Canoa Hills Trails
An Open Space Park

Master Plan - DRAFT
February 24, 2021
The Site

The 139-acre site occupies the former Canoa Hills Golf Course in Green Valley, Arizona. It consists of 7 parcels that sit in natural drainages between existing elevated suburban developments, and it straddles a major north-south vehicular route, Camino Del Sol. Parcels are connected by residential streets with culverts large enough to accommodate golf cart passage beneath Camino Del Sol.

The Canoa Hills Golf Course was in operation from 1984 to July 2013. In 2014 it was bought along with San Ignacio Golf Club by Borderland Construction, but never reopened due to prohibitive costs and a lack of perceived need in an area with several other prominent and functioning golf courses. This led to the donation of the property to Pima County Regional Flood Control District in December 2018 for the purpose of being rehabilitated into a public nature park. The entirety of the former Canoa Hills Golf Course makes up the site for the Canoa Hills Trails Park, except for the clubhouse and parking lot associated with the golf course.

Project Scope

Primary goals set forth by Pima County Flood Control include enhancing passive recreation and wildlife habitat by restoring the park to native plant communities, mitigating erosion issues, and enhancing floodplain function. Because budget and maintenance for Canoa Hills Trails Park is limited, design should be economical, functional, and efficient. Initially the park will use water from Canoa Ranch to irrigate restored areas, but this will be removed once native plant communities are well-established. Native vegetation on site must be able to thrive without supplemental irrigation or significant care. The master plan should minimize the need for maintenance and actively promote resilient native plant communities. Exceptions may be made for strategically located pollinator gardens that are cared for by project partners.

This report was completed between September 2019 and May 2020 by Tess Wagner, a University of Arizona Master of Landscape Architecture Student. Professor Margaret Livingston, PhD, was the primary faculty advisor for this project.
The following Literature Reviews were completed to provide comprehensive information on several topics related to the development of Canoa Hills Trails. Researched topics include:

1. **NOVEL ECOSYSTEMS | Ecological restoration in developed areas**
2. **ENGAGING COMMUNITIES WITH THE LANDSCAPE | Land stewardship, volunteering & citizen science**
3. **NATURE INTERPRETATION | Approaches and considerations for effective education in a nature park setting**
While the physical disturbances and challenges human-dominated
influenced by urban development (Alberti, 2005; Elmqvist et al., 2013).
patch size, shape, connectivity, and composition are also significantly
open spaces may have limited migration potential to the site. Open space
limited connectivity to other open spaces, exotic species found in the other
unwanted species (Alberti, 2005). On the other hand, if an open space has
which can disrupt native ecologies and make it difficult to eradicate these
non-native and/or invasive vegetative material to adjacent open spaces
flooding, erosion, and transport of human pollution such as heavy metals
hydrology altered through culverts and other diversions result in increased
on the native open spaces surrounding them (Elmqvist et al., 2013).
Developed areas are generally seen to have a net negative physical impact
ecosystems are anthropogenically altered but there is potential for the impacts to
reversed, and “novel” ecosystems have been so structurally, functionally,
and compositionally altered that they cannot be reverted to their historic
remained unchanged by humans, “hybrid” ecosystems have been anthropogenically altered but there is potential for the impacts to be
reversed, and “novel” ecosystems have been so structurally, functionally,
and compositionally altered that they cannot be reverted to their historic
conditions (Hobbs et al., 2006; Hobbs, Higgs, & Hall, 2013). Novel
ecosystems are common in and near to heavily developed areas, and
they feature new interactions amongst native and non-native species not
previously occurring in a landscape (Green, 20 3; Perring, Standish, &
Hobbs, 20 3).
Ecological restoration initiatives have historically focused on hybrid
ecosystems, attempting to replicate historic conditions on degraded lands
through the reestablishment of natural processes, the eradication of non-
native species, and the reintroduction of native species (Green, 20 3; Gross
& Hoffmann-Riem, 20 5). While in some cases this is an appropriate
approach, intensifying climate change impacts, shifting ranges of biotic
communities, and continued human development and expansion have
left much of the earth so altered that a return to historic conditions is
often impractical, infeasible, and unsustainable (Green, 20 3; Hobbs
et al., 20 3). This has led to increased attention on the acceptance of
novel ecosystems as a restoration goal, and the recognition of humans
as a dynamic and permanent influence on ecosystems around the world
(Perring et al., 20 3). Although novel ecosystems are seen as less desirable
and ecologically healthy when compared with historic conditions, a
focus on designing a novel ecosystem that intentionally provides specific
ecosystem services can result in a functional and sustainable novel
ecosystem (Perring et al., 20 3).
Identifying the overall restoration goal, and if the landscape represents
a hybrid or novel ecosystem (or somewhere on a gradient in between) is
a good place to start when developing an appropriate restoration plan.
Understanding and comparing past and present site conditions, inputs,
context, and human use is necessary to understand what can realistically
be restored and what modifications will need to be accepted to benefit
both people and the landscape (Gross & Hoffmann-Riem, 20 5). Furthermore, it is important to consider the role of all non-native species
in the present ecosystem, as in some cases native species have developed
a reliance on non-native species and removing certain non-natives could
have an overall detrimental effect on ecosystem function and the survival
of important sensitive species (Gross & Hoffmann-Riem, 20 5; Miller &
Bestelmeyer, 20 8). In short, present conditions should be understood and
studied and existing positive functional relationships should be maintained
when possible.

Defining Realistic Restoration Goals
In 2006, Richard Hobbs proposed a new way of defining ecosystems for
restoration purposes by classifying them into three categories: “historic”
ecosystems remain unchanged by humans, “hybrid” ecosystems have been
anthropogenically altered but there is potential for the impacts to be
reversed, and “novel” ecosystems have been so structurally, functionally,
and compositionally altered that they cannot be reverted to their historic
conditions (Hobbs et al., 2006; Hobbs, Higgs, & Hall, 20 3). Novel
ecosystems are common in and near to heavily developed areas, and
they feature new interactions amongst native and non-native species not
previously occurring in a landscape (Green, 20 3; Perring, Standish, &
Hobbs, 20 3).

Restoring Novel Ecosystems
The field of ecological restoration is experimental by nature and successful
restoration projects typically involve multi-disciplinary participation from
experts as well as the local community (Gross & Hoffmann-Riem, 20 5).
As previously mentioned, community participation and stewardship is an
important component of implementing and maintaining urban ecological

Introduction
Supporting native ecological parks surrounded by development requires
special consideration for the anthropogenic influences surrounding and
interacting with the park. Identifying and acknowledging the differences
between developed and native ecosystems is important in understanding
interactions between the two, the interventions needed at the urban-
native interface to support resilient and biodiverse native communities,
and the feasibility of restoration goals. This understanding is necessary
to intentionally emphasize assets and ecosystem services of both native
ecological and human systems, and to foster positive exchanges between
the two. The following review summarizes challenges and opportunities
associated with ecological restoration projects in developed areas, the
definition and management of novel ecosystems, and important
considerations needed to design and implement a successful restoration
project surrounded by human development and activity. Finally, this
information is considered in the specific case of Canoi Hills.

The Developed-Native Interface
Developed areas are generally seen to have a net negative physical impact
on the native open spaces surrounding them (Elmqvist et al., 20 3). Impervious
urban surfaces draining into native open spaces and upstream
hydrology altered through culverts and other diversions result in increased
flooding, erosion, and transport of human pollution such as heavy metals
and oils (Alberti, 20 5). Landscape plantings create a constant source of
non-native and/or invasive vegetative material to adjacent open spaces
which can disrupt native ecologies and make it difficult to eradicate these
unwanted species (Alberti, 20 5). On the other hand, if an open space has
limited connectivity to other open spaces, exotic species found in the other
open spaces may have limited migration potential to the site. Open space
patch size, shape, connectivity, and composition are also significantly
influenced by urban development (Alberti, 20 5; Elmqvist et al., 20 3).

While the physical disturbances and challenges human-dominated
restoration projects, and community insights and concerns should be considered throughout the restoration design and application process (Gobster, 2001; Gross & Hoffmann-Riem, 2005). Recreation needs must be balanced with restoration goals to ensure that the open space is functional both ecologically and socially, and to keep stakeholders engaged with the continued care of the space (Gross & Hoffmann-Riem, 2005).

Because the restoration process and plan work with dynamic social and natural systems, it is important to recognize the need to adapt and change the restoration plan as new information surfaces (Gross & Hoffmann-Riem, 2005). Ecological restoration is always an iterative process of planning, implementation, learning, and responding to new knowledge, but in the context of heavily human-dominated it is further complicated and changeable with the influence of social systems.

### Applicability to Canoa Hills Trails

Understanding the contextual suburban influences acting on the Canoa Hills site is important in identifying an appropriate and feasible restoration plan. The size, shape, and connectivity of patches within Canoa Hills are completely defined by the surrounding urban landscape and the current and potential ecological composition is largely determined by these influences. This is an unchangeable property of the site, and restoration activities must be appropriate and realistic for this context. Because the site is divided into several open spaces surrounded on all sides by subdivisions and roads, managing urban interactions with all sections of the site will be critical in creating and maintaining an ecologically and hydrologically functional landscape. Detaining and remediating run-off from the surrounding subdivisions would be beneficial, as would continued monitoring and active removal of non-native invasive vegetation.

Encouraging community stewardship of the site will likely be an effective way to maintain and support the rehabilitated native ecology, and community engagement should be incorporated throughout the design and implementation process.

The Canoa Hills landscape has been significantly fragmented, and the drastic hydrologic changes due to groundwater over-extraction and grading changes made in the surrounding suburban and agricultural areas and through the golf course development make the restoration of Canoa Hills to exact pre-development conditions infeasible. Furthermore, continued pollution from suburban areas, upstream mining activity, and possible changes in soil chemistry and composition from golf course installation and maintenance are a further alteration that will be difficult to reverse. A restoration plan for this area should respond to these facts and propose realistic goals and solutions. The concept of a novel ecosystem may be helpful in defining restoration goals and master planning for Canoa Hills, looking forward and incorporating human disturbance and continued activity as an integral and potentially beneficial component of the Canoa Hills ecology.

### References

Introduction

Today, human actions impact virtually all terrestrial ecosystems on earth. While we often (accurately) view ourselves as the cause of environmental degradation and damage, it is also important to realize our power to care for, restore, and enhance the landscapes we occupy. Due to limited funds and staff, land stewardship and volunteerism are often critical in natural resource and public land management. Volunteers can assist with restoration and monitoring activities, educational and other events, and general care and upkeep of a park. They can also alert land managers about issues arising in the park by providing additional sets of eyes on the park. The following review summarizes the necessary components in effective stewardship programs, considerations for recruiting and retaining an active volunteer base, and extending land stewardship beyond the site by promoting small-scale, at-home habitat creation and incorporating citizen science into volunteer projects.

Dimensions of Stewardship: Care, Knowledge, & Agency

In a review of stewardship definitions and applications, Enqvist et al., 2018, identified three dimensions promoted through successful stewardship initiatives that could be useful in guiding the development of effective stewardship programs. “Care” describes the relationship between people and landscape, including personal attachment, aesthetic values, feelings of responsibility, morality, ideology, and identity both at the individual and community level (Enqvist et al., 2018; Nassauer, 2011). Establishing care is a critical base for successful stewardship programs, as it fuels the motivation and interest of stakeholders, encouraging them to initially participate in stewardship activities (Enqvist et al., 2018; Nassauer, 2011). The idea of “care” encompasses not only the actions of caring for a landscape – it necessitates that the care be noticeable and understandable by the general public, as recognized by Nassauer, 1995, with her concept “cues to care”. Because ecologically robust and resilient landscapes are not readily legible as such by most individuals, evidence of intentional human intervention in a landscape becomes “cues to care” – signs to other visitors that a landscape has value and should continue to be cared for (Nassauer, 1995). These cues are necessary for the continued stewardship and care of a landscape, and are especially important in ecological landscapes such as the Canoa Hills site, where important environmental relationships and functions may not be visible (Nassauer, 1995).

