site biology experts would help ensure higher accuracy in species identifications. There are many cost-free resources available on how to plan a BioBlitz. The website and smartphone app iNaturalist is commonly used for BioBlitzes, and, as one of the top citizen science programs in the world, iNaturalist will ensure that Castlewood contributes its wildlife records to enhancing scientific knowledge of the region's natural resources.

Similarly, but focused on bird species, the Audubon Society Christmas Bird Count is the longest running citizen science effort. Since Christmas Day 1900, Audubon has organized volunteer participants to record bird observations within an approximately two week window at over 2,500 sites, primarily across North America. Castlewood could work with a local Audubon chapter to become a new site and host a count.

Host environmental stewardship workdays

Many organizations enlist volunteers to help with stewardship projects. In particular, club members could be really helpful as volunteers, due to their familiarity with the site. Club members could adopt a section of habitat and take care of it, or serve as docents during nature walks and other educational activities. Other volunteers from the broader community could be recruited from the broader community as individuals or as a group. Partnering with a group, such as Boy Scouts of America, Girl Scouts of the USA, local 4-H hubs, or a local high school's Key Club, is advantageous because groups may have interest in a longer-term commitment. Groups may also have existing incentives internally that increase the likelihood of repeat volunteers. Repeat volunteers would lessen the time required of Castlewood's staff to recruit and train new volunteers. Tasks that could be accomplished by volunteers include:

- Constructing, installing and maintaining nest boxes (see the "Native Habitat and Wildlife Connectivity" section for details)
- Removing invasive plants and grasses from the native habitat areas
- Installing native plants and grasses in the native habitat areas
- Harvesting seeds in the fall from the native habitat areas
- Maintaining interpretive signs

VISITORS AT CASTLEWOOD'S VALLEY COURSE • PHOTOS BY SFEI

A REFLECTION ON COVID-19

As we write this report, COVID-19 continues to ravage our communities and reshape our future in ways that we still don't fully understand. Keeping people from coming into close contact with each other has become crucial in preventing the transmission of this novel coronavirus. This has called into question the ways in which we gather for social events, recreation, and exercise. It is likely that following public health guidance to contain the spread of the virus will impact the size, frequency, and types of events that can be held, and we recognize that some of the recommended strategies discussed here may need to be modified in order to align with public health requirements.

Related ACSP Standards

- Assemble Resource Advisory Group.
- Conduct at least two stewardship projects to engage employees, patrons, and community members.
- Create a display that highlights stewardship projects on the course and involvement with ACSP
- Develop written materials (e.g., informational hand-outs).
- Communicate with neighboring property owners.

Related Urban Biodiversity Framework elements

- Management: Human activities and planning that promote positive biodiversity outcomes.

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Appendices

APPENDIX A. ADDITIONAL RESOURCES

Topic		Resources
Nestboxes	General Information	Educator's Guide To Nest Boxes from The Cornell Lab https://www.birds.cornell.edu/k12/educators-guide-to-nest-boxes/
	Western Bluebird	Nest box plan and information for western bluebirds from The Cornell Lab's Nest Watch https://nestwatch.org/learn/all-about-birdhouses/birds/western-bluebird/?region=california-nevada&habitat=open-woodland
	Bats	Article from Bat Conservation International http://www.batcon.org/resources/media-education/bats-magazine/bat_article/574
	Barn Owl	Nest box plan and information for barn owls from The Cornell Lab's Nest Watch https://nestwatch.org/learn/all-about-birdhouses/birds/barn-owl/?region=california-nevada&habitat=open-woodland
Drought-tolerant, native plant selection		California Native Plant Society's Calscape website https://calscape.org Xerces Society recommended plants to benefit pollinators https://xerces.org/sites/default/files/2019-10/15-049_03_PPBI_CA-CentralCoast_web.pdf
Deer browse resistance rating of plants		Las Pilitas Nursery https://www.laspilitas.com/easy/deerfire.htm
Organizing a BioBlitz		iNaturalist BioBlitz Guide https://www.inaturalist.org/pages/bioblitz+guide
Integrated Pest Management: tools and resources		University of California Statewide Integrated Pest Management Program (UC IPM) http://ipm.ucanr.edu/
Toxicity information for current and future chemical products		National Pesticide Information Center http://npic.orst.edu/ UC IPM's pesticide active ingredients database http://ipm.ucanr.edu/PMG/menu.pesticides.php
Irrigation and Water Budget		California Department of Water Resources' California Irrigation Management Information System https://cimis.water.ca.gov US Environmental Protection Agency's Water Budget Data Finder https://www.epa.gov/watersense/water-budget-data-finder UC IPM's Guide to Healthy Lawns http://ipm.ucanr.edu/TOOLS/TURF/MAINTAIN/irrsched.html

APPENDIX B.
OBSERVATIONS OF SENSITIVE ANIMAL SPECIES WITHIN FIVE MILES OF THE VALLEY COURSE

Observations of the following sensitive species of plant have been recorded in the California Natural Diversity Database (CNDDB, 2019). * denotes federally listed species. # denotes state listed species.

