



COUNTY ADMINISTRATOR'S OFFICE

PIMA COUNTY GOVERNMENTAL CENTER
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C.H. HUCKELBERRY
County Administrator

March 19, 2018

Don Weaver, President
Green Valley Council

Re: **Technical Reports and Analysis Completed by County Staff Regarding the Canoa Hills Golf Course Proposal**

Dear Mr. Weaver:

Enclosed is a March 15, 2018 memorandum from the Director of the Regional Flood Control District answering a number of questions I raised to analyze in detail various issues associated with converting the Canoa Hills Golf Course into a natural resource park. (Attachment 1)

Also enclosed are several technical reports regarding hydrologic and hydraulic of the property as well as a January 30, 2018 report regarding existing biological conditions, vegetation analysis and restoration activities. (Attachments 2 & 3)

Please feel free to share these memoranda and reports with the Green Valley Council Subcommittee studying this issue.

Finally, I have enclosed a map demonstrating the floodplain delineation of Canoa Hills Golf Course. (Attachment 4) This shows approximately 60 percent or 77 acres of the property is subject to inundation or flooding during a 100-year flood event. A technical report regarding flooding which describes flooding of the clubhouse is incorrect; it is simply the flooding of the maintenance building being reserved from this transaction by the owner. We will inform the owner of our analysis for future consideration if the property is sold or conveyed to another party.

Mr. Weaver

Re: **Technical Reports and Analysis Completed by County Staff Regarding the Canoa Hills
Golf Course Proposal**

March 19, 2018

Page 2

Also, the statement in the technical report should be modified to change the word clubhouse to maintenance facility for the structure that is inundated with up to one foot of flood waters.

Sincerely,



C.H. Huckelberry
County Administrator

CHH/anc

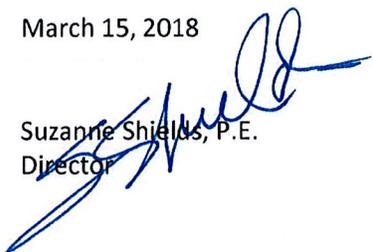
Enclosures

c: The Honorable Steve Christy, District 4 Member, Pima County Board of Supervisors
Carmine DeBonis, Jr., Deputy County Administrator for Public Works
Nanette Slusser, Assistant County Administrator for Public Works
Suzanne Shields, Director, Regional Flood Control District

ATTACHMENT 1

DATE: March 15, 2018

TO: C. H. Huckelberry
County Administrator

FROM: 
Suzanne Shields, P.E.
Director

SUBJECT: Canoa Hills Golf Course – Proposed Donation

The following information summarizes the additional review and evaluation you requested in your December 7, 2017 memorandum. The information will assist in planning and design potential for short-term and long-term transition plans for the proposed Canoa Hills Golf Course donation of approximately 130 acres. The gathering of this information has been a coordinated effort by the Regional Flood Control District (District), Natural Resources, Parks and Recreation (NRPR), Development Services Department (DSD), Department of Transportation (DOT), the Office of Sustainability and Conservation (OSC) and Real Property Services (RPS). This memorandum is formatted with answers to your questions shown in italics:

1. Zoning – For the proposed donated land, please determine the underlying Pima County zoning that would govern the use of the property if it remained privately owned. Provide appropriate use parameters for the particular zoning such as residential density and units per acre if it is residentially zoned.

The zoning on the Canoa Hills Golf Course is a combination of CB-2 (General Business), RH (Rural Homestead), and CR-5 (Multiple Residence Zone). Approximately 3 acres of the property is zoned CB-2. The CB-2 portion of the property is located at the southeast corner of Camino del Sol and Camino Urbano. This area is the clubhouse and restaurant. The remaining golf course property is primarily zoned RH. Properties zoned RH require a minimum 180,000 square foot (4.13 acre) minimum lot size for each dwelling unit. Given the size of approximately 130 acres, approximately 31 residences could be permitted. The exception to the RH zoning is the 16th Hole, which is Common Area B (open space) within the Canoa Estates subdivision as recorded in Book 38, Page 6, which was zoned CR-5. At some point the property was transferred to the golf course owner; however, the restriction for open space use remains.

2. Comprehensive Plan Designation – Is the property part of a Master Planned community? Is the Master Plan dependent upon other adjacent land uses? Are the adjacent land uses individually platted subdivision development that do not rely on the proposed donated land for open space calculations, common area requirements or any other condition of development for the adjacent subdivided lands? What is the comprehensive plan designation for the proposed donated property? What land use intensity is allowed under the designated comprehensive plan land use for the property?

The golf course development for this site predates the adoption of the golf course overlay zone. However, this golf course was part of a much larger rezoning. Many residential subdivisions that surround the golf course were approved as part of the rezoning. Throughout the rezoning process, the area was consistently shown as a golf course. Other passive uses such as parks, walking/hiking trails and other amenities consistent with a

Canoa Hills Golf Course – Proposed Donation

March 15, 2018

Page 2

county park would be allowed. The golf course is not part of a master planned community or specific plan per se. There is no record of this area being used to offset natural open space or to assist in density calculations for adjacent subdivisions. Each adjacent subdivision appears to function independently of all other subdivisions.

The comprehensive plan designation on the golf course property is Low Intensity Urban 3.0. This designation requires no minimum density of homes, but does prescribe a maximum of 3.0 residential units per acre should a rezoning be requested.

3. Property Taxes Paid – What property taxes have been paid? What was the amount paid for the last property tax year? How does the Assessor have the property valued? What is its value and classification for property tax purposes?

Property taxes for the first half of the 2017 assessment have been paid; proportioned amount of the second half should be part transfer of the title. A number of the parcels are classified as Vacant/Agriculture/Golf, but the largest parcel, which contains the clubhouse and other structures, is classified as mixed. The cumulative value of the parcel from the Assessor is \$417,178 for the land and \$483,986 for the improvements for a full cash value of \$901,194. It is understood that the structures other than 3 restrooms will not be donated.

4. List of Adjacent Homeowners Associations – Please provide a list of any homeowners association adjacent to any portion of the proposed donated land. With each association, list the association Board of Director's names and contact information.

See attached Exhibit A, which provides a map and listing of adjacent homeowner associations (HOAs). This information has been previously provided to Nanette Slusser, Assistant County Administrator, for her use in contacting and meeting with the HOAs.

5. Inventory of Improvements – Please develop a list of all physical improvements on the proposed donated land that remain in place or can be reused for passive recreational purposes. These physical improvements would include cart paths, restrooms and other obvious above ground physical improvements on the property.

An inspection of the property identified the presence of restrooms, cart paths, underpasses, ponds and irrigation. Exhibit B shows the locations of the restrooms, cart paths and underpasses. Their condition is described in Item 6.

6. As-built Plans or other Documents Related to the Improvements – Please provide, if available, any as-built plans or plans used to construct the improvements on the property. This would include all golf course improvements and amenities, including, but not limited to:
 - a) Water system and irrigation improvements;
 - b) Bathrooms and/or restrooms;
 - c) Major utility connections;

C. H. Huckelberry, County Administrator

Canoa Hills Golf Course – Proposed Donation

March 15, 2018

Page 3

- d) Cart paths;
- e) Plans associated with underpass tunnel construction and/or drainage improvements constructed in association with the golf course; and
- f) Above ground lighting structures.

For all of the above, have there been any condition assessments made regarding the usability and/or repair requirements for all of the built systems associated with the golf course?

- *Restrooms – Three restrooms are on the property. Utilities are not operational. Two of the structures appear to be in good condition with roofs, doors and fixtures all in need of replacement or repair. The third was in poor condition.*
- *Cart Paths – 80 percent of the total path is concrete and in good condition. Twenty percent of the total path is asphalt and in poor condition. Small portions of the path with drainage crossings has significant debris. Where cart paths cut into hillsides, the retaining walls are in poor condition.*
- *Natural Drainage – Debris is blocking the flow causing erosion from the flow of water.*
- *Ponds – Poor condition, equipment removed, spillways washed out, the banks are deteriorated.*
- *Underpasses – Full of debris.*
- *Irrigation Infrastructure – Has been cannibalized or damaged beyond repair.*

As of March 6, 2018, no As-built plans have been found with the exception of an addition to the clubhouse.

7. Specific Cart Path Review – Please provide specific detailed assessment of the golf cart paths and identify specific areas where modifications may be necessary to improve functionality from an access perspective and minimize use hazards.

The majority of the potential hazards and repair areas are related to erosion and drainage as well as repair to retaining walls. Spot erosion control will be necessary and pedestrian bridges are recommended for two areas where the path crosses the regulatory watercourse. Safety improvements such as handrails may be required where slopes or drop-offs present a hazard.

8. Structural Review of Golf Course Underpasses under Camino del Sol – Have any structural inspections been made of the golf course underpasses that provide east/west passage under Camino del Sol? I understand there are at least two underpass structures. What are their dimensions and appropriate clearance for pedestrians and other passage?

There is one 10'x10' concrete box culvert that is under Camino del Sol which is undersized and model results show the roadway being overtopped. A second drainageway originates within the former driving range. At this location, two 10'x10' concrete box culverts go under Camino

del Sol and contain the 100-year discharge. These culverts are also used as a cart path under the roadway.

Structural inspection reports have been requested from the DOT.

9. Utility, Drainage or Access Easements – What easements encumber the property and who are the beneficiaries for any purpose related to drainage, access or utilities?

Access Easements. Based on legal descriptions and plat maps, the access easements, which will be part of the title transfer, have been shown as parcels 10 through 22, on the map attached as Exhibit C. Concerns over use of the access easements expressed by the impacted HOAs are provided below:

- A. *The Canoa Ridge HOA's concern relates to Access Easement 17 on Exhibit C. This access easement is necessary for continuous access through the former golf course property. The subject easement is for "ingress, egress, utilities, drainage, purposes related to Grantee's use of adjacent land as a golf course, and related purposes. The HOA asserts the easement has been abandoned by the closing of the golf course and requests termination of the easement. If the HOA continues to insist the easement interest has reverted to the HOA, Pima County would need to contest the abandonment of the easement to assure continuous flow around the property for trail users. From a maintenance standpoint, it is not an issue.*

Their other request is that all ingress/egress to the abandoned clubhouse and parking lot onto S. Camino Urbano by any future owner be denied. The context in which the question is raised has to do with the initiation of any future rezoning action. This purely speculative scenario may never arise and would be dealt with through normal channels if it did.

- B. *The Canoa Estates HOA would like Pima County to convey the 16th Hole, Parcel 304-18-916B, to the HOA along with a portion of the access easements bordering that parcel because the 16th Hole is completely surrounded by residential lots. Persons utilizing the cart path through that parcel can see directly into the adjacent property owners' back yards. However, conveying this parcel to the HOA would mean the loss of continuous access to the large southern portion of APN 304-18-919A. This would cause users of the trail to have to stop and turn around at that point. A possible solution would be to exchange APN 304-18-916B along with access easement numbers 10 and 12 with the HOA granting an access easement to Pima County over that portion of W. Camino Urbano, which connects the western terminus of Access Easement 12 to 14, which would give users of the trail access to Parcel 919A and permit the continuous flow of movement around the property.*

The Canoa Estates HOA also expressed concerns that access to the driving range parcel would require, at least in part, vehicular access over the HOA's private streets.

The former driving range is mainly accessed on S. Camino del Sol, which is a publicly maintained street with only a very short jog over to W. Camino Urbano for Access Easement 16.

Utility Easements. *Locations of utility easements is still being researched because the legal descriptions are either blanket easements or are based upon the centerline of the former route of US Highway 89 or at later dates Interstate-19. Exhibit D shows the location of the sewer system, which is known, Utility easements for the adjacent subdivision plats are shown; where easements extend onto the former golf course, utility connection can be inferred, but not confirmed at this time.*

Drainage easements. *The golf course serves as the flow path for 4 watersheds, but recorded drainage easements do not exist. The exception is a flowage easement given to the Arizona Department of Transportation (ADOT) for a culvert crossing under I-19. There are a number of drainage easements for tributary flow from the platted subdivisions that discharge onto the golf course property. Drainage information is provided in more detail as part of response to Item 11.*

10. Water Hazards and Lakes – What water hazards and/or lakes have been constructed on the property and what is their current condition? Are they dry? Do they have remnant water? Have they been breached to ensure rainwater does not pond in the lakes or any other golf course depression such as sand traps, etc.? Are the water hazards and/or lakes properly drained so as not to impound or retard stormwater or create mosquito or other insect infestations?

The water hazards are relatively small and in poor condition with the plastic liners torn and deteriorated. These water hazards are deep, bowl shaped ponds with no outlets and will retain stormwater. To avoid mosquito infestations as well as drowning hazards, it is recommended that these depressions be filled with earthen material reduce ponding depth. Once modified, they may serve as water harvesting basins for restoration.

11. Mapping of Floodprone Impacts, Drainage Patterns and 100-year Discharge Values – What information is available regarding drainage systems that pass through the golf course? Has there been any identification or mapping of 100-year floodplain impacts from these drainage courses? What are the 100-year discharge values associated with any drainage that enters or passes through the proposed donated property? What is the likelihood that channel and/or arroyo cutting will be reestablished upon direct stream flow reestablishment through either flooding or other natural causes?

In most typical installations of golf courses in this area, the ridgetop is used for homes and the valley is used for conveying floodwaters through natural arroyos. What is the probability these natural arroyos will reestablish themselves based on the normal recurrence of flood flows through the donated area?

The following is a summary of the hydrologic and hydraulic analysis that the District completed for the Canoa Hills Golf Course, which can be found along with the 100-year discharges and associated floodplains in Exhibit E.

The golf course consists of approximately 130 acres of fairway, surrounded by elevated subdivisions. The fairway occupies the bottoms of the natural drainages, which generally run from the NW to the SE. I-19 forms the downstream end of the golf course; culverts convey the surface runoff from the golf course under I-19 to the Santa Cruz River. With a few exceptions, the natural channels were eliminated during fairway construction by smoothing the drainage bottoms. Improvements include paved cart paths, ponds, and culverts under the residential streets, which cross the fairway. Some of these culverts serve a dual purpose of drainage and cart access.

There are 4 main watersheds that flow along the fairways. In general, drainageways 1 and 4 are more floodprone. These drainageways have the largest watersheds and widest floodplains, which cover the entirety of all of the fairways. It is expected that more erosion will occur within these drainageways due to higher velocities. Restoration will be needed in these areas to control erosion. Floodplains along drainageways 2 and 3 are narrower and provide areas that are not subject to flooding which would allow for the installation of improvements or alternative uses, if desired.