“Knowledge” is the second stewardship dimension identified by Enqvist et al., 2018, and refers to the importance of land stewards in understanding the resources, ecology, and dynamic processes that comprise a site. It also stresses the need for continued learning and informed response to site conditions as stewards engage and work with the site (Enqvist et al., 2018). The knowledge dimension is necessary in promoting successful execution of stewardship initiatives, and it includes collective memory as well as scientific, indigenous, and experiential information sources (Enqvist et al., 2018).

Finally, Agency is defined as the ability of stewardship activities to take effect (Enqvist et al., 2018). It is determined by individual and communal capacities as well as the particular response of a given landscape to specified stewardship activities (Brown & Westaway, 2011; Enqvist et al., 2018). It determines which stewardship goals are realistic and feasible for a given socio-ecological setting, and takes into consideration the uniqueness and individuality of the community, individual, landscape, and the relationship between the three.

Recruiting and Retaining Volunteers

Recruitment of individuals for participation in environmental stewardship activities can be divided into active (in-person connections and demonstrations) and passive strategies (impersonal interactions such as mailed pamphlets and outreach through social media). Unsurprisingly, in-person active strategies are generally more effective at recruiting functional and committed environmental stewards than passive strategies (Guzman, Malarich, Large, & Danoff-burg, 2018).

Understanding volunteer motivations and how they change over time is necessary in designing stewardship programs that effectively recruit and retain volunteers. The primary motivation for initially participating in volunteer citizen science projects and environmental conservation activities is typically to help or enhance the environment (Alender, 2016; Asah & Blahna, 2012; Donald, 1997; Ryan, Kaplan, & Grese, 2001). Site visitors who are involved with conservation activities are more likely to visit parks for birding and nature viewing than for other activities (Hvenegaard & Dearden, 1998). This indicates that enhancing opportunities for these types of nature activities could attract visitors that are more likely to become park volunteers.

Other important motivators are to build community, connect with nature, and contribute to science (Alender, 2016). Additionally, retirees and older volunteers (such as those that comprise the volunteer base at Canoa Hills) typically rate personal gain – such as career development or enhancing an individual’s standing within a community – as significantly lower volunteer motivation than younger demographics (Alender, 2016). Thus, highlighting the environmental enhancement, community building, and scientific contributions facilitated by stewardship activities may be a persuasive communication tactic to initially engage Green Valley community members in stewardship activities.

While environmental and ecological enhancement is typically the primary reason for individuals to initially engage with environmental stewardship activities, ongoing volunteer engagement and overall level of commitment is often related to completely different factors (Asah & Blahna, 2012; Ryan et al., 2001). In particular, social benefits largely influence the frequency and duration of an individual’s volunteerism (Asah & Blahna, 2012; Donald, 1997; Ryan et al., 2001). Providing opportunities for volunteers to build social networks and friendships within stewardship and volunteer activities is recognized as being an important element in retaining engaged, active, and long-term volunteers (Donald, 1997; Ryan et al., 2001). Volunteer projects that have immediate and noticeable direct impacts also inspire continued activism by volunteers, as do volunteer...
opportunities that facilitate continued volunteer learning (Moskell, Allred, & Ferenz, 2017). Additionally, maintaining communication over the long term with volunteers helps them stay engaged and feel valued (Moskell et al., 2017). These findings indicate that creating volunteer and stewardship programs that intentionally build social connections, provide tangible and immediate results, and continue to enhance the learning of participants are important factors in maintaining long-term volunteer engagement.

**Stewardship Beyond the Site**

The majority of environmental stewardship initiatives focus on interventions for one specific site such as a particular watercourse, park, or open space (Fisher, Campbell, & Svendsen, 2012). While this is the case for Canoa Hills, there is also an opportunity to extend stewardship activities and thinking beyond the boundaries of the site by encouraging volunteers to consciously implement ecological and environmental enhancements within their own private yards. By teaching volunteers and site visitors about native ecology and opportunities for simple at-home interventions with visible impacts, land stewardship and environmental consciousness is encouraged to percolate beyond the site.

Over the past decade, citizen science has gained popularity as a tool to understand large-scale environmental patterns, species occupancy, and migration (McKinley et al., 2017). In addition to contributing to scientific data, citizen science requires participants to continually pay attention to environmental features they may otherwise not notice, such as the phenology or migration patterns of a particular species. This provides a more intimate understanding and more nuanced perspective of the environment, and can result in increased awareness and interest in related issues and policies (McKinley et al., 2017). Additionally, citizen science contributes to large-scale (sometimes global) scientific datasets, extending the positive impacts of volunteer citizen scientists far beyond the site scale.

**Applicability to Canoa Hills Trails**

There is already a robust community interest in participating in the development and care for Canoa Hills by neighbors, other Green Valley council and community members, and the Friends of the Canoa Parks group. Providing volunteer events and activities that not only address Pima County restoration and environmental goals but also incorporate opportunities for socialization, community building, and education could be beneficial in retaining engaged volunteer groups. Individual and community motivations for volunteering should be considered and adequately incorporated into volunteer activities to maintain an enthusiastic and consistent volunteer base.

Encouraging volunteers to apply ecological principles to their own homes and yards could be an effective way to extend stewardship outside the site boundaries. Specific education opportunities about stormwater harvesting and appropriate yard plantings that provide wildlife habitat and food could be beneficial for these purposes. In addition to fostering community consciousness and care for native wildlife and ecology, these small-scale, home-based interventions could result in direct benefits to Canoa Hills through the creation of wildlife habitat and management of stormwater runoff from residential areas upstream of and adjacent to the site. Citizen science could also be a beneficial activity to strengthen human-landscape connections, promote ecological literacy, and extend beneficial site impacts well beyond the boundaries of Canoa Hills.

**References**


NATURE INTERPRETATION | Approaches and considerations for effective education design in a nature park setting

Introduction

Interpretive programs and materials are often used in nature parks to provide visitors with information and perspectives that align with park management goals (Hughes & Saunders, 2005). The following summary provides a review of basic types of interpretation styles, approaches and considerations guiding interpretation design, and the specific relevance and applicability of this information in a nature park setting, and in particular Canoa Hills.

Interpretation Basics: Personal and Non-Personal Methods

Interpretation is generally divided into personal and non-personal types. Personal interpretation involves face-to-face contact with an interpreter or educator through a guided program, discussion, or lecture, while non-personal interpretation involves no contact with an interpreter or educator, relying on interpretive signage, brochures, electronic media, and other types of interpretive exhibits and displays to facilitate visitor learning (Ren & Folta, 2016; Weiler & Ham, 2016).

Personal interpretation is generally considered to produce more effective learning outcomes (in the form of more knowledge gained and longer knowledge retention periods) than non-personal interpretive methods, and has the added benefit of being able to answer specific visitor questions and tailor the experience to a specific visitor group (Hughes & Saunders, 2005; Ren & Folta, 2016). However, personal interpretive programs generally require adequate staffing, funding, and visitation to justify implementation and are thus not realistic in all scenarios. They can, however, be provided in more creative ways when staffing and funding is limited, such as through the implementation of community gardens, pollinator gardens, or other plots of community cared-for land that is left largely or completely up to the community; this type of learning through doing provides a different type of educational opportunity that may be more accessible and engaging to some individuals and when led by a knowledgeable volunteer or community member, could function as a personal interpretive experience (Krasny & Tiddall, 2009).

The primary activity a visitor engages with can be indicative of their level of learning from non-personal, on-site interpretive materials. Individuals who visit a site primarily for “exploratory” purposes – such as walking, running, or nature viewing – are generally more likely to engage with and learn from non-personal interpretive materials than those who visit a site primarily for recreation activities such as fishing, boating, picnicking, or sports (Ballantyne, Packer, & Beckman, 1998; Hendee, Gale, & Catton, 1971). Interpretive elements are often targeted to specific user groups to integrate with their experience of the site, reasons for visiting, and interests, and to hopefully reach more visitors whose primary activity is a recreational one (Hughes & Saunders, 2005). On-site interpretive materials should thus be designed to integrate with the activities visitors are likely to engage with in particular areas, and they should include information and presentation that is most likely to interest and engage them (Hughes & Saunders, 2005). Non-personal interpretation is greatly enhanced when visitors can observe or otherwise experience the interpretation topic within the landscape, such as with wildlife viewing (Ren & Folta, 2016). This can be an impactful and memorable experience for visitors by sparking their interest in and appreciation for the components of the landscape around them – feelings that may not occur with such intensity with just the knowledge gained through personal or non-personal interpretation methods (Ren & Folta, 2016).

Considerations for effective and respectful interpretation

In the literature, education is often broken down into formal and informal learning environments and methods (Markwell, 1996; Skanavis & Giannoulis, 2009; Wells, Butler, & Koke, 2016). Formal education encompasses learning in a traditional schooling setting, where learning outcomes are rigidly defined and facilitated by an educator, and participation is externally motivated (Markwell, 1996; Wells et al., 2016). Informal learning is self-motivated and includes learning environments such as non-personal education in parks, zoos, and museums (Markwell, 1996; Wells et al., 2016). Although informal learning encompasses both personal and non-personal forms, this summary will focus on non-personal forms as that is relevant to interpretive exhibits and elements at Canoa Hills.

Because formal and informal learning types include very different motivations and learning outcomes, relying solely on traditional formal pedagogical techniques focused on relaying information is not adequate in informal learning environment (Knowles, 1980; Markwell, 1996; Skanavis & Giannoulis, 2009). Informal learning opportunities must be fun and engaging to retain the attention of self-motivated learners. They should spark curiosity and creativity, and enhance the development of compassion and skills that relate to the interpretive topic (Markwell, 2004; Skanavis & Giannoulis, 2009). In the case of nature interpretation, a balance should be met between relaying factual information, enhancing the development of decision-making and problem-solving skills that contribute to environmental literacy, and creating opportunities to emotionally engage with a landscape to inspire care and connection to a place (Markwell, 1996, 2004). Additionally, nature parks should not be solely interpretive landscapes, as this can ultimately inhibit visitors’ engagement with a site (Markwell, 2004). Areas free of interpretive elements should be present, so that visitors can experience a place on their own and explore their own connection and feelings about a place (Markwell, 2004).

Recognized as global leaders in landscape interpretation, the U.S. National Park Service (NPS) often guides widespread trends in interpretation. Recently, they have acknowledged the one-sided, Anglo-American perspective that dominates interpretation within NPS sites and made efforts to incorporate Native American, African-American, Mexican-American and other minority voices and perspectives into their narrative (Coslett & Chalana, 2016). Incorporating these different perspectives and stories makes the interpretive narrative richer and more interesting and engaging to a wider range of people (Coslett & Chalana, 2016). This
Applicability to Canoa Hills Trails

Although staffing constraints and low visitation make regular staff-led personal interpretation unrealistic at Canoa Hills, there are still options for engaging visitors through personal interpretive experiences. Potential experiences include education through volunteer participation in restoration activities, guided nature walks (potentially led by community members with particular interest in birding and/or other environmental topics), and education through implementing and caring for community managed spaces that include habitat and pollinator gardens.

Non-personal interpretive materials will comprise the majority of interpretive experiences at Canoa Hills. These materials are important for educating and engaging all visitors who enter the site. Design of these materials should consider park programming and likely potential visitors, responding with presentation and information that will align with visitor interests and activities. Interpretive approach and content may vary throughout the site, based on expected activities and user groups. Pointing out areas where specific wildlife and/or other environmental features are present on site will be helpful in strengthening the connection between visitor and landscape. It may also be useful to design separate materials specifically to guide personal interpretive events such as those mentioned above. These materials could help guide volunteers in restoration activities and appropriate plantings for community managed areas when County staff are not on site and to ensure that County management goals are met.

