Floodplain Management Plan

Prepared for the Pima County Board of Supervisors
Sitting as the
Flood Control District Board of Directors

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March 2020

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EXECUTIVE SUMMARY

On October 2, 2018, the Board of Supervisors (Board), sitting as the Board of Directors for the Flood Control District (District), adopted Resolution No. 2018-FC6, which authorized the District to develop a Floodplain Management Plan for unincorporated Pima County. The Resolution further authorized the District to engage the public in the process, including the formation of a Planning Committee that would help develop the Floodplain Management Plan. The goal of this Resolution was to create a Floodplain Management Plan that meets or exceeds the National Flood Insurance Program (NFIP) standards and that can be considered as a sufficient prerequisite for Pima County to obtain a Class 4 designation under the NFIPs Community Rating System.

Currently, Pima County is a Class 5 community, meaning that residents and property owners can enjoy up to a 25% reduction of their flood insurance policy premiums. The current combination of the District's efforts for higher regulatory standards, outreach activities, floodprone land acquisition for open space, and drainage infrastructure construction and maintenance results in a score that would produce a better rating and increase the flood insurance discount available, but the County cannot improve beyond a Class 5 without a Floodplain Management Plan.

The NFIP guidelines for the creation of a Class 4 compliant Floodplain Management Plan emphasizes the need for a public process and focus on procedures. The procedural steps, as outlined below, create a roadmap to guide a community through a number of steps to evaluate the community's flood hazards, assess exposure to damage, and consider alternatives to address these issues. The alternatives are activities or actions that the County can take to improve how the floodplains are managed and how risk and flood damage potential can be mitigated.

With respect to the organization of the Floodplain Management Plan, the District has chosen to build on the statutorily-required and previously published Comprehensive Program Report. The District prepares this report every five years, and the report presents a summary of the programs and activities the District has implemented. The Floodplain Management Plan serves to look forward five years, and by building on the Comprehensive Program Report, the District anticipates that future iterations of the Floodplain Management Plan will meet this reporting requirement by looking back at what was accomplished over the previous five years while also considering how to move forward over the next five years.

Due to the size of Pima County, the District opted to divide the County geographically based on its largest watersheds and follow the NFIP procedural steps for each of those watersheds. This allowed the Planning Committee and the public to consider different activities for different watersheds, while also allowing some activities to occur on a County-wide basis. The result is an Action Plan, which will provide direction to the District over the next five years for various programs, including the Regulatory Program, Program for Public Information, Capital Improvement Program, and Interdepartmental and Interjurisdictional coordination. It does not supplant the normal Capital Improvement Program planning process, including basin studies, consultation with neighboring communities via the Flood Control District Advisory Committee or budget. Nor does it contain code revisions which must be considered independently.

The following is a description of the NFIP procedural steps with an explanation of the benefits of each step in the process to the formation of the Floodplain Management Plan. Where appropriate, excerpts are included to visualize the substance of the discussion at that step. The final product is the Floodplain Management Plan, which can be found at www.pima.gov/fmp. The District is seeking the Board's

approval of this document and the Action Plan (attached), which is the list of activities to implement the Floodplain Management Plan.

NFIP Floodplain Management Plan Process

Step 1 – Organize to Prepare the Floodplain Management Plan
This step was completed on October 2, 2018 with Board adoption of Resolution 2018 FC6. This resolution established the goals of the Floodplain Management Plan and authorized the creation of the Planning Committee.

Step 2 – Involve the Public
The Planning Committee was comprised of a broad spectrum of the public, including representatives from neighborhood associations, builders and developers, trade associations, insurance providers, environmental organizations, as well as the University of Arizona and the San Xavier District of the Tohono O'odham Nation. Other County departments were also represented on the committee, including County Administration, Development Services and Office of Emergency Management. The Planning Committee provided significant input and direction throughout Steps 4 through 8. The Planning Committee represented the following groups, specifically:

- Catalina Foothills Association
- Coalition for Sonoran Desert Protection
- Community Water Coalition
- Country Financial
- Farmers Investment Company
- Metropolitan Pima Alliance
- Natural Resources Parks and Recreation Pima Association of Governments
- Pima County Administrator's Office
- Pima County Department of Transportation
- Pima County Development Services Department
- Pima County Office of Emergency Management
- San Xavier District of the Tohono O'odham Nation
- Southern Arizona Homebuilders Association
- Tucson Association of Realtors
- Tucson Audubon Society
- Tucson Mountain Association
- University of Arizona Planning Program
- University of Arizona Water Resources Research Center
- Watershed Management Group

Although public involvement is only identified in Step 2, the District wanted to ensure to maintain consistent public outreach throughout the process. As the Floodplain Management Plan was being created, staff participated in the following additional public meetings to inform the members and solicit input and comments:

- American Public Works Association Southern Arizona Chapter
- Arizona Planning Association Annual Conference
- Catalina Foothills Neighborhood Association
- City of South Tucson

- City of Tucson
- Community Water Coalition Policy Roundtable at Ward 3
- Flood Control District Advisory Committee
- Flowing Wells Neighborhood Association
- Metropolitan Pima Alliance Board
- Oracle Foothills Neighborhood Association
- Oro Valley Stormwater Commission
- Pima Association of Governments Environmental Planning Advisory Committee
- Pima County GIS Fair
- Pima County Multi-Jurisdictional Hazard Mitigation Stakeholder Workshop
- Pima County Public Library
- Planning and Zoning Commission
- Santa Cruz River Meet Yourself
- Sustainable Action Plan for County Operations Open House
- Southern Arizona Homebuilders Association Technical Committee
- Town of Marana
- Town of Sahuarita
- Tucson Estates Property Owners Association
- Utility Contractors Coordinating Committee
- Winchester Ranch Homeowners Association

Finally, after completion of the Draft Floodplain Management Plan and Draft Action Plan, the District held two additional general public meetings. These occurred on February 26 as an informational item at the Pima County Planning and Zoning Commission Meeting, and on March 3 as an Open House at the Downtown Library. Over 400 survey respondents were invited to the open house via the email addresses provided as an expression of interest, in addition to advertisements.

Step 3 – Coordinate

In addition to public input, the NFIP guidance emphasizes internal coordination within the community's government in order to leverage additional benefits of the Floodplain Management Plan. As such, the District met frequently with the following departments:

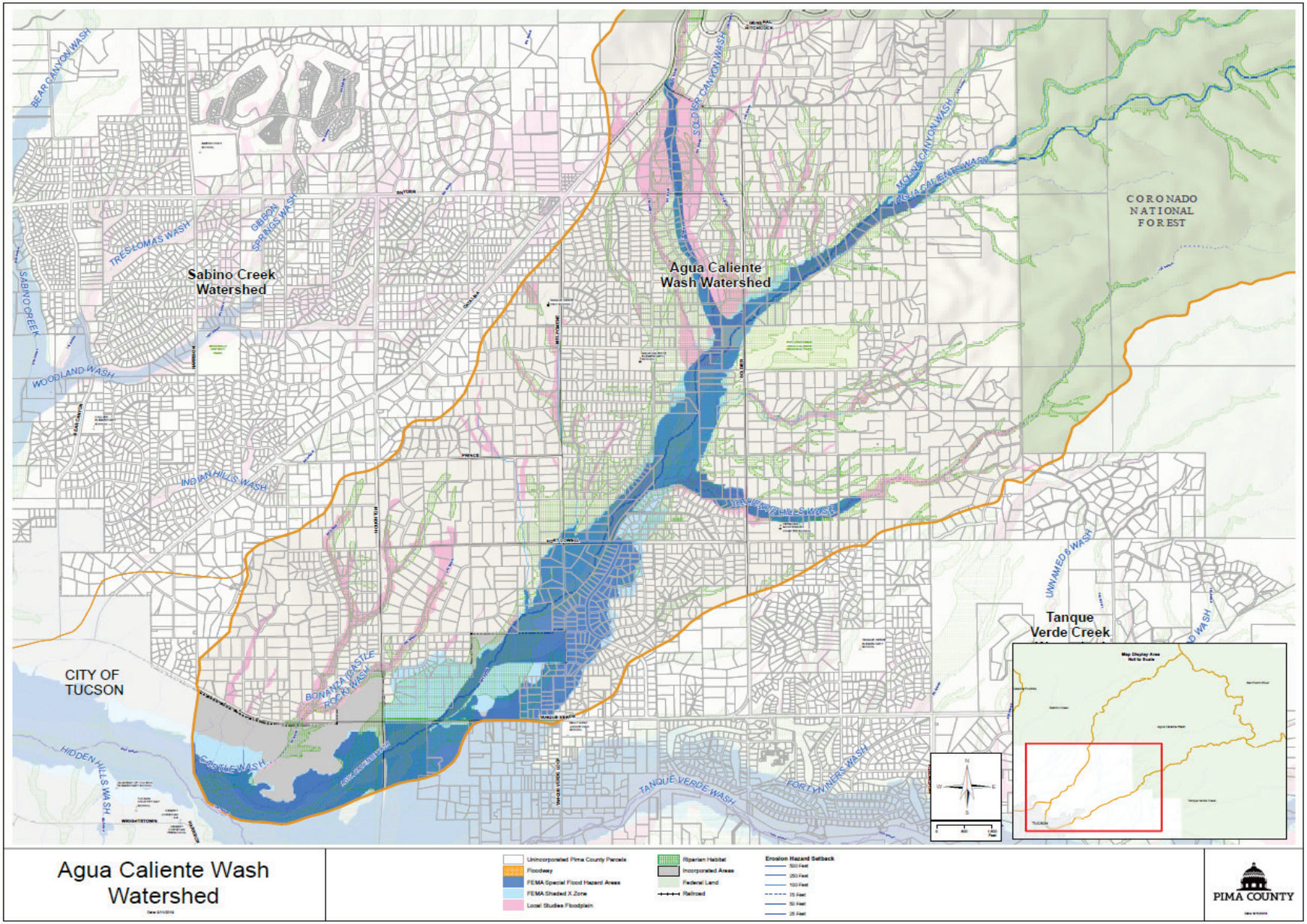
- Communications: In order to identify better ways to inform the public of this process, as well as to assist in future floodplain awareness outreach activities.
- Development Services: In order to promote awareness of the flood hazards and risks associated with new and existing development and ensure that any actions proposed by the Floodplain Management Plan related to development are compatible with Building Safety and Zoning requirements.
- Office of Emergency Management: In order to identify and address gaps with internal and external processes to communicate flood warning, flood risk messages to the public, critical facilities, and other agencies, as well as to coordinate flood response actions.
- Natural Resources, Parks and Recreation: In order identify, coordinate, and prioritize land management activities in order to maintain the natural and beneficial functions of floodplains and associated uplands.

- Department of Transportation: In order to coordinate the response to the public safety risk associated with flooded road conditions , to develop solutions to reduce the frequency of swift water rescues and to coordinate identification of safe travel routes during times of flooding.
- County Administration: In order to ensure the issues identified in the Floodplain Management Plan , and the proposed activities in the Action Plan continue to meet overall County objectives.

Step 4 – Assess the Hazard

Assessing the hazard is the first substantive step in the Floodplain Management Plan process and entails reviewing the floodplain mapping coverage County-wide. This provided a great opportunity to evaluate gaps in the District's flood hazard data, areas that have flood hazard information that is out-of-date or imprecise, and to consider additional hazards such as debris flows, alluvial fans, and canyon washes. The review of this information was completed on a watershed basis and resulted in the identification of flood hazard information needs which can be found in the watershed chapters of the Floodplain Management Plan. These needs will be used to create a work plan for the District's Watershed Studies Division over the next five years.

An example of the flood hazards maps is a map of the Agua Caliente Watershed below, which identifies the currently available flood hazard information. The map includes floodplain delineations, wash lines with erosion hazard setback requirements, and regulated riparian habitat, which are indicative of the presence of regulatory floodplains. Maps like these are used to determine where additional information is needed, and to discuss the age and accuracy of the existing mapping.


Agua Caliente Wash Watershed
Sabino Creek Watershed
Agua Caliente Wash Watershed
CORONADO NATIONAL FOREST
Tanque Verde Creek
CITY OF TUCSON
BEAR CANYON WASH
TRES LOMAS WASH
GIBBON SPRINGS WASH
SABINO CREEK
WOODLAND WASH
INDIAN HILLS WASH
SOLDIER CANYON WASH
MOLINO CANYON WASH
ARCADIA CANYON WASH
TRES HERMANOS WASH
UNNAMED A WASH
UNNAMED D WASH
BONANZA CASTLE ROCK WASH
CANADA WASH
HIDDEN HILLS WASH
TANQUE VERDE WASH
FORTYNINERS WASH
Agua Caliente Wash Watershed
Unincorporated Pima County Parcels
Floodway
FEMA Special Flood Hazard Areas
FEMA Shaded X Zone
Local Studies Floodplain
Riparian Habitat
Incorporated Areas
Federal Land
Railroad
Erosion Hazard Setback
500 Feet
250 Feet
100 Feet
75 Feet
50 Feet
25 Feet
PIMA COUNTY

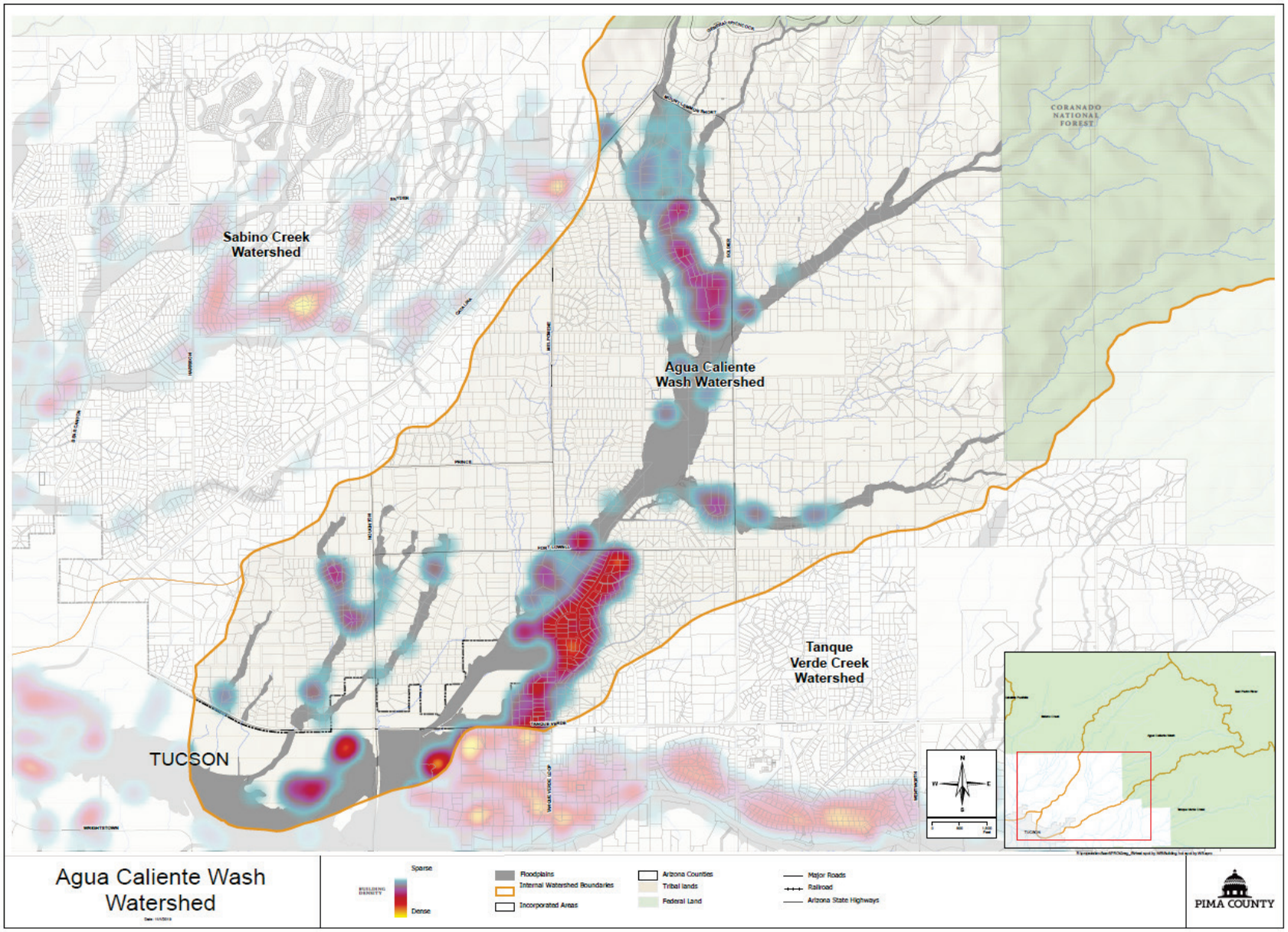
Step 5 – Assess the Problem

This extremely important step entails the identification of areas where development and the community are exposed to the known flood hazards. The process for identification of the problem areas was rigorous and included significant involvement of the Planning Committee members reviewing the problems on a watershed by watershed basis, outreach to various community stakeholders, including homeowners associations, neighborhood groups, and various relevant environmental and trade associations.

In addition, the District provided information on the adequacy of insurance coverage, estimates of potential loss due to flood hazards, and exposure of any critical facilities. Much of this information was previously prepared in the District's Program for Public Information and the County's Hazard Mitigation Plan, but required updates. As part of the update, the Program for Public Information will be made part of the Floodplain Management Plan to facilitate both programs administratively, as well as to make sure that they remain substantively relevant to each other.

The District developed maps, by watershed, of existing structures exposed to the known flood hazards. The resulting "heat maps" show the density of structures exposed to flood hazards and assist in showing that within certain floodplains there are areas of little exposure and areas with considerable exposure. This information will be used by the District's Floodplain Management and Design Engineering divisions to establish work plans to mitigate these problems using either structural improvements through the Capital Improvement Program and/or non-structural improvements through compliance enforcement of the Floodplain Management Floodplain Management Ordinance and acquisition of floodprone property. Assessing population exposure will also assist coordination with the Pima County Department of Transportation where transportation issues increase exposure risks and with the Office of Emergency Management for planning during times of emergency.

An example of the risk exposure maps, a map for the Agua Caliente Watershed is shown below which identifies the exposure of structures to the known flood hazards. A comprehensive list of problems identified by the Planning Committee and stakeholders can be found in Appendix C of the Floodplain Management Plan.


Sabino Creek Watershed
Agua Caliente Wash Watershed
Tanque Verde Creek Watershed
TUCSON
CORANADO NATIONAL FOREST
Agua Caliente Wash Watershed
Sparse
Dense
Floodplains
Internal Watershed Boundaries
Incorporated Areas
Arizona Counties
Tribal lands
Federal Land
Major Roads
Railroad
Arizona State Highways
PIMA COUNTY

Step 6 – Set Goals

The Federal Emergency Management Agency (FEMA) guidance for this step indicates that the goals set need to be sufficient to address all of the problems that were identified. The comprehensive nature of the problems identified in the previous steps resulted in the need for the Planning Committee to debate the language of the goals extensively. The deliberative exercise proved to be fruitful. To start the discussion, the District provided the Planning Committee with the District's existing mission and goals, which can be found in the Floodplain Management Floodplain Management Ordinance. The goals of the Floodplain Management Ordinance were generally satisfactory; however, there were a number of issues that the Planning Committee decided needed their own goals. These issues are associated with planning for future watershed conditions, including considering climate change, and increasing the District's role in providing interjurisdictional floodplain management services. The two new goals were added to the six relevant goals from the Floodplain Management Ordinance and identified with an asterisk below.

The goals of the Floodplain Management Plan are:

1. Identify, protect, and preserve watercourses and the natural floodplain function and riparian habitat associated with them, and restore and enhance them where they have been degraded;
2. Protect, preserve and enhance water resources;
3. Ensure that those who occupy areas within regulatory floodplain and erosion hazard areas are aware of the consequences of their actions within those areas;
4. Reduce the need for rescue and relief efforts;
5. Ensure the most effective expenditures of public money for flood control projects;
6. Prevent flood and erosion damages including ensuring the operability of critical facilities during flood events;
7. *Ensure flexibility for adaptive floodplain management for changing climate circumstances; and
8. *Increase regional cooperation and offer inter-jurisdictional floodplain management services.

   **new goals*

The Planning Committee needed to ensure that these goals address all problems previously identified. The spreadsheet that considers this requirement is in Appendix F of the Floodplain Management Plan.

Step 7 – Review Possible Activities

During this step, the Planning Committee discussed activities, both current and future, to implement the goals that were developed previously. These activities are those that can prevent or reduce the severity of the problems identified previously, and include all aspects of the District's organization as well as activities from other County departments. This was a systematic review of a wide range of activities to ensure all possible measures were explored. These activities were then organized to fit into activity areas using the terminology preferred by FEMA, with activities identified as those that are currently performed and proposed new activities. The FEMA Activity Areas are:

*A) **Preventive activities** keep flood problems from getting worse. The use and development of floodprone areas is limited through planning, land acquisition, or regulation. They are usually administered by building, zoning, planning, and/or code enforcement offices.*

- *Floodplain mapping and data*
- *Open space preservation*
- *Floodplain regulations*
- *Erosion setbacks*
- *Planning and zoning*
- *Stormwater management*
- *Drainage system maintenance*
- *Building codes*

*B) **Property protection activities** are usually undertaken by property owners on a building-by building or parcel basis.*

- *Relocation*
- *Acquisition*
- *Building elevation*
- *Retrofitting*
- *Sewer backup protection*
- *Insurance*

*C) **Natural resource protection activities** preserve or restore natural areas or the natural functions of floodplain and watershed areas. They are implemented by a variety of agencies, primarily parks, recreation, or conservation agencies or organizations.*

- *Wetlands protection*
- *Erosion and sediment control*
- *Natural area preservation*
- *Natural area restoration*
- *Water quality improvement*
- *Coastal barrier protection*
- *Environmental corridors*
- *Natural functions protection*

*D) **Emergency services measures** are taken during an emergency to minimize its impact. These measures are usually the responsibility of city or county emergency management staff and the owners or operators of major or critical facilities.*

- *Hazard threat recognition*
- *Hazard warning*
- *Hazard response operations*
- *Critical facilities protection*
- *Health and safety maintenance*
- *Post-disaster mitigation actions*

*E) **Structural project activities** keep flood waters away from an area with a levee, reservoir, or other flood control measure. They are usually designed by engineers and managed or maintained by public works staff.*

- *Reservoirs*
- *Levees/floodwalls*
- *Diversions*
- *Channel modifications*
- *Storm drain improvements*

*F) **Public information activities** advise property owners, potential property owners, and visitors about the hazards, ways to protect people and property from the hazards, and the natural and beneficial functions of local floodplains. They are usually implemented by a public information office.*

- *Map information*
- *Outreach projects*
- *Real estate disclosure*
- *Library*
- *Technical assistance*
- *Environmental education*

Step 8 - Draft an Action Plan

In order to create a Floodplain Management Plan that meets the prerequisite for a Class 4 community, at least 50% of all available points must be awarded. That requires that the Planning Committee consider all activities and address who is responsible for implementing the activity, when this activity will occur and how will the activity be funded. Similar to the previous steps, the Planning Committee then evaluated the activities on a watershed-by-watershed basis. Some activities were considered applicable County-wide, while other activities were relevant or more relevant in individual watersheds. In addition, when watershed specific projects could be identified they were included on the list.

The guidance does not require that any specific activity ultimately be adopted, just that they are considered and prioritized. Questions of responsibility, timing and funding were answered for the activities. Responsible parties, primarily the District, were identified, generalized timelines were assigned related to feasibility, and an estimate of potential cost range to implement the activity was determined.

This list of activities with priorities, costs, and timelines is considered in the Flood Control District's Floodplain Management Action Plan. This is essentially the distilled substance of the Floodplain Management Plan process and represents a forward-looking vision for the prioritization of the District's programs and projects for the next five years. It will become what is used at the end of that five year period to look back and evaluate accomplishments and satisfy the requirements of the Comprehensive Program Report.

It is important to note that funding for these activities will likely come from the Flood Control tax levy. While some of the activities may be considered new, they may have been known or considered by the District already. Plan credit is available for activities the District currently performs to reduce flood risk and exposure. The purpose of the Action Plan is to consolidate the District's various priorities in order to develop a reasonable and measurable way to ensure progress is made.

The Action Plan is the basic document that will provide direction to the District, and is provide information developed and discussed during this Planning Committee process. The Action Plan is attached.

Step 9 – Adopt the Plan

The FEMA guidance requires that the Floodplain Management Plan be adopted by the District's governing board, the Board of Directors of the Flood Control District. This full Floodplain Management Plan is on the District's website at www.pima.gov/fmp. This document represents a compilation of the numerous Planning Committee meetings, and is organized by the procedural steps described above with appendices, which break these same issues down by watershed.

This memorandum and the excerpted Action Plan have been provided as a summary of the procedural steps and detailed discussion that have occurred over the past 18 months. The District requests the Boards formal adoption of the Floodplain Management Plan and associated Action Plan.

Step 10 – Implement, Evaluate, and Revise

In order to retain credit under the Community Rating System, the Floodplain Management Plan must be annually reviewed and updated by the Planning Committee. In order to be more efficient, the District will combine the committee that reviews our Program for Public Information with the Floodplain Management Planning Committee, since both require annual review and update. Reporting of this action would occur through the District's annual reports.

The Floodplain Management Plan requires additional public process and Board adoption every five years. Again, for the purpose of efficiency, this five-year process will also result in the publication of the statutorily required Comprehensive Program Report. This allows the public process to look back on the past five years of accomplishments, while also looking forward to the next five years of planning.

Step 1.0 INTRODUCTION AND ORGANIZATION

The Pima County Regional Flood Control District (District) is a special taxing authority established under Arizona Revised Statutes Title 48, Chapter 21. As such, the District is responsible for providing regional flood prevention programs and flood control services for the County as directed by the Pima County Board of Supervisors (Board) sitting as the Board. The County is also a participant in the National Flood Insurance Program (NFIP) Community Rating System (CRS). Although District regulatory authority is limited to the unincorporated area, other authorized NFIP activities performed by the District benefit residents of incorporated areas.

The District strives to use forward-looking floodplain management planning practices to minimize the risk of flood and erosion damage for all County residents, property and infrastructure. These efforts include identifying high flood risk areas, preserving natural watercourses, constructing flood control facilities, establishing locally appropriate development standards, distributing public information, providing early warning, and responding to flood emergencies. By following the CRS, planning guidelines the Floodplain Management Plan (Plan) will help the District identify the activities that will be most effective in each of the watersheds in unincorporated Pima County. Doing so also helps keep flood insurance rates low.

1.1 Purpose and Scope

The purpose is to identify successes and needed improvements with respect to activities the District performs to protect the public from flood risk, to ensure the District delivers these services as efficiently and effectively as possible. The Board has supported these activities by approving of the Floodplain Management Ordinance (Ordinance), property tax levy, and annual budget. Furthermore, the Pima County Comprehensive Plan directs staff to create a Watershed Management Plan that identifies the watersheds affecting Pima County, their drainage characteristics, and regulatory and infrastructure needs. This Plan fills that purpose and as further directed in Resolution 2018-FC 6 to create a CRS compliant Floodplain Management Plan for Board adoption. A signed copy of this Resolution is included as Appendix A.

Too often property owners and local governments make flood protection decisions after a flood with inadequate or outdated information or without considering all possible mitigation alternatives or the consequences of those alternatives. As a result, the community may not allocate resources most appropriately and may not fully address the problems. Furthermore, natural floodplain functions may suffer.

To remedy this situation, the Federal Emergency Management Agency (FEMA) recommends a careful, systematic process of planning, described in the 2017 CRS Coordinator's Manual (Manual). The CRS does not specify what activities a plan must recommend; rather, it recognizes plans that have been prepared according to the standard planning process.

The scope of this plan is defined by both the CRS process and the local concerns raised by participating stakeholders, the public, and those identified by responsible professionals throughout local government. This includes activities within each of the 23 identified watersheds including:

1. Prevention
2. Property Protection
3. Natural Resources Protection
4. Emergency Services
5. Structural Projects
6. Public Information

Additional documents incorporated herein address federal NFIP requirements and local priorities. These include:

- Pima County Multi-Jurisdictional Hazard Mitigation Plan (HMP) that meets the NFIP requirement for a multi-hazard plan. Although FEMA credits it as the Pima County Floodplain Management Plan, it does not meet the Class 4 pre-requisites the District seeks to achieve due to the associated flood insurance discounts.
- Design Standards for Stormwater Detention and Retention that meets the NFIP requirement for a Watershed Management Plan in addition to the watershed sections of this Plan.
- Sonoran Desert Conservation Plan that meets the NFIP requirement for a Natural Floodplain Functions Plan.
- Program for Public Information.
- Repetitive Loss Area Analysis, Flood Insurance Coverage Assessment and Coverage Improvements Plan.
- Basin Studies completed by the District and approved by the Chief Engineer.
- Sustainable Action Plan for County Operations.
- Pima Prospers

1.2 Planning Process and Plan Organization

Organization reflects the planning steps recommended in the CRS Coordinator's Manual and includes watershed specific hazard and problem assessments. These steps are:

1. Organize to prepare the plan;
2. Involve the public;
3. Coordinate with other agencies;
4. Assess the hazard;
5. Assess the problem;
6. Set goals;
7. Review possible activities
8. Draft an action plan;
9. Adopt the plan; and
10. Implement, evaluate and revise.

Step 1 Introduction describes activities undertaken as part of CRS "Step 1- Organize to prepare the plan" including initiation by the Board and make-up of the Planning Committee.

Step 2 Public Involvement describes activities undertaken as part of CRS "Step 2 – Involve the public" including the planning process, public meetings and other information activities to encourage input.

Step 3 Intra-governmental Coordination describes activities undertaken as part of CRS "Step 3 – Coordinate with other agencies" including a review of existing studies and plans as well as coordination with other communities and agencies.

Step 4 Regional Flood Hazards describes activities undertaken as part of CRS "Step 4 – Assess the hazard" including creating hazard maps, past floods, less frequent floods, areas likely to flood and other hazards. This step focuses on hazards affecting the Pima County region. In order to avoid repetition those components of the watershed problem assessments below that are common are also included.

Step 5 Watershed Problem Assessment describes activities undertaken as part of CRS "Step 5 – Assess the problem" including a summary of hazards for each Pima County watershed and its impact on:

- Life, safety, health, warning and evacuation procedures;
- Public health including floodwaters and mold;
- Critical facilities and infrastructure;
- Community economy and tax base;
- Affected buildings;
- Damages to buildings and insurance claims;
- Areas that provide natural floodplain function;
- Development and population trends; and
- Future flooding conditions.

Each section devoted to a single watershed provides an assessment of the individual watershed and differences from others within the County. This includes flood characteristics, existing development and trends, riparian habitat and natural areas, historic floodplain management approach, structural projects and needs, and floodplain management strategy. The conclusion of Step 5 including individual watershed assessments contained in Appendix C is a problem and opportunities list. This list then forms the basis of the recommended goals and Action Plan. This concludes steps four and five of the CRS process.

Step 6 Goals describes activities undertaken as part of CRS "Step 6 – Set Goals" including identification of strategies to address common problems and opportunities identified in Step 5.

Step 7 Programs and Activities describes activities undertaken as part of CRS "Step 7 – Review possible activities" including a review of activities undertaken historically and during the previous five years, as well as any additional activities needed to implement goals identified in step 6. This is where the information contained in the Comprehensive Program Reports appears. The District strategy in doing so is to facilitate the transition to implementing a floodplain management strategy on a watershed-by-watershed basis and to provide the review of activities in a familiar format to the Planning Committee. Therefore, Step 7 and Appendix D reviews different CRS credited flood risk reduction activities that apply regionally and to specific watersheds. As defined by CRS these include:

- Preventative
- Property protection
- Natural resource protection
- Emergency services
- Structural projects
- Public information

Step 8 Goals and Recommendations describes, "Step 8 – Draft an action plan" including prioritized actions to address each problem identified in Step 5 and corresponding goals from Step 6.

Step 9 Plan Adoption presents the Plan for Board approval.

Step 10 Implementation describes activities undertaken as part of CRS "Step 10 – Implement, evaluate, and revise" including monitoring and revision procedures as well as the ongoing role of the Planning Committee.

The project schedule is as follows.

- October 2018 – Board directs the District to start the Floodplain Management Plan process.
- October 2018 – Establish Planning Committee according to guidelines.
- Fall 2018 – Begin conducting informational meetings in affected areas and continue throughout as needed.
- Summer 2018/19 – Assess known hazards and exposure of people and property.
- Fall 2019 – Set goals, review possible activities, and draft the Action Plan.
- Winter 2019 – Conduct meetings for the public to comment on the draft Action Plan.
- 2020 – Request approval by the Board.

A PowerPoint describing this process is available on the project webpage at www.pima.gov/fmp. District staff is available to present this information as well as provide a project status report for

community representatives, groups and organizations. The next section describes public involvement opportunities further.

Step 2.0 PUBLIC INVOLVEMENT

2.1 Planning Committee

A stakeholder Planning Committee (Committee) provided input at each step. Committee meetings hosted by the District at key project milestones were open to the public. The District advertised these dates on the project webpage and anyone responding in the affirmative to our survey or other outreach activities receives email announcements and updates. Participants included:

- Allyson Solomon, Metropolitan Pima Alliance
- Arlan Colton, University of Arizona Planning Program
- Brain Powell, Pima County Natural Resources Parks and Recreation Department
- Carolyn Campbell, Coalition for Sonoran Desert Protection
- Catlow Shipek, Watershed Management Group
- Chris Bertrand, San Xavier District of the Tohono O'Odham Nation
- Chris Gurton, Country Financial
- Christina McVie, Tucson Audubon Society
- Clair Zucker, University of Arizona Water Resources Research Center
- Craig Civalier, Community Water Coalition
- Eric Holler, Community Water Coalition
- Eric Shepp, Pima County Regional Flood Control District
- Griselda Moya-Flores, Pima County Office of Emergency Management
- Ian Sharp, Farmers Investment Company
- Ivy Schwartz, Tucson Mountain Association
- Jason Ground, Pima County Communications
- Jeff Guthrie, Pima County Office of Emergency Management
- John Baskett, San Xavier District of the Tohono O'Odham Nation
- Jonathan Horst, Tucson Audubon Society
- Lola Graeme, Catalina Foothills Association
- Melanie Mizell, Community Water Coalition
- Nicole Fyffe, Pima County Administrator's Office
- Patrick Marum, Southern Arizona Homebuilders Association
- Shane Clark, Pima County Office of Emergency Management
- Steve Dolan, Tucson Mountain Association
- Steve Huffman, Tucson Association of Realtors
- Terri Tillman, Pima County Development Services Department
- Tim Campbell, Farmers Investment Company
- Jeanette DeRenne, Pima Association of Governments
- Matt McGlone, Pima County Office of Emergency Management
- Mead Meir, Pima Association of Governments

Tragically, active committee member and former Marana Town Engineer, Craig Civalier passed away before the third meeting. The author dedicates this Plan to his spirit, and devotion to public service, safety and environmental health.

The CRS Coordinator conducted eight formal Committee meetings at each of the first eight steps of the CRS process leading to adoption and implementation.

Senior District and Department of Transportation *support* staff participated in many of these meetings including project, basin study, engineering, floodplain management, open space, outreach and Geographic Information System (GIS) program managers. They did not vote on key decisions. In part, this became necessary at the request of the Committee to conduct weekly workshops during steps 4 and 5 to assist members' access and interpret information from County GIS, Document Management System, and on the Pima County internet. The District hosted 10 of these workshops beginning on May 14, 2019 and ending on July 16, 2019. The CRS Coordinator facilitated these sessions using a large format GIS display enabling those present to look at each watershed and watercourse in the County Drainage System individually and evaluate historical and current aerial photography, hydrology, complaints, permits, and plans. These workshops helped refine the problem and opportunities lists generated at the end of Step 5.

At meeting 8, in addition to approving the Action Plan, the Committee agreed to meet after Board approval to celebrate the accomplishment and initiate participation during implementation. The flow chart below summarizes the process.

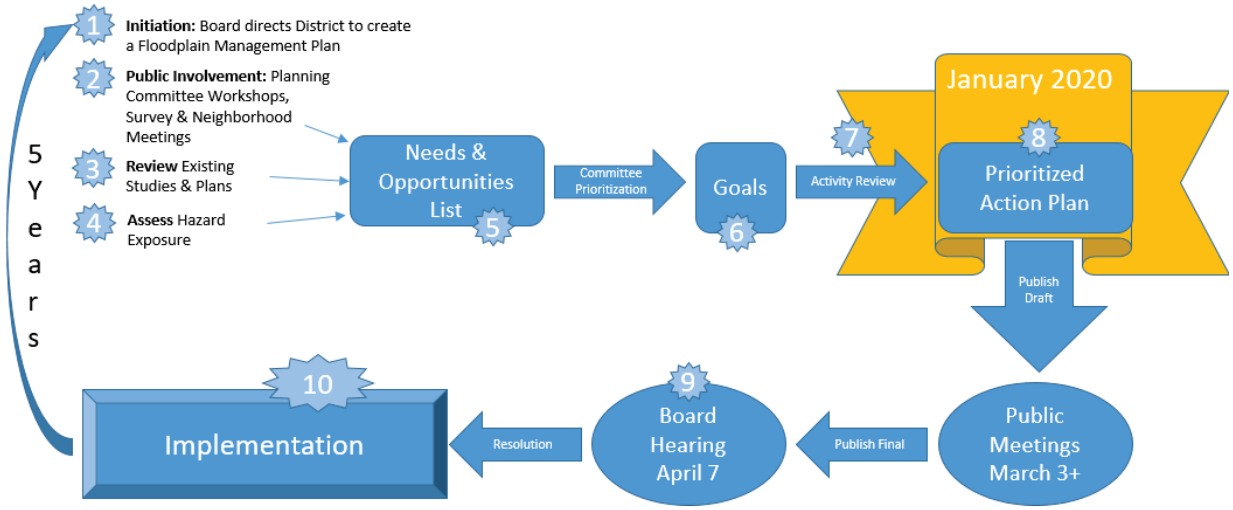


Figure 1 - Planning Process Flow Chart

2.2 Public Information Meetings

In addition to the 8 formal Committee and staff team meetings, District staff conducted informational meetings in floodprone areas at the beginning of the process including:

1) Pima County Multi-Jurisdictional Hazard Mitigation Stakeholder Workshop(s) in 2018 on various dates. Participants:
   - Pima County Office of Emergency Management
   - Pima County Sherriff
   - Jurisdictions
   - National Weather Service
   - University of Arizona CLIMAS (Climate Assessment for the Southwest) Team Arizona Department of Emergency and Military Affairs (ADEMA)

2) Staff Working Group Organizational Meeting on October 16, 2018
   Participants:
   - Andy Dinauer, Deputy Director
   - Eric Shepp, Deputy Director and Floodplain Administrator
   - Suzanne Shields, Director and Chief Engineer
   - Ann Moynihan, Civil Engineering Manager for Development Section
   - Brian Jones, Floodplain Management Division Manager
   - Deidre Brosnihan, Civil Engineer for CIP Section
   - Evan Canfield, Civil Engineering Manager for Basin Studies Section
   - Greg Saxe, Environmental Planning Manager and CRS Coordinator
   - Janice Hughes, Civil Engineer for CIP Section
   - Joseph Cuffari, Public Outreach Program Coordinator
   - Kenneth Maits, GIS Program Manager
   - Marisa Rice, Open Space Lands Program Manager

3) Pima County Regional Flood Control District Advisory Committee (FCDAC) - Informational Meeting on October 17, 2018.

   The FCDAC members include members appointed from each participating jurisdiction including the City of Tucson, Town of Marana, Town of Oro Valley, and Town of Sahuarita, as well as one member appointed by each County Supervisor. In addition to members, staff in attendance include the Floodplain Administrator, CRS Coordinator, and Outreach Program Manager.

4) Santa Cruz River Meet Yourself – Informational Meeting on October 18, 2018.

   Participants included over 50 members of the Santa Cruz Watershed Collaborative including local, state and federal agencies, environmental organizations, community groups and subject matter experts. District staff provided a display table at which there were ‘lightning talks’, hazard maps and the opportunity to fill out a survey.

5) Sustainable Action Plan for County Operations (SAPCO) Open House - Informational Meeting on November 11, 2018.

Public open house at the Main County Library with tables by departments and community partners involved in sustainability efforts including green infrastructure and riparian habitat restoration. County Administrator Chuck Huckelberry provided the keynote speech. Attendees included:

- Tucson Water
- Food Bank Community Cooperative Gardens
- Physicians for Social Responsibility
- Pima County Native Plant Nursery
- Pima County Wastewater
- Pima County Department of Environmental Quality
- Pima County Seed Library
- Pima County Department of Transportation
- Pima County Office of Sustainability and Conservation

6) Pima County GIS Fair – Informational Meeting on November 9, 2018.

Public open house in the County/City Public Works Building with tables by departments, consultants and community partners involved in GIS. Participants included:

- Borton Magnet School
- City of Tucson Information Technology
- GIS Services Division
- City of Tucson Parks and Recreation
- City of Tucson Transportation
- EagleView
- Northwest Fire District
- Pima Association of Governments
- Pima County Information Technology GIS
- Pima County Natural Resources, Parks and Recreation Department
- Pima County Regional Flood Control District
- Pima County Transportation EIM/Maps and Records
- Pima County Wastewater Reclamation
- Rick Engineering Company
- The Quiet Creek
- Tucson Police Department Research and Analysis Unit
- Tucson Water
- UA Enterprise GIS
- University of Arizona Library
- University of Arizona MS-GIST Program
- USDA-ARS SW Watershed Research Center
- Westland Resources, Inc.

District staff provided a table with Plan fact sheets and surveys, as well as a poster depicting the history of the Pima County Regional Flood Control District and Flood Control GIS kiosk.

7) Flowing Wells Neighborhood Association – Informational Meeting on November 15, 2018.

   District staff attend monthly potluck meetings to provide information on the FMP. Staff announced plan, handed out fact sheets, survey and hand delivered Committee meeting invitations.

8) Pima County Planning and Zoning Commission (Commission) Public Hearing – Informational Meeting on November 28, 2018.

   Announced approval of initiation resolution by the Board, described process and announced first the date of the Planning Committee meeting and offered full presentation for future Commission agendas. Handouts included the Fact Sheet.

9) Community Water Coalition Policy Roundtable – Keeping Water in the River: City of Tucson Council Ward 3 Office on December 5, 2018.

   FMP Informational and panel discussion with Tucson Water and retired BOR planner and Committee member Eric Holler. Several elected officials including city council and state legislature members attended along with interested individuals from Ward 3.

10) Pima Association of Governments Environmental Planning Advisory Committee on December 7, 2108 informational item.

11) Catalina Foothills Association Annual Meeting on January 29, 2019.

    Presentation on floodplain management including information on the Plan process, flood hazards and ongoing mitigation activities. Fifty plus homeowners in attendance in addition to Homeowners Association(s) president(s) and board members, Planning and Zoning Commission Chairman Brad Johns, FCDAC member Chris Langham, and the Rural Metro Fire District. Staff set up a table in the back of the meeting room at Saint Phillips Church to provide the opportunity for attendees to review maps, place stickers in areas of concern and fill out surveys.

12) Community Water Coalition, Lower Santa Cruz River Recharge and Oxbow Restoration Sites Tour on February 11, 1019.

    In attendance were Planning Committee members Eric Holler of the Community Water Coalition (CWC), Ivy Schwartz (Tucson Mountain Association), Jonathan Horst (Audubon) and Craig Civalier (FICO) along with others from CWC and District staff who manage the Marana High Plains.

13) Tucson Estates Property Owners Association Informational Meeting on February 27, 2019.

    Annual presentation by Pima County departments including Development Services, Transportation, Natural Resources Parks & Recreation, County Sherriff and Supervisor Bronson in addition to the District.

14) Metropolitan Pima Alliance – Pima County Stakeholders Meeting on March 13, 2019.

    Plan update on agenda with other items related to County activities. Attendees:

    - Allyson Solomon
    - Ryan Stucki
    - Lisa Bowers
    - Shawn Cote
    - Tommy Roof
    - Michael Guymon
    - Jason Wong
    - Carla Blackwell
    - Chris Poirier
    - Daniel Ice
    - Tom Drzazgowski
    - Joseph Godoy
    - Yves Khawam
    - Eric Shepp
    - Eric Wieduwilt
    - Richard Grimaldi
    - Kathryn Skinner
    - Tim Bee
    - Bruce Patton
    - Kevin Hall
    - Terry Klipp
    - Linda Morales
    - Teresa Vasquez

15) Tucson Mountain Association Board – March 26, 2019 Informational Meeting
16) Santa Cruz River Watershed Collaborative Forum – April 4, 2019 all-day Partnership Building Event
17) May 8, 2019 – Utility Contractors Coordinating Committee Informational and Stakeholder Outreach
18) April 4, 2019 – Tucson Association of Realtors Informational and stakeholder outreach
19) April 20, 2019 – Earth Day at the Children's Museum Informational Booth
20) May 8 and May 15, 2019 – Raytheon Employee and Families Event Informational Table
21) May 8, 2019 – Sahuarita Career Days Informational Table
22) SAHBA Technical Committee – May 21, 2019 Informational, Outreach for Stakeholders and Project Update

While the 19 meetings listed above were informational, the events below include *additional public information activities implemented to explain the process and encourage* input, as well as those interviews conducted as part of Step 3 *Coordinate with other Agencies* (see page 17) and the Committee and staff team meetings. It does not include the 10 GIS Hazard and Problem Assessment working sessions for Committee members described above.

23) May 31, 2019 – San Xavier District Neighboring Community Interviews
24) June 3, 2019 – Cadden Property Management Stakeholder Interview
25) June 4, 2019 – Arizona Department of Water Resources and United States Fish and Wildlife Service Agency Interviews
26) June 4, 2019 – San Xavier District Planning Department Neighboring Community Interview
27) June 6, 2019 – Tohono O'odham Nation Planning Department Neighboring Community Interview
28) June 7, 2019 – Pima Association of Government Environmental Planning Advisory Committee Project Update Presentation of Hazard Assessment and prior plans
29) June 7, 2019 – Tohono O'odham Nation Water Resources Program Interview
30) June 14, 2019 – KGUN 9 Interview and Story
31) June 28, 2019 – Farmer's Investment Company Stakeholder Interview
32) July 1, 2019 – Pascua Yaqui Tribe Facilities Neighboring Community Interview
33) July 10, 2019 – National Weather Service Agency Interview
34) July 19, 2019 – Oro Valley Stormwater Commission
35) July 22, 2019 – Planning Committee Meeting 3 Problem Assessment Teaser
36) July 31, 2019 – Winchester Ranch Homeowners Association
37) August 5, 2019 – Town of Sahuarita Neighboring Community Interview

38) August 9, 2019 – City of South Tucson Neighboring Community Interview
39) August 12, 2019 – Oracle Foothills Neighborhood Association
40) August 12, 2019 – Pima Farms Homeowners Association
41) August 13, 2019 – Town of Marana Neighboring Community Interview
42) August 29, 2019 – Coalition for Sonoran Desert Protection Goals discussion
43) August 30, 2019 – City of South Tucson tour with the Vice Mayor
44) September 5, 2019 – Tucson Mountain Association working session (President and representatives)
45) September 6, 2019 – Pima County Office of Sustainability and Conservation
46) September 13, 2019 – Participate in CRS Floodplain Management Plan panel at Arizona Planning Association annual conference
47) October 30, 2019 – American Public Works Association Southern Arizona Chapter Luncheon speaker
48) Dec 4, 2019 –City of Tucson Ward 3 Community Water Coalition Forum, FMP update
49) Dec 16, 2019 – Planning Committee Meeting 6 at TAR
50) January 15, 2020 – FCDAC Action Plan and Progress Review
51) January 16, 2020 – Planning Committee Meeting 7 Activity Review at the Public Works Building
52) January 22, 2020 – Staff team Committee meeting debrief
53) February 6, 2020 – Staff team Action Plan watershed detail workshop
54) February 12, 2020 – Planning Committee Meeting 8 Action Plan
55) February 18, 2020 – Southern Arizona Homebuilders Association Technical Committee Action Plan review

This list of public meetings and events is representational and not complete. Section 3.2 below provides the full list of interviews conducted as part of Step 3b coordinate with agencies and organizations.

While committee, neighborhood and neighboring community meetings are critical, the audiences may be limited. Therefore, the District has conducted a survey and established a project webpage that are described blow.

2.3 Community Survey

In addition to meetings, events, and interviews, the District developed a survey to assess flood knowledge, familiarity and satisfaction with District activities. Staff distributed pilot surveys during the informational meeting phase at the beginning of the process and staff made adjustments to the questions. Then beginning in June and July of 2019, the District mailed a brochure to floodplain residents announcing the project and encouraging recipients to fill out the revised survey. The survey was available in paper form during project meetings and online throughout the process. In this way, the address list used differed from the annual mailer to floodplain property owners. In part, this was a target audience recommendation of previously approved District Program for Public Information (PPI) documents, which identified the need to reach renters. Survey results are included in the Step 7, Review of Activities.

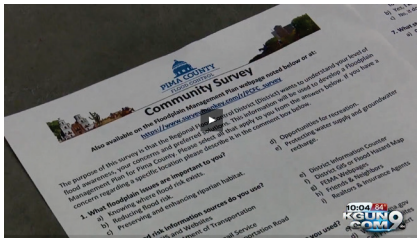
2.4 Project Webpage

The website link below provides a project overview, schedule, committee meetings, hazard assessment, problem assessment, and draft plan. It includes tabs for each watershed in the County. Links to the survey, ancillary plans and studies are also included along with project updates and press.

www.pima.gov/fmp

2.5 In the Media

The County Communications Office has participated in both staff working meetings and Committee meetings. Furthermore, the District's own Outreach Program Coordinator supports this effort. These individuals have been indispensable in promoting media presence at keys steps using press releases and social media. At the beginning of the project just before Monsoon season and as part of Monsoon Safety Awareness Week, several newspaper articles and television stories resulted announcing the plan process and promoting the survey.



https://webcms.pima.gov/cms/One.aspx?portalid=169&pageId=450475

The link above leads to four television and newspaper stories that encouraged citizens to participate in the process.

Step 3.0 INTER-GOVERNMENTAL COORDINATION

3.1 Review of Existing Studies and Plans

There have been six prior Comprehensive Program Reports published by the District as follows:

- 1979 Comprehensive Status Report
- 1990 Comprehensive Program Report
- Comprehensive Program Report for FY 1990/91 – FY 1995/96
- Comprehensive Program Report for FY 1995/96 – FY 2000/01
- Comprehensive Program Report for FY 2000/01 – FY 2005/06
- Comprehensive Program Report for FY 2005/06 – FY 2010/11
- Comprehensive Program Report for FY 2010/11 – FY2015/16

Completed one year after the District formed, the 1979 Comprehensive Status Report discussed the status of ongoing flood control projects and identified future needs. The 1990 Comprehensive Program Report was the first comprehensive documentation of District activities. It reviewed all aspects of District programs from the District's inception in 1978 through 1990. Additionally in 1990, the District first participated in the CRS. Completion of the

Flooded roads create travel hazards during rainfall.

first Pima County Floodplain Management Plan "Synopsis" occurred as part of this process. Subsequent reports have summarized activities conducted during the reporting period. In 2007, to implement the requirements of the Stafford and Disaster Mitigation Act of 2000 and better prepare local governments to mitigate and respond to hazards including flooding, the first Pima County Multi-Jurisdictional Hazard Mitigation Plan was completed. The HMP effort resulted in acceptance by FEMA as an NFIP compliant Floodplain Management Plan in 2012. Moving forward, the FMP shall fill the need for Comprehensive Program Reports required by State Statute.

In addition to these comprehensive reports, the District has published numerous special studies for watershed basins. The project webpage includes links organized by watershed for the first time.

The following paragraphs describe other relevant adopted County plans:

Sonoran Desert Conservation Plan (SDCP) - The award-winning plan is for balancing the conservation and protection of our cultural and natural resource heritage with County efforts to maintain an economically vigorous and fiscally responsible community. The SDCP considered the following elements: critical habitats and biological corridors, riparian areas, mountain parks, historical and cultural preservation, and ranch conservation. All five elements, along with fiscal analysis, were critical in forming a viable land management plan for Pima County.

The SDCP identified the types of development that improved the tax base, and the relationship of these with the sewer service area. Build-out analyses showed that adequate land for urban development exists, and that certain types of development would be costly to the tax base as well as to various community values identified through over 600 public meetings. Over 200 technical reports documented these values, using the combined talents of more than 150 contributing scientists.

In 2001, the Pima County Board updated the Pima County Comprehensive Land Use Plan, integrating the land-use policies and principles of conservation developed in the SDCP, including the Conservation Lands System or CLS. The CLS identifies lands necessary to achieve SDCP biological goals, while delineating areas suitable for development. The CLS covers approximately 2 million acres in eastern Pima County. The CLS was renamed the Maeveen Marie Behan Conservation Lands System in 2009 in memory of Dr. Behan's work on the SDCP and development of the CLS.

Since 2001, the SDCP has guided where public money is spent to conserve important natural areas, providing the basis for how cultural and historic resources are protected, and serving to help ensure that our western lifestyle, heritage, and traditions continues. The SDCP set the stage for later efforts such as the City-County Water Study, and reinvestment in the County's sewage treatment facilities, and created a new standard for public transparency and involvement. The Multi Species Conservation Plan (MSCP) is the part of the SDCP that deals with compliance with the Endangered Species Act.

Completion of this plan facilitates maintenance of the drainage system and identifies riparian habitats that are the highest priority for preservation and restoration.

Pima Prospers - On May 19, 2015, the Board unanimously passed the County's second update of its 1992 Comprehensive Plan as recommended by the Planning and Zoning Commission (Commission) with only four amendments affecting land use in unincorporated county. There were no changes to the Commission's recommendations on the policy document or appendices. It is available at the following link:

www.pimaprospers.com

Numerous policies directly relate to floodplain management. The two most significant are the Water Element and the Flood Control and Drainage Element. Both include an implementation measure to develop a Watershed Management Plan along with other specific guidance. Notably this plan calls for preservation of natural floodplains and identifies Flood Control Resource Areas. Pima Prospers establishes goals to avoid development in these areas, which include SDCP CLS Important Riparian Areas (IRA), Pima County Regulated Riparian Habitat and floodplains. A sample official map of these areas is below. The complete set is available on the Pima County Development Services Department (DSD) webpage at:

http://webcms.pima.gov/government/pima_prospers/

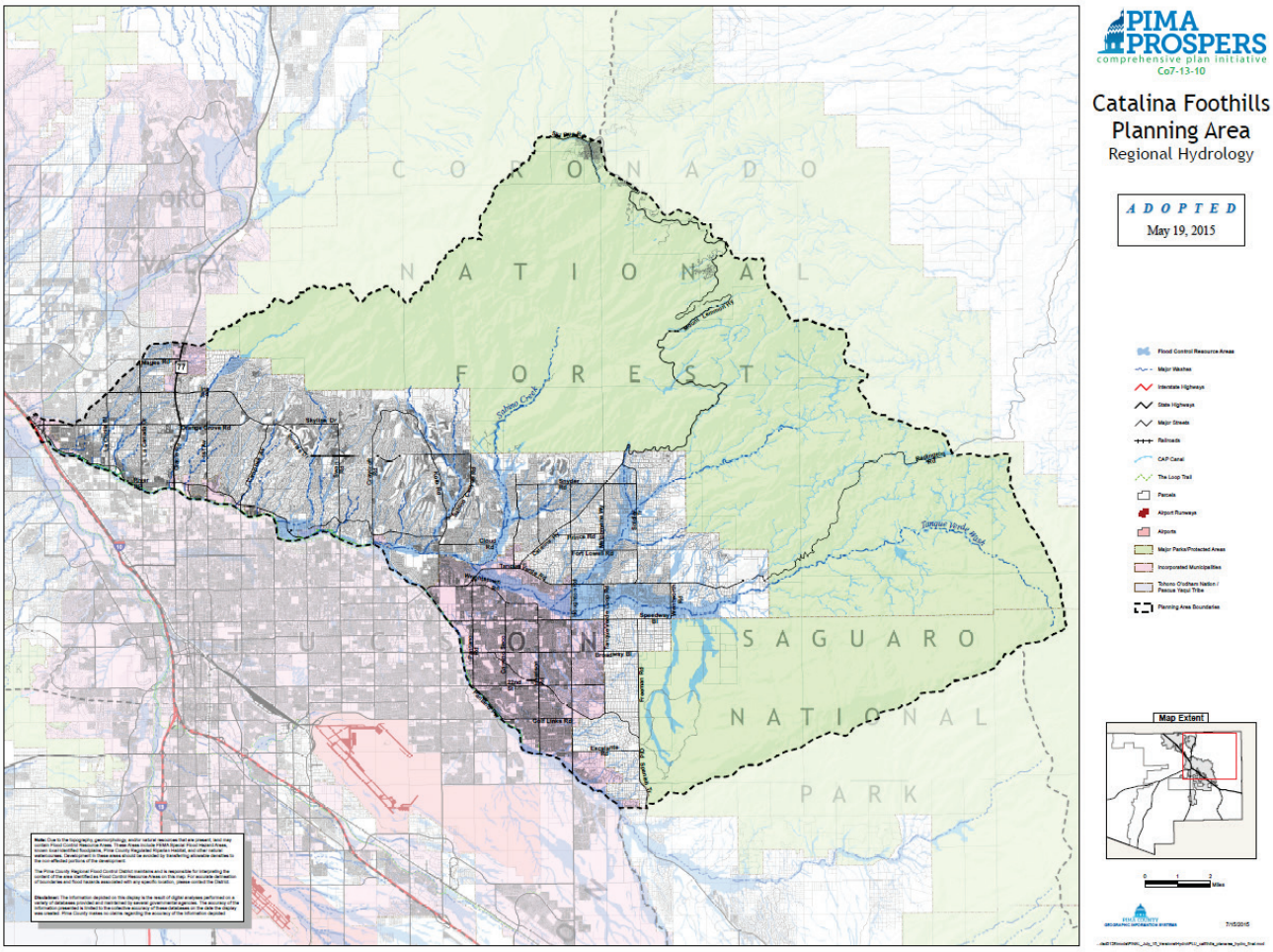


Figure 2 - Sample Flood Control Resource Area Map

Pima County Multi-Jurisdictional Hazard Mitigation Plan (HMP)

District staff including the CRS Coordinator and ALERT Monitor have participated in development of the HMP for over a decade. Currently, FEMA credits the HMP as the Floodplain Management Plan. As such, it identifies flood and other hazards, including:

- Drought
- Earthquake
- Extreme Cold
- Extreme Heat
- Flood
- Landslide
- Severe Wind
- Wildfire

Each of these is associated with weather with the exception of earthquakes. The HMP does not consider tornadoes separately from severe wind due to their infrequency in this region. Hurricanes elsewhere, particularly the Sea of Cortez, have an effect on rainfall and severe winds. Local downbursts cause significant damage to roofs, carports, and power lines every few years. The District staff, the HMP team and FMP Planning Committee expect each to increase in frequency due to climate change. The District is involved in numerous research projects with the Bureau of Reclamation and the University of Arizona to evaluate these risks and establish mitigation and resilience practices. These efforts are included in the recommended Action Plan.

The Goals identified by the Committee in Step 6 incorporate the Pima Prospers Water and Flood Control Resource Area, SDCP, and Floodplain Management Ordinance policies and goals. The Action Plan identifies countywide and watershed specific measures to address each of these goals as described further in Section 6. Basin studies identify some of these and the project webpage contains links by watershed to facilitate the Committee's ability to reference them over the course of the planning process.

3.2 Coordination with Communities and Other Agencies

In order to facilitate coordination with neighboring communities and partner agencies and as recommended by the CRS, District staff contacted these groups using email and phone calls. Monthly Flood Control District Advisory Committee meetings throughout the project included announcements and updates, as well as the opportunity for jurisdictional and supervisor's representatives to ask questions. This committee includes one representative from each of the incorporated jurisdictions within Pima County, one appointed by each Pima County Supervisor. The CRS Coordinator interviewed respondents including the following individuals and organizations.

1. Brett Cadden Anderson
   Vice President
   Cadden Community Management
   June 3, 2019

2. Jennifer Varin
   Watershed Program Manager
   Coronado National Forest
   May 20, 2019

3. Mead Meir
   Watershed Planning Lead
   Pima Association of Governments
   May 17, 2019

4. Luke Cole
   Associate Director
   Sonoran Institute
   May 17, 2019

5. Brian Cosson
   ADWR NFIP and Flood Warning Coordinator
   Arizona Department of Water Resources
   June 4, 2019

6. Scott Richardson
   Supervisory Biologist
   United States Fish and Wildlife Service
   June 4, 2019

7. John Baskett
   Planner
   San Xavier District
   June 4, 2019

8. Gerald Fayaunt
   Executive Director
   Planning Department
   Tohono O'odham Nation
   June 6, 2019

9. Selso Villegas
   Director
   Water Resources Department
   Tohono O'odham Nation
   June 7, 2019

10. Tim Campbell/Ian Sharp
    Farmers Investment Company
    June 29, 2019

11. Erin Boyle
    National Weather Service
    July 10, 2019

12. Ian Geitner, Director of Facility Management
    Pascua Yaqui Tribe
    July 1, 2019

13. Oro Valley Stormwater Commission
    July 18, 2019

14. David Pfordt
    Town of Sahuarita
    August 5, 2019

15. Robert "Bob" Tesso, Mayor
    Herman Lopez, Councilman
    John Vidaurri, City Manager
    South Tucson
    August 9, 2019

16. Keith Brann,
    Public Works Manager; and
    Glenn Phillips, CRS Coordinator
    Town of Marana

17. James MacAdam
    FCDAC Representative
    City of Tucson
    September 11, 2019

The CRS Coordinator conducted these interviews over the telephone and in person using the tracking form on the following page. Staff is tracking feedback from the outreach activities undertaken as part of steps 1, 2 and 3 in spreadsheet form. This facilitated outreach record keeping, hazard and problem area assessment, review of possible activities, and drafting an action plan. The results are in Step 7.

PIMA COUNTY
FLOOD CONTROL

Floodplain Management Plan

Stakeholder Contact Record

Date: **Staff POC:** Saxe

Stakeholder Contact:

Name:
Organization:
Title:
Email:
Office:
Cell:

What information or data related to flood hazards do you have which may be useful in the planning process?

What is the stakeholder doing that might be effected by flooding or which may affect properties in flood-prone areas?

What are your main concern(s)?

Are these concerns addressed in the Plan?

a) Yes **b) No** **c) Add** **d) Referred to**
_____

Additional Information Requested:

Role Requested:

a) Committee member
b) Provide information as a stakeholder
c) Complete survey
d) Review documents and comment

Other:
_____

Step 4.0 HAZARD ASSESSMENT

This step describes the causes and types of flood hazards within the County. The map, excerpted from the approved 2017 HMP below shows the extent of flood hazards identified by FEMA and locally in eastern Pima County and the context within the natural basin and range environment described in detail below. This step provides an overview of regional hazards, past floods and other hazards. Appendix C provided details hazard and problem assessments for each of the 27 watersheds in unincorporated Pima County.

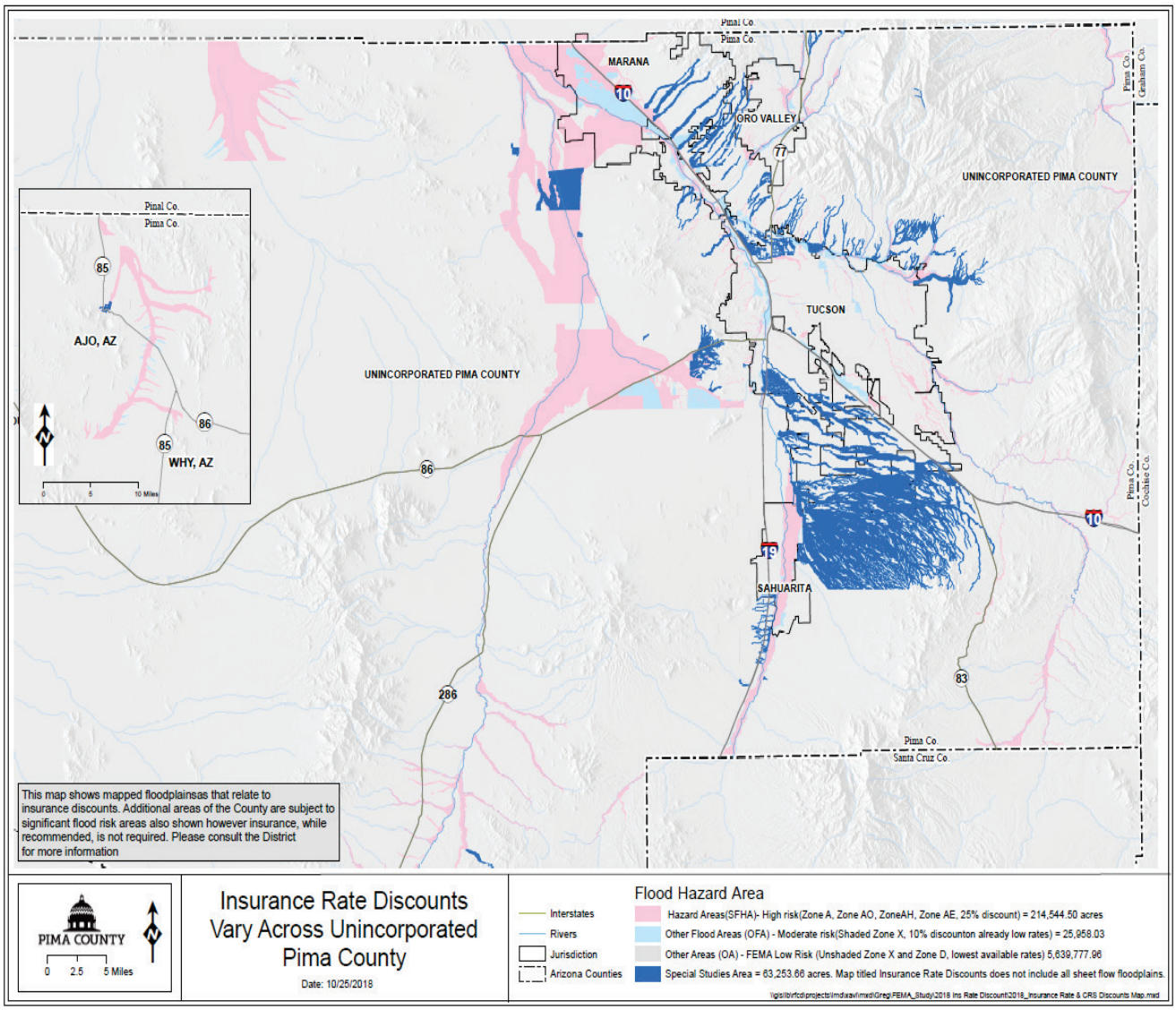


Figure 3 - Map of Known Flood Hazards

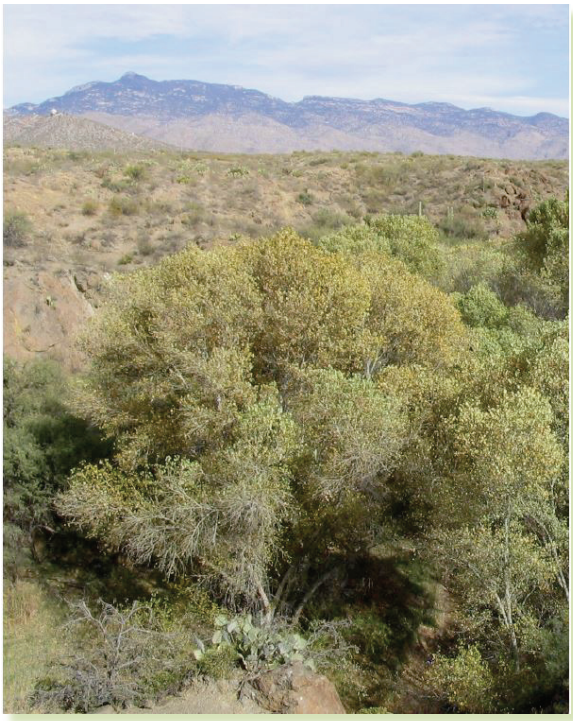
The HMP also includes assessments of the other hazards including earthquakes and those that are climate related including flooding, wind, heat, fire, landslides and drought. Erosion is also a significant hazard identified in Section 4.5 of this plan. Climate change exacerbates each.

4.1 Natural Environment

Very wide alluvial basins and steep linear mountain ranges, referred to as Sky Islands, characterize Pima County. Though located in southern Arizona in the Sonoran Desert biome, the presence of tall mountains up to 10,000 feet means that the County is home to several types of forest in addition to desert scrub and grasslands. On the Sky Islands above roughly 6,500 feet, there are pine and fir forests more typically associated with the high latitudes in Canada. The middle elevations, between 3,500 and 6,500 feet are primarily Madrean evergreen forest, often associated with the Sierra Madre Occidental, consisting of Black Oaks and Alligator Juniper as well as Arizona Ash, Canyon Hackberry, occasional Cottonwood and Sycamore groves, and semi-arid grasslands. These sky islands create a land bridge between the Sierra Madre and Rocky Mountains.

Avra Valley & the Baboquivari Mountains

Alluvial fans forming above the valley floor are common at the margins of mountains. Bajada is the area where two or more alluvial fans connect. Bajadas consist largely of Chihauhuan Scrub and Sonoran Desert habitat. Desert plants that thrive in these areas includes Saguaro and a wide variety of cacti; trees such as Mesquite, Palo Verde and Ironwood; along with significant shrub and seasonal undergrowth. Generally, the lowest elevations of the County are broad, relatively flat geologic floodplains associated with the major watercourses including the Santa Cruz River, Rillito, Pantano, Black, Brawley, Avra Valley, Aguirre Valley, San Simon and Santa Rosa washes. Additionally, the soils are silty sand, and the vegetation characterized by creosote flats, scrub mesquite with larger specimen trees and cactus along the low-flow channels and arroyos.



Cienega Creek & the Rincon Mountains

In addition to a unique flora such as the iconic Saguaro cactus found nowhere else in the United States, the Sonoran Desert is also home to unique and diverse fauna including; Jaguar, Mountain Lion, Bobcat, Javelina, Coati, Ringtail Cat, Jaguarundi, Pronghorn, Gila Monster, Crested Caracara, Pygmy Owl, Bell's Vireo and many intriguing desert insects. Major continental migrations of hummingbirds and butterflies rely on the land bridge and ecological connectivity created by the Sky Islands, high desert grasslands and Madrean evergreen forest located between the Rocky Mountains and Sierra Madre Occidental. Geographers

recognize this as a weather generator. This wealth of biodiversity contributes greatly to the quality of life in the County while the geography poses planning challenges, including flooding.

Illustration of species diversity from the Sonoran Desert Conservation Plan

4.2 Basin and Range Geohydrology

As with plant life, flood risk varies with elevation, soils, slope and aspect. Forest vegetation and soils attenuate more frequent low rainfall events at higher elevations above 6,500 feet, to reappear in springs at lower elevations, often where the bedrock escarpment meets the alluvial fans and bajadas. In less frequent higher intensity and duration rainfall events flows are significant enough to travel from higher elevations all the way onto the valley floor as flash flooding and, rarely, debris flows.

Vegetation changes created by drought and fire can greatly increase rainfall runoff from upper watersheds. Much of the higher elevations of Pima County are within National Forests where management reflects recreational and extractive industry demands as well as fire control. Their role in mitigating and contributing to climate change cannot be understated.

Flows originating from above or within bajadas often occur as flash floods in canyons and incised washes exiting the mountain front. These floods include swift water and high debris loads, making them one of the most significant flood risks in the County. Sediment and debris deposited when flows reach shallower slopes on alluvial fans and the geologic floodplains of major rivers causes flows to take unpredictable paths, increasing the difficulty of managing flood risk in these areas. These foothills or canyon washes include: the Agua Caliente, Soldier Canyon, Tanque Verde, Cañada Agua, Campbell, Finger Rock, Cañada del Oro, Sweetwater, and Camino de Oeste, to name just a few. Special studies identifying these hazards are a need identified by the Planning Committee.

Most development occurs within the valley bottoms where the most significant risks are widespread flooding from regional watercourses, lateral channel migration and maintaining all-weather access. All-weather access is especially a problem in rural areas, where widespread sheet flow flooding and unimproved roads create conditions that hinder travel. This may occur frequently in small events and for longer periods during larger events. Bank failure, channel migration, and sediment deposition are the main risks and opportunities within the urban core, such as along the Rillito, Pantano and Santa

Cruz rivers where the District has engaged in an extensive erosion control and habitat restoration efforts. Critical road infrastructure is especially susceptible to erosion and debris associated with flood events.

4.3 Weather Patterns

Flood producing storms in Pima County typically fall into one of two types: summer monsoon thunderstorms and winter mesoscale storms.