Taxonomic Group	Scientific Name	Common Name
Amphibians	*Ambystoma californiense* *#	California tiger salamander
	Rana boylii #	Foothill yellow-legged frog
	Rana draytonii *	California red-legged frog
Birds	*Accipiter cooperii*	Cooper's hawk
	Agelaius tricolor #	Tricolored blackbird
	Aquila chrysaetos	Golden eagle
	Ardea herodias	Great blue heron
	Athene cunicularia	Burrowing owl
Crustaceans	*Linderiella occidentalis*	California linderiella
Fish	*Oncorhynchus mykiss irideus pop. 8* *	Steelhead trout - central California coast DPS
Insects	*Bombus crotchii*	Crotch bumble bee
	Bombus occidentalis	Western bumble bee
Mammals	*Antrozous pallidus*	Pallid bat
	Corynorhinus townsendii	Townsend's big-eared bat
	Myotis yumanensis	Yuma myotis
	Neotoma fuscipes annectens	San Francisco dusky-footed woodrat
Reptiles	*Emys marmorata*	Western pond turtle
	Masticophis lateralis euryxanthus *#	Alameda whipsnake

APPENDIX C.
OBSERVATIONS OF SENSITIVE PLANT SPECIES WITHIN FIVE MILES OF THE VALLEY COURSE

Observations of the following sensitive species of plant have been recorded in the California Natural Diversity Database (CNDDB, 2019). None are currently listed at the federal or state level.

Scientific Name	Common Name
Campanula exigua	Chaparral harebell
Centromadia parryi ssp. *congdonii*	Congdon's tarplant
Clarkia concinna ssp. *automixa*	Santa Clara red ribbons
Extriplex joaquinana	San Joaquin spearscale
Navarretia prostrata	Prostrate vernal pool navarretia
Plagiobothrys glaber	Hairless popcornflower
Polemonium carneum	Oregon polemonium
Spergularia macrotheca var. *longistyla*	Long-styled sand-spurrey
Streptanthus albidus ssp. *peramoenus*	Most beautiful jewelflower
Trifolium hydrophilum	Saline clover
Puccinellia simplex	California alkali grass

APPENDIX D. NATIVE HABITAT PLANTING PALETTES

Table D1. Drought-Tolerant Scrub Plant Palette

Level	Species Name	Common Name	On-Center Spacing (feet)	Deer Browse Resistance Rating
Shrub	*Arctostaphylos glauca*	Big berry manzanita	6	9
Shrub	*Arctostaphylos patula*	Greenleaf manzanita	6	9
Shrub	*Artemisia californica*	California sagebrush	6	5
Shrub	*Baccharis pilularis*	Coyote brush	6	8
Shrub	*Ceanothus cuneatus*	Buck brush	6	9
Shrub	*Ceanothus thyrsiflorus*	Blue blossom ceanothus	6	5
Shrub	*Epilobium canum*	California fuchsia	6	7
Shrub	*Eriogonum fasciculatum*	California buckwheat	6	6
Shrub	*Eriogonum nudum*	Naked buckwheat	6	6
Shrub	*Frangula californica*	California coffeeberry	6	8
Shrub	*Heteromeles arbutifolia*	Toyon	8	7
Shrub	*Rhus integrifolia*	Lemonade berry	6	8
Shrub	*Salvia mellifera*	Black sage	6	9
Forb	*Anaphalis margarita*	Pearly everlasting	seed	9
Forb	*Asclepias fascicularis*	Narrow leaf milkweed	4	9
Forb	*Asclepias speciosa*	Showy milkweed	4	9
Forb	*Achillea millefolium*	Common yarrow	4/seed	9
Forb	*Eschscholzia californica*	California poppy	seed	9
Forb	*Eriophyllum confertiflorum*	Golden yarrow	4	6
Forb	*Lupinus bicolor*	Miniature lupine	seed	9
Forb	*Lupinus nanus*	Sky lupine	seed	7
Forb	*Primula hendersonii*	Mosquito bill	seed	4
Grass	*Bromus carinatus*	California brome	seed	9
Grass	*Festuca idahoensis*	Idaho fescue	3/seed	9
Grass	*Stipa pulchra*	Purple needlegrass	4/seed	9

Table D2. Oak Woodland Plant Palette

Level	Species Name	Common Name	On-Center Spacing (feet)	Deer Browse Resistance Rating
Tree	*Quercus lobata*	Valley oak	14	5
Tree	*Quercus agrifolia*	Coast live oak	14	7
Shrub	*Baccharis pilularis*	Coyote brush	6	8
Shrub	*Ceanothus thyrsiflorus*	Blue blossom ceanothus	6	5
Shrub	*Epilobium canum*	California fuchsia	6	7
Shrub	*Eriogonum fasciculatum*	California buckwheat	6	6
Shrub	*Frangula californica*	California coffeeberry	6	8
Forb	*Achillea millefolium*	Common yarrow	seed	9
Forb	*Eschscholzia californica*	California poppy	seed	9
Forb	*Eriophyllum confertiflorum*	Golden yarrow	seed	6
Forb	*Lupinus bicolor*	Miniature lupine	seed	9
Grass	*Elymus glaucus*	Blue wild rye	seed	9
Grass	*Stipa pulchra*	Purple needlegrass	seed	9