Areas without interpretive elements should be designated at Canoa Hills, to allow visitors to explore their own connection with the site, free of distraction and influence by interpretive materials.

Non-Personal Interpretive Design

Interpretation design begins with the development of a communication plan that defines interpretive objectives, key message, and audience (Bruno & Wallace, 2019). Interpretive elements within the landscape should respond to the landscape and relate to it, engaging visitors further with the site (Bruno & Wallace, 2019). Language used should be concise and clear and speak in an active voice to engage individuals, and technical or scientific language should be rewritten to be understandable by the general public (Bruno & Wallace, 2019; Colquhoun, 2005; Trapp, Gross, & Zimmerman, 1994). Interpretive panels should consider the 3-30-3 rule presented by Trapp et al. (1994): the panel title should be large and readable within 3 seconds, a summary of the key message should be below this and readable within 30 seconds, and the body text should be readable in no more than 3 minutes. Graphical imagery is the first thing people notice about an interpretive display, so images should be large and carefully selected to engage visitors and to set the tone of the narrative (Bruno & Wallace, 2019).

Several techniques can be used to enhance understanding of presented material. Relaying scientific and factual information through story-telling can be an effective technique to make otherwise dry information more accessible and interesting to the public (Bruno & Wallace, 2019). Active learning, where individuals are engaged in activities or thought experiment is also an effective learning technique (Bruno & Wallace, 2019).

References


Four case reviews are presented in the following chapter. They illustrate successful projects that incorporate concepts and/or partnerships similar to those that exist with the Canoa Hills Trails Park project. These reviews will help inform the development of the Master Plan. They include a golf course converted to a nature park in Cleveland, OH, a restoration planning document, a restoration project completed by Pima Flood Control in Tucson, and an interpretive birding landscape in Patagonia, AZ managed by the Tucson Audubon Society (a partner in the Canoa Hills Trails Park).
**Description:** Golf course restored to nature park

**Location:** Cleveland, OH

**Date:** 2012-present

**Summary:** Acacia Country Club was a 155-acre golf course acquired by Cleveland Metroparks in 2012 through an anonymous donation managed by the Conservation Fund (Cleveland Metroparks, 2014). The site is surrounded by residential and commercial areas with major roadways on two sides, and it is largely fragmented from existing open space and natural areas, not unlike Canoa Hills. The Acacia Reservation Ecological Restoration Master Plan was completed in 2014 by Biohabitats, and re-imagines the golf course as a nature preserve and open space park, balancing ecological and recreation goals to create Acacia Reservation. Prior to restoration activities, the site was primarily comprised of turf with limited succession, an unstable and eroding creek channel winding through the site, and several human-made water features (Cleveland Metroparks, 2014). Initial studies of the site included a soil inventory and analysis to determine pre-golf course ecological assemblages, and initial interventions focused on removal of constructed drainage systems to restore hydrologic conditions – although some of the old irrigation system was left in place as it was considered a minimal impact on restoration activities (Cleveland Metroparks, 2014; Frolik & Fecteau, 2018).

The restoration plan outlines two primary goals: restoring surface and sub-surface hydrologic conditions, and transitioning the site to include a mosaic of native ecologies, and stresses the importance of integrating these goals with park use and stewardship programs. The resulting master plan broadly divides the site into ecologic zones and land-cover such as meadows, different types of forests, and an array of wetlands. It details nine restoration strategies for six identified habitats including streams, forests, ponds, wetlands, meadows, and a green infrastructure habitat implemented around developed areas. Regenerative design is stressed as an important theme in the plan by enhancing the connection between people and landscape and increasing the resilience, biodiversity, and stewardship of the park through restoration awareness and activity. Events and features to support regenerative design in Acacia Reservation include volunteer plantings and invasive species removal, citizen science opportunities and Bioblitzes, interpretive displays along trails, and signage and mobile apps that highlight the changing landscape over time.

**References:**

**Design Implications**
Acacia Reservation is of similar size and occupies a similarly developed area to Canoa Hills. The identification of broadly categorized restoration areas in the Acacia Reservation Ecological Restoration Master Plan can serve as a guide for the scope and detail that is feasible and useful for the Canoa Hills Master plan. Additionally, the integration of stewardship and visitor use with restoration activities through a regenerative design approach is highly applicable to Canoa Hills, especially considering the already robust interest from stakeholders in participating in the development of the Canoa Hills park. Interpretive elements, citizen science opportunities, and volunteer days could contribute to stewardship at Canoa Hills. Additionally, the identification of a “green infrastructure habitat” as the interface between the golf course and the surrounding developed area is a useful concept to handle adjacent residential stormwater run-off.
RESTORING BRITISH COLUMBIA’S GARRY OAK ECOSYSTEM

Description: Restoration planning document
Location: British Columbia, Canada
Date: 2011

Summary: Restoring British Columbia’s Garry Oak Ecosystem is a regional guide written by 12 academics and ecologists for restoration practitioners working on Garry oak restoration projects. Although the plan is written for an ecosystem that is not present in southern Arizona, it includes chapters on outreach and public participation, defining restoration goals, and understanding context – all ideas that are broadly applicable to any public space restoration project.

Six principles supported the development of the guide, and several could be useful for the Canoa Hills project. One principle is to adopt an eco-cultural approach, considering humans as a component of the ecosystem that should be integrated into all phases of the restoration process from planning through implementation and monitoring. Another important principle is the application of adaptive management which emphasizes the need for flexibility and adjustment of the restoration process when unexpected results occur, or new knowledge comes to light. The third relevant principle is to set clear objectives – is there a certain habitat or function the restoration project should promote? The plan suggests that rather than focus on restoring sites to a particular state, focus should be placed on restoring four fundamental processes: water cycling, nutrient cycling, energy flow, and succession. The plan also stresses the importance of understanding past conditions and the feasibility of replicating these conditions, considering the role of climate change and other anthropogenic influences in designing a restoration plan.

Congruent with other research conducted for this report, Restoring British Columbia’s Garry Oak Ecosystem emphasizes the importance of public participation and stakeholder engagement to ensure a successful restoration process, starting by featuring the community as an important component in the project program. Considerations are outlined for determining an overarching communication/outreach strategy to guide interaction with stakeholders throughout the project process.

These considerations include:
- The definition of communication objectives
- Understanding of who the audience is as well as their perspectives, concerns, backgrounds, and what they want to gain from the communication
- Determining the key message and how best to communicate this clearly and concisely
- Identifying the best formats of communication, outreach, and/or education in achieving communication objectives, and how the community can communicate their concerns
- Understanding communication resources available
- Determining evaluation criteria for understanding success of communication (number of people who responded, overall response of participants etc.)
- Adjusting communication methods based on evaluation and learning throughout the communication process

References:

DESIGN IMPLICATIONS

Restoring British Columbia’s Garry Oak Ecosystem stresses the importance of adaptive management and focusing projects to restore processes rather than a specific state. These ideas suggest the importance of a restoration plan that is changeable and not too focused on small details, which should be kept in mind throughout the master plan design process. Understanding the past, present, and projected climatic, physical, and social context is also an important concept identified in the plan which should guide the master plan for Canoa Hills. The document also provides a framework for guiding community participation and communication which will be a useful reference in designing stakeholder engagement activities and information gathering and maximizing the efficiency and effectiveness of these processes.
RILLITO RIVER ECOSYSTEM RESTORATION PROJECT

Description: Sonoran Desert ecological restoration project

Location: Tucson, AZ

Date: 2006-2008

Summary: The Rillito River Ecosystem Restoration Project was implemented through a partnership between Pima County Flood Control and the U.S. Army Corps of Engineers. It includes 60 acres of land on the south bank of the Rillito River, and is divided into four distinct areas that determined project phasing. Primary project goals included enhancing native vegetation and increasing passive stormwater harvesting capacity through the construction of small basins, while providing recreation opportunities for nearby residents (Pima County, 2018). Existing drainage channels were also modified, with cement removed from channel beds and sinuosity increased to slow flow and increase infiltration (Pima County, 2018). Bank steepness was decreased and native vegetation was planted along the banks (Pima County, 2018). Efforts were made to preserve existing native vegetation and limit grade modifications, minimizing the impacts of restoration activities on existing native ecologies and amphibian habitat.

Plantings throughout the restoration area included mesquite-dominated mesoriparian vegetation transitioning to mesquite and palo verde upland communities. Plantings were followed by hydroseeding with native desert plants, and reclaimed water supplied irrigation during initial plant establishment (Pima County, 2018). A five-year establishment period was defined for the project, after which the project has functioned without supplemental irrigation or other human-provided resources (Pima County, 2018). Five primary restoration treatments were implemented in the project: xeroriparian terracing, xeroriparian buffering, enhancement areas, seeded-only areas, and areas for intensive invasive removal (Pima County, 2018).

The work plan for this project was prepared by RECON Environmental Inc., and included a detailed description of project scope, a site inventory and analysis, context and goals of the work plan, and invasive species management and monitoring plans. The invasive species management plan focused on eradicating existing non-native invasive species, preventing future establishment of non-native species, identifying ongoing invasive species management actions, and continuous monitoring of invasive species within the site. Methods for invasive species removal include both chemical (herbicide) and manual (mowing, pulling, cutting) processes and mulching, and were dependent on the extent and type of species present. A competition and restoration approach was discussed, in which invasive removal was coupled with native plantings, allowing native plants to out-compete invaders. Invasive plant removal was prioritized and proposed based on an invasive species threat ranking by The Arizona Wildlands Invasive Plant Working Group. Higher ranking species were identified and targeted for heavy control and eradication, while lesser ranking species were secondarily targeted for control. A third category of non-native invasive species was identified as not currently being present on site, but as having a possibility of establishment and thus being the subject of ongoing monitoring. A five-year monitoring plan followed restoration implementation and evaluated vegetative diversity and density.

References:


DESIGN IMPLICATIONS

This project is an example of an ecological restoration project within the Sonoran Desert context which includes consideration for stormwater management and irrigation needs for plant establishment. It also provides insight into other restoration work completed by Pima County Flood Control, and possible treatments that could be feasible and applicable to Canoa Hills such as targeted planting, hydroseeding, and invasive exotic plant removal. Although Canoa Hills does not have significant non-native invasive plant coverage, methods for removal and principles for monitoring are applicable and should be considered in the development of the master plan.
**Description:** Public educational center and birding landscape

**Location:** Patagonia, AZ

**Date:** 2014

**Summary:** The Paton Center has its origins in 1973, when Marion and Wally Paton bought the 1.4 acre property in a residential area in Patagonia, Arizona (Tucson Audubon Society, 2019). They set up bird feeders and the diversity of birds they observed soon caught the attention of curious neighbors and visitors (Jones, 2018). The Patons eventually officially opened the property to the public, setting out field guides, benches, and a board for visitors to record bird sightings (Jones, 2018). Despite the modest size of the property and the town it is in, the Paton Center has gained international recognition as a birding destination due to the high diversity of species observed on the property that exemplifies the unique birding experiences of southern Arizona. In 2017, 14,000 visitors visited the center, hailing from 20 countries (Jones, 2018).

After the passing of both Wally and Marion in the early 2000’s, the Tucson Audubon Society (TAS) took over the property in 2014 (Jones, 2018). Since then, they have focused on providing bird, butterfly, and pollinator habitat throughout the property, while providing educational and interpretive programs and displays (Jones, 2018). Recently, TAS constructed an accessible viewing pavilion in the backyard and an information kiosk near the parking lot, replaced exotic invasive vegetation with native plants that provide hummingbird food and habitat, converted an old agricultural field into a native meadow, created a library of field guides for visitors to use, and connected the property to a nearby Nature Conservancy reserve with trails (Jones, 2018; Tucson Audubon Society, 2019). TAS makes efforts to integrate the community into Paton Center improvements, plantings, and restoration activities by engaging locals in volunteer weed removal and planting days and commissioning local artists to design and produce interpretive signage for the site (Tucson Audubon Society, 2019). They also offer occasional talks and interpretive programs, and are hoping to develop these events further in the future (Tucson Audubon Society, 2019).