Summer monsoon storms are highly convective systems that produce intense rainfall over relatively small areas. Monsoon storms are more likely to trigger flood events on watercourses with a watershed of <1 mi^2 in size, particularly later in the monsoon season when antecedent soil moisture is higher. Monsoon storm flooding is short-lived and may affect an area suddenly in the form of a flash flood.

These floods tend to be of short duration, but high intensity. Furthermore, monsoon rainfall may affect just one watershed or neighborhood. In most years, the annual peak flow will occur on different days at different gauging stations. However, a storm event in the Santa Catalina Mountains that culminated on July 31, 2006 produced over 200 debris flows and resulted in significant flooding on watercourses ranging from the upper watersheds in the Catalina foothills all the way to the Santa Cruz River.

Winter mesoscale storms, which includes tropical storms, generally originate in the Pacific Ocean and produce bands of precipitation over a period of days. Precipitation characteristics create floods that build slowly and may last for days or weeks. In general, the largest floods on the Santa Cruz River have occurred because of tropical storms that come up from the Sea of Cortez in the fall season. Though characterized by low rainfall intensity, these long duration storms yield the high volumes of water necessary to saturate watersheds and produce significant flow events on the major watercourses. These storms generally affect the County about once per decade.

In October 1983, Tropical Storm Octave produced the flood of record on the Santa Cruz River. Between 6 ½ to 7 ½ inches of rain fell across the area in five days. The storm caused $106M in damage in The County and more than a dozen people died. Pima County also experiences frontal systems that can provide more sustained flow durations, though flood peaks tend to remain low. Winter frontal systems may also produce rain-on-snow flood events in January to March.

Hikers trapped by a flash flood in Sabino Canyon

4.4 Types of Flooding

Damaging floods in the County include riverine, sheet, alluvial fan, and local area flooding. Riverine flooding occurs along established watercourses when the runoff, including rainfall and snowmelt, exceeds bank-full capacity of a watercourse and the overbank areas become inundated. Sheet flooding occurs in regionally low areas with little topographic relief that generate floodplains over a mile wide, Alluvial fan flooding is generally located on piedmont areas near the base of the local mountains, such as the Tortolita Fan, that are characterized by multiple, highly unstable flow paths that can rapidly change during flooding events. Local area flooding is often the result of poorly designed or planned development wherein natural flow paths are altered, blocked or obliterated, and localized ponding and conveyance problems result. Erosion is also often associated with damages due to flooding.

Another major flood hazard comes as a secondary impact of wildfires in the form of dramatically increased runoff from ordinary rainfall events that occur on newly burned watersheds. Denuding of the vegetative canopy and forest floor vegetation, and development of hydrophobic soils are the primary factors that contribute to the increased runoff. Canopy and floor level brushes and grasses intercept and store a significant volume of rainfall during a storm event. They also add to the overall watershed roughness that generally attenuates the ultimate peak discharges. Wildfire damages soil making them water repellant. These hydrophobic soils, in combination with a denuded watershed, will significantly increase the runoff potential, turning a routine annual rainfall event into a raging flood with drastically increased potential for soil erosion and mud and debris flows. The need to study the impacts of catastrophic wildfires was a priority of the Planning Committee.

4.4.1 Flash Floods

Flash floods are generally associated with summer monsoon thunderstorms. Several factors make flash floods a challenging hazard to mitigate.

1) Real-time precipitation gages may miss storm cells that are small in aerial extent or may not capture the most intense portion of a storm cell. As a result, a storm that is large enough to cause flash flooding may escape detection by the rainfall monitoring network.
2) Extreme rainfall intensities can generate runoff that reaches peak flow in periods measured in minutes, providing little or no ability to provide the public with a warning about any specific event.
3) Flash floods often occur on watercourses that do not have stream gages. Placing stream gages on all watercourses is cost prohibitive and technically infeasible.
4) The leading edge of the flood may extend miles below the storm event that created it, flooding an area that may have received no rainfall and may not have even been cloudy, thus catching individuals completely unaware of the threat.

Due to the unpredictability of flash flooding flood threat recognition and streamflow, early warning has been limited to general, area-wide watches and warnings. These warnings require individuals to make wise choices by staying away from washes and avoiding flooded roadway crossings. Recently, the District established warnings based on predicted inundation areas and the Planning Committee recommended expansion of this service.

Motorists underestimate the force of water and require rescue

4.4.2 Sheet Flooding and Alluvial Fans

Sheet flow flooding is a phenomenon unique to watersheds with low topographic relief and a severe lack of adequate channel flow conveyance. The lack of defined drainage channels often deceives the public into thinking that there are no flood hazards in the area. Sheet flow flooding may develop quickly, but the duration of sheet flow flooding may extend more than 24 hours where slopes are particularly shallow or watersheds are large. Roadways, walls and other minor improvements may distribute or concentrate flow, creating unpredictable flood conditions. Private roadways not designed for all-weather access are common in these areas of the County. As a result and in combination with the widespread nature of sheet flow flooding, the ability of residents and emergency services to gain safe or reliable access to and from the affected area is often limited during times of flooding. The Planning Committee recognized this as one of the greatest needs for expansion of the warning system and response pre-planning.

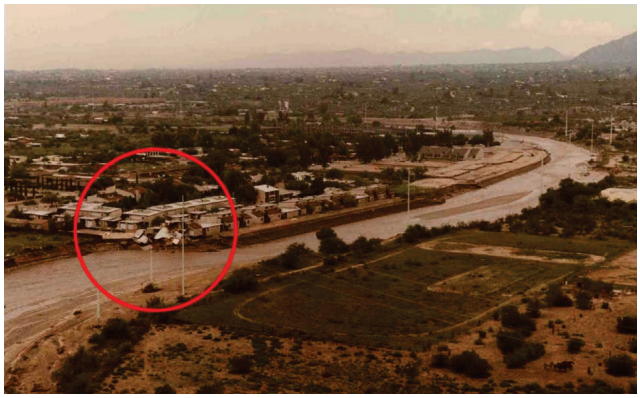
While elevated on a stem wall, sheet flooding has isolated this home and damaged vehicles.

Alluvial fans create a special type of floodplain that has characteristics that are similar to sheet flow floodplains. Alluvial fans occur below mountain fronts and consist of an accumulation of sediment carried out of the mountains via riverine flow. At the margin of the mountain front, flow containment is lost and floodwaters spread out across the alluvial fan. Alluvial fans may have better defined channels or flow corridors than other sheet flow floodplains, but they are not large enough to convey large storm events and, due to their location below the break in slope, channels often aggrade and lose capacity. Since alluvial fans often consist of poorly consolidated alluvium, the loss of channel capacity in existing channels leads to the creation of new channels or the reestablishment of old channels. This characteristic of alluvial fans leads to significant uncertainty with respect to the location and severity of flood flows even in less frequent events. Unconsolidated soil conditions also put structural improvements at increased risk of erosion related damage. The combination of severe, directed flow at uncertain locations, unconsolidated soils and the likelihood of flash floods in this environment results in potentially extreme and unpredictable flood and erosion hazards. This is another of the unique local hazards the Planning Committee prioritized for additional mapping activity.

4.5 Erosion Hazards

The vegetation characteristics of the County's arid environment, combined with anthropomorphic alterations to the landscape, create conditions that promote the lateral migration of watercourses. Erosion along major watercourses resulted in some of the most dramatic flood damage in recent history. For this reason, the County does not allow new construction within erosion hazard areas unless structural protections are in place. Furthermore, the District's Capitol Improvements Plan (CIP) has historically focused on providing erosion protection and open space along major watercourses where the threat of lateral migration is most severe. This can help mitigate the impacts for future

conditions including increasingly intense rainfall events, land use and changes associated with erosion, aggradation and degradation.



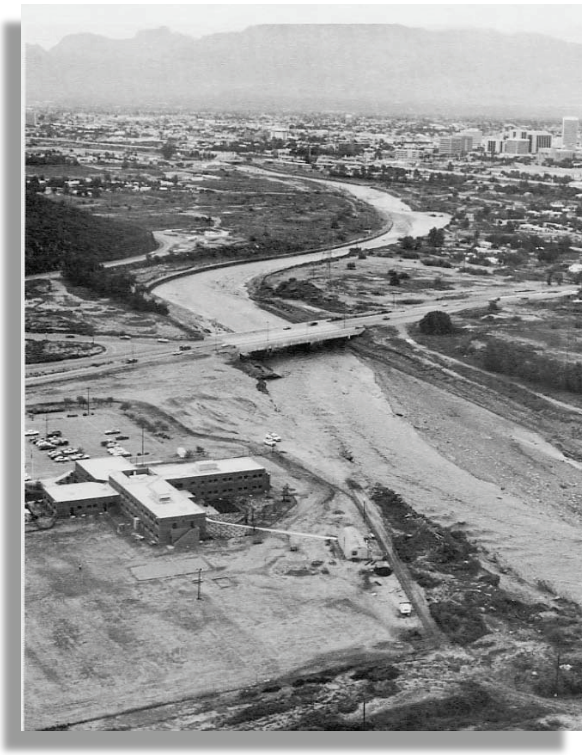
Bridge and homes lost to erosion in 1983.

Bank collapse and channel migration continues to threaten homes in floodplains along desert washes with natural banks.

It is widely recognized by experts and the public that maintaining floodplains in their natural condition, including healthy riparian habitat, can be a cost effective way to reduce flood risk when compared to engineered structural controls intended to remove land from the floodplain in order facilitate development. FEMA has recognized this by greatly increasing the weighted value of natural floodplain protection within the NFIP CRS described in Step 4. However, it can be difficult to maintain natural functions on small sites with few options. Community partner organizations such as the Watershed Management Group assist landowners and neighborhoods fill this gap in what government can accomplish. The Planning Committee prioritized mapping of these hazard areas and habitat.

4.6 Historic and Future Flood Hazards

Historically, flood events of limited aerial extent occur at least every few years in Pima County. These floods may not affect many people, but the effects of these floods within the impacted area may be severe. Floods on the major watercourses occur approximately once every 10 years. Historically, these floods had a significant impact on the community; however, flood and erosion hazard improvements within the urban core have been successful at reducing the hazards to the public from large flood events on the major watercourses and many minor watercourses. Mitigation includes installation of bank protection to prevent lateral migration and damage to bridges and adjacent development. In addition, improved regulation of development, including elevating structures above the base flood, establishing foundation requirements, protecting structures from erosion hazards and protecting natural floodplains has ensured that new development is more flood resilient than was previously the case.



Channelization has facilitated development along the major river corridors in urban areas.

There remains significant flood risk in Pima County. Developed areas away from the urban core often lack drainage infrastructure or land use patterns that avoid flood hazard areas. These areas will continue to have access issues due to the presence of dip sections and the large number of non-publicly maintained roads. The urban-wildland interface will continue to be at risk to extreme storm events and the effects of future wildfires. Events of greater magnitude than the base flood due to climate change may increase flood related hazards throughout the County. Years after catastrophic fires, sediment continues to move through the drainage system. Large events associated with climate change would likely overwhelm existing infrastructure designed for the base flood.

Rillito River 2019 Winter Storm Flows

In addition to the immediate risk to life and property from flooding, the after effects can include disease and mold. Black mold is of particular concern within the desert environment as are viruses and bacteria transmitted by animal feces that have been associated with Valley Fever. Mosquitoes and other vectors breeding in pooled water is a common community complaint. Even shallow floods such as those in sheet flood areas can damage ground-mounted heating and cooling units, vehicles, and foundations outside the home. If water enters the home, the lower four feet of sheetrock and electrical may require replacement after sources of mold are dry. While the District has a program to acquire flood damaged property, not all affected are willing nor are unlimited funds available. In these cases, the District provides valuable technical, but not direct financial assistance. Property tax funding also enables an extensive and ongoing Capital Improvements Program described in detail in Step 7, Activity review. The Planning Committee recommended outreach to promote acquisition and assistance activities.

Flooding is clearly a major hazard in Pima County. The County has been part of 13 disaster declarations for flooding, with none of those declarations occurring in the past five years. There have been numerous other non-declared events of reported flooding incidents. The following incidents represent examples of major flooding that has affected the County:

- During August and September of 1983, nearly seven inches of rain fell, saturating the soil around the Tucson metropolitan area. These conditions were exacerbated when a surge of moisture from Tropical Storm Octave, which was located off the central Baja California coast, moved northeast across the area. The result over a four-day period were torrential rains ranging from five to nine inches, causing flooding in Tucson and southeast Arizona. Flooding damaged all but one of the Santa Cruz River bridges. Additional damage occurred along the other watercourses throughout the area. Several buildings fell into Rillito Creek due to bank erosion and extensive damage occurred to agriculture in the Town of Marana. Cost estimates (using 1984 dollars) to repair and mitigate flood damage were $105.7 million. Four flood related deaths occurred in Eastern Pima County.
- In late December 1992 and early January 1993, a series of winter storms produced record-breaking precipitation amounts and severe weather across much of Arizona. Heavy rains combined with melting snowpack caused heavy flooding of both local washes and regional rivers within the County. The storms affected nearly every community and city within the County at some level. Most of the heavy damage was associated with the Gila, San Pedro, and Santa Cruz rivers. According to the United States Army Corps of Engineers Flood Damages Report, the total public and private damages from the 1993 floods exceeded $12 million in the County alone. The flooding prompted a federal disaster declaration (FEMA-977-DR-AZ) for almost the entire state.
- On August 14, 2005 and August 23, 2005, intense heavy rains caused significant damage to public infrastructure throughout the County. The severe runoff resulted in damages to numerous roads, traffic lights, water well fields, and berms, crossings, and police vehicles. After over an inch of rain fell across a large portion of the Tucson metro area, some locations with more than two inches, several roads became flooded, closed, and impassable. In addition to all the flooded roadways, rising water surrounded several trailer homes located in the southern portion of the Tucson metro area. Rescue teams evacuated several people from these homes. The water within the Brawley Wash overtopped its banks flooding roadways causing them to be impassable. Over $260,000 in damages occurred.
- In late July and early August 2006, several areas of the state were struck by severe storms and flooding from July 25 to August 4, 2006. Tropical moisture poured into Southeast Arizona, saturating the ground at most locations. As rainfall continued, additional runoff quickly filled rivers and washes, exceeding bank-full capacities and flooding homes and businesses as well as nearby roads. Some roadways washed away due to the strong floodwaters. Lots of flash flooding occurred throughout the Tucson metro area due to saturated grounds and extremely heavy rainfall. Numerous roads closed due to flooding throughout the entire metro area for many hours. Floodwaters destroyed a United States Geologic Survey (USGS) stream gage in Rincon Creek. Additionally, there were numerous swift water rescues and car stranded in flooded roadways. Nearly 100 vehicles were flooded. Several rivers running through the Tucson metro area flooded on July 31, 2006. The Rillito River flooded with water over the cement banks near Dodge Boulevard. Additionally, the Rillito River was over bank-full just east of the Swan Road Bridge. River Road near La Cholla Road was flooding from the Rillito River. Sabino Creek over bankfull and houses were flooded near Sabino and Bear canyons. Below is a listing of some of the damage, but not all, caused by the flooding and an estimate for the cost of repairs:

    - Sabino Canyon recreation area road and facility damaged, $100,000;
    - Forty homes and businesses flooded, $1,200,000;
    - One home destroyed due to flooding, $150,000;
    - Water main broke near the Mt. Lemmon highway, $20,000;
    - Catalina Highway road washed away, $50,000;
    - Agricultural irrigation system damaged, $500,000;
    - Cement plant flooded, $400,000;
    - Gravel pit flooded, $30,000; and
    - General infrastructure damage, $500,000.
- The flooding prompted a federal disaster declaration (FEMA-1660-DR-AZ) for Gila, Graham, Greenlee, Pima, and Pinal counties. Total disaster expenditures exceeded $13.6 million (ADEM, 2010; PCRFCD, 2011).
- On February 19, 2008, Pima County declared a state of emergency for flooding and damages due to 8.5 inches of precipitation that fell in and around Mt. Lemmon in less than a 24-hour period. Damages to roads left residents stranded in their homes, limited access to food and medical assistance and damaged potable water supply lines, which affected transmission and distribution of potable water to homes. The rainfall and snowmelt created conditions that threatened the health and safety of residents and exceeded the capabilities of the County. First responders rescued several people in Tucson from flowing washes. Damages exceeded $770,000.
- In January 2010, flash flooding trapped 16 hikers on Sabino Canyon Trail at approximately 11 AM on January 21 after the stream rose above its banks, covering low water crossings. The San Simon and Vamori washes in the Tohono O'Odham Nation rose one-to-two feet out of their banks during the evening of January 21. Several other washes flowed out of their banks, resulting in barricaded roadways near Saguaro National Park east and west, including East Tucson and Avra Valley. Flash flooding trapped a motorist was trapped in the Cañada del Oro Wash near Rancho del Lago at approximately 7 AM on January 22 requiring a swift water rescue. Storm-wide damages were $300,000 (NCDC, 2011). The president issued a disaster declaration (FEMA-1888-DR-AZ) for several counties and Indian tribes in the state including the County.
- In July 2010, torrential rainfall across portions of eastern Pima County resulted in numerous reports of flash flooding in the Tucson metro area. Flash flooding on Tanque Verde Creek had a peak depth of 11.69 feet at Tanque Verde Guest Ranch. Approximately 30 homes on Barbary Coast Road, Gold Dust Road, and Kitt Carson were flooded. Numerous swift water rescues were in the Tucson metro area, near the County fairgrounds, in the Rincon Valley area, and on the Old Spanish Trail in the Hilton Head Ranch area. Damages exceeded $500,000.
- Between 2011 and April 2016 there were 39 flash flooding events with two deaths and damage amounting to $2.366 million dollars on September 15, 2011 the 5th highest rainfall total on record occurred at the Tucson International Airport with 2.84 inches, and up to 3.00 inches at nearby locations. Over three feet of water covered the roads near the airport causing the closure of over 30 roads and two flights diverted to Phoenix. There were six swift water rescues and six people rescued from their homes as rivers exceeded their banks. In

Sahuarita, a wash overflowed flooding 15 homes. Santa Cruz River flows swept away a homeless man. Damages of $1 million in Tucson and $500K in Sahuarita.

- On September 8, 2014, moisture associated with Tropical Depression Norbert caused extensive street flooding on the east side of Tucson requiring numerous swift water rescues. One woman drove into the Alamo Wash and drowned when floodwaters swept her vehicle downstream and under a bridge. (NCEI 2016)
- Heavy rain in the Corona de Tucson area of Vail on July 7, 2014 caused widespread flash flooding, closed roads, and caused property damage. According to the District's ALERT system precipitation gauges, the area experienced storms with total rainfall ranging from 1.5 to over two inches, with rainfall intensities of up to two inches in less than an hour reported in portions of the watershed. The high intensity of the storm over a relatively short duration caused the floodwaters to rise and fall quickly, catching many by surprise.
- On July 9, 2014, an intense, localized storm with rainfall intensities of two inches per hour or greater affected Why, Arizona. The event damaged several structures.
- On September 2, 2018, an intense rainfall event with up to seven inches of rain in a short time span within the Sopori Wash watershed resulted in significant flooding within the town of Amado, Arizona. Several structures had three or more feet of water in them. Some of these structures were in Pima County and others were in Santa Cruz County. The District hired Stantec to perform a post-flood analysis to determine the return-period of the flood.

1983 Rillito Flood Damages

In addition to the geographic and historical descriptions of floods provided above any plan must address future conditions. Furthermore, the Planning Committee identified the need to remain flexible to adapt to future conditions. The Action Plan recommended by the Planning Committee includes numerous Countywide and watershed specific activities to address future conditions. These conditions include the land use trends described in Section 5.1.4 and the watershed assessments contained in Appendix B.

Step 5 below describes how these hazards impact residents and commerce in the County as a whole and within each of the 23 watersheds identified.

4.7 Warning and Evacuation Procedures for Life, Safety, and Health

The unique hazards of the basin and range desert geomorphic environment described above coupled with land use patterns described below create hazards for travelers and residents. Response and recovery may include swift water rescues and mold remediation as well as reconstruction or relocation. The high frequency and level of economic stress indicators reduce individual's preparedness for and resilience to these hazards. The Planning Committee identified numerous geographically specific activities to reduce these risks including:

- Emergency access pre-planning;
- Road closure and inundation area warning;
- Identification of assistance funds;
- Promotion of flood insurance including Increased Cost of Compliance and contents coverage to renters; and
- Stress index assistance, warning and acquisition outreach targets.

Step 8 presents the complete recommended Action Plan to address the problems and opportunities summarized at the end of Step 5 and each watershed assessed in Appendix C.

Step 5.0 PROBLEM ASSESSMENT

The primary goal of the District and therefore this plan is to protect the public from flood risk. Step 6, Setting Goals will further define this based upon Committee and community input. This step describes population trends and community infrastructure distribution within the watersheds flowing into and out of unincorporated Pima County, and the relative flood risk exposure within each including economy, life, health and safety.

With 9,184 square miles and almost 8,000 feet of vertical relief, Pima County drainages, landscape and uses of land vary greatly. The first sections of this step apply to the regional landscape scale features associated with all the watersheds affecting the County, including the natural and built environment. Appendix C presents individual watershed hazard and problem assessments to reduce the size of the main body document. These are also available individually on the project webpage along with large format hazard assessment and Action Plan maps.

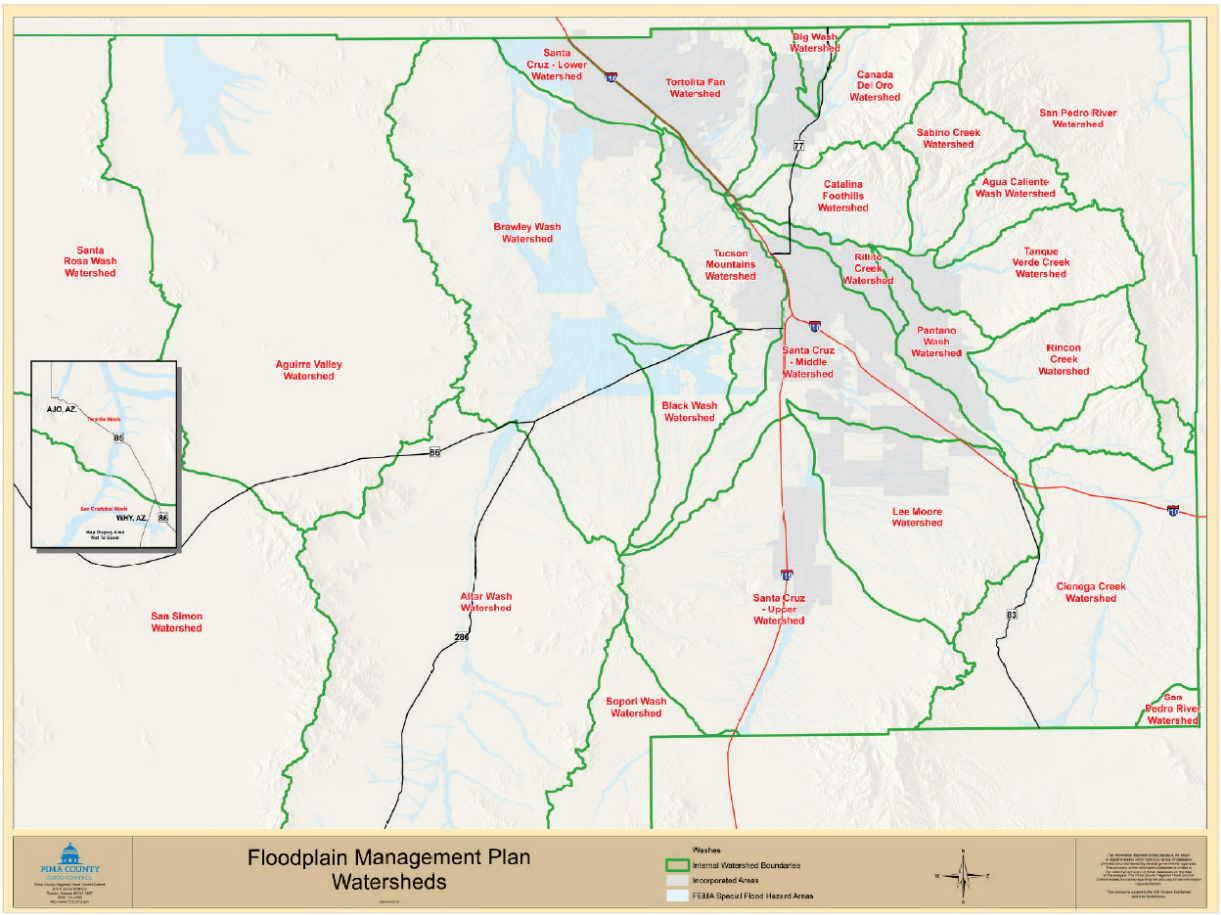


Figure 4 - Watershed Key Map

5.1 Developed Areas

Population and residential development have steadily grown in Pima County throughout the past decade. The 2013 American Community Survey (ACS) population estimated 996,554 residents, of which over 350,000 reside in unincorporated areas. Pima Association of Governments (PAG) projects the County's population to increase to 1.45 million by 2041.

This population growth led to both rural and suburban development within the region. Much of this development occurred in the urban fringe areas, creating an expanded urban area. Recent development trends have also focused on infill within the urban area primarily along major river corridors.

Most growth has occurred in eastern Pima County, with the exception of the extreme eastern area. The latter includes the San Pedro and Cienega Creek watersheds. The former is the longest free flowing river in Arizona coming all the way from Mexico and passing several counties up and downstream of the County. The latter contributes greatly to the Tucson aquifer, and mining on public land threatens the upper watershed in the exact area identified by geographers as a weather generator. Lack of local government control on federal land contributes to the complexity of mitigating the impacts of flooding in the County.

The insurance coverage analysis table below excerpted from the approved PPI gives a good indication of the value and impact of flooding on the economy and tax base. This does not include the economic and potentially life threatening effects of transportation delays.

Table 1 - Flood Risk Exposure and Insurance Coverage for All Properties containing Structures with or without Flood Insurance Policies

Flood Zone Type	Assessor's Full Cash Value	Exposed Value*	Coverage in Force	Exposed Value Covered
FEMA SFHA Zone A - AO1	$ 1,867,156,782	$ 242,730,382	$ 220,615,900	91%
FEMA Shaded X	$ 699,906,063	$ 90,987,788	$ 50,268,300	55%
Local Special Studies	$ 2,252,201,813	$ 292,786,236	$ 102,957,200	35%
Not in Mapped Floodplain**	$ 3,479,539,495	$ 452,340,134	$ 116,081,100	26%
Total	$ 8,298,804,153	$ 1,078,844,540	$ 456,654,000	42%

* Exposed Value is Assessor's Full Cash value times .65 to estimate building value, times .2 to estimate potential damage costs.

** While these properties are outside mapped risk areas, the ratio is applied to reflect what may occur should those properties be flooded.

5.1.1 Land Ownership

Native American communities control nearly half of the land in the County although the watersheds are largely separate. The Pascua Yaqui reservation is 1.87 square miles and is located southwest of the City of Tucson. Most of the 4,453 square mile Tohono O'odham Nation lies within Pima County. Figure 2 shows land ownership as a percentage of all land in the County per the Assessor's database.

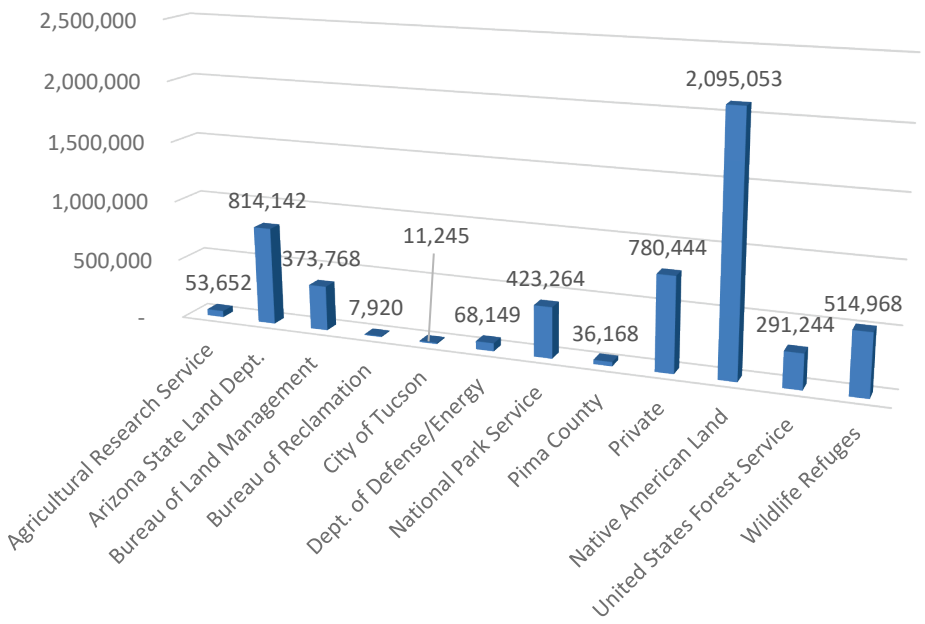


Figure 5 – Unincorporated Pima County Land Ownership

Another 29 percent of the County is federal land. The largest areas of federally managed land are the Buenos Aires and Cabeza Prieta National Wildlife Refuges, Coronado National Forest, Saguaro National Park and Organ Pipe National Monument. Both the Cabeza Prieta Refuge and Organ Pipe National Monument are located west of the Tohono O'odham Nation and surround the small rural communities of Why and Ajo. Coronado National Forest and Saguaro National Park is in the eastern portion of the County adjacent to and upstream of the urbanized area.

The state of Arizona controls another sizeable portion of the County through the Department of Game and Fish, state parks, and state trust. The Arizona State Land Department issues leases for a variety of uses including grazing, mining and beekeeping. Permits are also available for camping, hunting and off-road vehicles. The State Land Department periodically sells to private owners for development as part of its mission to provide public school funding.

The District owns over 10,000 acres, which the District purchased through the voluntary Floodprone Land Acquisition Program (FLAP) or donated by conservation-minded owners. The Planning Committee identified an opportunity to target FLAP outreach to certain locals and this is reflected in the Action Plan.

The bulk of privately owned land is concentrated within the low-lying urban areas, as well as in the urban fringe areas. The map below shows the general pattern of land ownership in Pima County.

Figure 6 - SDCP Preserves and Riparian Areas

5.1.2 Population Characteristics and Community Health

Prior to the recession that began in late 2007, Arizona was experiencing rapid population growth. Between 1990 and 2010, the Arizona population increased by 74%. Although the current rate of increase is not nearly as drastic, the State's population is still increasing annually by approximately 3.67%. Pima County's rate of increase is lower than the state's, but the County's population is increasing steadily. Between 1990 and 2010, the County saw a population increase of 47%. Between 2010 and 2013, the rate of increase dropped to 1.66%.

The Arizona Department of Administration's Office of Employment & Population Statistics (ADOA-EPS) projects the state's population will be just below 7.5 million by the year 2020. The ADOA-EPS also indicates the County's total population will increase to 1.1 million by the same year. Areas within the County will increase at different rates. Certain suburbs of Tucson, such as Marana and Sahuarita are experiencing the fastest growth rates. In these two areas, growth rates of over 3% by the year 2020 are projected. In contrast, projections show a negative growth rate over the same period for the City of South Tucson. Projections indicate a 1% growth rate in unincorporated areas of Pima County.

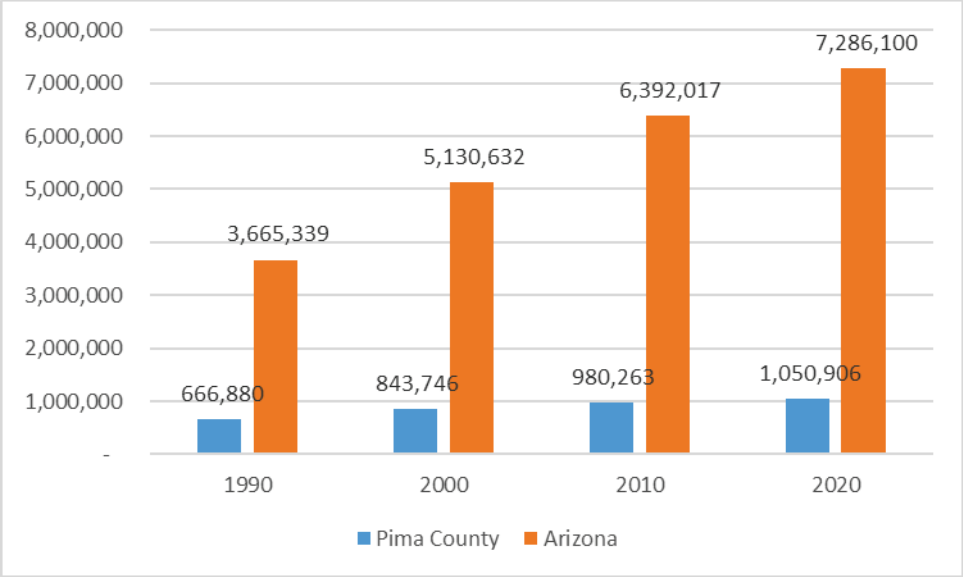


Figure 7 - Pima County and Arizona Population

Population growth often leads to an expansion of urban areas. This leads to a demand for additional flood mitigation projects. Although projected growth rates are subject to economic conditions for planning purposes, past and current population trends are considered.

The Planning Committee and support staff felt strongly that social and economically stressed populations be identified as new outreach target areas. These factors include identifying areas with high populations of renters, Spanish speakers, commuters and residents with limited mobility. The Planning Committee recommended that the stress indicators guide outreach regarding assistance and warning as these populations are less able to prepare, respond and recover without aid.

According to www.census.gov, the population of Pima County in July 2016 was 1,016,206. The American Community Survey (ACS) provides further information regarding County residents (2015 data):

- The median income is $46,162. The national median income is $55,775.
- The median value of owner-occupied units is $159,900. This is $18,700 less than the national median.
- Median gross rent is $816. This is $112 less than the national median rental rate.
- Renters make up 38.8% of the 389,658 occupied housing units.
- Those under the age of 65 with a disability make up 29.1% of the population. This is 4.3% higher than the national rate.
- Residents who are 65 or older make up 17.1% of the population. This is 1.9% higher than the national rate.
- 23.7% of residents are Spanish speakers. Of those, almost 6.8% (63,489 residents) speak English "less than very well."

Planning Committee members also identified and targeted major employers to receive commuter safety and new employee outreach materials related to arid region flood hazards. Major employers including Raytheon participated in developing materials that are available to all employers. Major employers have incorporated these into orientation packages provided to new employees who may also be new to the region.

New and existing outreach projects will ensure these target areas and audiences are receiving outreach that is appropriate for their needs.

5.1.3 Population Distribution

The following is a summary of the information presented in the Flood Insurance Coverage Assessment (FICA) and Repetitive Loss Area Analyses conducted as part of the PPI.

As of July 2016, within unincorporated Pima County, there were 210,827 acres of FEMA "high risk" Special Flood Hazard Area (SFHA), where the CRS Class 5 community flood insurance premium discount of 25% is available. "Moderate risk" areas include 21,558 acres of Shaded Zone X that receive a 10% discount. The lowest available premiums apply in the remaining 5,624,023 acres of "low risk" areas that FEMA has not identified as being in a regulatory floodplain.

Due to the size and flood characteristics of Pima County, FEMA has not mapped many flood-prone areas. The District has undertaken a widespread and ongoing effort to identify additional areas exposed to flood risk. These locally mapped flood-prone areas referred to as Special Studies Floodplains total 52,741 acres. Since the completion of the FICA, the District mapped an additional 77,365 acres of floodplains using detailed modeling. These figures exclude 204,410 acres of approximate sheet flood mapped by the District and erosion hazard areas.

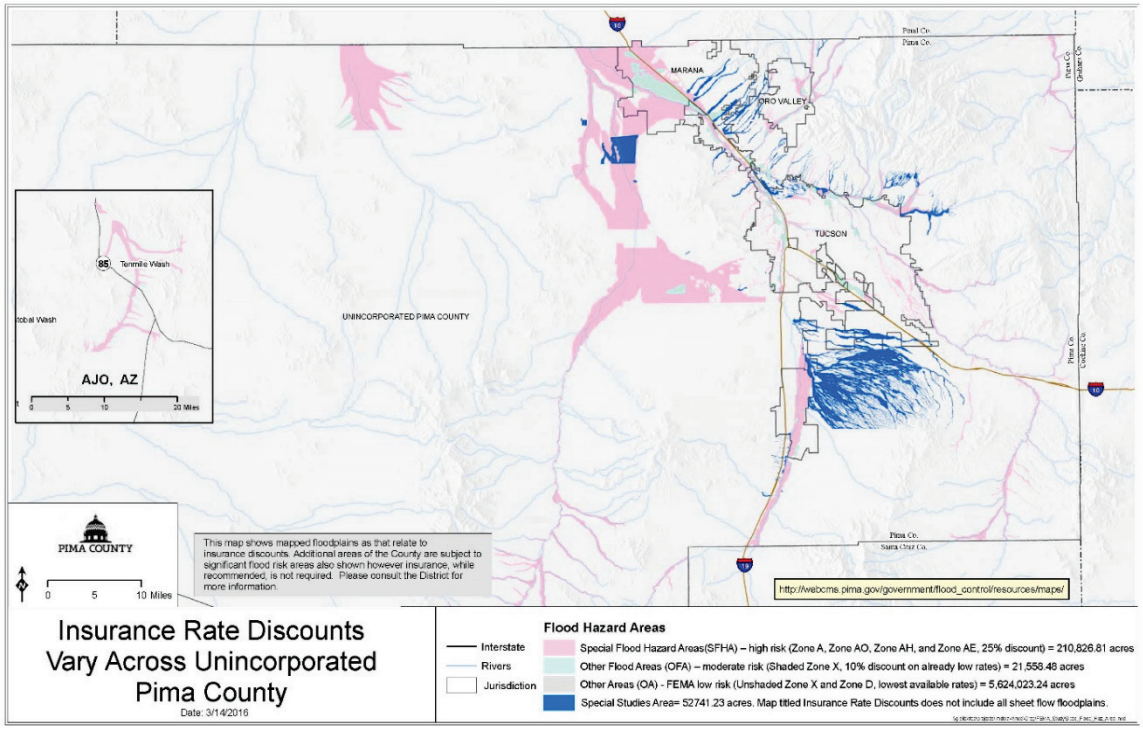


Figure 8 - Map of FEMA and Special Studies Floodplains with Insurance Rate Discounts

Table 1 shows the distribution of parcels with structures within federal and local floodplain areas as well as outside of mapped floodplains.

Table 2 - Hazard Exposure and Insurance Coverage by Flood Zone and Occupancy Type

Flood Zone Type	**Parcels with Structures**	**Parcels with Structures and Insurance**	**Percent of Parcels with Structures Insured**
FEMA SFHA Zone A – AO1	7,292	1,000	13.71%
FEMA Shaded X	3,636	212	5.83%
Local Special Studies	9,820	458	4.66%
Not in Mapped Floodplains	122,450	586	0.48%
Total	143,198	2,256	1.58%
Occupancy Type			
Residential	169,081	2,169	1.28%
Commercial	18,796	87	0.46%
Total	187,877	2,256	1.20%

One finding of the FICA was that there are no contents-only policies within unincorporated Pima County. This appears to indicate that renters are not getting flood insurance although they make up

36% of 388,660 occupied housing units. Most significantly, less than 14% of structures that are within FEMA floodplains are insured. The number of insured structures is far lower elsewhere.

The figures below show current census population distribution across the watersheds and floodplains of unincorporated Pima County.

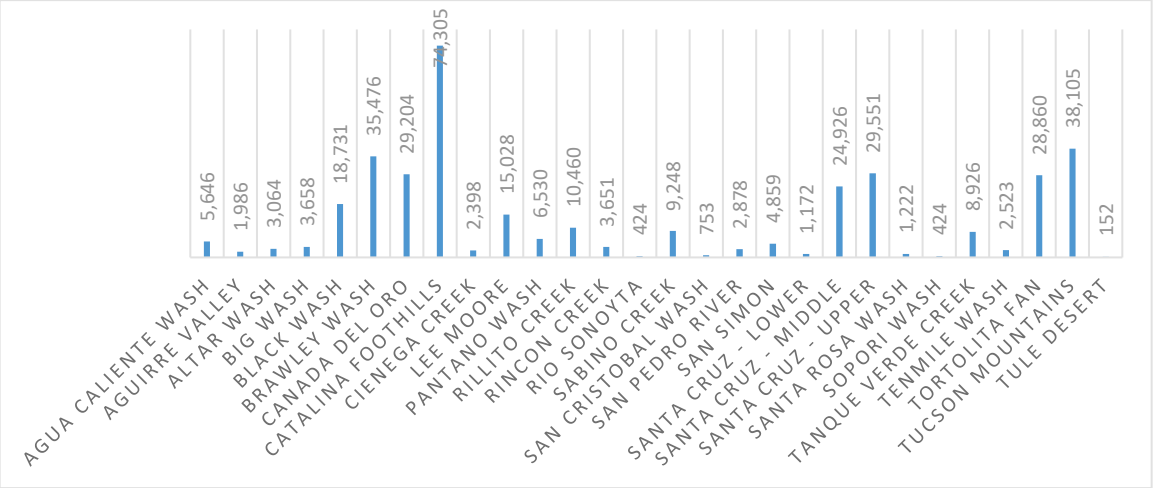


Figure 9 - Unincorporated Pima County Population by Watershed

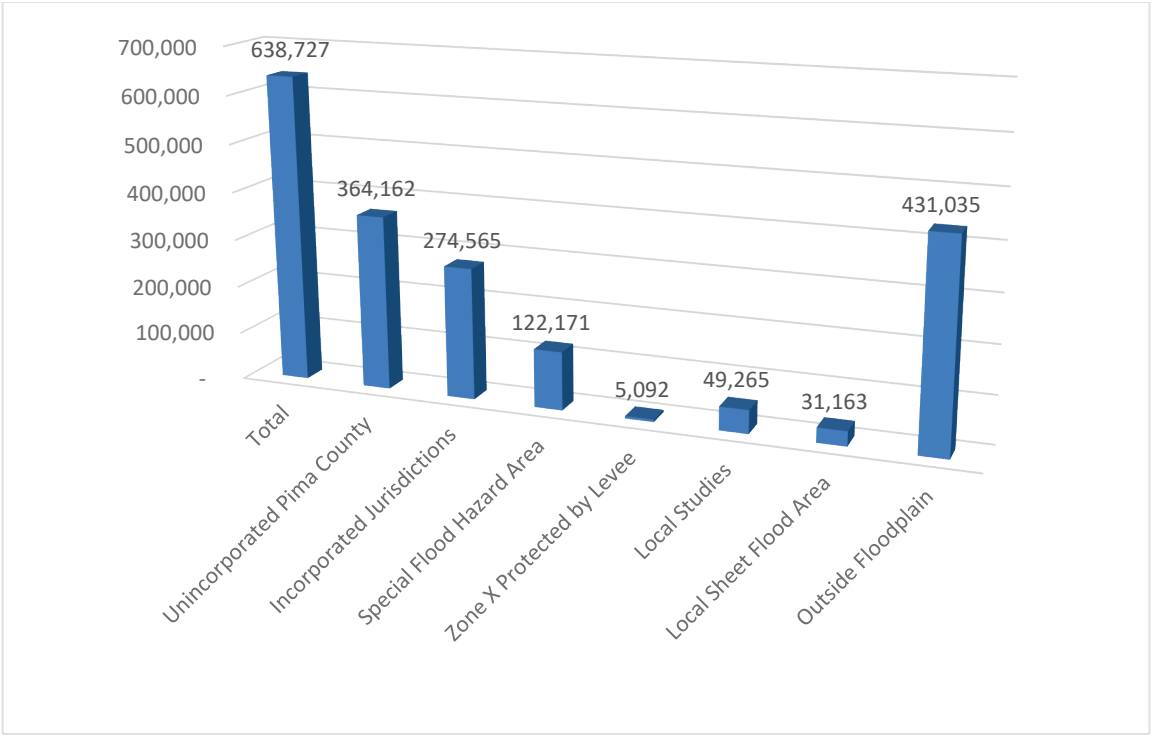


Figure 10 - Floodplain Population

District GIS staff created hazard and exposure heat maps for each watershed used in goal and action plan prioritization exercises conducted with the Planning Committee. They are also included in Appendix C and the project webpage along with fact sheets summarizing hazard and problem assessments.

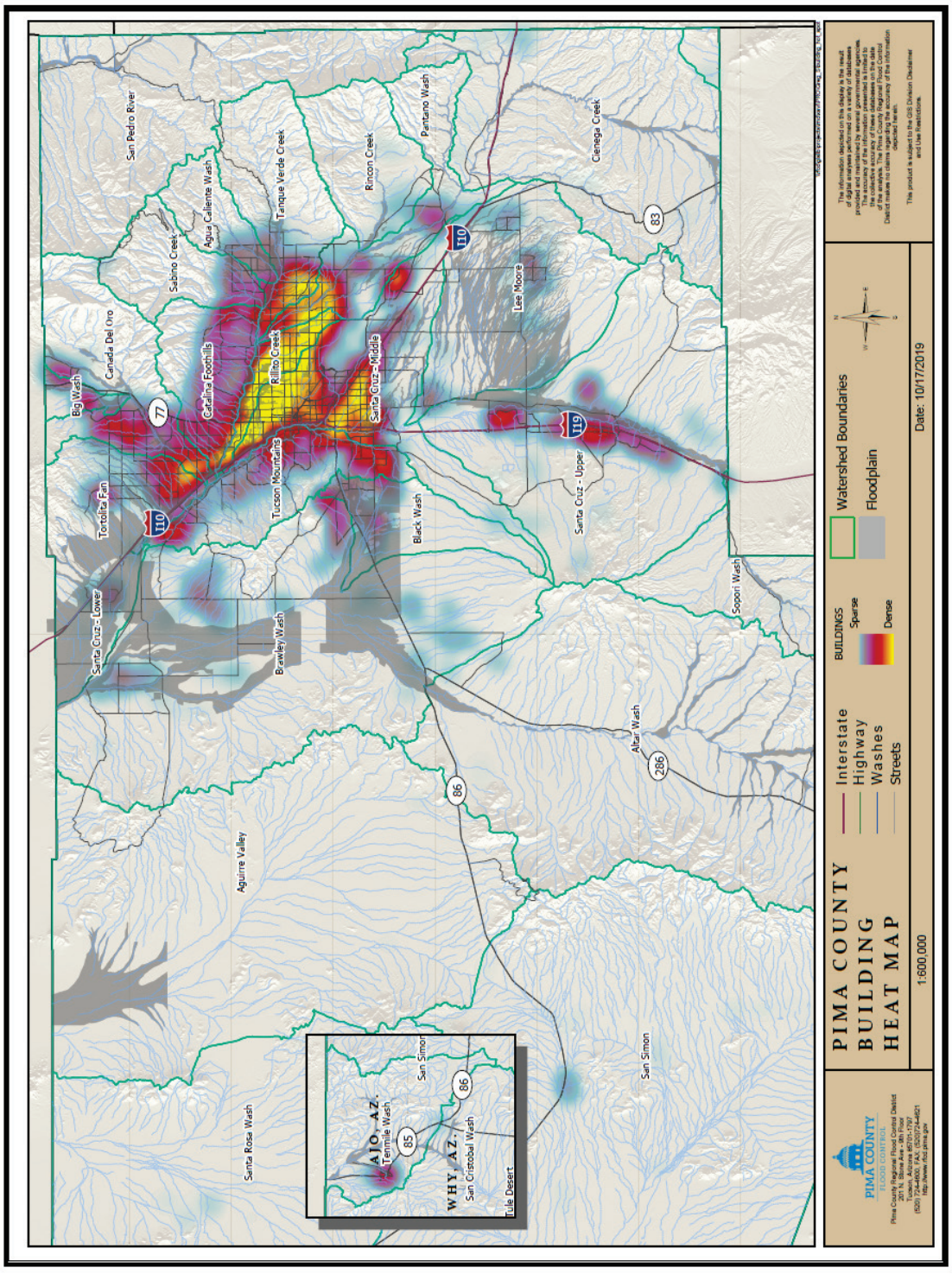


Figure 11 - Building Density Heat Map

5.1.4 Land Use and Economy

In 1907, the Southern Pacific Railroad built the Tucson railway station. It enabled Tucson to become Arizona's largest commercial and railroad center. Today, Tucson is the home of the University of Arizona and Davis-Monthan Air Force Base. The local commercial economy is driven by the military and research conducted by and in partnerships with these institutions, in addition to distribution activities associated with the international border and transportation hub. High rates of residential growth is also due to the attractiveness of the Sonoran Desert lands of the Tohono O'odham and other tribes whom have farmed this area for 10,000 years.

Historically, there were significant areas of agricultural lands in Pima County, often clustered around major transportation corridors such as I-10, I-19, and River Road, which also largely coincide with major watercourses. Much agricultural land remains, though residential developments are replacing these areas. Two notable examples of this are the Continental Ranch and Gladden Farms residential communities, located on former agricultural lands within the Town of Marana, as well as Avra Valley. The figure below shows the acreage of different land uses within unincorporated Pima County.

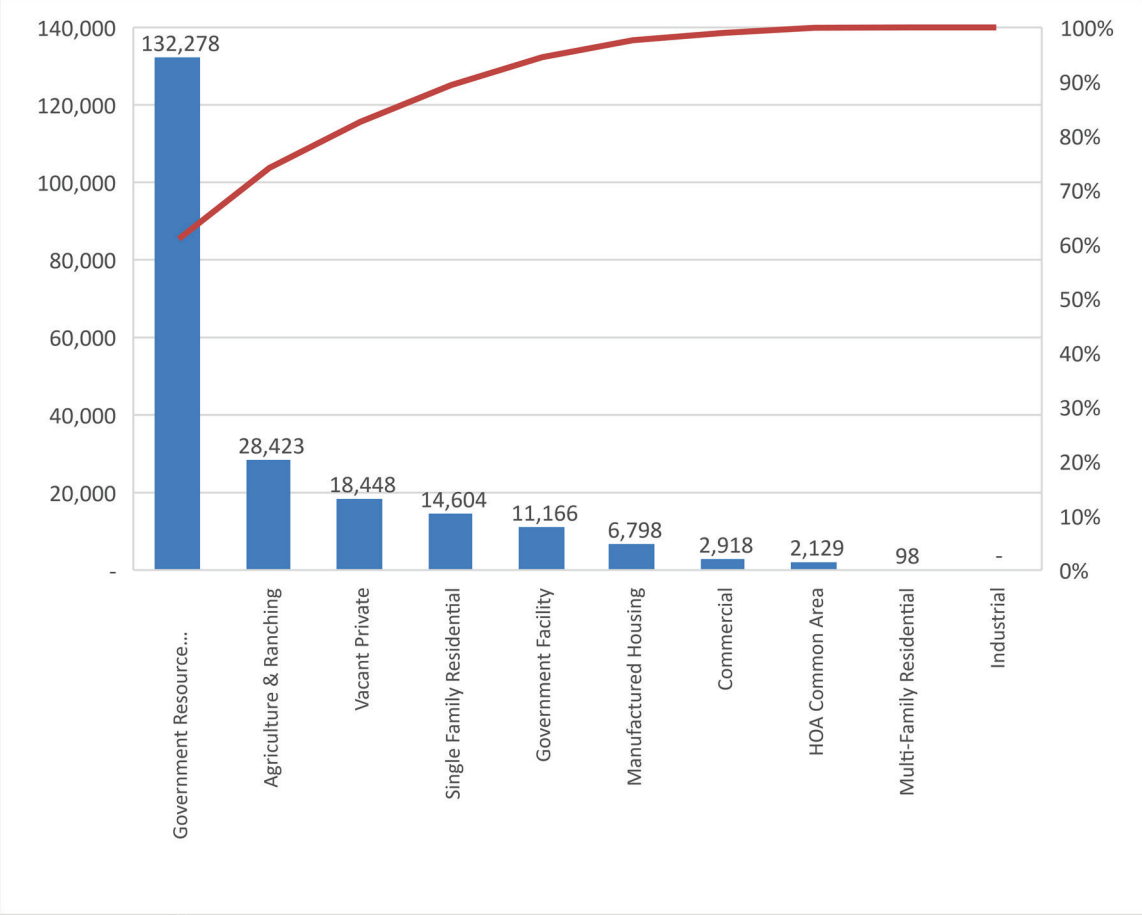


Figure 12 - Unincorporated Pima County Land Use in Acres (source Assessor's Land Use Code)

As shown above, today and into the foreseeable future management by public owners is as significant to hydrologic conditions as private land uses. The Action Plan addresses this with reference numbers 1.1.f, 1.1.g and 1.2.h.

The map below shows a large part of eastern Pima County as an example of the available information and generally indicates the distribution of use within unincorporated areas.

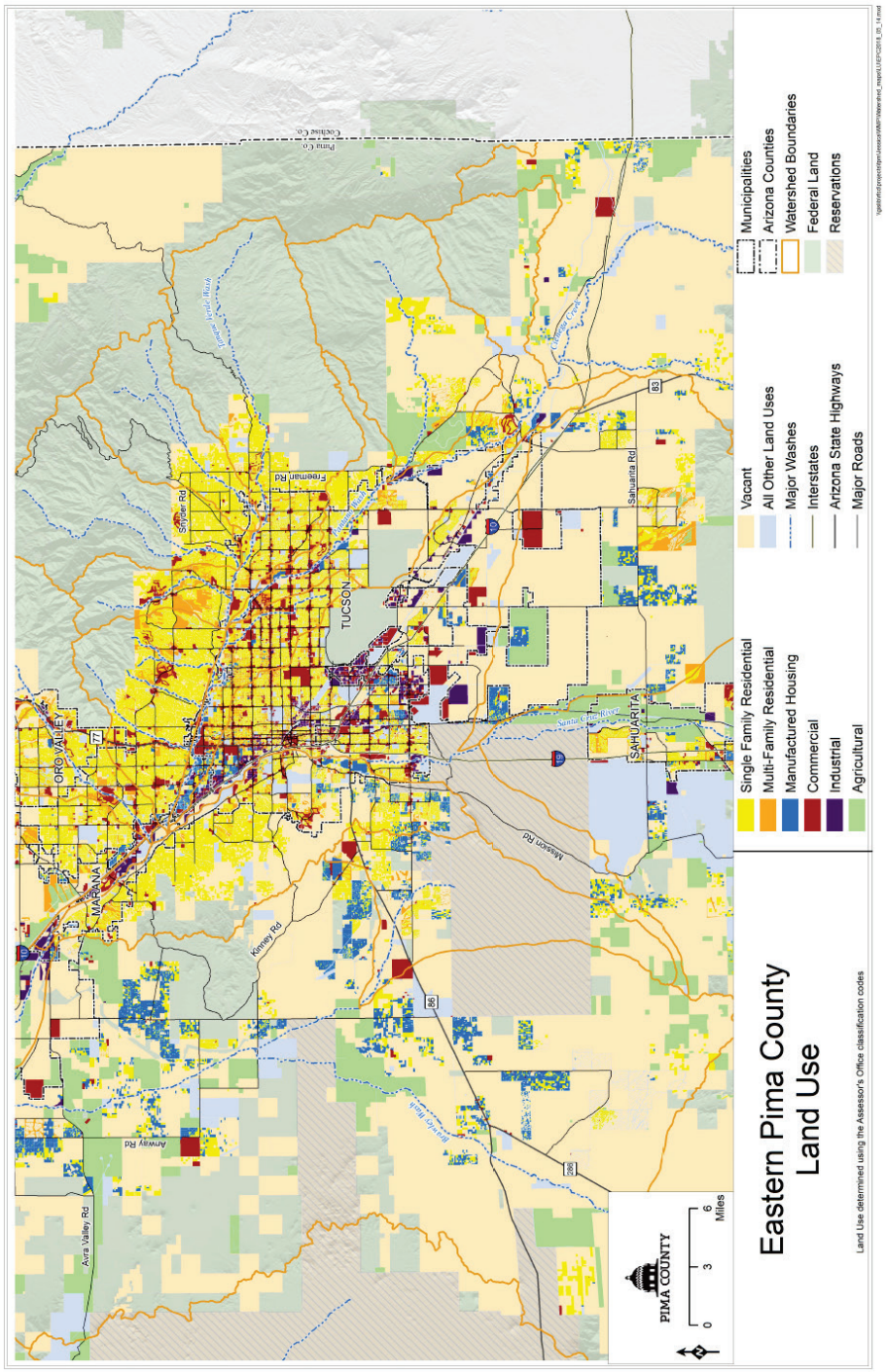


Figure 13 - Eastern Pima County Land Use Map

5.1.5 Trends and Future Conditions

While the urban core and greater Tucson's northwest and foothills areas will continue to see infill and expansion of existing facilities, growth areas identified in the Comprehensive Plan include the southwest, Flowing Wells area, and the Sonoran and Aerospace corridors, all of which are seeing projects revitalized as the economic recovery continues. Planners expect this trend to continue due to the favorable local climate and economic conditions that attract retirees, residents and businesses from other parts of the country and world. The Sonoran Desert Conservation Plan Conservation Lands System and Pima County Code enable the District to continue providing flood and erosion protection in urban areas while preserving natural corridors and upper watershed open spaces. This will ensure that floodplain management reduces risk while also protecting future water supplies and a healthy environment for the community. The District expects to continue this trend.

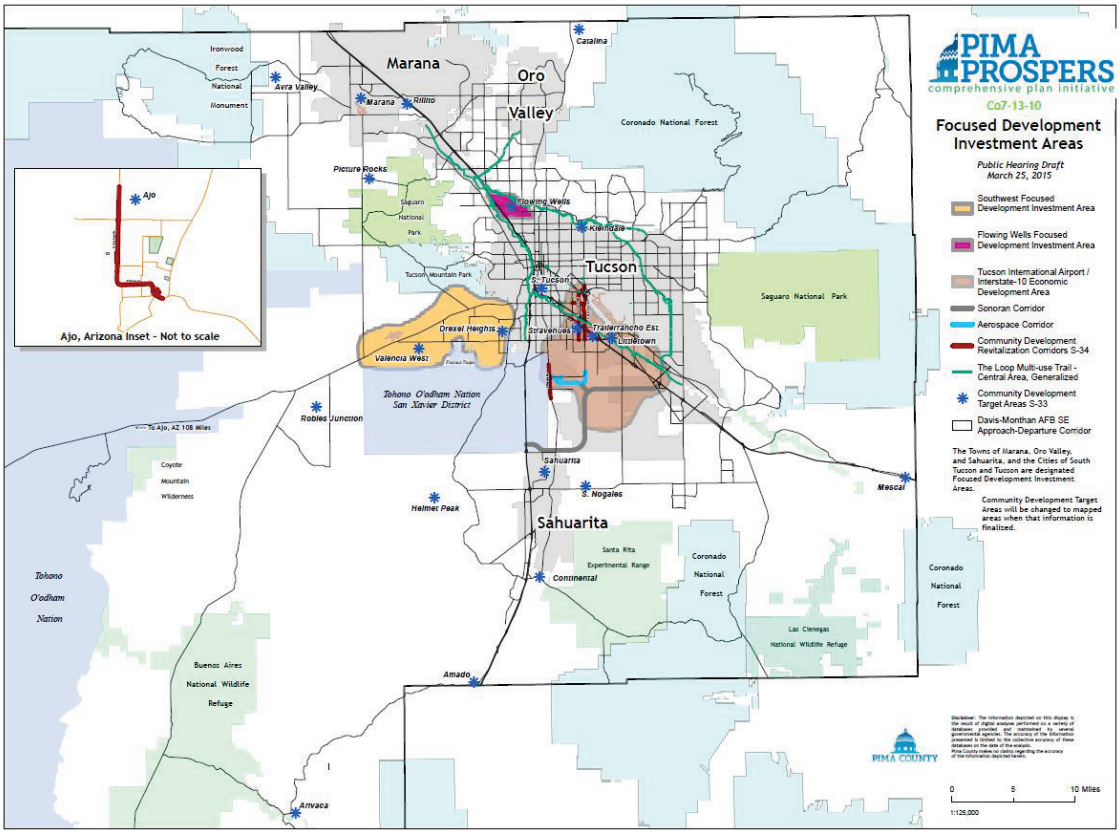


Figure 14 - Pima County Comprehensive Plan Growth Areas Map

August 2016 Storm in Arroyo Chico

5.2 Natural Areas

5.2.1 The Significance of Riparian Habitat in the Desert

The County is widely recognized as home of the Saguaro cactus, an icon of the Sonoran Desert, and Tohono O'odham (Desert People). How did these people live? The floodwater farming practices taught to the Jesuits and other settlers at San Xavier Mission and all over the Papagueria made the arid, but rich Sonoran Desert, arable. While most of their large earthworks are unknown today and many practices, of a temporary nature, the presence of riparian habitat and agricultural communities first enabled settlement by immigrants. In modern terms, what image of the west is more iconic and marketable than the meander of a cottonwood gallery forest through Saguaro and Prickly Pear studded hills? Furthermore, the survival of as much as 60% of wildlife and 70% of threatened and endangered vertebrate species depends on much rarer riparian habitat. In addition to such critical biologic functions, riparian habitat has the additional benefits of mitigating flooding, promoting groundwater recharge and providing a recreational amenity, all of which improve the quality of life for residents and visitors alike, including health and economic benefit.

While the biodiversity created by the unique geography of Pima County including the Sonoran Desert and Sky islands, the County has become a worldwide tourist attraction, second home, and retirement destination the natural environment has been greatly impacted by historic land use and unfortunately, less than 90% of historic riparian habitat exists today. The result is unstable, incised arroyos, increased runoff, greater erosion potential, and improved conditions for invasive, non-native plants to outcompete native vegetation. This diminishes water availability for all species, including humans. While lowland riparian habitat nearly vanished, and verdant historic grassland replaced by scrub desert, recent catastrophic fires, drought, and National Forest land use and management decisions potentially combine to reduce the availability of water while also increasing the potential for property flooding and erosion. Climate changing toward more severe events will exacerbate these trends. The Planning Committee identified protection and enhancement of natural floodplain function as an action item to increase resilience to climate change.

In recognition of the significance of the remaining riparian habitat, the County has identified Regulated Riparian Habitat and Important Riparian Areas as the highest preservation priority. The Sonoran Desert Conservation Plan (SDCP) and Maeveen Behan Conservation Lands System ensure this priority is a part of the entitlement process. The County has also adopted a set of Regulatory Riparian Classification Maps and Riparian Habitat Mitigation Guidelines in the Floodplain Management Ordinance to apply during permitting and entitlement. Most of this habitat coincides with FEMA Special Flood Hazard Areas and other locally mapped floodplains. In the absence of a floodplain study, riparian habitat is a good indicator that flood hazards may exist and provides an opportunity to evaluate potential risks during the development review process. The Planning Committee prioritized expansion of coverage for these maps.

The SDCP map excerpt below shows the distribution of these resources. The maps in Step 5 and Appendix C show the distribution of Pima County Regulated Riparian Habitat in each watershed and, along with regulatory floodplains, make up the Pima Prospers Flood Control Resource Areas shown on Figure 2.

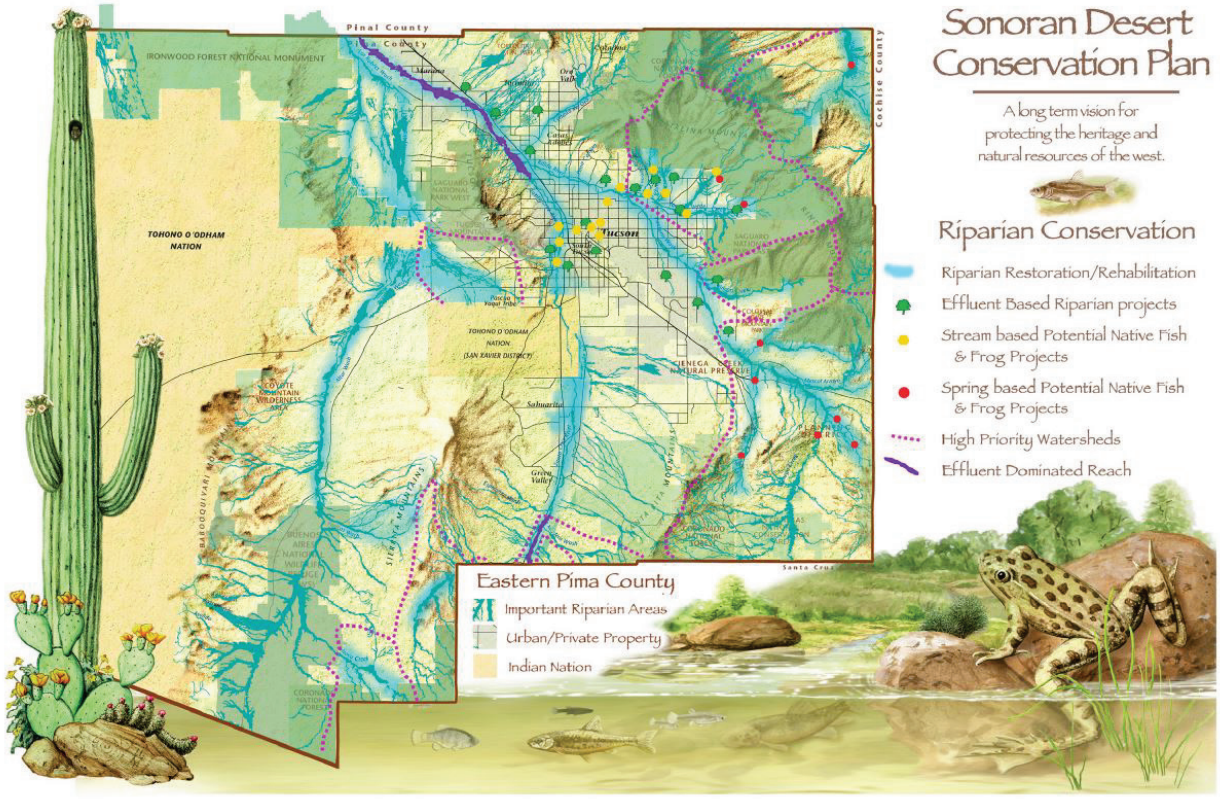


Figure 15 - Sonoran Desert Conservation Plan Riparian Conservation Map

The County updated the Regulated Riparian Habitat maps in 2005 using data from the *SDCP Riparian Vegetation Mapping and Classification* report prepared by Harris Environmental Group (Harris et. al., 2001). The report categorized the Regulated Riparian Habitat classifications into vegetation communities based on the Brown, Lowe, and Pase (BLP) hierarchical classification system (Brown, 1979).

The riparian areas are classified into two primary plant communities, Sonoran Desertscrub biome and Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series (Harris, 2001). The xeroriparian habitat falls into the former, while the mesoriparian habitat falls into the latter. The Sonoran Desertscrub can be further divided into the Arizona Upland Subdivision, which is characterized by a diverse assemblage of cacti, trees and shrubs, and the Lower Colorado River Valley Subdivision, which is primarily characterized by creosotebush (*Larrea tridentata*) and bursage (*Ambrosia deltoidea*). This watershed includes both plant communities.

Sonoran Desertscrub Subdivision (left) and Lower Colorado River Valley Subdivision (right)

Harris further classifies the Sonoran Desertscrub Subdivision as desert riparian shrub or xeroriparian along the washes. This vegetation community contains similar tree and shrub species found in upland sites such as paloverde, velvet mesquite, and ironwood, although certain shrub species, such as canyon ragweed (*Ambrosia ambrosioides*) and cheesebush (*Ambrosia salsola*) are more prevalent.

The Brawley Wash at 3-points (left), unnamed xeroriparian wash (center), xeroriparian understory vegetation (right)

The Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series, is an open to dense drought-deciduous woodland dominated by velvet mesquite (*Prosopis velutina*). Understory vegetation is characterized by shrubs such as wolfberry (*Lycium sp.*), snakeweed (*Gutierrezia sp.*), burroweed (*Iscocoma tenuisecta*), whitethorn acacia (*Vachellia constricta*) and catclaw acacia (*Senegalia greggii*) and native grasses, vines and annuals.

Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series (left), Mesquite Series understory vegetation (right)

A further description of the regulatory use of the Harris maps included in Appendix D.

5.2.2 CRS and the Natural and Beneficial Functions of Floodplains

The CRS that is the foundation of our work recognizes the following natural and beneficial functions of floodplains:

Natural Flood and Erosion Control

- Provide flood storage and conveyance.
- Reduce flood velocities.
- Reduce peak flows.
- Reduce sedimentation and erosion.

Water Quality Maintenance

- Filter nutrients and impurities from runoff.
- Process organic wastes.
- Moderate temperature fluctuations.
- Reduce sediment load in floodwaters.

Groundwater Recharge

- Promote infiltration and aquifer recharge.
- Reduce frequency and duration of typical surface flows.

Biological Productivity

- Rich alluvial soils promote vegetative growth.
- Maintain biodiversity.
- Maintain integrity of ecosystems.

Fish and Wildlife Habitats

- Provide breeding and feeding grounds.
- Create and enhance waterfowl habitat.
- Provide connectivity between plant and animal communities.
- Protect habitats for rare and endangered species.

A natural section of the Rillito River managed by the District.

As noted above, riparian habitat is particularly significant in the Sonoran Desert basin and range geography. In this environment, run-off generated in the steep rocky mountain ranges recharges the aquifer along major valley bottom watercourses where alluvium is deep, while perched aquifers and other shallow water tables provide the groundwater to the canyon gallery oasis that are so important.

Natural floodplains benefit the community by reducing flood and erosion hazards, improving water quality, increasing groundwater recharge and providing biological corridors for plants and wildlife to thrive, all providing a public health, safety, and economic benefit to the citizens of Pima County. To the greatest extent possible, the District prioritizes maintaining the natural functions of floodplains over structural measures to control flooding.

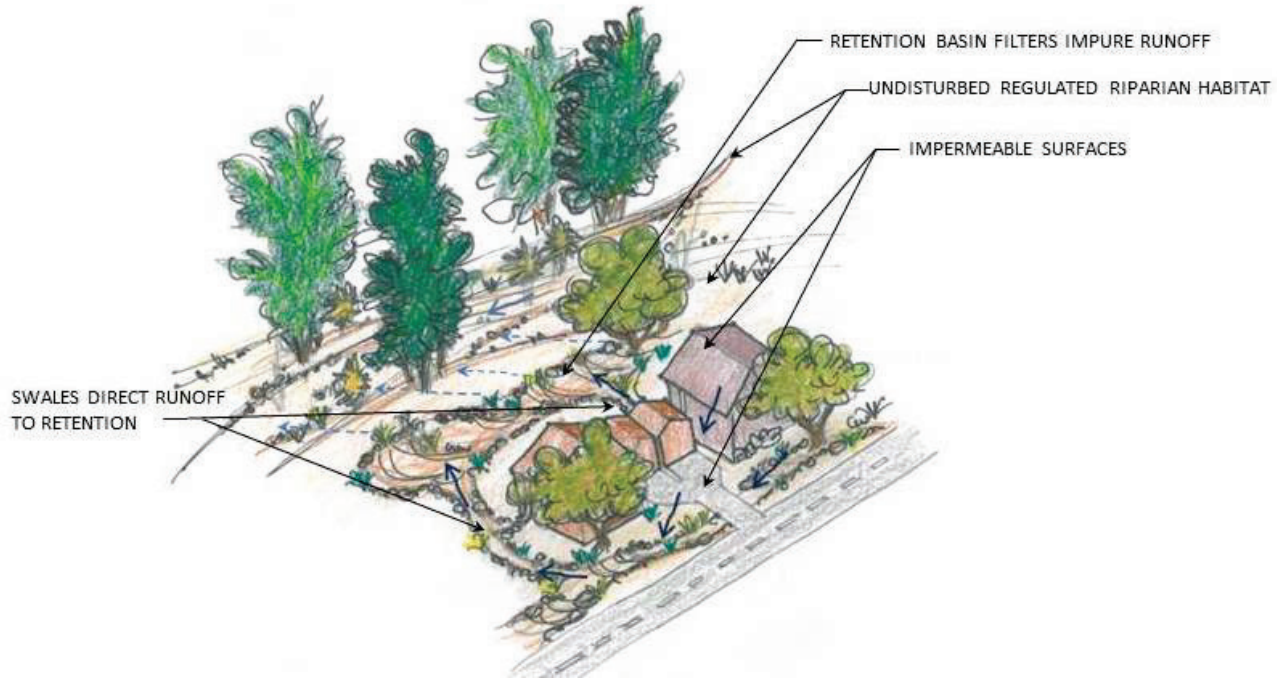


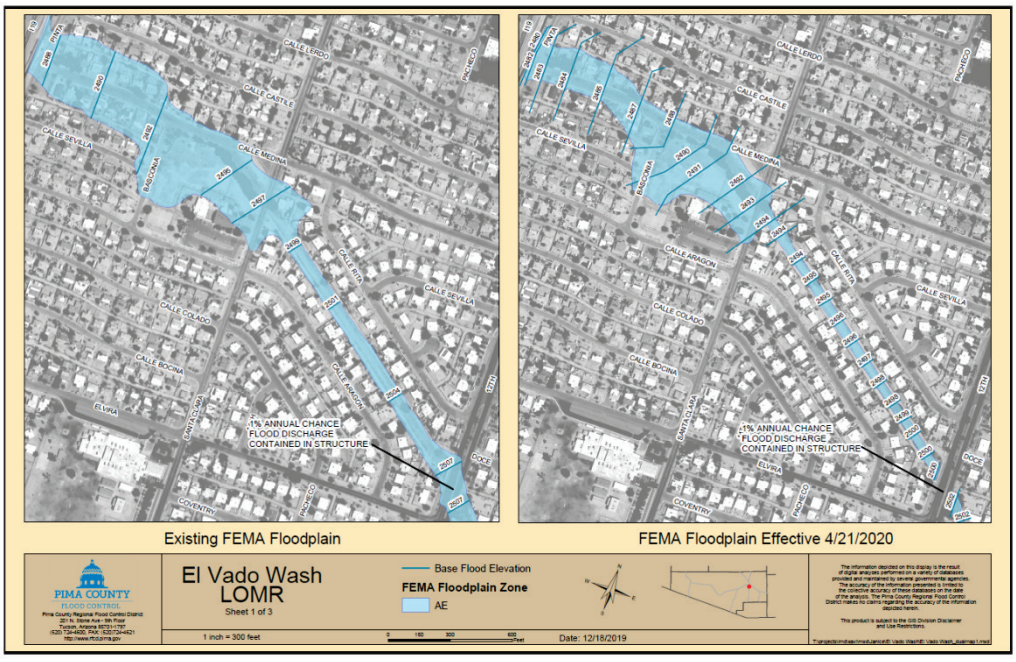
Figure 16 - Conceptual Drawing of Natural Design Practices

The benefits of natural floodplains go beyond conveying flows safely and includes filtering, slowing and attenuating flows, which may contribute to recharge, and supports habitat amenities. Even when floodplains are no longer natural, when feasible, the District promotes restoring and enhancing these functions using Green Infrastructure and Low Impact Development methods. Although they enhance and mimic natural function, they may be heavily engineered or simple landscape design practice.