If the golf course is allowed to return to a native state, reestablishment of the channels in the fairways will be necessary. This process may proceed naturally or alternatively by excavation guided perhaps by historic channel characteristics obtained from aerial photography. It is anticipated that wash reestablishment will produce sediment, which may deposit in and near the ponding areas and potential erosion along the cart path. Minor erosion control measures using rock rip rap or gabions could be installed to minimize erosion and reduce annual maintenance costs. In two path locations where heavy sedimentation occurs, pedestrian bridges are recommended.

12. Vegetation Inventory – What is the predominate vegetation type as determined by photogrammetric interpretation? What are the ranges and classes of natural Sonoran Desert plants and systems? Are there any known non-native and invasive species on the property? What is the present inventory of native plants, similar to those that exist naturally in this specific area of the Sonoran Desert that is now contained within the County's Native Plant Nursery. Do we have an adequate supply of appropriate species that could be easily used to establish a native palette for the golf course reclamation?

The following is a summary of the vegetation inventory and recommendations for restoration (Exhibit F).

On the retired golf course, there are large areas of native annual grasses and Palmer's amaranth (pig weed). The amaranth is an excellent source of forage as the stalk, leaves and seeds are highly nutritious; however, this fast growing summer plant is typically considered a

Canoa Hills Golf Course – Proposed Donation

March 15, 2018

Page 7

weed due to the plant's pollen, which causes hay fever, allergic reactions and skin irritation from spikes on the end of leaves and seed stalks are prickly. There are also areas of native trees preserved in place and native desert scrub and grasslands totaling approximately 69 acres. Areas with poor to no plant cover include the former ponds, sand traps and tee boxes. There are still patches of Bermuda grass which need to be mapped and removed.

The recommendation for restoration would be to increase the species' richness using container plants and seed mix using a plant palette that was developed for the Canoa Ranch Restoration project. The amount of Palmer's amaranth need to be reduced since many native plants would not be able to compete and thrive with this fast growing plant. Natural channel techniques such as small rock dams, cutting sinuous channels, and harvesting local subdivision runoff would be a low cost way to slow and infiltrate stormwater to support native plant reintroduction.

13. Surface Water Conveyance and Discharge Points – What are the primary entry points for surface waters that would flow through the proposed donated property? What are discharge and exit points? Are the exit points constrained by the lack of downstream floodwater conveyance capacity through culverts or other flow constraints?

In addition to the offsite flows that were identified in Item 11, Exhibit G shows the primary entry points for surface drainage that runs off the adjacent neighborhoods. Although there is a lack of capacity of downstream infrastructure, it does not impact adjacent residential development.

14. Biological Viability Assessment – Has there been any examination of the property and its biological capacity and/or viability from the Pima County Office of Sustainability and Conservation? It would be appropriate to determine the value of this donation from a biological connectivity perspective.

The presence of Freeport-McMoRan's Sierrita Mine immediately to the west of the proposed donation represents a long-term landscape barrier that interrupts landscape connectivity with undeveloped desert areas and the Sierrita Mountains and Tinaja Hills, now and into the foreseeable future. In addition, houses, which closely surround the linear donations, likely represent a barrier for use by some species.

To the east, there are two culvert locations that appear to have passage underneath I-19 including two 84" corrugated metal pipe culverts at the north end and three 10'x7' reinforced concrete box culverts at the south end of the proposed donation. These features are not contiguous across both of the north and south lanes and are interrupted by the wide vegetated median. Studies of similar drainage features have shown that some wildlife species will adapt to these types of culverts as a means to cross highways. The one prominent fatal flaw relates to the disjointed nature of the culverts at the median. As a result, animals may wander onto the highway, a situation that could result in a vehicle-wildlife collision.

Canoa Hills Golf Course – Proposed Donation

March 15, 2018

Page 8

While not regionally significant, the proposed donation area does make a contribution to biological connectivity by providing habitat and vegetation on a more local scale. The native vegetation—existing and what manifests following restoration—provides habitat elements essential to the survival of some desert wildlife species. There is evidence the donation area is being used by many of the common, desert species (e.g., deer, coyote, javelina, bobcats, raptors, songbirds, and reptiles). These and other species are known to utilize the regionally significant Demetri/Esperanza Wash and Escondido Wash connectivity corridor just to the south of the proposed donation area. To the extent that the proposed donation area supports native plants and animals, restoration of the parcel is likely to have an overall positive contribution to biological connectivity in the area of the donation.

15. View Shed Values and/or Assets – Does the proposed property contain any unique or unusual vistas and/or view sheds that would be valuable from a larger area context as opposed to view-shed protection for simply adjacent landowners?

The proposed donation lands are primarily valley bottoms, which limits the view sheds. As riparian restoration occurs, the vistas are likely to diminish further, although onsite visual benefits would increase for pedestrians who use the paths.

16. Use Compatibility with Adjacent Owners – There have been several letters from adjacent homeowners associations regarding concerns. Please address each of the issues. In addition, we will be conducting a meetings with all adjacent homeowners during the time between the donation and final acceptance to determine their unique needs for appropriate adjustments to accommodate without impairing the natural passive park value of the donation.

Meeting with adjacent property owners, HOAs, and interested parties are ongoing, a response will be provided at a later date.

17. Fringe Compatibility – There have been concerns regarding the fringe area between homeowners' properties/common areas and the proposed donated land becoming a nuisance either through lack of weed removal or other actions. What arrangements can be made to convey a buffer property interest to the homeowners for their use and management?

Boundaries of the golf course footprint do not always align with the property boundaries separating the golf course from the common areas. For the most part, the trees and shrubs as well as the subdivision drainageways lie within the common areas. A field survey has been ordered to better define the location of improvements and boundaries of common areas of adjacent subdivisions. This will assist both Pima County and adjacent HOAs in identifying what may be an appropriate buffer area along different segments of the golf course property.

C. H. Huckelberry, County Administrator

Canoa Hills Golf Course – Proposed Donation

March 15, 2018

Page 9

Once the property is conveyed to Pima County, a discussion with HOAs concerning establishing buffer area easement(s), or provide a land exchange that would be advantageous to all parties, would be recommended. One option is for the current owner to establish a buffer area before Pima County takes title, and they would acquire the property subject to the easement or lease.

18. Groundwater Monitoring and Subsurface Flow Detection – Based on geotechnical and other groundwater records, what is the depth of the groundwater below the former golf course? Do we anticipate any unusual groundwater sub-surface flows, springs or seeps?

Based upon the review of available geotechnical information, well data, and groundwater level records, the depth to water in the Canoa Hills Golf Course area ranges from about 220 feet below land surface (bls) on the eastern boundary to approximately 330 feet bls on the western boundary. There are some shallower water levels (60-250 feet bls) recorded near the mine tailings, about a half mile west of the property. However, several wells at this location are being pumped for mine operations and this pumping captures the groundwater and keeps it from entering the regional water table along the residential area surrounding the I-19 corridor. If the mine wells stopped pumping, there is the potential for groundwater mounding in the vicinity as nearby geologic logs show a 30' clay lens starting around 130 feet bls; however, there is no evidence of existing or potential unusual subsurface flows, seeps or springs at the old golf course.

19. Cultural and Archeological Review – It appears most of the natural areas have been disturbed by pre-construction activity related to the golf course. Has there been any cultural or archeological surveys conducted on the property at the time of development? Are there any cultural/archeological artifacts within the proposed donated property or in the proximity of same?

The property has not been surveyed for cultural resources to modern standards. There are three previously recorded known archaeological sites that probably occur on the property [AZ DD:4:39 (ASM), AZ DD:4:40 (ASM), and AZ DD:4:41(ASM)]; however, these were recorded in 1952 as part of the Fricke survey and the locations may be inaccurate. The property is partially within the Sonoran Desert Conservation Plan's (SDCP) high archaeological sensitivity zone adjacent to I-19, but most of the property is within the low SDPC sensitivity zone.

20. Technical Literature Review – Please develop an appropriate literature search regarding specific information on the adaptive reuse of golf courses for other uses, particularly natural open space for passive recreation use. This would include golf courses that have already been adaptively reused in southwestern arid environments.

Canoa Hills Golf Course was opened in 1984. Canoa Hills was built in low lying and floodplain areas with residential development on the top of the hills, which provide golf course views. This was a time when the nature and type of courses built were more costly,

longer, more difficult to play and took longer to play compared to courses built previously. Approximately 40% of golf courses built during the 1990s were tied to real estate development. The consensus among developers was that master planned communities that had a high profile golf course as a featured amenity were able to get premium lot prices. Many of the golf courses were not sustainable. These golf courses were costly to build and maintain, were long and difficult to play, and the routings were such that a golf cart was needed to traverse from tee to green to the next tee.

Arizona has had 10 golf course closures. There are 38 golf courses in the Tucson area and to date two are closed: Santa Rita Golf Course located at Corona de Tucson and Canoa Hills Golf Course. Santa Rita is also a subdivision with a golf course and was constructed in 1976 and closed in 2011. There was a request to have Pima County take possession of the golf course land and convert it to a park, which we declined. Individuals have purchased the golf course greens and fairways and have built homes. This option is from Pima Prospers, Chapter 3, Policy 18 "Explore options to address the re-use of entitled, unconstructed golf courses; retired/abandoned golf courses; and golf courses without an alternative use."

Golf courses can be repurposed for many uses, however; the Canoa Hills Golf Course will have its own design challenges with the limits of RH zoning, access, topography, floodplains, physical constraints and distance between subdivisions limiting development and compatible uses with the adjacent residents. This is an age restricted community and the 55 plus market values nature, walking/jogging paths, and staying physically active among other activities.

Potential funding sources for maintenance of Canoa Hills include private funds, general funds, bond program, and a partnership with Green Valley Recreation and Park District, HOA, or commercial development.

There are alternatives to the site that would enumerate the positive and negative impacts associated with each.

- 1. No change. No action to be taken by the developer.*
- 2. Ownership by Pima County HOA or other. Ownership means taking responsibility of the maintenance for the proposed use(s).*
- 3. Recreation items for the property. Maintenance costs for each activity will factor in the types of uses to provide. Types of recreational items to think through: walking paths, sitting areas (ramadas, picnic tables, benches), dog park, pickleball courts, birding, environmental restoration, conservation easements, floodway maintenance area, single-family residences, or reconfigured golf course.*

In summary, based on the above information, initial recommendations for initial short-term actions would include:

- Golf Cart Path. Address erosion repairs, sediment removal, vegetation and tree trimming, and safety improvements including handrails where necessary;

C. H. Huckelberry, County Administrator
Canoa Hills Golf Course – Proposed Donation

March 15, 2018

Page 11

- Maintenance Plan. Develop a maintenance plan to address vegetation control via mowing, establishment of fire break(s) where necessary, and address buffer areas with HOAs; and
- Golf Course Depressions. Fill depressed areas such as former water hazards or other golf course related depressions so as not to impound or retard stormwater or create mosquito or other insect infestations

Long-term restoration planning for adaptive re-use of the golf course could potentially include:

- Re-establishment of Natural Drainage Pattern. Areas lying within regulatory floodplains could be reshaped to restore more natural flow paths and channels, provide areas of stormwater harvesting of the main flow areas as well as local drainage from adjacent subdivisions;
- Environmental Restoration. Address invasive weeds and develop landscape plan to restore the riparian canopy.
- Those areas that are outside the floodplain and where access is sufficient could be adaptively reused. Rather than the County constructing new improvements, any reuse could potentially occur at the request and expense of private entities such as HOAs or Green Valley Recreation and Park District, with the County leasing the land to these entities.

Both short-term actions and long-term adaptive re-use plans will be developed with input from the adjacent HOAs, Green Valley Recreation and Park District, Green Valley Community Coordinating Council, and other interest stakeholders.

Please let me know if you have questions or need further information.

SS/tj

Attachments

c: Carmine DeBonis, Deputy County Administrator – Public Works
Nanette Slusser, Assistant County Administrator for Public Works Policy
Nicole Fyffe, Executive Assistant to the County Administrator
Chris Cawein, Director – Natural Resources, Parks and Recreation
Linda Mayro, Director – Office of Sustainability and Conservation
Neil Konigsberg, Manager – Real Property Services
Eric Shepp, P.E., Deputy Director – Regional Flood Control District

| Corp_Name | Address_Line1 | Address_Line2 | City | Zip_Code | Agent_Name | Agent_Address_Line1 | Agent_City | Agent_State | Agent_Zip |
|-----------------------------------|-----------------------------|-----------------|--------------|------------|---------------------------------|-------------------------|-----------------|-------------|------------|
| CANOA LEIATIES INC | 2980 S CAMINO DILL SOL #114 | NBU 206 DOOR 14 | GREEN VALLEY | 85622- | KATHRYN LINGALSBL | 1710 W CAMINO URBANO | GREEN VALLEY AZ | | 85622-4665 |
| CANOA CANYON ESTATES INC | PO BOX 1212 | | GREEN VALLEY | 85622- | ALBERT LUCKE | P O BOX 1212 | GREEN VALLEY AZ | | 85622- |
| GREEN VALLY DESERT HILLS NO 4 INC | 2980 CAMINO DEL SOL #108 | | GREEN VALLEY | 85622-8700 | RICHARD DUFFIELD | 3430 E. SUNRISE DRIVE | TUCSON AZ | | 85718- |
| CANOA RIDGE INC | 2980 S CAMINO DILL SOL #113 | | GREEN VALLEY | 85622- | GLEN L PFEFFERORN | 3472 S VIA DEL PAPAGAYO | GREEN VALLEY AZ | | 85622- |
| | | | | | GERALDINE SIWEK, VICE PRESIDENT | 3786 VIA DEL REYESCUELO | GREEN VALLEY AZ | | 85622 |



- Streets
- Golf Course Parcels
- HOAs Registered with Development Services

1 inch = 700 feet



Date: 1/10/2018



The information depicted on this display is the result of data provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the accuracy of the data provided. The Pima County Regional Flood Control District makes no claims regarding the accuracy of the information depicted herein.