The Paton Center now serves as a model for TAS’s Habitat at Home initiative – an effort that promotes the use of native plants in urban residential landscapes to provide bird and pollinator habitat, reduce maintenance needs and energy bills, and educate urban dwellers on the benefits of native plant use in the Sonoran Desert (Jones, 2018).

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The following Site Assessment provides an inventory and analysis of the Canoa Hills Trails Park as of 2019. It presents the history, community, partnerships, ecology, hydrology, and physical characteristics of the site. It concludes with a summary of site opportunities and constraints which will guide master plan development.
REGIOnAL CONTEXT

An overview of the natural history of the areas provides historical context and illustrates the rich historical interpretive opportunities in the region.

**The River**

The Santa Cruz River is a defining geographical feature that runs through Green Valley less than a mile east of the site. A tributary of the larger Gila River, it flows north for 184 miles, although today it is primarily dry except during rainy seasons. Like many rivers in the southwest, the Santa Cruz historically served as a critical wildlife migration corridor and provided habitat and vital resources for amphibians, mammals, birds, and native fresh-water species (Webb, Betancourt, Johnson, & Turner, 2014).

An overview of the natural history of the areas provides historical context and illustrates the rich historical interpretive opportunities in the region.

**The Bosque**

Three primary plant communities historically existed along the Santa Cruz River - cottonwood galleries, mesquite bosques, and cienegas (Stromberg, 1993). Today, mesquite bosques are the most threatened of the three communities, and include some similar species to those found at Canoa Hills. Occupying areas with groundwater levels 20-40', they can function as important riparian flooding buffers (Stromberg, 1993). Typical mesquite bosques include a canopy of mesquite, netleaf hackberry, velvet ash, and Arizona walnut above an understory of graythorn, fourwing saltbush, catclaw acacia, and other small trees and shrubs (Stromberg, 1993).

Two enormous mesquite bosques persisted along the Santa Cruz River into the 20th century, although they began showing signs of significant alteration by the late 19th century (Johnson & Webb, 2014). The larger of these bosques, The Great Mesquite Forest, was located just north of what is now Green Valley and featured mesquites up to 75 feet tall with 4 foot diameter trunks, covering an area of at least 7 square miles (Webb et al., 2014). This bosque was a primary feature attracting ornithologists and birders to southern Arizona, and established Tucson as the birding center of Arizona in the late 19th century with 85 bird species observed in one summer (Johnson & Webb, 2014). O riginally a sacaton-dominated cienega encircled by large mesquites, late 19th century downcutting led to the draining of the cienega and mesquite encroachment that expanded mesquite coverage (Johnson & Webb, 2014). In the 20th century, these large mesquites became an important source of fuel for Tucson, and this unsustainable wood harvesting coupled with decreasing water table levels and agricultural expansion catalyzed the collapse of this ecosystem throughout the following decades (Johnson & Webb, 2014). The construction of I-19 through what remained of the bosque in 1970 was the final event contributing to the bosque's demise (Johnson & Webb, 2014).

Today, what was once the Great Mesquite Forest is now home to shrubby mesquites, desert plants, and invasive exotic tamarisk (Johnson & Webb, 2014). This temporal transition towards more arid plant communities is a trend that occurs throughout the arid southwest and especially near waterways, and is an important point of discussion for restoration work and interpretive opportunities.

Riparian cottonwood forests lined the banks of the river and connected cienegas, transitioning to mesquite bosques in the floodplains (Webb et al., 2014). Development and increased agricultural activity in the river's floodplains for over 150 years have caused irreversible physical alterations to the river, impacting both the plants and wildlife that rely on these areas. Erosion and downcutting of the Santa Cruz was observed as early as the 1880's, followed by considerable channel widening in the early 20th century (Webb et al., 2014). With drought and increasing groundwater extraction, water table levels began falling throughout the watershed, and by 1920 levels were so low that shallow water-loving riparian species began to die off (Webb et al., 2014).

References:


The Canoa Hills Trails Park is located off I-19 in Green Valley, Arizona, 30 miles south of Tucson and 35 miles north of Nogales. It includes seven parcels nestled within a suburban residential area. The western edge of the site is bounded by mine property which includes undeveloped desert and a large mound of tailings. The north-flowing Santa Cruz River is just east of the site with significant agricultural operations in the river’s floodplains.

The area surrounding the site features a number of recreation opportunities. The West Desert Preserve is a mountain biking and hiking park owned by Phelps-Dodge Mining that sits adjacent to the northwestern corner of the Canoa Hills Trails Park. Connecting Canoa Hills trails with the existing regularly used dirt trail network at the Preserve could increase access, use, and connectivity for both parks, although this may be undesirable if biking at Canoa Hills Trails is not encouraged. Connection to this preserve could be a future development, as this is not a current primary focus for the County.

Two Pima County properties east of I-19 present potential open space connections to the site. Canoa Preserve Park includes ramadas, grills, and two softball fields. The 4,800-acre Canoa Ranch Conservation Park south of the site is operated by the Natural Resources, Parks and Recreation Division and features a number of educational and recreational events including historical interpretive tours, birding and wildlife programs, equestrian activities, and organized star gazing. The ranch has an open multi-use event space that can be used to facilitate these and other community events, and the County plans to provide a dog park on this property as well. Additionally, this property includes a 3.5-acre pond that can provide irrigation for plant establishment at the Canoa Hills Trails Park.

Because a large event space and softball fields are provided less than 2 miles from the site, and plans for a dog park elsewhere are being discussed, these types of spaces are not a priority at Canoa Hills Trails. Currently, I-19 poses a significant barrier to non-vehicular traffic between the site and these amenities, so safe highway crossing infrastructure would be necessary to facilitate non-vehicular movement between these spaces. Other local recreation opportunities include San Ignacio Golf Club and Canoa Ranch Golf Club south of the site, Desert Hills Golf Club to the north, Torres Blancas Golf Club across I-19 to the east, and the Santa Rita Mountains to the east.
In fall 2019, the Tucson Audubon Society received funding for their proposed Gardens on the Greens project. This project will focus on creating habitat and wildlife gardens within the old greens of Canoa Hills Trails. Three focus areas are proposed: one in parcel D, one in parcel F, and one in parcel G. The parcel D focus area includes a small pond and stream flowing east. Parcel F includes three water-harvesting pollinator gardens placed around the existing cart paths at the parcel's western edge. These gardens are located in an area with significant run-off from the road and surrounding development, and will be fed by stormwater. The final focus area includes two large stormwater-fed habitat areas along the eastern edge of parcel G. These focus areas should be accessible to visitors and stakeholders, and relocation may be possible if required.

Community & Partners

Partners

Canao Hills Trails has a network of partners and engaged community members to assist with project implementation and on-going stewardship. Friends of the Canoas is a friends group with over 60 members that serves Canoa Ranch, Canoa Preserve, and Canoa Hills Trails. They can likely assist with trash pick-up, invasive plant removal, pollinator habitat care, hosting of events, and other stewardship activities. The Tucson Audubon Society is another project partner that received funding for their Gardens on the Greens project proposal, which should be incorporated into the master plan design. There is also interest by Pima County and the Friends group in working individually with the five HOAs bordering the site, although no official partnerships have been formed. The Green Valley Council is another entity with interest in Canoa Hills Trails. They are a liaison between the Green Valley community and the County, and they will be instrumental in organizing public meetings and disseminating information regarding Canoa Hills Trails.

Site Use & Community Concerns

Since the closure of the Canoa Hills Golf Course, the site has seen moderate use by adjacent residents. Golf cart paths are used for walking, running, and biking, although residents have expressed concern over potential safety issues associated with bicycling on steep, windy sections of the golf cart path. Other concerns and priorities commonly raised by the public and documented by the GVC Park Advisory Committee in March 2019 include the need for functioning bathrooms, designated parking, memorial benches, and dog waste bag stations and disposal points. Interest in Sonoran desert sculptures and additional trails was also expressed. Other suggestions presented by community members included the implementation of outdoor exercise equipment, putting stations, and a permanent pond, although not all of these features align with the goals and objectives of this project.

HOAs

Site parcels are designated by letters A through G for ease of communication throughout the rest of the report. The ten HOAs bordering the site are identified and could be potential partners for Canoa Hills Trails. Each parcel within the site is bordered by at least one HOA. Parcel B represents a unique case, as it has been relatively well maintained by surrounding homeowners recently through mowing and trash pick-up. At just 3.4 acres, parcel B is the smallest of the seven, and is closely surrounded by residences which gives it a backyard feel. There may be interest by the Canoa Estates HOA in continuing to care for this parcel with active participation by adjacent residents. These ten HOAs should be included in Master Plan development public participation opportunities, to ignite interest and a sense of ownership and stewardship by nearby residents for Canoa Hills Trails.

Adjacent Amenities

Two recreation centers are located near the site. Recreation center users may have interest in outdoor recreation opportunities at Canoa Hills Trails, and should be considered a potential user group.
Grade is an important consideration in trail design and placement, as it determines level of accessibility and overall physical difficulty of the recreation experience. Slope for Canoa Hills Trails was calculated using provided contours for the site and categorized based on general design standards. Easier running trails in urban and rural areas typically maintain a slope of 5% or less, with a maximum slope of up to 10% for no more than 30’. Less developed trails of moderate difficulty can have a sustained grade up to 8%, with a maximum 14% grade occurring for no more than 50’ in length. Difficult (typically backcountry) trails may have a sustained grade of 12%, with areas of up to 20% slope for up to 50’.

Areas of the site in blue (0-5% slope) could be used for easy trails without significant grade changes, while green and yellow (5-12% slope) signify areas of moderate difficulty. Orange (12-20% slope) areas are challenging trails, and areas in red are not advised to include trails because of their prohibitively steep slopes.

Based on existing slopes, it is clear that parcel G and E are the flattest areas and the most suitable for accessible recreation and parking lot siting. Secondary parking could also be included on the east portion of parcels A and D, as these areas feature small fall areas that are accessible by vehicle from Camino Del Sol.
**Movement**

Because traveling between parcels requires moving through residential areas, along roads, and/or through culverts, the site appears as seven disparate open spaces. Although connection between parcels may be enhanced and encouraged, the separation between them is unavoidable. This creates the opportunity to target different types of recreation and/or restoration based on parcel, and maximize site use and function by separating uses.

Because golf courses are constructed to be one large loop, there is a need for additional paths to create smaller loops and a diversity of recreation experiences. These should be targeted in areas where accessible recreation makes sense and is encouraged, such as in parcels E and G.

**Access & Parking**

Two types of access and parking are needed for the site: public access and restricted parking access for County maintenance. Because the original clubhouse and associated parking are not part of the project area, additional public parking is required. Currently there is one small parking lot in poor condition in parcel D (the former driving range). This could provide public access to parcel F by way of the culvert. Two additional restricted access parking areas are also identified. With its connection to Camino Del Sol via Duval Mine Waterline Road and its large flat area, the southwest corner of parcel G could be a functional location for a parking lot. The eastern edge of the site, accessible by Frontage Rd, could also provide access and parking.

**Path Condition**

The majority of golf cart paths on site are concrete and in good condition. However, there are sections of the path that are broken asphalt that need to be replaced or removed. Poor condition asphalt paths (shown with a dotted line in the map to the left) form many of the connections between parcels, although they also occur in short sections of parcels A, F, and G. Additionally, the path in the northeastern section of parcel E is affected by erosion of the former pond feature, so this should be mitigated. Poor condition paths outside the site along Camino Del Sol have recently been replaced by the nearby Phelps Dodge mining company, which will enhance connection between parcels.