5.3 Floodplains and Development

In addition to studies updating FEMA designated floodplains, the District has been actively delineating new locally mapped floodplains in a continual effort to improve management of floodplain development to create a more flood resilient community in the face of current conditions and climate change. The hazard assessment maps contained in the individual watershed sections of this report show both. The District also requires developers to delineate floodplains within project boundaries. Because of these mapping efforts, the aerial extent of local floodplains within the County exceeds the extent of federally Special Flood Hazard Areas. Continuing mapping activities was a high priority of the Planning Committee.

In addition to elevating structures at least one foot above the base flood elevation and protecting structures from the lateral migration of watercourses, the District has recently made significant advances in protecting structures from erosion hazards due to local scour by establishing minimum requirements for building foundations for structures placed in regulatory floodplains. Robust protection of natural floodplain functions and the acquisition of floodprone land further reduces development pressure on some of the most hazardous areas, further increasing the flood resilience of Pima County in the face of climate change. The census based population chart below shows how many people live in floodplains.



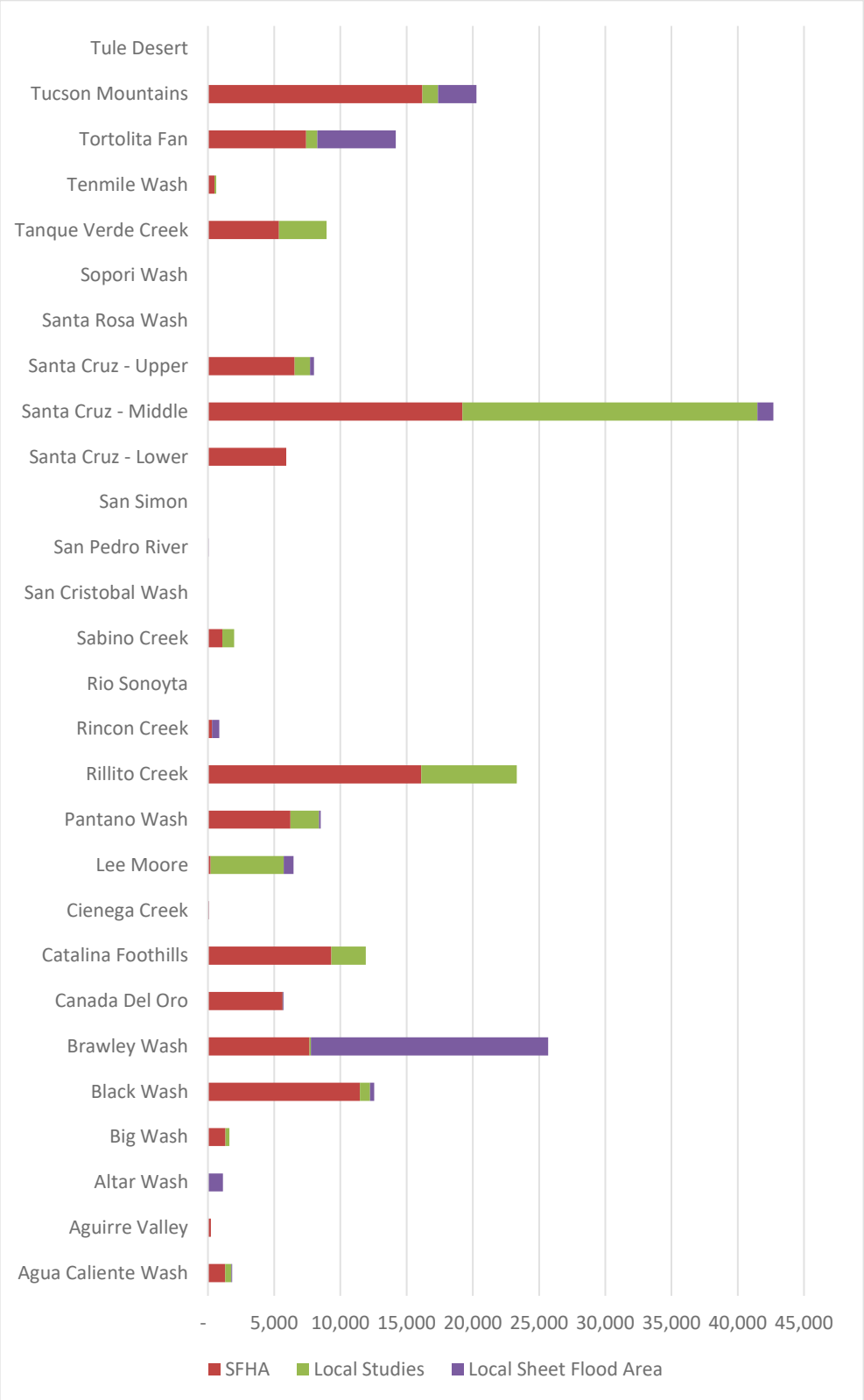


Figure 17 - Floodplain Population by Watershed

The following table is an excerpt from the approved HMP and includes an inventory of critical facilities, exposure loss estimates and information on levees.

Table 3 - Pima County Multi-Jurisdictional Hazard Mitigation Plan Exposure and Loss Estimates Due to Flooding

Pima County exposure and loss estimates due to flooding								
Flood Hazard Exposure/Loss	Marana	Oro Valley	Pascua Yaqui Tribe	Sahuarita	South Tucson	Tucson	Unincorporated Pima County	Total
Total Critical Facilities	**270**	**132**	**17**	**74**	**20**	**1,552**	**1,374**	**3,439**
Facilities in High Hazard Areas	99	7	0	23	0	71	91	291
Percentage of Total Facilities	36.7%	5.3%	0.0%	31.1%	0.0%	4.6%	6.6%	8.5%
Estimated Replacement Cost (x $1,000)	$418,998	$9,896	$0	$140,530	$0	$199,014	$234,820	$1,003,258
Estimated Structure Loss (x $1,000)	$83,800	$1,979	$0	$28,106	$0	$39,803	$46,964	$200,652
Facilities in Medium Hazard Areas Not Protected by Levees *	36	0	13	0	0	71	14	134
Percentage of Total Facilities *	13.3%	0.0%	76.5%	0.0%	0.0%	4.6%	1.0%	3.9%
Estimated Replacement Cost (x $1,000) *	$102,348	$0	$95,391	$0	$0	$242,089	$35,197	$475,025
Estimated Structure Loss (x $1,000) *	$5,117	$0	$4,770	$0	$0	$12,104	$1,760	$23,751
Facilities in Medium Hazard Areas Protected by Levees *	4	3	0	0	0	18	9	34
Percentage of Total Facilities *	1.5%	2.3%	0.0%	0.0%	0.0%	1.2%	0.7%	1.0%
Estimated Replacement Cost (x $1,000) *	$1,818	$20,876	$0	$0	$0	$8,640	$76,770	$108,104
Estimated Structure Loss (x $1,000) *	$91	$1,044	$0	$0	$0	$432	$3,838	$5,405
Total Population	**34,718**	**40,806**	**3,691**	**25,267**	**5,612**	**523,012**	**337,676**	**970,782**
Population in High Hazard Areas	2,914	563	279	803	3	16,013	17,376	37,951
Percent Exposed	8.4%	1.4%	7.6%	3.2%	0.1%	3.1%	5.1%	3.9%
Population in Medium Hazard Areas Not Protected by Levees *	8,413	97	3,370	754	0	22,668	6,379	41,681
Percent Exposed *	24.2%	0.2%	91.3%	3.0%	0.0%	4.3%	1.9%	4.3%
Population in Medium Hazard Areas Protected by Levees *	784	649	0	0	0	62	1,529	3,024
Percent Exposed *	2.3%	1.6%	0.0%	0.0%	0.0%	0.0%	0.5%	0.3%
Total Residential Building Count	**14,615**	**20,205**	**896**	**10,626**	**2,116**	**231,414**	**157,525**	**437,397**
Estimated Replacement Cost (x $1,000)	**$3,636,438**	**$5,710,908**	**$146,861**	**$2,673,610**	**$364,907**	**$66,121,087**	**$36,203,274**	**$114,857,085**
Structures in High Hazard Areas	1,155	283	66	281	1	7,622	7,083	16,491
Percentage of Total Structures	7.9%	1.4%	7.4%	2.6%	0.0%	3.3%	4.5%	3.8%
Estimated Replacement Cost (x $1,000)	$273,173	$79,888	$10,669	$69,088	$117	$2,204,333	$1,363,762	$4,001,030
Estimated Structure Loss (x $1,000)	$54,635	$15,978	$2,134	$13,818	$23	$440,867	$272,752	$800,206
Structures in Medium Hazard Areas Not Protected by Levees *	3,221	46	815	316	0	10,633	2,755	17,786
Percentage of Total Structures *	22.0%	0.2%	91.0%	3.0%	0.0%	4.6%	1.7%	4.1%
Estimated Replacement Cost (x $1,000) *	$704,812	$13,161	$134,904	$71,172	$0	$2,801,127	$580,502	$4,305,678
Estimated Structure Loss (x $1,000) *	$35,241	$658	$6,745	$3,559	$0	$140,056	$29,025	$215,284
Structures in Medium Hazard Areas Protected by Levees *	290	329	0	0	0	20	573	1,212
Percentage of Total Structures *	2.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.4%	0.3%
Estimated Replacement Cost (x $1,000) *	$67,848	$94,766	$0	$0	$0	$5,827	$125,144	$293,585
Estimated Structure Loss (x $1,000) *	$3,392	$4,738	$0	$0	$0	$291	$6,257	$14,679

** Medium hazard area figures ONLY include critical facilities, population, or structures outside of high hazard areas (but within medium hazard areas)*

While this data suggest that the economic impacts of flooding may be catastrophic, as described above, flood events are typically limited in extent.

5.3.1 Critical Facilities

Pima County utilizes two functional definitions of critical facilities; the definition contained within the Floodplain Management Ordinance (Ordinance) Section 16.26.055, the Pima County Multi-Jurisdictional Hazard Mitigation Plan. They are consistent in including communication, electrical power, gas and oil, transportation, water supply, essential government services and emergency services. They differ in that the Ordinance addresses assisted living facilities, while the HMP excludes them. Financial institutions such as banks are included in the HMP but not in the Ordinance. This is due to the latter's focus on "infrastructure assets" as defined by the Critical Infrastructure Assurance Office (CIAO) and the eight categories adopted by the state of Arizona for the purpose of the HMP. The HMP asset inventory excludes riparian areas and residential areas although each is included as a cultural asset in the definition. This is due to how the purpose of the asset inventory used in the HMP versus the regulatory nature of the Floodplain Management Ordinance definition.

Critical facilities damaged during 1983 flood

For the purposes of the HMP, the Pima County Office of Emergency Management planners first inventoried all government facility assets then added HAZUS®-MH data to a Geographic Information System database. Each jurisdiction then determined which were critical. The data is a work in progress. Population exposure to risks identified in the HMP including flooding were estimated using census data.

While the assessment contained in the HMP provides valuable information, this plan uses the Floodplain Management Ordinance definition of critical facilities. It is consistent with that used in the CRS and is as follows:

1. A structure or facility that produces, uses or stores highly volatile, flammable, explosive, toxic, and/or water reactive materials;

2. Hospitals, emergency medical facilities, nursing homes and/or housing facilities likely to have occupants who may not be sufficiently mobile to avoid injury or death during a flood;

3. Essential emergency response facilities, such as police stations, fire stations, emergency shelters and/or operation centers that are needed for public safety and/or flood response activities before, during and after a flood; and

4. Public and private utility facilities, such as, but not limited to power, water and wastewater treatment, and/or communications, that are vital to maintaining or restoring normal services to flooded areas before, during and after a flood.

The HMP contains the total value and relative risk associated with flooding as well as Pima County's mitigation efforts. The HMP is approved and compliant with the NFIP CRS Floodplain Management Plan and Disaster Mitigation Act. County staff used census data within HAZUS software to evaluate the population living within 100-year high-risk floodplain and those within 500 year or medium risk areas including those protected be levees. In 2012, there were 25,067 floodplain residents in Unincorporated Pima County and 6,929 within medium risk areas.

For the purposes of this plan, District staff inventoried critical facilities using the Assessor's Land Use Code. District staff prepared fact sheets for each watershed and the County as a whole for the Planning Committee during Step 4. These are available on the project webpage and include building and population information. Below is the countywide summary sheet.

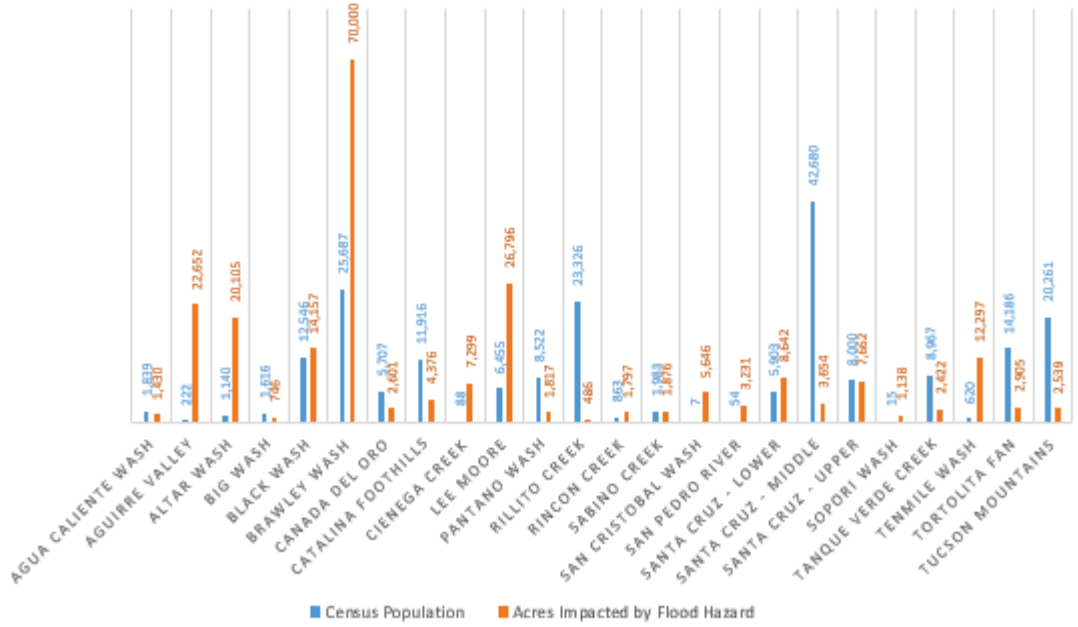
PIMA COUNTY
FLOOD CONTROL

Floodplain Management Plan
Flood Hazard Problem Assessment

The Pima County Regional Flood Control District (District) has prepared this assessment as part of Steps 4 & 5 of the Floodplain Management Plan process for the Planning Committee (Committee) and public, neighboring communities and partner agencies. The District strives to use forward-looking floodplain management planning practices to minimize the risk of flood and erosion damage for all county residents, property and infrastructure. These efforts include identifying high flood risk areas, preserving natural watercourses, constructing flood control facilities, establishing locally appropriate development standards, distributing public information, providing early warning, and responding to flood emergencies. This assessment will help the Committee identify the activities that will be most effective in each of the watersheds in unincorporated Pima County, as part of identifying goals in Step 6 and reviewing possible activities in Step 7.

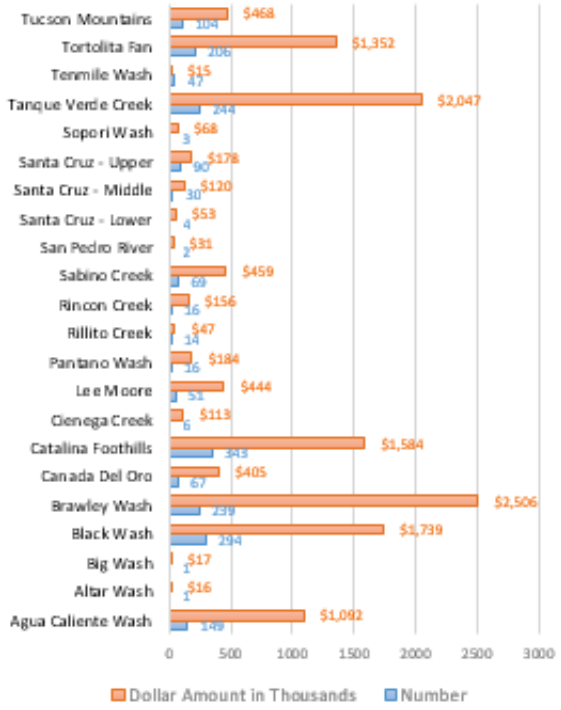
Flood Hazards in Pima County

This chart includes acreage of Federal Emergency Management Agency (FEMA) Special Flood Hazard Area wherein flood insurance is required for insured mortgages. It also includes locally regulated, Local Study floodplains and Sheet Flood areas mapped by the District and included in the District's Geographic Information System. This fact sheet introduces readers to flood problems. The draft Plan will contain greater detail. Focused fact sheets are also available for each watershed.



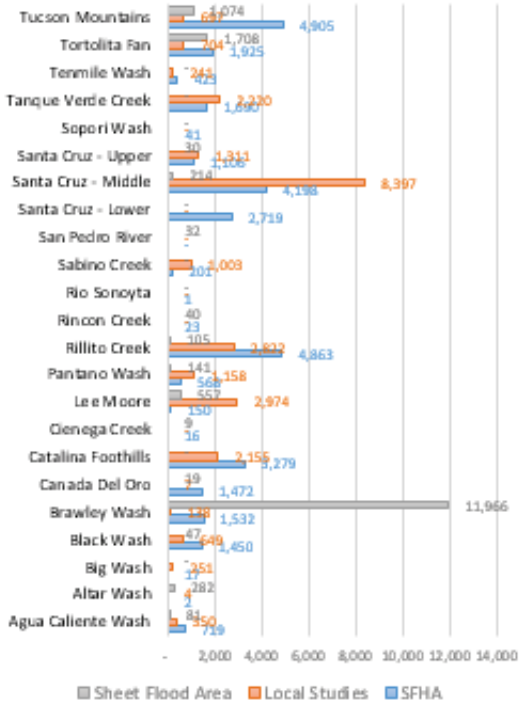
For More Information
www.pima.gov/fmp/ * greg.saxe@pima.gov * 520-724-4633
201 N. Stone Avenue, 9th Floor, Tucson Arizona 85701

Insurance Claims Paid



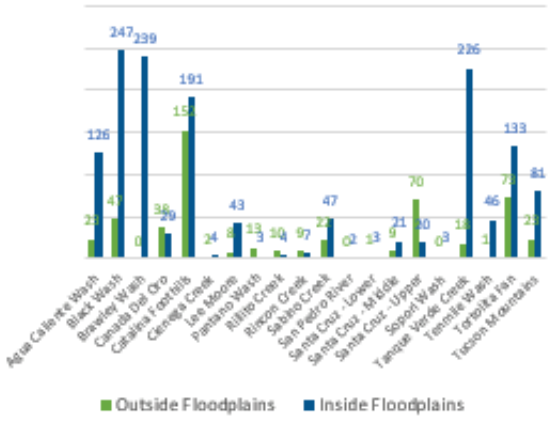
The chart above shows the number and amount of insurance claims paid in the unincorporated area since Pima County joined the National Flood Insurance Program. Watersheds with no buildings counted are excluded.

Buildings in the Floodplain



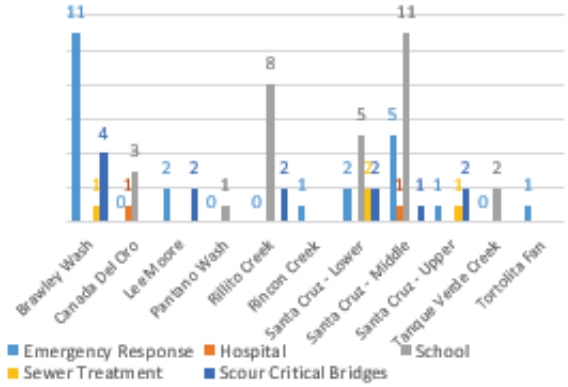
The chart above shows the number of buildings within Pima County that may be exposed to floodplain hazards included in the District GIS. Watersheds with no buildings are excluded. It should be noted that federal lands are excluded from both data sources.

Insurance Claims and Floodplains



The chart above shows the distribution of insurance claims paid in the unincorporated area since Pima County joined the National Flood Insurance Program. Watersheds with none are excluded.

Critical Facilities in Floodplain



The chart above shows the types of critical facilities within Pima County that may be exposed to floodplain hazards included in the District GIS. Types and watersheds not found were excluded from the chart including: jails, TEP substations and water treatment plants.

While the potential for economic and safety impacts of flooding are demonstrated by these countywide inventories and those contained in Section 5.1, Appendix C provides a further breakdown of exposure indicators including floodplain population, buildings, and areas that become inaccessible for each watershed. While the latent effects of flooding including displacement and mold are the most prevalent risk in the County, swift water rescues resulting from motorists entering flooded roads are the most common cause of fatalities associated with flooding.

The Planning Committee requested that the Action Plan include expanded coordination with Critical Facility Operators regarding risk reduction, warning, response and recovery.

5.3.2 Repetitive Loss Areas

FEMA defines Repetitive Loss Areas (RLAs) as areas in which floods have damaged insured structures more than once within a rolling 10-year period. FEMA provides the District with confidential claims information for all properties filing claims each year. Since disclosure laws protect individual information, the District has generalized this loss claims data to identify RLAs and other high-density single loss areas that then become the focus of increased outreach and other mitigation efforts.

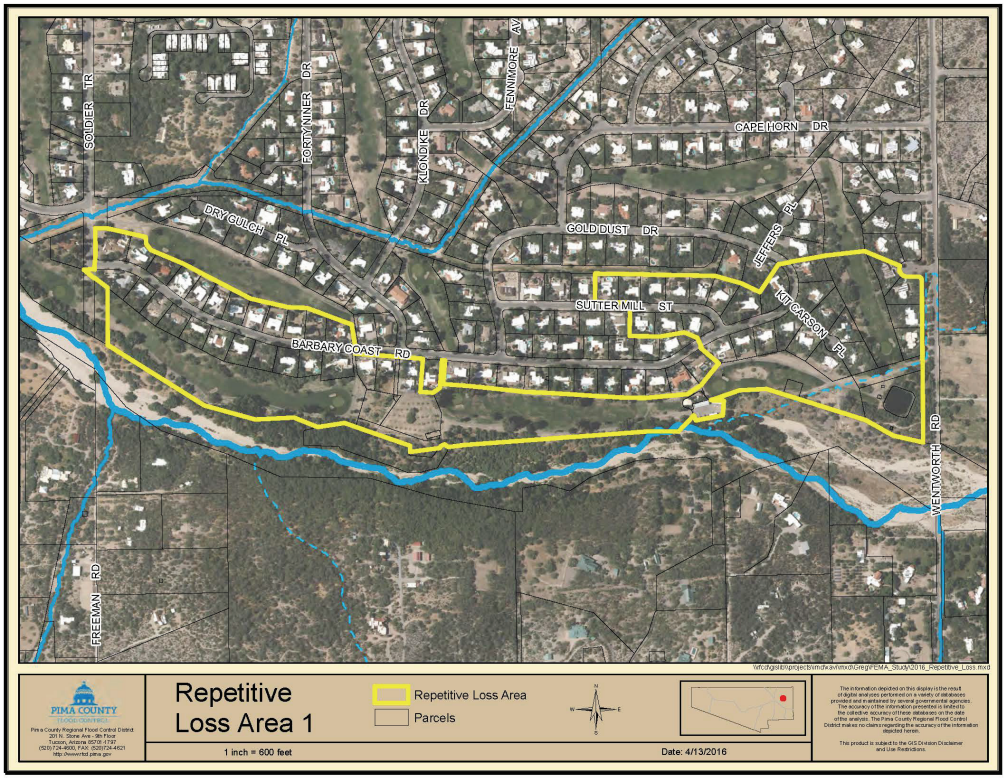


Figure 18 - Map of Repetitive Loss Area at 49ers Country Club

A single subdivision, 49ers Country Club, is the location of three of the four unmitigated Repetitive Loss Properties (RLP), and other homes within the same floodplain make up RLA1. In 1993, the District

Flood damages at 49ers Country Club Repetitive Loss Area

worked with the United States Army Corps of Engineers (USACOE) to design a levee to protect this subdivision; however, the homeowners association rejected it and flooding remains a risk.

The fourth RLP home listed as unmitigated is located in RLA2, an area subject to major debris movement following a 2006 forest fire on Mt. Lemmon in the Cañada del Oro and Sutherland Wash tributaries and headwaters. The District acquired this repetitively flooded home and demolished it. As such, it is no longer an insurable structure. While large, RLA2 has been the major focus of both CIP and open space acquisitions that included utilizing citizen approved bond funds. These activities have reduced flood risk for both individual residences and critical facilities in this area. Lastly, although the County removed the repetitively flooded structure, FEMA continues to list the property at 3371 E River Road as an RLP. Pima County falls well under the 10-unit threshold of RLP for participation in the CRS in part due to follow up on damage reports, and confidential claims data provided by FEMA to NFIP communities.

5.3.3 Insurance Coverage

Per the most recent data provided by FEMA in September 2018, there were 2,133 policies in force, including $418,863,800 in building coverage and $92,697,400 in contents coverage. Since inception of the NFIP in 1978, there have been 296 claims made, with 175 paid totaling $3,977,194. Payments ranged between $36 and $201,814, and averaged $32,120. Of these, 17% were made in 1983, 5% in 1990, 22% in 1993, 9% in 2003 and 11% each in 2006 and 2010. As such, 75% of claims were during years with significant flood events, and fewer than six claims filed in any other given year. Insurance Coverage Assessment is included as part of the PPI in Appendix A.

Figure 19 below shows the distribution of claims over time per FEMA data.

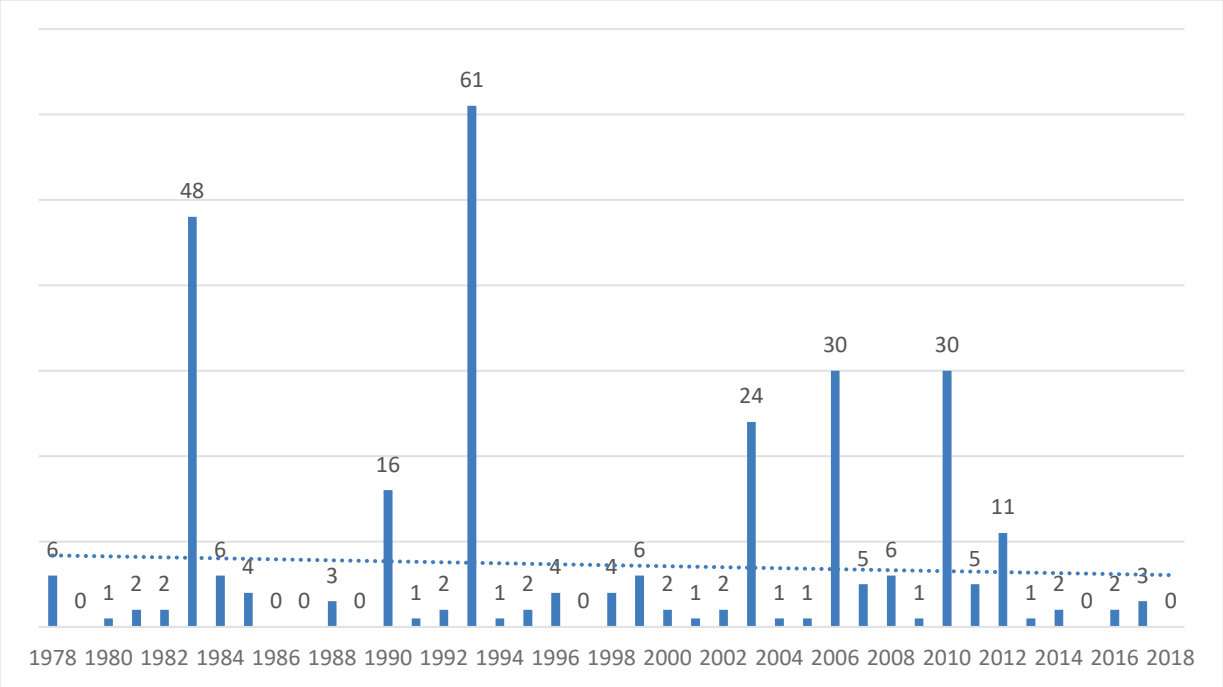


Figure 19 - Distribution of Flood Insurance Claims Paid by Year

As indicated by the trend line there have been fewer and smaller claims since program inception. The chart below shows the distribution of claims by dollar amount, further demonstrating the relative infrequency of large claims.

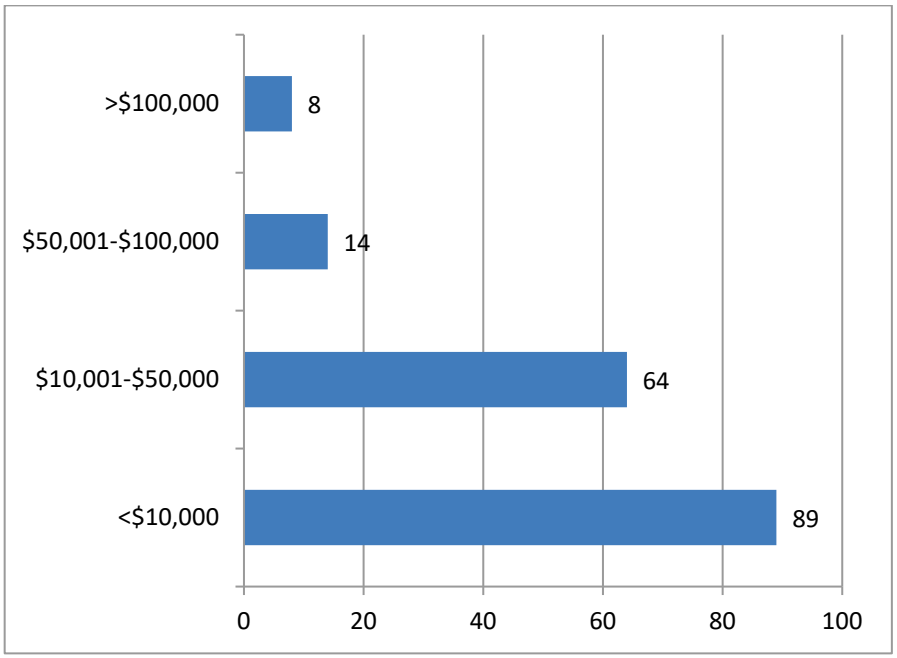


Figure 20 - Distribution of Insurance Claims by Dollar Amount Paid

Construction Site Flood Damage

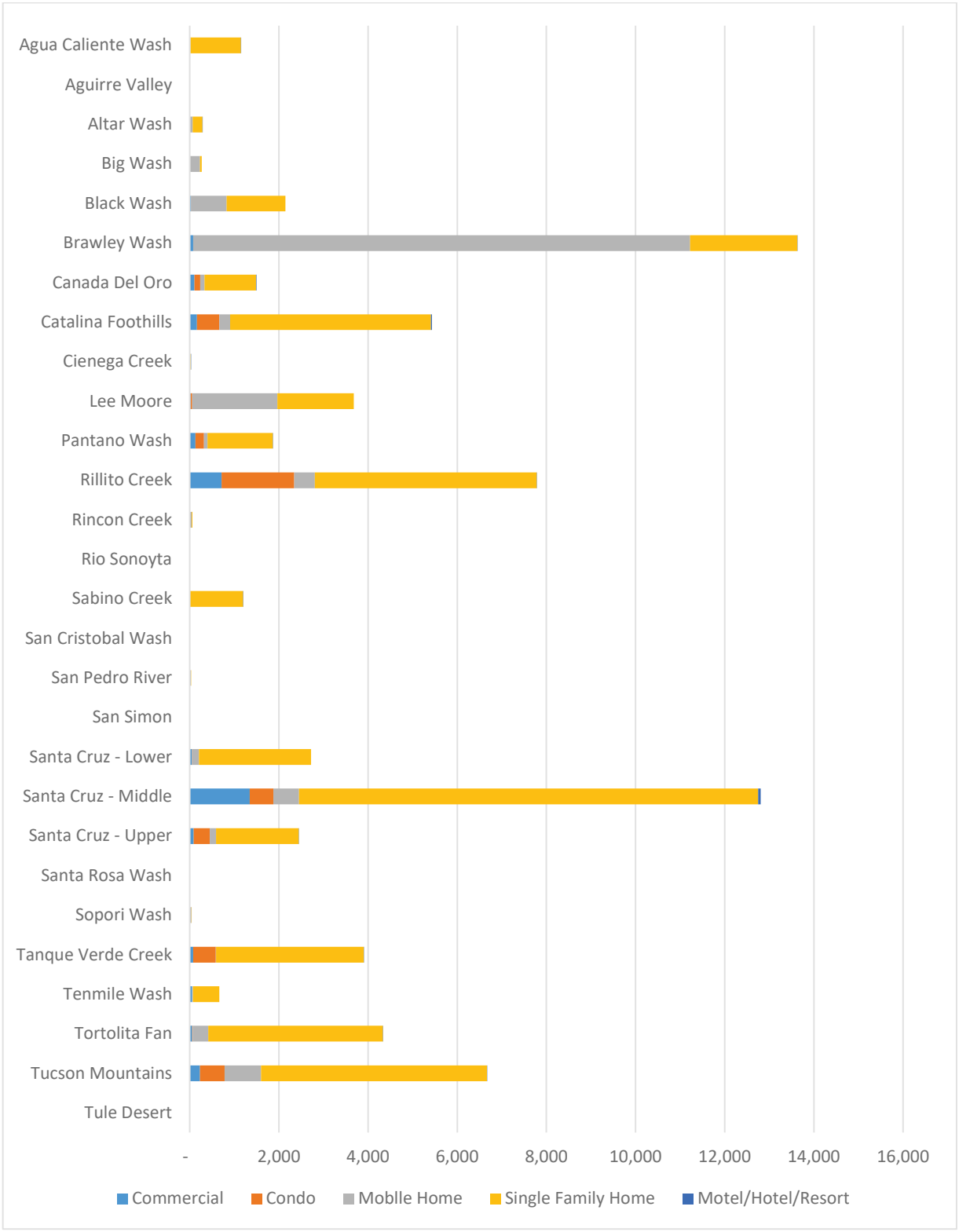


Figure 21 - Buildings in the Floodplain by Watershed and Type

The chart below shows the dollar amount of claims paid by watershed and floodplain type. While the proportion with SFHA is quite high, the chart also shows that areas outside the SFHA are subject to flooding and that promotion of insurance to these areas is appropriate, as reflected in the PPI and the photograph above.

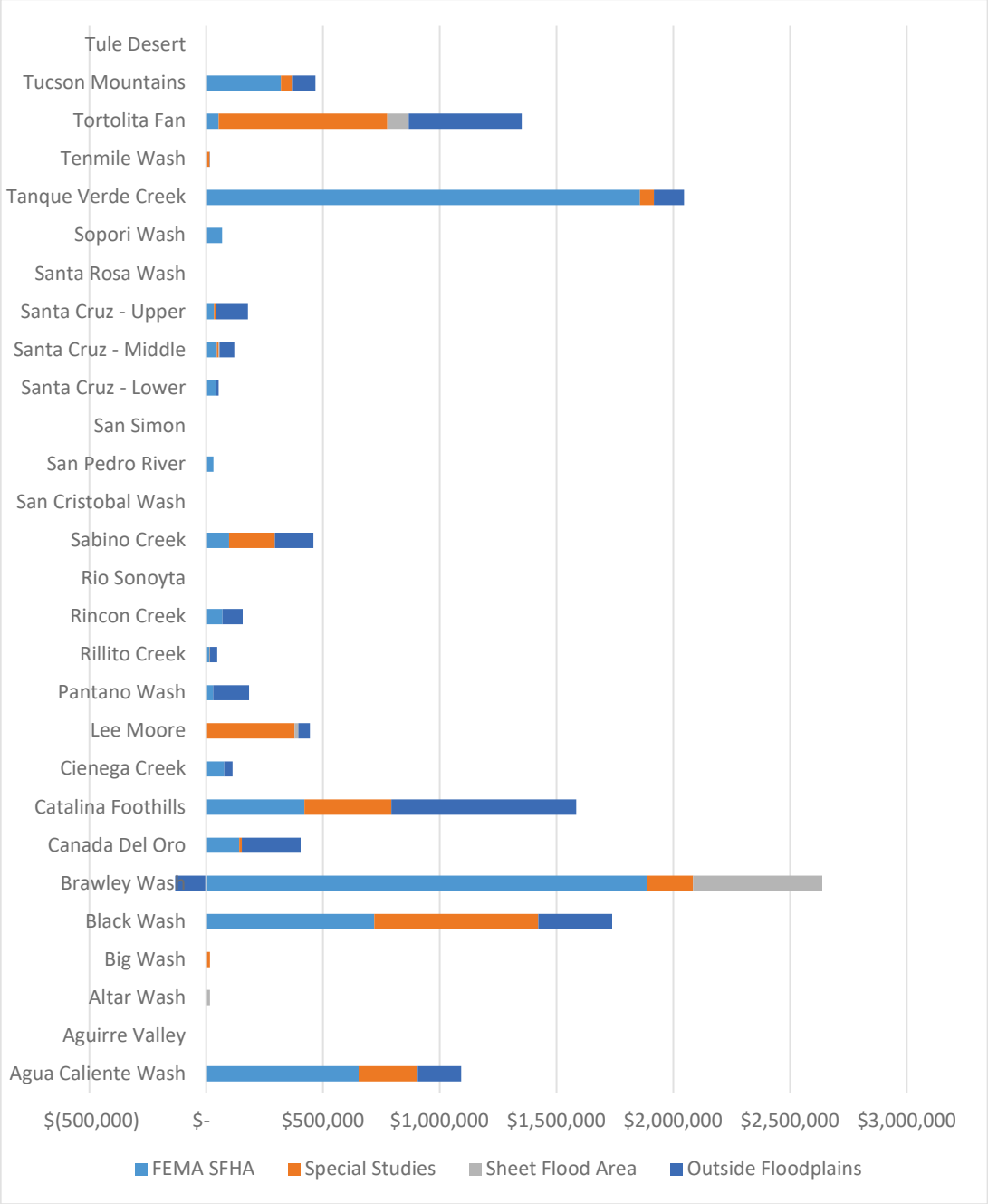
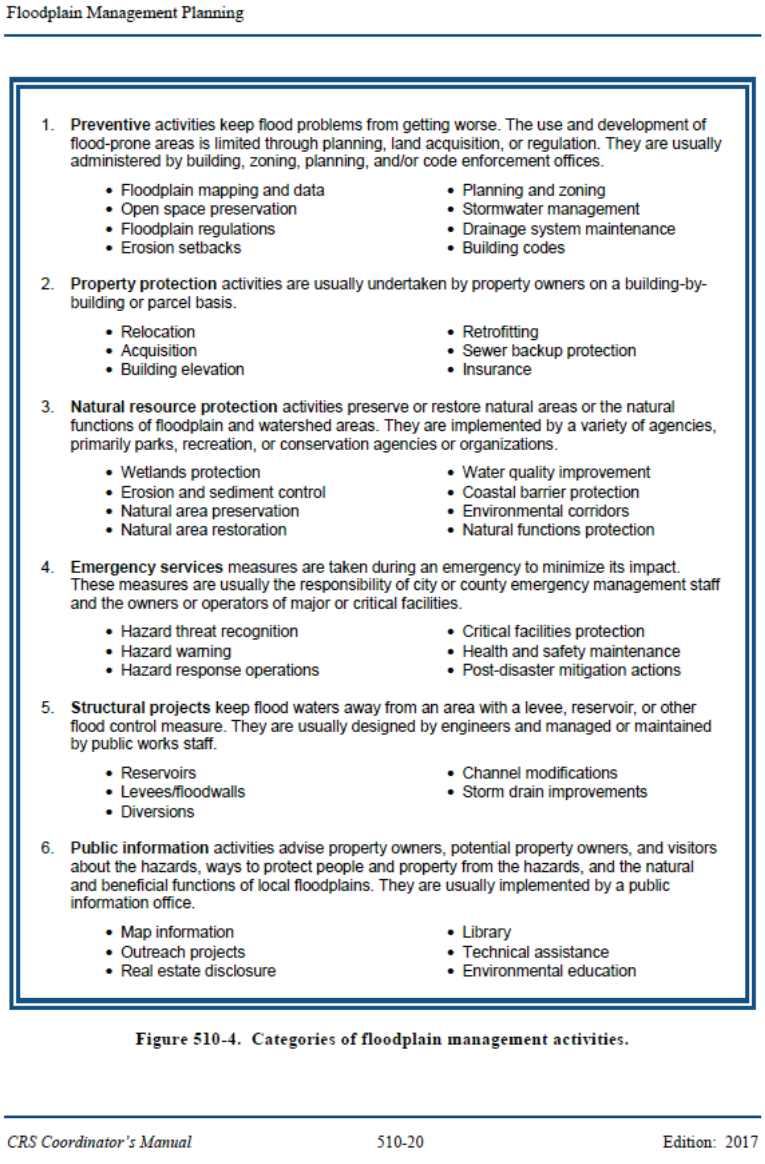


Figure 22 - Insurance Claims and Floodplains

These trends may reflect the shallow flooding depths found in most floodplains in the County as well as the success of County activities to reduce riverine flood risk and regulate construction practices.

The hazard and problem assessments for each of the urban and rural watersheds included as Appendix C describe the conditions and trends within each in order to meet the requirements of steps 4 and 5 of the planning process described in the CRS Manual. Each section contains a description of the watershed, hydrology, development patterns and trends, riparian areas, historic floodplain management approach, capital improvements and needs. In so doing, these steps shall form the basis of the Planning Committee discussion on Goals and Activities in Steps 6-8.

The County utilizes all six of the floodplain management categories of activities identified in federal guidelines (2017 CRS Manual). The excerpt from the Manual below describes these.



Floodplain Management Planning

1. **Preventive** activities keep flood problems from getting worse. The use and development of flood-prone areas is limited through planning, land acquisition, or regulation. They are usually administered by building, zoning, planning, and/or code enforcement offices.
   - Floodplain mapping and data
   - Open space preservation
   - Floodplain regulations
   - Erosion setbacks
   - Planning and zoning
   - Stormwater management
   - Drainage system maintenance
   - Building codes
2. **Property protection** activities are usually undertaken by property owners on a building-by-building or parcel basis.
   - Relocation
   - Acquisition
   - Building elevation
   - Retrofitting
   - Sewer backup protection
   - Insurance
3. **Natural resource protection** activities preserve or restore natural areas or the natural functions of floodplain and watershed areas. They are implemented by a variety of agencies, primarily parks, recreation, or conservation agencies or organizations.
   - Wetlands protection
   - Erosion and sediment control
   - Natural area preservation
   - Natural area restoration
   - Water quality improvement
   - Coastal barrier protection
   - Environmental corridors
   - Natural functions protection
4. **Emergency services** measures are taken during an emergency to minimize its impact. These measures are usually the responsibility of city or county emergency management staff and the owners or operators of major or critical facilities.
   - Hazard threat recognition
   - Hazard warning
   - Hazard response operations
   - Critical facilities protection
   - Health and safety maintenance
   - Post-disaster mitigation actions
5. **Structural projects** keep flood waters away from an area with a levee, reservoir, or other flood control measure. They are usually designed by engineers and managed or maintained by public works staff.
   - Reservoirs
   - Levees/floodwalls
   - Diversions
   - Channel modifications
   - Storm drain improvements
6. **Public information** activities advise property owners, potential property owners, and visitors about the hazards, ways to protect people and property from the hazards, and the natural and beneficial functions of local floodplains. They are usually implemented by a public information office.
   - Map information
   - Outreach projects
   - Real estate disclosure
   - Library
   - Technical assistance
   - Environmental education

Figure 510-4. Categories of floodplain management activities.

CRS Coordinator's Manual 510-20 Edition: 2017

Figure 23 - CRS Activities List from the CRS Manual

The District puts substantial effort into mapping new regulatory floodplains and requiring developers to do so. Just as regulatory floodplains are those with a peak discharge of 100 cfs during the 100-year event, those watercourses considered part of the drainage system for CRS purposes are those with a flow in excess of 100 cfs. Of these, the District maintains some in a natural condition. In this natural part of the system, the District need only conduct maintenance activities such as vegetation management and grading in exceptional circumstances. Instead, monitoring and regulation enforcement are priorities. Others parts of the system are improved and therefore maintained on a regular basis in order to prevent flooding of habitable structures. As defined by FEMA this report refers to both as drainageways. The following sections elaborate on which if these management activities are most critical for each watershed given current and future conditions and continuation of these activities was a Planning Committee priority.

5.4 Problem Summary

Staff provided the table below as a *sample* from the list of the problems identified by the Planning Committee during steps 4 and 5 the hazard and problem assessments and from existing studies and community input. Note that the recommended actions are exemplary to facilitate discussion during steps 6, 7 and 8, as well as review of the first draft by the Planning Committee.

Problems Identified			
Name	Description	Associated Hazard	Reccomended Action Item
Uninsured buildings in the floodplain	Significant numbers of buildings and population are in the floodplain and lack insurance. Properties without insurance may not have recovery capacity.	Property Flooding	Conduct targetted outreach to promote flood insurance. Continue program of local sheet flood area mapping to help target mailers and increase inquiry.
Lack of all weather access	Broad floodplains and roadway design constribute to numerous road closures during time fo flooding. Fatalities, risk associated with rescues, delayed emergency response.	Road Flooding	Identify affected roadways, establish comprehensive GPS compatible road closure dashboard integrating ALERT, interjusirsdictional dispatch, and PCDOT.
Utility work impacts	Floodplain and PCRRH bladed for transmission line installation. No notification, ROE, permit, or mitigation required.	Flood Impacts on work site. Work inpacts on flooding (ilcreased velocity, increased sediment transport, channel migration, erosion, decreased infiltration).	Establish Drainage System Facility Impact Permit Requirement.
Critical facilities in the floodplain	Facilities inlcuding a wastewater treatment plant and care facilies are located in floodpains or may become isoloted during floods.	Inability to provide essential services.	Update EOP flood annex and COOP, implement MyAlerts.

Prior to the Step 5 meeting, staff distributed the full problem list in order to ensure completeness and to facilitate discussion of goals. This list was as follows:

Opportunities for Improvement (aka Problem List)

Unique Local Hazards

- Erosion.
- Debris flows and sedimentation.
- Alluvial fans.
- Distributary and uncertain flow paths.
- Canyon wash floodways.
- Sheet flooding.
- Missing, outdated information and approximate mapping.
- Subsidence and changes in topography.
- Upper watershed land management

Future Environmental Conditions

- Changing weather.
- Unknown hazards.
- Vegetation changes.
- Climate change including extreme events and extended dry periods.
- Post catastrophic fire impacts.

Population Exposure to Hazards

- Critical facilities and utilities in the floodplain (potential loss of service).
- Floodplain populations especially those with low mobility and resources.
- All-weather and emergency vehicle access.

- Ponded water and virus vectors (mold, mosquitos, etc.).
- Underinsured and uninsured.
- Water quality and spread of contamination.

Existing and Future Development

- Existing development that does not meet current standards(old and undersized infrastructure).
- Historic entitlements not based on current hazard information.
- Increasing runoff volume due to cumulative improvements.
- Loss of natural floodplain function.
- Lot splitting and wildcat developments.
- Infill and redevelopment.
- Encroachment and channelization.
- Regional scale projects.
- Flow diversions.
- Groundwater depletion.
- Riparian habitat disturbance.
- Loss of natural tributary connectivity.
- Water rights, recharge projects, and managed surface flows.

Maintenance Needs

- Private infrastructure.
- Public infrastructure.
- Conveyance capacity.
- Illegal dumping activities.
- Trash accumulation.
- Invasive species .

Emergency Response

- Inter-agency 2-way reporting during events for road closures and situation assessment.
- Public tools for near real time reporting.
- All-weather access for responders.
- Advanced warning for road closures and flooding.
- Publication of alternate routes.
- Fire nexus.
- Swift water rescues.

Emergency Management

- Real time status update of conditions as they evolve during a flooding event.
- Tools for near real time reporting of potential risks to specific communities during a flooding event.
- Advance warning of potential road closures that would impact egress/ingress and therefore impede evacuation ability.

Unauthorized Uses

- Homeless camps.
- Off-road vehicles.
- Grazing.
- Utilities.
- Encroachments.
- Riparian habitat destruction.
- Flow diversions.

Awareness

- District services.
- Pima County services.
- Best practices.
- Flood hazards in the desert.
- Interjurisdictional collaboration opportunities.
- Inter-departmental/integrated planning needs.
- Increase recreation opportunities.

Appendix C provides lists of the most prevalent of these problems and opportunities in each watershed within unincorporated Pima County.

Step 6.0 SETTING GOALS

At the beginning of Step 6, exemplary goals from the Pima County Code (PCC) Title 16.04.030, the Floodplain Management Ordinance, the Sonoran Desert Conservation Plan, and the Pima County Comprehensive Plan, also known as Pima Prospers, were included in the draft plan. The CRS Coordinator presented them to the Planning Committee as possible goals. The scope therefore was limited to previously identified problems and the approved legal and financial framework under which the District operates. While the District believes these to be comprehensive and effective, the CRS Coordinator asked the group to determine if additional goals are appropriate to address the problems identified in Step 5. Staff also distributed the draft problem list prior to the Step 5 meeting. The Committee identified the following goals. The first six are nearly identical to those contained in the Floodplain Management Ordinance. Seven and eight are new!

1. Identify, protect, and preserve watercourses and the natural floodplain function and riparian habitat associated with them, and restore and enhance them where they have been degraded;
2. Protect, preserve and enhance water resources;
3. Ensure that those who occupy areas within regulatory floodplain and erosion hazard areas are aware of the consequences of their actions within those areas;
4. Reduce the need for rescue and relief efforts;
5. Ensure the most effective expenditures of public money for flood control projects;
6. Prevent flood and erosion damages including ensuring the operability of critical facilities during flood events;
7. Ensure flexibility for adaptive floodplain management for changing climate circumstances; and
8. Increase regional cooperation and offer interjurisdictional floodplain management services.

As part of assessing the problems and opportunities, goal identification and activity prioritization, Planning Committee Meeting 5 included a map-based exercise. Staff distributed large versions of the hazard maps for each watershed around the Public Works Building basement conference room. Members then placed as many color-coded goal stickers on each to correspond with site-specific needs and opportunities. Thus, it was a quantitative and qualitative process. Staff tallied the numbers of each type of sticker and provided as a reference for discussion during the review of activities.

Step7.0: ACTIVITY REVIEW

The Planning Committee and staff used several means to accomplish this step including the publication of documents to the project webpage, meetings, and survey results. At the first Planning Committee meeting, members were encouraged to review the District Comprehensive Program Report on the project webpage www.pima.gov/fmp. This report, produced per State Statute, summarizes all District activities for the previous five years. It also forms the basis of the Activity Review elements contained in Appendix D. In this way, the Planning Committee considered not just the *categories* of activities, but also the District's performance. At the second meeting, staff summarized this report including all activities completed during the previous five years and since joining the NFIP. In the third meeting, staff summarized existing plans and regulations and any shortcomings and strengths thereof. Detailed discussion followed as reflected in the minutes contained in Appendix E. Most of the stakeholders are involved with District activities on a regular basis and were already familiar with them. During meeting 6, the seven categories of CRS activities contained in Figure 510-4 of the CRS Manual were described for the Committee. This presentation included a review of what the District has done in each category as described herein in Appendix D. The CRS Coordinator again summarized this information at the beginning of meeting 7 as an introduction to the draft Action Plan.

The District utilizes a state authorized property tax levy to fund hazard mitigation activities that include the full range of those recognized by the CRS. The following sections summarize the effectiveness of current District activities and highlights accomplishments during the previous five-year planning period. While the CRS Manual identifies six "categories" of "activities" to consider for local implementation, the CRS awards points based upon four classes of activities as follows:

- Public Information (300)
- Mapping and Regulation (400)
- Flood Damage Reduction (500)
- Flood Warning and Response (600)

A section devoted to each, describing current District activities and identifying future needs is included as Appendix D. The following financial information shows the scale and distribution of these activities.

The chart below shows District tax levy revenues over time. Additional sources of revenue including bonds and federal funds have been decreasing in significance over the last five years. Typically, the property tax makes up over 95% of revenues.

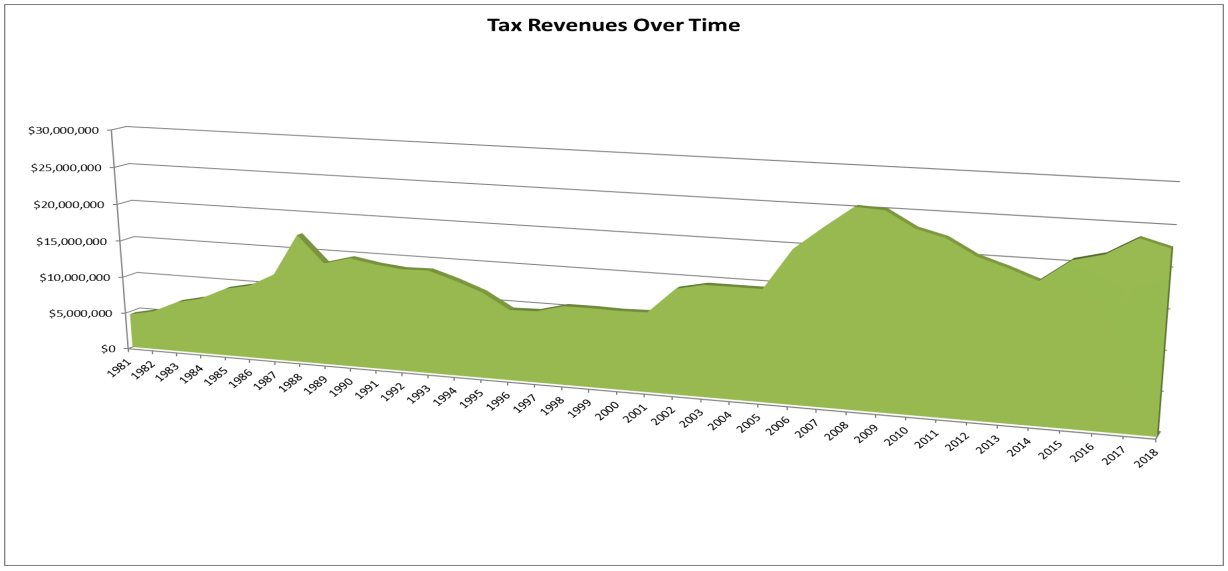


Figure 24 - Revenues

The table below excerpted from the last Comprehensive Program Report shows a parallel shift in expenditures from CIP much of which had been bond funded to operating expenses including maintaining channel conveyance:

Table 4 - Expenditures

Expenditures	FY 11/12	FY 12/13	FY 13/14	FY 14/15	FY 15/16
Capital Improvements	11,121,058	12,097,821	14,225,843	11,413,161	8,188,139
Operating Budget	10,550,092	11,093,517	11,399,089	14,011,582	14,595,991
Pima Association of Governments	30,266	-	-	73,230	-
PimaCore/Debt Services	-	49,536	42,460	50,068	63,591
Total	**21,701,416**	**23,240,874**	**25,667,392**	**25,548,041**	**22,847,721**

The overview above demonstrates the level of financial commitment shown by the County. The following section assesses effectiveness.

Improved Drainageways

Natural Drainageways

Regional Detention Basins

7.1 Overview of Current Activities and Survey Results

The District's Capital Improvement Plan continues to be successful in completing projects that benefit public safety, natural floodplain function and recreation. Each contributes to public health and local economic strength.

In 2018, the District completed the Pantano Wash Bank Protection and River Park project. Funding for the $8.2 million project came from the District's tax levy, a secondary property tax. Contractors completed construction under budget, saving $400,000. The project, located along the Pantano Wash between Fort Lowell Park and Tanque Verde Road provided:

- Bank protection along the banks of the Pantano Wash to protect from flooding and erosion hazards;
- Channel bed stabilization;
- River Park and passive recreational improvements that completed The Loop (a 131-mile urban paved pathway, alternative transportation and recreational system along the major watercourses and encompasses the Tucson metropolitan area);
- Protected riparian habitat within the existing floodprone lands;
- A new restoration area, which utilized stormwater harvesting in a formerly degraded depression;
- Stormwater harvesting basins throughout the project;
- Reuse of onsite inert debris to create lizard habitat;
- Reuse of onsite inert debris and rejected cobble material for slope erosion protection; and
- Public art, sitting areas and interpretive signage.

The project closed the final gap in The Loop and received a "Project of the Year" honor from the Southern Arizona Branch of the American Public Works Association.

There is no finer example of how District CIP contributes to public health and local economic strength than the attractiveness of the Chuck Huckelberry Loop trail system installed on bank protection along the major rivers throughout the urbanized portions of the County. The 2017 County report entitled *The Loop Means Business* reported that over 217,328 people lived within one-half mile of the 131-mile long system. Per the report, the National Association of Realtors and National Association of Home Builders "found that residential properties increase in value from 10 to 20 percent the closer they are to green space." Furthermore, "Homeowners are willing to pay a premium of $9,000 on houses that are within 10,000 feet of bike paths."

The following map is a sample of the Action Plan maps prepared to show activities. While not all Action Plan items are included the maps show:

- Regulated watercourses.
- Federal and locally mapped floodplains.
- Pima County Regulated Riparian Habitat.
- Drainage System – Both natural and improved land controlled by the District for flood management.
- Existing and funded capital improvements.
- Riparian habitat restoration projects.

Appendix C contains these maps for each watershed, and they are available separately in large format on the project webpage watershed tabs.

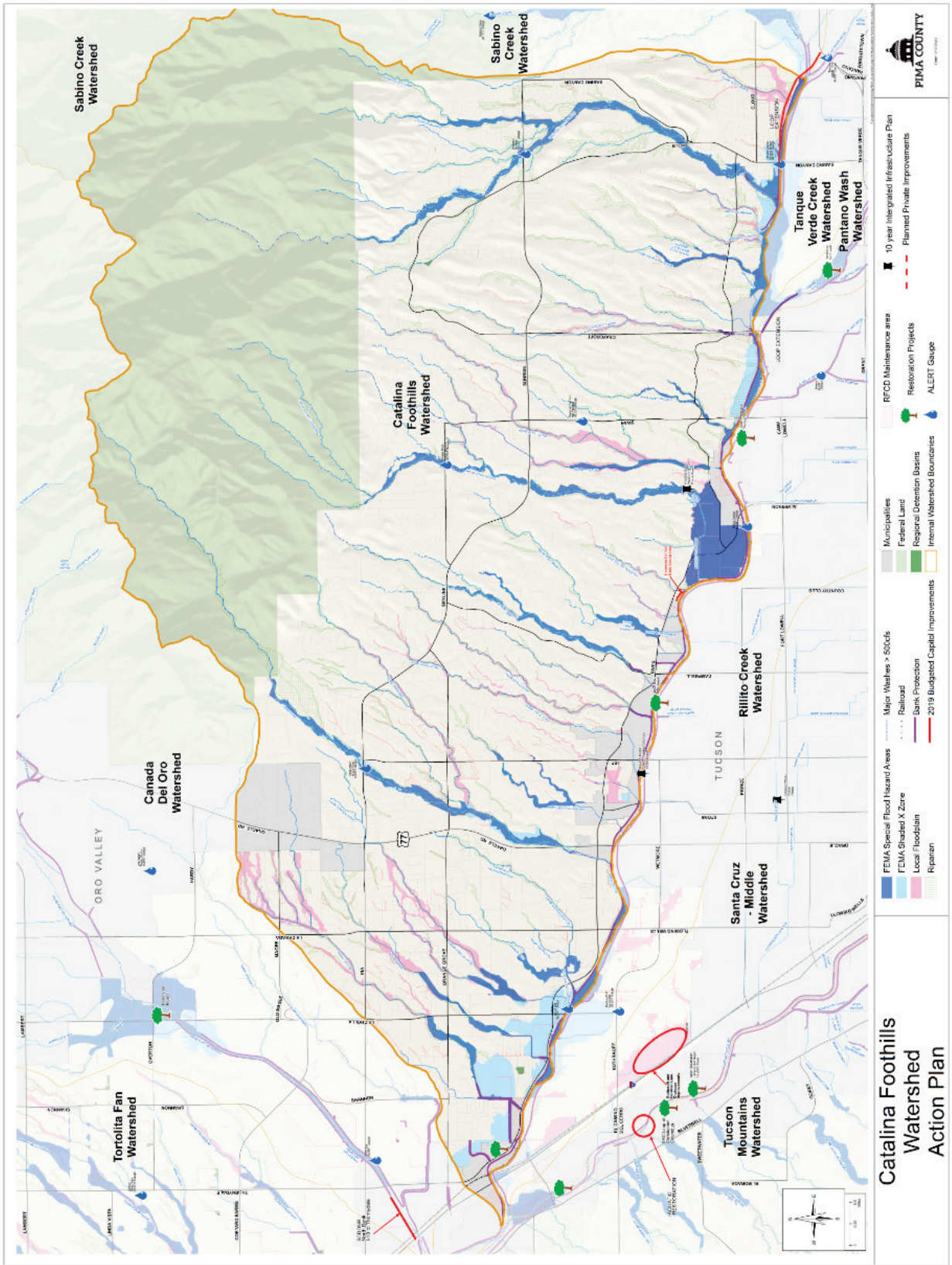


Figure 25 - Action Plan Map Sample

While the frequency and severity of floods and related weather hazards have increased with climate change, property exposure and damages have not. Increased compliance enforcement and inspection capability have resulted in better maintenance of both public and private drainage improvements and preservation of natural flow corridors where appropriate.

The combination of significant acquisition programs and active watershed restoration using Green Infrastructure/Low Impact Development methods and water harvesting, along with robust regulatory frameworks, has made the County a regional and national leader under the NFIP. During the previous five years, District staff facilitated development of a PPI, greatly expanded maintenance and GIS map service capability, added technical regulatory guidance, and established automated inundation area warning systems. Because of these programs, FEMA has recognized our success and as a result, significantly lowered flood insurance premium rates in unincorporated Pima County. Continual improvements undertaken with community and Board support, especially approval of this plan, positions the District to achieve even greater and discounts within the next 5 years. This is due to success in protecting public safety and the natural functions of floodplains

Preserving open space for the safe conveyance of floods has long been a high priority for the District. The District continues to find new ways to maximize the available land acquisition funding to achieve the greatest results. One aspect of this is the protection of riparian habitat, which is an essential part of managing watersheds and watercourses. Vegetation along stream banks and in the overbank serves to slow the flow of floodwaters, encourages the infiltration of floodwaters, attenuates contaminants and stabilizes soil against erosion. The District continues to provide protection of the natural riparian habitat through land use regulations in the Ordinance, acquisition of floodprone land, and the management of drainage to maintain the environment necessary for healthy riparian vegetation.

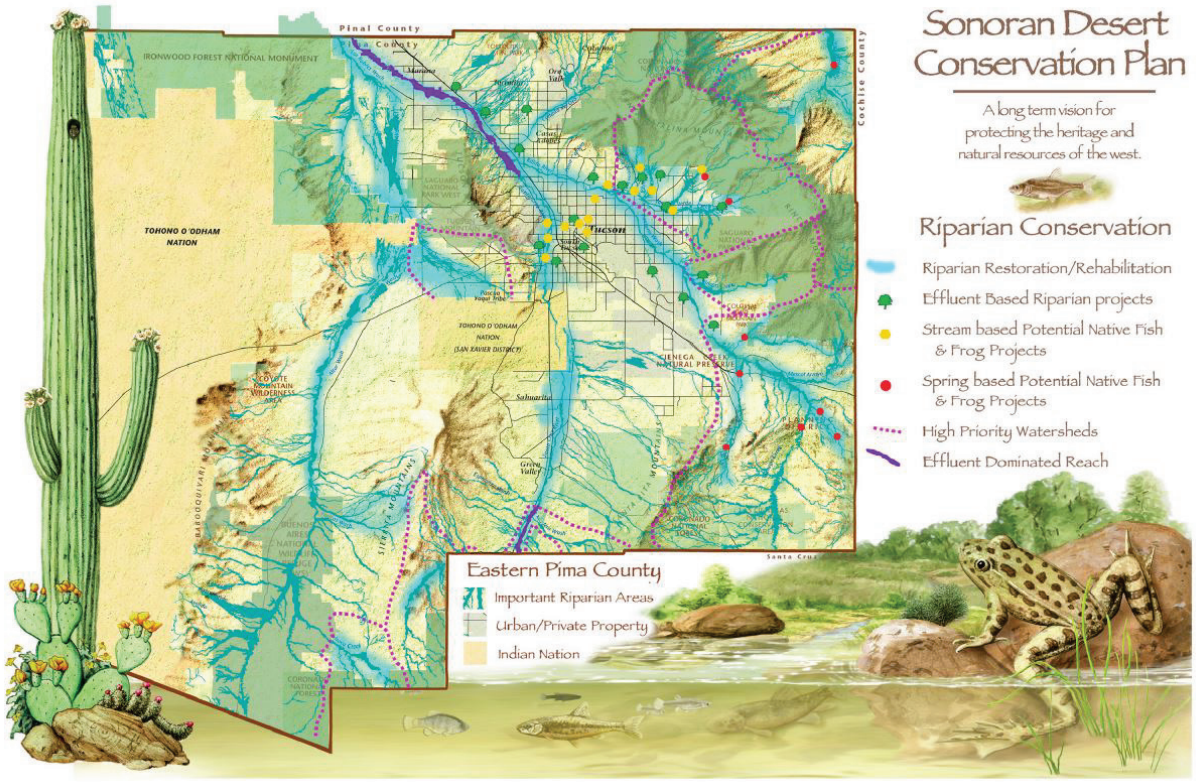


Figure 26 - Sonoran Desert Conservation Plan Riparian Conservation Map

Since the adoption of the SDCP and the Maeveen Marie Behan Conservation Land System, the District has participated in mapping important riparian areas along the major watercourses and other streams for protection. The District has assisted in the development of updated riparian mapping of the County's resources and has revised the Ordinance to align it with the land use plan of the SDCP and the updated and more detailed mapping of riparian habitat in Pima County. In concert with the SDCP, the District will continue technical studies and evaluations of habitat and water resources for the preservation and protection of riparian habitat in the County. Partnerships with the University of Arizona and citizens organizations such as the Audubon Society of Tucson, Coalition for Sonoran Desert Protection, Sonoran Institute, and the Watershed Management Group have been keys to success.

As part of the SDCP, the District acquires and manages land to preserve the natural and beneficial functions of floodplains and to reduce exposure to flood risk. Since 1984, the District has been active in acquiring floodprone land in upper watershed areas such as Cienega Creek and the Santa Cruz River at Canoa Ranch. This program also, FLAP, provides a cost effective means of removing residents from floodprone areas where structural flood control options are not practical. Step 5, and Appendices C and D describe lands acquired and enhanced during the last five years. District Annual Report include expenditures for these activities. The FLAP is partly responsible for our success in protecting floodplain open spaces and our high score under the CRS. The SDCP map in Figure 27 provides a general depiction of acquisition strategy along with FLAP parcels in blue.

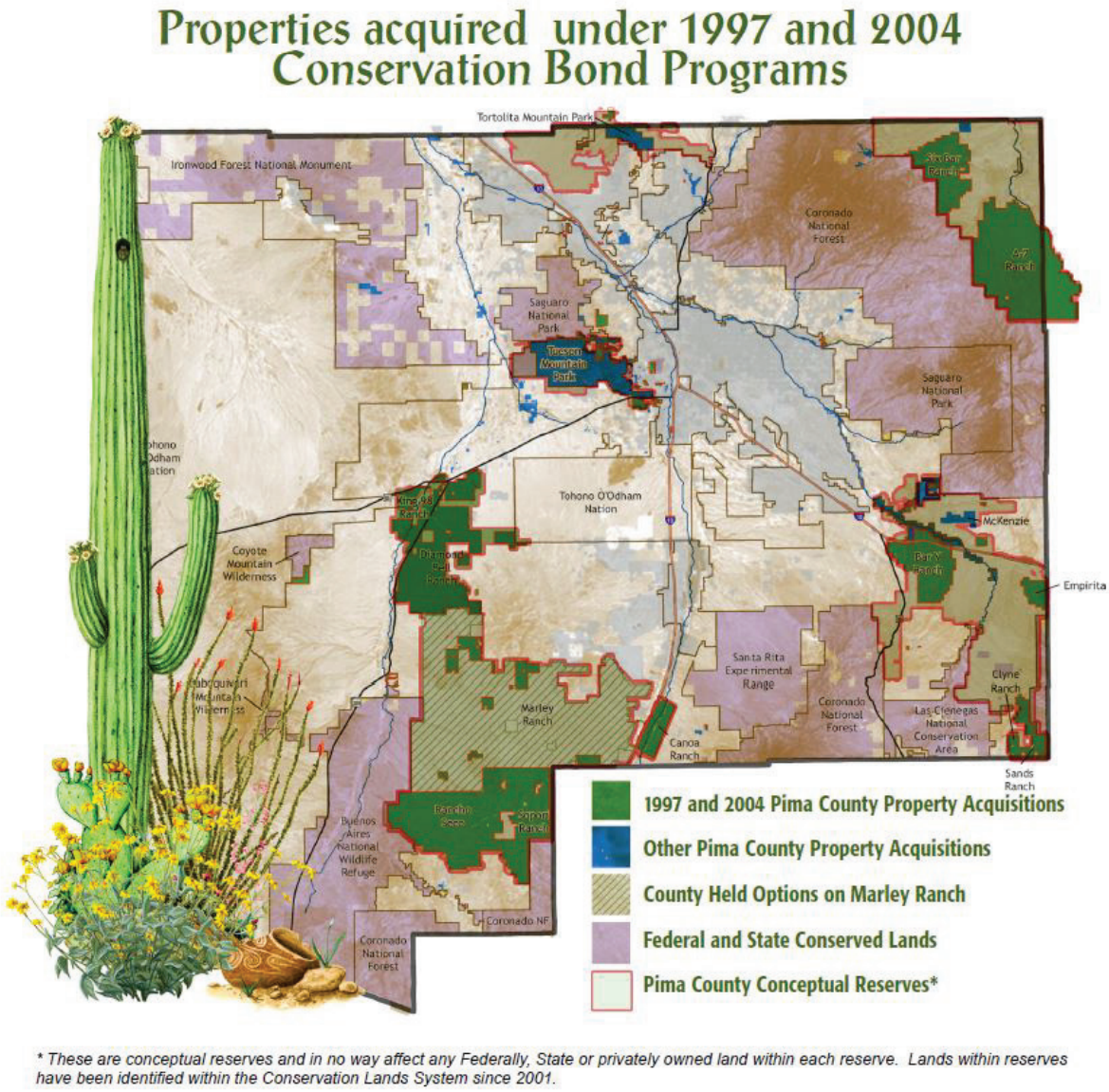


Figure 27 - Open Space Acquisition

Preventative activities such as mapping and regulation are those, most residents are familiar with per the survey results. In addition, acquisition and management of recreation and habitat amenities were the most popular amongst respondents. Never the less, the greatest expense has been the construction and maintenance of improvements including channelization, bank protection, grade control, and regional detention basins. While bond funds have decreased, the need for major additional improvements has demonstrated the need since the flood of 1983. The floods of 2006 demonstrated the effectiveness of this strategy as damages to critical infrastructure and residences were relatively minor, if non-existent. Still this period of acquisition and CIP has left the District with significant land management responsibility. So much so, that staffing and budgeting has shifted to open space and infrastructure management. An emphasis has been on maintaining channel conveyance capacity, including management of sediment and vegetation.