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FLOOD CONTROL
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 FLOOD CONTROL
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Legend:
 Culvert Crossings (Blue line)
 Golf Cart Paths (Purple line)
 Streets (Black line)
 Golf Course Parcels (Green outline)
 Subdivisions (Orange outline)

Scale: 1 inch = 700 feet
 0 175 350 700 1,050 1,400 Feet

Date: 11/30/2017

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| Symbol | Description | Docket | Page |
|--------|--------------------------|--------|------|
| 3 | Sewer Easement | 5943 | 425 |
| 7 | Sewer & Utility | 7380 | 660 |
| 8 | Sewer | 7429 | 727 |
| 9 | Blanket Sewer Easement | 7539 | 603 |
| 11 | Sewer & Utility | 7565 | 1506 |
| 16 | Sewer & Utility | 7728 | 849 |
| 17 | Slope, Drainage, Utility | 7885 | 1786 |
| 18 | Slope, Drainage, Utility | 8070 | 664 |
| 19 | Sewer | 8092 | 1914 |
| 21 | Private Sewer | 8289 | 774 |

Legend

Exhibit_B

Type

- Private Sewer
- Sewer
- Sewer & Utility
- Slope, Drainage, Utility
- Blanket Sewer Easement

Exhibit_A

Type

- Property
- Subdivisions

ATTACHMENT 2



DATE: January 24, 2018

TO: Eric Shepp, PE
Deputy Director

FROM: Rachael Weissman, CFM
Senior Hydrologist

Andy Seiger
Civil Engineering Manager

SUBJECT: Hydrologic and Hydraulic Analysis of Canoa Hills Golf Course

A hydrologic and hydraulic analysis was completed on the Canoa Hills Golf Course in Green Valley, AZ. The golf course consists of approximately 130 acres of fairway, surrounded by elevated subdivisions. The fairway occupies the bottoms of the natural drainages, which generally run from the NW to the SE. Interstate 19 forms the downstream end of the golf course; culverts convey the surface runoff from the golf course under the Interstate and to the Santa Cruz River. With a few exceptions, the natural channels were eliminated during fairway construction by smoothing the drainage bottoms. Improvements include paved cart paths, ponds, and culverts under the residential streets which cross the fairway. Some of these culverts serve a dual purpose of drainage and cart access. The golf course has not been active for about three years. The grounds have been maintained minimally, including mowing. This analysis was based on existing conditions.

Hydrology

The contributing watershed to the 130 acre golf course is 1,719 acres. The upstream most area of the watershed consists of mine tailings on a very steep slope. Downstream of the mine tailings but upstream of the golf course is undeveloped natural desert with rolling hills and defined washes. The washes flow into the golf courses, which have typically been graded to distribute flow in a sheet-like manner across the width of the fairway. In one case, a natural channel continues adjacent to the fairway.

The 100-year (1% annual chance) discharge was analyzed for this site using Pima County Regional Flood Control District PC Hydro version 6.1 software. Flow paths, soils, and vegetation types were analyzed using spatial analysis tools in ArcGIS. The site was divided into four drainage areas. A summary of the 100-year discharges is in the table below. A map of the drainage areas and the Hydrologic Data Sheets are provided as an attachment.

| Watershed | Area (acres) | 100-Year Discharge (cfs) | USGS Regression Equation (cfs) |
|------------------|-------------------------|---|---|
| 1 | 615 | 1,725 | 1,226 |
| 2 | 119 | 685 | 362 |
| 3 | 57 | 215 | 193 |
| 4 | 928 | 1,816 | 1,605 |
| 3+4 | 986 | 1,921 | 1,668 |

Hydraulics

The 100-year floodplain was delineated using HEC-RAS and HEC-GeoRAS software. Routing of the flood wave was not investigated, so the volume of ponded water predicted by this hydraulic analysis at certain locations was not compared to the available volume of runoff in the hydrograph. A flood routing investigation may reduce the magnitude of ponding at these areas. Ground elevation data was collected from 2015 PAG LiDAR data, which was processed into a 2-foot resolution digital elevation model (DEM) that was used for cross section data and floodplain mapping. Ten culverts were modeled within HEC-RAS, culvert sizes were field verified. Culvert invert elevations were collected from the DEM. Manning's "n" values used within this model are based on existing conditions. The limits of the resulting 100-Year Floodplain can be seen on the attached map.

During the 100-year storm event, Drainage Way 1 (Watershed 1) generally inundates the entire fairway, up to the steep slopes coming off the subdivisions. Stormwater will fill the ponds used as water features for the golf course. There is 1-10'x10' concrete box culvert that is under Camino Del Sol which is undersized and model results show the roadway being overtopped. The culvert causes backwater which inundates the club house with up to 1 foot of water. Downstream of Camino Del Sol the channel is reestablished and runs along the north side of the fairway. The channel is a natural sand and rock bottom and has fairly dense vegetated overbanks. During a field visit, significant downcutting was observed and railroad ties used as bank stabilization. In some places banks were more than 6 feet tall. At the downstream end of this drainage way the fairway widens and flows spread. Underneath the I-19 frontage road there are 2-6' corrugated metal pipe culverts, which are also undersized, model results show flow overtopping the frontage road.



Downcutting in Drainage Way 1

Drainage Way 2 (Watershed 2) originates within the former driving range. The 2-10'x10' concrete box culverts under Camino Del Sol contain the flow 100-year discharge. These culverts are also used as a golf cart path under the roadway. The 100-year floodplain within this drainage way is generally along the low flow area on the north side of the fairway. The floodplain widens and flow depths become deeper downstream as undersized culverts cause backwater. There are 2-4' corrugated metal pipe culverts under Camino Del Pato and 1-5' corrugated metal pipe culvert under the I-19 frontage road. Model results show that both of these roadways are overtopped during the 100-year event.



Driving Range, Headwaters of Drainage Way 2, looking upstream (to the NE)

Drainage Way 3 (Watershed 3) is a tributary to Drainage Way 4. Drainage Way 3 begins just upstream of Camino Urbano, where there is 1-30" corrugated metal pipe culvert, which cannot contain the 100-year discharge and does overtop this residential road. However, downstream of Camino Urbano, the fairway provides adequate capacity, leaving much of the fairway outside of the 100-year floodplain. At Camino Del Sol there are 2-48" corrugated metal pipe culverts, which contain the 100-year discharge. Downstream of Camino Del Sol there is a small grouted rock channel that flows downstream about 500 feet then discharges into the golf course green. The confluence of Drainage Way 3 with Drainage Way 4 occurs about 600 feet south of where Via De La Gloria dead-ends.



Gouted Rock Channel, Drainage Way 3

Drainage Way 4, like Drainage Way 1, is generally inundated the entire width of the fairway during the 100-year event. There are 2-10'x5' concrete box culverts at Camino Del Huarache which are undersized and model results show flow going over the road. At Camino Del Sol, flow is constricted through 1-8'x8' concrete box culvert which is also undersized and overtopped during the 100-year event. Downstream of Camino Del Sol and the confluence with Drainage Way 3, flows spread out to fill the fairway, with the exception of small hills along the golf course. At the downstream end of the drainage way, there are 2-10'x6' concrete box culverts under I-19 which contain the 100-year discharge.

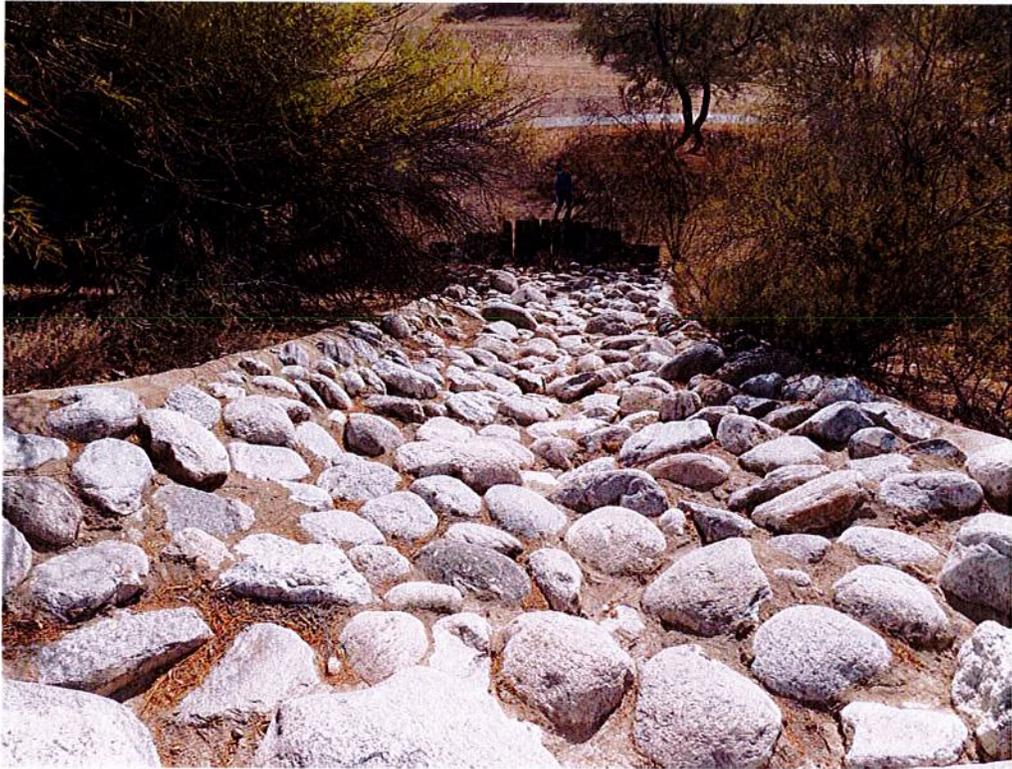


Typical Low Flow Path

Subdivision Drainage

There are nine subdivisions which discharge storm runoff into the general vicinity of the golf course. Subdivision drainage flows down streets with curb and gutter, then discharges into drainage easements, which outlet into the golf course through constructed down-chutes. The designs of these down-chutes vary, but some examples seen were steep grouted rock channels, smooth paved chutes, or dumped rock, which may have railroad ties or grouted rip-rap as energy dissipaters at the downstream end to slow the water and redistribute it across the golf course. Locations of these drainage outlets can be seen on the attached map.

This subdivision drainage infrastructure seems to be functioning properly and constructed well. It is assumed that allowing the subdivision drainage to disperse over the golf course supplemented the irrigation needs of the golf course. Maintenance will be needed downstream of these drainage outlets, as erosion could occur easily with high velocity flows coming off the steep slopes.



Grouted Rock Outlet from Subdivision with Railroad Tie Dissipater at Downstream End



Concrete Paved Outlet from Subdivision with Grouted Rock at Downstream End

Conclusions

Without maintenance of the fairways for the last few years, the low areas of the fairways have begun to erode and develop small channels. In many places, this erosion has exposed corrugated plastic drain piping (approximately 6 inches in diameter). This piping was installed about 6 inches below ground in the low areas of the fairway, presumably to prevent the fairways from becoming water-logged during Monsoons. In addition, at a few locations channels are beginning to reestablish adjacent to the golf cart paths and eroding underneath the path. A byproduct of the erosion is sedimentation, which was also witnessed along the path.

In general, Drainage Ways 1 and 4 are more floodprone, they have the largest discharges and widest floodplains. It is expected that more erosion will occur within these drainage ways due to higher velocities. Restoration will be needed in these areas to control erosion of the forming channel. Drainage Ways 2 and 3 provide the most non floodprone space.



Erosion Reestablishing Channel, Exposed Piping



Erosion along Golf Cart Path, Exposed Piping



Sedimentation along Golf Cart Path



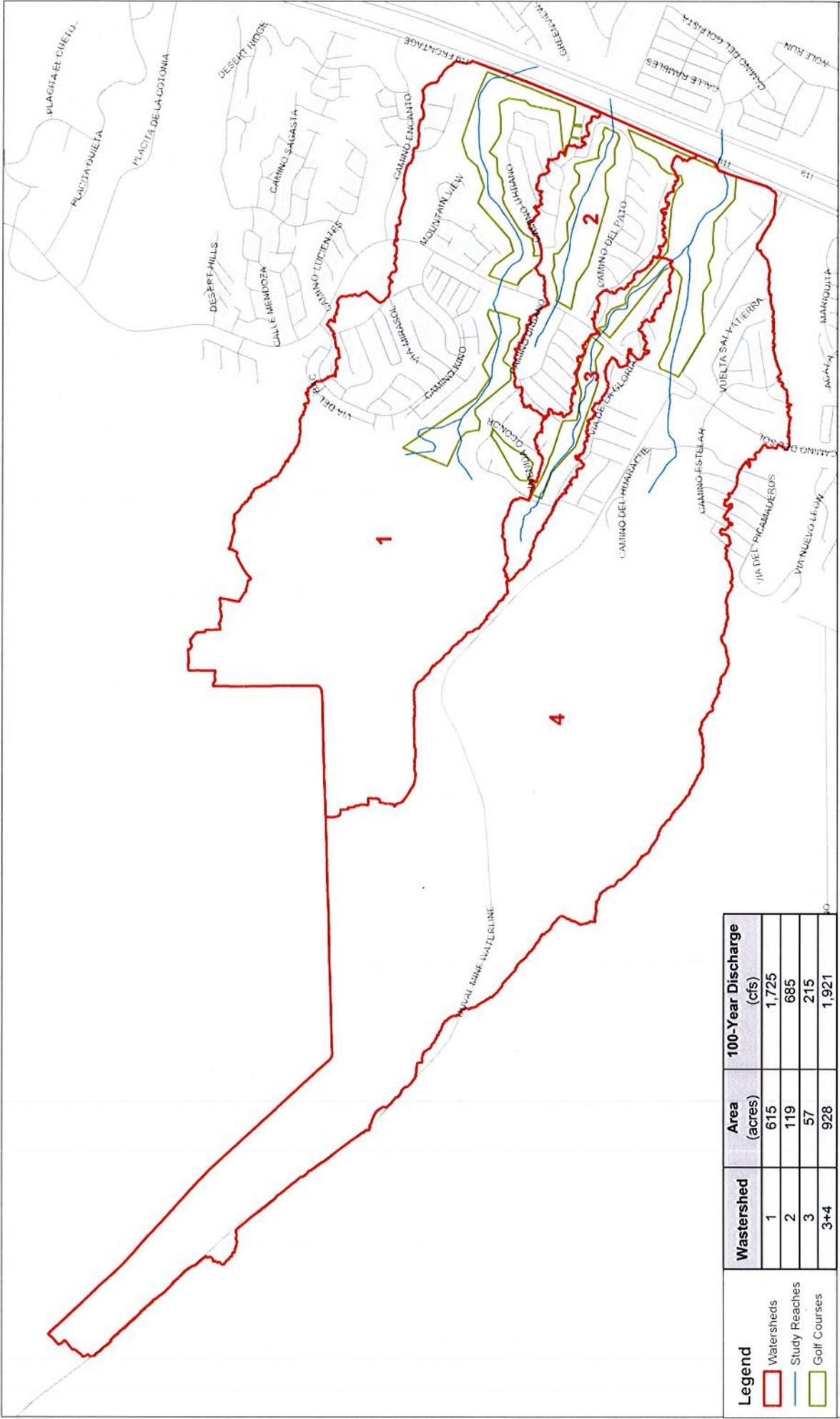
Erosion Upstream of Culvert at I-19 Frontage Road

Reclamation

The following observations may be valid if the golf course is to be allowed to return to a native state. Due to the manner in which the fairway was constructed by smoothing the drainage bottoms, reestablishment of the washes will be necessary. This process may proceed naturally, or alternatively by excavation guided perhaps by historic channel characteristics obtained from aerial photography. It is anticipated that wash reestablishment will produce sediment which may deposit in and near the ponding areas predicted by the hydraulic analysis. To maintain capacity of culverts, this deposition may need to be managed. Channel re-establishment may also damage the existing cart paths at locations where the cart path intersects the channel. This damage may be minimized by placement of bank protection and bridge construction on the cart path. When the main washes become established, the tributary flow paths back to the down-chutes carrying subdivision drainage onto the golf course will reestablish by head-cutting. Maintenance will be required to prevent this head cutting from damaging the outlet of the down-chutes. Ponds constructed within the fairway may need to be filled or breached.