The implementation of DG paths could diversify potential recreation experiences at Canoa Hills Trails, and provide visitors the opportunity to engage with a more traditional nature trail. Concrete paths should be strategically kept to provide accessible recreation, but in more hilly areas or on longer trails, DG may be a more appropriate material.
Hydrology & Existing Infrastructure

Infrastructure:
- Existing plumbed buildings
- Box culverts
- Roads

Hydrology:
- Subdivision drainage chute
- Washes under 500 cfs
- Washes 500-1000 cfs
- Washes 1000-2,000 cfs
- Washes 5,000-10,000 cfs

Topography:
- Watershed boundary
- 3,100' elevation
- 2,880' elevation
Hydrology

An extensive hydrologic analysis for Canoa Hills was completed in January 2018 and included the calculation of the 100 year floodplain and discharge volumes, watershed delineation, and an inventory and assessment of existing washes and stormwater management features on site. Relevant details from the report have been summarized here.

Water generally flows across the site from west to east, running under I-19 through culverts before emptying into the Santa Cruz River. The contributing watershed to the site is 1,719 acres and includes runoff from the mine tailings west of the site as well as the surrounding subdivisions. Historic channels were removed through grading during golf course construction, so flow on site is more sheet-like and less channelized than typical natural flow. One densely vegetated natural channel exists on the north edge of parcel F, though it exhibits significant down-cutting along its length.

The largest floodplains with the highest discharges are found in parcels A, E, and G, and these areas have been identified as the most flood-prone with the greatest potential for increased erosion. Erosion mitigation is most critical for these parcels.

Relevance to Infrastructure

Three plumbed facilities exist on site - one ball-washing station in parcel D and former restrooms in parcels A and G. None of these facilities are in operation and both restrooms need to be relocated as they currently occupy the 100 year floodplain. New restroom facilities should be located out of the floodplain and in ADA accessible areas, which limits location options.

Other structures like ramadas and benches could be located in the floodplain, but these features should be able to withstand occasional flooding.

Stormwater Management

Several efforts to manage stormwater have been made on site. Run-off from subdivisions is diverted into the site through steep constructed channels that include chutes lined with loose rock, grouted rock, and some with a smooth paved surface. Railroad ties and grouted rip-rap occur at the base of the chutes to slow and spread run-off flow. A grouted rock channel exists on-site along the western edge of parcel F, flowing north before diverting to the east. This channel collects and carries run-off from the subdivision to the south. The hydrologic analysis found that the described stormwater management features are generally well-functioning and do not need alteration at this time.

The site is comprised of 4 sub-watersheds which flow into the Santa Cruz River to the east.

1. Total area: 615 acres
   100-yr storm discharge: 1,725 cfs

2. Total area: 57 acres
   100-yr storm discharge: 215 cfs

3. Total area: 119 acres
   100-yr storm discharge: 685 cfs

4. Total area: 928 acres
   100-yr storm discharge: 1,816 cfs
Erosion

Shallow eroded channels occur in some of the fairways. In many places, these have exposed 6" diameter drainage piping that likely helped drain water-logged greens during monsoon season. Erosion has also begun to undercut some of the golf cart paths. In areas, Pima County has managed this by installing rip-rap along the path which appears to be functional. In other areas, sedimentation occurs on the path during rain events. The hydrologic report anticipates increased erosion in watersheds 1 and 4 due to high flow volumes in these areas. Erosion mitigation should target these areas.

Wash Re-establishment

The hydrologic report identifies a need to re-establish natural drainages within the site. Two options are presented; the first is to use excavation to re-establish historic drainage patterns using aerial imagery as a guide and allowing drainageways to form naturally over time on site. The second option is a more passive approach and might be appropriate for the budget and maintenance regime of this project. It also would allow drainageways on-site to respond to existing site conditions, rather than replicating a drainage pattern that may not naturally form given the current site conditions.

As previously mentioned, several shallow eroded channels have begun to occur throughout the site. This could be left and allowed to evolve naturally. Plastic drainage piping could be removed as it becomes exposed in this process.

One problem with the passive approach is that drainageways may conflict with existing cart paths and contribute to path erosion and undercutting. In these areas, drainageways could be redirected and/or erosion control could be installed. Pathways could also be rerouted, where feasible. As drainageways re-establish, continued monitoring will be needed to identify the areas that are contributing to path erosion so that appropriate action can be taken.
The site is comprised primarily of upper Sonoran plant communities. In December 2017, before donation of the site to Pima County, a detailed vegetation inventory and assessment was completed for the site. The following analysis is based on the conclusions and land cover classifications found in the 2017 report, although updates have been included to reflect current conditions. Parcel D was not included in the 2017 report, but it has been added here. For a complete list of plant species found on site in December 2017, see appendix A (p. 54).

Ponds constructed for the golf course are found in parcels A, E and G. These areas are depressed and exhibit ponding following large rain events. Several exotic invasive species are found in these areas, including tamarisk, Bermuda grass, and buffel grass. Native desert broom is also found in these areas.

Bunkers (or sand traps) exist in all parcels except D, and many have limited vegetative growth within them, although sparse goldenrod, needle grama, and globemallow were recently observed in some of the bunkers. If plantings occur in these areas, soil remediation will be necessary. These areas could also be appropriate for ramada placement or other development.

Since irrigation was shut off, the retired golf course areas have been transitioning to native plant communities. Currently these areas exhibit low species richness and are dominated by early colonizers. The majority of these areas are dominated by pigweed, although some are comprised primarily of sixweeks threeawn and needle grama grasses. These areas are currently maintained by Pima County through mowing.
Land cover classified as native trees includes primarily mature mesquites, although hackberry is also present. Native trees occurring along the centers and adjacent to the greens are predominately pruned mesquites, which could be allowed to regrow to enhance wildlife habitat.

The remaining areas classified as native plant communities include desert scrub on hill tops and slopes, semi-desert grasslands between the floodplains and hill slope bases, and xeroriparian species found in the floodplains and along the drainages. Exotic invasive species occur sporadically, with the most obvious being African sumac within the xeroriparian areas.

**Exotic Invasive Species**

The site does not have significant populations of exotic invasive species. Observed exotic invasive species include Tamarisk within some of the old pond features, one small areas of Johnson grass in parcel A, buffelgrass, Russian thistle, and African sumac. Other sparsely occurring non-natives include escaped or intentionally placed landscape plants such as oleander, fountain grass, Texas ranger, bird of paradise, and eucalyptus, among others.

Because exotic invasive species are limited on the site, intensive treatment is not necessary. Many invasives could likely be effectively treated by appropriately timed mechanical removal and/or mowing. Chemical methods are also an option, particularly for larger woody species such as Tamarisk and African sumac.

**Vegetation Inventory**

The 2017 Vegetation assessment includes a list of existing vegetation on site, as well as a list of recommended container plants for the site and recommended species to include in a hydroseeding mix. The plant lists should be referenced in restoration plantings and hydroseeding.

**Landscape Connectivity**

The western edges of parcel A and C connect directly to a large swath of undeveloped open space to the west. This connection allows for deer, coyote, javelina, bobcats, and other adaptable native wildlife to enter the site. Culverts under Camino Del Sol facilitate movement of wildlife from the western parcels to the eastern ones. However, the site is comprised of seven separate, linear parcels (or patches) bordered primarily by roads and suburban development, limiting the establishment of more sensitive species. However, reptiles, birds, pollinator insects, and bat species could be appropriate targets for wildlife habitat creation.
VIEWS & CHARACTER

The site layout, topography, and integration with the surrounding residential area gives each of the seven parcels a distinctive feel and character. The western parcels do not have a clear view of the Santa Rita Mountains to the east, and unpleasant views of mine tailings to the west are much more prominent. Parcels A and C are both narrow and sunken and lack significant open space, and the proximity to residences within these parcels is obvious. Parcel B is the smallest parcel and feels very much like a backyard space for the surrounding residences. Parcel D is an open space without canopy coverage, and it slopes gently from west to east.

The eastern parcels are wider than the western ones, and have a more open feel. Canopy coverage within the interior of these areas breaks up the open space and makes the parcels feel larger. Surrounding residences are visually screened by topography and vegetation, and the site feels separate from the adjacent residences. Views of the Santa Rita Mountains are particularly stunning from these parcels, especially along the eastern edge of parcels E and G. The northwest branch of parcel G is an exception, due to its narrowness and proximity to surrounding residences.

The eastern parcels are more aesthetically pleasing than the western ones, making them appropriate areas to focus recreation.
SITE OPPORTUNITIES & CONSTRAINTS

Legend
- **Proposed Gardens on the Greens projects**
- Native trees (preserve)
- Native plant communities (preserve)
- Potential entrance/parking
- Existing entrance/parking
- Social trails
- Road crossing
- Box culverts
- Roads
- Good condition concrete paths
- Low/moderate slope
- Steep slope (reroute)
- Poor condition asphalt paths
  - Low/moderate slope (replace)
  - Steep slope (reroute)

Unpleasant Views of Mine Tailings

Beautiful Views of Santa Rita Mountains

SITE OPPORTUNITIES & CONSTRAINTS

600' 600' 600'

Camino Del Sol
Duval Mine Waterline Rd.
A
B
C
D
E
F
G

DRAFT - 2/24/2021
**Budget & Maintenance**

Budget is a limiting factor in master plan design and continued maintenance of Canoa Hills Trails. Proposed site alterations should be functional and financially sustainable, and the design should require relatively little care by Pima County staff once established.

**Interpretation**

The site's proximity to the Santa Cruz River, existing native vegetation, and habitat enhancements provided by the proposed Gardens on the Greens project provide numerous interpretive opportunities throughout the site. Views of the Santa Rita Mountains and mine tailings combined with the rich ecological and human history of the area also provide an opportunity to discuss the broader historical and regional context of the site.

**Community Engagement**

The Friend's Group, partnership with Tucson Audubon Society, and interest by Green Valley residents in the Canoa Hills Trails park is both an opportunity and a constraint. These involved parties provide a robust stakeholder group to assist with site care and habitat implementation, but also may have strong conflicting opinions and desires for the site which will need to be managed. Expertise from Tucson Audubon Society, and the proposed Gardens on the Greens project will be particularly useful in installing pockets of enhanced habitat.

**Connectivity**

The site's position between the West Desert Preserve hiking and mountain biking park and the Historic Canoa Ranch poses both an opportunity and constraint. There is an opportunity to connect with these existing recreation sites to increase access and human use, and to use the Canoa Ranch pond for irrigation during the plant establishment period. However, the connection with the West Desert Preserve may not be desired if biking is not allowed at Canoa Hills Trails.

**Access, Circulation, & Infrastructure**

Three potential areas have been identified as potential parking areas and vehicle access points to the site, including the existing parking lot. The existing golf cart path is predominantly comprised of good condition concrete that can be incorporated into the master plan. Identified steep sections should be rerouted to areas with moderate slopes, and several short sections of poor condition asphalt path should be replaced. Social trails are limited, but present an opportunity to formalize paths that are already being used. Additional paths should also be implemented to create shorter loops for a range of recreation levels and opportunities. Path material should be considered as well. DG paths could provide more naturalistic recreation opportunities, while concrete paths should be utilized in designated accessible area.

Steep slopes on site, vegetation to be preserved, and the extent of the 100-year floodplain throughout the site limit the areas where restrooms can be implemented. Low slope areas outside the floodplain are identified as locations for infrastructure.