In order to evaluate the public's familiarity with flood control activities and services, the District mailed a promotional brochure with a link to the survey to all regulatory floodplain residents in Pima County just prior to the monsoons, our summer rainy season. The project webpage and other outreach used in informational meetings throughout the project also contained this link. District distributed paper copies at each of the 50 plus meetings and events reported in Section 2.2.

The chart below shows the number and distribution of responses over time. The number in April is the test period. The mailing occurred in May of 2019.

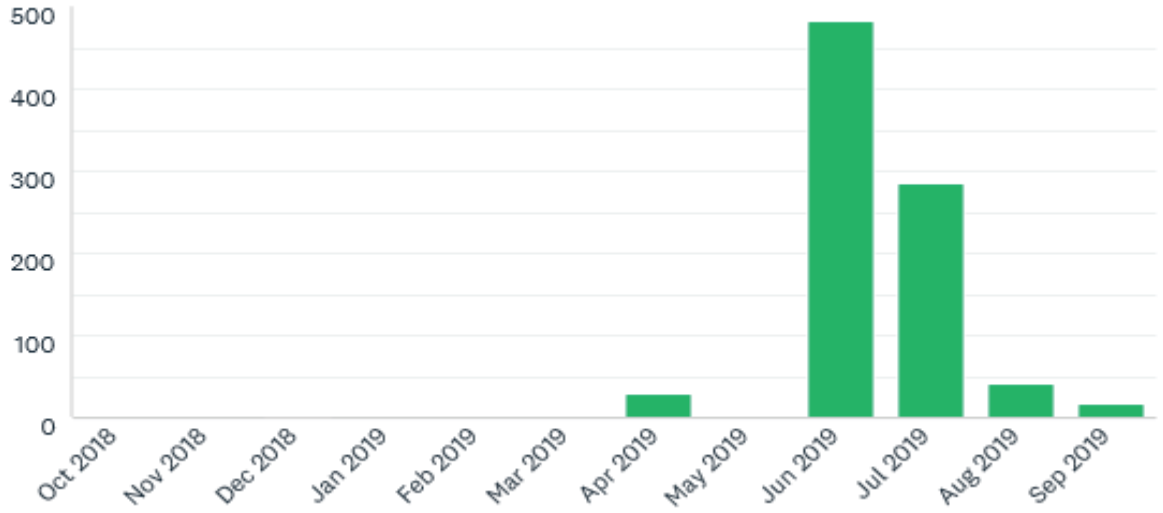


Figure 28 - Survey Responses

A blank sample of the paper version of the survey is below. Responses received on paper, largely during the test phase, although also at events throughout the project timeframe, are separate from those completed in the Survey Monkey online version for tracking purposes, and because the test audience was more familiar with flood control activities than the public at large. The complete set of results as of October 3, 2019, with the exception of comments, are below following the sample.

PIMA COUNTY
FLOOD CONTROL

Community Survey

Also available on the Floodplain Management Plan webpage noted below or at:
https://www.surveymonkey.com/r/PCFC_survey

The purpose of this survey is that the Regional Flood Control District (District) wants to understand your level of flood awareness, your concerns and preferred solutions. This information will be used to develop a Floodplain Management Plan for Pima County. Please select all that apply to you from the answers below. If you have a concern regarding a specific location please describe it in the comment box below.

1. What floodplain issues are important to you?

a) Knowing where flood risk exists.
b) Reducing flood risk.
c) Preserving and enhancing riparian habitat.
d) Opportunities for recreation.
e) Protecting water supply and groundwater recharge.

2. What flood risk information sources do you use?

a) County GIS and Websites
b) County Department of Transportation Hotline
c) County Road Closure Email Service
d) County Department of Transportation Road Closure Webpage and Map
e) District Information Counter
f) District GIS or Flood Hazard Map
g) FEMA Webpages
h) Friends & Neighbors
i) Realtors & Insurance Agents

3. What sources of flood warning information have you used?

a) District ALERT Webpage and/or Mobile App
b) National Weather Service (radio and television)
c) MyAlerts.pima.gov
d) Weather Websites
e) Cell Phone Alert

4. What flooding situations have you experienced?

a) I have experienced flooding while driving.
b) I have altered my route due to street flooding.
c) I have driven through flooded washes to get to my destination.
d) My home has flooded.
e) One or more buildings on my property have flooded.
f) My property has flooded (but no buildings).
g) A wash on my property has flowed.
h) My property has experienced erosion due to flooding.

5. Do you have flood insurance?

a) Yes, my mortgage requires building coverage.
b) Yes, I like to be safe.
c) Yes, I have contents coverage.
d) No, I don't have a mortgage that requires it.
e) No, it never floods here.
f) No, I rent and didn't know that contents coverage was available.
g) I don't know.

For More Information
www.pima.gov/fmp/ * greg.saxe@pima.gov * 520-724-4633
201 N. Stone Avenue, 9th Floor, Tucson Arizona 85701

6. Have you taken steps to reduce the impacts of flooding on your property and/or prepared for flooding?

a) Yes, I have taken steps to reduce damages to my property.
b) Yes, I know what to do during a flood.
c) No, it doesn't concern me.
d) No, I rent.
e) No, I don't have the money.
f) No, I didn't know what to do.

7. What steps have been taken in your area or neighborhood to reduce flood risk?

a) Constructed Improvements (channels, culverts, crossings, and erosion control)
b) Education (HOA meetings, handouts, public events)
c) Habitat and Open Space Preservation
d) Installation of Water Harvesting or Other Green Infrastructure.
e) Preventative Maintenance (brush and debris removal)

8. Please check all of the following District activities in which you have participated:

a) Resolving Complaints
b) Getting Technical Assistance
c) Education & Outreach (Including attending project meetings and workshops.)
d) Using Flood Maps & Studies, or Obtaining Elevation Certificates
e) Using Flood Warning Systems
f) Implementing Habitat Management, Water Harvesting and Green Infrastructure
g) Implementing Infrastructure Improvements
h) Visiting Multi-Use Recreation Sites
i) Obtaining Permit

9. Do you support public funding of flood control improvements?

a) Yes
b) No

10. Maintaining floodprone areas in their natural state is a beneficial and cost effective way of managing flood risks. Do you support preserving floodplains in their natural condition?

a) Yes
b) No

11. Would you be interested in participating further in the Floodplain Management Plan process? <u>If yes, please provide contact Email below!</u>

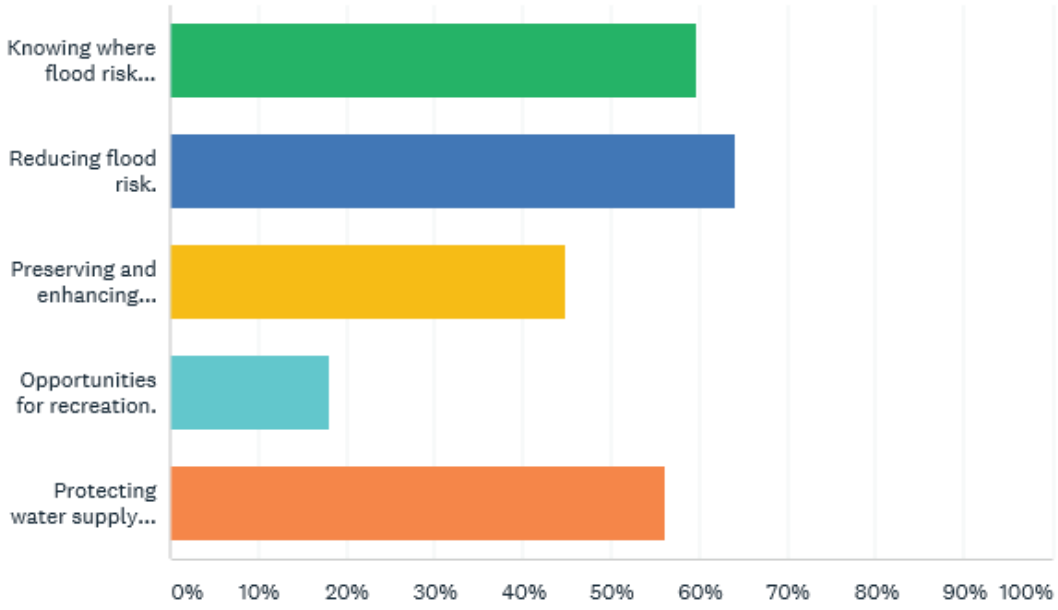
a) Yes, to receive meeting announcements and project update emails.
b) Yes, to complete a more detailed survey about flood hazard awareness and management preferences.
c) Yes, to provide information or management preferences regarding a specific location, or locations.
d) No

Comments:

Contact Email:

What floodplain issues are important to you?

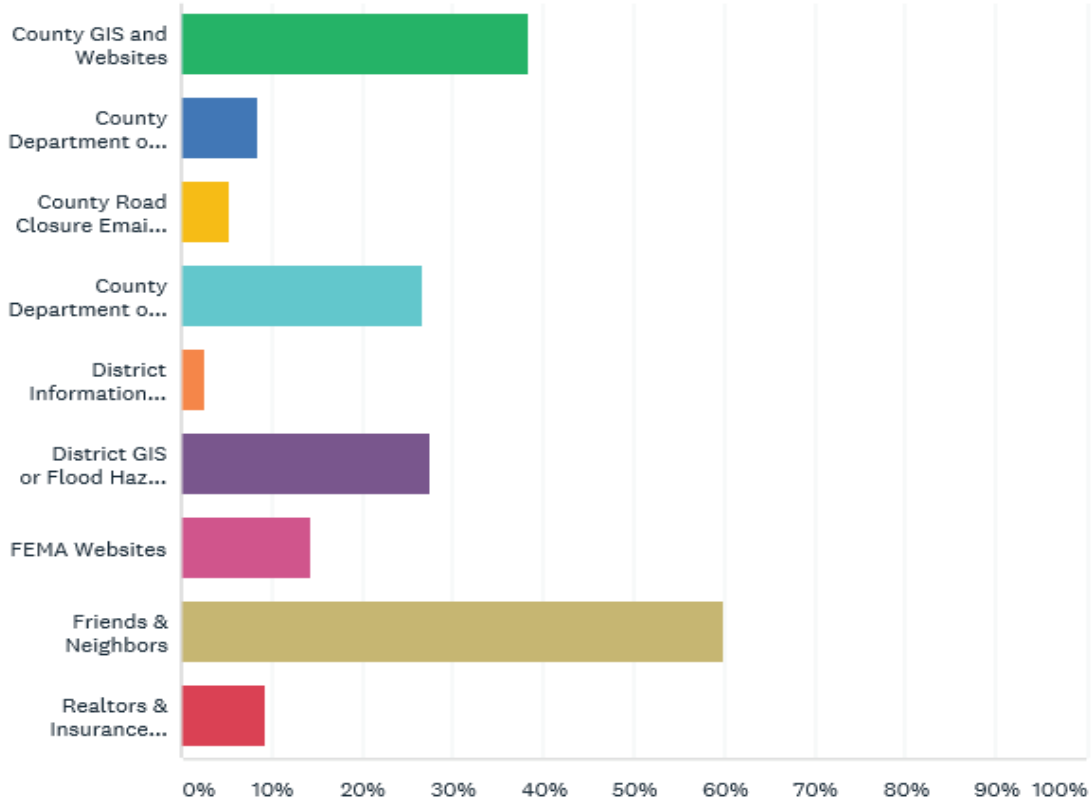
Answered: 855 Skipped: 4



ANSWER CHOICES	RESPONSES	
Knowing where flood risk exists.	59.53%	509
Reducing flood risk.	64.09%	548
Preserving and enhancing riparian habitat.	44.80%	383
Opportunities for recreation.	18.01%	154
Protecting water supply and groundwater recharge.	56.02%	479
Total Respondents: 855		

What flood risk information sources do you use?

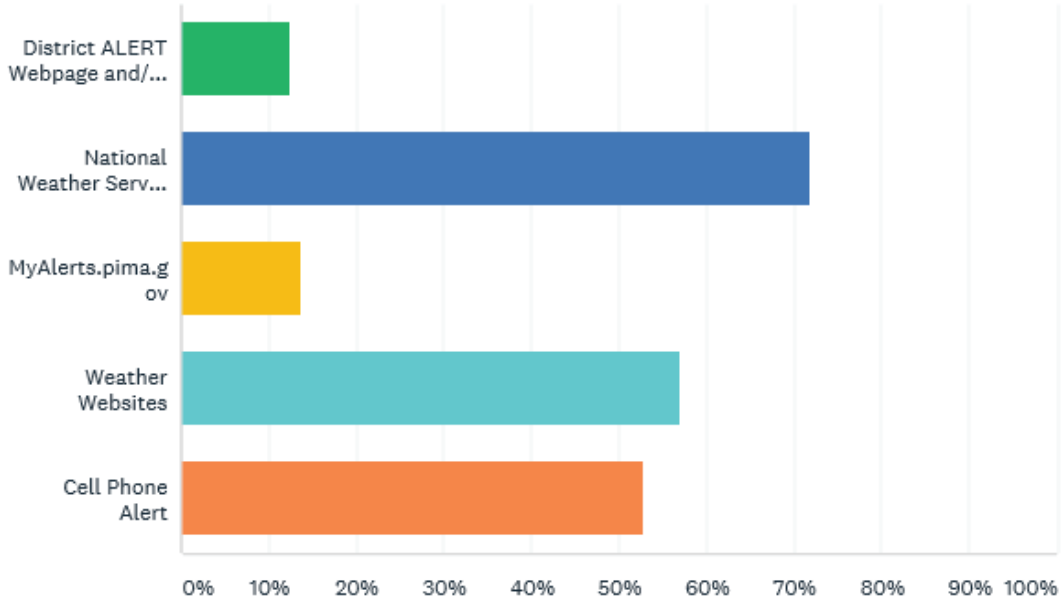
Answered: 810 Skipped: 49



ANSWER CHOICES	RESPONSES	
County GIS and Websites	38.27%	310
County Department of Transportation Hotline	8.40%	68
County Road Closure Email Service	5.19%	42
County Department of Transportation Road Closure Webpage & Map	26.67%	216
District Information Counter	2.47%	20
District GIS or Flood Hazard Map	27.41%	222
FEMA Websites	14.32%	116
Friends & Neighbors	59.75%	484
Realtors & Insurance Agents	9.26%	75
Total Respondents: 810		

What sources of flood warning information have you used?

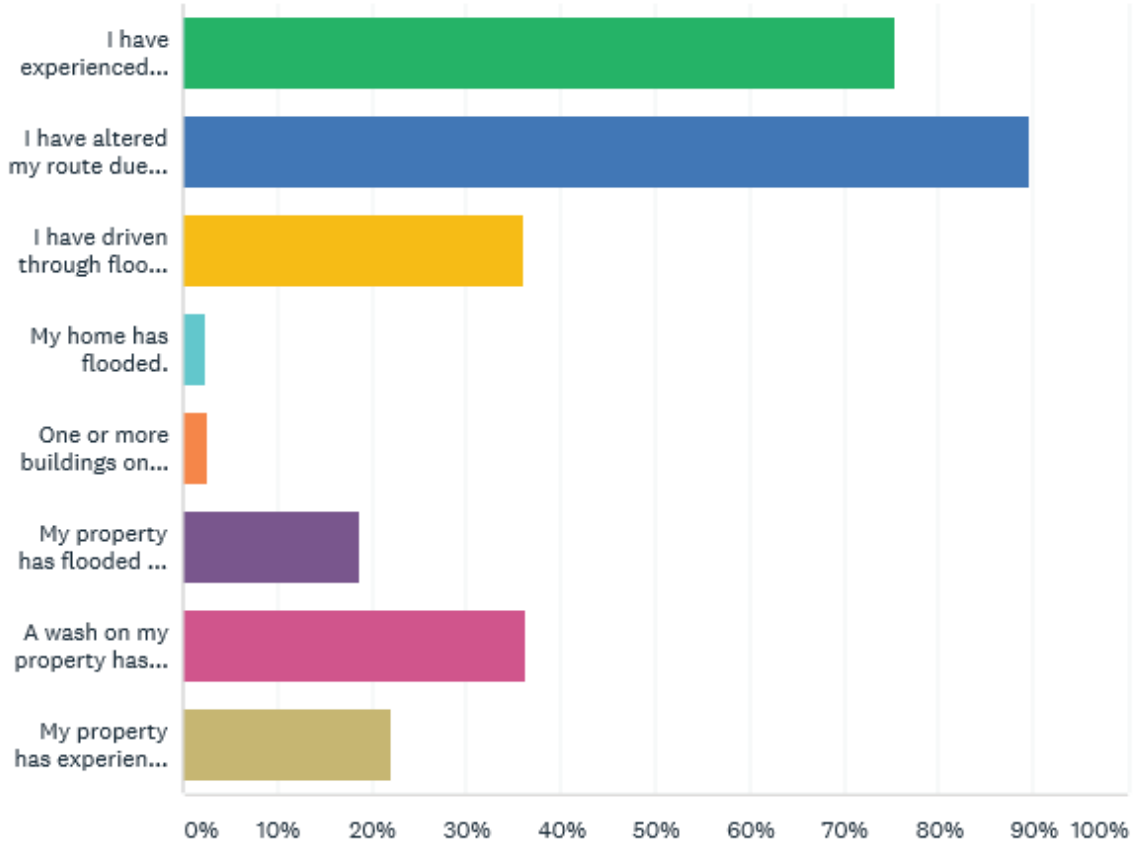
Answered: 822 Skipped: 37



ANSWER CHOICES	RESPONSES	
District ALERT Webpage and/or Mobile App	12.29%	101
National Weather Service (radio and television)	71.78%	590
MyAlerts.pima.gov	13.50%	111
Weather Websites	56.93%	468
Cell Phone Alert	52.80%	434
Total Respondents: 822		

What flooding situations have you experienced?

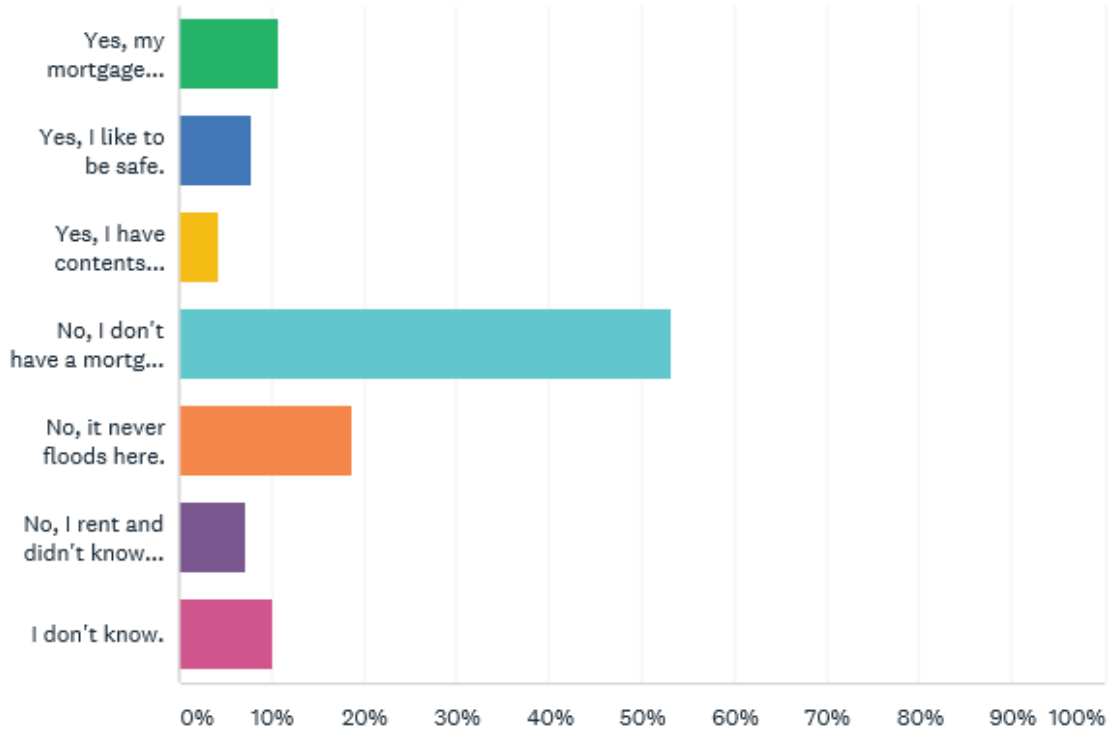
Answered: 836 Skipped: 23



ANSWER CHOICES	RESPONSES	
I have experienced flooding while driving.	75.24%	629
I have altered my route due to street flooding.	89.47%	748
I have driven through flooded washes to get to my destination.	36.00%	301
My home has flooded.	2.39%	20
One or more buildings on my property have flooded.	2.51%	21
My property has flooded but not buildings.	18.66%	156
A wash on my property has flowed.	36.12%	302
My property has experienced erosion due to flooding.	22.01%	184
Total Respondents: 836		

Do you have flood insurance?

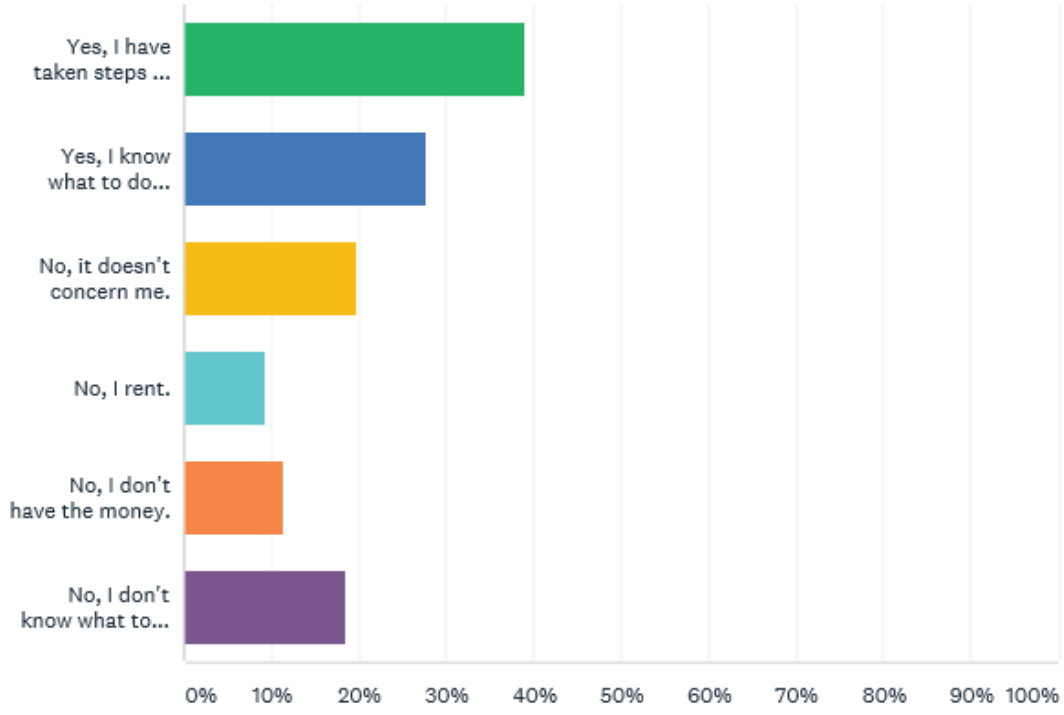
Answered: 849 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes, my mortgage requires the building to be covered.	10.72%	91
Yes, I like to be safe.	7.77%	66
Yes, I have contents coverage.	4.24%	36
No, I don't have a mortgage that requires it.	53.24%	452
No, it never floods here.	18.61%	158
No, I rent and didn't know that contents coverage was available.	7.18%	61
I don't know.	10.01%	85
Total Respondents: 849		

Have you taken steps to reduce the impacts of flooding on your property and/or prepared for flooding?

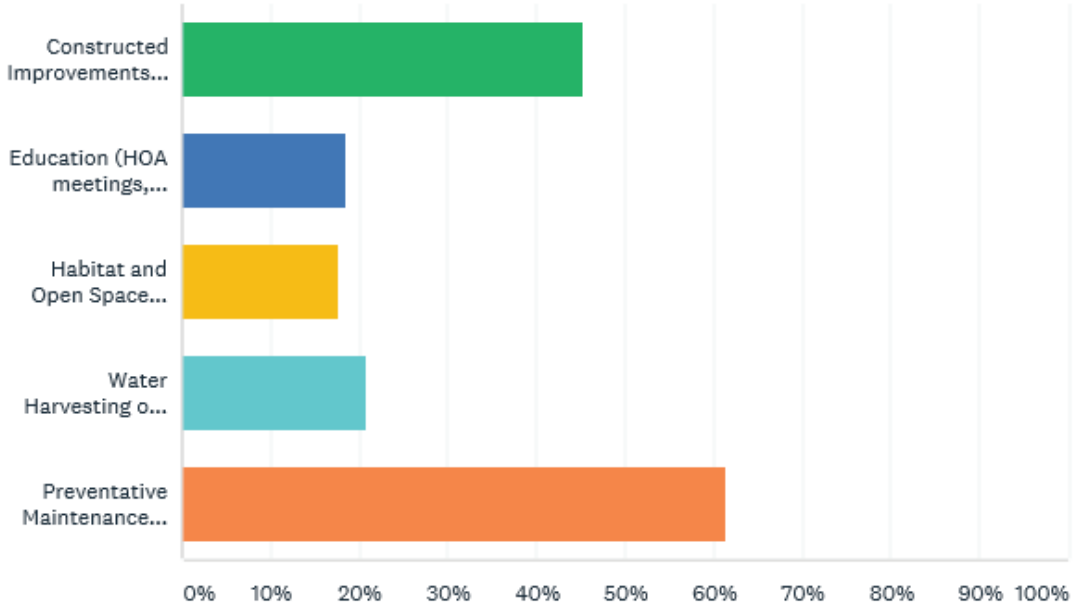
Answered: 846 Skipped: 13



ANSWER CHOICES	RESPONSES	
Yes, I have taken steps to reduce damages to my property.	38.89%	329
Yes, I know what to do during a flood.	27.54%	233
No, it doesn't concern me.	19.74%	167
No, I rent.	9.10%	77
No, I don't have the money.	11.23%	95
No, I don't know what to do.	18.44%	156
Total Respondents: 846		

What steps have been taken in your area or neighborhood to reduce flood risk?

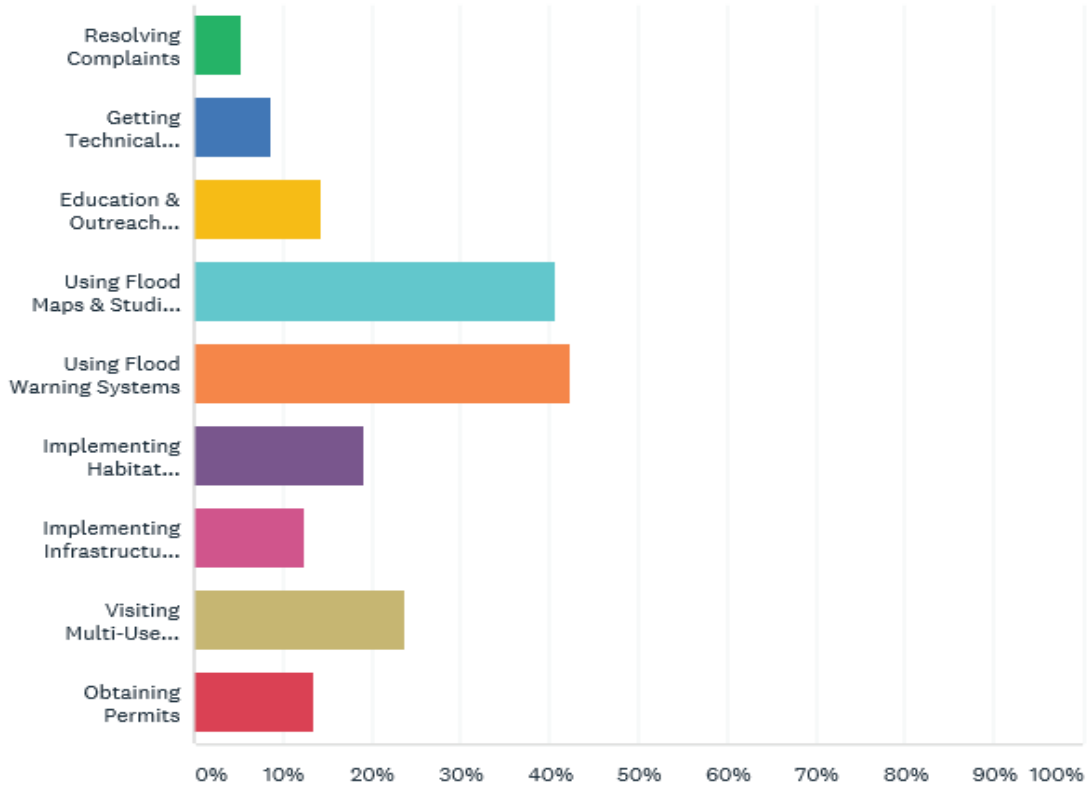
Answered: 696 Skipped: 163



ANSWER CHOICES	RESPONSES	
Constructed Improvements (channels, culverts, crossings, and erosion control)	45.11%	314
Education (HOA meetings, handouts, public events)	18.39%	128
Habitat and Open Space Preservation	17.67%	123
Water Harvesting or Other Green Infrastructure Installation	20.69%	144
Preventative Maintenance (brush and debris removal)	61.21%	426
Total Respondents: 696		

Please check all of the following District activities in which you have you participated:

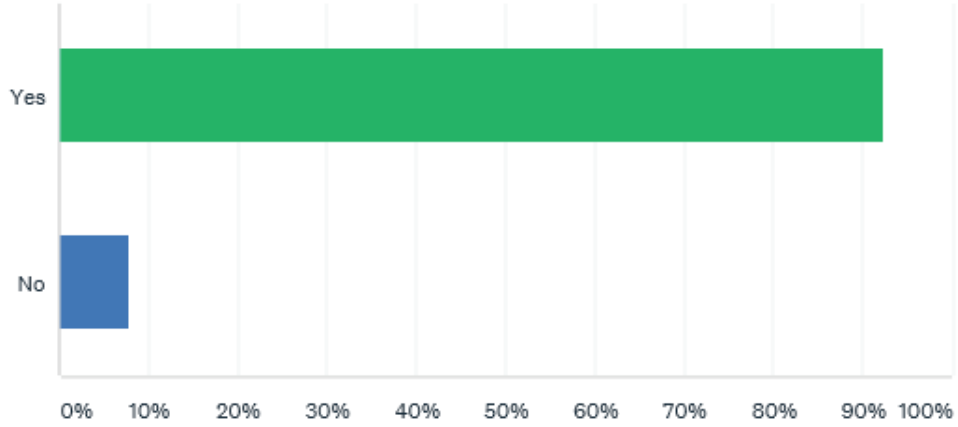
Answered: 671 Skipped: 188



ANSWER CHOICES	RESPONSES	
Resolving Complaints	5.22%	35
Getting Technical Assistance	8.49%	57
Education & Outreach (Including attending project meetings and workshops.)	14.31%	96
Using Flood Maps & Studies, or Obtaining Elevation Certificates	40.54%	272
Using Flood Warning Systems	42.18%	283
Implementing Habitat Management, Water Harvesting and Green Infrastructure	19.08%	128
Implementing Infrastructure Improvements	12.37%	83
Visiting Multi-Use Recreation Sites	23.70%	159
Obtaining Permits	13.41%	90
Total Respondents: 671		

Do you support public funding of flood control improvements?

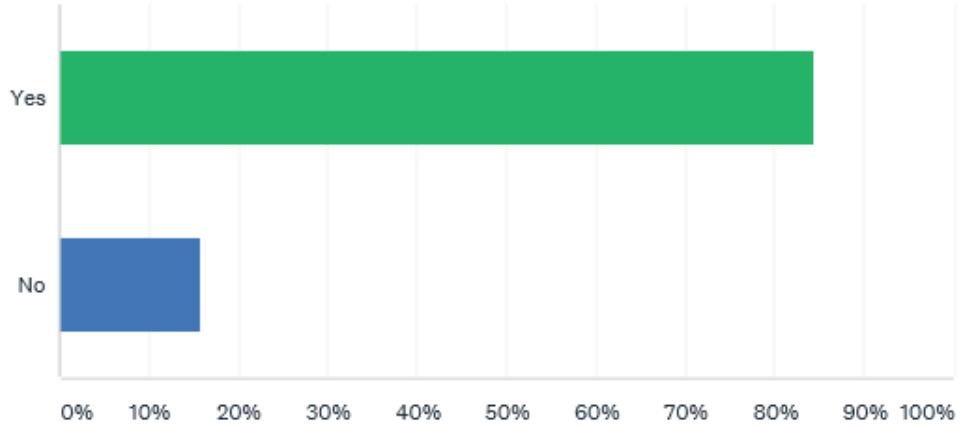
Answered: 846 Skipped: 13



ANSWER CHOICES	RESPONSES	
Yes	92.32%	781
No	7.68%	65
TOTAL		846

Maintaining floodprone areas in their natural state is a beneficial and cost effective way of managing flood risks: Do you support preserving floodplains in their natural condition?

Answered: 845 Skipped: 14



ANSWER CHOICES	RESPONSES	
Yes	84.38%	713
No	15.62%	132
TOTAL		845

Figure 29 - Sample Survey

These results clearly show areas requiring greater emphasis including outreach, warning, promotion of flood insurance and natural floodplain function including infiltration, as well as support for and widespread participation in these activities.

7.2 Recent Accomplishments

The recent accomplishments listed below reflect all 6 categories described in the CRS Manual.

Preventative:

- 2014 Adoption of revised *Design Standards for Stormwater Detention and Retention in Pima County*.
- 2014 Adoption of a new Floodplain Management Ordinance with procedures governing fines for non-compliance, appeal and hearing procedures.
- Approval of Technical Policies regarding hydrology, hydraulics and the design and construction of improvements in the floodplain.

Property Protection:

- Acquired over 400 acres of floodprone land and removed 16 structures from the SFHA in federal fiscal year 2018/19 alone.

Natural Resource Protection:

- 2015 Publication of the *Low Impact Development and Green Infrastructure Guidance Manual*;
- 2011 Adoption of the *Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines*.
- 2017 Updated shallow groundwater dependent ecosystem protections in the Comprehensive Plan, and added County regulated riparian habitat to regulatory floodplains as areas to be avoided during the entitlement process.

Emergency Services:

- 2019 Updated *Flood Response Field Manual*.
- Initiated multi-agency annual flood exercises.
- 2017 Approval of the *Multi-Jurisdictional Hazard Mitigation Plan*.
- 2019 Established inundation area early warning systems in cooperation with Pima County Office of Emergency Management and first responders.

Structural Projects:

- Completed the Paseo de las Iglesias project along the Santa Cruz River. This project used a design featuring a low flow channel and a restored overbank habitat and multi-use recreation area considered a model for future projects.
- Removed over 300,000 cubic yards of sediment from the Rillito and Santa Cruz River channels.
- Pantano bank protection.
- El Corazon del Norte, bank protection, habitat restoration and amenities.
- Arroyo Chico Cherryfield detention basin.
- Mission View detention basin.

Public Information:

- Established PPI Committee and annually updated the program.
- Published the Living River Report for 5 years.
- Hired an outreach project manager.

In addition to these highlights, throughout the five-year period covered by this Floodplain Management Plan, the District continued its program of conducting local flood hazard studies, including:

- Sabino Vista
- Tucson Mountains Unnamed Wash #10
- Caliente Hills
- Airport Wash
- Pima Wash
- Catalina Mountains Unnamed Wash #4
- Indian Hills Wash
- Red Butte/ Saginaw Hill
- Upper Santa Cruz River RiskMAP
- North Ranch
- Christmas Wash
- Santa Cruz River
- El Rio Wash
- Alamo Wash

Each of these include elements of all six Activities as many identify hazards, structural needs or higher regulatory standards.

7.3 Ongoing Program Improvements

Again, these are by the categories of activities identified in the CRS Manual.

Preventative

Drainage System Maintenance: During the last five years, the District expanded staff to provide improved drainage infrastructure inspection and monitoring capabilities. This has resulted in increased preventative drainage maintenance including removal of aggraded sediments from channels. Studies of aggradation and channel capacity remains a priority for the next five years to better direct this work.

Planning, Zoning and Open Space Preservation: The District implements and continues to improve upon numerous nonstructural programs to address flood hazards, such as; regulation of land use in floodplains, developing watershed plans, river and basin management studies to delineate flood hazards, identify improvements and avoid future risks, and floodprone land acquisitions.

Floodplain Regulations: The Ordinance provides goals and objectives to guide nonstructural activities, regulate land use and reduce the potential for future flood damages. District staff and the Flood Control District Advisory Committee review the Ordinance and associated standards annually for consistency with land development patterns and the NFIP.

Stormwater Management: The District develops watershed and basin management plans as strategic floodplain management tools to address the unique physical and hydrological characteristics of each watershed and major watercourse. The goal of watershed planning is to control the impact of urbanization within each watershed to minimize the potential for increased flood peaks and erosion that may occur with urbanization. Watershed plans provides guidance for acquisition of floodprone land, protect natural conditions, urban stormwater controls and detention, riparian habitat protection, and control of soil erosion. Watershed studies include topographic and aerial mapping to allow for improved identification of flood and erosion risks and to prepare improved floodplain mapping. Within an urbanizing watershed, basin management plans address the need for stormwater detention to minimize the potential for increased flood peaks with development.

Property Protection

Acquisition and Relocation: The Floodplain Land Acquisition Program continues and this year alone the Infrastructure Management Division removed 16 structures from AO Zones in the last five years. This effort to mitigate affected property in the lowlands complements significant donations in headwater riparian areas.

Natural Resource Protection

Land Stewardship Program: With extensive ownership and maintenance responsibility for major rivers and tributaries, the District employs inspectors and land managers. Maintenance of the District's capital improvements requires a large budget. As such preservation and restoration of natural

floodplain function has been identified as a key method to protect public safety while controlling cost. In addition to an Infrastructure Management Division, the District has established a Land Stewardship Program to address this need. Program staff including naturalists and restoration experts are conducting detailed inventory and management plans for these areas. These plans establish best practices including fencing, erosion control, water harvesting and habitat restoration.

Emergency Services

Hazard Warning: In part due to public concern over several major flood events and the recognition that transportation infrastructure is at risk, the District has embarked on an expansion of the ALERT network including inundation area mapping and outreach. Furthermore, the District is greatly improving the manner in which we convey flood threat information to the public and other agencies.

Hazard Response Operations: The District revised the *Flood Response Field Manual* in 2019. It now includes pre and post-flood procedures for staff conducting investigations, communication protocols and specific items of concern by watershed including:

- Data Gathering Needs
- Frequently Flooded Structures and Properties Subject to Damage
- Infrastructure; and
- Safety Concerns

This report provided the initial seed list of problems by watershed contained in Appendix C. Input from the Planning Committee, surveys, informational meetings and events supplemented this list. Staff then aggregated this information to arrive at the final problem and opportunity list included in Section 5.6.

Hazard Threat Recognition: Natural hazard mitigation planning is the process of identifying and implementing programs to reduce or eliminate the loss of life and property damage that may result from natural hazards such as floods. Through the Disaster Mitigation Act of 2000, the federal government has established criteria for state and local governments to develop a community-based hazard mitigation plan for natural and manmade disasters. Pima County, with assistance from the Arizona Department of Emergency Management, has developed an Multi-jurisdictional Hazard Mitigation Plan for Pima County and incorporated communities therein. The basic steps for mitigation planning include:

- *Organization of Resources*. For state and local communities, the initial focus is gathering resources, including identifying the necessary technical expertise and community agencies in hazard mitigation.

- *Assess Risks*. Identify the characteristics and potential consequences of natural hazards and the potential risks and damages.

- *Develop a Mitigation Plan.* Prioritize structural and nonstructural approaches to avoid or minimize damages by developing of a formalized hazard mitigation plan.

- *Implementation of the Plan and Monitoring of Progress.* Implementing specific mitigation projects, adopt land use regulations to avoid future hazards, periodic evaluation of the effectiveness of the plan, and project improvements and regulations in reducing or avoiding damages and loss from natural hazards.

Through annual reports and five-year Comprehensive Reports, the District has been formally reporting and evaluating flood hazard mitigation strategies. These hazard mitigation strategies include floodplain management, riparian habitat protection, and capital improvements.

The Department of Emergency Services and Homeland Security is the agency responsible for coordinating with local, state and federal agencies for hazard mitigation and emergency response, including Early Warning Dissemination. The District provides the local technical expertise for flood and erosion hazards, including providing Flood Threat Recognition and mitigation project implementation.

In 2017, the County Office of Emergency Management updated this plan, which FEMA has credited as the CRS Floodplain Management Plan for Pima County, as it receives formal approval by the Board and other participating jurisdictions. This report incorporates the HMP by reference and hazard exposure and mitigation activity materials are cross-referenced.

Structural Projects

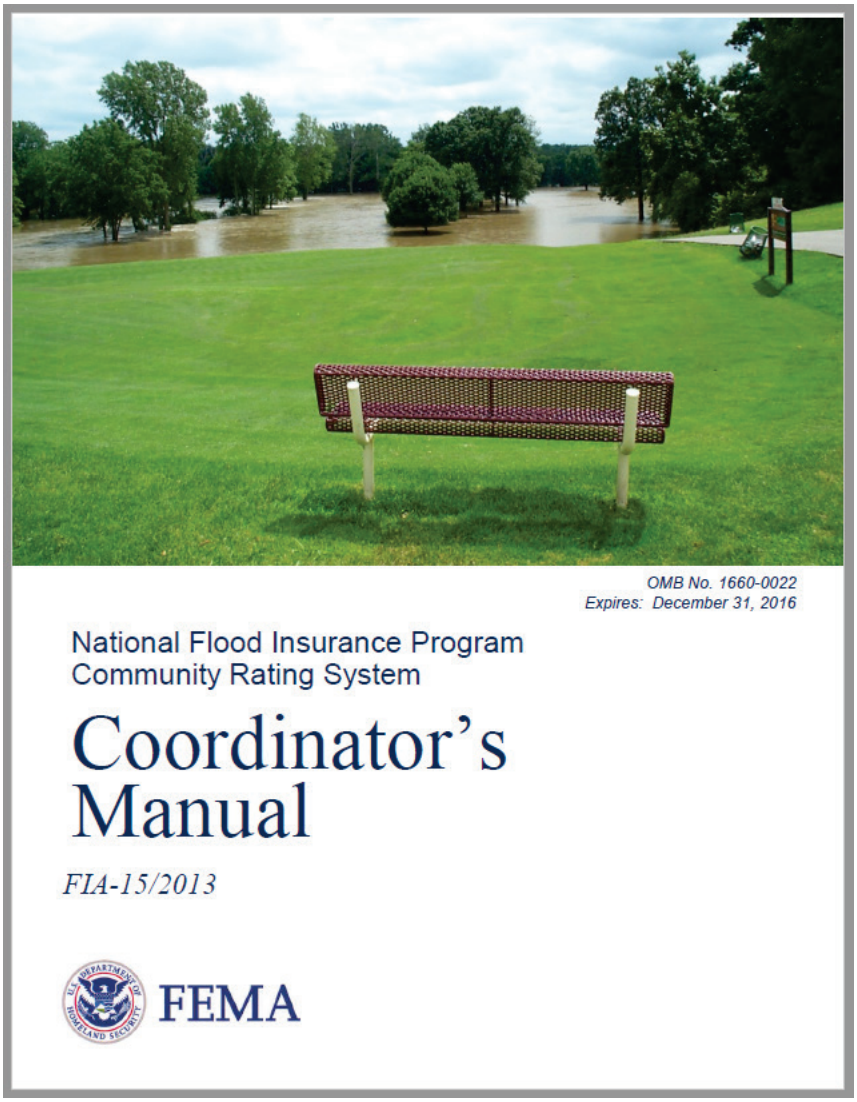
Descriptions of completed and ongoing Capital Improvements Projects are included along with the entire drainage system and restoration projects in Appendix D.3 and shown on the Action Plan maps included in Appendix C and the project webpage.

Public Information

Public education and awareness of potential severe storm and flood hazards is a vital component of the floodplain management strategy. Education includes addressing issues in the NFIP for homeowners and businesses. The District plans to continue and expand educating professionals in real estate, building and manufactured housing regarding disclosure and compliance issues; and educating citizens on flood preparedness, including flood insurance, family safety planning and safety tips about entering flooded washes. While existing programs are extensive and have been highly rated, in the last five years the District developed a formal Program for Public Information to improve our outreach by engaging stakeholders in the analysis of target audiences and message delivery. Step 5 contains information about the PPI. During the next five years, the District shall implement and update this program. Specific new outreach activities include developing courses for realtors and newcomer packages for major employers, along with modernizing the look of older materials and reevaluating the use of printed notices. Appendix B includes the entire PPI.

Public involvement and hazard awareness is the key to public safety

For CRS purposes, the 6 categories of activities identified in the Coordinator's Manual and described above are scored in four categories due to overlap. Appendix D provides a detailed review of District activities as scored during the previous audit.



Step 8.0 RECOMMENDED ACTION PLAN

8.1 Capital Improvements Plan

Since its inception, the District has completed capital improvements to reduce the risk of flood damages to private and public improvements in a manner that provides flood mitigation as well as restoration, education, exercise and recreation. The District develops both an annual and a five-year Capital Improvement Plan to address the needs within each jurisdiction or geographical area. Step 5 describes projects completed during the current five-year reporting period. The District develops the plan based on available funding and recommendations from watershed plans, jurisdictions and community members. The District's Capital Improvement Plan addresses:

- *Previous Flood Damages*. The District prioritizes projects that address previous flood damages and areas subject to repetitive flooding and drainage problems.
- *Regional Programs*. The District's projects and programs are regional and provide countywide benefits.
- *Downstream Benefits*. The District has developed master management plans for the major watercourses and watersheds to reduce the hazards from flooding and erosion that also consider downstream impacts and benefits.
- *Evolving Urban Edge*. The District has constructed a significant amount of bank stabilization and flood control improvements in existing urban and growth areas. Regulations and projects in growth areas and the evolving urban edge help new development to avoid future flood hazards.

Projects included in the fiscal year 2020/21 budget:

- %UDTON Tohono O'odham Nation Urban Drainage
- 4F2205 Arroyo Chico Detention Basin
- 5BFACQ Floodprone Land Acquisition Program
- 5CDDONB Cañada del Oro Wash North Bank: Thornydale to I-10
- 5CREST Historic Canoa Ranch Restoration
- 5ELVDO Airport Wash/El Vado Wash Drainage Improvements
- 5GVDW6 Green Valley Drainageways
- 5HASOL Rillito River Upper Bank at Hacienda del Sol
- 5LKMNA El Rio Preserve Bank Protection
- 5PANGC Pantano Grade Control Structures
- 5RMPAF Riparian Mitigation Acquisition Fund
- 5RMPAF Riparian Mitigation Project Acquisition Fund
- 5RMPLN Major Watercourse Infrastructure Management
- 5RRWMP Rillito River Maintenance Projects
- 5RRWMP Rillito River Wash Maintenance Project
- 5RUPRR Ruthrauff, Gardner lane Union Pacific Railroad Culvert

- 5SCRIR Santa Cruz River Irvington to Drexel Improvements
- 5SCRMP Santa Cruz River Maintenance Projects
- 5SCRMP Santa Cruz Wash Maintenance Project
- 5SCRPR Santa Cruz River Pavement Rehab
- 5SLIV Santa Cruz River Living River Management Plan
- 5TDSCW Tucson Diversion Levee – Swan to Craycroft Improvements
- 5URBAD Urban Drainage
- 5URBAD Urban Drainage
- 5XMSWS Christmas Wash Drainage Improvements

The Board appointed Flood Control District Advisory Committee revisits these priorities annually prior to budgeting and that process is ongoing. The list above contains only funded projects. Other projects excluded include those identified, but may not receive funding because the District could not acquire right-of-way or owners consent. Project needs identified on the 10-year horizon but not included in next year's budget include:

- ACPLKN Arroyo Chico – Plummer to Kino
- AJOGIB Ajo Gibson Arroyo
- ALAMOW Alamo Wash Palo Verde High School Detention Basin
- ALERTTU ALERT Upgrades
- BRAWLY Brawley wash – Restoration on City of Tucson Water Farms
- BRONXW Bronx Wash Flood Mitigation
- CDOWS1 Cañada del Oro Wash: Capacity Restoration
- CENGA1 Cienega Creek Erosion Stabilization
- CENGA2 Cienega Creek Riparian Restoration
- DTLINK Downtown Links
- FINROC Finger Rock Wash Channel Construction
- HILAND Oro Valley Highland Wash
- LEEMOR Lee Moore Wash Regional Basins
- LOOPIM Loop Ongoing Improvements & Maintenance
- PANTW2 Pantano Wash: Rancho del Lago Erosion Mitigation
- RILTO2 Rillito River: Capacity Restoration
- RIPMIT Riparian Mitigation Project Program
- SCRAVL Santa Cruz River: Avra Valley Levee Augmentation
- SCRCON Santa Cruz River: Constructed Recharge
- SCRCOR Santa Cruz River: Cortaro Road Grade Control
- SCRCRR Santa Cruz River: Canoa Ranch Restoration
- SCROWB Santa Cruz River: Old West Branch – Silverlake to Confluence
- SCRSUN Santa Cruz River: Sun Corridor
- TUCDIV Tucson Diversion Channel
- WILNAV City of Tucson Wilson - Navajo Flood Mitigation

- WNTWTH Wentworth & Tanque Verde Creek Channel Modification

The map below is a sample of the Action Plan maps prepared to show activities including capital improvements. Appendix C contains these maps for each watershed, and they are available separately in large format on the project webpage watershed tabs.

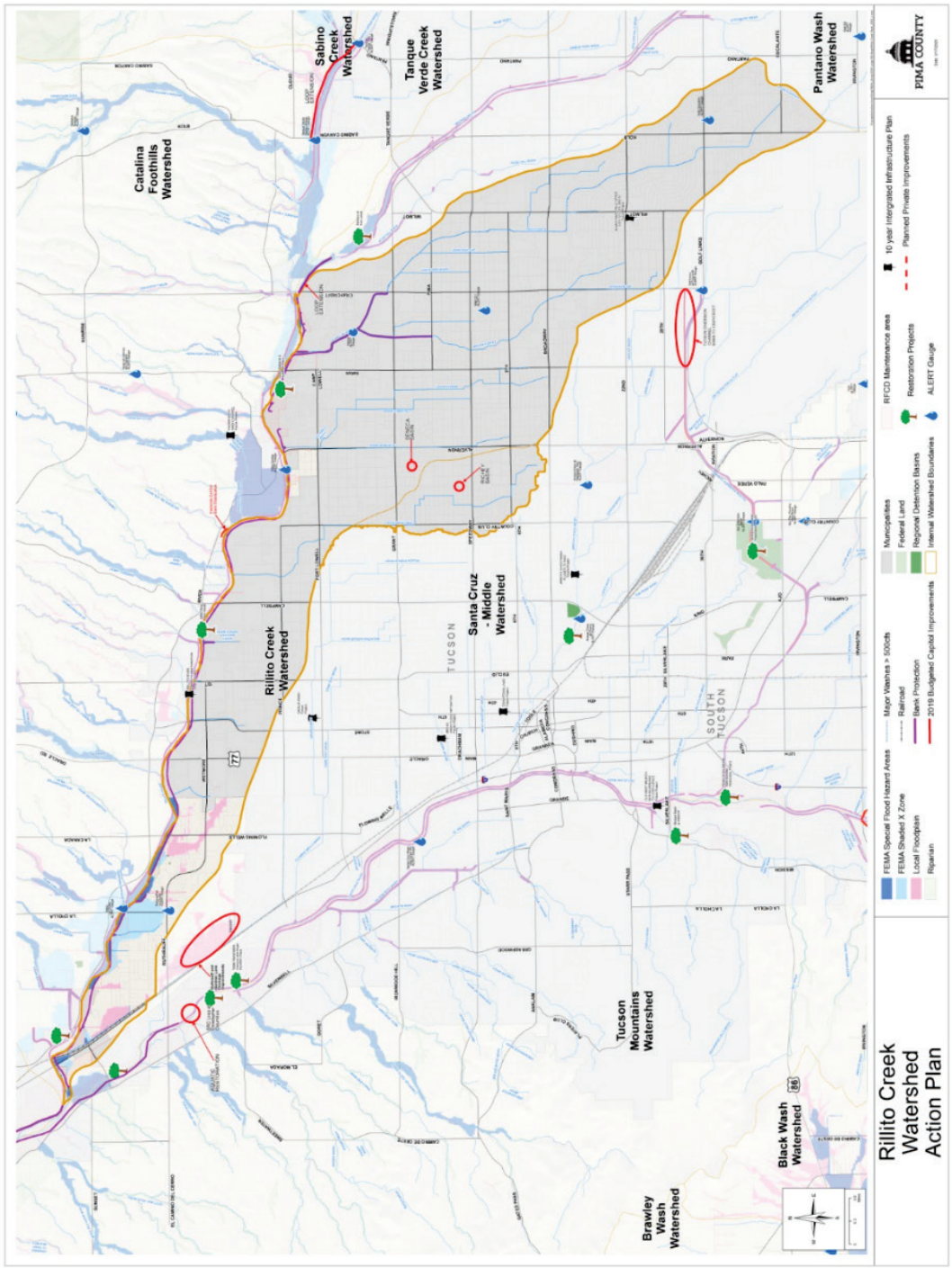


Figure 30 - Action Plan Map Sample 2

8.2 Future Needs

Despite these successes and the support of elected officials, environmental change (some climate related) including increased frequency and severity of storms and wildfires have resulted in a greater need for continued monitoring. During the program period, which followed a period of drought and fire, significant flood events produced large shifts in sediment load. In some locations, undercutting impacted erosion protection and in others, aggradation resulted in loss of channel capacity. This has the potential to increase flood risk on properties previously not impacted by FEMA floodplains. In order to address this problem on a region-wide basis, the District negotiated an Intergovernmental Agreement with the City of Tucson whereby the District is responsible for maintenance of major watercourses and the associated river park system. In the future, annual monitoring of sediment load will be required along with corrective measures to ensure designed conveyance capacity exists. Outreach to impacted communities will remain a priority.

The District plans to add gages and develop additional inundation maps for gaged watercourses in order to improve flood warning. Development of these maps and associated public messaging is a priority. Training for and coordination with first responders should be greatly increased. This includes participating in updating the Pima County Multi-Jurisdictional Hazard Plan, related Emergency Operations Plan(s) and especially exercises or drills.

The recommended Action Plan below includes multiple ongoing and new activities in each of the six CRS categories and that address each of the identified problems, opportunities and goals.

8.3 Action Plan

The Planning Committee approved the Action Plan presented below at the conclusion of Meeting 8.

Table 5 - Action Plan

			FMP Goals												
Ref #	Actions	Watershed Specific Actions	1	2	3	4	5	6	7	8	Chapter - Recommendation	Priority	Cost Range	Funding Source	Responsible Party	Deadline
1.1	**Implement Existing Preventive Activities**															
1.1.a	Participate in the National Flood Insurance Program Community Rating System	Countywide activity**	X	X	X	X	X	X	X	X	8, AC		$	District Budget	RFCD	2020
1.1.b	Enforce Pima County Code including Floodplain Management Ordinance, Comprehensive Plan, Zoning and other standards and policies	Countywide activity	X	X	X	X	X	X			8, AC		$			
1.1.c	Operate, inspect and maintain Flood Control lands and facilities	Countywide activity	X	X			X	X			8, AC		$$$			
		Bellbrook channel repairs (CF)					X	X			8, AC		$$			
		Mesquite Ranch Wash sediment removal (Pantano)					X	X			8, AC		$$			
		Mitigate Los Reales erosion (SCRM)					X	X			8, AC		$$			
		Mitigate Sonoran Ranch erosion (Brawley)					X	X			8, AC		$$			
		Monitor and maintain bank protection (SCRL)					X	X			8, AC		$$			
		Monitor and remove vegetation (SCRM)					X	X			8, AC		$$			
		Palo Verde Rd channel grading (Pantano)					X	X			8, AC		$$			
		Repair Continental Ranch bank protection erosion (SCRL)					X	X			8, AC		$$$			
		Repair Iberia sediment and sink holes (BW)					X	X			8, AC		$$			
		Repair Michael Perry Park bank protection (Pantano)					X	X			8, AC		$$			
		Repair SCR Old West Branch Bank protection erosion at Silverlake (SCRM)					X	X			8, AC	High	$$			
		Minor sediment control activities					X	X	X		8, AC		$			
		Create Drainage System maintenance plans including vegetation, sediment, and debris (SCRL SCRM, Rillito, Pantano, CDO)									8, AC					
		Create open space management plans and consider location specific vegetation maintenance practices (AV, CC, CDO, SCRM, SCRU, SCRL, SPR, TVC)	X	X					X		8, AC		$			
		Install controlled access (countywide)	X	X		X					8, AC		$			
1.1.d	Develop and maintain staff expertise	Countywide activity								X	8, AC		$			
1.1.e	Update spatial information periodically	Countywide activity	X		X					X	8, AC		$$			
1.1.f	Participate in interagency reviews including State, Federal and Local project	Countywide & regional activity	X					X		X	8, AC		$			
1.1.g	Participate in regional watershed planning activities to promote uniform standards	Countywide activity								X	8, AC		$			
		Create Intergovernmental Agreements with other jurisdictions (countywide)								X	8, AC		$			
		Coordinate with the City of Tucson for the Santa Cruz River Heritage groundwater recharge project and One Water efforts (SCRM)		X						X	8, AC		$			

Ref #	Actions	Watershed Specific Actions	FMP Goals 1	2	3	4	5	6	7	8	Chapter - Recommendation	Priority	Cost Range	Funding Source	Responsible Party	Deadline
1.2	**New Preventive Activities**															
1.2.a	Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas	Countywide activity	X	X	X				X		4, 5, App. C	L	$	District Budget	RFCD	2020
		Identify areas of shallow groundwater (ACW, Sabino, TVC)	X	X							4, 5, App. C	L	$			2025
		Assess unstable geomorphology (Pantano)							X		4, 5, App. C	L	$			2020
		Establish alluvial fan flow corridors (TF)			X				X		4, 5, App. C	M	$$			2022
		Expand riparian habitat maps to excluded watercourses (TM)	X	X							4, 5, App. C	L	$			2025
		Identify debris flows (ACW, CF, Sabino)							X		4, 5, App. C	L	$			2020
		Identify agriculture diversions (SCRU, SCRM, SCRL, Ajo, AV, LMW)						X			5	M	$			2020
		Identify and map canyon wash floodways (CDO, SCRM, TM, CF)			X	X			X		4, 5, App. C	M	$$			2020
		Identify and monitor erosion on tributaries to the Santa Cruz River (LMW, SCRM, SCRU, TM)						X		X	4, 5, App. C	H	$			2020
		Monitor sand and gravel operations (Pantano, SCRM, SCRL)					X				5	M	$			2020
		Remap the Carmack Wash in the distributary flow area (CDO)			X						4, 5, App. C	M	$			2020
		Work to address issue of sediment placement during road maintenance activities (AV, Brawley, BW, LMW, TF)				X		X		X	5	L	$			2020
1.2.b	Improve floodplain hazard mapping (e.g. New delineations, revise out of date mapping)	Countywide activity	X		X						4, 5, App. C	L	$			2020
		Complete RiskMap & SFHA (SCRU)			X						4, 5, App. C	H	$			2023
		Conduct a detailed floodplain analysis of Pima County Fair Grounds (LMW)			X						4, 5, App. C	H	$			2021
		Conduct detailed mapping of approximate FEMA Special Flood Hazard Areas (Brawley, Altar, BW, TF, TM, SCRM)			X						4, 5, App. C	M	$$			2023
		Conduct floodplain modeling for City of South Tucson (SCRM)			X					X	4, 5, App. C	H	$			2021
		Develop floodplain maps for Rincon Foothills Unnamed Wash #s 8, 9 and 10 (TVC)			X						4, 5, App. C	L	$			2025
		Provide detailed mapping for the area between the Herman's Road and Valencia Road (BW)			X						4, 5, App. C	M	$			2021
		Remap floodplains to confluence with the Tanque Verde Creek (Rillito)			X						4, 5, App. C	M	$			2025
		Remap Twenty-Seven Wash floodplain/floodway (CDO)			X						4, 5, App. C	M	$			2023
		Remap floodplains for Alamo Wash in the City of Tucson (Rillito)			X					X	4, 5, App. C	M	$			2021
		Remap floodplains for Bronx Wash in the City of Tucson (SCRM)			X					X	4, 5, App. C	M	$			2022
		Remap floodplains for Christmas Wash in the City of Tucson (Rillito)			X					X	4, 5, App. C	M	$			2020
		Remap floodplains for Navajo/Wilson Washes in the City of Tucson (SCRM)			X					X	4, 5, App. C	M	$			2022
		Remap floodplains for Silvercroft Wash in the City of Tucson (SCRM)			X					X	4, 5, App. C	M	$			2024
		Remap floodplains for the Roller Coaster Wash (ACW)			X						4, 5, App. C	M	$			2021
		Remap floodplains for the Wyoming and Dakota Washes (SCRM, TM)			X						4, 5, App. C	M	$			2021
		Update Black Wash Administrative Floodway (BW)			X						4, 5, App. C	H	$			2024
		Update floodplain maps for Sopori Wash (SW)			X						4, 5, App. C	M	$			2022
		Identification of flood risks at Sopori and SCR Confluence (SCRU, Sopori)			X					X	4, 5,	H	$			2022
1.2.c	Refine local approximate sheet flood maps and identify flow corridors	Countywide activity	X			X	X	X	X		4	L	$$	Annual Budget	RFCD	2020
		Conduct detailed mapping for remaining local approximate sheetflow floodplains (ACW, BW, Brawley, TF)	X		X						8, AC	M	$$			2021
		Conduct detailed mapping for Sierrita Mountain Road area (Brawley)	X		X		X				8, AC	M	$			2020
		Remap Pistol Hill sheet flow floodplains (Pantano)	X		X		X				8, AC	M	$			2020
1.2.d	Update the Critical Basin map	Countywide activity					X	X		X	8, AC	L	$			2025
		Identify undersized infrastructure (Urban Sub-Watersheds, Rillito, CF, CDO)				X	X		X		8, AC	H	$			2025
		Identify existing development at risk from flooding (Urban Sub-Watersheds, Rillito, CF, CDO)			X	X					8, AC	H	$			2022
1.2.e	Participate in monitoring groundwater change with other responsible partie	Countywide activity		X					X		8, AC	L	$			2020
		Conduct groundwater depth & quality monitoring (CC, AVG, SS, Sopori)		X					X		8, AC	L	$		PAG, DEQ	2020
		Operate Marana High Plains groundwater recharge project (SCRL)		X					X	X	8, AC	H	$$		RFCD	2020
1.2.f	Develop plan to provide controlled access to District lands	Countywide activity	X	X		X					8, AC	L	$			2020
1.2.g	Develop standards for site layout of large scale development in sheet flood areas	Countywide activity			X			X			8, AC	L	$		RFCD, BOR, UA	2021
1.2.h	Develop methods to identify future climate scenarios and upper watershed conditions (e.g. rain on snow, post catastrophic fire, debris flows)	Countywide activity							X		5	L	$		RFCD	2022
1.2.i	Develop criteria for site design and infrastructure at major watercourse confluence areas	Countywide activity (SCRM, TM, CF, TF)	X			X	X		X		8, AC	L	$			2022
1.2.j	Develop criteria to minimize encroachments in regulatory floodplains, erosion hazard areas and riparian habitat during entitlement and permitting processes	Countywide activity	X	X	X	X	X	X	X		8, AC	L	$			2021

Ref #	Actions	Watershed Specific Actions	FMP Goals 1	2	3	4	5	6	7	8	Chapter - Recommendation	Priority	Cost Range	Funding Source	Responsible Party	Deadline
2.1	**Implement Existing Property Protection Actions**															
2.1.a	Provide outreach and assistance on mitigation strategies to the community including obtaining flood insurance	Countywide activity			X		X				8, AC		$	District Budget & private funds	RFCD, developers, & outreach	2020
2.1.b	Implement Floodprone Land Acquisition Program	Countywide activity	X	X			X				8, AC	High	$$			2020
2.1.c	Identify and address maintenance needs of private infrastructure during the entitlement and permitting processes	Countywide activity			X		X				8, AC		$			2020
2.2	**New Property Protection Activities**										8, AC					
2.2.a	Develop standards to address climate change concerns (e.g. Increase design flood elevation and channel freeboard requirements, consider fully vegetated and compound channels in design)	Countywide activity							X		8, AC	**H**	$	District Budget	RFCD, FEMA, & UA	2022
2.2.b	Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance	Countywide activity			X	X	X				8, AC	**H**	$		ADEMA	2024
		Provide assistance to property owners related to bank reclamation (ACW, Sabino, TVC, TM)				X		X			8, AC	**L**	$		RFCD & neighborhood stakeholders	2021
		Conduct drainage infrastructure mapping for City of South Tucson					X			X	8, AC	**H**	$			2020
		Construct drainage improvements in the El Vado Watershed in the City of Tucson (SCRM)					X	X		X	8, AC	**M**	$$			2022
		Construct drainage improvements in the Ruthrauff/Gardner Lane area (SCRM)					X	X			8, AC	**M**	$$			2024
		Construct El Rio Golf Course drainage improvements (SCRM)					X	X			8, AC	**M**	$$			2020
		Evaluate cumulative impacts of lot-splits and identify mitigation (BW, TM)			X						8, AC	**L**	$			2024
		Work with responsible parties to address flooded roads (CDO, LMW, Pantano, Rillito, Sabino, TVC, TF, TM)						X	X	X	8, AC	**M**	$$			2020
2.2.c	Conduct voluntary floodprone land acquisition program outreach to areas impacted by flooding	Countywide activity as needed	X	X			X				5.1.1	**L**	$			2021
		Acquire property rights for effective management (Pantano)	X	X			X				8, AC	**M**	$$		RFCD	2020
		Target floodways and flow corridor areas (BW, Brawley, SCRM, SPR)	X	X	X	X	X				8, AC	**H**	$			2021
2.2.d	Promote use of Green Infrastructure/Low Impact Development techniques during redevelopment	Countywide activity	X		X				X		8, AC	**L**	$			2020
2.2.e	Expand outreach to Homeowners and Neighborhood Associations about the need for and approaches to maintaining private infrastructure	Countywide activity			X		X				8, AC	**L**	$		RFCD & HOAs	2020

Ref #	Actions	Watershed Specific Actions	FMP Goals 1	2	3	4	5	6	7	8	Chapter – Recommendation	Priority	Cost Range	Funding Source	Responsible Party	Deadline
3.1	**Existing Natural Resource Protection Activities**															
3.1.a	Enforce the Riparian Habitat Mitigation Standards during permitting and entitlement processes	Countywide activity	X	X			X		X		5		$	District Budget	RFCD & DSD	2020
3.1.b	Use open space management plans for monitoring, maintaining and protecting the Drainage System and Preserves in collaboration with partners	Countywide activity	X	X			X		X	X	**5**		$$		NRPR	2020
		Monitor base flows (CC, SCRL, SCRM)									8, AC	**High**	$		RFCD, PAG & citizen science partners	2020
3.1.c	Identify, acquire, preserve, restore and enhance the Drainage System and Preserves including riparian habitat and wildlife corridor areas	Countywide activity	X	X					X		4, 5, 7, App C		$$		PCRFCD	2020
		Support work for the Altar Valley Watershed Management Grant (AV)	X	X					X	X			$$$	Grants	NRPR	2020
3.1.d	Invasive species management	Countywide activity	X	X		X			X	X	8, AC		$$	Annual budget, volunteer network & grants	NRPR & NWFD	2020
3.1.e	Coordinate with water owners and entities on ground water recharge and effluent uses	Countywide activity		X					X	X	8, AC		$	District Budget	RFCD, COT, & WWRD	2020
3.2	**New Natural Resource Protection Activities**															
3.2.a	Spatially rectify riparian classification maps	Countywide activity	X	X							4, 5, 7, App C	**L**	$		RFCD and	2020
3.2.b	Refine, expand and implement District natural resource management plans including the Multi-Species Conservation Plan	Countywide activity	X	X							5	**L**	$$		NRPR	2023
		Complete Cienega Corridor Management Plan (CC)	X	X					X		App C	**M**	$$		NRPR	2021
3.2.c	Establish best management practices for and identify utility operators in the Drainage System	Countywide activity	X	X			X	X		X	5	**L**	$		UCC, provide	2024

Ref #	Actions	Watershed Specific Actions	FMP Goals 1	2	3	4	5	6	7	8	Chapter – Recommendation	Priority	Cost Range	Funding Source	Responsible Party	Deadline
4.1	**Implement Existing Emergency Services Activities**															
4.1.a	Operate the flood recognition and warning system	Countywide activity			X	X		X	X	X	8, AC		$$	Departmental Budgets	PCRFCD, USGS, & NWS	2020
4.1.b	Coordinate with other Departments in development of Hazard Mitigation Plans, Emergency Operations Plan Flood Annexes, Flood Response Plans and Grant Applications	Countywide activity			X	X	X	X	X	X	4	**High**	$		RFCD & OEM	
4.1.c	Coordinate with the Office of Emergency Management and sponsor annual events (e.g. exercises, drills and training)	Countywide activity				X				X	8, AC		$			
4.1.d	Identify critical facilities exposed to or isolated by flooding and evaluate level of risk	Countywide activity				X		X	X	X	8, AC		$			
4.2	**New Emergency Services Activities**															
4.2.a	Develop a plan to enhance public safety where roads flood and/or create isolated areas (e.g. reporting, warning, signage, permanent closures, all-weather crossings, automated temporary closures)	Countywide activity				X		X	X	X	4	**H**	$	Departmental Budgets	RFCD, DOT, & OEM	2022
4.2.b	Adopt an All-Hazards Planning Strategy per the Approved Hazard Mitigation Plan (e.g. health, catastrophic fire, extreme weather)	Countywide activity				X		X	X	X	4	**M**	$		RFCD	2020
4.2.c	Expand and update the District's flood threat recognition and integrate it with warning system	Countywide activity				X		X	X	X	4	**H**	$		RFCD, OEM & jurisdictions	2020
		Coordinate with other jurisdictions including the Tohono O'odham Nation on flood warning needs (RS, SC, SR, Tule, SCRU)				X				X	4	**L**	$			2025
4.2.d	Expand inundation mapping coverage for flood warning for use in flood warning system	Countywide activity				X		X	X	X	4	**M**	$			2020
		Create inundation mapping for Black Wash and Gibson Arroyo (BW, Ajo)				X			X		4	**H**	$			2023
4.2.e	Increase pre-event technical assistance to the Office of Emergency Management and first responders including identifying all weather emergency response access routes	Countywide activity				X		X	X	X	4	**H**	$			2022
		Utilize new streamflow gages to warn emergency services of road closures on Silverbell Road (TM)				X				X	App C	**L**	$$			2023
4.2.f	Provide outreach and technical assistance to critical facility operators regarding development of flood response plans	Countywide activity as needed				X	X	X	X	X	4, 5.3.1	**H**	$			2024

Ref #	Actions	Watershed Specific Actions	FMP Goals 1	2	3	4	5	6	7	8	Chapter - Recommendation	Priority	Cost Range	Funding Source	Responsible Party	Deadline
5.1	**Implement Existing Capital Program for Structural Projects**															
5.1.a	Utilize property tax revenues to fund drainage improvements to protect existing development and seek additional funds when available	Countywide activity					X	X		X	8, AC		$$$	District Budget	RFCD & jurisdictions	2020
		Address erosion advancing towards Soldier Trail (ACW)					X	X			8, AC		$$			2021
		Construct bank protection for El Rio Preserve (SCRL)					X	X			8, AC		$$$			2020
		Construct bank protection on the north bank of Canada del Oro Wash between I-10 and Thornydale (CDO)					X	X			8, AC		$$$			2021
		Construct drainage improvements within Christmas Wash and other urban watersheds (SCRM, Rillito)					X	X			8, AC		$$$			2020
		Construct Highlands Wash drainage improvements (CDO)					X	X			8, AC		$$$			2023
		Construct Sells Wash bank protection (SR)					X	X			8, AC		$$			2025
		Coordinate with the City of Tucson stakeholders on planned drainage improvements along Silverbell Road (SCRM, TM)					X	X			8, AC		$$			2020
		Remove un-necessary diversions (BW, Brawley)					X	X			8, AC		$$			2025
		Stabilize the Pantano Wash and tributaries (Pantano)					X	X			8, AC	High	$$$			2025
		Construct Wentworth Wash Channel (TVC)					X	X			8, AC		$$			2024
		Mitigate erosion at Hacienda del Sol confluence (Rillito)					X	X			8, AC		$$			2020
		Ruthrauff area drainage improvements (SCRM)					X	X			8, AC		$$$			2025
5.1.b	Complete new river and basin studies to identify needs and develop alternatives	Countywide activity	X	X	X		X	X	X	X	8, AC		$$			2020
		Coordinate with the Town of Marana on implementation of their Marana Drainage Master Plan (SCRL)			X		X	X		X	8, AC		$$			2020
		Create Basin Management Plans (BW, AV, SCRU)			X		X	X		X	8, AC		$$			2023
		Develop Santa Cruz River Management Plan (SCRL, SCRM, SCRU)			X		X	X		X	8, AC		$$			2020
5.1.c	Develop a 10-year plan for prioritizing the design and construction of capital projects	Countywide activity			X		X	X		X	8, AC		$$			2020
5.1.d	Design flood control improvements using a multi-function approach including infiltration, water quality, recreation and habitat enhancement	Countywide activity					X	X		X	8, AC		$$			2020
5.2	**New Structural Project Activities**															
5.2.a	Identify potential locations for Green Infrastructure/Low Impact Development projects	Countywide activity	X	X					X	X	8, AC	L	$	District Budget	RFCD	2020
		Coordinate with the Altar Valley Conservation Alliance to implement watershed restoration (AV)	X	X						X	8, AC	H	$			2020
		Loop and Trail Enhancements (CDO, Rillito, Pantano, SCRL, SCRM, SCRU)	X							X	8, AC	L	$$			2020
		Coordinate with City of Tucson on Proposition 407 projects (Rillito, Pantano, SCRM)	X							X	8, AC	H	$			2020
5.2.b	Apply Green Infrastructure/Low Impact Development design principles in District projects	Countywide activity	X	X					X		8, AC	L	$			2020
5.2.c	Prohibit the use of levees and floodwalls except as necessary to protect existing development	Countywide activity	X				X				8, AC	H	$			2020
5.2.d	Consider Future Conditions including climate and land use changes in design	Countywide activity					X	X	X		8, AC	H	$			2023
5.2.e	Develop and implement alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)	Countywide activity	X	X			X		X		8, AC	H	$$$			2023
		Develop and implement an erosion mitigation plan using natural channel design techniques (AV, BW, Brawley, CC, LMW, Pantano, Sabino, SCRM, SCRL)	X	X					X		8, AC	M	$$			2020

Ref #	Actions	Watershed Specific Actions	FMP Goals 1	2	3	4	5	6	7	8	Chapter - Recommendation	Priority	Cost Range	Funding Source	Responsible Party	Deadline
6.1	**Implement Public Information Activities**															
6.1.a	Implement the Program for Public Information	Countywide activity as needed	X		X	X	X			X	8, AC		$	District Budget	RFCD, jurisdictions & outreach partners	2020
6.1.b	Provide a system for the community to receive technical assistance or to address drainage concerns	Countywide activity as needed			X		X				4		$			
6.1.c	Coordinate outreach with local municipalities to promote consistent messages among the regions jurisdictions	Countywide activity as needed								X	5	High	$			
6.1.d	Provide a regional federal map repository	Countywide activity as needed								X	5		$			
6.1.e	Provide map information services in unincorporated Pima County	Countywide activity as needed			X						8, AC		$			
6.2	**New Public Information Activities**															
6.2.a	Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)	Countywide activity as needed	X	X	X	X	X	X		X	4, 5.3	L	$$	District Budget	RFCD, OEM, jurisdictions & outreach partners	2020
		Conduct targeted outreach about protection of vegetation and riparian habitat to prevent or reduce drainage runoff problems (TF)	X	X	X						8, AB	M	$			2021
		Conduct targeted outreach about improvements to nonconforming use structures (ACW, TVC)			X						8, AB	H	$			2021
		Conduct targeted outreach to property owners in the vicinity of the break-out of the Brawley Wash below 3 Points Bridge (Brawley)			X						8, AB	H	$			2021
		Conduct targeted outreach to property owners within the floodway (BW)			X	X					8, AB	H	$			2021
		Identify and conduct targeted outreach to areas which can get cut-off during flood events (ACW, SPR, LMW, AVG, TM)			X	X				X	8, AB	H	$			2021
		Promote flood insurance with Increased Cost of Compliance coverage for homes in the vicinity south of Irvington Rd. and east of San Joaquin Ave (SCRM)			X		X				4, 7, App C	H	$			2021
		Provide outreach on the availability of private road and drainage easement technical assistance (BW, Brawley, SCRM, TM)			X	X					4, 7, App C	M	$			2022
		Provide outreach promoting assistance available to homeowners in the vicinity of Oriole Circle and Mayes Place (SCRM)			X	X					4, 7, App C	H	$			2020
		Provide outreach promoting assistance available to homeowners in the vicinity of TRS131332 (SCRM)									4, 7, App C	M				2023
6.2.b	Create on-line crowd source reporting platform	Countywide activity			X	X				X	8, AB	L	$			2021
6.2.c	Provide regional local map repository	Countywide activity			X					X	8, AB	L	$			2023
6.2.d	Establish message partnerships with community based organizations serving access & functional needs populations	Countywide activity									4, 8	H	$			2021

The Action Plan recommended by the Planning Committee includes multiple actions in each goal, CRS activity category, and watershed.