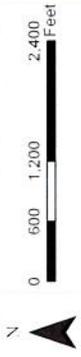
Attachments:

- Drainage Area Map
- Subdivision Drainage Map
- 100-Year Floodplain Map
- PC Hydro Hydrologic Data Sheets



Canoa Hills Watershed Map

| Watershed | Area (acres) | 100-Year Discharge (cfs) |
|-----------|--------------|--------------------------|
| 1 | 615 | 1,725 |
| 2 | 119 | 685 |
| 3 | 57 | 215 |
| 3+4 | 928 | 1,921 |





Canoa Hills 100-Year Floodplain Map

Legend

-  Culverts
-  100-Year Floodplain Limits
-  XS Cut Lines
-  Study Reaches





- Legend**
- ▲ Culverts
 - 100-Year Floodplain Limits
 - XS Cut Lines
 - Study Reaches
 - 2-Foot Topography



Canoa Hills 100-Year Floodplain Map



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE

Generated using methods provided by Pima County Regional Flood Control District

| | | | |
|----------------------|--------------------------|----------------|--------------------|
| Client: | Pima County | Prepared by: | R. Weissman |
| Project Name: | Conola Hills Golf Course | Date: | 12/28/2017 |
| Concentration Point: | 1 | Job # | 001 |
| Watershed Area: | 615.09 Acres | Watershed Type | Suburban Foothills |

Watercourse Data By Reach

| Reach No. | Height (Hi) | Length (Li) | Slope (Si) | Basin Factor (Nb) |
|-----------|-------------|-------------|------------|-------------------|
| 1 | 369 | 1143 | 0.3228 | 0.08 |
| 2 | 111 | 4875 | 0.0228 | 0.045 |
| 3 | 88 | 5934 | 0.0148 | 0.035 |

| | | | | |
|----------------------------------|--------------|------|---------------------|--------|
| Length of Watercourse (Lc): | 11952 | feet | Mean Slope: | 0.0207 |
| Length to Cen. of Gravity (Lca): | 7045 | feet | Weighted Basin Fac: | 0.043 |
| Veg. Cover Type(s): | Desert Brush | | Veg. Cover Density: | 20 |

RETURN PERIOD: 100-years NOAA Data Obtained: 2017-12-28 04:22:18 PM

| | | | | | | | | | | |
|--------------------|--|--------|--------|--------|------|------|------|------|-------|-------|
| Rainfall Depths: | NOAA Atlas 14 (90% UCL) @ Latitude: 31.8269 Longitude: -111.0216 | | | | | | | | | |
| Duration: | 5-min | 10-min | 15-min | 30-min | 1-hr | 2-hr | 3-hr | 6-hr | 12-hr | 24-hr |
| Point Values (in): | 0.91 | 1.38 | 1.71 | 2.31 | 2.86 | 3.17 | 3.27 | 3.71 | 4.04 | 4.43 |

| Soil Type | Percent | Curve # (CN) | Adj. Curve # (CN*) | Runoff Coef. (C) |
|-----------|---------|--------------|--------------------|------------------|
| B | 26.6 | 82.3 | 86.81 | 0.56 |
| C | 53.5 | 87.6 | 90.38 | 0.66 |
| D | 19.9 | 91 | 93.46 | 0.757 |
| Imp. | 25 | 99 | 99 | 0.959 |

| | |
|------------------------------|------------|
| Weighted Runoff Coef. (Cw): | 0.73 |
| Time of Concentration: | 38.9 min |
| Rainfall Intensity (i) @ Tc: | 3.82 in/hr |
| Runoff Supply Rate (q) @ Tc: | 2.78 in/hr |
| PEAK DISCHARGE: | 1725.3 cfs |



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE

Generated using methods provided by Pima County Regional Flood Control District

| | | | |
|----------------------|--------------------------|----------------|--------------------------|
| Client: | Pima County | Prepared by: | R. Weissman |
| Project Name: | Conola Hills Golf Course | Date: | 12/29/2017 |
| Concentration Point: | 2 | Job # | 001 |
| Watershed Area: | 119.42 Acres | Watershed Type | Medium Density Urbanized |

Watercourse Data By Reach

| Reach No. | Height (Hi) | Length (Li) | Slope (Si) | Basin Factor (Nb) |
|-----------|-------------|-------------|------------|-------------------|
| 1 | 23 | 763 | 0.0301 | 0.022 |
| 2 | 41 | 1022 | 0.0401 | 0.035 |
| 3 | 20 | 552 | 0.0362 | 0.035 |
| 4 | 44 | 2441 | 0.018 | 0.035 |

| | | | | |
|----------------------------------|-------------|------|---------------------|--------|
| Length of Watercourse (Lc): | 4778 | feet | Mean Slope: | 0.0244 |
| Length to Cen. of Gravity (Lca): | 1856 | feet | Weighted Basin Fac: | 0.033 |
| Veg. Cover Type(s): | Urban Lawns | | Veg. Cover Density: | 20 |

RETURN PERIOD: 100-years NOAA Data Obtained: 2017-12-29 11:27:32 AM

| | | | | | | | | | | |
|--------------------|--|--------|--------|--------|------|------|------|------|-------|-------|
| Rainfall Depths: | NOAA Atlas 14 (90% UCL) @ Latitude: 31.8198 Longitude: -111.0127 | | | | | | | | | |
| Duration: | 5-min | 10-min | 15-min | 30-min | 1-hr | 2-hr | 3-hr | 6-hr | 12-hr | 24-hr |
| Point Values (in): | 0.9 | 1.37 | 1.7 | 2.29 | 2.83 | 3.15 | 3.25 | 3.69 | 4.01 | 4.41 |

| Soil Type | Percent | Curve # (CN) | Adj. Curve # (CN*) | Runoff Coef. (C) |
|-----------|---------|--------------|--------------------|------------------|
| B | 46.7 | 83 | 87.4 | 0.573 |
| C | 53.3 | 88 | 91.15 | 0.681 |
| D | - | - | - | - |
| Imp. | 25 | 99 | 99 | 0.958 |

| | | |
|------------------------------|-------|-------|
| Weighted Runoff Coef. (Cw): | 0.71 | |
| Time of Concentration: | 10.6 | min |
| Rainfall Intensity (i) @ Tc: | 7.99 | in/hr |
| Runoff Supply Rate (q) @ Tc: | 5.69 | in/hr |
| PEAK DISCHARGE: | 685.2 | cfs |



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE

Generated using methods provided by Pima County Regional Flood Control District

| | | | |
|----------------------|--------------------------|----------------|--------------------|
| Client: | Pima County | Prepared by: | R. Weissman |
| Project Name: | Conola Hills Golf Course | Date: | 01/03/2018 |
| Concentration Point: | 3 | Job # | 001 |
| Watershed Area: | 57.28 Acres | Watershed Type | Suburban Foothills |

Watercourse Data By Reach

| Reach No. | Height (Hi) | Length (Li) | Slope (Si) | Basin Factor (Nb) |
|-----------|-------------|-------------|------------|-------------------|
| 1 | 46 | 1330 | 0.0346 | 0.045 |
| 2 | 105 | 4142 | 0.0254 | 0.035 |

| | | | | |
|----------------------------------|-------------|------|---------------------|--------|
| Length of Watercourse (Lc): | 5472 | feet | Mean Slope: | 0.0272 |
| Length to Cen. of Gravity (Lca): | 2626 | feet | Weighted Basin Fac: | 0.037 |
| Veg. Cover Type(s): | Urban Lawns | | Veg. Cover Density: | 75 |

RETURN PERIOD: 100-years NOAA Data Obtained: 2018-01-03 12:13:48 PM

| | | | | | | | | | | |
|--------------------|--|--------|--------|--------|------|------|------|------|-------|-------|
| Rainfall Depths: | NOAA Atlas 14 (90% UCL) @ Latitude: 31.8201 Longitude: -111.0198 | | | | | | | | | |
| Duration: | 5-min | 10-min | 15-min | 30-min | 1-hr | 2-hr | 3-hr | 6-hr | 12-hr | 24-hr |
| Point Values (in): | 0.9 | 1.37 | 1.7 | 2.29 | 2.83 | 3.15 | 3.25 | 3.69 | 4.01 | 4.41 |

| Soil Type | Percent | Curve # (CN) | Adj. Curve # (CN*) | Runoff Coef. (C) |
|-----------|---------|--------------|--------------------|------------------|
| B | 47.3 | 74 | 80.69 | 0.412 |
| C | 52.7 | 83 | 87.4 | 0.573 |
| D | - | - | - | - |
| Imp. | 15 | 99 | 99 | 0.958 |

| | |
|------------------------------|------------|
| Weighted Runoff Coef. (Cw): | 0.57 |
| Time of Concentration: | 15.7 min |
| Rainfall Intensity (i) @ Tc: | 6.59 in/hr |
| Runoff Supply Rate (q) @ Tc: | 3.73 in/hr |
| PEAK DISCHARGE: | 215.4 cfs |



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE

Generated using methods provided by Pima County Regional Flood Control District

| | | | |
|----------------------|--------------------------|----------------|--------------------|
| Client: | Pima County | Prepared by: | R. Weissman |
| Project Name: | Conola Hills Golf Course | Date: | 01/03/2018 |
| Concentration Point: | 4 | Job # | 001 |
| Watershed Area: | 928.49 Acres | Watershed Type | Suburban Foothills |

Watercourse Data By Reach

| Reach No. | Height (Hi) | Length (Li) | Slope (Si) | Basin Factor (Nb) |
|-----------|-------------|-------------|------------|-------------------|
| 1 | 297 | 1778 | 0.167 | 0.08 |
| 2 | 164.5 | 8669 | 0.019 | 0.045 |
| 3 | 51.5 | 3732 | 0.0138 | 0.035 |
| 4 | 46 | 3140 | 0.0146 | 0.035 |

| | | | | |
|----------------------------------|--------------|------|---------------------|--------|
| Length of Watercourse (Lc): | 17319 | feet | Mean Slope: | 0.0192 |
| Length to Cen. of Gravity (Lca): | 10671 | feet | Weighted Basin Fac: | 0.045 |
| Veg. Cover Type(s): | Desert Brush | | Veg. Cover Density: | 40 |

RETURN PERIOD: 100-years NOAA Data Obtained: 2018-01-03 03:19:33 PM

| | | | | | | | | | | |
|--------------------|--|--------|--------|--------|------|------|------|------|-------|-------|
| Rainfall Depths: | NOAA Atlas 14 (90% UCL) @ Latitude: 31.8222 Longitude: -111.0344 | | | | | | | | | |
| Duration: | 5-min | 10-min | 15-min | 30-min | 1-hr | 2-hr | 3-hr | 6-hr | 12-hr | 24-hr |
| Point Values (in): | 0.92 | 1.39 | 1.73 | 2.33 | 2.88 | 3.2 | 3.29 | 3.74 | 4.08 | 4.47 |

| Soil Type | Percent | Curve # (CN) | Adj. Curve # (CN*) | Runoff Coef. (C) |
|-----------|---------|--------------|--------------------|------------------|
| B | 22.94 | 81.2 | 86.04 | 0.543 |
| C | 67.28 | 86.4 | 89.76 | 0.644 |
| D | 9.78 | 89.4 | 91.88 | 0.707 |
| Imp. | 15 | 99 | 99 | 0.959 |

| | |
|------------------------------|-------------------|
| Weighted Runoff Coef. (Cw): | 0.68 |
| Time of Concentration: | 60.3 min |
| Rainfall Intensity (i) @ Tc: | 2.87 in/hr |
| Runoff Supply Rate (q) @ Tc: | 1.94 in/hr |
| PEAK DISCHARGE: | 1815.8 cfs |



HYDROLOGIC DATA SHEET FOR PIMA COUNTY FLOOD PEAK PROCEDURE

Generated using methods provided by Pima County Regional Flood Control District

| | | | |
|----------------------|--------------------------|----------------|--------------------|
| Client: | Pima County | Prepared by: | R. Weissman |
| Project Name: | Conola Hills Golf Course | Date: | 01/12/2018 |
| Concentration Point: | 5 | Job # | 001 |
| Watershed Area: | 985.77 Acres | Watershed Type | Suburban Foothills |

Watercourse Data By Reach

| Reach No. | Height (Hi) | Length (Li) | Slope (Si) | Basin Factor (Nb) |
|-----------|-------------|-------------|------------|-------------------|
| 1 | 297 | 1778 | 0.167 | 0.08 |
| 2 | 164.5 | 8669 | 0.019 | 0.045 |
| 3 | 51.5 | 3732 | 0.0138 | 0.035 |
| 4 | 46 | 3140 | 0.0146 | 0.035 |

| | | | | |
|----------------------------------|--------------|------|---------------------|--------|
| Length of Watercourse (Lc): | 17319 | feet | Mean Slope: | 0.0192 |
| Length to Cen. of Gravity (Lca): | 10671 | feet | Weighted Basin Fac: | 0.045 |
| Veg. Cover Type(s): | Desert Brush | | Veg. Cover Density: | 40 |

RETURN PERIOD: 100-years NOAA Data Obtained: 2018-01-12 07:51:18 AM

| | | | | | | | | | | |
|--------------------|--|--------|--------|--------|------|------|------|------|-------|-------|
| Rainfall Depths: | NOAA Atlas 14 (90% UCL) @ Latitude: 31.8221 Longitude: -111.0336 | | | | | | | | | |
| Duration: | 5-min | 10-min | 15-min | 30-min | 1-hr | 2-hr | 3-hr | 6-hr | 12-hr | 24-hr |
| Point Values (in): | 0.92 | 1.39 | 1.73 | 2.33 | 2.88 | 3.2 | 3.29 | 3.74 | 4.08 | 4.47 |

| Soil Type | Percent | Curve # (CN) | Adj. Curve # (CN*) | Runoff Coef. (C) |
|-----------|---------|--------------|--------------------|------------------|
| B | 24.355 | 81.2 | 86.04 | 0.543 |
| C | 66.435 | 86.4 | 89.76 | 0.644 |
| D | 9.21 | 89.4 | 91.88 | 0.707 |
| Imp. | 15 | 99 | 99 | 0.959 |

| | | |
|------------------------------|--------|------------------------|
| Weighted Runoff Coef. (Cw): | 0.68 | Notes: |
| Time of Concentration: | 60.4 | min Watersheds 3 and 4 |
| Rainfall Intensity (i) @ Tc: | 2.86 | in/hr |
| Runoff Supply Rate (q) @ Tc: | 1.93 | in/hr |
| PEAK DISCHARGE: | 1921.1 | cfs |

ATTACHMENT 3

DATE: January 30, 2018

TO: Chris Cawein, Director
Natural Resources, Parks and Recreation

FROM: Marisa Rice, Manager
Open Space Lands

Jessie Byrd, Manager
Native Plant Nursery

SUBJECT: Proposed Canoa Hills Golf Course Donation – Response to Item 12

On December 12, 2017, you asked us to address Item 12 in Mr. Huckelberry's memorandum dated December 7, 2017 (Exhibit A). Item 12 requests an assessment of the existing vegetation and provide restoration objectives for the proposed Canoa Hills Golf Course donation. We visited the Canoa Hills Golf Course on December 21, 2017 to evaluate existing conditions and assess for restoration opportunities. The following is a summary of our findings.