**Restoration & Ecological Enhancement**

Because natural drainageways were removed with the construction of the golf course, there is an opportunity and need to reestablish these in the restoration plan. Constraints exist where evolving drainageways intersect with the path, and these areas will need erosion treatment or rerouting of the path or drainageway. Runoff from the surrounding subdivisions provides additional water resources to the site and the opportunity to install stormwater harvesting basins to capture and slow this flow.

Existing native plant communities make up 69 acres of the site. There is an opportunity to preserve these areas, with restoration plantings focused on the remaining low-diversity areas of the site that are dominated by early colonizers. The previously conducted vegetation inventory provides a detailed seed and container plant list that should be referenced in restoration plantings.

Exotic invasive species on-site represent a constraint that should be managed. However, these species and their extent is minimal, requiring limited manpower in their management. Ongoing monitoring will be required though, to limit the further establishment of these species.

**Views**

There is an opportunity to take advantage of the stunning views of the Santa Rita Mountains to the east, by providing ramadas and/or benches along the eastern side of the site, and at higher elevation areas interior to the eastern parcels. Unpleasant views of the mine tailings to the west provide a constraint, and should not be augmented except for interpretive purposes.

**Focus Areas**

Considering budget, topography, views, and parcel separation and configuration, it may be advisable to focus recreation opportunities and more active management within 2 or 3 parcels. Parcel E, F, and/or G would be appropriate given the views, relatively flat topography, relatively large parcel size, adjacency to potential vehicle access, and the inclusion of the majority of the Tucson Audubon Society Gardens on the Greens proposed project sites. Other parcels could be hydroseeded and maintained through minimal mowing with little or no other interventions. However, neighbors adjacent to these parcels may be unhappy with this arrangement which is a consideration.
The following chapter includes design development based on the site assessment and background research. This section includes concept sketches, a preliminary master plan a community outreach plan, and next steps. Outcomes are based on the following program, which was developed based on the background research and Pima County Flood Control goals.

**Project Program**

- Enhance ecological and hydrological function and resilience of site
  - Preserve existing native vegetation on site and identify areas for sustainable ecosystem restoration and enhancement
  - Manage invasive species and develop a vegetation maintenance plan
  - Re-establish stable stormwater flow paths on site, mitigate erosion hazards, and provide basins to slow subdivision run-off

- Promote environmental stewardship through stakeholder and visitor engagement
  - Meet with stakeholder groups and identify their concerns and potential interest in caring for park
  - Develop ecological interpretive material to provide context for restoration activities

- Provide passive recreation opportunities for a range of users
  - Provide accessible trails with interpretive opportunities for visitors with more limited physical abilities
  - Implement longer, more strenuous trails for users desiring a more difficult and naturalistic trail experience
  - Designate interpretive and gathering nodes
Focus on connecting visitors with landscape
Interpretive signage throughout eastern half of site
Canopy enhancements increase shade coverage and provide additional wildlife habitat
All additional trails are DG to provide a more rustic recreation experience
Ramadas provide space for private gatherings, wildlife viewing, and small educational events
Spatial separation of interpretive themes allows visitors to learn a topic in depth during their visit without overwhelming the landscape with densely concentrated interpretive signage.

Strong focus on connecting people to landscape through education and citizen science enhances stewardship by neighbors and site visitors.

Volunteer developed interpretive booklet extends learning outside of the park and encourages stakeholders to apply citizen science and ecologically-conscious practices within their yards and communities.

Potential restoration area (G) and volunteer group managed areas (E) located at primary entrances are highly visible, encouraging learning and engagement with these landscapes.

Interpretive themes respond to existing landscape features and proposed habitat enhancements, encouraging visitors to engage with and notice the landscapes around them.

Ramadas and open areas provide flexible-use space to accommodate a variety of uses and users.

Spatial separation of interpretive themes makes it difficult for visitors to learn multiple topics in one visit.

Not all interpretive signage is located in an accessible area, limiting its reach.

Lack of programmed recreation may be a concern to some stakeholders who desire a park with more recreational elements.

Booklet development is reliant on volunteer interest in the subject, so it may not be realistic depending on the volunteer base.

**PROS**

- Spatial separation of interpretive themes allows visitors to learn a topic in depth during their visit without overwhelming the landscape with densely concentrated interpretive signage.
- Strong focus on connecting people to landscape through education and citizen science enhances stewardship by neighbors and site visitors.
- Volunteer developed interpretive booklet extends learning outside of the park and encourages stakeholders to apply citizen science and ecologically-conscious practices within their yards and communities.
- Potential restoration area (G) and volunteer group managed areas (E) located at primary entrances are highly visible, encouraging learning and engagement with these landscapes.
- Interpretive themes respond to existing landscape features and proposed habitat enhancements, encouraging visitors to engage with and notice the landscapes around them.
- Ramadas and open areas provide flexible-use space to accommodate a variety of uses and users.

**CONS**

- Spatial separation of interpretive themes makes it difficult for visitors to learn multiple topics in one visit.
- Not all interpretive signage is located in an accessible area, limiting its reach.
- Lack of programmed recreation may be a concern to some stakeholders who desire a park with more recreational elements.
- Booklet development is reliant on volunteer interest in the subject, so it may not be realistic depending on the volunteer base.

**Human History Interpretive Area: ramadas, picnic tables, benches, interpretive signage**

The interpretive focus of parcel E is on the human history of the area, including pre-Columbian occupation through the use of the site as a golf course. Volunteer group managed pollinator gardens provide demonstration of ongoing human interaction with the site and enhance habitat around the old golf course pond. Ramadas, benches, picnic tables and interpretive signage are found throughout this section.

**Geologic Interpretive Area: ramadas, picnic tables, benches, interpretive signage**

Parcel F is dedicated to geologic interpretation which aligns with the steep topography of this section and views to both the Santa Rita Mountains and the mine tailings. Interpretation in this parcel provides a broader contextual understanding of the site and discusses the ecological and community impacts of mining in southern Arizona, and the unique geological events that gave rise to the sky islands.

**Ecologic Interpretive Area: accessible paved paths, ramadas, picnic tables, benches, interpretive signage**

Interpretive signage throughout parcel G focuses on local ecology, providing context for the Tucson Audubon Society (TAS) habitat restoration area in this parcel. Interpretive elements include information on biotic communities, restoration efforts, and how to promote wildlife habitat at home. New compacted DG paths in this section connect existing concrete paths, providing a number of loop options ranging from 0.25 miles to 1 mile provide recreation opportunities for all fitness levels. Ramadas, benches, picnic tables, and interpretive signage are found throughout, as they are in parcels E and F.

**Western Parcels: minimal maintenance, benches**

Parcels A, B, C, and D include minimal intervention and ongoing maintenance, and will likely see less use than other parts of the site. These areas feature benches but no ramadas, interpretive signage, or picnic tables. Restoration efforts focus on hydroseeding, with little or no additional habitat enhancements except for a small TAS circulating pond and canopy enhancements in parcel D. Because of its small size, close proximity to neighbors, and the current active management of the parcel by neighbors, parcel B features spaces for pollinator gardens and small gathering areas to be implemented and managed by volunteer groups and neighbors.

**Promoting Site Stewardship**

Citizen science opportunities provide further connection between site neighbors, visitors, and the surrounding landscape. These opportunities could exist in the volunteer group managed areas in parcel E, and/or within the TAS managed demonstration areas in parcel G. These areas are accessible, visible, and could be designed to respond to existing citizen science projects such as phenology monitoring organized by Nature's Notebook and/or the Monarch Larva Monitoring Project which tracks milkweed phenology and monarch life stages and movement throughout the country. Additionally, the welcome area for each parking lot could include a book where visitors can record wildlife (and other) observations.

Restoration and interpretive information and citizen science resources could be compiled into an informational pamphlet or webpage by park volunteers, if that is of interest. Compiling this information could help guide volunteer groups in restoration activities and promote wider stewardship of the site.
Focus on separating different types of passive recreation to avoid conflicts between user groups and to encourage diverse use of the site.

- Interpretive area, walking/running trail, nature trail, and gathering area identified.
- Additional path connections are both DG and paved.

**Concept Overview**

- Existing mesquite canopy (preserve)
- Existing plant communities (preserve)
- Restored native plant communities (old golf course greens)
- Proposed Tucson Audubon Society (TAS) habitat improvements
- Potential future restoration area with TAS involvement
- Volunteer group managed pollinator gardens with seating/gathering
- Ephemeral pond (toad habitat)

**Landcover**

- Old Canoa Hills Clubhouse
- Public restroom
- Public parking
- Ramada
- Box culverts
- Existing paved paths
- Proposed paved paths
- Proposed decomposed granite (DG) trails

**Infrastructure**
Concept 2 Parcel Characteristics

**Rustic Nature Trail: minimal interventions, benches**
A nature trail, appropriate for slower, quieter walks sits along the north of the site in parcels A and E. It passes by a potential restoration area and an ephemeral toad pond. These parcels are the least developed on site, with limited built elements except for benches. Maintenance efforts are generally focused on other parcels. Potential future restoration efforts could be implemented in parcel E, as this is likely in an area with less use and thus less human activity and disturbance.

**Interpretive Area: ramadas, picnic tables, benches, interpretive signage**
Interpretation and birding activities are centered in parcel D, and include a circulating water feature implemented by TAS, as well as a potential expansion of habitat enhancements to the west that could be implemented with future acquired funding (possible interest in this has been expressed by TAS). This interpretive landscape could include interpretive signage, small ramadas, picnic tables, and benches.

**Running Trail: minimal interventions, benches**
A walking and running trail is located in parcel C and extends across Camina Del Sol into parcel G with a proposed cross-walk. This part of the park is too narrow to provide significant habitat or good wildlife viewing opportunities, and parts of the trail are slightly steeper than the path in parcels A and E, making this a suitable location for a trail used primarily for brisk walking or running. Interventions in this area are minimal, although benches will provide resting opportunities along the path.

**Gathering Area: ramadas, picnic tables, benches, interpretive signage**
With low slopes and wide open spaces, parcel G is programmed as an informal gathering and picnicking area and features ramadas and picnic tables for small, informal gathering. Loop trails of varying lengths (some completely paved and some with decomposed granite segments), this area is accessible to all.

**Volunteer Managed Area: picnic tables, benches**
Because of its small size and backyard feel, parcel B features volunteer-managed areas that could include pollinator gardens and small seating areas. This area will likely not see significant use by the public, and functions predominantly as a neighborhood space.

**Pros**
- Diversity of passive recreation opportunities including accessible walking, hiking, birding, learning, and gathering suits a number of site visitors
- Potential robust habitat enhancements cater to wildlife and provide the opportunity to management stormwater passively
- Spatial designation of recreation opportunities limits conflicts between different groups (runners/hikers, birders/wildlife viewers)
- Potential habitat restoration area in a lesser used parcel (E) minimizes disturbance events to wildlife in this area
- Core of interpretive area (parcel D) is accessible, allowing visitors of all abilities to enjoy it

**Cons**
- Walking and running route from parcel C to G requires functional connection of these areas by street crossing which may be difficult to implement
- For core of habitat area to be implemented in parcel D, additional project funding is required
Focus on providing a range of recreation opportunities, including workout stations
- Ramadas in four parcels facilitate gathering throughout park
- All proposed path segments are concrete to maintain accessibility throughout site
- Four parking options enhance accessibility to separate parcels
- Relatively flat northeastern parcel is dedicated to interpretation, ensuring accessibility for those with limited mobility
**Concept 3 Parcel Characteristics**

**Workout Trail: workout stations, benches**
The golf cart path in parcels A, B, and C is converted into an exercise trail, with six workout stations scattered along the route. Benches are also found within this section to provide resting opportunities and to take advantage of the view of the Santa Rita Mountains to the east. Similar to other concepts, parcel B also features a community managed area that aligns with current trends in this parcel.