The following watershed abbreviations indicate the location of these detailed actions.

URBAN

- ACW Agua Caliente Wash
- AC Arivaca Creek
- BgW Big Wash
- BW Black Wash
- Brawley Brawley
- CDO Cañada del Oro
- CF Catalina Foothills
- CC Cienega Creek
- LMW Lee Moore Wash
- Pantano Pantano Wash
- Rillito Rillito Creek
- Rincon Rincon Creek
- SC Sabino Creek
- SCRL Santa Cruz River Lower
- SCRM Santa Cruz River Middle
- SCRU Santa Cruz River Upper
- TVC Tanque Verde Creek
- Ajo Tenmile/Gibson Arroyo
- TF Tortolita Fan
- TM Tucson Mountains

RURAL

- AV Altar Valley
- AVG Aguirre Valley/Green Wash
- RS Rio Sonoyta
- SC San Cristobal
- SPR San Pedro River
- SS San Simon Wash
- Sopori Sopori Wash
- Tule Tule Desert

Countywide = Unincorporated Pima County

Step 9.0 ADOPTION

The Planning Committee and District management and staff, recommend approval of the Floodplain Management Plan and in particular the Action Plan. With the leadership of the CRS Coordinator, staff prepared this plan in consultation with a large stakeholder committee as directed by Board Resolution 2018-FC 6 and as described in the CRS Manual. This committee included the following private sector members:

- Catalina Foothills Association;
- Coalition for Sonoran Desert Protection;
- Community Water Coalition;
- Coronado National Forest
- Country Financial;
- Farmers Investment Corporation;
- Metropolitan Pima Alliance;
- Pima Association of Governments;
- Pima County Development Services Department;
- Pima County Natural Resources, Parks and Recreation Department;
- Pima County Regional Flood Control District;
- San Xavier District of the Tohono O'odham Nation;
- Southern Arizona Homebuilders Association;
- Tucson Association of Realtors;
- Tucson Audubon Society;
- Tucson Mountains Association;
- University of Arizona Planning Program; and
- Watershed Management Group.

The CRS Coordinator kept representatives from neighboring jurisdictions informed throughout the process and provided them with the opportunity to provide input via the Flood Control District Advisory Committee, individual interviews and group meetings. This committee includes one member appointed by each incorporated jurisdiction, and one from each Supervisor District. Furthermore, staff from the following County departments participated in the Planning Committee meetings to provide expertise:

- Communications
- Department of Transportation
- Flood Control District
- Office of Emergency Management

In addition, District staff, conducted or participated in over 50 public meetings, interviews and events to describe the process, plan and receive feedback. This included:

- Arizona Planning Association;
- American Public Works Association Southern Arizona Chapter;
- Cadden Property Management;
- City of Tucson
- City of South Tucson
- Community Water Coalition Forums at Ward 3;
- Earth Day at the Children's Museum;
- Metropolitan Pima Alliance Board Meetings;
- Neighborhood and homeowners associations;
- Pima Association of Governments Environmental Planning Advisory Committee;
- Southern Arizona Home Builders Association Technical Committee;
- Santa Cruz River Meet Yourself;
- Sustainable Action Plan for County Operations Open House;
- Town of Marana;
- Town of Sahaurita;
- Oro Valley Stormwater Commission;
- Tohono O'odham Nation
- Tucson Meet Yourself; and the
- Utility Contractors Coordinating Committee.

Throughout these processes and as indicated by the survey results, the support and need for the recommended Action Plan is high. Therefore, on April 7 the Planning Committee requests that the Board approve this Floodplain Management Plan via the formal DRAFT Resolution below.

PIMA COUNTY

FLOOD CONTROL

Approval Resolution

A RESOLUTION OF THE PIMA COUNTY FLOOD CONTROL DISTRICT BOARD OF DIRECTORS APPROVING A FLOODPLAIN MANAGEMENT PLAN AS PART OF THE NATIONAL FLOOD INSURANCE PROGRAM'S COMMUNITY RATING SYSTEM

The Board of Directors of the Pima County Flood Control District finds:

1. Pima County has experienced severe flood disaster events causing significant damage to public and private property, including homes and businesses, resulting in a need for insurance coverage for those who may be exposed to flood risks.

2. Relief from the economic hardships of flood damage is available in the form of federally subsidized flood insurance as authorized by the National Flood Insurance Act of 1968 and its subsequent amendments.

3. The National Flood Insurance Program (NFIP) is a federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding.
4. The Pima County Regional Flood Control District (District) participates in the NFIP's Community Rating System (CRS) which provides a framework necessary for a community's actions and efforts in meeting the three goals of: (1) reduction of flood losses;

(2) facilitation of accurate insurance ratings; and (3) promotion of awareness of flood insurance.

5. As part of the CRS, communities are encouraged to exceed minimum standards and in doing so qualify for a reduction in flood insurance premiums for policy holders, with a current premium discount of up to 25% within unincorporated Pima County.

6. The District plans to further exceed the minimum NFIP standards through the approval and implementation of a Floodplain Management Plan (FPM).
7. The FMP was a committee driven planning process including stakeholder involvement, hazard assessment, and identification of mitigation activities important to flood safety and the protection the natural beneficial functions of floodplains.

8. To ensure internal and external stakeholders involved in the full scope of NFIP activities are engaged throughout the planning and implementation process individuals from the following Pima County Departments participated in the Planning Committee: Administration, Communications, Development Services, Flood Control, Public Works and Office of Emergency Management. Additionally stakeholders representing the interests of groups such as the following were invited to participate in the Planning Committee: Arizona Transportation Builders Association (utilities), Community Water Coalition (environmental), Metropolitan Pima Alliance (business/major employers), Southern Arizona Homebuilders (builders), Tucson Mountain Association (homeowners/floodplain residents), and Tucson Association of Realtors. Stakeholders not participating directly in the Planning Committee are to be contacted individually and the general public will be invited to participate in surveys and at least two public meetings to be held in impacted areas.

9. A component of the FMP includes incorporating the previously approved Program for Public Information, Repetitive Loss Area Analysis, Flood Insurance Coverage Assessment and a Coverage Improvement Plan that requires promoting of the purchase of or an increase in coverage of flood insurance.

10. Pima Prospers Flood Control and Drainage Element Goal 2 Implementation Measure D is "Create and adopt a Watershed Management Plan which identifies the watersheds impacting Pima County, their drainage characteristics, regulatory and infrastructure needs."

NOW, THEREFORE, BE IT RESOLVED, that the District's Board of Directors hereby:

1. Approves the Floodplain Management Plan recommended by the Planning Committee; and

2. Directs the District to engage the Planning Committee consisting of staff and stakeholders per NFIP guidelines during implementation;

3. Authorizes District staff to do all things necessary to implement the Plan.

PASSED AND ADOPTED this ___ day of _____, 2020.

_____
Chair, Board of Directors

ATTEST:

_____
Clerk of the Board

APPROVED AS TO FORM:

_____

Step10.0 IMPLEMENTATION

10.1 Cooperation, Coordination and Consultation

Increasing project costs and complexities, including ownership and multi-functional scopes, necessitate the need for continuing to cooperate, coordinate and consult with stakeholders on program activities including all six, CRS activity categories. The District engages stakeholders as new projects are developed and implemented on an individual basis through our budgeting process. Furthermore, the Planning Committee has agreed to participate in implementing and updating the plan. Several of the actions identified specify working with partners. This includes coordinating flood warning with the Tohono O'odham Nation and Office of Emergency Management as well as consulting with neighboring jurisdictions on basin studies and capital improvements, cooperating on flood map services and outreach, and consulting neighborhood and citizen groups in drainage system restoration and management efforts.

10.2 Plan Approval and Updates

Following approval by the board, over the next five-year period, the District shall implement the activities identified in the Action Plan. Multiple activities in each of the six categories authorized by the NFIP have been included. Staff will engage the Planning Committee in evaluating implementation of this Action Plan and each element on an annual basis. Staff shall prepare and provide to FEMA auditors, the County Administrator and Board an annual Floodplain Management Plan progress report. Annually, the District will review:

- Any floods that occurred during the previous year;
- Drainage (hazard) and land use (exposure) changes that indicate emerging priorities; and
- Progress made towards implementing each element of the Action Plan.

The District will update the entire Plan, following the CRS process every five years, present it to the District Board of Directors for approval; and publish it on the project website to provide State of Arizona comprehensive program reports and to exceed NFIP CRS requirements. The District also posts Annual Reports and submits them to the Board.

APPENDICES

Appendix A- FMP Planning Process Initiation Resolution

RESOLUTION NO. 2018-FC_6___

A RESOLUTION OF THE PIMA COUNTY FLOOD CONTROL DISTRICT BOARD OF DIRECTORS APPROVING INITIATION OF A FLOODPLAIN MANAGEMENT PLAN PROCESS AS PART OF THE NATIONAL FLOOD INSURANCE PROGRAM'S COMMUNITY RATING SYSTEM

The Board of Directors of the Pima County Flood Control District finds:

1. Pima County has experienced severe flood disaster events causing significant damage to public and private property, including homes and businesses, resulting in a need for insurance coverage for those who may be exposed to flood risks.

2. Relief from the economic hardships of flood damage is available in the form of federally subsidized flood insurance as authorized by the National Flood Insurance Act of 1968 and its subsequent amendments.

3. The National Flood Insurance Program (NFIP) is a federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding.

4. The Pima County Regional Flood Control District (District) participates in the NFIP's Community Rating System (CRS) which provides a framework necessary for a community's actions and efforts in meeting the three goals of: (1) reduction of flood losses; (2) facilitation of accurate insurance ratings; and (3) promotion of awareness of flood insurance.

5. As part of the CRS, communities are encouraged to exceed minimum standards and in doing so qualify for a reduction in flood insurance premiums for policy holders. Based on the District's floodplain management efforts, residents in unincorporated Pima County currently enjoy a premium discount of up to 25%.

6. The District plans to further exceed the minimum NFIP standards through the design and implementation of a Floodplain Management Plan (FPM).

7. The FMP is a region-wide planning process including stakeholder involvement, hazard assessment, and identification of mitigation activities important to flood safety and the protection the natural beneficial functions of floodplains.

8. A component of the FMP includes incorporating the previously approved Program for Public Information, Repetitive Loss Area Analysis, Flood Insurance Coverage Assessment and a Coverage Improvement Plan that requires promoting of the purchase of or an increase in coverage of flood insurance.

9. Pima Prospers Flood Control and Drainage Element Goal 2 Implementation Measure D is "Create and adopt a Watershed Management Plan which identifies the watersheds impacting Pima County, their drainage characteristics, regulatory and infrastructure needs."

NOW, THEREFORE, BE IT RESOLVED, that the District's Board of Directors hereby:

1. Directs District staff to prepare for approval a written Floodplain Management Plan;

2. Directs District staff to engage the public in the Floodplain Management Plan process, including creation of a Planning Committee consisting of staff and stakeholders per NFIP guidelines; and

3. Authorizes District staff to do all things necessary to implement this Resolution.

Passed and adopted, this 2nd day of October, 2018.

Chairman, Board of Directors

ATTEST:

Clerk of the Board

APPROVED AS TO FORM:

Deputy County Attorney
KELL OLSON

Appendix B – Approved PPI

PIMA COUNTY
FLOOD CONTROL

2019 Program for Public Information

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Background

The Community Rating System (CRS) is a program of the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP). The CRS provides guidelines for delivery and evaluation of programs or projects that meet and exceed the minimum requirements of the NFIP to mitigate flood risks. Using a point system to rate those projects, CRS provides an opportunity for participating communities to reduce flood insurance premiums for their constituents.

The Pima County Regional Flood Control District (District) administers the CRS program within unincorporated Pima County. The District selects programs and projects that provide real benefits with respect to floodplain management and flood risk reduction. Based on our current designation as a Class 5 community, flood insurance policy holders currently enjoy premium discounts up to 25%. To improve the effectiveness of our projects and create a more flood-resilient community, the District is interested in the development of a formal Program for Public Information (PPI). The PPI will evaluate and update the District's existing outreach materials and messages while also engaging our partners and community stakeholders.

The District conducts extensive outreach on an ongoing basis. Outreach projects have been developed and are delivered to landowners and the general public by the District, partner municipalities, government agencies and public interest groups. Most of these projects are well established and have been conducted in the same manner for many years. Throughout this document, specific outreach projects will be identified by number, i.e. Outreach Project 11 or OP11.

Current projects include direct mailers to floodplain property owners, utility bill inserts, publications, technical guidance, participation in special events and public meetings, school programs and interactive websites. Stakeholder involvement includes hosting events such as public festivals and professional workshops, guest articles in newsletters, inclusion of District materials in their publications, distribution of District publications and installation and maintenance of on-site interpretive educational exhibits and signage.

Most outreach projects are oriented toward public safety and permitting activities. However, the District has also developed outreach projects about the ecosystem service functions of natural floodplains, including flood attenuation, groundwater recharge, habitat, property value, and micro-climate. Additional outreach on these topics occurs during floodplain mapping, capital improvement and maintenance projects, and floodplain permitting and compliance enforcement

Under the auspices of the PPI, the District formed a Program for Public Information Committee to evaluate the effectiveness of our outreach. This Committee has been very beneficial since we have not evaluated our outreach in a systematic manner prior to the formation in 2016. In addition to identifying needed projects, the committee members have already proved effective in providing stakeholder delivery.

Step 1
Establishing the PPI Committee

In February, 2015, the District mailed letters (Appendix A) inviting partners and stakeholders to participate in a PPI Committee with the purpose of cataloguing and evaluating current District outreach projects, identifying audiences and messages, assessing gaps and obtaining commitments from stakeholders to participate in delivering those messages. Invitees included representatives from environmental groups, insurance organizations and agents, realty organizations and agents, mortgage lenders, homebuilders, homeowners, homeowners associations and major employers. The PPI Committee was officially formed in May, 2015 and current Committee members included:

1. Luke Cole, Associate Director Sustainable Landscape and Communities, Sonoran Institute
2. Wayne Cran, Senior Manager of RMS Environmental, Health, Safety and Sustainability, Raytheon Missile Systems
3. Jason Ground, Communications Specialist, Pima County Communications Office
4. Christopher Gurton, Insurance Agent, Country Financial
5. Steve Huffman, Government Affairs Director, Tucson Association of REALTORS®
6. Patrick Marum, Southern Arizona Home Builders Association Member
7. Eric Shepp, P.E., Deputy Director, Pima County Regional Flood Control District
8. Rebecca Steinecker, Homeowner and public representative
9. Steve Van De Beuken, Mortgage Lender, Sunstreet Mortgage

In addition, the District provided staff to assist the Committee in its work, including:

10. Joseph Cuffari, CFM, Program Coordinator, Floodplain Management Division
11. Brian Jones, CFM, Chief Hydrologist, Floodplain Management Division Manager
12. Greg Saxe, PhD, MRP, Environmental Planning Manager and Pima County Community Rating System Coordinator, Floodplain Management Division

PPI Committee meetings were held on the following dates:

- December 18, 2018 - CRS Steps 6 & 7 – Implement, Monitor, and Evaluate the 2019 Program for Public Information Document

Agendas with associated materials were distributed to educate the Committee members and facilitate discussion. The contents and topics of these agendas were expanded upon at the Committee's direction. Agendas have been included in Appendix B.

Upon approval of the PPI by the Committee, the District will present the PPI to the Flood Control District Advisory Committee (FCDAC). FCDAC members include appointees from each of Pima County's supervisorial districts as well as representatives from each local municipality. The FCDAC advises the Pima County Board of Supervisors, sitting as the Board of Directors for the Flood

Control District, on substantive and technical matters related to the District. The PPI will be submitted to the Pima County Board of Supervisors for adoption in 2019.

Step 2
Community Public Information Needs Assessment

Determination of Target Areas and Audiences:
In addition to examples of all of the current outreach materials, the Committee was given an overview of current credited outreach projects and their intended audiences and target areas. The Committee was also provided an insurance assessment, demographics information, and the flood hazard distribution and exposure information contained in our Hazard Mitigation and Floodplain Management Plan. The PPI Committee agreed that the public is more likely to pay attention to and act upon messages they received from both the District and stakeholders. Such tandem messaging is considered more beneficial than messages that are delivered solely by the District.

In an effort to identify existing gaps, stakeholders' current efforts were identified. These efforts are summarized in Table 1.

Table 1 - Summary of Existing Outreach by Stakeholders

Organization	Project	Subject Matter	Frequency
FEMA	www.fema.gov	Flood information, brochures	Continuous
National Flood Insurance Program	www.floodsmart.gov	Flood Information, Flood Insurance information	Continuous
AZ Department of Emergency Management	Print outreach, broadcasts, emergency response, mapping services, general information	News, weather, safety and hazard response/oversight, general information	Continuous
Pima County Administration, Office of Emergency Management, Communications Office and Department of Transportation	Print and web media, broadcasts, emergency response, mapping services, general information	News, weather, and road conditions	Continuous
Local Jurisdictions and Chambers of Commerce (i.e. Hispanic, Tucson, Oro Valley, Marana, etc.)	Print outreach, broadcasts, general information	News, weather, mapping services and general information	Continuous

Environmental Organizations (Pima Association of Governments, Audubon Society, Tucson Clean & Beautiful, Beat Back Buffelgrass)	Print outreach, broadcasts, general information	News, weather, information, bike and pedestrian routes, safety, general information, birding, storm water harvesting	Continuous
Pima Community College, University of Arizona, Northern Arizona University, Arizona State University, University of Phoenix	Lecture, print brochures, educational opportunities	Education and community outreach related to the desert environment	Continuous
Homeowners Associations	Newsletters	News, weather and information	Continuous
Newspapers (AZ Daily Star, NW Explorer, Daily Territorial, Bear Essential News)	Print newspapers and websites	News, weather and information	Continuous
Radio Stations	Broadcast radio	News, weather and information	Continuous
TV Stations (KVOA, KGUN, Tucson News Now, News 4 Tucson, KOLD)	Local Broadcasts	News, weather and information	Continuous
Utility companies (Tucson Water, Tucson Electric, Southwest Gas, Various phone/internet)	Billing statements and flyers	Various topics important to Pima County	Monthly
Events (Be Safe Saturday, Earth Day, Monsoon Safety, Emergency Preparedness Month, Cyclovia, Various events/presentations)	Print outreach, broadcasts, emergency response, general preparedness materials	News, weather and information	Continuous
Tucson Association of REALTORS®, Southern Arizona Home Builders Association	Real Estate Documents	Real estate disclosure statements, news, permitting, construction, and insurance information	Continuous
Monsoon Awareness Organization	Pre-monsoon staff meetings and outreach	News, weather and information	Bi-Annual

The District makes a full suite of brochures, manuals and maps available to these stakeholders. These include information encouraging the public to contact the District for details regarding actions they can take to understand and reduce the risks they are exposed to, including the purchase of flood insurance.

In addition to these existing efforts by stakeholders, and existing outreach projects shown in Appendix E, the Committee suggested improvements and new projects. One example that both real estate agents and major employer representatives agreed to help formulate and deliver during plan implementation is the creation of a new-comers packet. It would explicitly include messages encouraging readers to; contact the District prior to buying or renting property, contact insurance agents regarding insurance, and plan safe travel routes. These improvements will be discussed under Section 7, Plan Implementation. New project are also identified in Appendix E the PPI Spreadsheet. The Committee also identified the target areas and audiences for inclusion in the PPI. Those target areas and additional topics related to those targets are described below.

Target Areas

Riverine Floodplain:
There are two primary types of riverine flooding within Pima County. The region is defined by mountainous areas that can quickly generate riverine floods within the mountain front that extend onto the valley floor. These floods can be triggered by both high intensity (short duration thunderstorms) or by low intensity (long duration mesoscale storms). The larger, regional riverine systems are largely controlled by engineered capital improvements that are effective at limiting damage caused by local thunderstorms. These larger riverine systems are typically most affected by mesoscale storms, which have a greater chance of generating the 1% chance flood that could overwhelm the constructed infrastructure in some areas. These areas include Zone A and AE Special Flood Hazard Areas, community mapped floodplains and developer mapped floodplains.

Sheet Flooding Areas:
Pima County has large areas characterized by broad, relatively flat terrain with minimal channel capacity. The small channels that are present in these areas don't have the capacity to convey the 1% chance flow that would result in considerable out-of-channel flows, called sheet flow flooding. Sheet flow flooding is generally shallow, but can affect large areas and cause significant problems. These areas also include Zone A, AH, and AO Special Hazard Areas as well as Zone Shaded-X Other Flood Areas floodplains.

A specific type of sheet flow floodplain, called alluvial fan floodplain, is characterized by channel deposition and evulsion near the mouth of mountain canyons where they transition to the shallower slopes of the alluvial fan. There are increased hazards in alluvial floodplains because of the presence of highly erodible soils, large sediment loads from steeper mountain canyons and the extreme unpredictability of the primary flow path once flow becomes unconfined.

Appendix G includes a map that shows areas which are subject to different types of flooding conditions. The map also includes a count of the number of buildings that are affected by these floodplains.

Target Audiences

Pima County Residents:
The District provides flood protection information and property protection assistance. Since the District is supported financially by a property tax levy, the District does not charge fees for services like floodplain permitting and assisting property owners wishing to develop their property and protect new or existing improvements. Providing our services free of charge means that there is no disincentive for the public to request flood hazard information. District staff includes hydrologists, engineers, biologists and planners, all of whom are knowledgeable about sound floodplain management practices. Numerous technical guidance and standards have been developed by the District and are available on our website.

Most residents are likely to drive on streets that have potential for flooding. To this end, residents should be made aware of the unique characteristics and hazards of desert floods, which can impact roads that are outside of mapped floodplains. Existing outreach projects to this audience include "Turn around, don't drown" type messages in water bill inserts (OP42), signage (OP3), public service announcements (OP4) and awareness campaigns including Monsoon Safety Week (OP25). New projects identified by the committee include new-employee orientation materials (OP49) and a creditable class for real estate agents (OP50). 90% of this audience will be reached through a multi-media approach.

The water bill insert goes to over 220,000 customers. The 2015 census population is just over one million. Using an average household size of 2.5 people, the District is close to reaching all households with the water bill mailers.

The District Website is comprehensive and interactive. In addition to providing descriptions of each our services and CRS activities two interactive features stand out. First while an interactive Geographic Information System is available to the public at:

http://gis.pima.gov/maps/mapguide/mgmap.cfm?path=dotmap65.mwf&scriptpath=/maps/RFCD/floodplain/floodplainmap.inc&theme=PCRFCD&LAT=31.966419&LON=-111.883502&WIDTH=193.604495&UNITS=mi&

A function called the Flood Hazard Map has recently been added which allows a user to enter a street address or parcel number and obtain a map with legend showing all regulatory floodplains and riparian habitat. This map may be printed or downloaded as a pdf. This Flood Hazard Map is found here:

http://pcmaps1.pima.gov/mapps/rfcd/parcelsearch/

Secondly, the District's webpage include an interactive ALERT page whereon users may monitor stream flow and weather in real time as well as query historic records. It has also recently been upgraded and coverage expanded. It is here:

http://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=60223

As with each of our services this page describes the data available, what it is used for, and directs users to information specific to their location. A mobile "App" is also available for download at this link along with other information related to all ten outreach topics identified above. Each topical page contains general information, FAQ's, links to publications including brochures and other agencies including local Emergency Management, FEMA, Transportation Department and municipalities.

Flood Prone Property Owners and Residents:
Property owners and residents in flood prone areas must live with and plan for specific flooding hazards associated with their parcels and travel routes. A targeted outreach plan will help to address particular topics identified by the committee, including: safe routes, sheet flooding, erosion, building and insurance needs and how these factors differ across the county. The Committee also recognized that Improvement Districts are underutilized in Pima County. An Improvement District can be created at a subdivision or neighborhood scale in order to fund the construction of improvements to reduce the risk and/or severity of flooding. The creation of outreach materials would provide general information about the function and purpose of Improvement Districts might encourage their use to address or mitigate flood-related issues. This potential target audience was identified by the committee's development community representative. At this time, the District has not formulated a specific message or project; however one possibility is the addition of such information to the District's *Homeowners Association Booklet* (OP17).

While numerous outreach projects reach this audience, the annual flood prone property mailer (OP47) is sent to 100 percent of properties identified as containing a mapped regulatory floodplain; Improvements to this mailer have already been initiated to provide more detailed travel and hazard information The combination of the flood prone property mailer to property owners (OP47) (which includes vacant properties), water bill inserts (OP42), and the use of radio and television ads (OP5, OP6, OP9) means the District is reaching more than 90% of this target audience.

Repetitive Loss and Inundation Area Residents:
Due to the District's Flood Prone Land Acquisition Program (FLAP), only a few repetitive loss areas remain throughout unincorporated Pima County. There are currently seven properties listed as unmitigated in the data provided by FEMA on April 30, 2015. The five areas in which these seven properties exist are described below. Maps of repetitive loss areas (Appendix D) are only shown

for the first two locations because the remaining properties have been mitigated or are isolated issues. The Committee agreed that we should continue outreach to these areas as required.

1. Three of the seven properties are in the portion of 49ers Country Club Subdivision within the floodplain of Tanque Verde Creek. Other homes in the subdivision are subject to similar risk. A levee to mitigate this risk was designed and funded; however it was rejected by the Homeowners Association. This area remains at risk.
2. A fourth property, along Sabino Creek, was flooded in 1990 and 1993. These are years when significant floods occurred. The repetitive loss area consists of this structure and a few other parcels at similar risk of flooding. Due to both the value and quality of these residences, the use of FLAP is an unreasonable solution from a cost/benefit perspective. Outreach regarding flood risk, flood damage prevention and emergency response are the most viable approaches at this location.
3. A fifth property on River Road was purchased and demolished as part of a road widening and drainage project. This property is still listed as unmitigated, perhaps because there are other buildings present. An opportunity to list this property as mitigated may exist if it can be shown that these other buildings were not subject to any claims or are not impacted by flooding due to drainage changes associated with the road project.
4. A sixth residence, located in the lower slopes of the Tucson Mountains, is not impacted by regulatory floodplains, but rather from adverse slope and poor road drainage. It is not known what measures the homeowner may have taken to mitigate this risk other than the purchase of insurance.
5. The seventh residence is not within a regulatory flood hazard area, but is located within a mass graded subdivision adjacent to a channel inlet. This channel was not being maintained as designed. The District assisted the Homeowners Association in removing vegetation and sediment and making channel modifications to correct this flooding. This information has yet to be submitted to update the Repetitive Loss Property list.

The District reaches 100 percent of this target audience described above via direct mail (OP35).

Inundation areas have been mapped for high hazard dams, levees and areas covered by the Districts ALERT Flood Threat Recognition System. Early Warning Dissemination triggered by this system is provided by the National Weather Service, Pima County Offices of Emergency Management, Transportation Department and Sherriff depending upon severity. The District plans to provide direct mailers to residents of these areas informing them about and encouraging them to utilize the District ALERT network as well as direct notification through MyAlerts.com.

Residents of Areas without All Weather Access:

Large portions of unincorporated Pima County contain development that utilizes unimproved private roads to access individual properties. Most of these private roads, and even many public roads, were not designed to create all weather access and therefore become impassable during times of flooding. Although generally not an issue of damage prevention, this public safety issue is a common topic of concern. The use of public funds on private roads is prohibited and modification of public roads to meet all-weather access standards in these areas is cost prohibitive. The only viable solution is outreach to provide the public information on finding

alternative safe routes or preparedness tips when no alternative routes exist. In addition, the provision of information about responsible and effective design, construction and maintenance of private roadways could be helpful for individuals who are dependent on private roadways. The committee recommendation to add information regarding all-weather access in our direct mailer to flood prone property owners (OP47) was implemented this year. The committee also recommended including this topic as part of the suite of information provided to real estate agents and to major employers for inclusion in the new employee orientation packets.

Current outreach projects include "Do Not Cross Flooded Roads" Signage (OP3), the water bill stuffer (OP42), flood prone property mailers (OP47) and legal access covenant disclosures obtained during the permitting process. These projects currently reach over 90% of the impacted population. Each of these focuses on all-weather access as documented during our audits and annual recertification packages. Our intent is to improve the information the community is receiving and increase public participation in heeding safety messages.

Residents and Property Owners in Riparian Areas:
The value of maintaining floodplains in their natural condition is well known. These benefits include flood attenuation, increased recharge, stable sediment transport, habitat for wildlife, and property-value-enhancing open space. The District implements specific regulations to encourage preservation of riparian areas associated with floodplains. In 2005, the Pima County Board of Supervisors adopted the latest edition of riparian habitat avoidance and mitigation standards which apply within mapped riparian areas. Property owners may not be aware of the existence of these areas nor their value and appropriate ways to maintain them. To this end, the District plans to improve outreach to owners of properties that contain riparian habitat including: individuals, real estate agents, Homeowners Associations, and the development community. The information provided to these groups would include the environmental value of riparian habitats and regulations governing their protection.

Riparian habitat brochures and information (OP37) reached 100% of this audience as an initial mailing when the maps were adopted. Information on riparian areas is included in the annual flood prone property mailer, which is sent to more than 90% of the properties that contain mapped riparian areas.

New County Residents Including Prospective Buyers and Renters:
Committee members from major private sector employers indicated a need to include flood information for new residents of Pima County. It is important that such residents have information about safe and reliable access to work, schools and other destinations during flood events. New residents considering purchasing a home would benefit from information about how to determine if a property is flood prone. It is important to get such information to new residents early so they can make informed decisions about where they want to live. It is also important to let new residents, especially renters, know about the availability and affordability of flood

insurance coverage for contents. Projects on these topics (OP49, OP50, and OP52) have been added to the currently-approved PPI spreadsheet presented herein as Appendix E.

Delivery of these messages by major employer stakeholders will rely on developing relationships with these employers. To reach a larger audience, the new resident flood information packet created for employers will also be made available to real estate agents and residential property management companies. While real estate agents currently are encouraged to hand out brochures on flood risk, contacts for finding more information including the District, FEMA FloodSmart.gov and flood insurance, including increased cost of compliance policies, the Committee agreed that a new-comers packet in concert with the recommended real estate agent education course would greatly increase participation. The local REALTORS® association representative on the Committee committed to participating in this effort and district staff agreed to coordinate with the Tucson Association of REALTORS® on development of both the packet including brochures, curriculum and promotion of their use. These brochures would advise prospective buyers and renters to contact the District to see if the property is in a floodplain or has a history of flooding, and to contact and agent regarding insurance costs.

There is no way to identify the number of new residents in Pima County for any given period, so it is not possible to measure if 90% of this group has been reached. Nonetheless, this type of effort is viewed as a worthwhile expansion of our outreach. The participation of a major employer such as Davis-Monthan Air Force Base, the University of Arizona or Raytheon Missile Systems would represent a significant expansion of our outreach. Expanding the information provided by real estate agents will also be highly beneficial as information contained upon disclosures may be limited.

Development Community, Non-Governmental Organizations (NGOs), Landowners and Designers:
The District takes advantage of numerous opportunities to provide outreach to the development community, NGOs, landowners and designers. The District hosts a brown bag lecture series (OP11) monthly and participates in workshops (OP41) multiple times per year. Such meetings cover a broad range of topics and appeal to a variety of target audiences. A specific example of an NGO meeting would be one that educates stakeholders about how Low Impact Development and Green Infrastructure benefit them.

The NFIP and local jurisdictions want to see more widespread use of Low Impact Development and Green Infrastructure practices. The more stakeholders understand the benefits of these practices, the more likely they are to implement them. Last year, the District worked with stakeholders to develop the *Low Impact Development and Green infrastructure (LID/GI) Guidelines*. Work continues on adoption of these techniques into common practice for private development and public projects. The committee agreed that outreach to professional organizations via newsletters and presentations were important new projects that could address drainage issues within existing neighborhoods and promote improved drainage design in new developments. While this project could have been added as a unique outreach project, it is

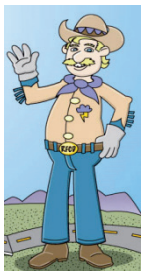
already a part of OP11, OP23 and OP41 on the currently approved PPI spreadsheet presented herein as Appendix E.

While the District makes these opportunities available to 100% of the target audience, it cannot guarantee participation.

Real Estate Agents, Insurance Agents and Lenders:
Current outreach to the real estate community includes print and digital articles on flood risks and workshops on specific issues as needed. The Committee also identified the need to provide qualifying classes so these professionals can obtain Continuing Education Credits (CECs) from national realty and insurance organizations. This outreach project (OP50) has been added to the currently-approved PPI spreadsheet.

As noted above current outreach by real estate agents includes providing prospective buyers and renters with information on flood risk, flood history, the availability of insurance and where to find out more including the District and FloodSmart.gov.

While the District and real estate agents make these opportunities available to 100% of the target audience, it cannot guarantee participation.

Schools, Children, and Educators:

Schools, children and educators can be encouraged to participate in flood hazard awareness activities. Such activities involve both children and their families and effectively convey messages regarding safety, preparedness, personal responsibility and stewardship. This effort utilizes special activities and standardized curriculum elements. Our current PPI includes the District's Sherriff Hank Highwater campaign to reach younger audiences and FEMA materials made available to local schools by the Pima County Office of Emergency Management. To reinvigorate efforts, the Committee recommended adding school curriculum as a new project (OP51) that would complement current projects (OP10, OP15, OP39 and OP41).

While the District makes these opportunities available to 100% of the target audience, it cannot guarantee participation.

Government Partners:
Government agencies within Pima County, such as incorporated cities and towns, Metropolitan Planning Organizations and Pima County Departments (i.e. Office of Emergency Management and the Department of Transportation), all conduct their own flood-related activities. The Committee advised that increased coordination with these government partners would be beneficial for all parties. The District is guided by an Advisory Committee consisting of members from all local municipalities, the public and the professional community. Furthermore, each NFIP-participating community has a CRS Coordinator who attends our Statewide CRS User's Group. Both of these organizations could assist in coordinating outreach. This PPI identifies the need to coordinate

outreach projects with government partners. Although no specific project has been identified or added to the PPI spreadsheet, it is expected that the ongoing Inter-jurisdictional Hazard Mitigation Plan update will improve coordination. Additional current cooperative projects include the Retention Detention Manual which has been credited as our WMP, Monsoon Safety Water Bill Insert (OP42) and the LID/GI Guidelines (OP23).

While the District makes these opportunities available to 100% of the target audience, it cannot guarantee participation.

Other Factors to Consider

Social and Economic:
The Committee and support staff felt strongly that social and economic factors should be assessed in order to identify new relevant Target Areas and adjust how outreach is presented to target audiences. These factors include identifying areas with high populations of renters, Spanish speakers, commuters and residents with limited mobility.

- According to www.census.gov, the population of Pima County in July 2016 was estimated at 1,016,206 persons. The American Community Survey (ACS) provides further information regarding Pima County residents (2015 data):
- The current median income is $46,162. The national median income is $55,775.
- The median value of owner-occupied units is $159,900. This is $18,700 less than the national median.
- Median gross rent is $816. This is $112 less than the national median rental rate.
- Renters make up 38.8% of the 389,658 occupied housing units.
- Those under the age of 65 with a disability make up 29.1% of the population. This is 4.3% higher than the national rate.
- Residents who are 65 or older make up 17.1% of the population. This is 1.9% higher than the national rate.
- 23.7% of residents are Spanish speakers. Of those, almost 6.8% (63,489 residents) speak English “less than very well.”

Committee members identified and targeted major employers to receive commuter safety and new employee outreach materials related to floods and flooding hazards. After these materials are developed in cooperation with the participating stakeholders, they will be made available to other employers.

New and existing outreach projects will be analyzed to ensure these target areas and audiences are receiving outreach that is appropriate to their needs.

Flood Insurance Coverage Assessment

This section is intended to summarize the findings of the Flood Insurance Coverage Assessment (FIA) and Coverage Improvement Plan (CP) conducted per Activity 370 of the CRS Manual. The FIA, CP and the social and economic factors identified above will help prioritize outreach efforts to a large and diverse community.

The map in Appendix C shows the floodplains within Pima County and how they relate to CRS NFIP discounts. Within unincorporated Pima County, there are 214,545 acres of FEMA SFHA, where the CRS Class 5 community flood insurance premium discount of 25% is available. "Moderate risk" areas include 25,958 acres of Shaded Zone X which receive a 10% discount. The lowest available premiums apply in the remaining 5,639,778 acres of "low risk" areas which have not been mapped by FEMA as being in a regulatory floodplain.

Due to the size and flood characteristics of Pima County, many flood prone areas have not been mapped by FEMA. The District has undertaken a widespread and ongoing effort to identify additional areas exposed to flood risk. These locally mapped flood prone areas are called Special Studies Floodplains and total 63,254 acres. Local floodplains are shown in blue on the map in Appendix C. Table 2 below and the map in Appendix C exclude approximate sheet flood mapping developed by the District. This tool is used to steer people to the District when Floodplain Use Permits might be necessary. Flood insurance in locally mapped floodplains is not required but is highly recommended. The District applies federal, state and local floodplain regulations within local floodplains. Mailings (OP47) are sent to properties impacted by FEMA SFHA or local Special Studies Floodplains.

The most recent insurance data available from the District's Insurance Services Organization (ISO) representative is updated to May 31, 2018. This was in conformance with the FIA requirement that data be less than one year old at the time of the Committee meetings. The FIA will be updated with the latest insurance data as it becomes available. This data includes two spreadsheets - Active Policies and Historical Claims - which form the basis of the following analysis.

According to this information, there are 2,133 policies currently in force, including $418,863,800 in building coverage and $92,697,400 in contents coverage. This is nearly a five percent drop and may be tied to annexation or the increasing percentage of compliant properties. The distribution of paid claims over time is shown In Figure 1. It is interesting to note that although flood events are becoming more frequent, those individual events result in fewer claims and those claims are less expensive. It is suspected that capital improvements, expanded maintenance and permitting activities through the District are reducing the total number of paid claims associated with each flood event even while flood frequency may be increasing. This cause and effect is not well understood by the public and the role of CIP and maintenance is a worthwhile outreach effort to increase community support of flood control efforts. Current outreach efforts regarding this correlation are limited to our annual report, project groundbreaking ceremonies, news releases, website features and our advisory committee. More could be done to reach the general public.

While none of these are listed in our current PPI spreadsheet, they will be documented on future versions.

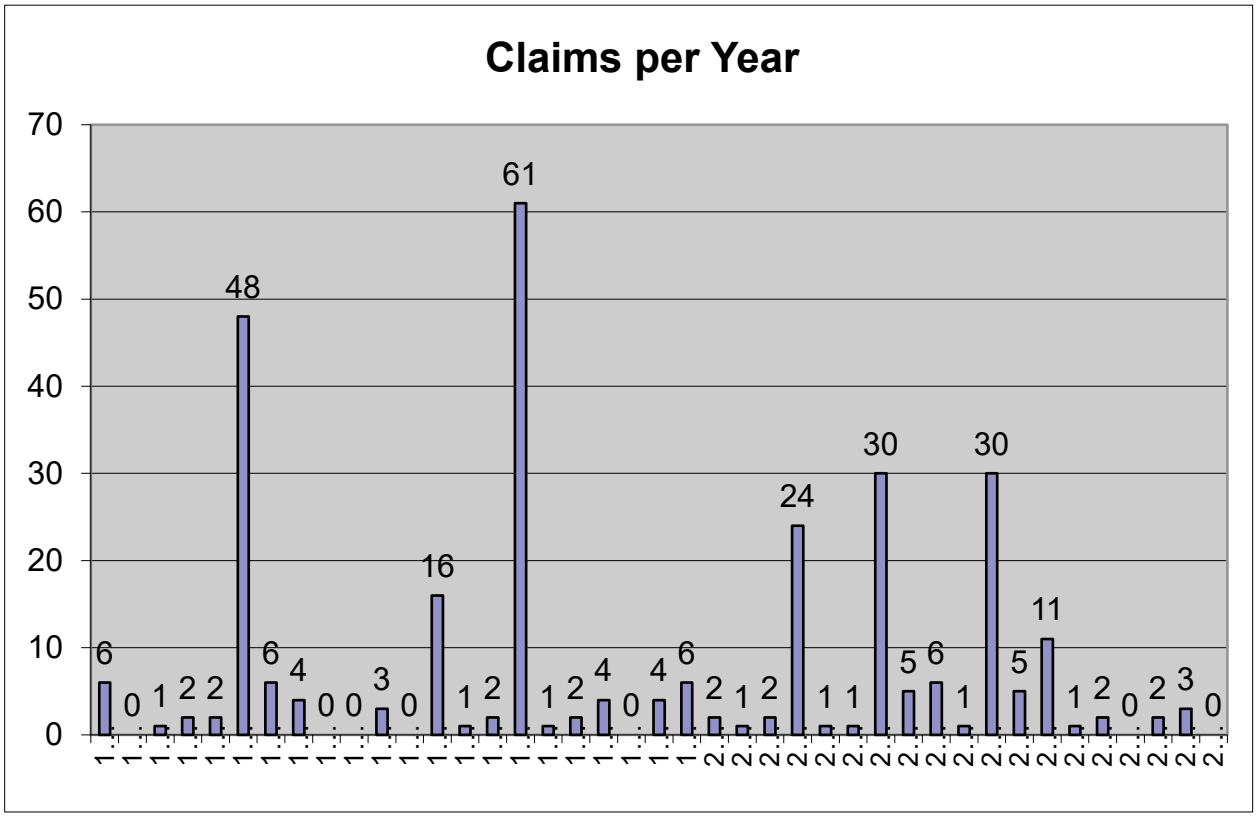


Figure 1 - Distribution of Flood Insurance Claims by Year

Since the inception of the National Flood Insurance Program in 1978 there have been a total of $3,997,194 dollars paid on 175 individual claims in unincorporated Pima County. An additional 121 claims were filed that resulted in no payment. It is not known how many of these were denied or how many claims were below the deductible. Payments ranged from below $50 to over $200,000 with an average of $22,727 paid per claim. The distribution of claims is heavily weighted toward lesser amounts as shown in Figure 2.

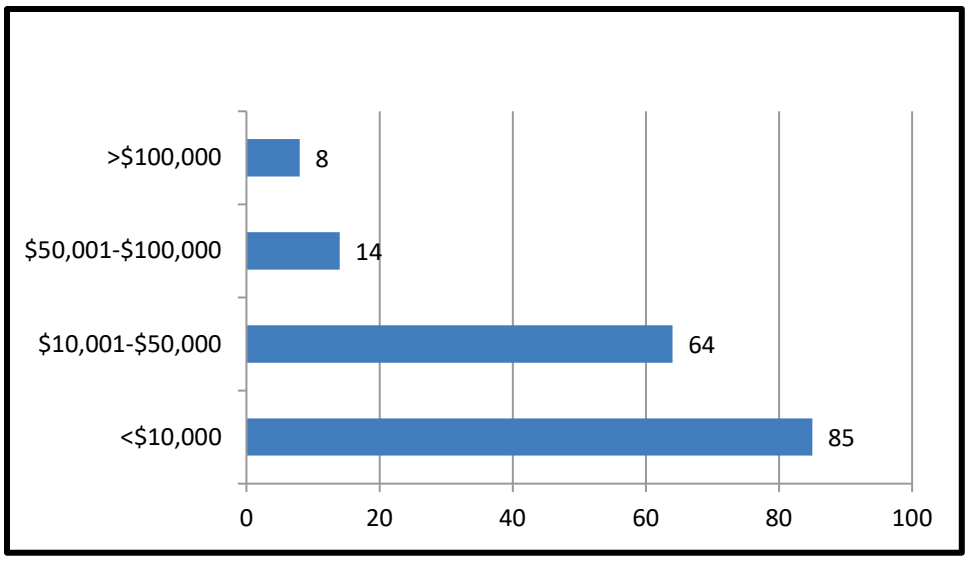


Figure 2 – Distribution of Claims by Dollar Amount Paid

The data provided by ISO in 2016 was input into the District's Geographic Information System (GIS) based upon address. Property values were then compared to insurance coverage by floodplain type, as well as occupancy data from the County Assessor's Land Use Code (LUC) associated with each parcel. The information is summarized in Tables 2 through 4.

Table 2 - Insurance Coverage by Flood Zone Type and Occupancy Type

Flood Zone Type	Parcels with Structures	Parcels with Structures and Insurance	Percent of Parcels with Structures Insured
FEMA SFHA Zone A – AO1	7,292	1,000	13.71%
FEMA Shaded X	3,636	212	5.83%
Local Special Studies	9,820	458	4.66%
*Not in Mapped Floodplains***	122,450	586	0.48%
Total	143,198	2,256	1.58%
Occupancy Type			
Residential	169,081	2,169	1.28%
Commercial	18,796	87	0.46%
Total	187,877	2,256	1.20%

Table 3 - Flood Risk Exposure and Insurance Coverage by Value for Only Those Properties with Flood Insurance Policies

Flood Zone Type	Assessor's Full Cash Value	Exposed Value*	Coverage in Force	Exposed Value Covered
FEMA SFHA Zone A - AO1	$ 217,214,827	$ 28,237,928	$ 220,615,900	781%
FEMA Shaded X	$ 118,057,666	$ 15,347,497	$ 50,268,300	328%
Local Special Studies	$ 149,105,053	$ 19,383,657	$ 102,957,200	531%
Not in Mapped Floodplain**	$ 237,438,758	$ 30,867,039	$ 116,081,100	376%
Total	$ 721,816,304	$ 93,836,120	$ 456,654,000	487%

* Exposed Value is defined as Assessor's Full Cash value times .65 to estimate building value, times .2 to estimate potential damage costs.

** While these properties are outside mapped risk areas, the same damage ratio is applied to reflect what may occur should those properties be flooded.

Table 4 - Flood Risk Exposure and Insurance Coverage for All Properties containing Structures with or without Flood Insurance Policies

Flood Zone Type	Assessor's Full Cash Value	Exposed Value*	Coverage in Force	Exposed Value Covered
FEMA SFHA Zone A - AO1	$ 1,867,156,782	$ 242,730,382	$ 220,615,900	91%
FEMA Shaded X	$ 699,906,063	$ 90,987,788	$ 50,268,300	55%
Local Special Studies	$ 2,252,201,813	$ 292,786,236	$ 102,957,200	35%
Not in Mapped Floodplain**	$ 3,479,539,495	$ 452,340,134	$ 116,081,100	26%
Total	$ 8,298,804,153	$ 1,078,844,540	$ 456,654,000	42%

* Exposed Value is defined as Assessor's Full Cash value times .65 to estimate building value, times .2 to estimate potential damage costs.

** While these properties are outside mapped risk areas same damage, the ratio is applied to reflect what may occur should those properties be flooded.

Flood Insurance Coverage Assessment Conclusions and Recommendations:
The following conclusions and recommendations were made by the Committee based on the data summary provided above.

There is a ratio between the number of policies in force and the number of properties at risk. While a large percent of the exposed building value is covered, this is misleading as a much lower percent of total structures are covered. As such, buildings that are insured appear to be generally over insured, while many buildings are not insured at all. There is a need to increase the number of buildings that are covered while at the same time ensuring that existing policy holders obtain coverage equal to their risk.

Another significant coverage gap is that there are 1,045 buildings insured without additional contents coverage. Perhaps more significantly there are no buildings listed with only contents coverage, so it appears that not a single renter has obtained contents coverage. Due to privacy requirements, we are looking for legal means to target this group.

In addition to the detailed data received from the ISO, the Arizona Department of Water Resources (ADWR) provided the following summarized data in 2016 which indicates the distribution of coverage within floodplains and by occupancy. This data reveals the prevalence of residential coverage outside the SFHA.

Table 5 - Insurance Coverage by Zone

Insurance by Flood Zone	Policies in Force	Premium	Insurance in Force	Number of Paid Losses
AO1-30 & AE	519	$ 651,835.00	$ 113,961,300.00	51
A	407	$ 399,731.00	$ 71,667,900.00	27
AO	507	$ 278,019.00	$ 88,064,200.00	13
AH	11	$ 10,428.00	$ 2,242,200.00	0
D	2	$ 3,228.00	$ 455,000.00	0
B, C & X - Standard	205	$ 141,918.00	$ 58,768,800.00	17
B, C & X - Preferred	790	$ 279,646.00	$ 227,531,000.00	27
Total	**2,441**	**$ 1,764,805.00**	**$ 562,690,400.00**	**135**

Table 6 - Insurance Coverage by Occupancy Type

Insurance by Occupancy Type	Policies in Force	Premium	Insurance in Force	Number of Paid Losses
Single Family	2,264	$ 1,529,692.00	$ 526,929,100.00	144
2-4 Family	20	$ 54,041.00	$ 3,531,900.00	2
All Other Residential	25	$ 16,839.00	$ 4,116,700.00	1
Non Residential	132	$ 164,233.00	$ 28,112,700.00	25
Total	**2,441**	**$ 1,764,805.00**	**$ 562,690,400.00**	**172**

The FIA data summarized above helped the Committee identify gaps in coverage and therefore identify gaps in outreach. The Committee made the following recommendations:

1. Increase the percentage of structures within the floodplain that are covered for property damage via revised materials and projects.
2. Increase contents coverage via targeted outreach to renters and owners.

Our Coverage Improvement Plan (CP) is to direct messaging at the targeted audiences presented in the next section.

Step 3
Recommended Messages

Historically, District outreach information focused on the six priority topics. Audiences included residents of flood prone areas, the community at large and the professional community. The PPI process provided an opportunity to establish additional appropriate topics and target audiences.

Although the District's existing outreach materials address many of these topics, they will be revisited with an expectation that some outreach will be revised and new outreach will be created. This is also covered in areas for improvement described under Step 7.

Topics and Messages:
Upon review of the Target Areas and Audiences identified in Step 2, insurance coverage analysis, and census data, the Committee agreed upon 4 additional outreach topics:

- **Topic 7 - Seasonal Flooding -** This topic includes summer monsoon storms and sustained winter rains, both of which are historical causes of flooding within Pima County. Due to severity, rapid development and other characteristics, flash flooding caused by monsoon storms is a major concern. The perception of the desert as a dry place makes it all the more important to educate residents about the unique risks associated with rapid onset flooding when intense rain occurs. Flash floods may travel downstream to areas far outside the storm area often leading to little or no warning signs that a flood is approaching. It is important that people learn about and understand the characteristics of these risks. Sustained winter rains typically cause our most widespread flooding.

- **Topic 8 - Low Impact Development and Green Infrastructure (LID/GI) -** This topic includes protecting existing flood prone areas and constructing water storage and recharge enhancements that provide public safety, drainage and water supply benefits. The beneficial use of storm water runoff and enhancement of recharge improves the regional water budget and makes the region more resilient to drought. It also benefits riparian habitats which provide flood attenuation and recharge while simultaneously reducing flood risk. These are but two justifications to maintain flood prone areas and riparian habitats in their natural state. The County has coordinated with other local jurisdictions to develop guidelines and regulations regarding LID/GI practices. Because the techniques and benefits of LID/GI are not widely known within the development and landowner communities, the District will depend on its own expertise, the expertise of other knowledgeable professionals and the expertise of NGO stakeholders to disseminate important information about the benefits of adopting LID/GI practices.

- **Topic 9 - Local Hazards** - This topic includes some of the unique flood hazards in Pima County: alluvial fan flooding, sheet flow flooding, and channel migration. Flood hazards in many areas are difficult to predict and quantify due to channel aggradation, down-cutting and lateral migration. This is especially true on alluvial fans. In alluvial fan areas, large

amounts of sediment and debris are carried down steep mountain canyons and are deposited at the mouth of the canyon, causing flows to become unpredictable. Throughout the County, the presence of unconsolidated alluvial soils and relatively sparse vegetation creates a high potential for lateral migration of watercourses. Much of the recorded flood damage in Pima County has been associated with the lateral erosion of watercourses undermining structures, buildings and public infrastructure.

- **Topic 10 – All Weather Access -** This topic covers the lack of safe access to certain areas during times of flooding. Some roads within Pima County have been designed to convey flows, while many others convey flow due to poor design. In addition, many roads utilize dip crossings to pass flows over the road as opposed to under the road. This has resulted in issues of unsafe or non-existent access to and/or within certain areas during times of flooding. Many complaints to the District and the County's Department of Transportation originate from such areas. These areas also require frequent maintenance. Awareness of these hazards and active emergency planning are critical for public preparedness in the event of lost access during a flood. The public should be prepared to use alternate routes to travel home, to work or to medical care. They should also be prepared to avoid such areas to prevent the need for being rescued during flood events. Almost all flood-related fatalities within Pima County have been associated with people trapped in cars while crossing flooded roads.

  Privately-maintained roads pose unique access problems. They are often constructed without any consideration of drainage or flooding. As a result, they often capture flow or become destroyed due to lack of adequate design. There was wide agreement on the Committee that planning flood-safe routes and improving private roadway construction are very important topics for outreach.

Outcomes:

The associated messages and desired measurable outcomes of the six CRS priority topics and four additional topics identified by the PPI Committee are shown in Table 7.

Table 7 - Topics, Messages, and Outcomes

Topic	Messages	Outcome
1: Know Your Flood Hazard	"A portion of your property is in a floodplain and the structure may be. View a Flood Hazard Map at: http://pcmaps1.pima.gov/mapps/rfcd/parcelsearch/ and then call the District to find out more." "Purchase Flood Insurance" "Prepare Before the Floods Come" "Protect Yourself From Flooding" "Monitor streamflow depth and rainfall for your local area at http://alertmap.rfcd.pima.gov/gmap/gmap.html"	Increased Flood Hazard Map website hits, flood hazard information requests, customer service counter visits and approved permits

2: Insure Your Property	"Building and contents insurance is available at discounted rates, contact your agent to find out how low they are." “Renters may contact an insurance professional to learn how inexpensive contents insurance is.” “Owners of properties outside federal floodplains qualify for discounted insurance rates, contact your agent to find out how low they are." “Please protect your home and your contents/belongings with a flood insurance policy today”	Increased number of flood insurance policies, especially contents and inquires
3: Protect People from the Hazard	"Don't drive through flooded washes" “Turn Around Don’t Drown” “Never Cross a Flooded Road” “Plan Ahead” “Make a flood preparedness plan.”	Decreased swift water rescues and law enforcement citations for ignoring barricades
4: Protect Your Property from the Hazard	"Contact the District for technical assistance in the best ways to protect your property"	Increase in requests from property owners to develop a plan to mitigate flood hazards
5: Build Responsibly	"Obtain a Floodplain Use Permit"	Decrease in unpermitted development and code violations
6: Protect Natural Floodplain Functions	"Do not dump in washes” “Preserve riparian habitat”	Decrease in illegal dumping complaints and unpermitted disturbance of riparian habitat
7: Seasonal Flooding	"Understand flash floods by monitoring streamflow depth and rainfall for your local area at http://alertmap.rfcd.pima.gov/gmap/gmap.html”	Increase in hits on ALERT website
8: Low Impact Development and Green Infrastructure	"Use the techniques found in the Low Impact Development and Green Infrastructure Manual at http://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=65263the following link for managing floods"	Increase in the use of LID/GI techniques
9: Local Hazards: Erosion, Floodplains,	"Contact the District to learn about all the risks to your property"	Increase in counter visits, flood hazard information

and Sheet Flooding)		requests, and approved permits
10: Safe Routes	"Plan for floods by knowing the safe routes to places of shelter shown herehttp://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=34193 "	Decreased swift water rescues, increase in safety plans by having people create them during site visits and outreach to schools and employers

Flood Response Preparations:
The District has a Flood Response Plan and an associated flood response procedure and field manual. District flood investigators are given emergency response supplies that include a variety of outreach and technical assistance materials that are distributed to the public as appropriate. Outreach on topics 1, 2, 4, 6, 7 and 10 is provided to owners in areas impacted by a flood event: Know Your Flood hazard, Insure Your Property, Protect Your Property and Build Responsibly, Understand Flash Floods and Don't Drive through Flooded Roads.

In addition to materials that are distributed during and after a flood event, there are also outreach materials for flood preparation in advance of an event, including:

- Water bill insert (OP42)
- Floodplain property brochure (OP47)
- 1983 flood brochure (OP40)
- Public event booths (OP10)
- Monsoon Safety Awareness Week (OP25)
- Monsoon safety brochure (OP26)
- Sheet flood and map change outreach letter (OP13)
- Repetitive loss property letters (OP35)
- Sherriff Hank Highwater coloring book/campaign (OP15)

The entire list of outreach projects can be found in the PPI Spreadsheet in Appendix E. This spreadsheet contains a master list and additional lists with outreach organized by target demographic audiences and geographic areas.

Step 4
Recommended Outreach Projects

The Committee reviewed existing outreach projects, including 2018 District efforts (**Appendix J)**, to ensure that the topics and messages are adequately presented. The Committee also identified a number of future outreach projects to be included in the PPI. These projects will be implemented in 2019. Current and recommended outreach projects are found on the PPI spreadsheet (Appendix E). Appendix E includes additional tables specific to each target audience or target area.

Gaps in coverage identified in the Flood Insurance Coverage Assessment (FIA) include renters and locally mapped Special Studies floodplains. The District has revised its outreach methods and materials to provide information on flood insurance availability to a larger audience of flood prone area renters and owners. Insurance information is included in outreach projects including (OP42, OP 48, OP49, OP52 and OP55.

It was decided that the projects termed “outreach projects” will be deliverable and implemented at least once per year. Flood response projects will be prepared but will not be distributed until needed after the occurrence of a flood event.

The Committee recommended new projects are outlined in Table 8:

Table 8 – 2019 New Outreach Projects

New Outreach Project	Topics and Messages Covered	Message Delivery by Stakeholders	Outcome
Engineering and Capital Improvements brochure (OP57)	3, 6, 8 & 9	RFCD, Pima County Communications Office, Identified Stakeholders	Provide a general information document highlighting District engineering projects
Floodplain Management Plan Support	1-10	RFCD, various stakeholder groups and individuals	Support the District’s Floodplain Management Plan for watershed management

Step 5
Other Public Information Initiatives

In addition to the efforts of the District and stakeholders, it is important to review other public information efforts and identify opportunities for coordination and consolidation.

REALTOR® Disclosures:
In Arizona, real estate agents are required to disclose the presence of Special Flood Hazard Areas to buyers. Recognizing one of our primary functions under the NFIP, the District provides detailed FIRM information to agents. Various organizations of real estate professionals coordinate with the District to assist real estate agents via targeted and general outreach projects numerous times annually. These are intended to raise awareness of flood-related issues and provide information and materials needed to meet the disclosure requirement. Brochures, the website and general and targeted outreach projects all address this need. Additional new projects have also been identified in this plan (OP48, OP49, OP50 and OP52). Using these materials, real estate agents can meet their disclosure requirement and provide their clients with FEMA and District contact information, brochures and relevant website links.

Web Resources:
In addition to the District Webpage which covers all ten topics, all CRS activities and much more as described above other Departments also maintain websites that provide information describing actions the public can take to avoid or mitigate flood risk, and to recover from floods.

Pima County has a Road Closure hotline and website that includes closures due to flooding: (webcms.pima.gov/cms/one.aspx?portalId=169&pageId=34193).

The Pima County Office of Emergency Management website contains information about emergency preparedness, disaster recovery, MyAlerts resource application and flood insurance: (webcms.pima.gov/government/office_of_emergency_management_homeland_security/).

Disaster Recovery Assistance:
The American Red Cross provides information to help the public prepare for disasters, provides shelter and other resources during floods. It also provides information to help individuals recover from flood damage.

On-Site Open Space Educational Exhibits and Signage:

The County has a system of open spaces identified for preservation in the Sonora Desert Conservation Plan. Much of the focus of this plan has been ion what are locally referred to as Important Riparian Areas which are a subset of our regulated riparian habitats. These have been acquired through bond and FLAP purchases, easements obtained during the entitlement process, donations and as part of Capitol Improvement Projects. Notable is the system of river park greenways known as "The Loop" which circles the metropolitan area mostly along major river corridors. The bank protection installed by the District to prevent channel migration has provided for this continuous bike path that is complemented with passive and active recreation areas including riparian restoration and groundwater recharge projects.

Most County open space lands are managed jointly by the District and the Natural Resources Parks and Recreation Department. River parks and recharge facilities throughout the county feature water harvesting, riparian habitat restoration, groundwater recharge and other beneficial functions of floodplains. In most cases, these are developed to provide public access and educational opportunities regarding beneficial floodplain functions. On-site materials include interpretive centers containing exhibits, conservation workshop spaces, trails with interpretive signage and demonstration projects. These are complemented by a suite of outreach materials, including general riparian habitat information (OP36 and OP38) and site specific brochures. In the case of Cienega Creek Preserve these brochures includes maps and species lists. Related groundwater level monitoring data is made available on our website and is an example of the range of materials produced by the District, from coloring books for kids and the Living River of Words poetry and art contest to highly verifiable scientific data for use by modelers. In the case of Agua Caliente Park, a ranching and water use history is available.

The Mountain Lion of the Rocky Mountains
Bailey Puls, age 9
Presidio School - Ms. Cohn
Grand Prize-Art-Category 2

Illegal dumping outreach efforts associated with the Clean Water Act include code enforcement signage. The Pima Association of Governments, Pima County (Sherriff's Office and Department of Transportation) and others are involved in the placement of such signage. The District supplements this type of anti-dumping outreach with stormwater pollution prevention information (OP32).

Related CRS Activities:

Outreach projects conducted by others were considered throughout the Committee review process. It was decided that in addition to ensuring completion of those outreach projects identified on the PPI spreadsheet, the District should also pursue the following improvements:

- **Activity 320 (Map Information Services) -** The information provided with the Flood Hazard Map (available on the District's website) will be modified to include the four additional CRS topics consented to by the Committee.
- **Activity 340 (Hazard Disclosure) -** Real estate disclosure practices have been identified and discussed by the Committee. While the MLS sheet used by the Tucson Association of REALTORS® requires disclosure of FEMA SFHAs, the District will work with real estate agents to educate them on investigation and disclosure of local flood hazards prior to execution of purchase and sale agreements.
- **Activity 350 (Flood Protection Information) -** The District's current outreach webpage will be modified to reflect the four additional CRS topics consented to by the committee.
- **Activity 360 (Flood Protection Assistance) -** The District's current flood response projects will be implemented during flood response efforts during and after flooding events.
- **Activity 370 (Flood Insurance Promotion) -** The Committee was presented with flood insurance data to help identify gaps in coverage. A more detailed explanation of this activity can be found in Step 2. Existing materials will be modified and new materials will be developed to address these gaps. Additionally, public service announcements have been produced (OP55) in conjunction with a member of the District's elected leadership.
- **Activity 510 (Floodplain Management Planning) -** The Flood Insurance Coverage assessment and PPI will be incorporated into the Floodplain and Watershed Management Plan(s).
- **Activity 540 (Drainage System Maintenance) -** The Committee helped to create a document related to dumping regulations for homeowner associations and private areas. The District will partner with the Pima County Department of Environmental Quality to help advertise future illegal dumping messages. In addition, the District has a Drainage Complaint system in place that provides the public with an opportunity to not only notify the District of potential floodplain violations, but also to seek out advice on how to protect properties from flood hazards. Those needing financial assistance are directed to a number of governmental and non-governmental organizations as appropriate, including the American Red Cross and local housing and economic development agencies. While the District directly funds maintenance and construction of capital improvement projects, the District does not provide direct financial assistance for private property owners.
- **Activity 610 (Flood Warning and Response) -** The District has recently made substantial revisions to the public face of the ALERT Flood Threat Recognition System and needs to provide outreach about the revisions. The District is also working to update the Hazard Mitigation Plan (HMP).

Step 6
PPI Document Preparation

This document was prepared by District staff to support and memorialize the efforts of the Committee and District during the 2016, 2017 and 2018 calendar years.

Step 7
Plan Implementation

Following adoption of the PPI by the Board of Supervisors, we plan to schedule a PPI Committee meeting to celebrate completion and discuss implementation of the plan. Invitations will also be sent to organizations that have been identified as participating in stakeholder delivery. That plan is outlined in Table 7 above. District staff will continue to coordinate the development and delivery of outreach projects as identified in the PPI. Stakeholders will continue to be involved in the development and delivery of projects as noted herein.

In addition to ongoing work by District staff and stakeholders, the PPI Committee shall meet at least annually to review progress and make recommendations regarding updating target audiences, areas and additional topics. District staff shall provide annual progress reports to the PPI Committee. This report, in the form of an updated PPI, shall include emerging issues, updated insurance, available demographic data and any available outcome measures.

District staff will then incorporate the PPI Committee recommendations along with corresponding documentation. The updated PPI will then be presented to the Flood Control District Advisory Committee and Board of Supervisors for adoption.

PPI Appendix A
Committee Invitation Letter

February 25, 2015

Name, Title
Company/Organization
Address
City, AZ 857XX

Subject: **Program for Public Information Stakeholders Committee**

Dear XXXX,

The Pima County Regional Flood Control District (District) is seeking stakeholders with an interest in helping their community, especially individuals with some involvement or knowledge of the National Flood Insurance Program (NFIP) or who may advocate for some of its priorities, in order to provide guidance and direction to the District with respect creating a comprehensive outreach program.

The District is a participant in the NFIP's Community Rating System (CRS), which is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Participating in the CRS program can benefit the community through the reduction of flood insurance premium rates when community actions meet the following three goals: 1) reduce flood damage to insurable property; 2) strengthen and support the insurance aspects of the NFIP; and 3) encourage a comprehensive approach to floodplain management.

At present, District efforts towards those goals have resulted in a Class 5 Community designation, which means that residents of unincorporated Pima County are eligible for up to a 25% discount on flood insurance premiums. The District is poised to become a Class 4 Community, which will increase that discount to 30%.

In order to further these goals, the District is establishing a Program for Public Information (PPI), which includes distributing public outreach materials to communities, owners of flood prone property, and stakeholders within the community with connections to floodplain issues such as real estate agents, insurance agents, engineers and surveyors. The PPI is a community driven outreach effort to help provide the public with the information necessary to increase flood hazard awareness and to help motivate actions to reduce flood damage, encourage flood insurance coverage, improve public safety and help protect the natural functions of floodplains.

Awareness of flood hazards is not enough to meet these goals, and a community driven program is needed to develop local strategies to motivate residents to take action to mitigate flood hazards. The District is in the process of setting up a stakeholder committee to help prepare a PPI for a combined effort that will assess the community's public information needs, formulate outreach messages, identify ways to disseminate the information, and implement outreach projects.

We ask for your help because of your special interest/knowledge in (area of interest). (INSERT SUPPLEMENTAL STAKEHOLDER SPECIFIC INFORMATION)

The District strives to use forward-looking floodplain management practices to increase flood hazard awareness, minimize damages to property and infrastructure from flood hazards, and promote the health, safety and welfare for all Pima County residents.

If you would like to become a stakeholder or would like more information, please contact Joseph Cuffari at 724-4624 or via e-mail at joseph.cuffari@pima.gov. If you are unable to participate, but know someone else who might be interested in participating, please let us know.

Sincerely,

Suzanne Shields, P.E.
Director and Chief Engineer

SS/tj

Supplemental Stakeholder Specific Outreach

Realtors

Realtors have an obligation to disclose to the buyer if a parcel is subject to FEMA Special Flood Hazard Areas, but not if a home is within a locally mapped floodplain. New construction activities or additions to current structures could be limited by locally identified flood hazards. A realtor who is informed about floodplain issues could better serve buyers by making them aware of the potential liabilities of a property being considered for purchase, which would foster a new level of trust between you and the client. Likewise, an informed realtor can assist sellers by identifying issues that may affect sales at the last minute thus allowing time to correct the liabilities before they become a problem.