EXISTING CONDITIONS

Available GIS Data

Ephemeral washes upstream of the golf course are mapped Xeroriparian C habitat, while the golf course, developed prior to the mapping, contains no mapped habitat. The Harris Riparian classification is 143.1, Semidesert Grassland, or sometimes referred to as desert grassland, mesquite grassland, or scrub grassland. The Arizona Grasslands and The Nature Conservancy Grasslands layers classify this area as historic grassland with shrub cover greater than 35%. Canoa Hills is not part of the Conservation Lands System. Undisturbed vegetation upstream of the golf course is classified by the SWReGAP digital land cover layer as Sonoran Paloverde-Mixed Cacti Desert Scrub.

Existing Site Conditions

The golf course was constructed in historic ephemeral washes, generally taking advantage of the site's natural topography, although grading occurred to accommodate the golf course design. Improvements include the excavation of several ponds that create topographically low points and berms at several locations that constrict and divert the floodplain and create areas of ponding.

Vegetation communities outside of the constructed course were mostly preserved in place (see Photos 1 and 2) and contain large remnant patches of native vegetation that support a diverse array of species (Table 1 – Existing Plant List). Generally, these areas are topographically higher than the golf course and would provide a local source of native seed over time.



Photo 1. Sonoran Desert Scrub plant community preserved in place.



Photo 2. Semidesert Grassland plant community preserved in place.

While there is an abundant seed source nearby, staff observed minimal recruitment of native perennial plants on the golf course with the exception of a small patch of Cholla cactus and mesquite trees (photos 3 and 4), although it is very likely the mesquite trees are hybridized.



Photo 3. Cholla Cactus Recruitment



Photo 4. Mesquite Tree Recruitment

Staff observed several locations along the path where non-native species have been intentionally planted including the non-native invasive Fountaingrass (Photo 5). We also found patches of various annual and perennial non-native invasive species throughout the site, either along the edge of the golf course or within the preserved in place plant communities (Table 1). The bulk of the perimeter edge of the golf course is residential landscape. Proximity to these residential landscapes could lead to a potential source of seed both native and non-native.



Photo 5. Landscaped area containing Fountaingrass.

The upstream watershed is highly developed by Freeport-McMoRan's Sierrita Mine. Upstream of the golf course, drainages are truncated by the Sierrita Mine tailings, while downstream I-19 acts as a barrier with the exception of two box culvert crossings. The first is three 10' x 7' reinforced concrete box culverts located at the southern end of the course and the second is two 84" corrugated metal pipe culverts located at the northern boundary. There are several smaller culverts, but it is unknown whether they provide a connection east of I-19; the hydrology and hydraulic review will provide insight regarding existing infrastructure. During the inspection, we observed wildlife use of the site including signs of coyote, javelina, deer, raccoon, and various bird species.

The community frequently uses the old golf cart path. In the few hours spent onsite, we passed multiple people walking and biking with several commenting on how much they enjoy using the path.

The golf course contains mostly recently mowed annual vegetation that desiccated after the summer rainy season making it difficult to identify species and plant community structure. Based on the site's history, staff expected to find large patches of Bermudagrass, but was surprised to find very little throughout the site. Instead, we found large areas of Palmer's amaranth (*Amaranthus palmeri*) and native annual grasses. The site has been off irrigation for some years, possibly stressing the Bermudagrass and allowing for displacement by native annuals. Based on vegetation that was present, staff was able to identify five land cover classes (Figure 1):

1. Retired golf course converting to an annual native plant community with low species richness (54 acres; see Photos 6 and 7).
2. Native trees preserved in place with understory converting to an annual native plant community (12.6 acres; see Photo 8).

3. Native plant communities (Desert Scrub/Semidesert Grassland/Xeroriparian) preserved in place (56.2 acres; see Photos 1 and 2).
4. Former ponds (3.1 acres; see Photo 9).
5. Denuded areas including sand traps and tee boxes (4.1 acres; see Photo 10).

Land cover Class 1, retired golf course converting to an annual native plant community with low species richness. This class consists of large patches of either Palmer's amaranth, or annual native grasses, primarily needle grama (*Bouteloua aristidoides*) and sixweeks threeawn (*Aristida adscensionis*), which are typically the first species to colonize a disturbed area. An occasional subshrub or forb/herb was observed, but these areas appear mostly homogenous including just a few species.

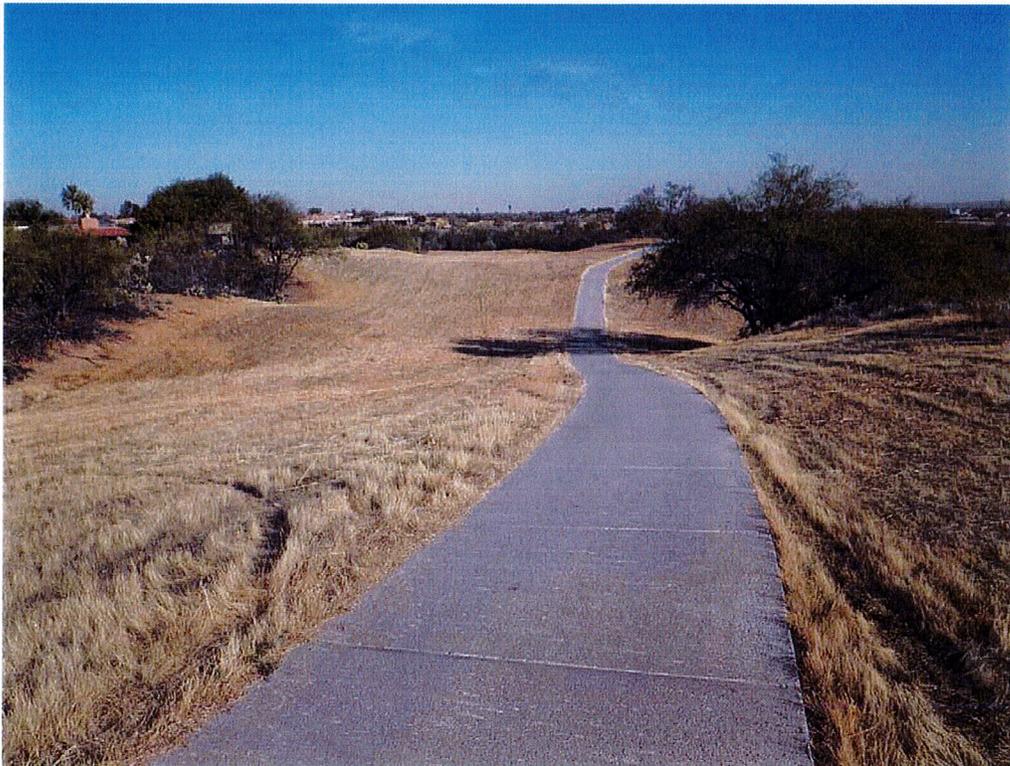


Photo 6. Retired golf course converting to annual native grasses.



Photo 7. Retired golf course converting to Palmer's Amaranth

Land cover Class 2, native trees preserved in place with understory in the process of converting to an annual native plant community. This class contains primarily mature velvet mesquite (*Prosopis velutina*) trees with an understory of either Palmer's amaranth or annual native grasses. The understory plant community is similar to Class 1 with a slightly higher plant species richness that includes perennial shrubs. The increased species richness is likely due to tree shading, cycling of nutrients and possibly reduced disturbance.



Photo 8. Land cover Class 2; native trees preserved in place with native understory.

Land cover Class 3, Native plant communities preserved in place. Varying topography throughout the site supports three separate plant communities including Sonoran Desertscrub, Semidesert grassland, and Xeroriparian habitat. The Sonoran Desertscrub is located on the hilltops and slopes (Photo 1), Semidesert grassland (Photo 2) is between the base of slopes and floodplain/riparian areas, and Xeroriparian habitat (Photo 9) is along the wash corridors and areas of ponding. These remnant habitat fragments provide resources for native animals, birds and insects. Native plant communities that have been preserved in place could provide a seed source for plant recruitment or for collection and growth at the Native Plant Nursery.



Photo 9. Example of a Xeroriparian habitat preserved in place.

Land cover Class 4, former ponds. The former ponds are low depressions on the landscape that collect water during storm events and support vegetation that tolerates periodic inundation. Vegetation in the ponds consists mostly of non-native invasive species such as Bermuda grass and tamarisk, and the weedy native Palmer's amaranth. Also present was the native perennial Desertbroom (*Baccharis sarothroides*), a common pioneer species on disturbed soils. We did observe one partially dead Gooding's willow tree, a remnant from when the ponds held water. At two of the ponds, we observed a torn and exposed liner, which may indicate the ponds no longer hold water for extended periods.



Photo 10. Example of land cover Class 4; area was former pond.

Land cover Class 5, denuded areas including sand traps and tee boxes. There was very little vegetation growing in these areas, possibly due to a soil fertility issue from lack of organic matter present. These areas contained coarse sand and it is possible the soil was compacted when originally constructed.



Photo 11. Land cover Class 5, Sand Trap

RESTORATION OPPORTUNITIES

While the disturbed areas contained low species richness, it was promising to find native plants have successfully re-established on their own. Land cover Class 5, sand traps and tee boxes, contained very little vegetation, which may be due to a soil fertility issue. Staff recommends testing soil fertility prior to undertaking restoration efforts. We also observed several areas of active erosion, primarily headcuts along drainage swales (Photo 12).



Photo 12. Headcut with Active Erosion

Staff identified the following restoration objectives:

1. Map and remove non-native invasive species. Methods to remove invasive species may include mechanical, chemical or biological. Staff recommends solarization to treat the few patches of Bermuda grass.
2. Identify soil fertility problems and improve problem areas with soil amendments. The highly disturbed nature of golf courses from long-term management actions such as excessive irrigation, soil amendments, etc., may have modified native soils by increasing soil salinity, leaching out soil minerals, or other adverse effects. As such, staff recommends soil fertility testing prior to undertaking restoration and amending problem areas, if needed.
3. Modify ground topography to slow and infiltrate stormwater. An example would be to cut a sinuous channel in the drainage area to convey water through the site.
4. Use natural channel design techniques (one-rock dams, media lunas, and rock rundowns) to slow and infiltrate stormwater and mitigate erosion.
5. Increase species richness by planting native plants using both container plants and seed mix. Staff recommends a plant palette (Tables 2 and 3) modified from the Canoa Ranch restoration project plant list. Additional actions to help achieve this goal include reducing the amount of Palmer's amaranth during the active growing season using chemical and/or mechanical means and considering the site's topographic variability when installing container plants to locate in areas where they will most likely succeed.

The regeneration of native plants since the golf course closed shows potential for restoration, which could be accomplished using relatively low-tech, low-cost solutions allowing the site to demonstrate how a disturbed land can recover some of the Sonoran Desert ecosystem functions. Strategies for reducing restoration costs could include Pima County working with the Green Valley community to form a "land stewardship" volunteer group to assist with restoration objectives. Work may include mapping and removing invasive species, helping to build simple rock structures to mitigate erosion in partnership with non-profit groups, and/or helping to plant trees and apply seed mix.