**Interpretive Nature Trail: ramadas, picnic tables, benches, interpretive signage**
An interpretive trail throughout the northeast parcel features an ephemeral pond, volunteer-managed pollinator gardens, and interpretive signage about local ecology. Ramadas provide space for outdoor education. The pond in the northeast corner (converted from an old golf course pond) functions as ephemeral toad habitat.

**Running Trail: ramadas, picnic tables, benches**
The hilly trails at the center of the site in parcel F are perfect for those desiring a more strenuous walking or running experience. Small ramadas are placed to provide views of the Santa Rita Mountains and offer relief from the sun. Benches and picnic tables are also in this parcel to provide a variety of resting and informal gathering opportunities.

**Gathering Area: ramadas, picnic tables, benches**
The gathering area features ramadas and picnic tables for small, informal gathering. With low slopes and loop trails of varying lengths, the southeastern parcel is accessible to all. A small parking lot in the southwestern corner of parcel G provides direct access to this parcel and increases accessibility of this area.

**Neighborhood Space: ramadas, picnic tables, benches**
Parcel D features two small ramadas, picnic tables, benches, and two nested loop trails. No significant habitat enhancements are provided here except for the small seep in the TAS restoration area.

**PROS**
- Workout stations may be desirable and relevant for a community comprised primarily of active retired adults, and may be liked by those who want more programmed recreation opportunities
- Separation of toad habitat from more intense recreation areas minimizes human disturbance to wildlife in this area
- Parcel E is relatively flat, providing accessibility for all site visitors to the interpretive area

**CONS**
- All parcels feature large infrastructure improvements (ramadas or workout stations). This may be infeasible economically and for maintenance purposes.
- Generally less focus on restoration/habitat creation in this concept
Native-dominated communities on the perimeter of the site include a combination of Sonoran Desert Scrub, Semi-Desert Grassland, and Xeroriparian vegetation. These areas should be preserved and monitored for problematic exotic invasive species. Canopy is dominated by pruned mesquites and should be preserved. Discontinue pruning of mesquites unless necessary for visitor safety or tree health.

Potential expansion of TAS restoration areas requires additional funding. These areas could include rainwater harvesting basins planted with native vegetation to create a birding and interpretive landscape. Hydroseed to encourage greater diversity and to further succession. These areas provide focus for volunteer groups and could include bird, bat, and/or other pollinator habitat depending on volunteer interests. Citizen science activities could also occur here, if there is interest by volunteers.

Additional native trees enhance bird habitat and walkability. DG trails provide naturalistic recreation and increase route options across the site. Ponds in E and G incorporate existing topographic depressions to create interconnected basins that manage stormwater and provide seasonal toad habitat.

Circulating Water Feature
Feature provides year-round water source necessary for bird habitat.

Rainwater Harvesting
Rainwater basins with native plantings enhance habitat and manage stormwater runoff from Camino Del Sol.

Future Habitat Enhancements

Existing Canopy

Circulating Water Feature

Hydroseed & Monitor for Invasives

Canopy Expansion

Volunteer Managed Areas

Existing Concrete Path

Proposed DG Trails

Ephemeral toad pond
Container plants (including trees and plants in rainwater harvesting basins and volunteer managed areas) will need supplemental irrigation during establishment, which may be 1-2 years following planting. Irrigation can be transported from the pond at Canoa Hills Ranch during this period.

Ongoing monitoring for and removal of invasive species is required to prohibit the establishment of exotic invasive species on site. Friends of the Canoas should be trained in identification of the most common and/or potentially problematic exotic invasive species on site, including buffelgrass, tamarisk, African Sumac, fountain grass, and Russian thistle. A simple protocol should be implemented to assist volunteers with the reporting of invasive species to County staff. This could be as simple as taking a photo of the plant, a photo of the context (so that it can be located again), and a location description. County staff can then verify the species identification and advise volunteers on removal. Volunteers should be discouraged from removing invasive species without first checking with the County, unless they are experienced with identification of southern Arizona flora. Either way, reporting of invasive species occurrences should be encouraged so that the County has knowledge of where invasive species establish on site. This information could inform future targeted monitoring for exotic invasive species.

**TAS Restoration Areas**

Due to project deadlines, TAS areas should be the first restoration focus. TAS efforts will be on constructing vegetated rainwater harvesting basins along the western edge of parcel F, implementing a circulating water feature in parcel D, and providing habitat improvements in the southeast corner of parcel G. Parcel G improvements will include redirecting stormwater into the ephemeral toad pond and providing appropriate habitat and stormwater management surrounding this feature.

**Invasive Species Removal Priorities**

Although exotic invasive species are not prevalent on-site, management of tamarisk and African sumac should begin as soon as possible to restore habitat and hydrologic function. Tamarisk is found in parcel E growing inside the proposed ephemeral toad habitat. These should be cut down and their stumps sprayed with herbicide. Additional applications may be necessary to completely kill the plants. African sumac is choking some of the developed drainages on site, and these should also be removed and treated. In particular, the western edge of parcel F and the developed drainage in parcel E (see next page for a map of the drainages) have large African sumac which should be removed.

**Restoration Plantings & Seeding**

Canopy enhancements should be implemented prior to hydroseeding so as to avoid disturbing hydroseeded areas. For a complete list of suggested native tree species for planting, see appendix B (p. 55). Planting trees near the beginning of monsoon season (early July) is advisable, as the ground will be soft, and this will take advantage of monsoon rains for irrigation.

Hydroseeding can occur directly following tree planting. A list of appropriate species for a hydroseed mix can be found in appendix C (p. 56). Hydroseeding may occur in phasing, and should occur after installation of ramadas, benches, and other infrastructure if possible to limit disturbance to hydroseeded areas. Initial phase may include hydroseeding areas that do not feature significant infrastructural improvements or interventions. Hydroseeded areas should be temporarily fenced off with signage to alert site visitors of restoration activities and to remind them to not disturb these areas during restoration.

**Volunteer Managed Areas**

Volunteer managed areas can be phased based on County and/or volunteer interests. Design and features of these areas will respond to volunteer and community interests, and can be implemented and cared for with assistance of Friends of the Canoas. Several of these areas interact with drainages on site (see next page for details), and this should be considered and incorporated into the design of these areas. A list of appropriate container species to be planted in these areas can be found in appendix B (p. 55).

**Vegetation Establishment**

Container plants (including trees and plants in rainwater harvesting basins and volunteer managed areas) will need supplemental irrigation during establishment, which may be 1-2 years following planting. Irrigation can be transported from the pond at Canoa Hills Ranch during this period.

**Invasive Species Management**

Ongoing monitoring for and removal of invasive species is required to prohibit the establishment of exotic invasive species on site. Friends of the Canoas should be trained in identification of the most common and/or potentially problematic exotic invasive species on site, including buffelgrass, tamarisk, African Sumac, fountain grass, and Russian thistle. A simple protocol should be implemented to assist volunteers with the reporting of invasive species to County staff. This could be as simple as taking a photo of the plant, a photo of the context (so that it can be located again), and a location description. County staff can then verify the species identification and advise volunteers on removal. Volunteers should be discouraged from removing invasive species without first checking with the County, unless they are experienced with identification of southern Arizona flora. Either way, reporting of invasive species occurrences should be encouraged so that the County has knowledge of where invasive species establish on site. This information could inform future targeted monitoring for exotic invasive species.
PRELIMINARY PLAN | Hydrology

Hydrologic Flow
- Existing drainage chute
- Moderately developed drainage
- Engineered drainage
- Nascent drainage
- Proposed drainage alteration

Path Network
- Ephemeral Toad Pond
- TAS Habitat Enhancements
- Canopy Expansion
- Existing Canopy
- Volunteer Managed Areas
- Future Habitat Enhancements
- Circulating Water Feature

Camino Del Sol

Duval Mine Waterline Rd.

Frontage Rd.

DRAFT - 2/24/2021
Overview

Because grading and leveling of drainages occurred during golf course construction and irreversibly altered drainage patterns on-site, restoration of on-site drainages to historic, pre-golf course conditions is unrealistic. Instead, the proposed hydrology plan incorporates existing established and nascent drainages on-site, allowing drainage to evolve naturally where possible. Minimal rerouting of drainages is proposed to limit site disturbance while enhancing stormwater management and wildlife habitat, and mitigating problematic erosion occurring under paths. Rerouting is prioritized in the watersheds with the greatest discharge (1 and 4) to create ephemeral toad ponds and minimize total off-site runoff. Additionally, erosion monitoring areas are identified where paths and drainages intersect and interventions are proposed to mitigate erosion that may occur in these areas. Following is a detailed summary of proposed hydrology on-site, focusing on the sub-watersheds identified in the Canoa Hills Hydrology Report.

Watershed 1 - 100-Year Storm Discharge: 1,725 cfs

Watershed 1 includes parcels A, B, and E. Water in parcel B flows northeast into parcel A, traveling along existing drainage chutes as shown. Community-managed planting areas are strategically positioned to intercept flow, and could include rainwater harvesting basins to decrease flow traveling towards parcel A off-site and over streets.

Water in parcel A parallels the path, flowing through the box culvert into parcel E. The drainage is rerouted in parcel E, using the existing culvert beneath this section of the path to funnel flow into the ephemeral toad pond. Overflow travels through the community-managed area, allowing an additional opportunity for capturing stormwater in the landscape before it exits the site.

Watershed 2 - 100-Year Storm Discharge: 685 cfs

Parcels D and F are within watershed 2. Stormwater basin construction in parcel D should slow and capture street run-off and guide flow into the box culvert and parcel F. TAS habitat restoration areas in parcel F should capture runoff from Camino Del Sol. Proposed canopy enhancements along the north edge of the site enhance bird and other wildlife habitat along the north of the site. Because runoff produced in this sub-watershed is significantly less than in Watersheds 1 and 4, many identified stormwater harvesting areas in this watershed require future funding and would be a later phase of the project and a lesser priority. The three small future habitat enhancements areas in parcel F are stormwater harvesting features to minimize flow off-site.

Watersheds 3 & 4 - 100-Year Storm Discharge: 1,921 cfs

Watershed 3 flows into watershed 4, exiting the site at the box culvert in parcel G. Parcels C and G are included in these watersheds. Water flows parallel to the path through parcel C and into two small culverts that transport flow into an engineered, rock-lined drainage north of the path in parcel G. This flow joins with the more developed drainage running through the center of the site. Flow is rerouted as shown to funnel water into the existing golf-course ponds, creating seasonal toad habitat and mitigating path erosion issues to the east.

The constructed drainage in the northwest corner of parcel G is functional and integrated into the hydrology plan.
Conveyance
- Water flow
- Paths

Path-Drainage Intersections
- New path-drainage intersection
- No issues present
- Sedimentation on path
- Erosion under path

No issues present
Sedimentation on path
Erosion under path
Targeted Maintenance

With water comes erosion and sedimentation. Path-drainage intersections are the most likely areas for problematic erosion and sedimentation to occur. Shown here are all path-drainage intersections with information about current erosion and sedimentation issues. Path-drainage intersections should be periodically checked (especially during and following monsoon season) for developing sedimentation and erosional issues. This will allow for the immediate mitigation of these issues which is important for human safety and to avoid future costly construction interventions necessary for remediation of severe erosional issues.

Path sedimentation and erosion can be addressed through the installation of rip-rap along the path edges. As mentioned in the site assessment, this has already been accomplished in several areas and has proven to be a low-cost and effective solution to trail sedimentation and erosional issues.

Erosion adjacent to the path is most developed and extensive along the eastern trail in parcel G. Currently, stormwater flows across the path with significant downcutting and channelization downstream of the path. The hydrology plan redirects this flow into the old golf course ponds, creating ephemeral toad habitat.
Camino Del Sol

**Rustic Recreation (minimal intervention)**

These walking/running paths will likely see minimal use compared to other areas of the site. They provide a quieter, more naturalistic recreation experience and are accompanied by benches. No other infrastructural improvements are implemented along these paths.