Insurance Agents

Insurance agents should make homeowners aware of the importance of flood-proofing and insuring a flood prone home, whether flood insurance is or is not federally mandated. Since homeowners' insurance policies do not cover flood damage, insurance agents should let their clients know about the high costs of flood damage and the importance of insurance to cover those costs at the time of sale. Potential policy holders should be made aware that a new policy usually takes 30 days from the date of purchase to become effective. Buying a policy early could save the property owner thousands of dollars later. Insurance agents should also discuss the availability of insurance for contents of the home to both owners and renters.

Developers / Surveyors / Engineers / Contractors

Development occasionally is located in an area with a high risk of flooding. Developers must either design and construct improvements that are appropriately flood resilient and resistant, safe for homeowners, and will not increase the flood risk in surrounding areas, or modify the site layout to avoid the high hazard areas and leaving the watercourse in a natural state. If avoidance is not possible, developers should seek flood risk management opportunities such as proper elevation, erosion protection measures, and mitigation strategies such as water harvesting for irrigation. By

avoiding high risk areas or providing flood safe improvements, a developer can reduce costs and risks while creating an amenity with significant value for the customer.

Regional Sustainability Organizations

By regulating riparian habitat and flow corridors, the District is dedicated to preserving the natural and beneficial functions of floodplains, which is an ecosystem-wide approach that helps to reduce peak flood discharge rates, enhance water quality, maintain watershed scale sediment balance, and provides biological corridors that benefit plant and animal communities. In addition, the preservation of these areas provides a more livable community for residents and visitors alike. Stormwater collection and conservation can lead to a reduction in the use of potable water and free up our most precious resource for other beneficial goals. Protection of these assets is vital to a more sustainable quality of life for plants, animals, and humans.

Homeowners Associations (HOA) and Community Assistance

Homeowners are often in need of assistance post-disaster and must look for aid from local disaster relief organizations. A person's home and contents may be damaged, but many belongings can be restored through community help. The NFIP has suggested steps that can be taken to help the public remain calm during a traumatic experience including taking care of themselves and family, rehabilitating their home and making sure it is safe to re-enter, and checking for financial grant assistance. Sometimes these processes, such as the requirements for post-disaster construction, can be daunting and a collaborative effort with the District can help your neighbors and community prepare for a future flood disaster.

Community assistance organizations such as yours regularly respond to natural and manmade disasters throughout Pima County including local flooding from monsoon storms or heavy rain events. During times of floods, homeowners may be trapped in their homes with no working utilities or without a dry place to spend the night. Recovery from a disaster can take months or years to mitigate and the support you provide is important to the recovery of our community. Homeowners may not be aware of the services you offer and a collaborative effort would be beneficial in the rebuilding of Pima County post-disaster.

Major Employers

Major employers in Pima County can play an important role in keeping their employees and the broader community safe when disaster looms. Research has shown that human behavior is most likely to change when an individual receives information from multiple sources, especially from sources that they otherwise trust. A company's response to imminent or ongoing flood risks has the power to not only keep people safe during the flood event itself, but project a powerful message that flood hazards need to be taken seriously. An example of a company taking the initiative to keep employees safe includes allowing employees to leave work early so they aren't driving when a major storm hits, which makes streets safer for emergency responders. Other strategies include allowing people to flex their time or work from home. We look forward to having you as a business partner in keeping our community safe.

School Districts

Developing a program that teaches kids what to do before, during, and after a flood related emergency is important in preparing a child for a real disaster. Emergencies and natural disasters can be both scary and fascinating, but a child can find reassurance by applying classroom lessons to real world situations. By developing a curriculum showing what could happen, how a child should prepare, and what to do during a flood related event, students will feel empowered and can become

essential parts of disaster relief efforts as students become teachers to their families to help the family and the whole community prepare a plan to keep everyone safe. Every person who knows how to stay safe during a flood is one less person who may need to be rescued or need emergency services. All learning activities lead to important discussions through collaborative fact finding and classroom sharing. The District can work with your school to help foster a curriculum which will educate the student as well as the teaching staff on how to best prepare for a flood related disaster whether at home or school.

PPI Appendix B
Meeting Agendas

December 18 2018: 9AM-10AM

201 N. Stone Ave., 9th Floor Conference Room C

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1. Introduction of new member
    a. Luke Cole, Associate Director of Sustainable Landscape and Communities, Sonoran Institute
2. Review of the District's 2018 outreach efforts as related to the 2017 Program for Public Information document
    a. Automated Local Evaluation in Real Time (ALERT) inundation mapping messaging (OP #53)
        i. The District is currently working with Pima County Office of Emergency Management (OEM) to provide inundation maps for certain major watercourses related to specific flood discharges. Appropriate safety/warning messages for inundation areas and discharges will be loaded into OEMs MyAlerts emergency messaging service. This will allow the District and OEM to use real-time flood discharge data from stream gages to distribute warning messages to those residents in the affected area who have signed up for MyAlerts. These maps are available on the District's ALERT website. Outreach to critical facilities within these inundations will be a priority related to this outreach project.
    b. Levee fact sheet (OP #54)
        i. A fact sheet will be mailed to residents in areas protected by a levee that are identified as being in a FEMA Shaded Zone X Other Flood Hazard Area. The fact sheet focuses on the hazards associated with living near a levee and levee safety.
    c. Work with elected officials to deliver messages and promote the need for flood insurance (OP #55)
        i. The District worked with Pima County District 2 Supervisor Ramon Valadez and the Pima County Communications Office to produce public service announcements addressing flood insurance and road safety. These videos were shot in both English and Spanish to reach a more broad audience.
    d. Outreach associated with the Living River (OP #56)
        i. The District worked with the Sonoran Institute to notify and inform the public on an ongoing District project that focuses on the Lower Santa Cruz River wetland restoration.
    e. Other outreach
        i. The District delivered various brochures, radio advertisements, presented at events per previous PPI Document requirements.

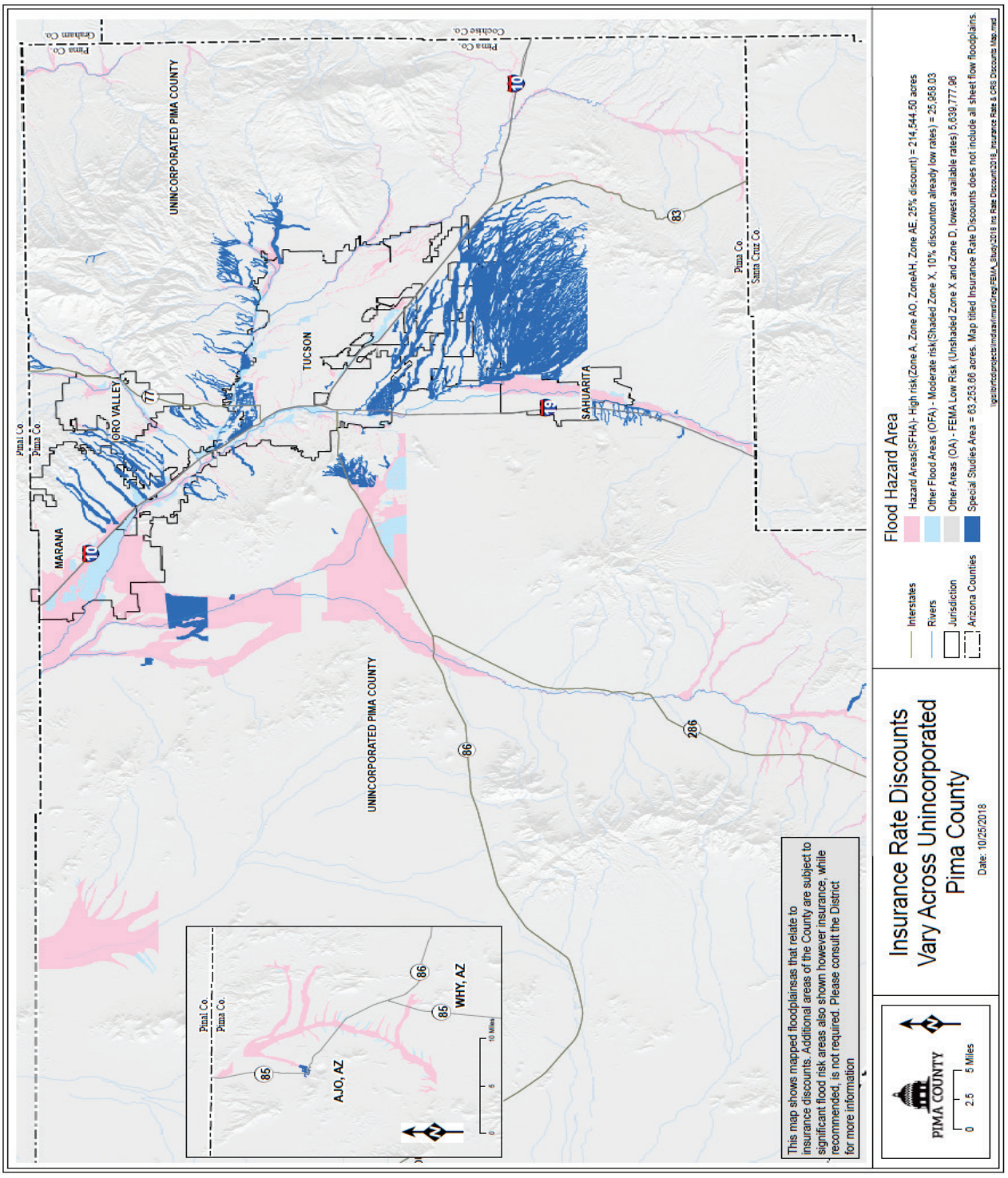
3. **Overview of the Pima County Regional Flood Control District's (District) Floodplain Management Plan**
    a. The District is seeking input from the public on the preparation of a Floodplain Management Plan. Efforts include identifying high flood risk areas, preserving natural watercourses, constructing flood control facilities, establishing locally appropriate development standards, distributing public information, providing early warning, and responding to flood emergencies. This plan will help the District identify the activities that will be most effective in each of the watersheds in unincorporated Pima County. A website has been created and will include updates and opportunities for public input including a survey – http://www.pima.gov/fmp/

4. 2019 potential outreach efforts
    a. Brochure development related to the District's engineering and capital improvement projects
        i. Develop a brochure that highlights specific engineering projects such as Paseo De Las Iglesias, Arroyo Chico improvements, etc.
    b. Floodplain Management Plan
        i. Provide support in outreach efforts to the District's Floodplain Management Plan
    c. Other activities as decided by the PPI Committee
        i. TBD

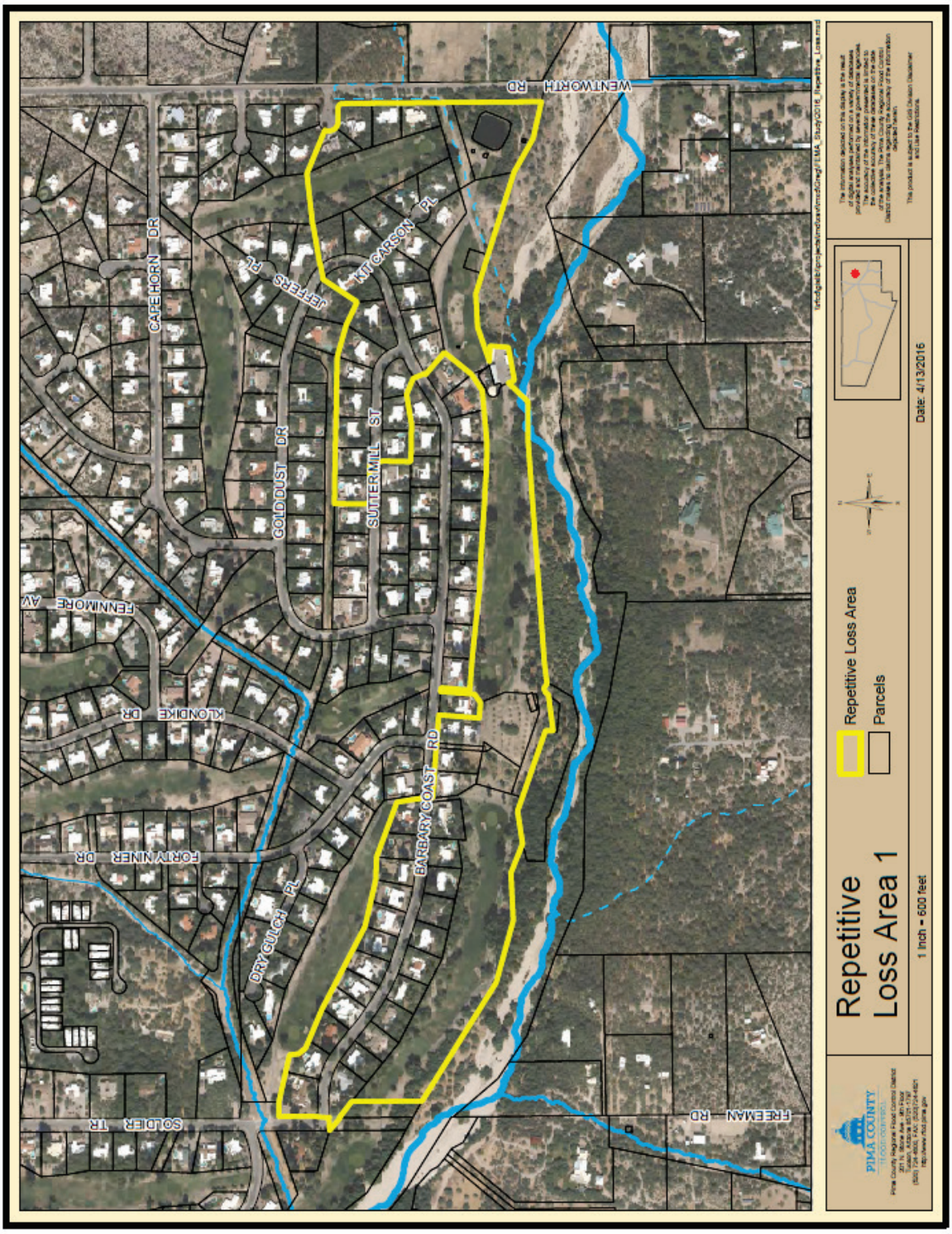
5. **Updates to the 2019 PPI Document**
    a. Page 17 & 18 – Updated total acreage of regulatory floodplains and insurance policy counts
    b. Page 26 – Updated 2019 outreach projects as approved by the PPI Committee
    c. Page 36 – Appendix C updated map using newer available data
    d. Page 39 – Appendix E updated to reflect 2019 outreach projects
    e. Page 41 – Appendix G updated map using newer available data
    f. Page 42 – Appendix H updated to reflect public service announcement scripts (OP55)
    g. Page 46 – Appendix J updated to summarize 2018 outreach efforts
    h. Entire Document was updated to reflect changes in approval years (i.e. 2017 changed to 2018)

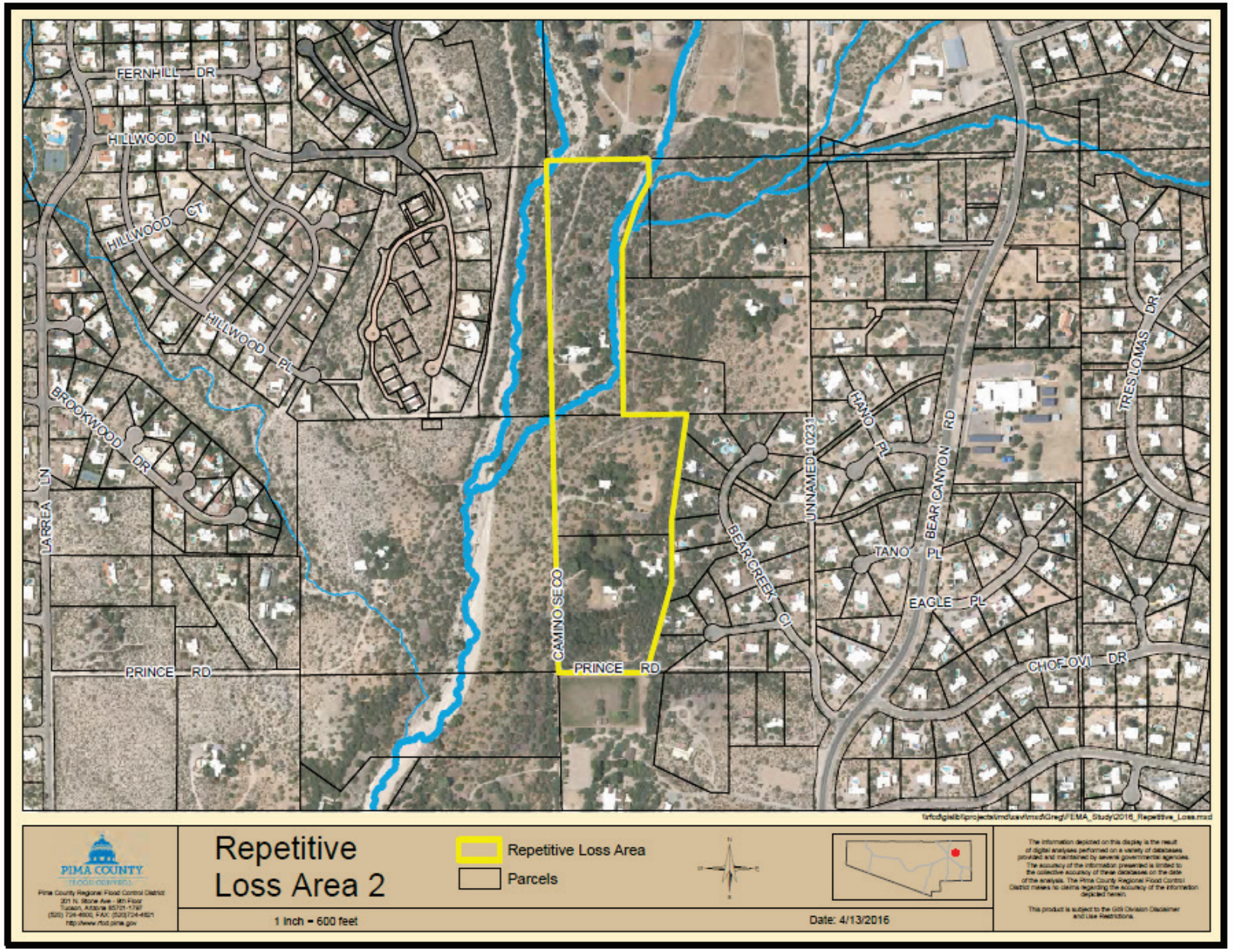
6. **Explanation of Committee expectations for the rest of 2018 and 2019**
    a. Approve the 2019 PPI Document
    b. Provide support as stakeholders in development and delivery of outreach projects and messages

PPI Appendix C
Insurance Rates & CRS Discounts Map



PPI Appendix D
Repetitive Loss Area Maps



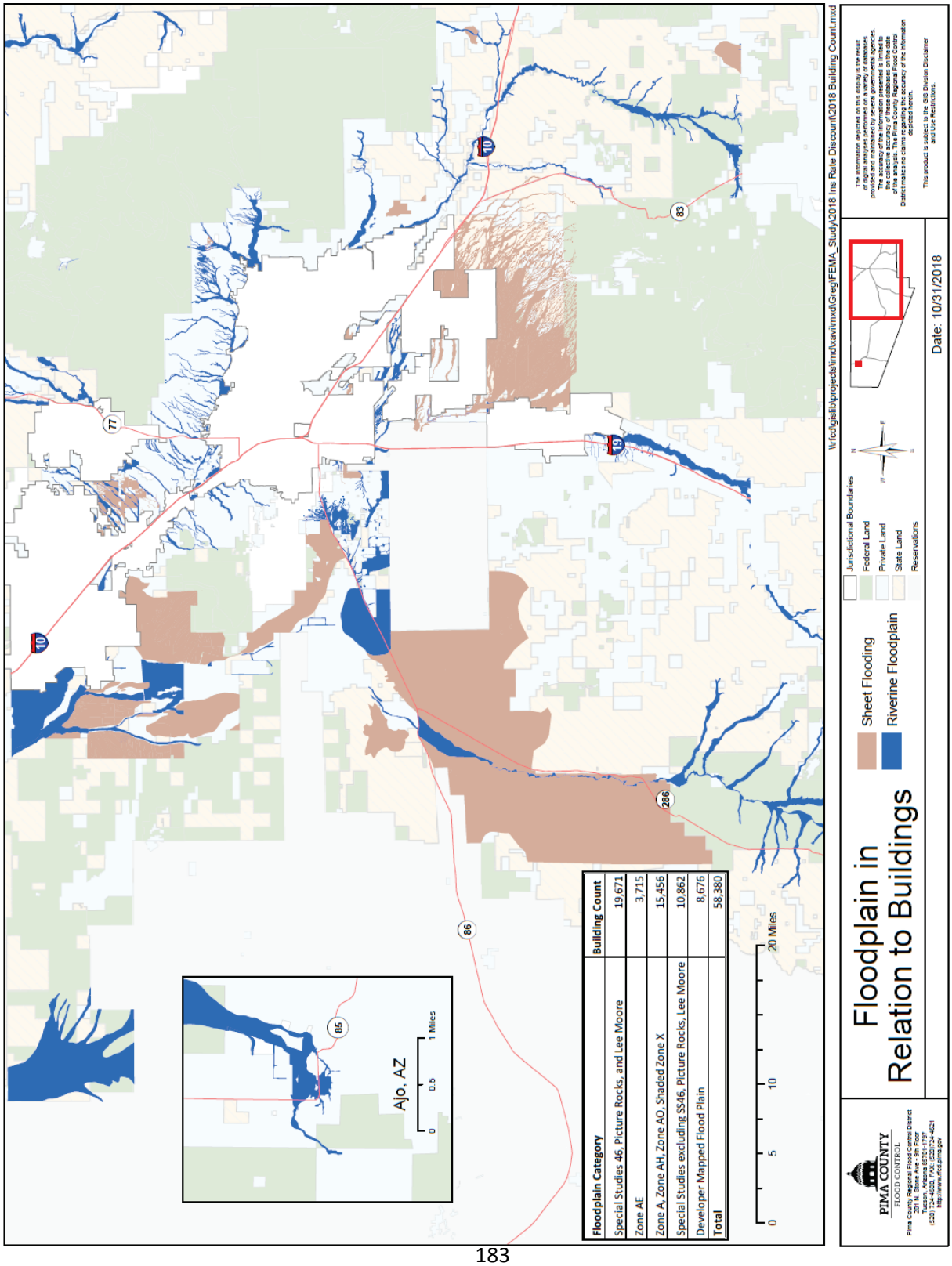

FERNHILL DR
HILLWOOD LN
HILLWOOD CT
HILLWOOD PL
BROOKWOOD DR
LARREA LN
PRINCE RD
CAMINO SECO
PRINCE RD
BEAR CREEK CI
UNNAMED 10231
HANO PL
BEAR CANYON RD
TRES LOMAS DR
TANO PL
EAGLE PL
CHOF OVI DR
Repetitive Loss Area 2
Repetitive Loss Area
Parcels
1 Inch = 600 feet
Date: 4/13/2016
PIMA COUNTY
FLOOD CONTROL

PP1 Appendix E
PPI Spreadsheet
(Not included for purposes of the FMP)

PPI Appendix F
Acronyms

ACS: American Community Survey
ADWR: Arizona Department of Water Resources
CEC: Continuing Education Credit
CIS: Community Information System
CP: Coverage Improvement Plan
CRS: Community Rating System
District: Regional Flood Control District
FCV: Full Cash Value
FEMA: Federal Emergency Management Agency
FIA: Flood Insurance Assessment
FLAP: Flood prone Land Acquisition Program
FCDAC: Flood Control District Advisory Committee
GIS: Geographic Information System
HMP: Hazard Mitigation Plan
ISO: Insurance Services Organization
LID/GI: Low Impact Development/Green Infrastructure
NGO: Non-Governmental Organization
NFIP: National Flood Insurance Program
PPI: Program for Public Information
WMP: Watershed Management Plan

PPI Appendix G
Areas Subject to Different Flood Conditions



PPI Appendix H
Elected Officials Declaration (OP55)

30 second - Flood Insurance Spot:
I'm Pima County Supervisor Ramón Valadez. Anyone who's lived here awhile knows flooding can happen anywhere in Pima County. Flooding can damage your vehicle, home or business, and everything inside them. Protect your property, especially if you own or rent in a floodplain or near a wash. Flood insurance provides piece of mind that your property can be repaired or replaced when flooding strikes. With discounted policies available for buildings or their contents, it's probably more affordable than you think. To learn more, contact the Pima County Regional Flood Control District.

Hola, soy Ramón Valadez, Supervisor del Condado Pima. Quien ha vivido en esta región sabe que las inundaciones suceden en cualquier lugar. Una inundación puede dañar su vehículo, hogar o negocio. Proteja su propiedad con seguro de inundación, especialmente si es propietario o inquilino en un sitio propenso a inundaciones. Hoy en día existen tarifas reducidas para edificios y sus pertenencias. Para más información, contacte al Departamento de Control de Inundaciones del Condado Pima.

15 second - Flood Insurance Spot:
I'm Pima County Supervisor Ramón Valadez. Flooding can happen anywhere in Pima County… damaging vehicles, homes, and business, and everything inside them. Get peace of mind with flood insurance. Discounted policies are available for buildings or their contents. To learn more, contact the Pima County Regional Flood Control District.

Hola, soy Ramón Valadez, Supervisor del Condado Pima. En esta región las inundaciones suceden en cualquier lugar, y pueden dañar su vehículo, hogar o negocio. Proteja su propiedad con un seguro de inundación. Para más detalles, contacte al Departamento de Control de Inundaciones del Condado Pima.

30 second - Road Safety Spot:
I'm Pima County Supervisor Ramón Valadez. You've probably experienced flooded roads, but you may not know that flash floods are the number one weather-related killer in the United States, mostly from people driving through these deadly waters. If you can't see the road stripes, turn around, don't drown, and find another route. Your safety is worth a few extra minutes. Better to arrive late than not at all. Contact the Pima County Regional Flood Control District to learn more about avoiding flood risks and protecting yourself from flooding.

Hola, soy Ramón Valadez, Supervisor del Condado Pima. ¿Sabía que en Estados Unidos, las inundaciones repentinas son la causa número uno de muertes relacionadas con el clima? Si no puede ver las líneas en el camino, de la vuelta y encuentre una ruta segura. Esos minutos extra le

pueden salvar la vida. Para más información sobre los riesgos de inundación y cómo protegerse, contacte al Departamento de Control de Inundaciones del Condado PIma.

15 second - Road Safety Spot:
I'm Pima County Supervisor Ramón Valadez. Flash floods can be killers, especially on the road. If you can't see the road stripes, turn around, don't drown. Better to arrive late than not at all. For more information

Hola, soy Ramón Valadez, Supervisor del Condado Pima. Las inundaciones repentinas pueden ser fatales, especialmente en la carretera. Si no puede ver las líneas en el camino, de la vuelta, y evite una desgracia. Para más información contacte al Departamento de Control de Inundaciones del Condado PIma.

PPI Appendix I - Adopted Resolution

A RESOLUTION OF THE PIMA COUNTY FLOOD CONTROL DISTRICT BOARD OF DIRECTORS APPROVING A PROGRAM FOR PUBLIC INFORMATION AS PART AS THE NATIONAL FLOOD INSURANCE PROGRAM'S COMMUNITY RATING SYSTEM

WHEREAS, Pima County has experienced severe flood disaster events causing significant damage to public and private property, including homes and businesses which results in a need for insurance coverage for those who may be exposed to flood risks: and,

WHEREAS, relief from the economic hardships of flood damage is available in the form of federally subsidized flood insurance as authorized by the National Flood Insurance Act of 1968 and its subsequent amendments: and,

WHEREAS, the National Flood Insurance Program (NFIP) is a federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding: and,

WHEREAS, the Pima County Regional Flood Control District (District) participates in the NFIPs Community Rating System (CRS) which provides a framework necessary for a community's actions and efforts in meeting the three goals of: (1) reduction of flood losses; (2) facilitation of accurate insurance ratings; and (3) promotion of awareness of flood insurance: and,

WHEREAS, as part of the CRS, communities are encouraged to exceed minimum standards and in doing so qualify for a reduction in flood insurance premiums for policy holders, with a current premium discount of up to 25% within unincorporated Pima County: and,

WHEREAS, the District plans to further exceed the minimum NFIP standards through the design and implementation of a Program for Public Information (PPI): and

WHEREAS, the PPI is an ongoing, stakeholder driven, public information effort to identify and transmit the messages that the Committee has prioritized as the most important to flood safety and the protection the natural beneficial functions of floodplains: and

WHEREAS, a component of the PPI includes a Flood Insurance Coverage Assessment and a Coverage Improvement Plan that requires promoting of the purchase of or an increase in coverage of flood insurance:

NOW, THEREFORE, BE IT RESOLVED, that this community's governing body hereby:

1) Approves the PPI and submittal of annual progress reports to the administrator of the CRS by the Committee: and,
2) Commits to participate in the promotion of the benefits of flood insurance and other flood safety messages that have been identified by the Committee in the PPI.

PPI Appendix J
2018 Outreach Efforts

2018 Outreach Projects

New Outreach Project	Topics and Messages Covered	Message Delivery by Stakeholders	Outcome
Development of brochure(s) targeted at specific audiences covering all 10 PPI topics (OP52) – This was also a 2017 outreach project	1-10	Pima County Communications Office, Identified Stakeholders TBD	Provide a general information document to specific target audiences
Automated Local Evaluation in Real Time (ALERT) inundation mapping and messaging (OP53)	1, 2, 3, 4, 6, 7, 9 & 10	Pima County, First Responders	Notify properties adjacent to major watercourses that flash flooding is a potential threat
Levee failure messaging (OP54)	1, 2, 3, 4 & 6	Pima County, Real Estate Agents	Notify properties adjacent to levees about the potential threat of failed infrastructure
Work with elected officials to deliver messages and promote the need for flood insurance (OP55)	1, 2, 5, 6 & 10	Pima County Communications Office, various elected officials	Produce public service announcements addressing flood insurance and road safety
Outreach associated with the *Living River Project (*OP56*)*	5, 6 & 8	Pima County, Sonoran Institute	Notify and inform the public on an ongoing District project focusing on Santa Cruz River wetland restoration

Appendix C – Watershed Hazard and Problem Assessments

C.1 Urban Watersheds

C.1.1 Agua Caliente Wash

Agua Caliente Wash has its origin above 5000 feet mean sea level in the Santa Catalina Mountains. It descends through the Coronado National Forest before spilling out onto the bajada foothills and geologic floodplains associated with Tanque Verde Creek where they merge to become the Rillito Creek. The total size of this watershed is 27,438 (42.8 square miles) acres, with 26,823 in the unincorporated area.

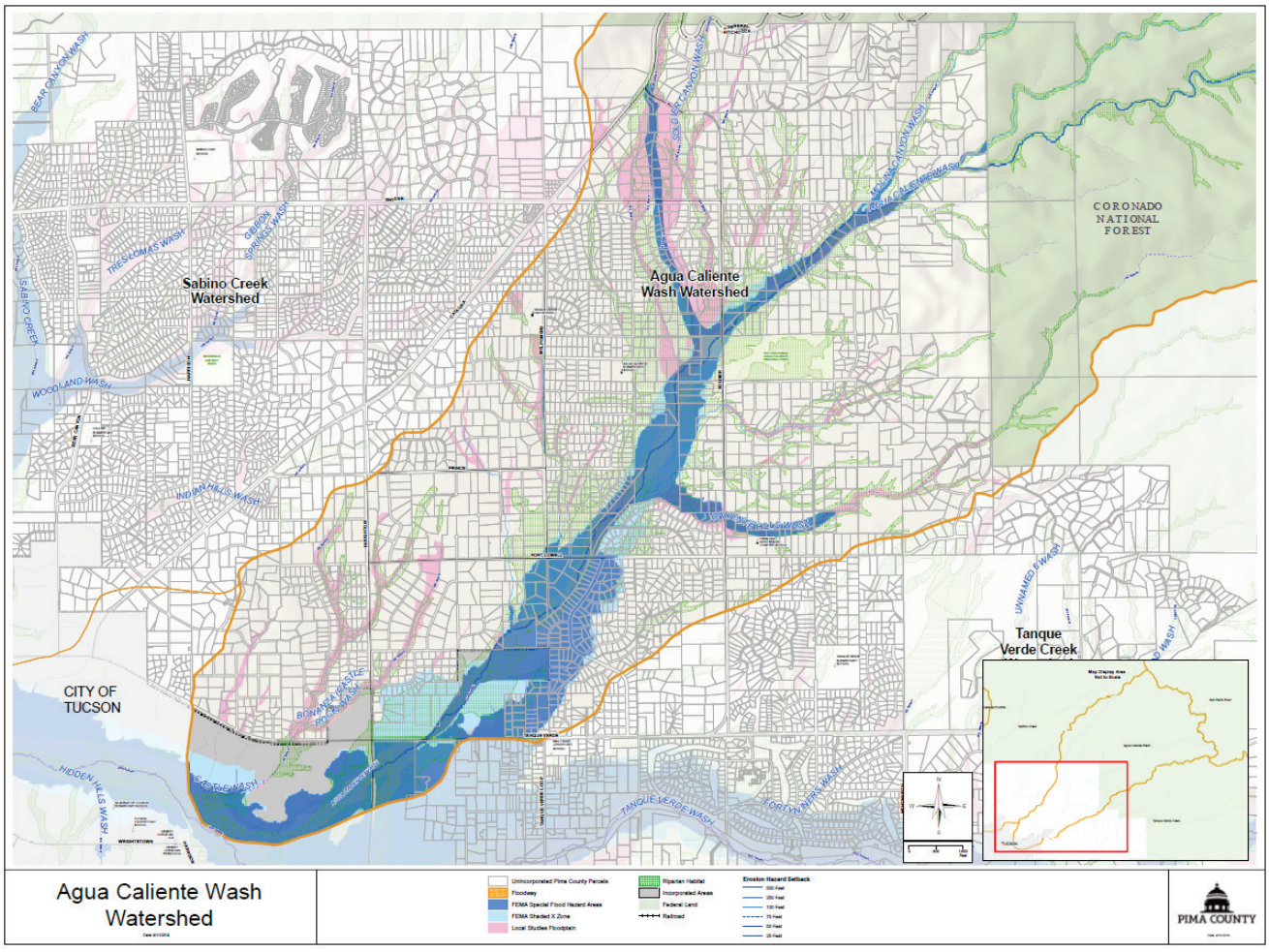


Figure 31 - Agua Caliente Wash Watershed Flood Hazard Map

C.1.1.1 Flood Characteristics

In addition to the 930 acres of SFHA zones included on the pie chart above, there are also 405 acres of District Special Studies Floodplains and 100 acres of locally mapped sheet flood area in this watershed.

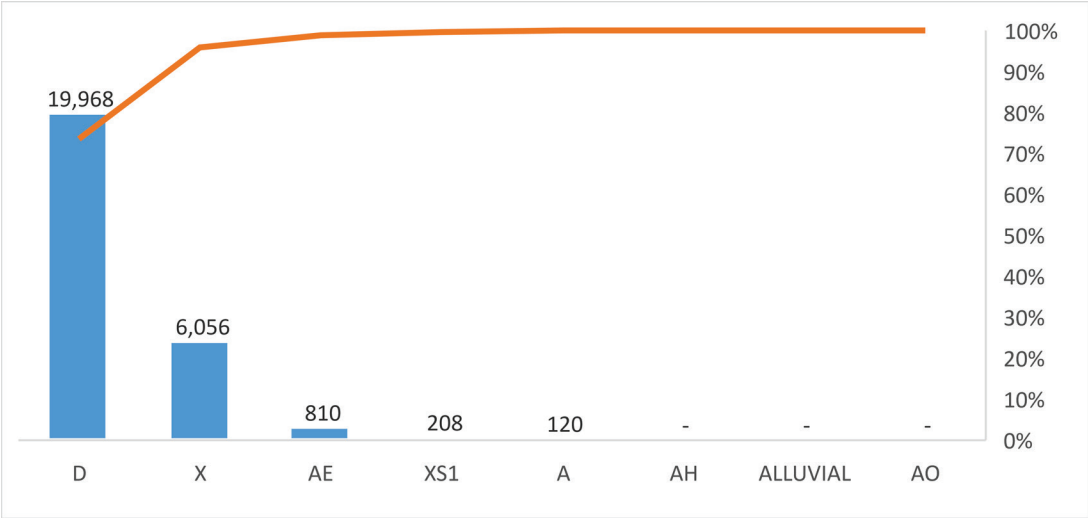


Figure 32 - Agua Caliente Wash SFHA in Acres

Unlike most of Pima County flow, flow in this watershed can continue for extended periods, and the upper watersheds may even experience perennial flow. Flow measurement in the Agua Caliente is more complete than many other watersheds. A summary of the USGS gauging station records is as follows:

Table 33 - Agua Caliente Watershed USGS Gages

USGS Gaging Station	**USGS 09483100 TANQUE VERDE CREEK NEAR TUCSON, ARIZ**	**USGS 09484500 TANQUE VERDE CREEK AT TUCSON, AZ.**	**USGS 09483200 AGUA CALIENTE WASH TRIB NEAR TUCSON, ARIZ**	**USGS 09484000 SABINO CREEK NEAR TUCSON, AZ**	**USGS 09484200 BEAR CREEK NEAR TUCSON, ARIZ.**
Period of Record	Nov. 1960 to Dec. 2012	Aug. 1940 to Jan. 2015	Aug. 1965 to Aug. 1980	Jul. 1932 to Jan. 2015	Nov. 1960 to Dec. 1978
Watershed Area (sq. m)	43	219	2.14	35.5	16.3
Flood Peak of Record (cfs)	8,600	26,600	430	15,700	1,400
Date	2-Oct-83	31-Jul-06	19-Sep-71	31-Jul-06	18-Dec-78

These records indicate that floods in the Agua Caliente watershed can occur from all three of the three primary flood mechanisms that occur in Pima County, convective storms, tropical storms and frontal storms. Rain on snow events occur in this watershed when frontal storms produce rain on existing winter snow.

The table below summarizes Pima County's Alert Gages. The locations are from the District's Alert map.

Table 6 - Agua Caliente Watershed ALERT Streamflow Gages

Pima County ALERT Gage	Agua Caliente wash at Tanque Verde Road ID: 2203	Agua Caliente at Houghton Road ID: 2199	Agua Caliente Wash Near LA Milagrosa Canyon ID: 2253
Location (Latitude, Longitude)	(32.2509,-110.7667)	(32.2483,-110.7722)	(32.297,-110.7167)
Period of Record	199-12-14 to Present	1994-06-02 to Present	2017-07-13 to Present
Watershed Area (sq. m)	60.9	40.88	25.18
Flood Peak of Record (cfs)	9756.2	8300	4609.4
Date	07-31-2006	07-31-2006	07-22-2017

ALERT precipitation gages in this watershed are co-located with stream gages.

Below are excerpts for Agua Caliente from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 7 - Agua Caliente Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Agua Caliente Wash:			
Upstream of confluence with Tanque Verde Creek	7,180	40.40	FEMA Map Revision (11-09-1817S)
Downstream of the divergence of the Agua Caliente Spur Flow	10,540		"
Downstream of confluence with Soldier Canyon Wash	13,000		"
Upstream of confluence with Soldier Canyon Wash	12,000	28.60	"
Agua Caliente Split Flow			
@ Divergence from Agua Caliente Wash	3,360		FEMA Map Revision (11-09-1817S)
@ Confluence with Tanque Verde Creek	5,820		"
Agua Caliente Spur Flow			
@ Confluence with Agua Caliente Split Flow	2,460		FEMA Map Revision (11-09-1817S)
Forty-Niners Wash			From Previous Discharge Table
@ National Forest Boundary	4,578		
@ Tanque Verde Road	3,500		"
Old Grandad Tank Wash			
@ Tanque Verde Creek Confluence	3,942	2.02	Pima County Regional Flood Control District Special Study (#57)
Sabino Creek			
Upstream of Confluence with Tanque Verde Creek	18,000	66.40	FEMA, Flood Insurance Study
Upstream of Confluence with Bear Creek	12,500	36.80	"

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Tanque Verde Creek			
Upstream of Confluence with Rillito Creek	34,000	241.0	FEMA, Flood Insurance Study
Upstream of Confluence with Sabino Creek	28,000	149.0	‘’
Near the confluence with the Agua Caliente Wash	23,000	99.60	‘’
Wentworth Wash			
Upstream of Speedway Boulevard	4,719	5.3	Pima County Regional Flood Control District Special Study (#58)

Flood characteristics vary greatly on the watershed. While flow is primarily constrained in mountainous channels, distributary flow patterns develop where these channels enter the valley floor at the apex of alluvial fans, and residential properties are at risk for flood damage where drainage infrastructure does not exist. Potential for overbank flow leading to flooding exists along the Tanque Verde Creek, particularly at its confluence with Agua Caliente Wash.

Likewise, flood characteristics themselves vary greatly depending on whether the event is convective, such as on July 31, 2006, (which was a high intensity, shorter duration event) or a rain on snow event such as the February 1993 event, which released a higher volume of water, over a longer period. Tributary flooding is likely during short and long duration storms while main stem flooding typically occurs during long duration or overlapping storm events.

Agua Caliente Creek enters the valley floor onto alluvial fans, which is where most of the development has occurred. Flows on these fans can cause erosion, deposition and channel avulsion. The July 31, 2006 also produced debris flows on these alluvial fans, which resulted in flooding of some structures that would not have been at risk if the debris flow had not altered the flow pattern at the apex in Soldier Canyon. In addition, even where flow-patterns were not altered, such as in Sabino Canyon upstream of Bear Canyon, the sediment released in the debris flow filled the channel and reduced the flood capacity.

C.1.1.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. While 31% of the watershed population lives within a regulatory floodplain, another 109 residents live behind a levee.

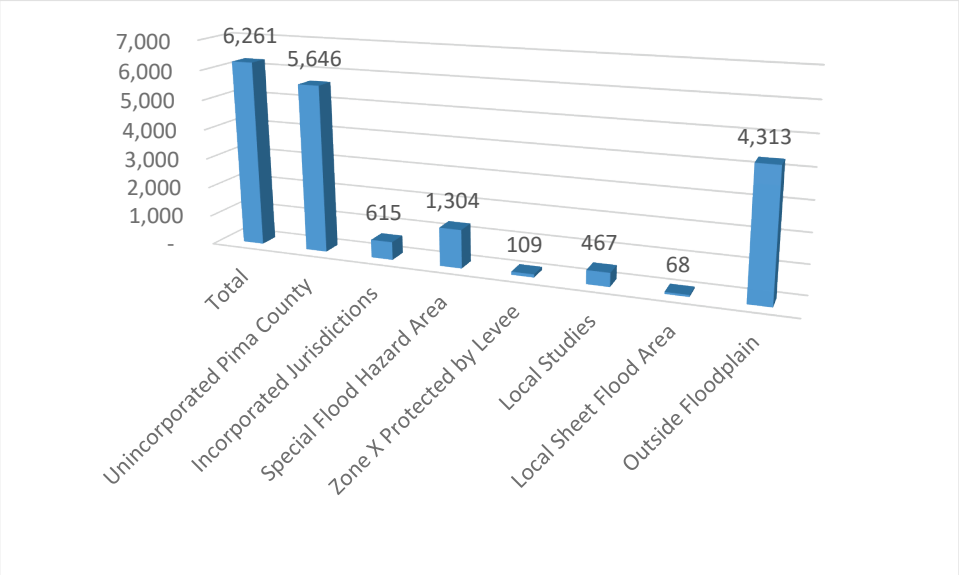


Figure 34 - Agua Caliente Watershed Population Distribution

The chart below shows ownership.

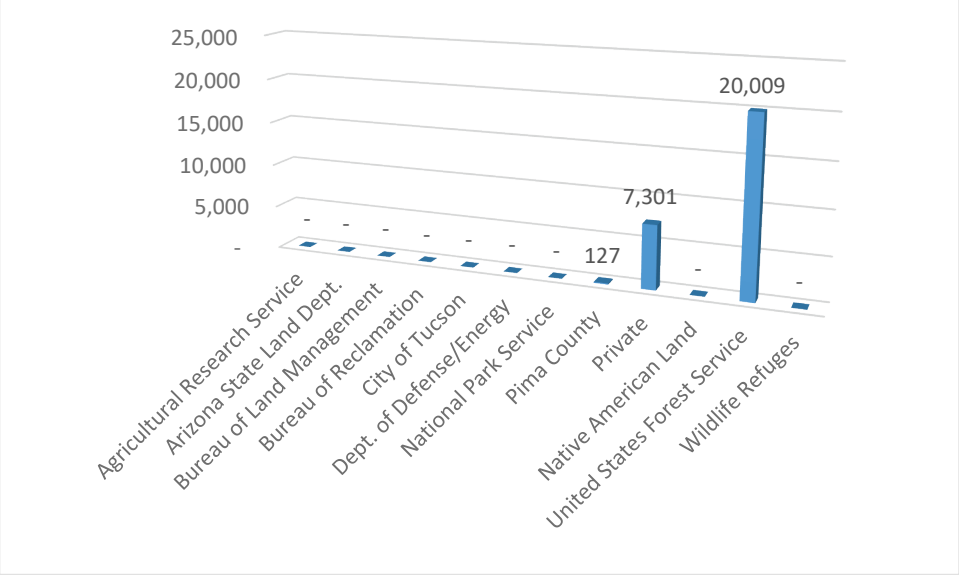


Figure 35 - Agua Caliente Wash Unincorporated Pima County Ownership in Acres

While build out of improved developments and some lot splitting can be expected few large tracts are available for development. The charts below show land use in the watershed and floodplain.

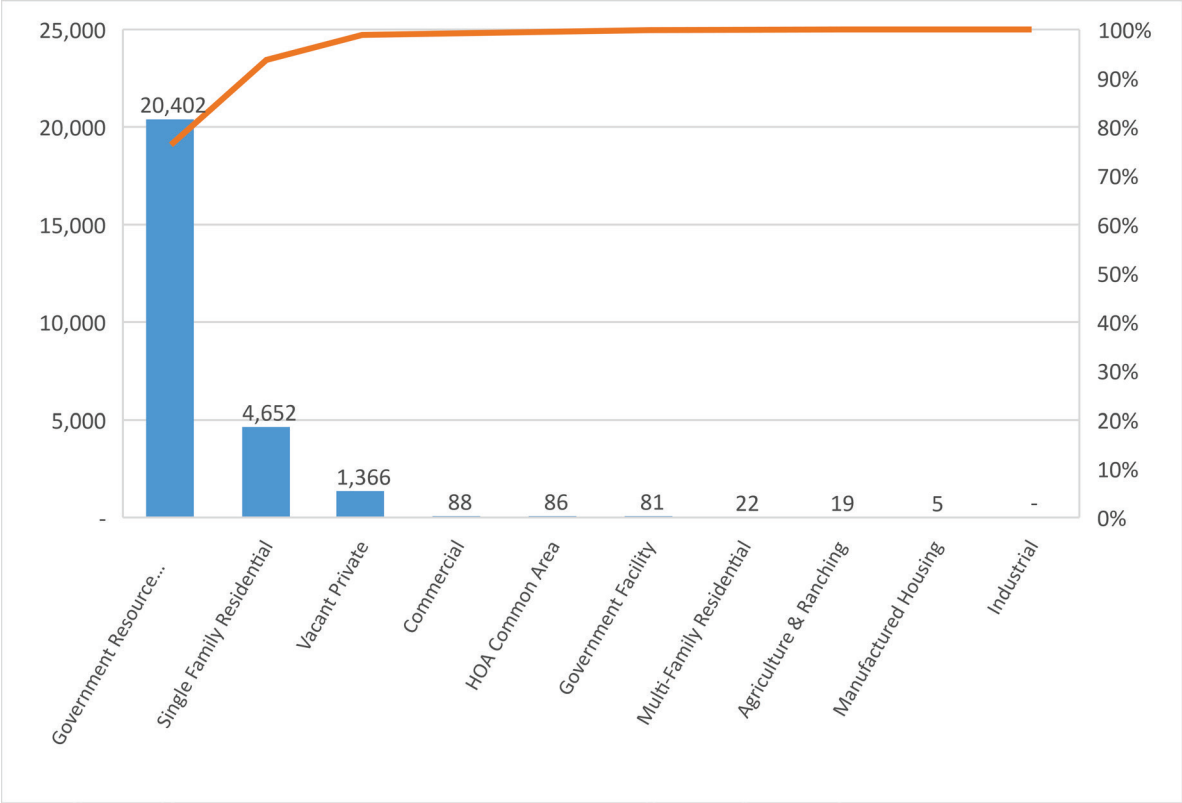


Figure 36 - Agua Caliente Wash Watershed Land Use in Acres

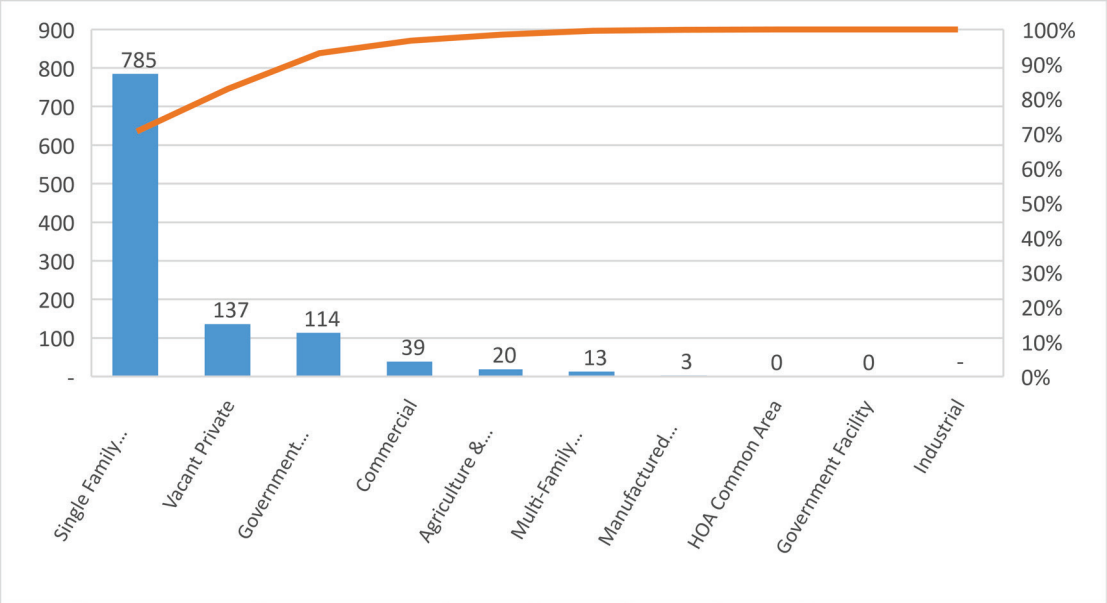


Figure 37 - Agua Caliente Floodplain Land Use

As noted above single family residential is the largest non-governmental use of private floodplain land. The map below shows these land use patterns.

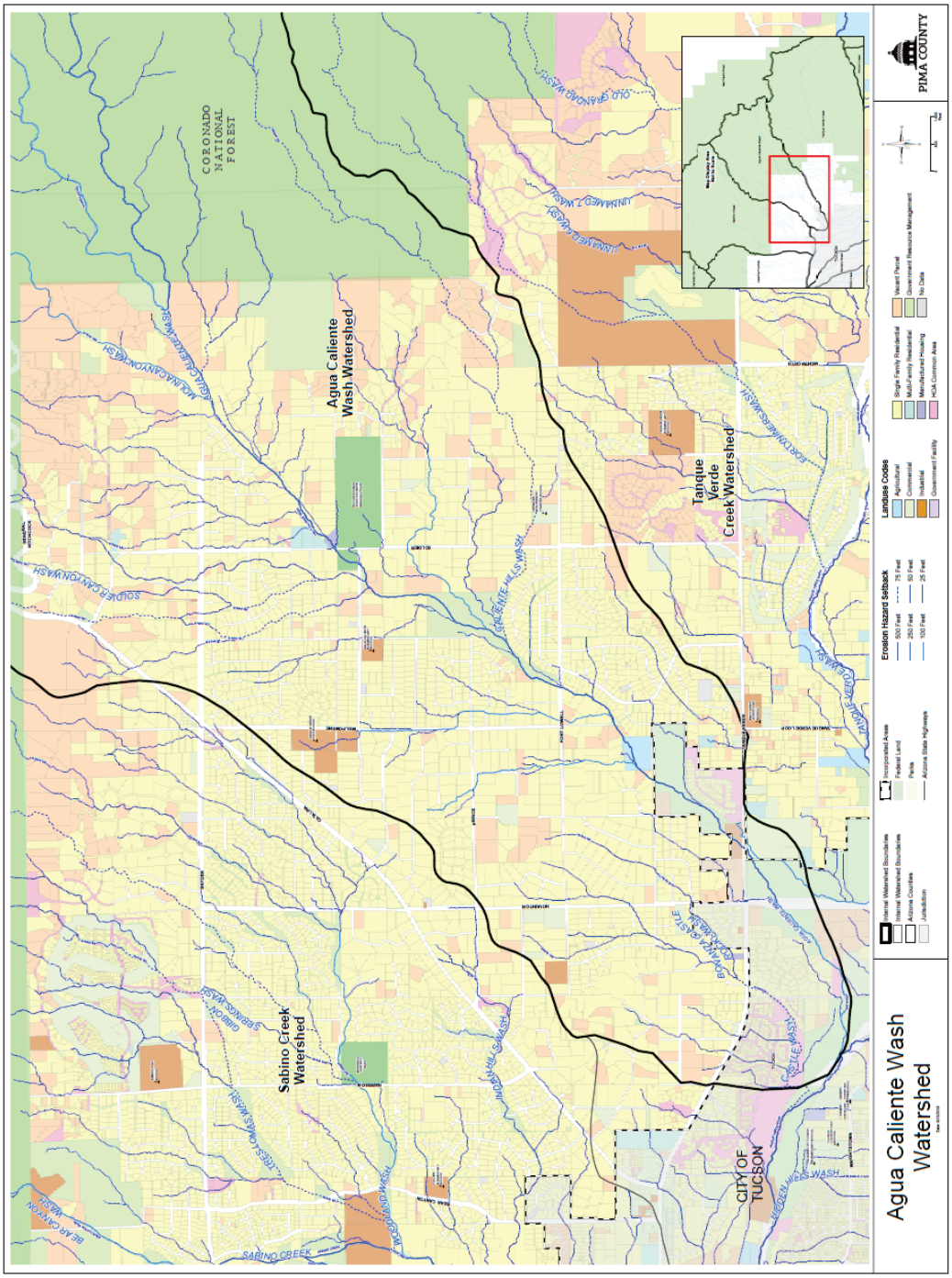


Figure 38 - Agua Caliente Land Use Map

C.1.1.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 1,224 acres of Pima County Regulated Riparian Habitat within unincorporated Pima County in this watershed. IRA includes areas without underlying habitat designation based upon connectivity and soils amongst other factors. There are also 20,181 preserved acres in this watershed, including 241 in regulatory floodplain.

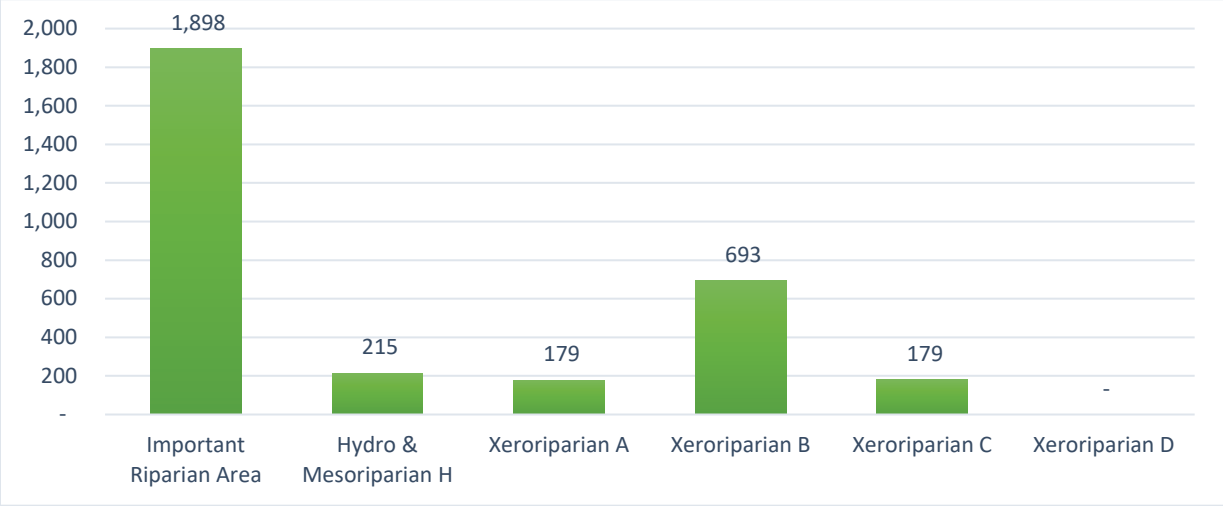


Figure 39 - Agua Caliente Wash Watershed Riparian Habitat in Acres

The confluence with the Rillito as well as the headwaters contain some of the largest networks of springs, surface flows and shallow groundwater anywhere in the County. This water availability has contributed both to the biologic, historic and cultural significance of this region as well as current high property and recreational amenity values, which warrant the full measure of protection afforded by floodplain management practices.

The County-owned Agua Caliente spring has been anomaly dry for most of the past decade, and pumped groundwater sustained the historic main pond. The District is renovating the landscape and lining the ponds to preserve water, and in 2018, the spring began flowing again.

Today, landowners and community stakeholder groups including, Friends of Redington Pass, Watershed Management Group, Coalition for Sonoran Desert Protection and Audubon Society are also pursuing preservation and enhancement actions. A coalition of conservation groups and landowners is critical for addressing groundwater decline and non-native bullfrog infestation treats to the biologic diversity in this watershed.

The Agua Caliente watershed transitions from 5,000 feet at its headwaters to 2,560 feet at the confluence with Tanque Verde Creek, supporting a diverse riparian plant community. Higher in the watershed, Oak Woodland, an open woodland dominated by one or more species of oak, fingers down riparian corridors, supported by shallow groundwater and intermittent flow.

Further downstream in the watershed, slopes become less steep and the floodplain widens. Along the main channel of Agua Caliente Wash, shallow groundwater and seasonally intermittent flows support Interior Southwestern Riparian Deciduous Forest and Woodland, Mixed Broadleaf Series (Harris, 2001), where cottonwood (*Populus fremontii*), Arizona sycamore (*Platanus wrightii*), velvet ash (*Fraxinus velutina*), and Arizona black walnut (*Juglans major*) are commonly observed. Moving away from the main channel, along the ephemeral tributaries, the plant community transitions into Sonoran desertscrub, commonly referred to as xeroriparian habitat, with an occasional Netleaf hackberry (*Celtis reticulata*) and western soapberry (*Sapindus saponaria*) mixed in where the two plant communities meet.

Molina Canyon Wash (left), Agua Caliente Wash at Prince Road (right)

Due to drier conditions in this reach, the main channel supports Sonoran Interior Strand, a plant community commonly found along riverine channels subject to frequent inundation. Species commonly associated with Sonoran Interior Strand include both perennials and annuals, including many of those associated with scrubland communities, such as burrobrush, desert broom, seep willow, saltbush, Amaranth, sunflowers, dock (*Rumex sp.*), nightshades (*Solanum sp*.), buckwheats (*Eriogonum sp.*), common cocklebur (*Xanthium strumarium*), datura (*Datura sp.*) and others (Harris, 2001).

At the confluence with Tanque Verde Creek, Sonoran Riparian Deciduous Forest and Woodlands, both the Mesquite Series and Cottonwood-Willow Series occur. These tropic-subtropic deciduous riparian forests are dominated by one or more species of cottonwood (*Populus fremontii*), willow (*Salix gooddingii*), and velvet mesquite (*Prosopis velutina*).

Along the channel edges of the floodway, Cottonwood-Willow Series is primarily found and is dominated by Fremont cottonwood (Populus fremontii) and Goodding's willow (*Salix gooddingii*). Common shrub species include graythorn (*Ziziphus obtusifolia*), wolfberry (*Lycium sp*.), and others.

Transitioning away from the main channel is the Mesquite Series, an open to fairly dense drought deciduous woodland dominated by velvet mesquite, commonly referred to as a “bosque”. In many areas, understory vegetation has been removed by private development, but where it still exists, vegetation is dominated by catclaw acacia (*Senegalia greggii*), graythorn (*Ziziphus obtusifolia*), wolfberry (*Lycium sp*.), and Mexican elderberry (*Sambucus mexicana*), as well as native grasses, annuals and vines. Once the understory has been disturbed, the bosque becomes susceptible to introduction of non-native invasive species London rocket (*Sisymbrium irio*), and native invasive species Palmer’s Amaranth (*Amaranthus palmeri*). These species take advantage of the newly disturbed areas, oftentimes creating a monoculture that inhibits re-establishment of native species.

Bosque with an understory of London rocket at the Desert Willow property (left), and Isabella Lee property (right)

In recent years, declining groundwater levels and the on-going drought have caused groundwater dependent species to die-off, causing a slow transition into a more xeric plant community that includes desert willow (*Chilopsis linearis*), burrobrush (*Ambrosia monogyra*), and velvet mesquite (*Prosopis velutina*).

C.1.1.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

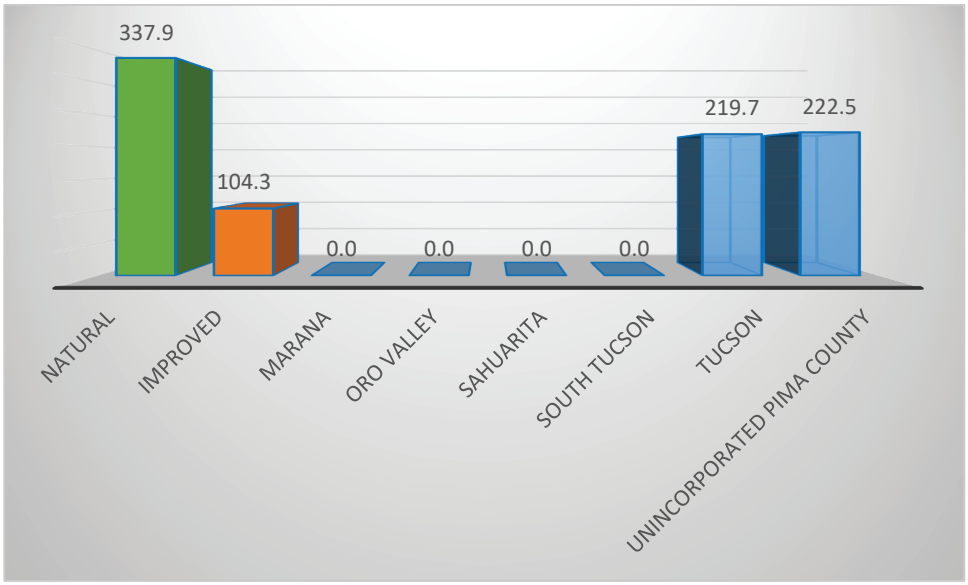


Figure 40 - Agua Caliente Wash Drainageway Acreage

The Agua Caliente 2,200 (+/-) foot long soil cement levee is located on along the western embankment of the upstream of the Tanque Verde Road Bridge. The Agua Caliente spur dike is not a levee but had to pass many of the FEMA levee criteria in order for them not to map the floodplain as if the spur dike failed. It is located upstream of Tanque Verde Road along east embankment of the Agua Caliente Wash. The southern portion of the spur dike, adjacent to the channel, is soil cement. On the northern end, the structure bends to the east and becomes an earthen embankment with armoring. There is one flap gate upstream of the bridge

The District manages 280 acres of open space lands in this watershed. The District primarily acquired these lands through the Floodprone Land Acquisition Program (FLAP) and the majority lie within floodprone areas, with some upland areas included as part of a larger parcel. The District inspects these lands triennially to inventory infrastructure (if present), natural resources and identify threats and stressors.

Raccoon track (left), pot sherd (center) and a canyon tree frog (right)

In 2017, the District implemented a trail plan to improve an existing trail system at the Desert Willow property. Equestrians have heavily used this property for years prior to acquisition by the District in 2014, resulting in a maze of trails throughout the property. The trails capture stormflow, resulting in erosion. Working with the local community, the District developed a plan to close 30 percent of the trails and repair erosion, reducing the impact on natural resources while still meeting the recreational needs of the community. The equestrian community has taken ownership of the property, notifying the District when they have opened or closed trails.

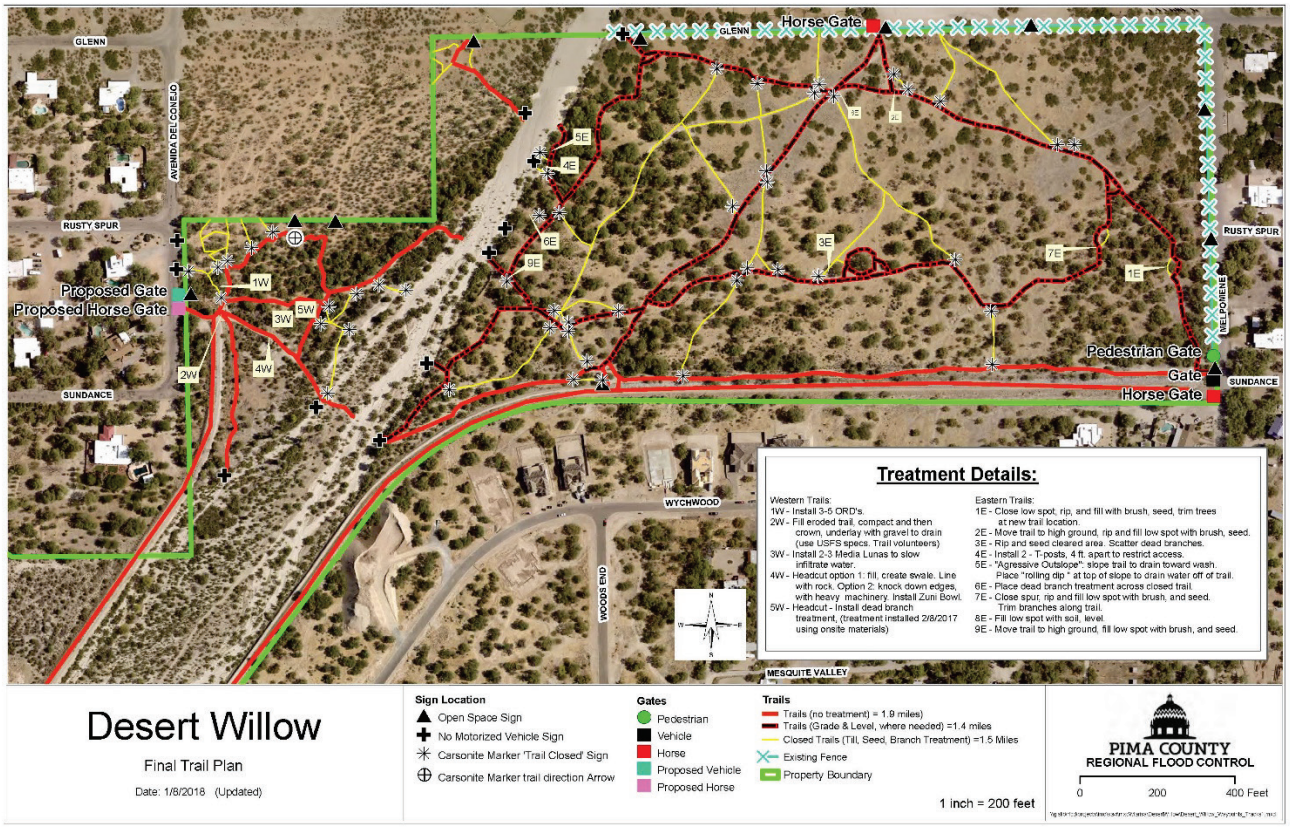


Figure 41 - Desert Willow Trail Plan

Natural and human activities that threaten natural and cultural resources in the watershed include land disturbance caused by adjacent property owners encroaching, invasive species, erosion, OHV use, illegal dumping, wildcat trails, and illegal paintball and BMX courses. As resources allow, the District actively manages these threats through placement of fencing, signage, and enforcement when needed.

Partially dead Arizona black walnut (left), erosion, headcut (middle), and wildcat trail (right)

Illegally dumped manure (left), illegal bmx course at Isabella Lee (middle), and non-native invasive species fountaingrass (right)

Recent OHV tracks (left), illegal paintball course (middle), and trail closure (right)

C.1.1.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Data gathering needs include monitoring effects of 2006 debris flow event. The trigger discharge to monitor the area east and south of the spur dike is approximately 7,500 cfs at the Tanque Verde Road Gage (ALERT ID# 2203). While the district does not need additional gauge stations, it is important to use satellite to monitor aggregation and degradation of the channels.

Frequently Flooded Structures and Properties Subject to Damage

- Agua Caliente Wash breaks out near in the Melpomene and Glenn area.
- Agua Caliente Wash overbanks on the left bank near Limberlost and Soldier Trail. Tributary flows exacerbate flooding.
- Agua Caliente Wash: there are erosion issues along Bel Air Ranch Estates.
- Agua Caliente Wash: channel migration of Agua Caliente Wash threatens 3980 N. Homestead Road
- Soldier Trail Wash: due to elevated roadway and lack of a dip section at Snyder road, flow tends to divert, at least partially, instead of remaining in the main channel of wash. DOT has placed large berm in front of property for protection. Elevated roadway has caused sediment deposition upstream of Snyder road between Catalina Hwy and Soldier Trail (DOT issue). Several structures downstream of Snyder Road have flooded in the past.
- Soldier Trail Wash: immediately downstream of Mt. Lemmon Short Road properties and structures experience flooding during large storm events.
- Castle Rock Wash contains a lot of sediment and the overbank floods frequently.
- Agua Caliente Wash: Inundation of homes adjacent to the main watercourse may start at 5,000 cfs, recorded at Tanque Verde Road Gage (ALERT ID# 2203). Homes located on both sides of the wash north of the spur dike and south of Ft. Lowell Road are expected to flood as flows approach 7,000 cfs. Flows greater than 7,000 cfs are likely to go around the spur dike. Homes immediately upstream of Fort Lowell Road are expected to flood as flows reach 13,000 cfs, with more likely flooding occurring further upstream as flows exceed 13,000 cfs.

Infrastructure

- Agua Caliente Wash is head-cutting (6-8 ft. deep) up towards Soldier Trail. Damage to roadway likely as head-cutting progresses up stream.
- Snyder Road is potentially subject to damage along the eastern portion of the Santa Catalina mountain front.