MR/JB/tj

Attachments

c: Suzanne Shields, P.E., Director – Regional Flood Control District
Eric Shepp, P.E., Deputy Director – Regional Flood Control District
Colby Fryar, P.E., Civil Engineering Manager – Regional Flood Control District
Julia Fonseca, Environmental Planning Manager – Sustainability and Conservation

FIGURES

Figure 1. Canoa Hills Golf Course Donation - Land Cover

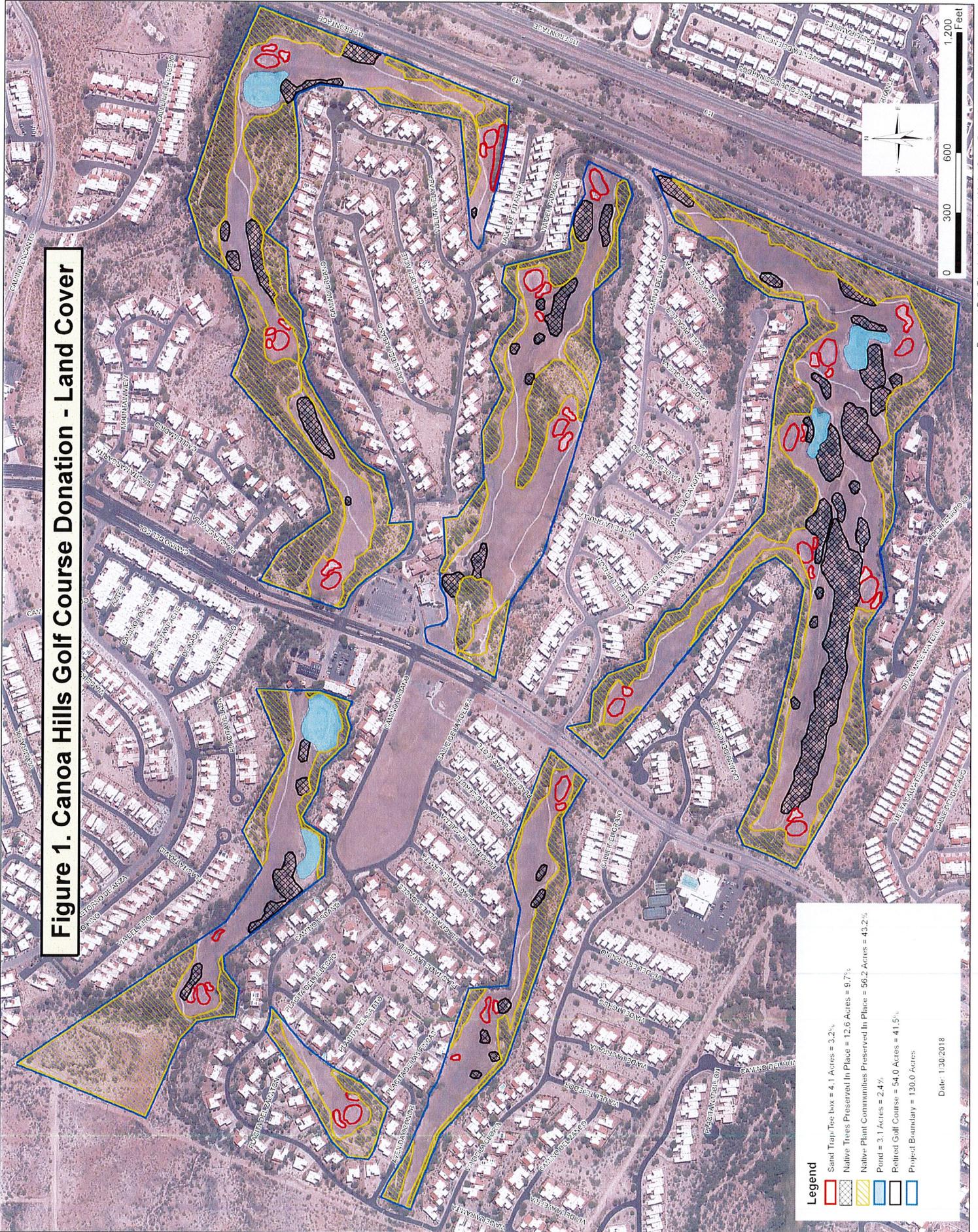


Table 1. Canoa Hills Golf Course Donation - Plants Observed 12/21/2017

| Scientific Name | Common Name | Primary Growth Habit | Nativity | Duration |
|----------------------------------|-------------------------------|----------------------|-------------------|-------------------|
| Abutilon sp. | mallow | Forb/Herb | Native | Perennial |
| Acacia constricta | whitethorn acacia | Tree | Native | Perennial |
| Acacia greggii | catclaw acacia | Tree | Native | Perennial |
| Acourtia nana | dwarf desertpeony | Forb/Herb | Native | Perennial |
| Allionia incarnata | trailing windmills | Forb/Herb | Native | Annual, Perennial |
| Aloysia wrightii | Wright's beebrush | Shrub | Native | Perennial |
| Ambrosia confertiflora | weakleaf burr ragweed | Forb/Herb | Native | Perennial |
| Aristida adscensionis | sixweeks threeawn | Graminoid | Native | Annual |
| Aristida purpurea | purple threeawn | Graminoid | Native | Annual, Perennial |
| Aristida ternipes | spidergrass | Graminoid | Native | Perennial |
| Atriplex canescens | fourwing saltbush | Shrub | Native | Perennial |
| Baccharis sarothroides | desertbroom | Shrub | Native | Perennial |
| Bahia absinthifolia | hairyseed bahia | Forb/Herb | Native | Perennial |
| Boerhavia scandens | climbing wartclub | Vine | Native | Perennial |
| Boerhavia sp. | spiderling | Forb/Herb | Native | Annual |
| Bouteloua aristidoides | needle grama | Graminoid | Native | Annual |
| Brickellia sp. | brickellbush | Subshrub | Native | Perennial |
| Calliandra eriophylla | fairyduster | Shrub | Native | Perennial |
| Carnegiea gigantea | saguaro | Succulent | Native | Perennial |
| Celtis ehrenbergiana | spiny hackberry | Shrub | Native | Perennial |
| Chloris virgata | feather fingergrass | Graminoid | Native | Annual |
| Cocculus diversifolius | snailseed | Vine | Native | Perennial |
| Cylindropuntia arbuscula | Arizona pencil cholla | Succulent | Native | Perennial |
| Cylindropuntia fulgida | jumping cholla | Succulent | Native | Perennial |
| Cylindropuntia spinosior | walkingstick cactus | Succulent | Native | Perennial |
| Cylindropuntia versicolor | staghorn cholla | Succulent | Native | Perennial |
| Dasyochloa pulchella | low woollygrass | Graminoid | Native | Perennial |
| Datura wrightii | sacred thorn-apple | Forb/Herb | Native | Annual, Perennial |
| Echinocereus engelmannii | Engelmann's hedgehog cactus | Succulent | Native | Perennial |
| Encelia farinosa | goldenhills | Subshrub | Native | Perennial |
| Ephedra trifurca | longleaf jointfir | Shrub | Native | Perennial |
| Ericameria laricifolia | turpentine bush | Subshrub | Native | Perennial |
| Ferocactus wislizeni | candy barrelcactus | Succulent | Native | Perennial |
| Fouquieria splendens | ocotillo | Shrub | Native | Perennial |
| Gutierrezia sp. | snakeweed | Subshrub | Native | Perennial |
| Ipomoea sp. | morning-glory | Forb/Herb | Native | Annual |
| Isocoma tenuisecta | burroweed | Subshrub | Native | Perennial |
| Justicia candicans | Arizona water-willow | Shrub | Native | Perennial |
| Muhlenbergia porteri | bush muhly | Graminoid | Native | Perennial |
| Opuntia engelmannii | cactus apple | Succulent | Native | Perennial |
| Opuntia phaeacantha | tulip pricklypear | Succulent | Native | Perennial |
| Opuntia santa-rita | Santa Rita pricklypear | Succulent | Native | Perennial |
| Pappophorum vaginatum | whiplash pappusgrass | Graminoid | Native | Perennial |
| Parkinsonia florida | blue paloverde | Tree | Native | Perennial |
| Phoradendron californicum | mesquite mistletoe | Subshrub | Native | Perennial |
| Physalis sp. | groundcherry | Forb/Herb | Native | Annual, Perennial |
| Prosopis velutina | velvet mesquite | Tree | Native | Perennial |
| Salix gooddingii | Goodding's willow | Tree | Native | Perennial |
| Sapindus saponaria | wingleaf soapberry | Tree | Native | Perennial |
| Setaria leucopila | streambed bristlegrass | Graminoid | Native | Perennial |
| Setaria macrostachya | large-spike bristlegrass | Graminoid | Native | Perennial |
| Simmondsia chinensis | jojoba | Shrub | Native | Perennial |
| Solanum elaeagnifolium | silverleaf nightshade | Subshrub | Native | Perennial |
| Stephanomeria pauciflora | brownplume wirelettuce | Subshrub | Native | Perennial |
| Verbesina encelioides | golden crownbeard | Forb/Herb | Native | Annual |
| Yucca elata | soaptree yucca | Tree | Native | Perennial |
| Zinnia acerosa | desert zinnia | Subshrub | Native | Perennial |
| Ziziphus obtusifolia | lotebush | Shrub | Native | Perennial |
| Acacia farnesiana | sweet acacia | Tree | Non-Native | Perennial |
| Agave americana | American century plant | Succulent | Non-Native | Perennial |
| Caesalpinia pulcherrima | bird of paradise | Shrub | Non-Native | Perennial |
| Eragrostis echinochloidea | African lovegrass | Graminoid | Non-Native | Perennial |
| Eucalyptus sp. | Eucalyptus | Tree | Non-Native | Perennial |
| Leucophyllum frutescens | Texas ranger | Shrub | Non-Native | Perennial |

| Scientific Name | Common Name | Primary Growth Habit | Nativity | Duration |
|---|-------------------------|----------------------|------------|-----------|
| <i>Nerium oleander</i> | oleander | Tree | Non-Native | Perennial |
| <i>Opuntia engelmannii</i> var. <i>linguiformis</i> | cactus apple | Succulent | Non-Native | Perennial |
| <i>Panicum antidotale</i> | blue panicum | Graminoid | Non-Native | Perennial |
| <i>Parkinsonia aculeata</i> | Jerusalem thorn | Tree | Non-Native | Perennial |
| <i>Pennisetum ciliare</i> | buffelgrass | Graminoid | Non-Native | Perennial |
| <i>Pennisetum setaceum</i> | crimson fountaingrass | Graminoid | Non-Native | Perennial |
| <i>Prosopis</i> sp. | non-native mesquite | Tree | Non-Native | Perennial |
| <i>Rhus lancea</i> | African sumac | Tree | Non-Native | Perennial |
| <i>Salsola tragus</i> | prickly Russian thistle | Forb/Herb | Non-Native | Annual |
| <i>Schinus molle</i> | Peruvian peppertree | Tree | Non-Native | Perennial |
| <i>Tamarix</i> sp. | tamarisk | Tree | Non-Native | Perennial |

Table 2. Canoa Hills - Container Plant List

| | Scientific Name | Common Name |
|-------------------|--------------------------------------|-------------------------|
| Trees: | <i>Acacia constricta</i> | Whitethorn acacia |
| | <i>Acacia greggii</i> | Catclaw acacia |
| | <i>Cercidium floridum</i> | Blue Paloverde |
| | <i>Chilopsis linearis</i> | Desert Willow |
| | <i>Parkinsonia florida</i> | Blue Paloverde |
| | <i>Prosopis velutina</i> | Velvet Mesquite |
| Shrubs: | <i>Aloysia wrightii</i> | Wright's beebrush |
| | <i>Anisacanthus thurberi</i> | Desert honeysuckle |
| | <i>Atriplex canescens</i> | Fourwing saltbush |
| | <i>Calliandra eriophylla</i> | Fairyduster |
| | <i>Celtis pallida</i> | Desert hackberry |
| | <i>Condalia warnockii</i> | Kearney's snakewood |
| | <i>Cylindropuntia arbuscula</i> | Arizona pencil cholla |
| | <i>Cylindropuntia fulgida</i> | Chain-fruit cholla |
| | <i>Cylindropuntia leptocaulis</i> | Christmas cactus |
| | <i>Cylindropuntia spinosior</i> | Cane cholla |
| | <i>Ferocactus wislizenii</i> | Candy barrel cactus |
| | <i>Fouquieria splendens</i> | Ocotillo |
| | <i>Gossypium thurberi</i> | Thurber's cotton |
| | <i>Lycium andersonii</i> | Anderson Wolfberry |
| | <i>Lycium exsertum</i> | Thornbush |
| | <i>Lycium fremontii</i> | Fremont Wolfberry |
| | <i>Opuntia engelmannii</i> | Prickley pear |
| | <i>Rhus aromatica var. trilobata</i> | Three-leafed sumac |
| | <i>Yucca elata</i> | Soaptree yucca |
| | <i>Zizyphus obtusifolia</i> | Graythorn |
| Subshrubs: | <i>Bebbia juncea</i> | sweetbush |
| | <i>Brickellia californica</i> | California brickellbush |
| | <i>Encelia farinosa</i> | Brittlebush |
| | <i>Isocoma tenuisecta</i> | Burweed |
| | <i>Psilostrophe cooperi</i> | Whitestem paperflower |
| | <i>Senna covesii</i> | Desert senna |
| | <i>Trixis californica</i> | American threefold |
| | <i>Zinnia acerosa</i> | Desert Zinnia |
| | <i>Acacia angustissima</i> | Prairie acacia |
| | <i>Ambrosia deltoidea</i> | Triangleleaf bursage |
| Forbs: | <i>Abutilon sp.</i> | Mallow |
| | <i>Asclepias linaria</i> | Pine-leaf milkweed |
| | <i>Asclepias subulata</i> | Desert milkweed |
| | <i>Bahia absinthifolia</i> | Dealbata's bahia |
| | <i>Commicarpus scandens</i> | Climbing wartclub |

ATTACHMENT 3

DATE: January 30, 2018

TO: Chris Cawein, Director
Natural Resources, Parks and Recreation

FROM: Marisa Rice, Manager
Open Space Lands

Jessie Byrd, Manager
Native Plant Nursery

SUBJECT: Proposed Canoa Hills Golf Course Donation – Response to Item 12

On December 12, 2017, you asked us to address Item 12 in Mr. Huckelberry's memorandum dated December 7, 2017 (Exhibit A). Item 12 requests an assessment of the existing vegetation and provide restoration objectives for the proposed Canoa Hills Golf Course donation. We visited the Canoa Hills Golf Course on December 21, 2017 to evaluate existing conditions and assess for restoration opportunities. The following is a summary of our findings.

EXISTING CONDITIONS

Available GIS Data

Ephemeral washes upstream of the golf course are mapped Xeroriparian C habitat, while the golf course, developed prior to the mapping, contains no mapped habitat. The Harris Riparian classification is 143.1, Semidesert Grassland, or sometimes referred to as desert grassland, mesquite grassland, or scrub grassland. The Arizona Grasslands and The Nature Conservancy Grasslands layers classify this area as historic grassland with shrub cover greater than 35%. Canoa Hills is not part of the Conservation Lands System. Undisturbed vegetation upstream of the golf course is classified by the SWReGAP digital land cover layer as Sonoran Paloverde-Mixed Cacti Desert Scrub.

Existing Site Conditions

The golf course was constructed in historic ephemeral washes, generally taking advantage of the site's natural topography, although grading occurred to accommodate the golf course design. Improvements include the excavation of several ponds that create topographically low points and berms at several locations that constrict and divert the floodplain and create areas of ponding.

Vegetation communities outside of the constructed course were mostly preserved in place (see Photos 1 and 2) and contain large remnant patches of native vegetation that support a diverse array of species (Table 1 – Existing Plant List). Generally, these areas are topographically higher than the golf course and would provide a local source of native seed over time.



Photo 1. Sonoran Desert Scrub plant community preserved in place.



Photo 2. Semidesert Grassland plant community preserved in place.

While there is an abundant seed source nearby, staff observed minimal recruitment of native perennial plants on the golf course with the exception of a small patch of Cholla cactus and mesquite trees (photos 3 and 4), although it is very likely the mesquite trees are hybridized.



Photo 3. Cholla Cactus Recruitment



Photo 4. Mesquite Tree Recruitment

Staff observed several locations along the path where non-native species have been intentionally planted including the non-native invasive Fountaingrass (Photo 5). We also found patches of various annual and perennial non-native invasive species throughout the site, either along the edge of the golf course or within the preserved in place plant communities (Table 1). The bulk of the perimeter edge of the golf course is residential landscape. Proximity to these residential landscapes could lead to a potential source of seed both native and non-native.