**Building Community (moderate intervention)**

Gold paths correspond with community-managed areas that feature pollinator gardens, habitat enhancements, benches, and small ramadas for gathering.

**Accessible Gathering (high intervention)**

Low-grade paths in parcel G allow for accessible recreation. This parcel is programmed for group gathering and walking, and includes large ramadas, benches, and picnic tables.

**Interpretive Core (high intervention)**

Paths in parcels D and F form loops of varying lengths with site interpretive material focused in this area to align with the robust habitat enhancements. Benches and small ramadas for wildlife viewing and educational activities are found in these areas.

**Restricted Access Parking**

These areas are for restricted access parking.

**Public Parking**

This area is for public parking.

**Ramadas**

- Small ramadas for education and nature appreciation
- Large ramadas to accommodate group gathering

Ramadas are placed to take advantage of views and provide areas of rest along the path. Many are located in sand traps to limit disturbance to vegetated areas.

Primary use of the site will likely occur in parcels D, F, and G. Public parking is available to access these areas. D and F form an interpretive area, while G is focused on providing space for gathering and other passive recreation.
The following section presents guidance for further design development and implementation of Canoa Hills Trails. It includes a community outreach plan, a list of design considerations, and a conclusion to this report.
Because Canoa Hills T Rails is physically integrated into the community of Green Valley, and Friends of the Canoas will have an active role in caring for the park, site design and implementation should respond to community interests and concerns. The previously presented concepts and preliminary plan respond to County goals and available resources. The next step is to present these ideas to the community to get feedback and further refine the master plan for the site. Following is a community outreach plan which incorporates the unique limitations placed on gathering in light of COVID-19. The plan consists of two phases - a scoping questionnaire to gain more information about Canoa Hills T Rails site users, and a more interactive phase two which gathers feedback on the designs proposed in this report.

Phase 1: Visitor Information

Phase 1 is an online questionnaire that could be developed using Google Forms or a similar program. This survey allows individuals that cannot make in-person meetings to have a voice in the design of Canoa Hills T Rails, and it avoids in-person meetings that are not currently possible due to COVID-19. The questionnaire seeks to gain information about site users, uses, interests, and concerns, as well as potential availability and format for future meetings. This questionnaire could be distributed to stakeholders through GVC, the surrounding HOAs and the Flood Control District website and social media. See appendix D (pp. 57-58) for the complete questionnaire associated with this phase.

Phase 2: Design Feedback

The second part of the outreach plan involves some version of an in-person meeting followed by a second questionnaire. The meeting could be in a Zoom virtual meeting format to expedite community feedback gathering, if there is interest in that. This meeting will present initial questionnaire results and initial design concepts to the community, and will allow community members to ask questions of County staff (this can be moderated using the chat function of Zoom). The primary purpose of this meeting will be to connect County staff with the community and update the community on the design process. The presentation of the 3 concepts will be helpful for answering the second questionnaire which will be distributed following the meeting. It will include the 3 concept plans and have questions related to spatial layout of the site (such as which restroom/parking lot(s) locations would be most likely to be used, which concept is favored or not favored and why, and what recreational features are most likely to be used).

Design Considerations

Following is a list of considerations regarding future developments of Canoa Hills T Rails based on the site assessment and design application developed in this report.

- The majority of the site is within the 100-year floodplain. Many amenities such as restrooms, ramadas, benches and parking may overlap with the floodplain, so infrastructure in these areas should be able to handle occasional flooding.
- Sections of asphalt trail within the site are in poor condition and should be replaced (noted in site assessment section).
- Signage will be needed, especially at main/public entrances to the site. Smaller signs should be provided at all neighborhood entrances to provide some continuity and way-finding.
- A path map showing level of difficulty and lengths of trails would be recommended (this can show which trails are accessible and which are relatively steep).
- Restricted parking areas could temporarily become public parking for events if needed. If this is of interest to the County, it might be useful to have some small signage at these parking entrances so people can find them.

Conclusion

This report presents relevant background research, a comprehensive site assessment, and preliminary concept and master plan design for Canoa Hills T Rails. A community outreach plan is identified and next steps are proposed. Design outcomes presented here can be used to acquire funding for future site interventions, to spark engagement, interest, and conversations within the Green Valley community. More broadly, this design can serve as a precedent for realistic restoration and management of retired golf courses in the arid southwest.
Four appendices are referenced in the report and are included in the following pages.
The following is a list of plant species recorded on site in December 2017 and includes nativity of observed species. This information is from the 2017 Canoa Hills Trails Vegetation Inventory report.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Primary Growth Habit</th>
<th>Nativity</th>
<th>Duration</th>
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<td>Abutilon sp.</td>
<td>maple</td>
<td>Forb/Herb Native</td>
<td>Perennial</td>
<td></td>
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<tr>
<td>Acacia confinis</td>
<td>whitehorn acacia</td>
<td>Tree</td>
<td>Native</td>
<td>Perennial</td>
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The following is a list of recommended container species appropriate for habitat restoration at Canoa Hills Trails. This information is from the 2017 Canoa Hills Trails Vegetation Inventory report.

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<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
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<tbody>
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<tr>
<td>Acacia constricta</td>
<td>Whitethorn acacia</td>
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<td>Blue Paloverde</td>
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<td>Pectis papposa</td>
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The following is a list of recommended species for inclusion in hydoseed restoration mixes. This information is from the 2017 Canoa Hills Trails Vegetation Inventory report.
CANOA HILLS TRAILS USER QUESTIONNAIRE

The purpose of this questionnaire is to gather information to assist the Pima County Regional Flood Control District (District) in the development of a final master plan for Canoa Hills Trails (formerly Canoa Hills Golf Course). Your answers will make the park more successful by helping the District understand the interests of park users. We value your input and feedback. Please submit questionnaires by Friday, March 19, 2021 online, at the Green Valley Council Office or at the Green Valley Library.

VISITORS & VISITATION

1. What is the zip code of your primary residence?
   a. 85614
   b. 85622
   c. 85629
   d. Other: __________

2. Which of the following age groups currently reside in your household (select all that apply)?
   a. Children under 12
   b. Teenagers ages 13-19
   c. Working adults (commuters)
   d. Working adults (work from home)
   e. Retirees

3. Which of the following recreation sites/opportunities do you and members of your household currently use in Green Valley (check all that apply)?
   a. Canoa Hills Trails
   b. Historic Canoa Ranch
   c. Canoa Preserve Park
   d. West Desert Preserve
   e. Desert Meadows Park & Arid Gardens
   f. Recreation center(s)
   g. Golf course(s)
   h. None
   i. Other: __________

4. How often do you or your household visit Canoa Hills Trails (select one)?
   a. Three of more times a week
   b. Once or twice a week
   c. Once or twice a month
   d. A few times a year
   e. Less than a few times a year
   f. Never

5. In which seasons do you visit Canoa Hills Trails (select all that apply)?
   a. Spring (March - May)
   b. Summer (June - August)
   c. Fall (September - November)
   d. Winter (December - February)

6. Which parking lot amenities would you and your household use at Canoa Hills Trails (select all that apply)?
   a. Bike racks
   b. Motor vehicle parking
   c. Golf cart parking
   d. None (we walk to Canoa Hills Trails)
   e. N/A (we do not use Canoa Hills Trails)

7. Which parking lot location would you and your household prefer to use (select one)?
   a. The old driving range parking lot
   b. The old clubhouse parking lot
   c. Either one
   d. N/A (we do not use parking at Canoa Hills Trails)

8. If you or your household do not currently visit Canoa Hills Trails, why (check all that apply)?
   a. We are not interested
   b. We do not know how to get there/access the site
   c. We did not know the site existed
   d. We do not feel safe at Canoa Hills Trails
   e. There are not enough site amenities (restrooms, drinking fountains, etc.)
   f. Physical/mobility issues
   g. N/A (we do visit Canoa Hills Trails)
   h. Other: __________

9. How far do you live from Canoa Hills Trails?
   a. Immediately adjacent
   b. <1 mile
   c. 1-3 miles
   d. 4-6 miles
   e. 7-10 miles
   f. >10 miles

SITE USE

10. For you and your household, how important are the following primary project goals at Canoa Hills Trails (rank 1-3, 1 being the most important)?
   a. Ecological restoration - preserving and enhancing native habitat while managing problematic non-native invasive species
   b. Recreation - enhancing the visitor experience on site through additional amenities (restrooms, parking, ramadas, benches, etc.) and activities (gathering, birding, learning)
   c. Volunteering and community building - providing volunteer opportunities to integrate the Green Valley community and site visitors into the care of the site (native gardening, docents, guided walks, etc.)

11. Which are the primary recreational activities that you and your household currently engage with in at Canoa Hills Trails (select up to 3)?
   a. Walking/running
   b. Walking the dog
   c. Birdwatching/wildlife viewing
   d. Nature appreciation
   e. Picnicking/gathering
   f. Photography/sketching
   g. None
   h. Other: __________
12. Which recreational activities would you like to engage in (but currently don't) at Canoa Hills Trails (select all that apply)?
   a. Walking/running
   b. Walking the dog
   c. Exercising with outdoor workout stations (not presently on site)
   d. Birdwatching/wildlife viewing
   e. Nature appreciation
   f. Picnicking/gathering
   g. Photography/art
   h. None
   i. Other: ____________________

13. Which organized group activities would you be interested in participating in at Canoa Hills Trails (select all that apply)?
   a. Site care (plantings, plant care, removal of exotic invasive species, vegetation monitoring, trash pick-up days)
   b. Citizen science (organized monitoring of specific species on site to contribute to national or international scientific data sets)
   c. Educational events (birding and wildlife tours, regional history, site ecology)
   d. None
   e. Other: ________________________

14. Which areas do you primarily use at Canoa Hills Trails (select one)? [Include site map]
   a. Parcels east of Camino Del Sol
   b. Parcels west of Camino Del Sol
   c. I do not know
   d. I do not currently use Canoa Hills Trails

15. Which amenities would you most like to have on the portion of the park East of Camino Del Sol (select all that apply)? [Include site map]
   a. Drinking fountains
   b. Restrooms
   c. Ramadas
   d. Benches
   e. Educational signage
   f. None
   g. I do not care

16. Which amenities would you most like to have on the portion of the park West of Camino Del Sol (select all that apply)? [Include site map]
   a. Drinking fountains
   b. Restrooms
   c. Ramadas
   d. Benches
   e. Educational signage
   f. None
   g. I do not care

17. How do you envision Canoa Hills Trails in 10-20 years?

18. Do you have any additional thoughts or comments related to the design and use of Canoa Hills Trails?

19. Would you be interested in participating in an online Zoom meeting to review preliminary design concepts for Canoa Hills Trails, and if so, when could you generally attend this meeting (select all that apply)?
   a. Weekday mornings (9am-12pm)
   b. Weekday afternoons (12pm-4pm)
   c. Weekday evenings (4pm-8pm)
   d. Weekend mornings (9am-12pm)
   e. Weekend afternoons (12pm-4pm)
   f. Weekend evenings (4pm-8pm)
   g. I am not interested in attending any online Zoom meetings
   h. I would like to attend community meetings but am unable to do so

20. When social distancing measures are no longer needed, when could you and/or your household attend in-person community meetings in Green Valley to provide feedback to be incorporated into the design of Canoa Hills Trails (select all that apply)?
   a. Weekday mornings (9am-12pm)
   b. Weekday afternoons (12pm-4pm)
   c. Weekday evenings (4pm-8pm)
   d. Weekend mornings (9am-12pm)

21. Please enter your email address if you would like to be notified about future community meetings and information gathering for Canoa Hills Trails:
   Name: _______________________________________________
   Email: ________________________________________________