C.1.1.6 Floodplain Management

Future needs identified by District staff include:

- Riparian preservation
- Shallow groundwater
- High value unprotected property
- Repetitive Loss Properties
- Cumulative Improvements to non-conforming uses
- Bank reclamation
- Warning System Outreach

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify areas of shallow groundwater
- Identify debris flows

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Remap floodplains for the Roller Coaster Wash

Ref# 1.2.c Refine local approximate sheet flood maps and identify flow corridors

- Conduct detailed mapping for remaining local approximate sheetflow floodplains

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Provide assistance to property owners related to bank reclamation
- Work with responsible parties to address flooded roads

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Address erosion advancing towards Soldier Trail

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Conduct targeted outreach about improvements to nonconforming use structures
- Identify and conduct targeted outreach to areas which can get cut-off during flood events

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

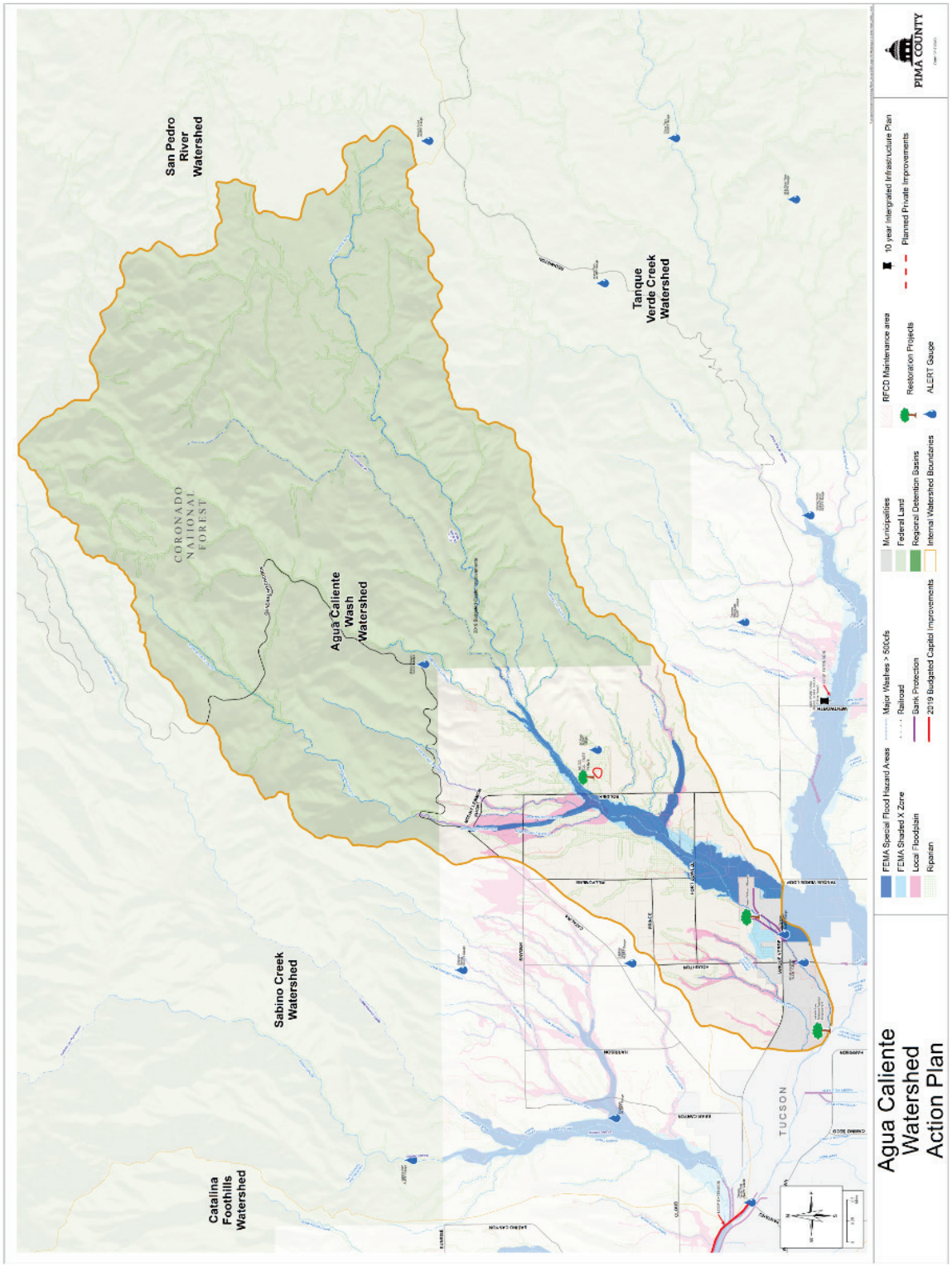


Figure 42 - Agua Caliente Action Plan Map

C.1.2 Black Wash

While the previous watersheds were predominately agricultural and federal land managed for wildlife with scattered residential areas, this watershed is a growth area adjacent to the Tucson basin. It is comprised of 45,040 acres (70.4 square miles). The wash originates on Black Mountain within the San Xavier District of the Tohono O'odham Nation. Tributaries from the northeastern slopes of the Sierrita Mountains south of San Xavier join it along with those emanating from the southwestern slopes of the Tucson Mountains. It joins the West Branch of the Brawley Wash west of Sandario Road. As shown on the watershed map below much of this watershed is within the San Xavier District of the Tohono O'odham Nation.

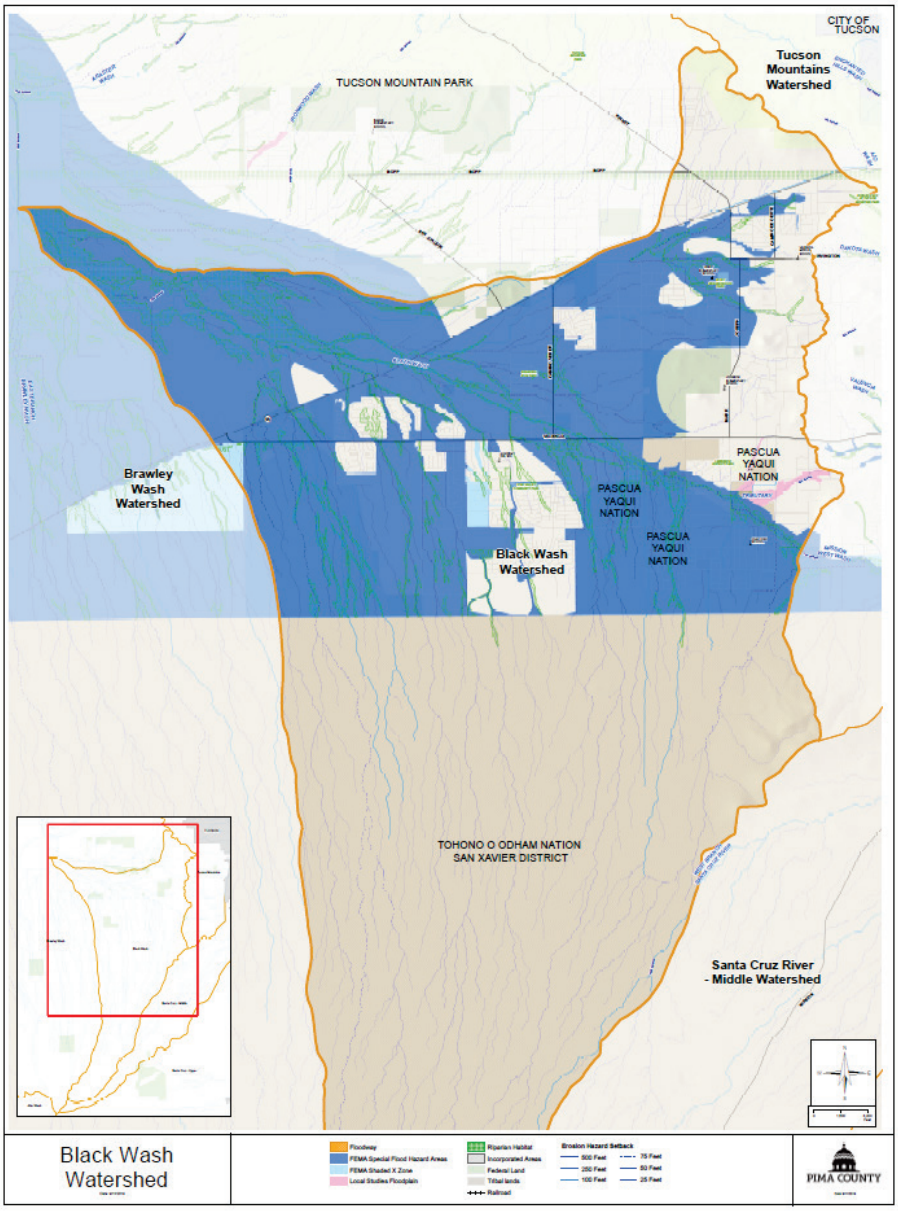


Figure 43 - Black Wash Watershed Map

C.1.2.1 Flood Characteristics

Like Brawley Wash to which it is tributary, the floodplains and floodway associated with this watershed are amongst the widest within Pima County. This is due to distributary flow patterns, shallow braided streams, and significant areas where stream banks do not confine larger storm flows. Because of the poor conveyance and distributory flow, floods can occur from convective, frontal and tropical storms. Still these SFHA floodplains were determined by mapping the extent of historical flooding and are in need of further study.

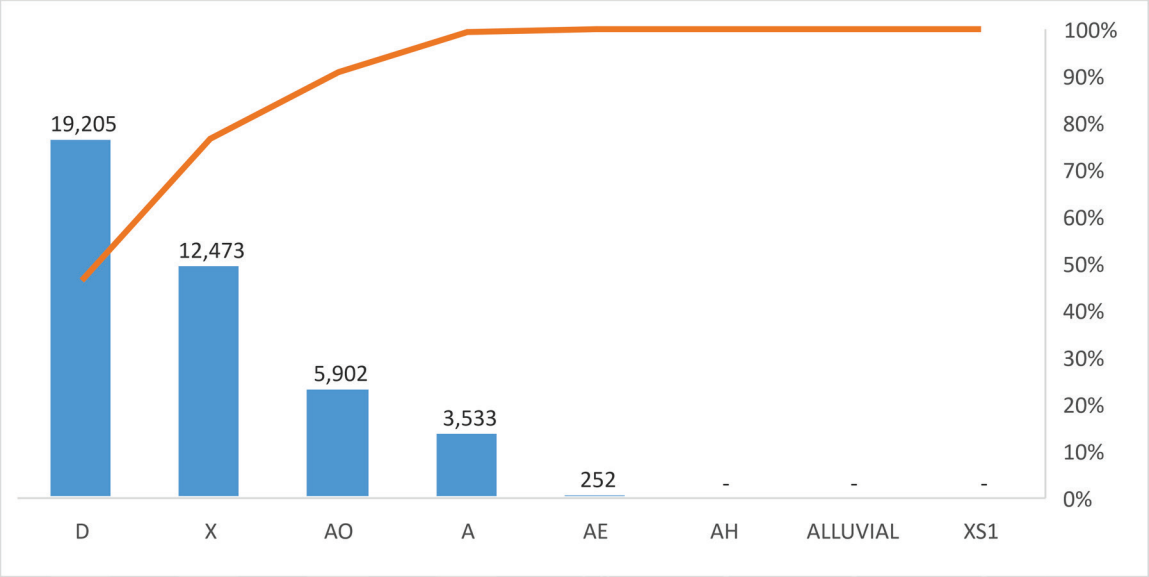


Figure 44 - Black Wash SFHA in Acres

In addition to the 9,687 acres of SFHA included on the chart above, there are also 650 acres of District Special Studies Floodplains and 1,893 acres of locally mapped sheet flood area in this watershed. Together regulatory floodplain areas cover 27 percent of the total watershed. Base flood elevations have not been determined for the majority of this watershed. The exception is the main stem Black Wash where even the FEMA Floodway is broad and based on approximate modeling assumptions to limit breakout and distributed flows. Further much of the A zone was determined based upon historical flooding.

C.1.2.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas.

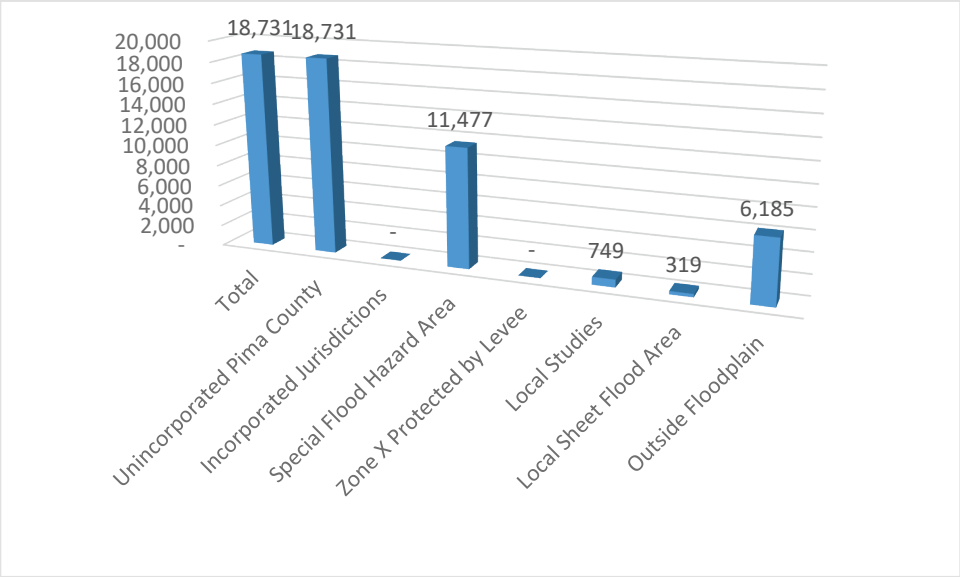


Figure 45 - Black Wash Watershed Population Distribution

As shown below much of this watershed outside of the reservations is private and available for development. While historically this area has been developed with large lots and individually built homes development during the last decade has shifted to mass graded subdivisions. This has led to a mix of constrained and unconstrained flood areas across very broad floodplains. The design of most recent subdivisions includes fill, channelization and bank protection to confine the otherwise widespread flow paths.

The County Comprehensive Plan identifies this area as a growth area. To address infrastructure needs the 2007 Southwest Infrastructure Plan identified locations for regional detention basins and other drainage improvements; however, funding for regional drainage solutions was not included in the approved impact fees. The Pima County Department of Transportation did construct drainage improvements to collect distributed flows along Valencia Road and the Arizona Department of Transportation made drainage improvements along State Route 86/Ajo Highway.

Landowners have yet to find builders for many approved commercial and residential developments as reflected in the high percentage of vacant land shown on the bar chart below. However, that is not the only factor as there is so much federal land as well.

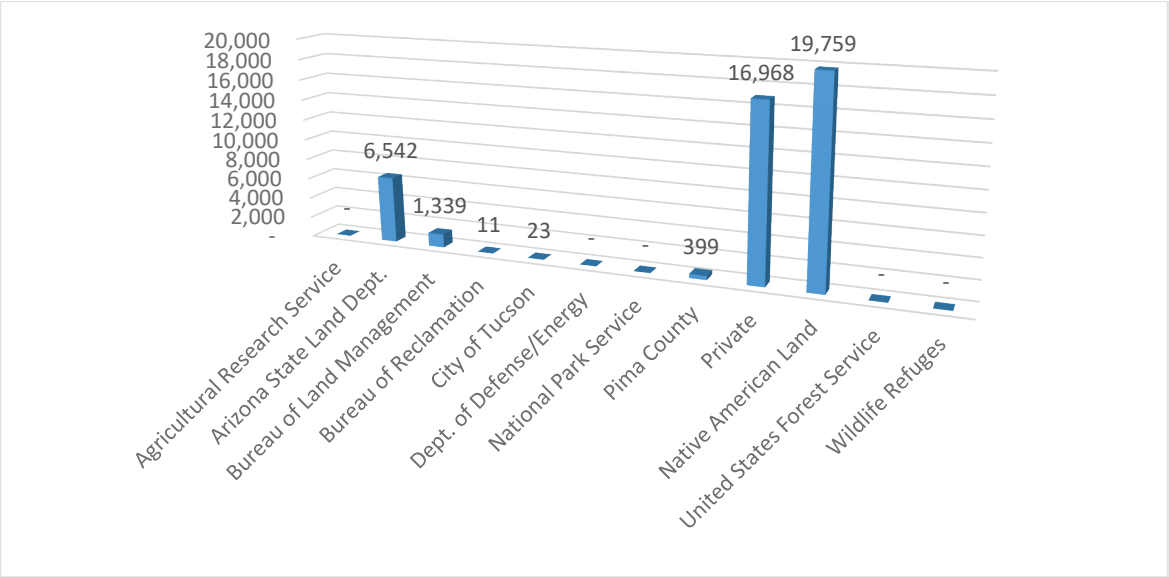


Figure 46 - Black Wash Watershed Ownership in Acres

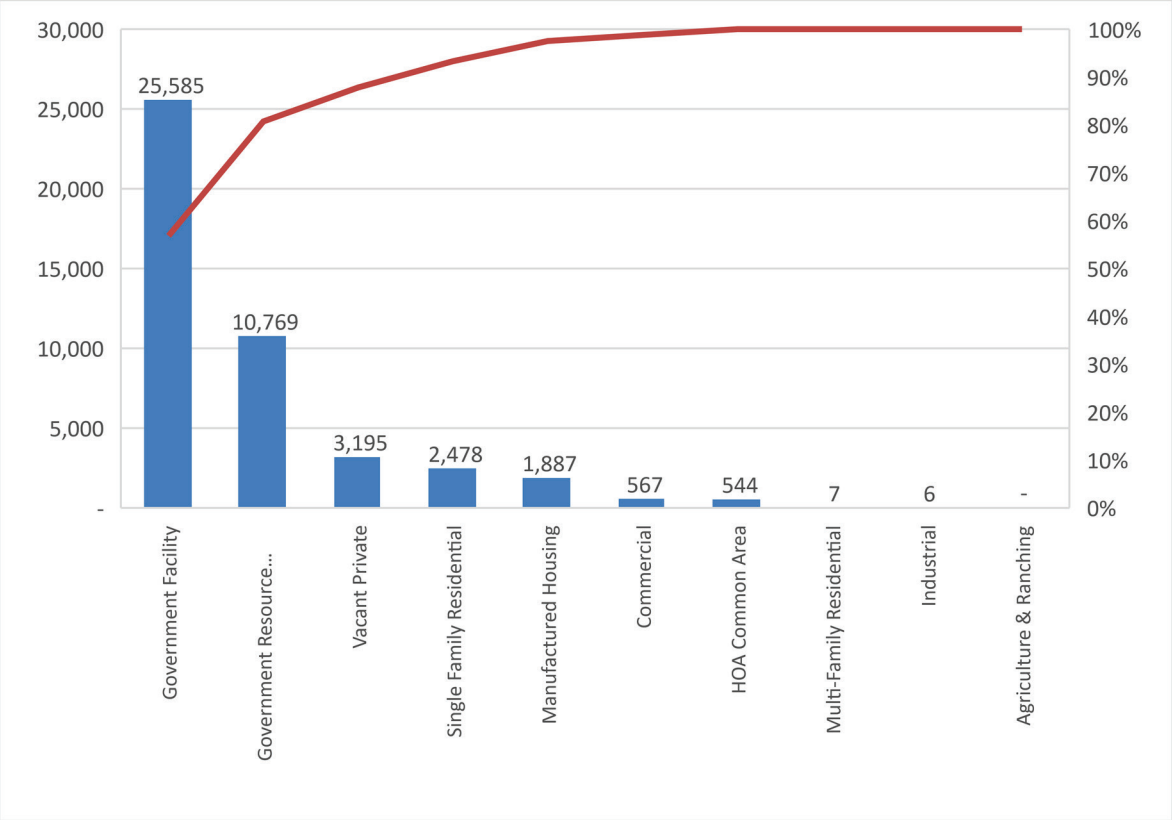


Figure 47 - Black Wash Watershed Land Use in Acres

As shown above, the Assessor classifies tribal land as vacant and therefore the percentage is high for this watershed. The developed area of San Xavier is located east of Black Mountain while westerly the predominant use is low intensity grazing and habitat for many species with cultural and practical significance.

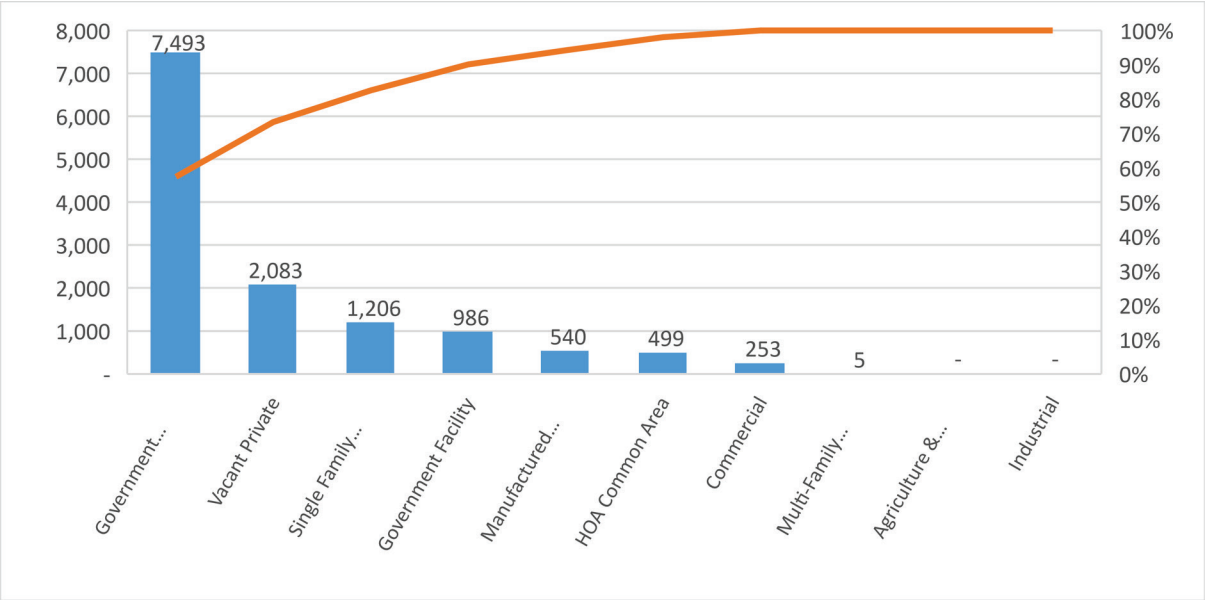
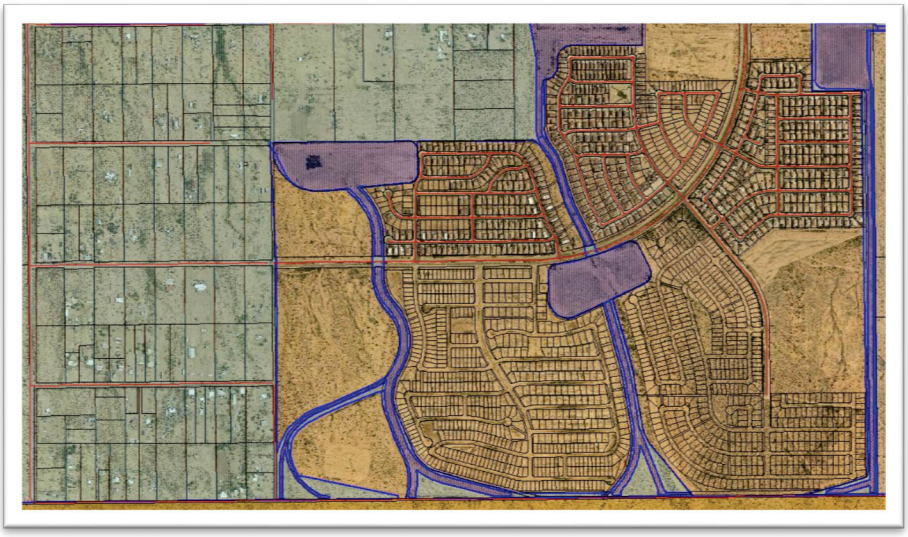


Figure 48 - Black Wash Floodplain Land Use in Acres

As indicated on the land use map below much of the private land is floodprone and few high spots exist. Development within the floodplain has been of all types by necessity. The high percentage of manufactured housing is notable. The owners were not aware of flood risks when then building these homes and many are only accessible by unimproved dirt roads and/or at grade wash crossings. Within recent years, development patterns have shifted to large planned subdivisions. These require significant engineered features including mass grading on imported fill, establishment of channels or flow corridors, large detention basins and improved road crossings to provide access during times of flooding. The Land use map below shows these patterns.



Mass Graded Subdivision and Individual Lot Development in Floodplains

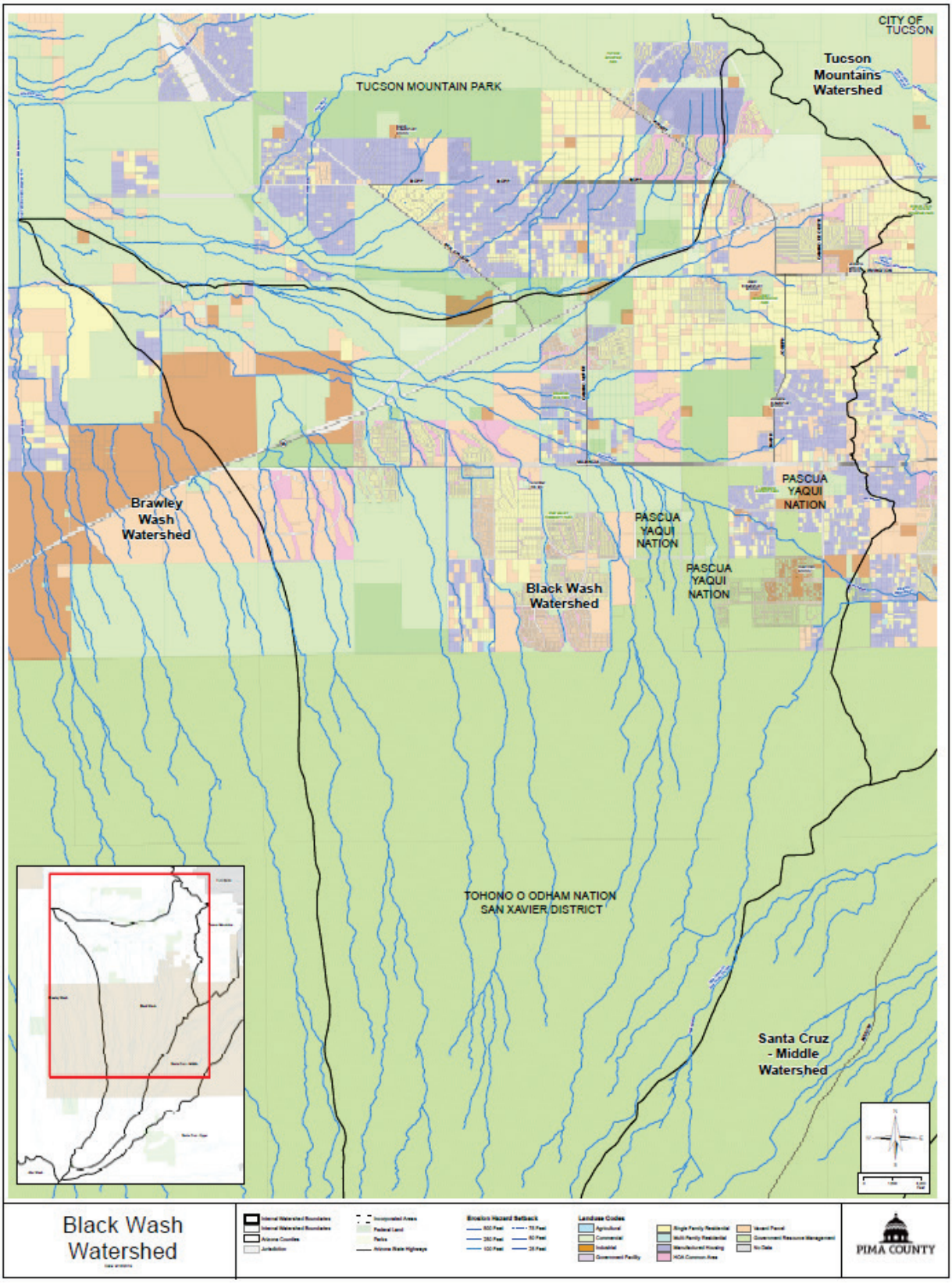


Figure 49 - Black Wash Land Use Map

C.1.2.3 Riparian Habitat and Natural Areas

As shown on the bar chart below, there are 1,444 acres of Pima County Regulated Riparian Habitat in this watershed. There are also 1,048 preserved acres in this watershed, including 717 in regulatory floodplain.

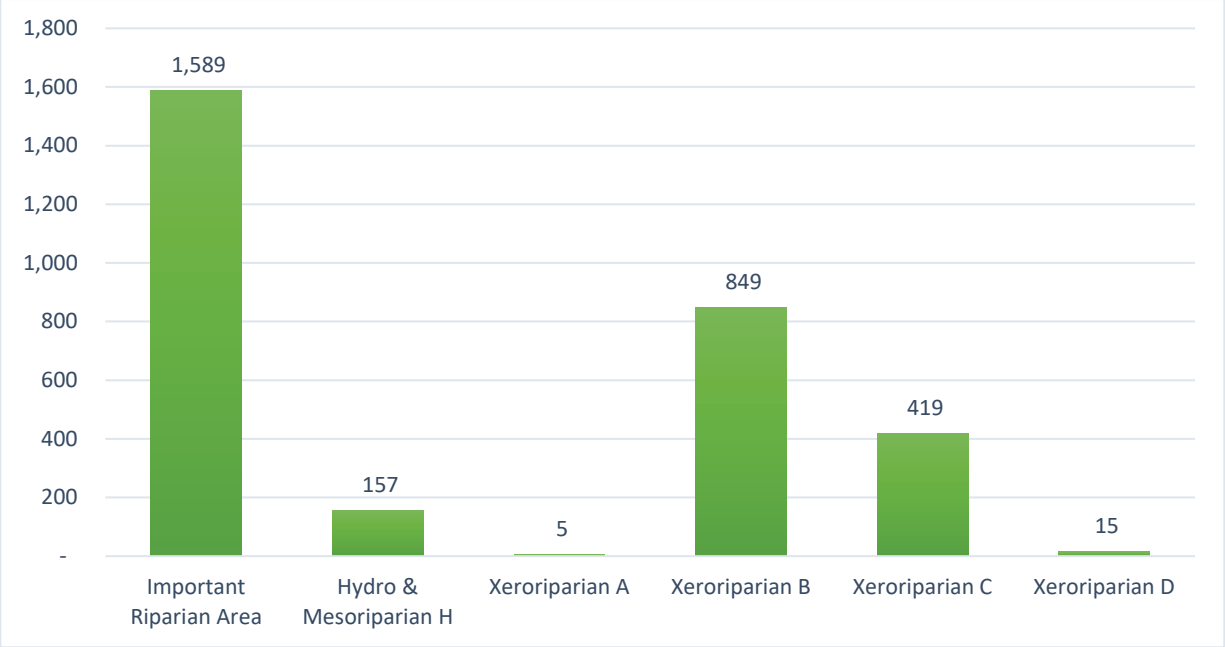


Figure 50 - Black Wash Riparian Watershed Habitat in Acres

Unfortunately, efforts to create greenway preserves have been frustrated with the exception of FLAP acquisitions and small parks. Furthermore trespassing including illegal dumping is frequent as the area is relatively remote. Those floodplain habitats, which owners have preserved, require protection and maintenance including in some cases restoration.

The riparian areas are classified into two primary plant communities, Sonoran Desertscrub biome (BLP #154.1) and Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series (BLP #224.52) (Harris, 2001). The xeroriparian habitat falls into the former, while the mesoriparian habitat falls into the latter. The Sonoran Desertscrub can be further divided into the Arizona Upland Subdivision, which is characterized by a diverse assemblage of cacti, trees and shrubs, and the Lower Colorado River Valley Subdivision, which is primarily characterized by creosotebush (*Larrea tridentata*) and bursage (*Ambrosia deltoidea*). Plant communities of both types occur in this watershed.

Sonoran Desertscrub, Arizona Upland Subdivision (above) and Lower Colorado River Valley Subdivision (right)

The Sonoran Desertscrub Subdivision is further classified as desert riparian shrub or xeroriparian along the washes. This vegetation community contains similar tree and shrub species found in upland sites such as paloverde, velvet mesquite, and ironwood, although certain shrub species, such as canyon ragweed (*Ambrosia ambrosioides*) and cheesebush (*Ambrosia salsola*) are more prevalent.

The Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series, is an open to fairly dense drought-deciduous woodland dominated by velvet mesquite (*Prosopis velutina*). Understory vegetation is characterized by shrubs such as wolfberry (*Lycium sp.*), snakeweed (*Gutierrezia sp.*), burroweed (*Iscocoma tenuisecta*), whitethorn acacia (*Vachellia constricta*) and catclaw acacia (*Senegalia greggii*) and native grasses, vines and annuals.

Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series (left), Mesquite Series understory vegetation (right)

A unique natural resource in this watershed is the presence of Pima Pineapple Cactus (PPC) (*Coryphantha scheeri var. robustispina*), listed as endangered in 1993. A primary strategy of the 2018 Recovery Plan is to protect individuals and their seedbanks in their native habitat. One of the District's fee owned open space properties contains a low density, but healthy population of PPC, and the District has taken steps to protect the cactus by removing illegal dump sites and buffelgrass.

Multi-headed PPC (left), multiple PPC beneath a velvet mesquite tree (right)

Other important natural resources include the Thornber fishhook cactus (*Mammillaria thornberi*), commonly found hiding beneath native trees.

The Black wash serves as an important wildlife corridor and provides habitat for native wildlife. It is common to see evidence of mule deer, javalina, jackrabbits, bobcat, coyote, and various amphibians and reptiles. In addition to supporting abundant vegetation and wildlife, there is evidence of prehistoric people throughout the watershed.

Thornber fishhook cactus (Mammillaria thornberi) (left), pot sherd (right)

C.1.2.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

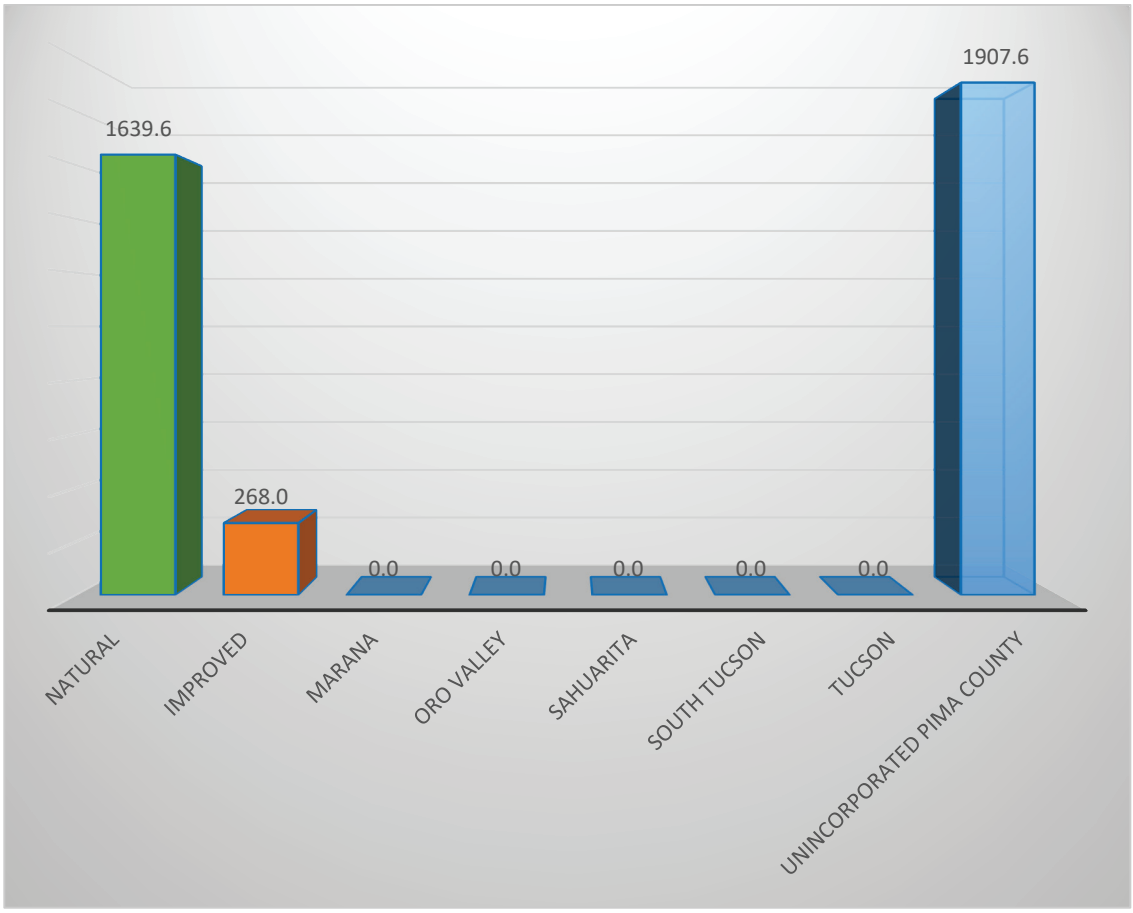


Figure 51 - Black Wash Drainageway Acreage

The District manages 998 acres of open space lands in the Black Wash watershed. The District acquired these lands primarily through the Floodprone Land Acquisition Program (FLAP). The lands are inspected triennially to inventory infrastructure (if present), natural resources and identify threats and stressors.

The watershed has been impacted by human development, including flow diversions due to roads, development, and past agricultural activities, which has led to erosion and minor channelization. Other natural and human activities that threaten natural and cultural resources in the watershed include land disturbance caused by adjacent property owners encroaching, cattle grazing, invasive species, illegal dumping, OHV use, shooting, and woodcutting. Illegal dumping and OHV use in particular have become more prevalent in recent years and efforts to stop these activities have resulted in varied outcomes. The District has begun installing a new design of OHV resistant fence, which appears to be working for the time being. As resources allow, the District will continue to actively manage these threats through placement of fencing, signage, and enforcement when required.

Buffelgrass (left), cattle grazing (middle), and soil erosion (right)

Non-native invasive Globe Chamomile (left), illegal dumping (middle), and mesquite die-off (right)

OHV damaging native vegetation (left), fence cut by OHV users (middle), and illegal woodcutting (right)

Since 2015, the District has collaborated with the Arizona Conservation Crew and Pima County Summer Youth crews to remove illegal trash sites, invasive species, and interior barbed wire fences to improve corridors for wildlife movement. While these projects have helped to reduce the impact on the natural resources, there are still many opportunities for restoration and land stewardship projects throughout the watershed.

Because this watershed is predominately rural, the management approach had been limited. The Program for Public Information identifies a need to expand outreach in rural areas wherein permitting and accessibility are frequent concerns.

While flows within the main channel are significant, this watercourse and many of its tributaries are ill defined with channels that do not contain flows. This area is also subject to sheet flooding. The FEMA Special Flood Hazard Areas affecting this watershed are up to a mile wide in places. At this time, there are no stream gauges. Precipitation and radar imagery provides the basis for ALERT staff contacts.

Heavy precipitation in the Black Wash area may translate downstream to the Mile-wide (6443) and Manville Road crossings. Currently there is no good travel time information available. Large storms or a series of storms may result in sustained flow downstream.

Due to these characteristics numerous at-grade crossings may be impacted and travel to emergency and essential services restricted during times for flooding. Major improvements to Ajo and Valencia Roads have provided dramatic improvements for travelers in the east west direction; however, the connectors to residential area remain problematic. As described in the program for Public Information safe travel routes is a focus of our outreach efforts. Problem areas identified in the ALERT Flood Response Protocol include:

- Valencia Road
- Camino Verde Road
- Mark Road
- Camino de Oeste
- Snyder Hill Road west of Desert Sunrise
- Tucson Estates area
- Branding Iron Park subdivision
- Near Tillery Street and Jeffery Road
- Wade Road south of Bilby Road
- Tetakusim Road and Settle Avenue

If heavy precipitation occurs, assigned senior staff makes the decision as to whether to notify the Pima County Office of Emergency Management OEM). OEM then notifies the affected public and critical facility operators via the approved State procedure. Downstream of Valencia the District has utilized the FLAP where sellers are willing.

Camino Verde at Bilby Sheet Flood

This floodprone urban fringe watershed will continue to be a focus of study, outreach, permitting and accessibility efforts.

C.1.2.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- Homes have been known to flood near Tillery St. and Jeffrey Rd.
- Branding Iron Park is a dense development in the Black Wash Floodway.
- Wade Road south of Bilby Road.

Infrastructure

- Look at collector channels for Camino Verde Estates II.
- Look at collector channels for Star Valley subdivisions.
- The drainageway on the east side of Tucson Estates Unit 6 is maintained by the county.

C.1.2.6 Floodplain Management

Outstanding issues identified by District staff include:

- Need to revisit Black Wash Floodway
- Need to better define flood risks in approximate FEMA zones. Determining flow patterns and depths may require 2-dimensional modeling
- FLAP
- Non-permitted construction and planning, encroachments, private roads and drainage easements

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Repair Iberia sediment and sink holes

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Work to address issue of sediment placement during road maintenance activities

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Conduct detailed mapping of approximate FEMA Special Flood Hazard Areas
- Provide detailed mapping for the area between the Herman's Road and Valencia Road
- Update Black Wash Administrative Floodway

Ref# 1.2.c Refine local approximate sheet flood maps and identify flow corridors

- Conduct detailed mapping for remaining local approximate sheetflow floodplains

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Evaluate cumulative impacts of lot-splits and identify mitigation

Ref# 2.2.c Conduct voluntary floodprone land acquisition program outreach to areas impacted by flooding

- Target floodways and flow corridor areas

Ref# 4.2.d Expand inundation mapping coverage for flood warning for use in flood warning system

- Create inundation mapping for Black Wash

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Remove un-necessary diversions

Ref# 5.1.b Complete new river and basin studies to identify needs and develop alternatives

- Create Basin Management Plans

Ref# 5.2.e Develop alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

- Develop and implement an erosion mitigation plan using natural channel design techniques

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Conduct targeted outreach to property owners within the floodway
- Provide outreach on the availability of private road and drainage easement technical assistance

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

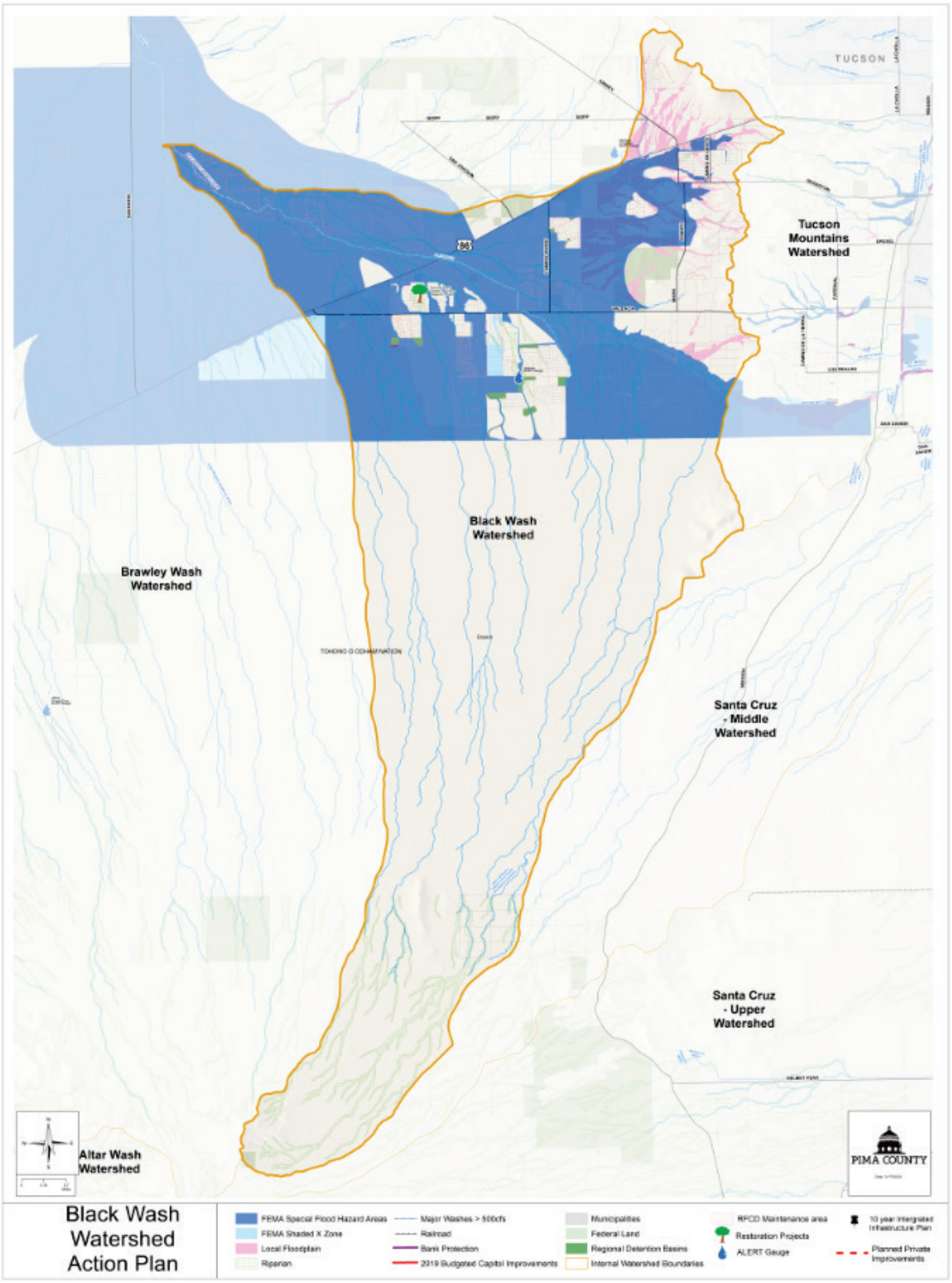


Figure 52 - Black Wash Action Plan Map

C.1.3 Brawley Wash

While predominately rural, this watershed contains urban fringes as well as growing community centers including Three Points, Picture Rocks and Marana. This watershed is the largest within Unincorporated Pima County and is comprised of 347,106 acres (542 square miles). Its namesake watercourse, the Brawley Wash and major tributary, the Blanco Wash originate in the Roskruge and Coyote Mountains on the south side of State Route 86 in the community of Three Points/Robles Junction. The Altar Wash is a 776 square mile tributary watershed that drains the eastern slopes of the Baboquivari, as well as the western slopes of the Sierrita Mountains. Black Wash is also tributary to the Brawley Wash. Brawley Wash drains northward to Pinal County where it joins the Santa Cruz River.

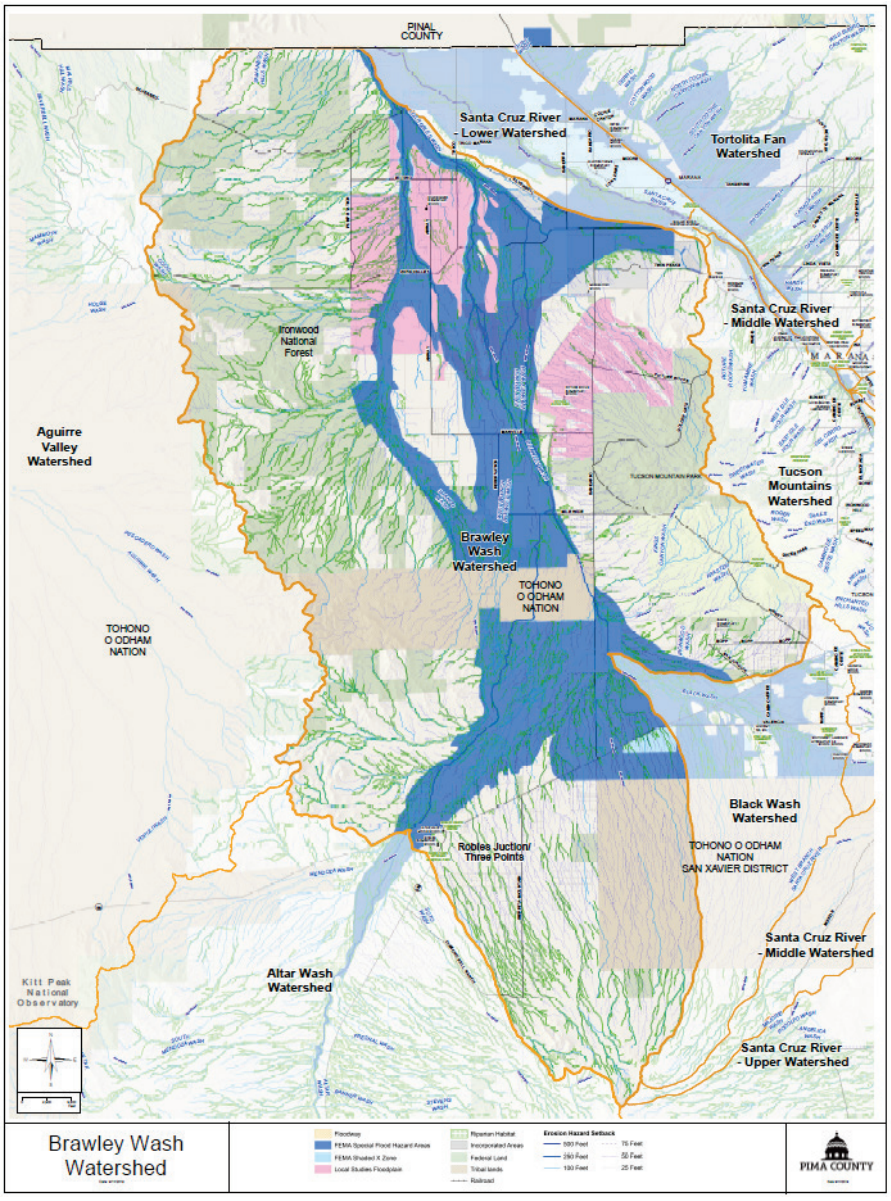


Figure 53 - Brawley Wash Watershed Map

C.1.3.1 Flood Characteristics

This system is distributary and braided consisting of numerous named and unnamed washes. Like its major tributaries the Black and Altar Valley Washes the floodplains like the basins they are within are very broad. These characteristics along with the massive size of the watersheds and surrounding mountains mean that flooding may occur even where it is not raining. Flooding can occur from convection and frontal storms. The largest floods on the Brawley main stem have occurred from tropical storms. Flash flooding may arrive expectantly and affect a broad area making access difficult if not impossible. In addition to residential areas, critical infrastructure including bridges and the Marana Waste Treatment Plant are at risk. The City of Tucson maintains two major recharge facilities for Tucson's annual allocation of Colorado River Water near the East Branch Brawley Wash and just to the south of the East Branch confluence with the main stem Brawley Wash.

Wastewater Treatment Plant during the 2006 Flood

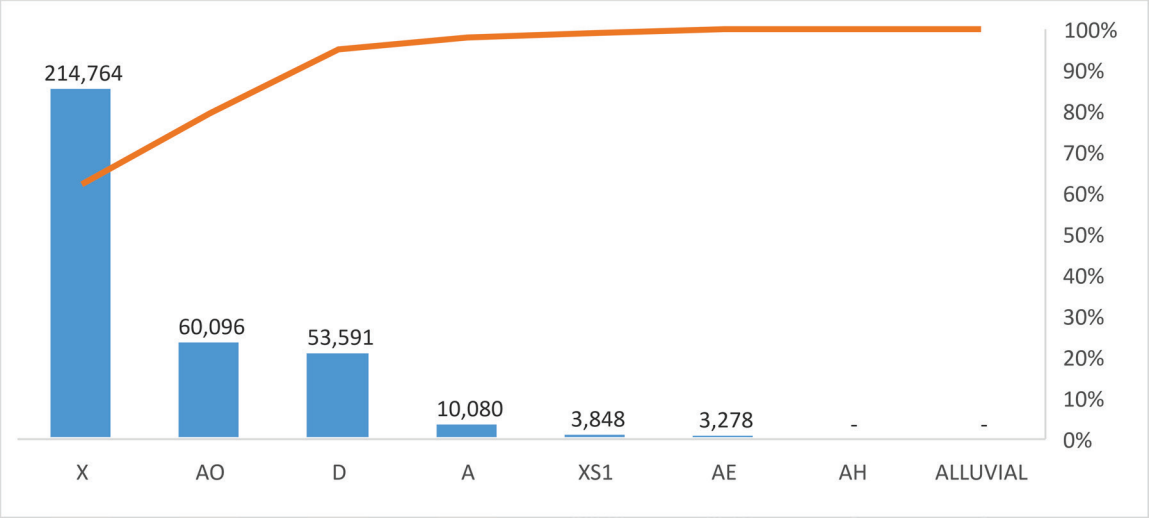


Figure 54 - Brawley Wash Federal Floodplain Designations in Acres

In addition to the 73,453 acres (114.7 square miles) of SFHA included on the chart above, there are also 513 acres of District Special Studies Floodplains and 87,082 of local sheet flood area in this watershed. Together these mapped floodplain areas are 46 percent of the total watershed area!

The Brawley Wash to the west is unconfined and braided. Special Study #31 evaluated flows in this area and estimated that 21,000 cfs of the 35,000 cfs 1% chance flood is along the west branch of the Brawley, with the remaining 14,000 cfs in the channel to the east. Sheet flooding affects a majority of this area within unincorporated Pima County (Special Study #46; 08/08/2007).

Ajo Highway Bridge during 2006 Flood, looking north

Flood and erosion risks need further evaluation on this western edge, to identify structural and non-structural means to address the ongoing sheet flooding and lack of drainage infrastructure problems. Tropical storms are the main threat to widespread flooding on the Brawley, but monsoon convective storms can also cause local flash flooding.

This system is distributary and braided consisting of numerous names and unnamed washes.

The table below summarizes of historic USGS gaging station records.

Table 8 - Brawley Wash Watershed USGS Gages

USGS Gaging Station	Brawley Wash near Three Points, Az 09487000	Little Brawley Wash near Three Points, AZ 09487100	Los Robles Wash near Marana, AZ 09487250
Period of Record	1940-08-14 to 2015-07-01	1962-09-26 to 1981-09-05	1962-09-26 to 1983-10-02
Watershed Area (sq. m)	776	11.90	1170
Flood-Peak of Record (cfs)	19,100	19,800	32,000
Date	10-1-1983	09-26-1962	09-26-1962
Table of Regulatory Discharge (cfs)	NA	13,800	35,000

The table below summarizes Pima County ALERT Gages.

Table 9 - Brawley Wash Watershed ALERT Streamflow Gages

Pima County Alert Gage	Brawley Wash at Three Points ID: 6423	Brawley Wash At Milewide Road ID: 6443
Location (Latitude, Longitude)	(32.0756,-111.3383)	(32.2486, -111.2444)
Period of Record	1991-09-01 to Present	2001-03-08 to Present
Watershed Area (sq. m)	785.48	247.44
Flood-Peak of Record (cfs)	14000	6047
Date	07-05-1998	07-31-2010

Table 10 - Brawley Wash Watershed ALERT Precipitation Gages

Pima County ALERT Gage	Brawley Wash at Three Points ID: 6420	Brawley Wash At Milewide Road ID: 6440	Diamond Bell Ranch - Brawley Basin ID: 6410	Hilltop Road - Brawley Basin ID: 6450	Picture Rocks Community Center - Brawley Basin ID: 6460	Tucson Water Treatment Plant - Brawley Basin ID: 6470
Location (Latitude, Longitude)	(32.0756,-111.3383)	(32.2486, -111.2444)	(31.9897, -111.2972)	(32.0436, -111.2417)	(32.3092, -111.2356)	(32.1711, -111.0872)
Period of Record	1991-09-01 to Present	1991-10-10 to Present	1989-02-27 to Present	2001-10-18 to Present	2001-10-19 to Present	2006-11-09 to Present

The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Tables of Regulatory discharges.

Table 11 - Brawley Wash Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Brawley Wash			
Upstream of confluence with Los Robles Wash	35,000	1,165	FEMA, Flood Insurance Study
East Branch Brawley Wash @Avra Valley Road	22,100		" "
Little Brawley Wash USGS Gage station 09487100	13,800	11.9	USGS Water-Resources Investigation open file report 78-33 (March 1978)
Los Robles Wash Downstream of confluence with Blanco Wash	37,000	1,340	FEMA, Flood Insurance Study
Los Robles Wash @ Trico Road	35,000	1,175	" "

C.1.3.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas.

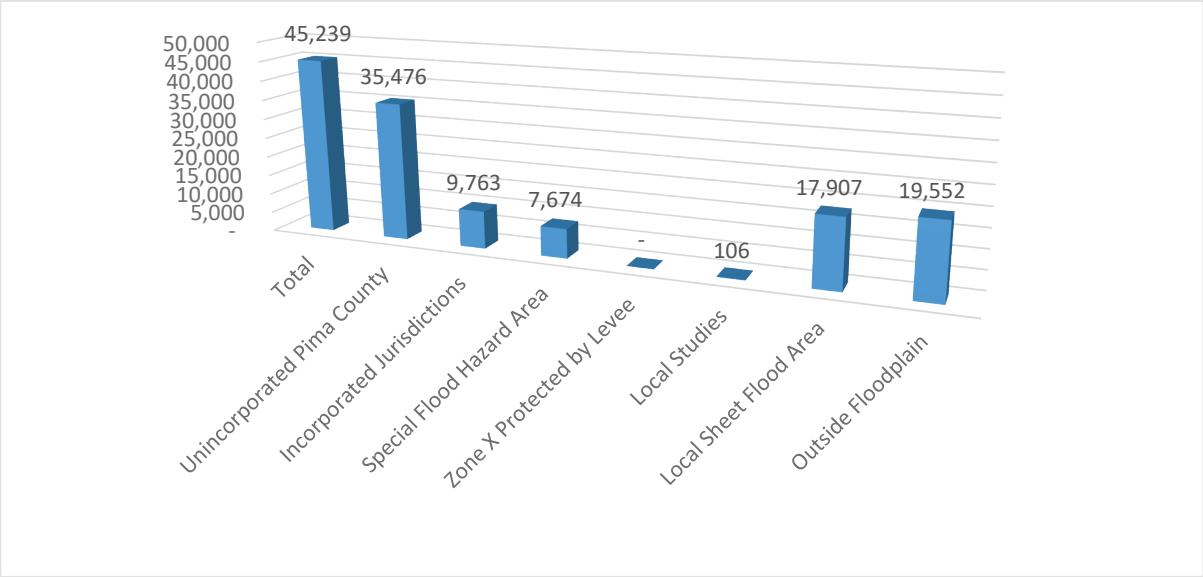


Figure 55 - Brawley Wash Watershed Population Distribution

As is the case in the Black Wash watershed, this watershed contains very broad floodplains however much is available for development. While it retains a rural character, it is widely developed with large lot residential and rural commercial uses including agriculture and mining.

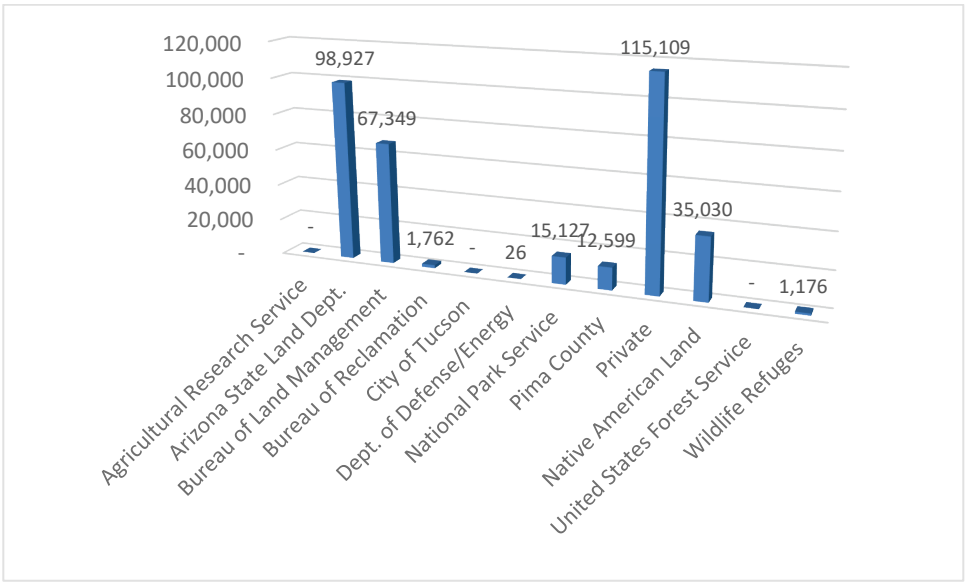


Figure 56 - Brawley Wash Ownership in Acres

Both ownership and land use patterns provide opportunity for future growth despite floodplain constraints.

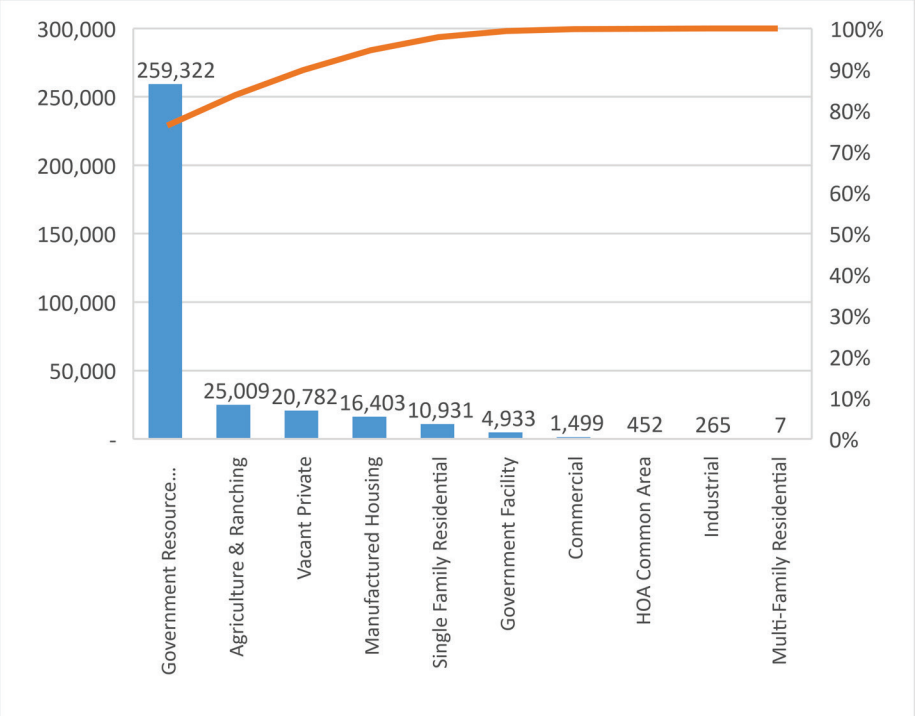


Figure 57 - Brawley Wash Land Use in Acres

Future land use may depend upon decisions made by the State Land Department and Arizona Department of Transportation. The envisioned Interstate Highway (I-11) would intensify development pressure and large players have begun to emerge including Monsanto. However, is unlikely to occur in the next five years. It is interesting to note however that this is where groundwater recharge is occurring to balance the drawdown within the adjacent Tucson hydrogeological basin. A fact, which may increase the attractiveness of the area significantly, as supplies dwindle and development pressure mounts. The Central Arizona Project (CAP) canal can cause flow diversions in portions of the watershed draining to the East Branch, as would any new linear infrastructure.

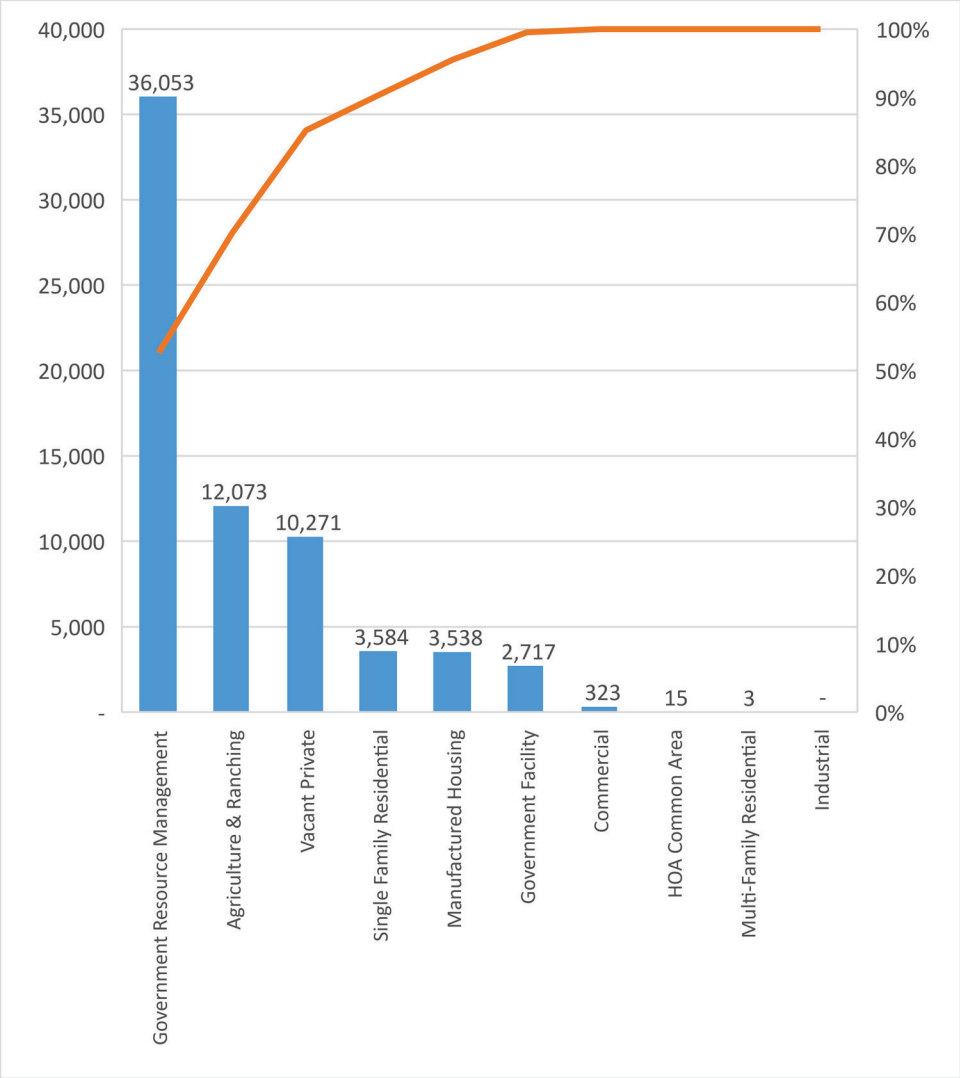


Figure 58 - Brawley Wash Floodplain Land Use in Acres

The broad floodplain has historically attracted agriculture and while much converted to rural residential uses, the area is increasingly urbanized and large segments of the population exposed to flood risk. As with the Black Wash watershed, the extent of manufactured housing within the floodplain is notable.

Along the western edge of the sub basin, where development occurred without consistent drainage infrastructure drainage and sheet flow conditions, flows on unpaved roads produce further down cutting, which in turn results in more flow along the roadway. This process of flow capture results in degradation of the local flow conditions. The land use map below also shows these patterns.

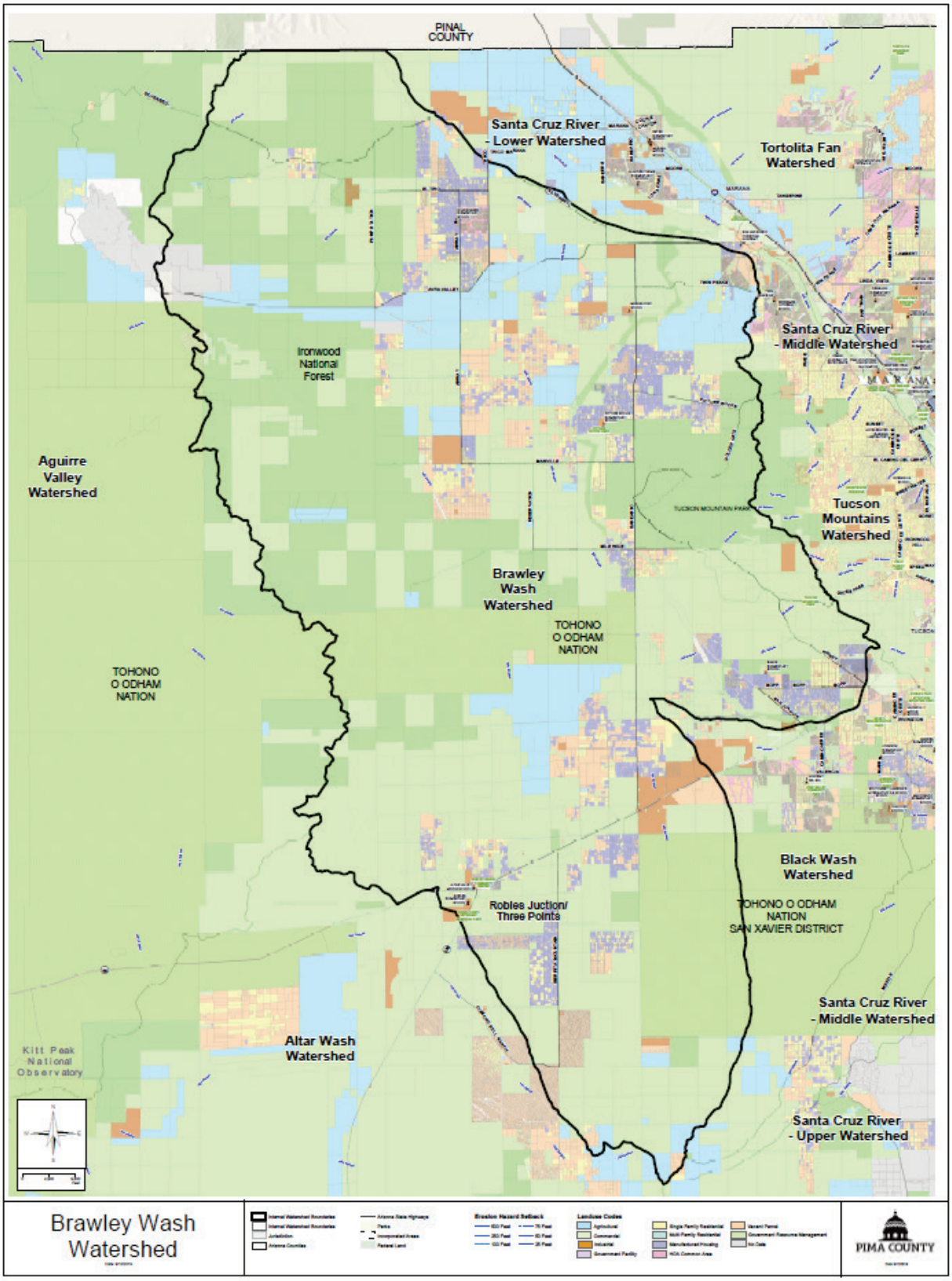


Figure 59 - Brawley Wash Watershed Land Use

C.1.3.3 Riparian Habitat and Natural Areas

As shown on the bar chart below, there are 15,088 acres of Pima County Regulated Riparian Habitat in this watershed and 21,508 acres of IRA. There are also 107,796 preserved acres in this watershed, including 9,539 in regulatory floodplain.

The rich habitat in this watershed supports wildlife and facilitates beneficial natural floodplain function. Preservation of natural floodplain function is important in this watershed to reduce channelization, which disrupts habitat and can lead to extensive maintenance requirements due to sedimentation.

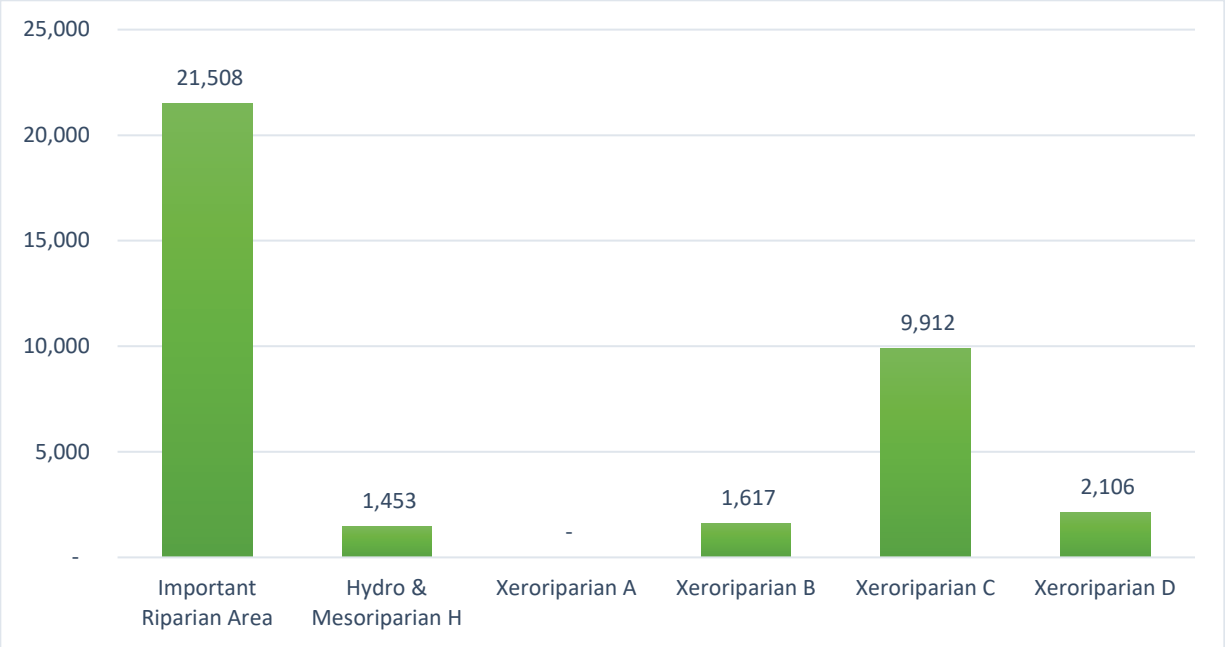


Figure 60 - Brawley Wash Watershed Riparian Habitat in Acres

The riparian areas are classified into two primary plant communities, Sonoran Desertscrub biome (BLP #154.1) and Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series (BLP #224.52) (Harris, 2001). The xeroriparian habitat falls into the former, while the mesoriparian habitat falls into the latter. The Sonoran Desertscrub can be further divided into the Arizona Upland Subdivision, which is characterized by a diverse assemblage of cacti, trees and shrubs, and the Lower Colorado River Valley Subdivision, which is primarily characterized by creosotebush (*Larrea tridentata*) and bursage (*Ambrosia deltoidea*). This watershed contains both of these plant communities.

Sonoran Desertscrub Subdivision on the left and Lower Colorado River Valley Subdivision on the right

The Sonoran Desertscrub Subdivision is further classified as desert riparian shrub or xeroriparian along the washes. This vegetation community contains similar tree and shrub species found in upland sites such as paloverde, velvet mesquite, and ironwood, although certain shrub species, such as canyon ragweed (*Ambrosia ambrosioides*) and cheesebush (*Ambrosia salsola*) are more prevalent.