Table D3. Riparian Plant Palette

Level	Species Name	Common Name	On-Center Spacing (feet)	Deer Browse Resistance Rating
Tree	*Acer negundo*	Boxelder	12	9
Tree	*Aesculus californica*	California buckeye	10	7
Tree	*Platanus racemosa*	California sycamore	16	4
Tree	*Quercus agrifolia*	Coast live oak	14	7
Tree	*Quercus lobata*	Valley oak	16	5
Shrub	*Cercis occidentalis*	Western redbud	10	7
Shrub	*Epilobium canum*	California fuchsia	6	7
Shrub	*Heteromeles arbutifolia*	Toyon	8	7
Shrub	*Ribes sanguineum*	Flowering currant	6	9
Shrub	*Rosa californica*	California rose	6	7
Shrub	*Rubus ursinus*	California blackberry	6	8
Shrub	*Sambucus nigra ssp. caerulea*	Blue elderberry	8	9
Shrub	*Symphoricarpos albus*	Snowberry	6	8
Understory	*Carex praegracilis*	Clustered field sedge	4	9
Understory	*Elymus glaucus*	Blue wild rye	4/seed	9
Understory	*Elymus triticoides*	Creeping wild rye	4/seed	9
Understory	*Festuca idahoensis*	Idaho fescue	4/seed	9
Understory	*Muhlenbergia rigens*	Deer grass	6	9
Understory	*Stipa pulchra*	Purple needle grass	4/seed	9

Table D4. Pond Edge/Transition Zone Plant Palette

Level	Species Name	Common Name	On-Center Spacing (feet)	Deer Browse Resistance Rating
Tree	*Salix lasiolepis*	Arroyo willow	8	5
Forb	*Erythranthe guttata*	Seep monkeyflower	4	5
Forb	*Sisyrinchium bellum*	Blue eyed grass	4	8
Grass-Mat Forming	*Agrostis pallens*	Bent grass	sod/seed	9
Sedge-Mat Forming	*Carex pansa*	Sand dune sedge	sod/seed	9
Grass-Mat Forming	*Festuca rubra*	Red fescue	sod/seed	9
Segde-Bunch forming	*Carex nudata*	Naked sedge	4	9
Sedge-Bunch forming	*Carex praegracilis*	Clustered field sedge	4	9
Grass-Bunch forming	*Hordeum brachyantherum*	Meadow barley	4/seed	9
Rush-Bunch forming	*Juncus mexicanus*	Mexican rush	4	9
Rush-Bunch forming	*Juncus patens*	Spreading rush	4	9

Table D5. Native Rough Plant Palette

Level	Species Name	Common Name	On-Center Spacing (feet)	Deer Browse Resistance Rating
Grass-Mat Forming	*Agrostis pallens*	Bentgrass	sod/seed	9
Sedged-Mat Forming	*Carex pansa*	Sand dune sedge	sod/seed	9
Grass-Mat Forming	*Festuca rubra*	Red fescue	sod/seed	9
Grass-Bunch forming	*Festuca idahoensis*	Idaho fescue	3/seed	9
Grass-Bunch forming	*Stipa pulchra*	Purple needlegrass	4/seed	9

Table D6. Aquatic/Wetland Plant Palette

Level	Species Name	Common Name	On-Center Spacing (feet)	Deer Browse Resistance Rating
Short	*Eleocharis macrostachya*	Spikerush	3/natural recruitment	10
Tall	*Schoenoplectus acutus*	Hardstem bulrush	5/natural recruitment	10
Tall	*Schoenoplectus californicus*	California bulrush	5/natural recruitment	10
Tall	*Typha spp.*	Cattails	5/natural recruitment	10

APPENDIX E. URBAN BIODIVERSITY FRAMEWORK

The urban biodiversity framework consists of seven elements, described as the characteristics of urban landscapes that support biodiversity (taken from Spotswood et al., 2019).

Element	Definition
Patch Size	The size of a contiguous patch of greenspace in a city (at least 2 acres in size).
Connectivity	Features in the urban landscape that facilitate the movement of plants and animals. Connections include corridors (thin stretches of greenspace that promote linear movement) and stepping stones (sets of discrete but nearby patches that together promote connectivity across the landscape).
Matrix Quality	Habitat elements that support ecological process and movement in the urban matrix between patches of greenspace and corridors.
Habitat Diversity	The type, number, and spatial distribution of habitat types within an urban area. Together, mosaics of habitats create diversity in habitat types at the landscape scale.
Native Vegetation	Plant species long evolved in a specific geography (including nearby species that may be appropriate in the near future, given anticipated range shifts with climate change).
Special Resources	Unique habitat features necessary to support species' life history requirements, including large trees, wetlands, streams, and rivers.
Management	Human activities and planning that promote positive biodiversity outcomes.