Photo 5. Landscaped area containing Fountaingrass.

The upstream watershed is highly developed by Freeport-McMoRan's Sierrita Mine. Upstream of the golf course, drainages are truncated by the Sierrita Mine tailings, while downstream I-19 acts as a barrier with the exception of two box culvert crossings. The first is three 10' x 7' reinforced concrete box culverts located at the southern end of the course and the second is two 84" corrugated metal pipe culverts located at the northern boundary. There are several smaller culverts, but it is unknown whether they provide a connection east of I-19; the hydrology and hydraulic review will provide insight regarding existing infrastructure. During the inspection, we observed wildlife use of the site including signs of coyote, javelina, deer, raccoon, and various bird species.

The community frequently uses the old golf cart path. In the few hours spent onsite, we passed multiple people walking and biking with several commenting on how much they enjoy using the path.

The golf course contains mostly recently mowed annual vegetation that desiccated after the summer rainy season making it difficult to identify species and plant community structure. Based on the site's history, staff expected to find large patches of Bermudagrass, but was surprised to find very little throughout the site. Instead, we found large areas of Palmer's amaranth (*Amaranthus palmeri*) and native annual grasses. The site has been off irrigation for some years, possibly stressing the Bermudagrass and allowing for displacement by native annuals. Based on vegetation that was present, staff was able to identify five land cover classes (Figure 1):

1. Retired golf course converting to an annual native plant community with low species richness (54 acres; see Photos 6 and 7).
2. Native trees preserved in place with understory converting to an annual native plant community (12.6 acres; see Photo 8).

3. Native plant communities (Desert Scrub/Semidesert Grassland/Xeroriparian) preserved in place (56.2 acres; see Photos 1 and 2).
4. Former ponds (3.1 acres; see Photo 9).
5. Denuded areas including sand traps and tee boxes (4.1 acres; see Photo 10).

Land cover Class 1, retired golf course converting to an annual native plant community with low species richness. This class consists of large patches of either Palmer's amaranth, or annual native grasses, primarily needle grama (*Bouteloua aristidoides*) and sixweeks threeawn (*Aristida adscensionis*), which are typically the first species to colonize a disturbed area. An occasional subshrub or forb/herb was observed, but these areas appear mostly homogenous including just a few species.

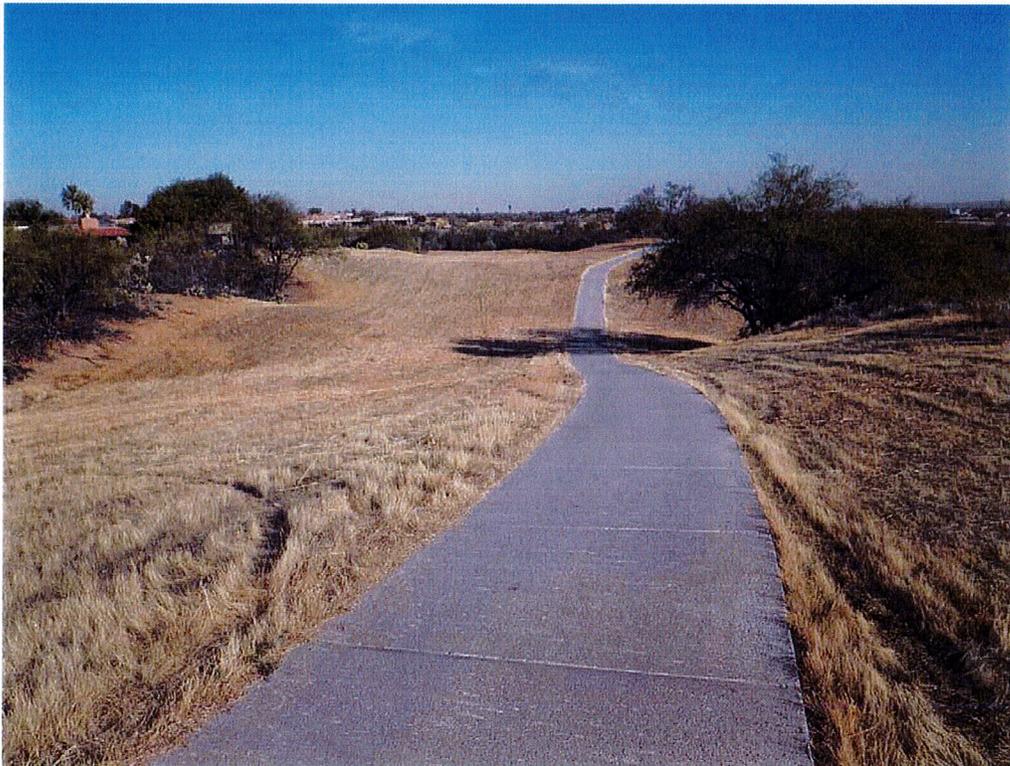


Photo 6. Retired golf course converting to annual native grasses.



Photo 7. Retired golf course converting to Palmer's Amaranth

Land cover Class 2, native trees preserved in place with understory in the process of converting to an annual native plant community. This class contains primarily mature velvet mesquite (*Prosopis velutina*) trees with an understory of either Palmer's amaranth or annual native grasses. The understory plant community is similar to Class 1 with a slightly higher plant species richness that includes perennial shrubs. The increased species richness is likely due to tree shading, cycling of nutrients and possibly reduced disturbance.



Photo 8. Land cover Class 2; native trees preserved in place with native understory.

Land cover Class 3, Native plant communities preserved in place. Varying topography throughout the site supports three separate plant communities including Sonoran Desertscrub, Semidesert grassland, and Xeroriparian habitat. The Sonoran Desertscrub is located on the hilltops and slopes (Photo 1), Semidesert grassland (Photo 2) is between the base of slopes and floodplain/riparian areas, and Xeroriparian habitat (Photo 9) is along the wash corridors and areas of ponding. These remnant habitat fragments provide resources for native animals, birds and insects. Native plant communities that have been preserved in place could provide a seed source for plant recruitment or for collection and growth at the Native Plant Nursery.



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Photo 10. Example of land cover Class 4; area was former pond.

Land cover Class 5, denuded areas including sand traps and tee boxes. There was very little vegetation growing in these areas, possibly due to a soil fertility issue from lack of organic matter present. These areas contained coarse sand and it is possible the soil was compacted when originally constructed.



Photo 11. Land cover Class 5, Sand Trap

RESTORATION OPPORTUNITIES

While the disturbed areas contained low species richness, it was promising to find native plants have successfully re-established on their own. Land cover Class 5, sand traps and tee boxes, contained very little vegetation, which may be due to a soil fertility issue. Staff recommends testing soil fertility prior to undertaking restoration efforts. We also observed several areas of active erosion, primarily headcuts along drainage swales (Photo 12).



Photo 12. Headcut with Active Erosion

Staff identified the following restoration objectives:

1. Map and remove non-native invasive species. Methods to remove invasive species may include mechanical, chemical or biological. Staff recommends solarization to treat the few patches of Bermuda grass.
2. Identify soil fertility problems and improve problem areas with soil amendments. The highly disturbed nature of golf courses from long-term management actions such as excessive irrigation, soil amendments, etc., may have modified native soils by increasing soil salinity, leaching out soil minerals, or other adverse effects. As such, staff recommends soil fertility testing prior to undertaking restoration and amending problem areas, if needed.
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MR/JB/tj

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Eric Shepp, P.E., Deputy Director – Regional Flood Control District
Colby Fryar, P.E., Civil Engineering Manager – Regional Flood Control District
Julia Fonseca, Environmental Planning Manager – Sustainability and Conservation

FIGURES

Figure 1. Canoa Hills Golf Course Donation - Land Cover

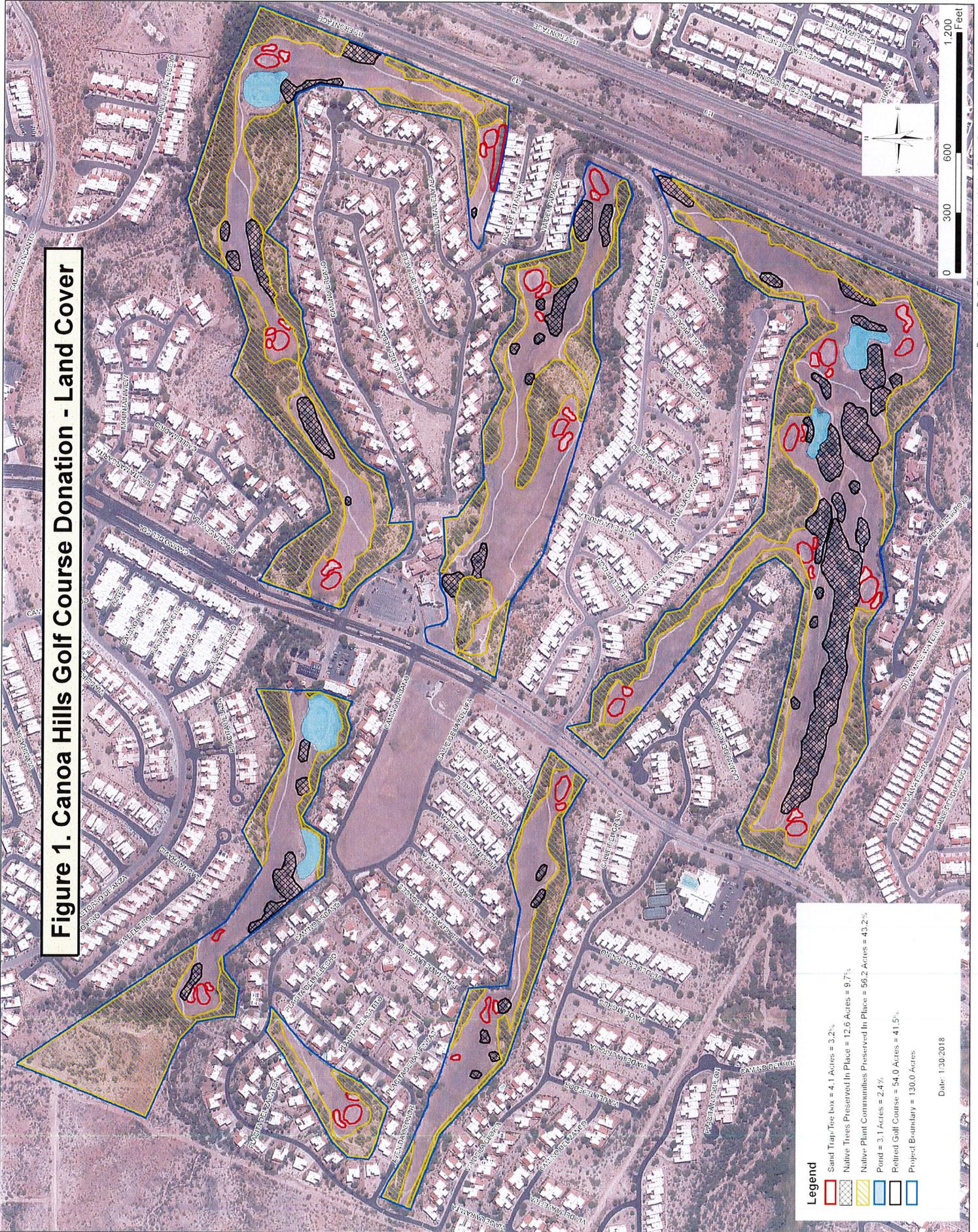


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| Allionia incarnata | trailing windmills | Forb/Herb | Native | Annual, Perennial |
| Aloysia wrightii | Wright's beebrush | Shrub | Native | Perennial |
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| Aristida purpurea | purple threeawn | Graminoid | Native | Annual, Perennial |
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| Baccharis sarothroides | desertbroom | Shrub | Native | Perennial |
| Bahia absinthifolia | hairseed bahia | Forb/Herb | Native | Perennial |
| Boerhavia scandens | climbing wartclub | Vine | Native | Perennial |
| Boerhavia sp. | spiderling | Forb/Herb | Native | Annual |
| Bouteloua aristidoides | needle grama | Graminoid | Native | Annual |
| Brickellia sp. | brickellbush | Subshrub | Native | Perennial |
| Calliandra eriophylla | fairyduster | Shrub | Native | Perennial |
| Carnegiea gigantea | saguaro | Succulent | Native | Perennial |
| Celtis ehrenbergiana | spiny hackberry | Shrub | Native | Perennial |
| Chloris virgata | feather fingergrass | Graminoid | Native | Annual |
| Cocculus diversifolius | snailseed | Vine | Native | Perennial |
| Cylindropuntia arbuscula | Arizona pencil cholla | Succulent | Native | Perennial |
| Cylindropuntia fulgida | jumping cholla | Succulent | Native | Perennial |
| Cylindropuntia spinosior | walkingstick cactus | Succulent | Native | Perennial |
| Cylindropuntia versicolor | staghorn cholla | Succulent | Native | Perennial |
| Dasyochloa pulchella | low woollygrass | Graminoid | Native | Perennial |
| Datura wrightii | sacred thorn-apple | Forb/Herb | Native | Annual, Perennial |
| Echinocereus engelmannii | Engelmann's hedgehog cactus | Succulent | Native | Perennial |
| Encelia farinosa | goldenhills | Subshrub | Native | Perennial |
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| Ferocactus wislizeni | candy barrelcactus | Succulent | Native | Perennial |
| Fouquieria splendens | ocotillo | Shrub | Native | Perennial |
| Gutierrezia sp. | snakeweed | Subshrub | Native | Perennial |
| Ipomoea sp. | morning-glory | Forb/Herb | Native | Annual |
| Isocoma tenuisecta | burroweed | Subshrub | Native | Perennial |
| Justicia candicans | Arizona water-willow | Shrub | Native | Perennial |
| Muhlenbergia porteri | bush muhly | Graminoid | Native | Perennial |
| Opuntia engelmannii | cactus apple | Succulent | Native | Perennial |
| Opuntia phaeacantha | tulip pricklypear | Succulent | Native | Perennial |
| Opuntia santa-rita | Santa Rita pricklypear | Succulent | Native | Perennial |
| Pappophorum vaginatum | whiplash pappusgrass | Graminoid | Native | Perennial |
| Parkinsonia florida | blue paloverde | Tree | Native | Perennial |
| Phoradendron californicum | mesquite mistletoe | Subshrub | Native | Perennial |
| Physalis sp. | groundcherry | Forb/Herb | Native | Annual, Perennial |
| Prosopis velutina | velvet mesquite | Tree | Native | Perennial |
| Salix gooddingii | Goodding's willow | Tree | Native | Perennial |
| Sapindus saponaria | wingleaf soapberry | Tree | Native | Perennial |
| Setaria leucopila | streambed bristlegrass | Graminoid | Native | Perennial |
| Setaria macrostachya | large-spike bristlegrass | Graminoid | Native | Perennial |
| Simmondsia chinensis | jojoba | Shrub | Native | Perennial |
| Solanum elaeagnifolium | silverleaf nightshade | Subshrub | Native | Perennial |
| Stephanomeria pauciflora | brownplume wirelettuce | Subshrub | Native | Perennial |
| Verbesina encelioides | golden crownbeard | Forb/Herb | Native | Annual |
| Yucca elata | soaptree yucca | Tree | Native | Perennial |
| Zinnia acerosa | desert zinnia | Subshrub | Native | Perennial |
| Ziziphus obtusifolia | lotebush | Shrub | Native | Perennial |
| Acacia farnesiana | sweet acacia | Tree | Non-Native | Perennial |
| Agave americana | American century plant | Succulent | Non-Native | Perennial |
| Caesalpinia pulcherrima | bird of paradise | Shrub | Non-Native | Perennial |
| Eragrostis echinochloidea | African lovegrass | Graminoid | Non-Native | Perennial |
| Eucalyptus sp. | Eucalyptus | Tree | Non-Native | Perennial |
| Leucophyllum frutescens | Texas ranger | Shrub | Non-Native | Perennial |

| Scientific Name | Common Name | Primary Growth Habit | Nativity | Duration |
|---|-------------------------|----------------------|------------|-----------|
| <i>Nerium oleander</i> | oleander | Tree | Non-Native | Perennial |
| <i>Opuntia engelmannii</i> var. <i>linguiformis</i> | cactus apple | Succulent | Non-Native | Perennial |
| <i>Panicum antidotale</i> | blue panicum | Graminoid | Non-Native | Perennial |
| <i>Parkinsonia aculeata</i> | Jerusalem thorn | Tree | Non-Native | Perennial |
| <i>Pennisetum ciliare</i> | buffelgrass | Graminoid | Non-Native | Perennial |
| <i>Pennisetum setaceum</i> | crimson fountaingrass | Graminoid | Non-Native | Perennial |
| <i>Prosopis</i> sp. | non-native mesquite | Tree | Non-Native | Perennial |
| <i>Rhus lancea</i> | African sumac | Tree | Non-Native | Perennial |
| <i>Salsola tragus</i> | prickly Russian thistle | Forb/Herb | Non-Native | Annual |
| <i>Schinus molle</i> | Peruvian peppertree | Tree | Non-Native | Perennial |
| <i>Tamarix</i> sp. | tamarisk | Tree | Non-Native | Perennial |

Table 2. Canoa Hills - Container Plant List

| | Scientific Name | Common Name |
|-------------------|--------------------------------------|-------------------------|
| Trees: | <i>Acacia constricta</i> | Whitethorn acacia |
| | <i>Acacia greggii</i> | Catclaw acacia |
| | <i>Cercidium floridum</i> | Blue Paloverde |
| | <i>Chilopsis linearis</i> | Desert Willow |
| | <i>Parkinsonia florida</i> | Blue Paloverde |
| | <i>Prosopis velutina</i> | Velvet Mesquite |
| Shrubs: | <i>Aloysia wrightii</i> | Wright's beebrush |
| | <i>Anisacanthus thurberi</i> | Desert honeysuckle |
| | <i>Atriplex canescens</i> | Fourwing saltbush |
| | <i>Calliandra eriophylla</i> | Fairyduster |
| | <i>Celtis pallida</i> | Desert hackberry |
| | <i>Condalia warnockii</i> | Kearney's snakewood |
| | <i>Cylindropuntia arbuscula</i> | Arizona pencil cholla |
| | <i>Cylindropuntia fulgida</i> | Chain-fruit cholla |
| | <i>Cylindropuntia leptocaulis</i> | Christmas cactus |
| | <i>Cylindropuntia spinosior</i> | Cane cholla |
| | <i>Ferocactus wislizenii</i> | Candy barrel cactus |
| | <i>Fouquieria splendens</i> | Ocotillo |
| | <i>Gossypium thurberi</i> | Thurber's cotton |
| | <i>Lycium andersonii</i> | Anderson Wolfberry |
| | <i>Lycium exsertum</i> | Thornbush |
| | <i>Lycium fremontii</i> | Fremont Wolfberry |
| | <i>Opuntia engelmannii</i> | Prickley pear |
| | <i>Rhus aromatica var. trilobata</i> | Three-leafed sumac |
| | <i>Yucca elata</i> | Soaptree yucca |
| | <i>Zizyphus obtusifolia</i> | Graythorn |
| Subshrubs: | <i>Bebbia juncea</i> | sweetbush |
| | <i>Brickellia californica</i> | California brickellbush |
| | <i>Encelia farinosa</i> | Brittlebush |
| | <i>Isocoma tenuisecta</i> | Burweed |
| | <i>Psilostrophe cooperi</i> | Whitestem paperflower |
| | <i>Senna covesii</i> | Desert senna |
| | <i>Trixis californica</i> | American threefold |
| | <i>Zinnia acerosa</i> | Desert Zinnia |
| | <i>Acacia angustissima</i> | Prairie acacia |
| | <i>Ambrosia deltoidea</i> | Triangleleaf bursage |
| Forbs: | <i>Abutilon sp.</i> | Mallow |
| | <i>Asclepias linaria</i> | Pine-leaf milkweed |
| | <i>Asclepias subulata</i> | Desert milkweed |
| | <i>Bahia absinthifolia</i> | Dealbata's bahia |
| | <i>Commicarpus scandens</i> | Climbing wartclub |

| | Scientific Name | Common Name |
|-----------------|----------------------------------|------------------------------|
| | <i>Datura wrightii</i> | Sacred datura |
| | <i>Dicliptera resupinata</i> | Arizona foldwing |
| | <i>Proboscidea althaeifolia</i> | Devil's claw |
| | <i>Ruellia nudiflora</i> | Violet wild petunia |
| | <i>Senna hirsuta</i> | Slimpod senna |
| | <i>Sphaeralcea ambigua</i> | Desert globemallow |
| | <i>Sphaeralcea laxa</i> | Caliche globemallow |
| Grasses: | <i>Aristida purpurea</i> | Purple three-awn |
| | <i>Aristida ternipes</i> | Spidergrass |
| | <i>Bothriochloa barbinooides</i> | Cane beardgrass |
| | <i>Bouteloua curtipendula</i> | Sideoats grama |
| | <i>Digitaria californica</i> | Arizona cottontop |
| | <i>Heteropogon contortus</i> | Tanglehead |
| | <i>Leptochloa dubia</i> | Green Sprangletop |
| | <i>Muhlenbergia porteri</i> | Bush muhly |
| | <i>Pappophorum vaginatum</i> | Spike Pappusgrass |
| | <i>Setaria leucopila</i> | Streambed bristlegrass |
| | <i>Setaria macrostachya</i> | Plains bristlegrass |
| | <i>Sporobolus contractus</i> | Spike dropseed |
| | <i>Sporobolus cryptandrus</i> | Sand dropseed |
| | <i>Sporobolus wrightii</i> | Big Alkali Sacaton |
| | <i>Trichloris crinita</i> | False Rhodesgrass |
| Vines: | <i>Aristolochia watsonii</i> | Watson's dutchman's pipevine |
| | <i>Clematis drummondii</i> | Virgin's bower |
| | <i>Cottisia gracilis</i> | Slender janusia |
| | <i>Cucurbita digitata</i> | Fingerleaf gourd |
| | <i>Funastrum cynanchoides</i> | Climbing milkweed |
| | <i>Marah gilensis</i> | Gila manroot |
| | <i>Maurandya antirrhiniflora</i> | Roving sailor |
| | <i>Passiflora mexicana</i> | Mexican passionflower |

Table 3. Canoa Hills - Seed Mix Plant List

| | Scientific Name | Common Name | Duration |
|---|---------------------------------|-----------------------------|-----------------------|
| Shrubs: | <i>Atriplex canescens</i> | Fourwing saltbush | Perennial |
| | <i>Larrea tridentata</i> | Creosote bush | Perennial |
| Subshrubs: | <i>Atriplex elegans</i> | Wheelscale saltbush | Summer Annual |
| | <i>Atriplex polycarpa</i> | Allscale saltbush | Summer Annual |
| | <i>Atriplex wrightii</i> | Wright's saltbush | Summer Annual |
| | <i>Calliandra eriophylla</i> | Fairyduster | Perennial |
| | <i>Gutierrezia microcephala</i> | Threadleaf snakeweed | Perennial |
| | <i>Isocoma tenuisecta</i> | Burroweed | Perennial |
| | <i>Psilostrophe cooperi</i> | Whitestem paperflower | Perennial |
| | <i>Senna covesii</i> | Desert senna | Perennial |
| | <i>Trixis californica</i> | American threefold | Perennial |
| | Forbs: | <i>Allionia incarnata</i> | Trailing four-o'clock |
| <i>Astragalus arizonicus</i> | | Arizona milkvetch | Perennial |
| <i>Ayenia filiformis</i> | | Trans-Pecos ayenia | Perennial |
| <i>Bahia absinthifolia</i> | | Dealbata's bahia | Perennial |
| <i>Baileya multiradiata</i> | | Desert marigold | Annual |
| <i>Chamaesyce florida</i> | | Chiricahua Mountain sandmat | Winter Annual |
| <i>Chamaesyce hyssopifolia</i> | | Hyssopleaf sandmat | Annual/Perennial |
| <i>Croton pottsii</i> | | Leatherweed | Perennial |
| <i>Datura wrightii</i> | | Sacred datura | Annual/Perennial |
| <i>Dicliptera resupinata</i> | | Arizona foldwing | Perennial |
| <i>Eriastrum diffusum</i> | | Miniature woollystar | Winter Annual |
| <i>Erigeron divergens</i> | | Spreading fleabane | Biennial |
| <i>Eschscholzia californica ssp. mexicana</i> | | Mexican gold poppy | Winter Annual |
| <i>Euphorbia heterophylla</i> | | Mexican fireplant | Annual/Perennial |
| <i>Evolvulus arizonicus</i> | | Wild dwarf morning glory | Perennial |
| <i>Glandularia gooddingii</i> | | Goodding's verbena | Perennial |
| <i>Heliomeris longifolia var. annua</i> | | Longleaf false goldeneye | Summer Annual |
| <i>Ipomopsis longiflora</i> | | flaxflowered ipomopsis | Winter Annual |
| <i>Kallstroemia grandiflora</i> | | Arizona poppy | Summer Annual |
| <i>Lotus humistratus</i> | | Foothill deervetch | Winter Annual |
| <i>Machaeranthera tanacetifolia</i> | | Tansyleaf tansyaster | Summer Annual |
| <i>Mentzelia multiflora</i> | | Desert blazing star | Perennial |
| <i>Oenothera primiveris</i> | | Desert evening primrose | Winter Annual |
| <i>Pectis papposa</i> | | Manybristle cinchweed | Summer Annual |
| <i>Penstemon parryi</i> | | Desert penstemon | Perennial |
| <i>Phacelia arizonica</i> | | Arizona phacelia | Winter Annual |
| <i>Phacelia bombycina</i> | | Mangas Spring phacelia | Winter Annual |
| <i>Phacelia crenulata</i> | | clefthead wildheliotrope | Winter Annual |
| <i>Phacelia distans</i> | | Distant phacelia | Winter Annual |
| <i>Physalis pubescens</i> | | Husk tomato | Summer Annual |
| <i>Physaria gordonii</i> | Gordon's bladderpod | Winter Annual | |
| <i>Plantago ovata</i> | Desert Indianwheat | Winter Annual | |
| <i>Plantago patagonica</i> | Woolly plantain | Winter Annual | |

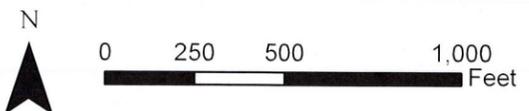
| | Scientific Name | Common Name | Duration |
|-----------------|---------------------------------------|------------------------|---------------|
| | <i>Proboscidea althaeifolia</i> | Devil's claw | Perennial |
| | <i>Proboscidea parviflora</i> | Doubleclaw | Summer Annual |
| | <i>Rafinesquia neomexicana</i> | New Mexico plumeseed | Winter Annual |
| | <i>Salvia columbariae</i> | Desert chia | Winter Annual |
| | <i>Sphaeralcea angustifolia</i> | Copper globemallow | Perennial |
| | <i>Sphaeralcea emoryi</i> | Emory's globemallow | Perennial |
| Grasses: | <i>Aristida purpurea</i> | Purple threeawn | Perennial |
| | <i>Aristida ternipes</i> | Spidergrass | Perennial |
| | <i>Bouteloua barbata</i> | Sixweeks grama | Annual |
| | <i>Bouteloua curtipendula</i> | Sideoats grama | Perennial |
| | <i>Bouteloua rothrockii</i> | Rothrock's grama | Perennial |
| | <i>Chloris virgata</i> | Feather fingergrass | Annual |
| | <i>Dasyochloa pulchella</i> | Fluffgrass | Perennial |
| | <i>Eriochloa acuminata var. minor</i> | tapertip cupgrass | Annual |
| | <i>Heteropogon contortus</i> | Tanglehead | Perennial |
| | <i>Hilaria mutica</i> | tobosagrass | Perennial |
| | <i>Muhlenbergia microsperma</i> | Littleseed muhly | Annual |
| | <i>Muhlenbergia porteri</i> | Bush muhly | Perennial |
| | <i>Panicum capillare</i> | Witchgrass | Annual |
| | <i>Panicum obtusum</i> | Vine mesquite | Perennial |
| | <i>Setaria leucopila</i> | Streambed bristlegrass | Perennial |
| | <i>Setaria macrostachya</i> | Plains bristlegrass | Perennial |
| | <i>Urochloa arizonica</i> | Arizona signalgrass | Annual |
| | <i>Vulpia octoflora</i> | Sixweeks fescue | Annual |
| Vines: | <i>Clematis drummondii</i> | Virgin's bower | Perennial |
| | <i>Cottisia gracilis</i> | Slender janusia | Perennial |
| | <i>Cucurbita digitata</i> | Fingerleaf gourd | Perennial |
| | <i>Echinopepon wrightii</i> | Wild balsam apple | Summer Annual |

ATTACHMENT 4



Legend

- ▲ Culverts
- 100-Year Floodplain Limits
- XS Cut Lines
- Study Reaches
- 2-Foot Topography



Canoa Hills 100-Year Floodplain Map