The Brawley Wash at 3-points (left), unnamed xeroriparian wash (center), xeroriparian understory vegetation (right)

The Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series, is an open to fairly dense drought-deciduous woodland dominated by velvet mesquite (*Prosopis velutina*). Understory vegetation is characterized by shrubs such as wolfberry (*Lycium sp.*), snakeweed (*Gutierrezia sp.*), burroweed (*Iscocoma tenuisecta*), whitethorn acacia (*Vachellia constricta*) and catclaw acacia (*Senegalia greggii*) and native grasses, vines and annuals.

Sonoran Riparian Deciduous Forest and Woodland Biome, Mesquite Series (left), Mesquite Series understory vegetation (right)

The District manages 3,666 acres of open space lands in the Brawley Wash watershed. The District acquired these lands through the Floodprone Land Acquisition Program (FLAP) primarily. The majority lie within floodprone areas, with some upland areas included as part of a larger parcel. The District inspects these lands triennially to inventory infrastructure (if present), natural resources and identify threats. A few unique plant species that have been found during inspections include Tumamoc globeberry (*Tumamoca macdougalii*), Thornber fishhook cactus (*Mammillaria thornberi*), and nightblooming cereus (*Peniocereus greggii*).

Tumamoc globeberry (left) and a fruiting nightblooming cereus (right).

The Brawley wash serves as an important wildlife corridor and provides habitat for native wildlife. It is common to see large herds of mule deer, javalina, jackrabbits, and coyote. Less common species include the secretive badger, bobcat, desert iguana, Crested Caracara, and Swainson's hawk. The riparian habitat corridors provide an important source of food, shelter, and protection from predators for a number of other reptile, amphibian, bird, and mammal species.

Badger tracks (left), desert iguana (center), and gophersnake (right).

Distributary flow areas in the Brawley Wash contain unique ephemeral water features located in both the floodplain overbank and in channel. These features fill with water during flood events and due to the deposition of fine sediments, hold water for a period afterwards, providing a water source for wildlife.

In-channel ephemeral water (left) and floodplain overbank ephemeral water (right)

In addition to supporting abundant vegetation and wildlife, there is evidence of prehistoric people throughout the watershed.

Painted pot sherd (left) and a lithic artifact (right)

Over the years, the watershed has been impacted by human development, the primary impact being flow diversions. Historic agricultural activities bermed large areas for farming, redirecting natural flow to create areas of dense vegetation on the upstream side of berms, and areas of vegetation die-off on the downstream side. This paired with diversions due to roads, development, and drought has resulted in wash channelization, creating a disconnection between the main channel and floodplain overbank. This "disconnect" results in vegetation die-off and soil erosion. Wash channelization becomes more severe moving downstream in the watershed, with channel depths exceeding 15 feet or more near Silverbell Road.

Upper watershed near 3-points (left), middle watershed (middle), and lower watershed (right)

In areas where wash channelization has occurred, the floodplain overbank continues to be vegetatively productive. Spring and summer annual plants respond to rainfall, creating pockets, or sometime a carpet of vegetation across the landscape, and desiccate quickly once freezing temperatures or the heat of summer arrives. These ephemeral plant communities provide an important source of food for insects, and by relation, native bird species and other insectivores.

Pockets of native annuals grow in shallow depressions following the summer rains.

Other human actions that threaten natural and cultural resources in the watershed include land disturbance caused by encroachment by neighboring property owners, cattle grazing, invasive species, illegal dumping, OHV use, shooting, and woodcutting. As resources allow, the District actively manages these threats through placement of fencing, signage, and enforcement when needed. Additionally, the District has been actively removing damaged interior fences and filling in open pipes along the City of Tucson fencelines, when time allows.

Buffelgrass (left), cattle grazing (middle), and soil erosion (right)

Encroachment (left), illegal dumping (middle), and mesquite die-off (right)

OHV damaging native vegetation (left), saguaro damaged by a shotgun blast (middle), and illegal woodcutting (right)

This watershed provides multiple opportunities to implement restoration and land stewardship projects.

C.1.3.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

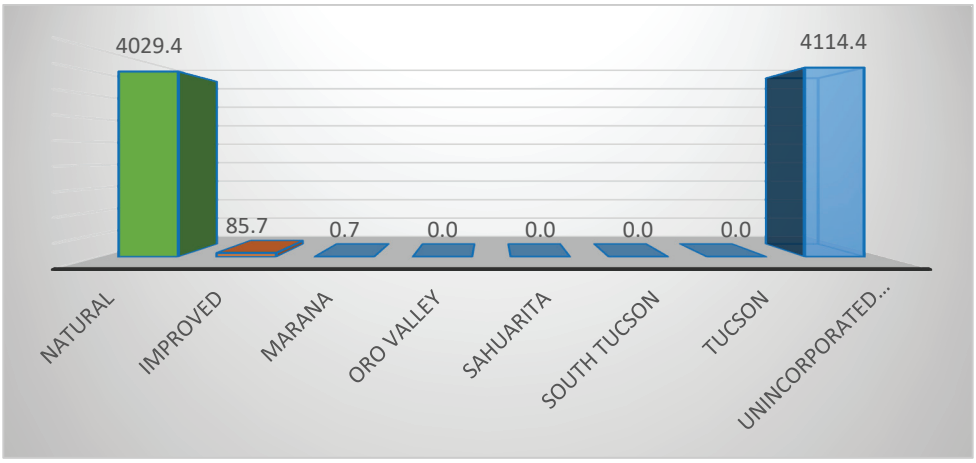


Figure 61 - Brawley Wash Drainageway Acreage

In this watershed, there are 3,751 acres of improved drainageways and 3,569 acres that are designated open space.

Downstream of Highway 86 near ALERT gauge 6423, the channel cannot convey large flows and becomes distributary. Based on a recent (9/13/14) flow event, an old channel, flowing to the east-northeast approximately 1.25 miles downstream of 6423, begins to breakout at less than 3,340 cfs (approximate stage: 6.5 ft.). The September, 2013 event moved through the Quinlan Trail area and spread as far northeast as the residential area north of Snyder Hill and Marstellar Roads. Subsequently the District has identified this as a potential area for acquiring parcels from impacted and willing sellers under the FLAP program.

This channel also flowed in the 2005 event and affected a number of residential structures in the Quinlin Trail area and downstream areas. Moderate flows may affect the Milewide Road area, Manville Road area, and the Avra Valley Road area. Due to the character of the downstream channels, travel times will be long. This area is also subject to sheet flooding that stream gauges may not register. Moderate flows at Milewide Road (6443) may affect at-grade crossings at Manville Road. Streamflow at 6423 of 2,000 cfs may indicate channel breakouts downstream. Additional at-grade crossings include those at Milewide and Manville Roads. At this streamflow, senior staff makes the decision whether or not to contact OEM. At this streamflow, ALERT staff contacts the Pima County Department of Transportation as they have responsibility for closing flooded roads, removing debris, and inspecting for damages to roadside swales, dips sections, culverts, and bridges.

C.1.3.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- Hazardous conditions exist at the location of a break-out flow from the Brawley Wash north of Ajo Highway and Quinlin Trail. The breakout occurs at flows below 11,800 cfs (official USGS discharge for August 14, 2005 event per USGS Publication, Water Data Report AZ-05-1 Titled: Water Resources Data, Arizona Water Year 2005.)
- The area around Honeysuckle Farm Trail is subject to potential break-out flow from the Brawley Wash as well as the large wash to the east. Both washes have levees containing flow that are not designed to withstand the base flood.
- A number of washes converge on an area just north of Los Reales Road west of Marstellar Road, creating potentially hazardous conditions.
- Several properties near W Avra Valley Road between the West Branch of the Brawley Wash and an agricultural levee. Depths of flow are expected to exceed three feet with high DV2 values.
- Homes in the Avra Vista subdivision have experienced erosion of fill pads. Structures were supposed to be constructed on fill pads with engineered erosion protection, but most were permitted by DSD without this requirement.
- Millstone Manor #6 has frequent flooding problems.
- The Blue Aloe Street area flooded in 2013 when a 3,340 cfs (measured at Ajo Highway) flow broke out of the Brawley Wash and moved northeast, per USGS Water Data Report 2013.

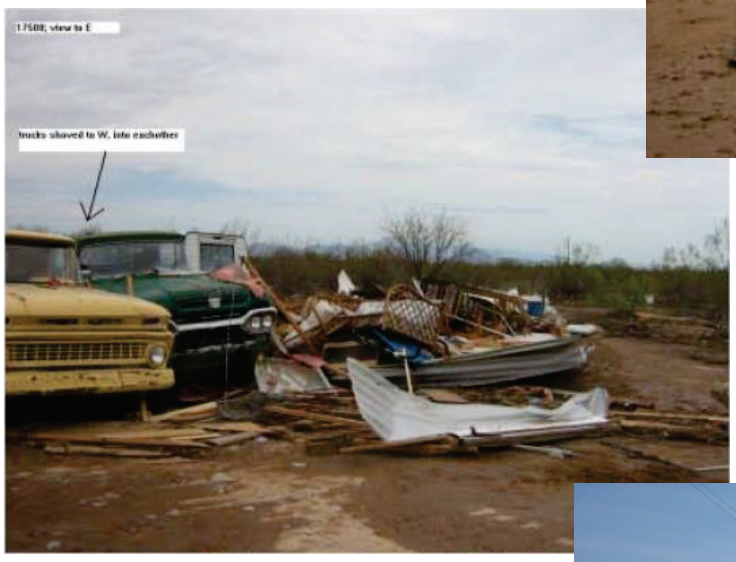
Infrastructure

- The drainageways within Tucson West Ranchettes, Book 32 Page 099, are county maintained. They are not specifically dedicated to the District.
- The detention basin in Camino Verde Estates at the intersection of Camino Verde Road and Copper Leaf Road has overtopped during large storm events, such as 8/2/2016, though it was not damaged by this event.

C.1.3.6 Floodplain Management

Future needs identified by District staff include:

- Need to update historic floodplain information and to conduct studies to identify flood risks in areas that the District has not studied.
- FLAP
- Non-permitted construction and planning, private roads and easement drainages and associated flow path capture
- Access



Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Work to address issue of sediment placement during road maintenance activities

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Conduct detailed mapping of approximate FEMA Special Flood Hazard Areas

Ref# 1.2.c Refine local approximate sheet flood maps and identify flow corridors

- Conduct detailed mapping for remaining local approximate sheetflow floodplains
- Conduct detailed mapping for Sierrita Mountain Road area

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.c Conduct voluntary floodprone land acquisition program outreach to areas impacted by flooding

- Target floodways and flow corridor areas

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Remove un-necessary diversions

Ref# 5.2.e Develop alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

- Develop and implement an erosion mitigation plan using natural channel design techniques

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Conduct targeted outreach to property owners in the vicinity of the break-out of the Brawley Wash below 3 Points Bridge
- Provide outreach on the availability of private road and drainage easement technical assistance

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

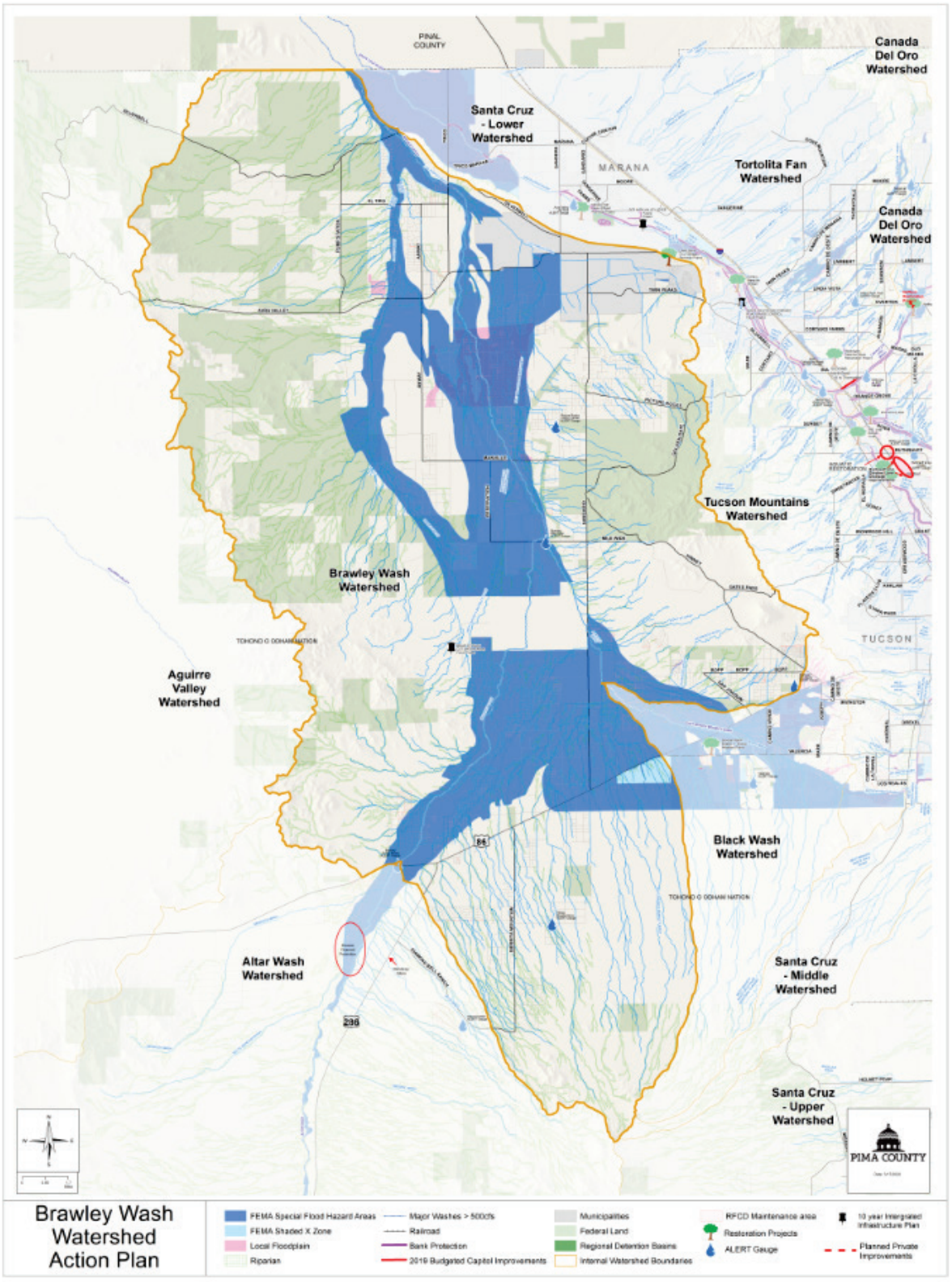


Figure 62 - Brawley Wash Action Plan Map

C.1.4 Cañada Del Oro & Big Wash

For the purposes of this study, this watershed includes the Cañada Del Oro and two of its largest tributaries the Big Wash and the Sutherland Wash. This system drains the western slopes of the Santa Catalina Mountains and the eastern slopes of the Tortolita Mountains. The Cañada del Oro and Big Wash enter Pima County from Pinal County into the community of Catalina. The Cañada del Oro passes under Interstate 10 and railway before its confluence with the Santa Cruz River. Within Pima County, it is comprised of 86,362 acres (134.9 square miles), of which 16,503 acres are in the Town of Oro valley and 564 acres in the Town of Marana.

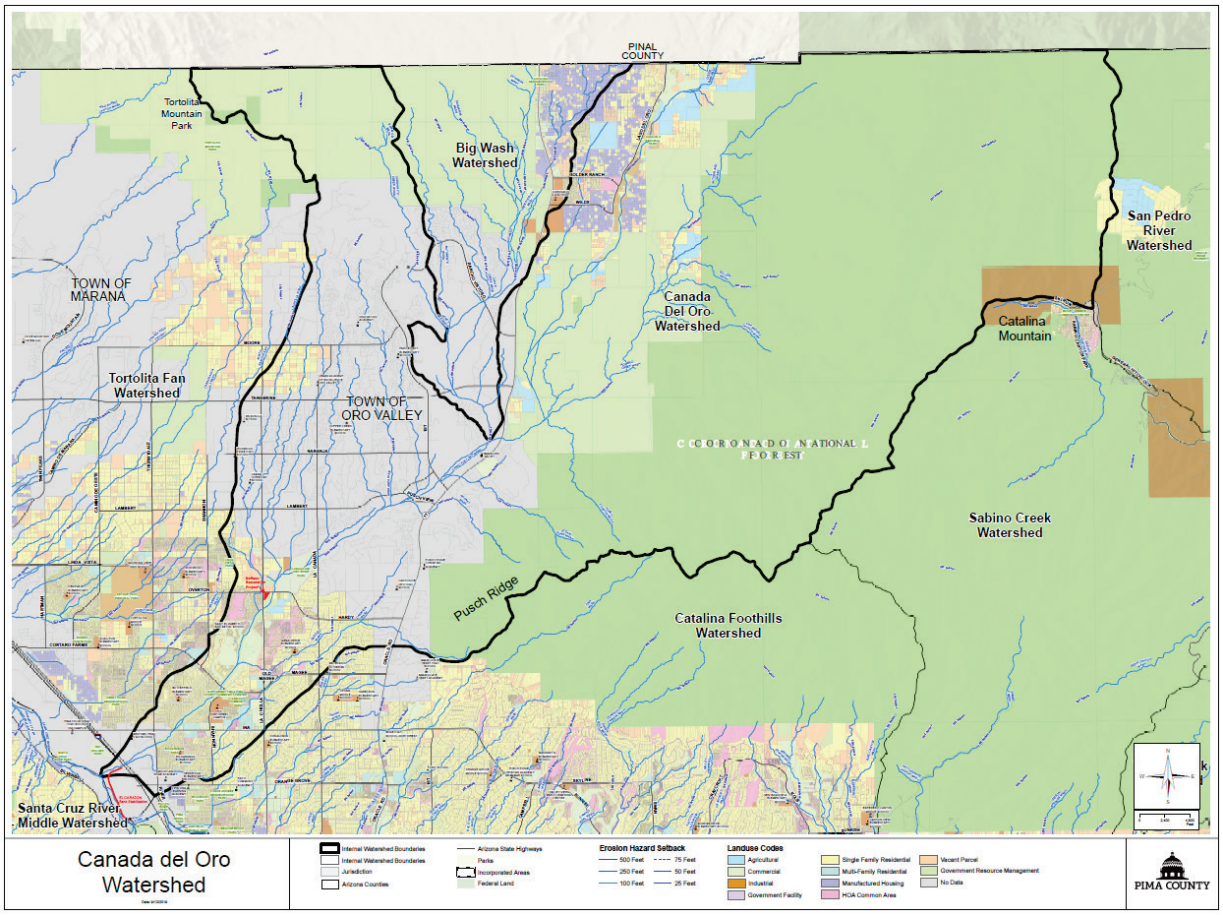


Figure 63 - Cañada Del Oro Watershed Map

C.1.4.1 Flood Characteristics

In addition to the 4,758 acres of SFHA included on the chart above, there are also 1,023 acres of District Special Studies Floodplains and 5.54 acres of local sheet flood area in this watershed. Together these mapped floodplain areas are 6 percent of the total watershed area. The CDO in particular has very steep and rocky upper slopes within the Catalina Mountains and thus flash flooding on tributaries in convective storms is a significant concern.

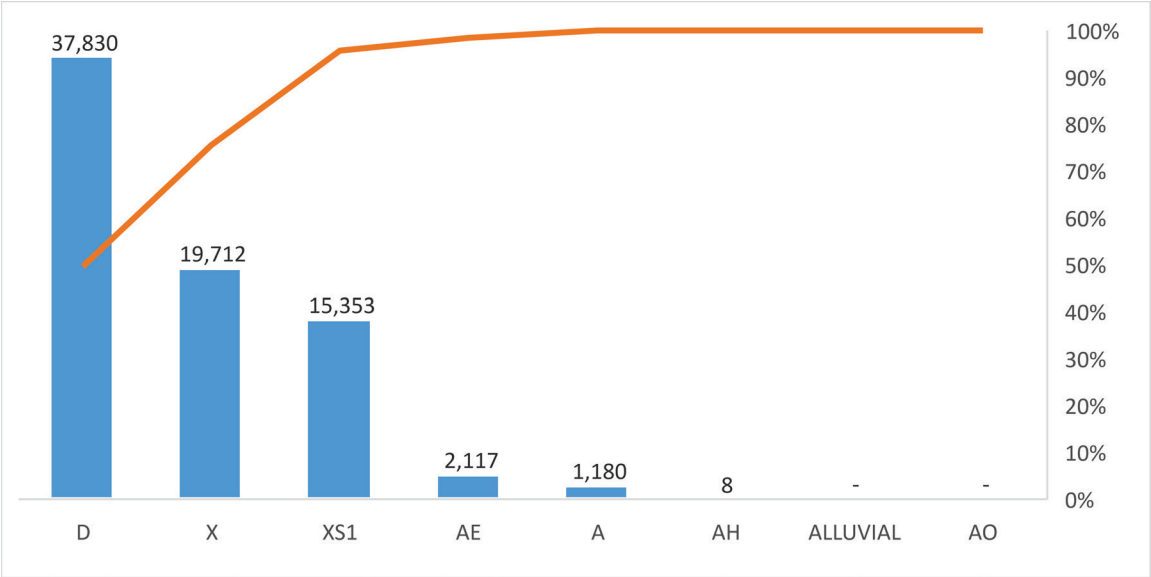


Figure 64 - Cañada Del Oro & Big Wash SFHA in Acres

The table below summarizes historic USGS gaging station records.

Table 12 - Cañada del Oro and Big Wash Watershed USGS Gages

USGS Gaging Station	Cañada Del Oro near Tucson, AZ 09486300	Cañada Del Oro BLW Ina road near Tucson, 09486350
Period of Record	1959-07-21 to 1983-10-01	1992-08-07 to 2015-08-07
Watershed Area (sq. m)	250	255
Flood Peak of Record (cfs)	17000	9870
Date	07-21-1959	09-08-2014
Table of Regulatory Discharge (cfs)	NA	NA

The next table provides a summary of Pima County ALERT streamflow gages.

Table 13 - Cañada del Oro and Big Wash ALERT Streamflow Gages

Pima County ALERT Gages	Cañada Del Oro Wash at Golden Ranch Road (PT) ID:1103	Big Wash at Cañada Del Oro Wash ID: 1274	Cañada Del Oro Wash at Ina Road ID: 1203
Location (Latitude, Longitude)	(32.4784, -110.8995)	(32.413,-110.942)	(32.3355,-111.0421)
Period of Record	1999-07-01 to Present	2007-07-03 to Present	1993-01-11 to Present
Watershed Area (sq. m)	64.8	110.4	255.19
Flood Peak of Record (cfs)	2193.2	7396	19028
Date	08-09-2004	9-08-2014	07-29-2006
Table of Regulatory Discharge (cfs)	NA	NA	NA

Table 14 - Cañada del Oro and Big Wash ALERT Precipitation Gages

Pima County ALERT Gages	Samaniego Peak-Cañada Del Oro Basin ID: 1130	Dan Saddle-Cañada del Oro Basin ID: 1140	Cargodera Canyon-Cañada Del Oro Basin ID: 1070	Cañada Del Oro Wash at Golder Ranch Road ID: 1100	Rancho Vistoso-Cañada Del Oro Basin ID: 1260	Cañada Del Oro Wash at Big Wash ID: 1270	Oro Valley Public Works-Cañada Del Oro Basin ID: 1230
Location (Latitude, Longitude)	(32.4683 -110.8172)	(32.4813,-110.7491)	(32.4455,-110.8768)	(32.4783,-110.8989)	(32.45-110.9458)	(32.4125,-110.9419)	(32.3739,-110.9827)
Period of Record	2006-02-01 to Present	2005-08-23 to Present	1987-03-27 to Present	1987-01-05 to Present	2001-10-19 to Present	2007-04-05 to Present	2001-10-19 to Present

The table below provides discharge locations within the watershed. The locations are from the District's tables of regulatory discharges.

Table 15 - Cañada del Oro and Big Wash Regulatory Discharges

Watercourse		Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Cañada Del Oro Wash				
@ Confluence with Santa Cruz river		22,400	256	FEMA Conditional Map Revision (08-09-0112R)
@Overton Road		22,100	250	" "
Above Confluence with big Wash		15,000	115	" "
Above Confluence with Southernland Wash		11,900	75.90	" "
@Pinal County Line		9,600	47	" "
Big Wash				
Upstream of confluence with Cañada Del Oro Wash		18,300	110	FEMA, Flood Insurance Study
Upstream of Confluence with Honey Bee Wash		16,900	89.90	" "

These records indicate that floods in the Cañada Del Oro can occur from all three of the three primary flood mechanisms that occur in Pima County, convective storms, tropical storms and frontal storms. While not apparent in the record rain on snow events could occur in this watershed when frontal storms produce rain on existing winter snow.

C.1.4.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. While the 13% of the population living in floodplains is not remarkable, there are also 552 people living behind a levee.

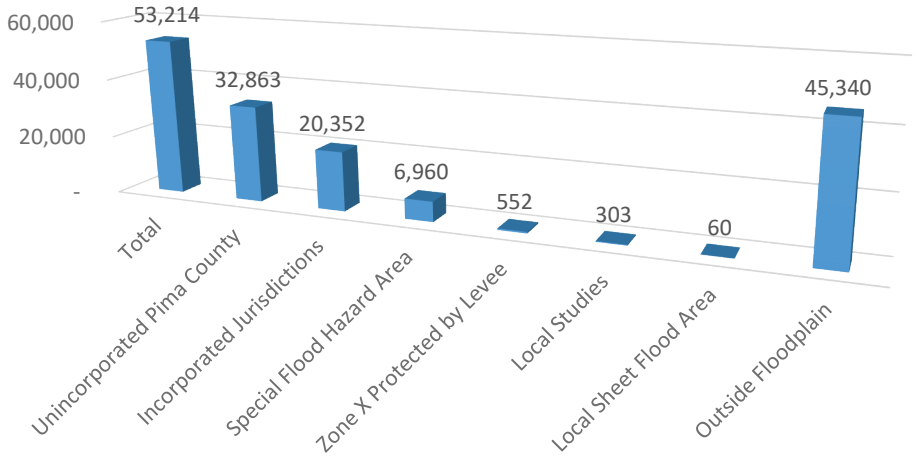


Figure 65 - Cañada Del Oro & Big Wash Watershed(s) Population Distribution

As shown on the bar chart below, 44% of this watershed is within the Coronado National Forest, with nearly 37% private and another 19% of State Trust.

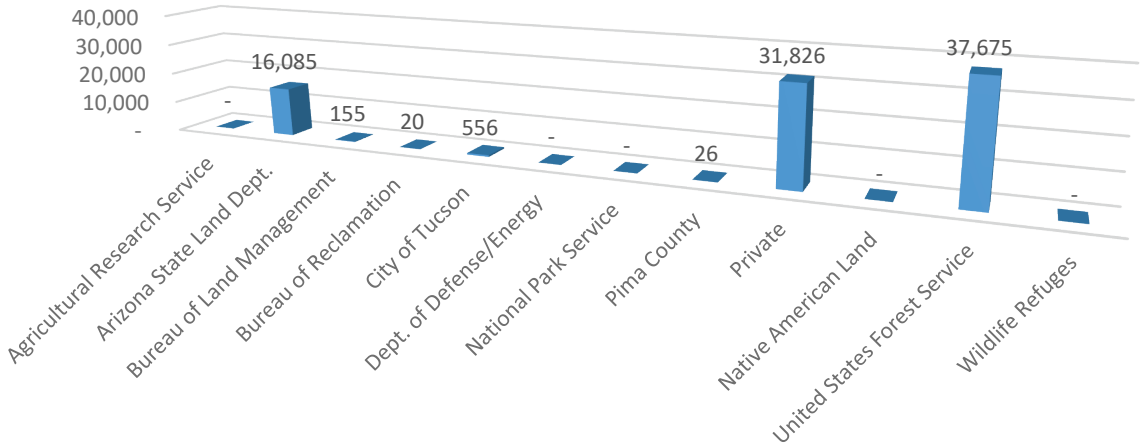


Figure 66 - Cañada Del Oro & Big Wash Watershed Ownership in Acres

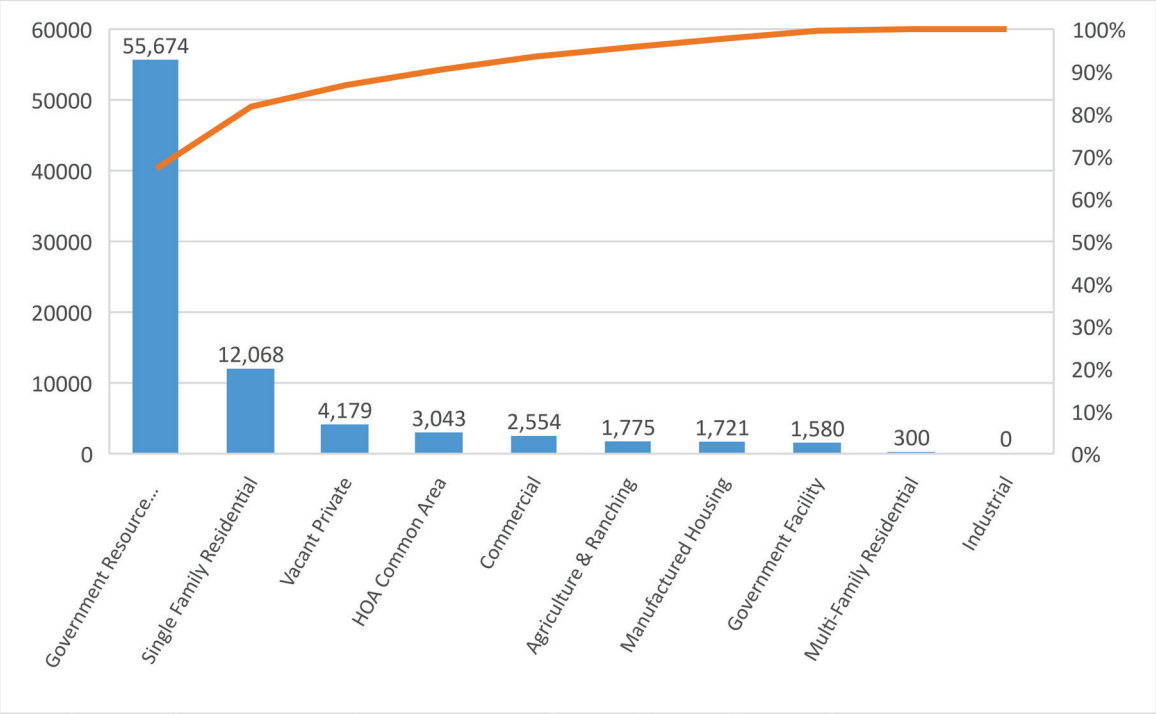


Figure 67 - Cañada Del Oro & Big Wash Watershed Land Use in Acres

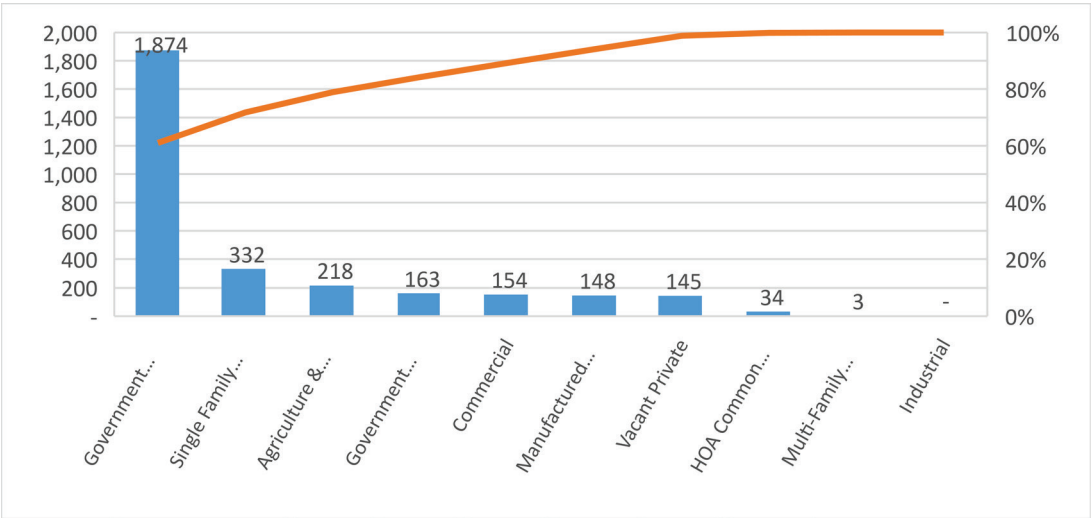


Figure 68 - Cañada Del Oro & Big Wash Floodplain Land Use in Acres

While a casual drive down Oracle Road suggests the land uses are predominately residential, commercial and recreational, within the floodplains ranching and other agricultural uses still exist. The map below depicts these land-use patterns.

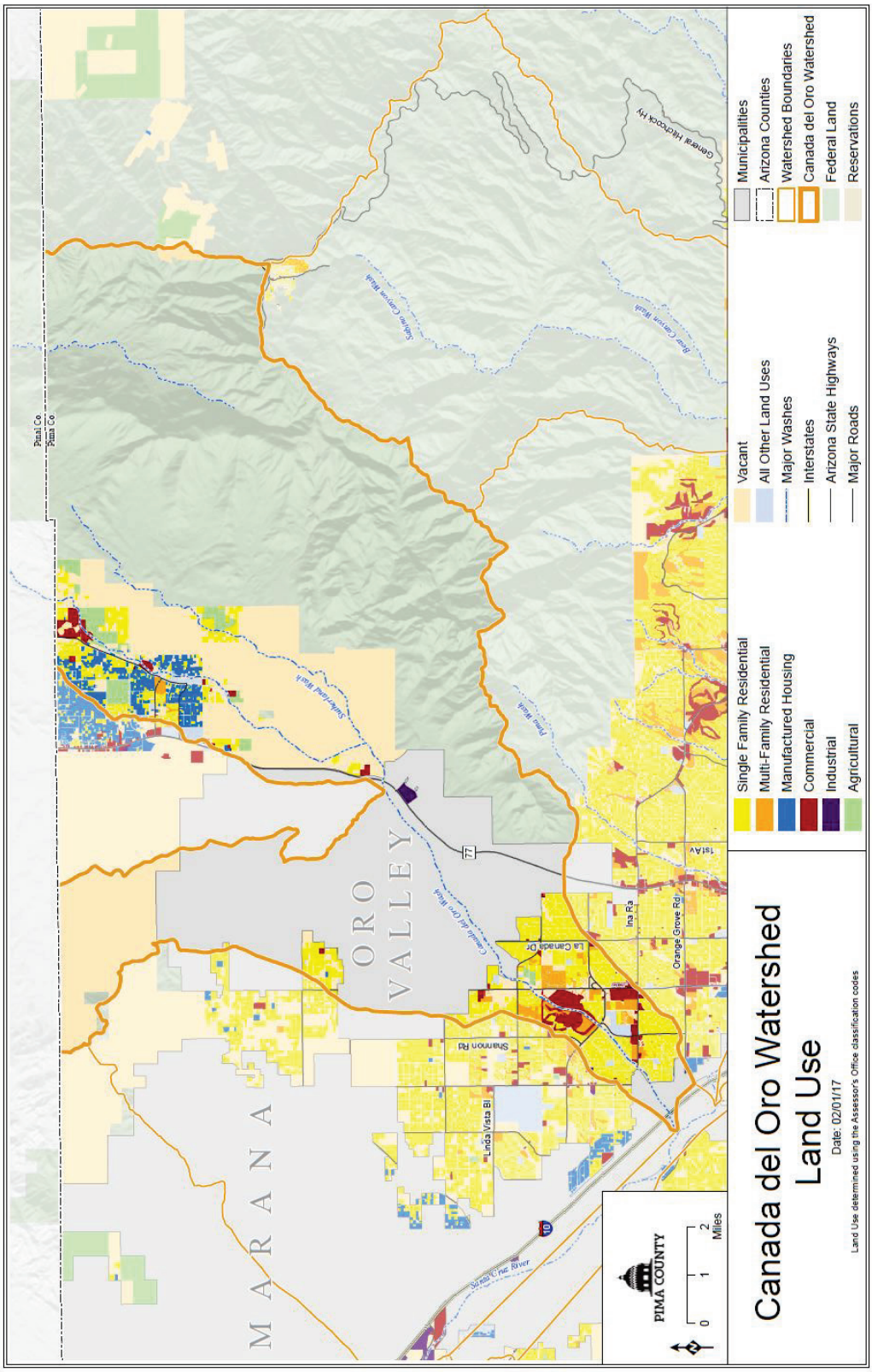


Figure 69 - CDO Land Use Map

C.1.3.3 Riparian Habitat and Natural Areas

As shown on the bar chart below, there are 3,976 acres of Pima County Regulated Riparian Habitat in this watershed. There are also 45,974 preserved acres in this watershed, including 1,977 in regulatory floodplain.

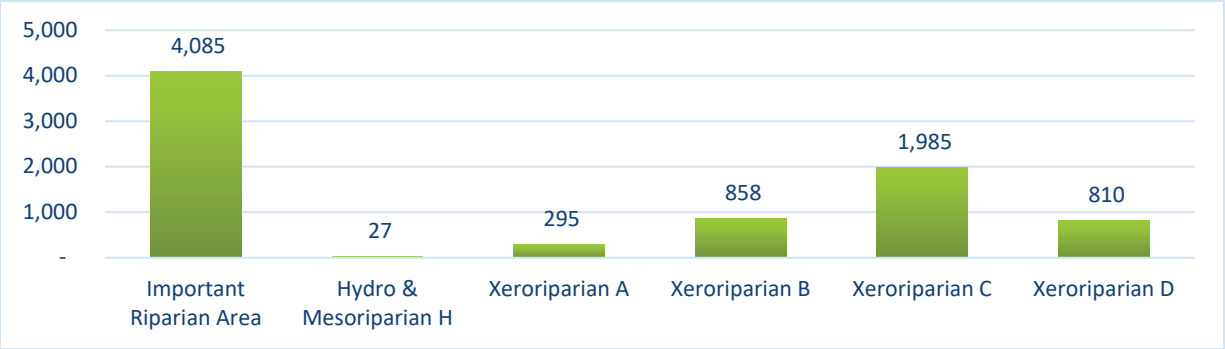


Figure 70 - Cañada Del Oro & Big Wash Riparian Habitat in Acres

It contains some of the most significant riparian areas within the county providing both unique and rare habitat types as well as connectivity between the Catalina and Tortolita Mountains. In fact a major wildlife overpass has been completed recently connecting Catalina State Park and the National Forest on the east to county ranch preserves in the Tortolita Mountains on the west side of Oracle Highway. Recent roadway improvements including grading and widening have made this critical.

The District assisted with design and management, and recently assumed ownership of a private mitigation restoration in Big Wash. The project successfully utilized Low Impact Development techniques in funneling rooftop nod parking stormwater into the restoration project, enabling rapid recovery of mesquite bosque in a former agricultural field.

C.1.3.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

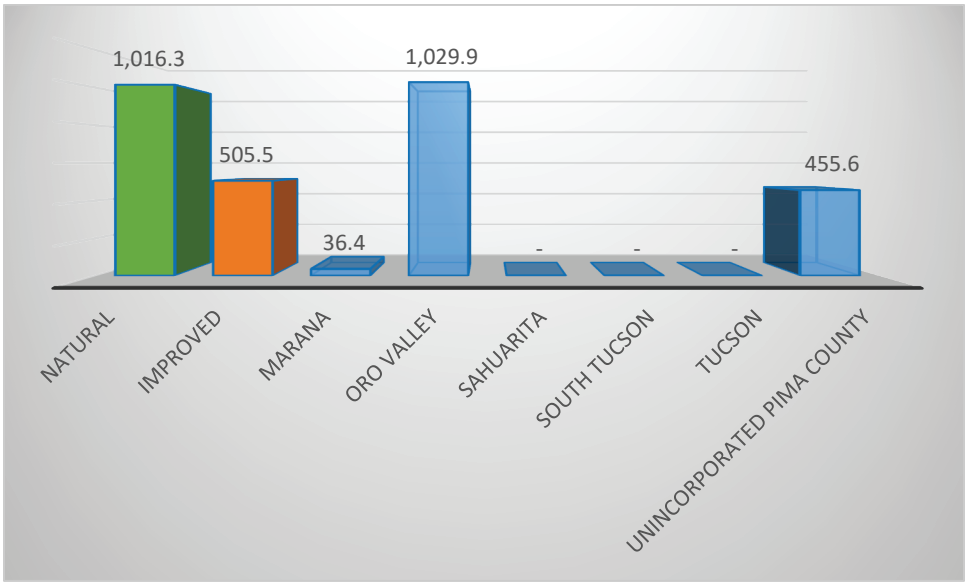


Figure 71 - Cañada del Oro & Big Wash Drainageway Acreage

The CDO is a major watercourse that originates in National Forest, passes through unincorporated Pima County into Oro Valley, and then back into the County near the confluence with the Santa Cruz River. Because of this interjurisdictional coordination is an important component of a successful mitigation program. Bank protection and use of acquisition has been the focal point of management in this area especially since growth, wildfires and associated debris movement have been significant.

Exposed Bank Protection Toe

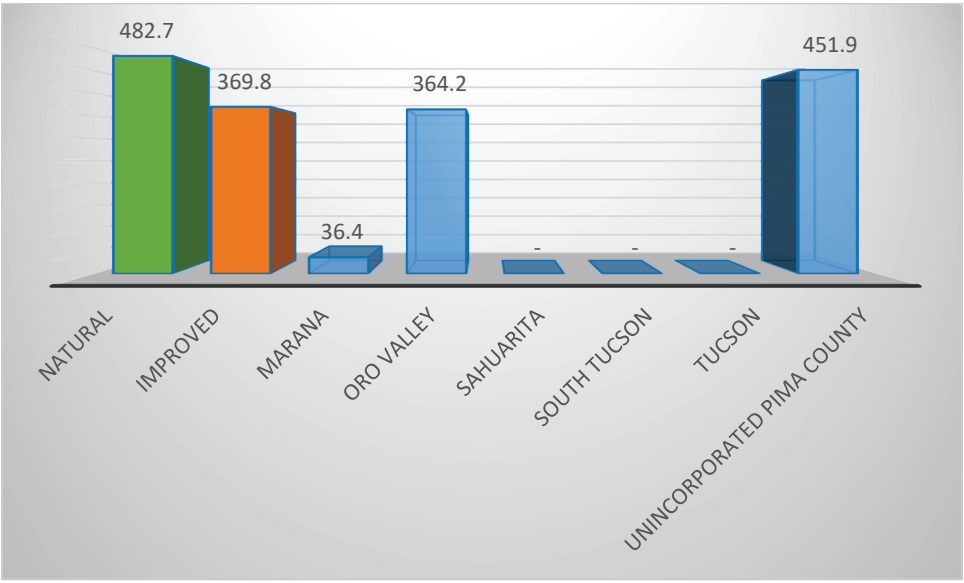


Figure 72 - Cañada Del Oro Improved vs. Open Space Drainageways in Acres

In this watershed, there are 1,406 acres of improved drainageways and 800 acres that are designated open space. There is also 45,130 acres of preserved open space that together with the drainageways shown on the figure above makes up only 61% of the watershed.

Following catastrophic forest fires in the National Forest headwaters of the Cañada del Oro the District and the Town of Oro Valley began acquiring floodprone and damaged properties. This management approach was appropriate hear as grandfathered non-conforming developments existed within the geologic floodplain near the mountain canyons. Doing so has certainly helped prevent repetitive losses.

Downstream within the commercialized and more densely developed residential areas bank protection projects have complemented the development of linear parks known locally as the Loop. This consists of an interconnected set of river paths for walkers, biking and equestrians with additional park amenities including recreation, education and riparian restoration projects.

The Big Wash Levee is a soil cement levee upstream of Tangerine Road along the eastern side of the Big Wash floodplain and west of the Oro Valley Hospital. Additional freeboard was added to the levee because of the hospital, a Critical Facility and because the Big Wash is in a conservation easement.

The Cañada Del Oro Wash Levee is along the left embankment (looking downstream) of the Cañada Del Oro Wash from Oracle Highway downstream to La Cañada Drive. This is a soil cement levee.

The Canyon Shadows Levee is a soil cement levee south of the Canyon Shadows subdivision along the north embankment of the Cañada Del Oro Wash Downstream of La Cañada Drive.

The Rams Canyon Levee is a soil cement levee along the south embankment of the Cañada Del Oro Wash upstream of the Oracle Highway.

Downstream of the county line that is Edwin Road, the Cañada del Oro channel cannot convey large flows. Travel time from Rancho Solano (1079/1083) to Golder Ranch Road (1099/1103) is approximately 1 hour. The earliest channel breakout, near Golder Ranch Road, occurs at approximately 1,500 cfs. If breakout occurs, Lago Del Oro Parkway may be affected.

Flow registered at the stream gauges at CDO at Oracle (1273) and Big Wash at the CDO (1274) may incorporate flow from sub basins below Golder Road (including Big Wash, Sutherland Wash, Romero Canyon, etc.). Flow at these locations may affect downstream at-grade crossings. Little travel time information available. Assuming an average channel velocity of 10 fps, travel time from 1273 and 1274 to Overton Road, is approximately 45 minutes to 1 hour. Travel times change through the rainy season as the channel becomes wetted. At this streamflow, the following at-grade crossings are impacted:

- Edwin Road
- Wilds Road
- Overton Road

In 2013, the Department of Transportation completed a new bridge at a former at-grade crossing on La Cholla Boulevard downstream of the Overton Road at-grade crossing. The bridge provides safe north-south access across the CDO at a crossing, which previously detoured traffic in nearly every storm event. The bridge constitutes a significant improvement to public safety and access, especially since the Overton Road crossing closes in nearly every storm event. The Overton crossing is particularly hazardous because storms can initiate in CDO headwaters while no rainfall occurs at Overton. Flows can arrive at Overton with little warning to traffic.

At streamflow of 800 cfs at Rancho Solano, stream gauge (1079/1083) the District contacts the Pima County Department of Transportation, as is the Golder Ranch Fire Department, as flows will reach Golder Road in approximately 1 hour and 20 minutes.

At streamflow of 1,500 cfs at the Rancho Solano stream gauge, senior staff makes the decision as to whether to contact OEM.

At streamflow of 500 cfs at either sensor at CDO or Big Wash (1273/1274), the District contacts Pima County Department of Transportation, as water may affect downstream road crossings. The information on the table below also guides the Flood Threat Recognition and early Warning Dissemination process for which the District is responsible.

Table 16 - Flood Thresholds Less Than 1% Chance Flood

Flood Threshold Known to be Less Than 100 Year Discharge (1% Chance Flood)				
Gauge	Stage (ft)	Discharge (cfs)	Contact	Concern
1079/1083	5	800	Golder Ranch Fire Dept. PCDOT	Edwin/Wilds/Overton/La Cholla
1079/1083	7.1	2,000	District IMD	Overbank at Golder
1099/1103	4.2	2,000	District IMD	Overbank at Golder
1273	1.1	450	PCDOT	Overton Road
1274	1.4	300	PCDOT	Overton Road
1203	7.3	10,000	District IMD	Ina Road Bridge on the Santa Cruz

C.1.3.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- Wilds Road flow breaks out of the channel in this area at around 1500-2000 cfs.
- Golder Ranch Road subject to erosion damage from a tributary to the Cañada del Oro.
- N. Lago del Oro Parkway structures in the floodway.

Infrastructure

- Carmack Wash is eroding laterally towards Shannon Road. Sediment and water overtops Shannon Road as well.
- Carmack Wash is down-cutting the channel downstream of Ina Road.

C.1.3.6 Floodplain Management

Future needs identified by District staff include:

- Sediment transport and need for increased maintenance
- At grade crossing at Overton Road
- EHS development on tall steep banks
- Inter-jurisdictional Coordination
- Grade control

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Create Drainage System vegetation maintenance plans
- Create open space management plans

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify and map canyon wash floodways
- Remap the Carmack Wash in the distributary flow area

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Remap Twenty-Seven Wash floodplain/floodway (CDO)

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Work with responsible parties to address flooded roads

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Construct bank protection on the north bank of Cañada del Oro Wash between I-10 and Thornydale
- Construct Highlands Wash drainage improvements
- Loop and Trail Enhancements

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

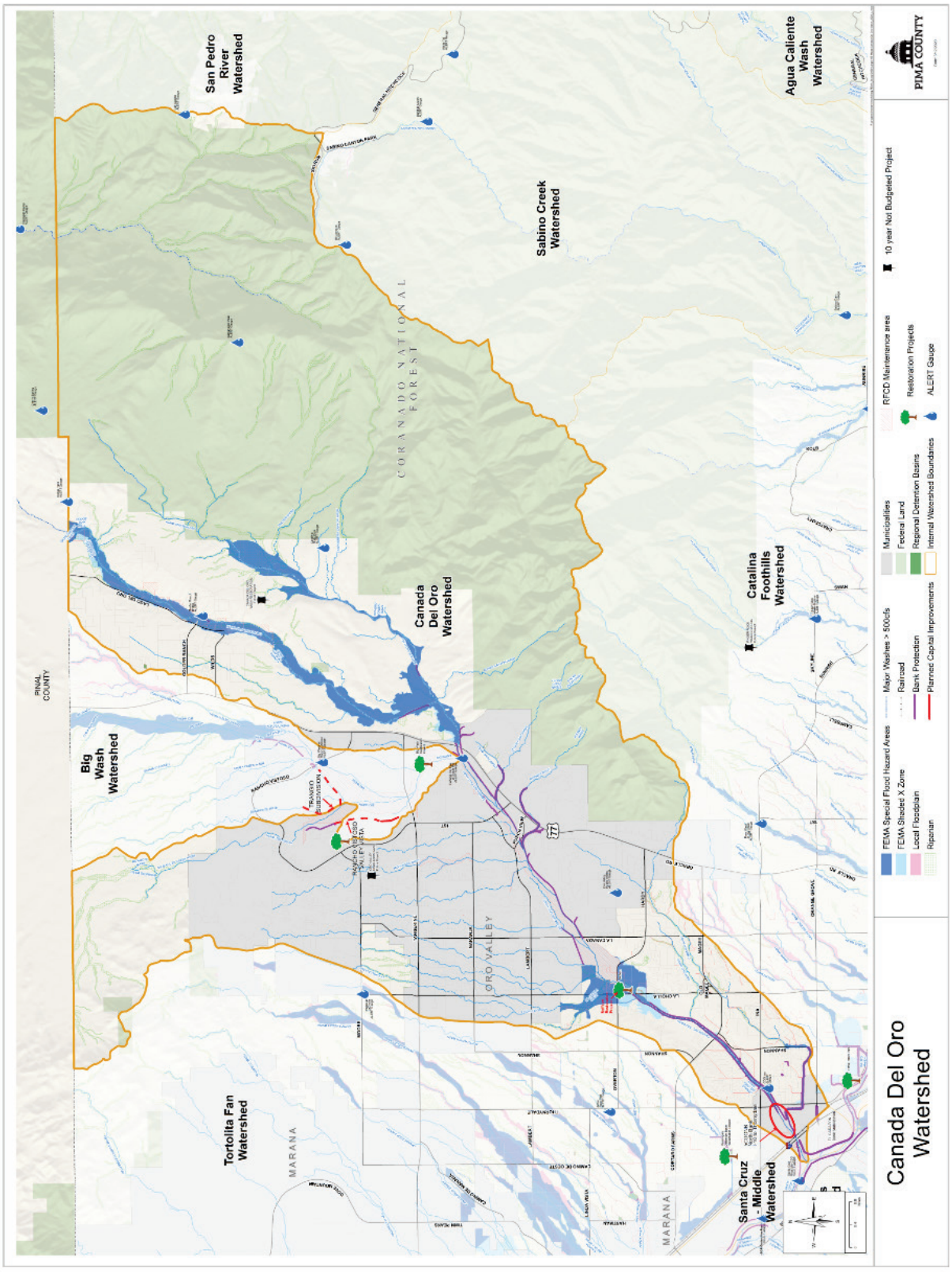


Figure 73 - Cañada del Oro Action Plan Map

C.1.5 Catalina Foothills

For the purposes of this study, this watershed includes numerous washes draining the southern slopes of the Pusch Ridge of the Santa Catalina Mountains. These include Pima, Finger Rock, Valley View and Ventana Canyon Washes. Originating in near vertical terrain, these descend steeply through dramatic canyon walls before spilling out onto the alluvial bajada foothills and geologic floodplains associated with Rillito Creek. Within Pima County, it is comprised of 47,661 acres (74.5 square miles).

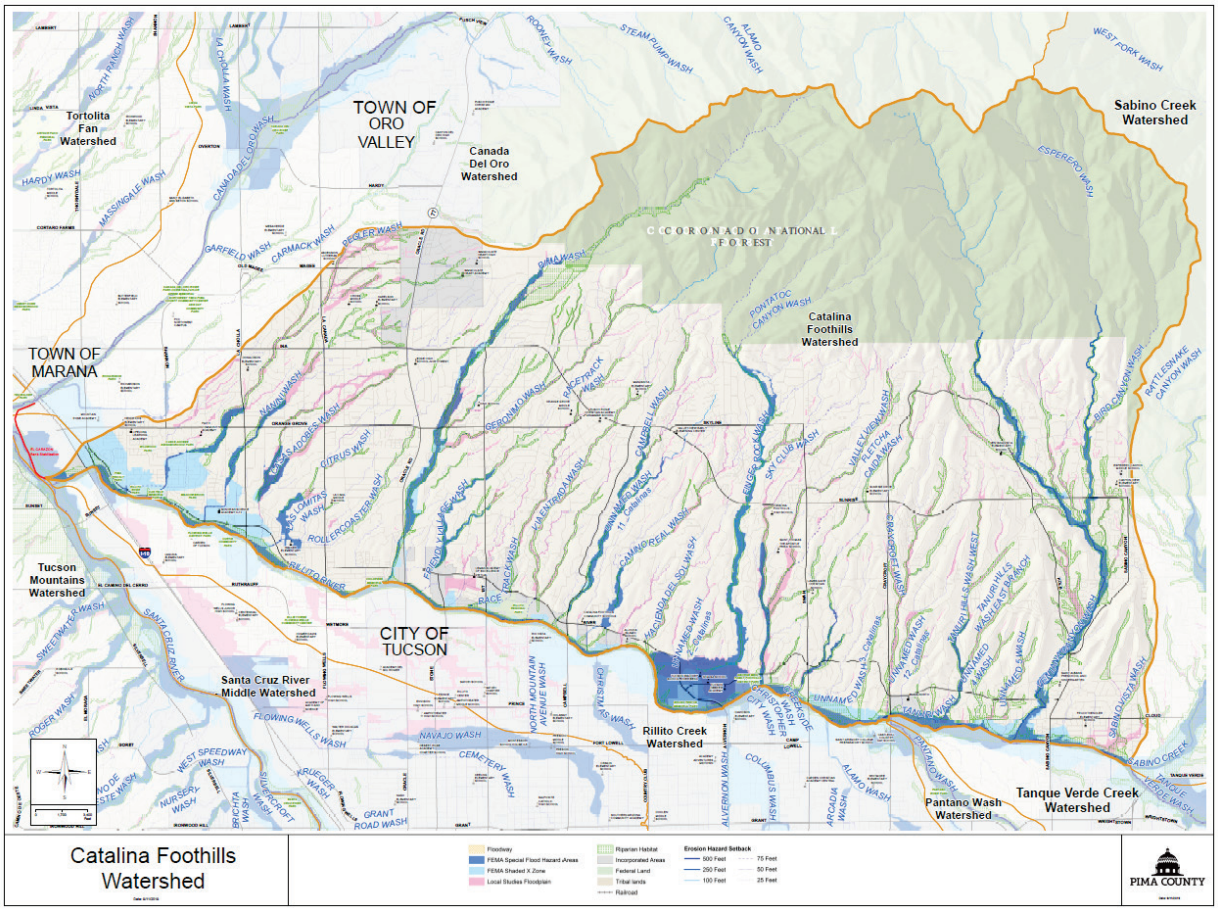


Figure 74 - Catalina Foothills Floodplain Map

The watershed lies primarily within the flood control jurisdiction of Pima County, with the exception of discontinuous areas adjacent to the Rillito River under jurisdiction of the City of Tucson, and Town of Oro Valley area adjacent to Oracle Rd, north of Ina Rd.

C.1.5.1 Flood Characteristics

In addition to the 1,490 acres of SFHA included on the pie chart below, there are also 1,035 acres of District Special Studies Floodplains in this watershed. Together these mapped floodplain areas are 6.6 percent of the total watershed area.

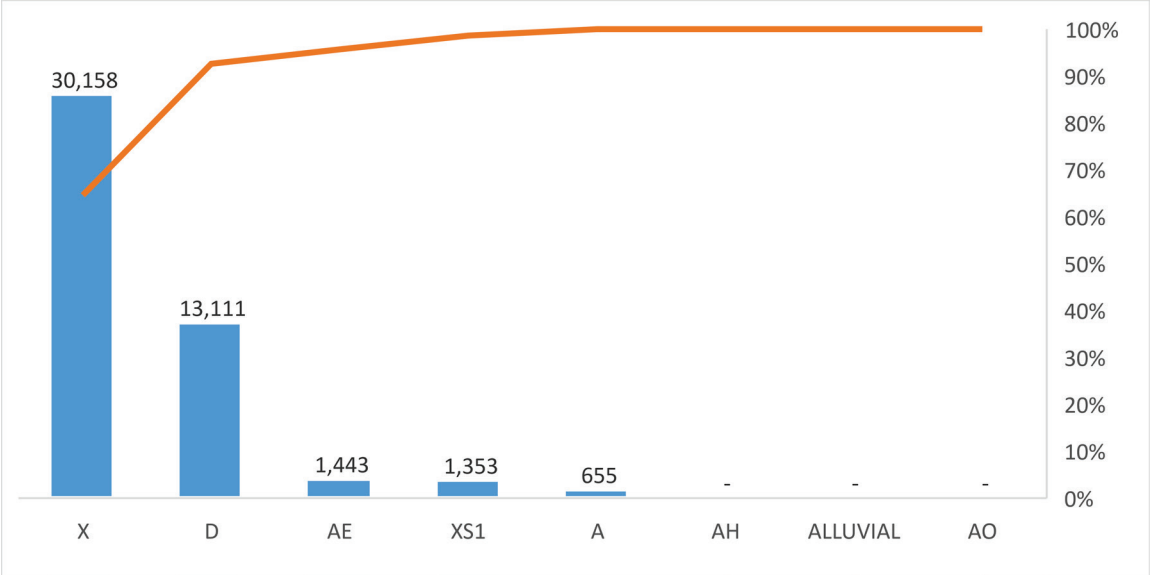


Figure 75 - Catalina Foothills SFHA in Acres

Major tributaries in the watershed with 1% annual peak discharges in excess of 10,000 cfs, include the Ventana Canyon Wash, a tributary to Tanque Verde Creek, and its tributary, Esperero Wash. Tributaries with discharges in the range of 5000 cfs to 10,000 cfs, include Pima Canyon Wash and Finger Rock Wash, which drain to the Rillito River. The table below provides a summary of the historic USGS gaging station records.

Table 17 - Catalina Foothills Watershed USGS Streamflow Gages

USGS Gaging Station	Roller Coaster Wash NR Tucson AZ 09486050	Geronimo Wash Near Tucson, Ariz. 09485950	Pima Wash Near Tucson, Ariz. 09485900	Craycroft Wash NR Tucson AZ 09484533	Craycroft Wash Tributary Near Tucson AZ 09484530
Period of Record	1982-08-23 to 1990-07-24	1964-09-06 to 1981-07-10	1964-09-06 to 1983-10-01	1982-09-11 to 1983-10-02	1982-09-11 to 1990-07-20
Watershed Area (sq. m)	1.75	2.08	4.93	2.37	0.03
Flood Peak of Record (cfs)	960	705	460	557	28
Date	8-9-1983	8-12-1971	10-1-1983	10-02-1983	10-02-1983
FIS Discharge (cfs)	NA	NA	NA	NA	NA

The table below provides Pima County ALERT Gages. The locations are from the District's Alert map.

Table 18 - Catalina Foothills Watershed ALERT Streamflow Gages

Pima County Alert Gage	Pima Wash at Ina Road ID: 1253	Finger Rock Wash at Skyline Drive ID: 2393	Ventana Canyon Wash at Sunrise Drive ID: 2173	Tanque Verde Creek at Sabino Canyon Road ID: 2123
Location (Latitude, Longitude)	(32.3371,-110.9624)	(32.3231,-110.9008)	(32.3083,-110.8389)	(32.2653,-110.8414)
Period of Record	2001-10-18 to Present	2001-10-19 to Present	1991-08-27 to Present	1992-12-28 to Present
Watershed Area (sq. m)	4.95	4.38	7.12	219.8
Flood Peak of Record (cfs)	1836.8	102.9	3863.4	19788
Date	09-08-2014	07-29-2012	07-31-2006	07-31-2006

Table 19 - Catalina Foothills Watershed ALERT Precipitation Gages

Pima County Alert Gage	Pima Wash at Ina Road ID: 1250	Finger Rock Wash at Skyline Drive ID: 2390	Ventana Canyon Wash at Sunrise Drive ID: 2170	Tanque Verde Creek at Sabino Canyon Road ID: 2120	Swan Road near Camino del Pantera-Rillito Basin ID:2100
Location (Latitude, Longitude)	(32.3371,-110.9624)	(32.3231 - 110.9008)	(32.3083,-110.8389)	(32.2653-110.8414)	(32.2995,-110.8929)
Period of Record	2001-10-18 to Present	2001-10-19 to Present	1990-11-20 to Present	1987-07-23 to Present	2000-10-20 to Present

The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 20 - Catalina Foothills Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Camino Real Wash			
@River Road	1956	1.7	PCFCD Special Study #36
East channel downstream of River Rd	1205		"
West channel downstream of River Rd	1151		"
Campbell Wash			
Confluence with Rillito Creek	2899		From Previous Discharge Table
1,295 feet upstream of Campbell Ave.	2879	2.15	PCFCD Special Study #76
Upstream of junction with East Branch of Campbell Wash at Camino Juan Paisano	2160	1.34	"
2,150 feet downstream of Skyline Drive	1841	0.75	"
East Branch Campbell Wash @ Camino Juan Paisano	1336	0.62	"
Casas Adobes Wash			
@ Rillito Creek	1987	2.22	PCFCD Special Study #75
@ Las Lomitas	1474	1.42	"
@ La Cañada Road	1363	1.06	"
Tributary @Las Lomitas	1133	0.52	"
Tributary @ La Cañada Road	479	0.15	"
Citrus Wash			
Approximately 2,500 feet upstream of Oracle Jaynes Station Road	1562	0.80	FEMA Map Revision 02-09-0746X
@ Oracle Jaynes Station Road	1152	0.80	"
Craycroft Wash			
@ Rillito Creek	3620	3.16	PCFCD Special Study #56
South of Rio Verde Vista Drive	3145	2.51	"
West Branch Craycroft Wash North of Center Village Drive	1413	1.02	"
West Branch Craycroft Wash	1489	0.95	"

South of Territory Drive			
East Branch Craycroft Wash North of Center Village Drive	2093	1.34	"
East Branch Craycroft Wash South of Territory	1269	0.73	"
Esperero Wash			
Upstream of Confluence with Ventana Canyon Wash	8898		PCFCD Special Study #68
Upstream of Sunrise Drive	9170	6.19	PCFCD Special Study #68
Downstream of Thimble View Way	10,762	6.11	"
		5.9	
Finger Rock Wash			
@ Alvernon Way	5756		FEMA Map Revision 11-09-0275P
@ Skyline Drive	6060	6.4	"
@ Coronado National Forest Boundary	2324	5.3	"
Finger Rock Wash Split Flow @ Coronado Drive	1922	1.5	"
		3.4	
Flecha Caida Wash			PCFCD Special Study #55
@ Confluence with Rillito Creek	1370	1.42	"
@ River Road	846	0.83	"
@ Via Ra Posa	781	0.69	"
@ Paseo del Bac	604	0.47	"
Eastern Tributary @ River Road	574	0.41	
Friendly Village Wash			PCFCD Special Study #73
@ Stone Loop	1610	1.16	"
@ Yvon Road	1671	1.11	"
Friendly Village Wash, East Branch @ Agave Road	666	0.29	"
@ First Avenue	442	0.18	"
Friendly Village Wash, West Branch @ Approximately 1,800 Feet Upstream of Yvon Road	1101	0.62	"
@ First Avenue	1007	0.42	PCFCD Special Study #54
Geronimo Wash			"
@ confluence with Pima Wash	4894		"
Approximately 500 feet upstream of			

confluence with Pima Wash	4002	3.37	"
			"
		2.54	
			"
South of Orange Grove Road	4132		
			"
@ Skyline Avenue	4005	2.33	
			"
@ Ina Road	3713	1.9	
North of Calle Sin Desengana	2411	1.68	
		0.99	PCFCD Special Study #48
Hacienda Del Sol Wash			
@ Rillito Creek	806		FEMA Conditional Map Revision 06-09-BG74R
Nanini Wash		0.66	PCFCD Special Study #74
@ Rillito Creek	2246		"
@La Cholla Boulevard	1903	1.83	
@ La Cañada Boulevard	1831	1.78	FEMA Map Revision 04-09-0465X
		1.04	FEMA Map Revision 09-09-0020P
Pegler Wash			
@ Rillito Creek	3142		
@ Shannon Road	1874		FEMA FIS
Pima Wash			
Upstream of Confluence with Rillito Creek	5300		"
Upstream of Confluence with Geronimo Wash	4250	9.80	FEMA Map Revision 11-09-0275P
Pontotoc Canyon Wash		6.3	
@ Coronado National Forest Boundary	2503		PCFCD Special Study #71
Race Track Wash		1.1	"
@ River Road	1883		
Between Camino Padre Isidoro and Calle de la Culebra	1680	1.38	PCFCD Special Study #51
		0.93	"
Tanuri Wash			
@ Tanque Verde Creek	2409		"
Upstream of confluence with East Branch of Tanuri Wash	1887	1.8	
Tanuri Wash (East Branch)	1092	1.2	PCFCD Special Study #73
			"
Valley View Wash		0.5	
Near River Road	3514		PCFCD Special Study #50
@ Flecha Drive	3219	4	
@ Swan Road			PCFCD Special Study #68

	2802	1.94	"
Ventana Canyon Wash		1.42	"
@ Confluence with Tanque Verde Creek	11,527		"
Downstream of River Road		16.64	
Upstream of Kolb Road	12,058		
Downstream of confluence with Esperero Wash	15,939	15.87	"
Upstream of confluence with Esperero	17,753	14.14	
		14.1	"
Upstream of Sunrise Drive	11,484		"
Upstream of Resort Drive		7.94	
	12,044		PCFCD Special Study #77
Via Entrada Wash East Branch	10,596	6.98	
@ River Road		3.85	"
Via Entrada Wash West Branch	944		
@ River Road		0.54	
	1630		
		0.67	

These records indicate that floods in the Catalina Foothills can occur from all three of the three primary flood mechanisms that occur in Pima County, convective storms, tropical storms and frontal storms. Rain on snow events occur in this watershed when frontal storms produce rain on existing winter snow.

In addition, 1% annual chance discharge values from 2-dimensional analyses are available at the Finger Rock Wash Lower Floodplain based upon the study, Two-Dimensional Hydraulic Modeling Study Report for the Finger Rock Wash Lower Floodplain. Completed in 2016, this report encompasses the area below the mouth of the incised channel of the Finger Rock Wash, west of Alvernon Road. Flood hazards associated with the watercourses include under-capacity roadway crossings, and flow splits, breakouts and shallow sheet flooding associated with the natural channels. Nanini and Casa Adobes washes have undersized infrastructure associated with older subdivisions. Distributary flow conditions are associated with flow hazards on the Valley View and Roller Coaster washes.

Currently there is no contained conveyance of runoff for the Finger Rock Wash from the mouth of the incised channel near Alvernon Way to the Rillito Creek. This results in a broad FEMA Zone A floodplain adjacent to Rillito Creek, impacting homes and businesses.

Three FEMA certified levees/floodwalls provide flood protection within the watershed. The Casa Adobe Levee is located on the west bank of the Casas Adobes Wash from immediately upstream of Sunset Rd. up to Las Lomitas Rd and on the eastside from Sunset Rd. to a point approximately 450 ft. north. The Camino Real Wash floodwall is

located upstream of River Rd. The Sotmayor Ranch levee is located on the north side of the Sotmayor Ranch Subdivision, north of Oracle Jaynes Station Rd. and provides flood protection from the Pegler Wash.

C.1.5.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. In this watershed 16% of the population lives on parcels within the floodplain, another 132 people live in areas protected by a levee.

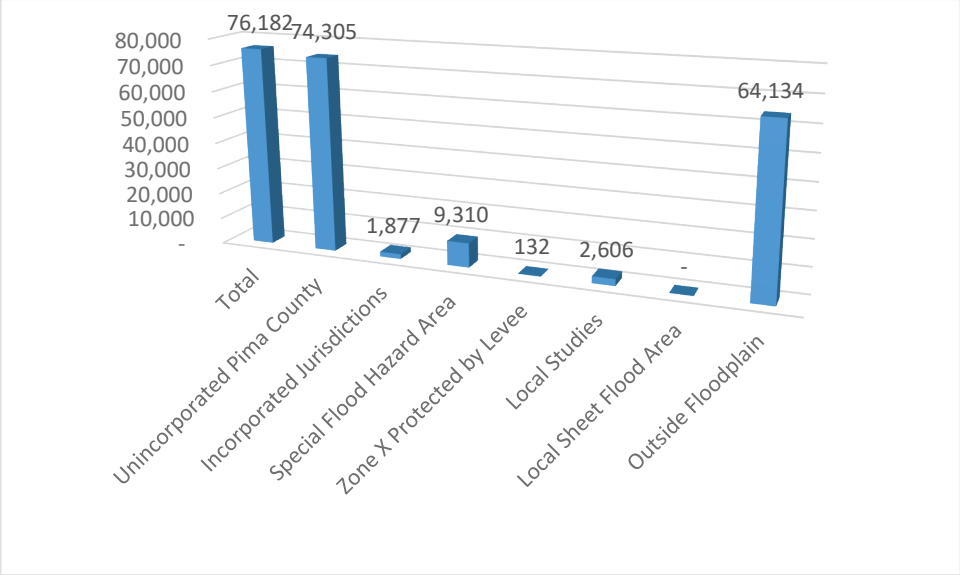


Figure 76 - Catalina Foothills Watershed Population Distribution

Located at the base of the escarpment of the Coronado National Forest, within unincorporated Pima County 72% of this watershed is private.

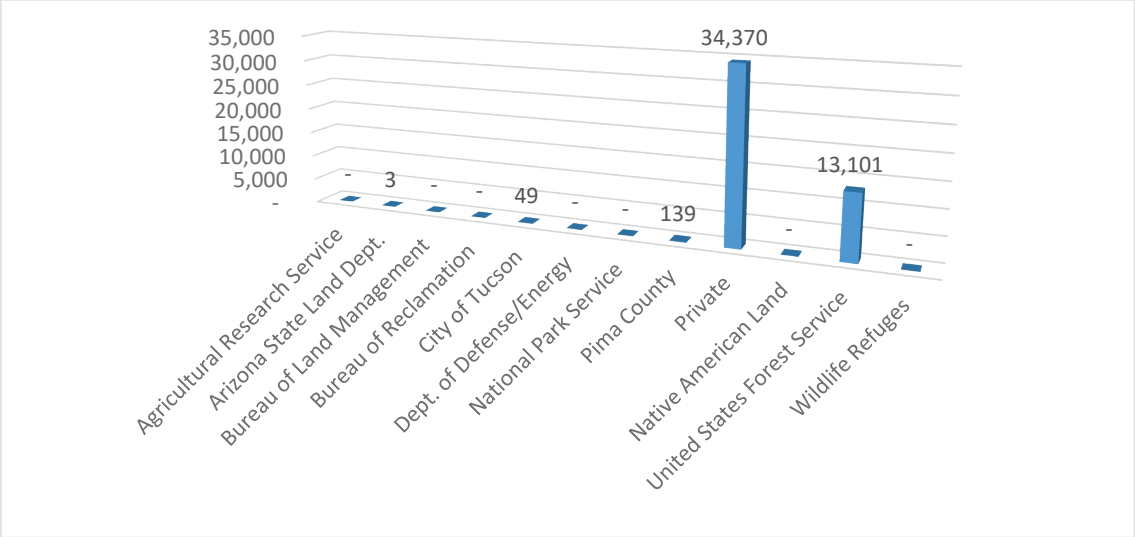


Figure 77 - Catalina Foothills Watershed Ownership in Acres

Much of the private land is residential site built homes on large lots of one to five acres, or clustered housing with common areas intended to remain natural by covenant.

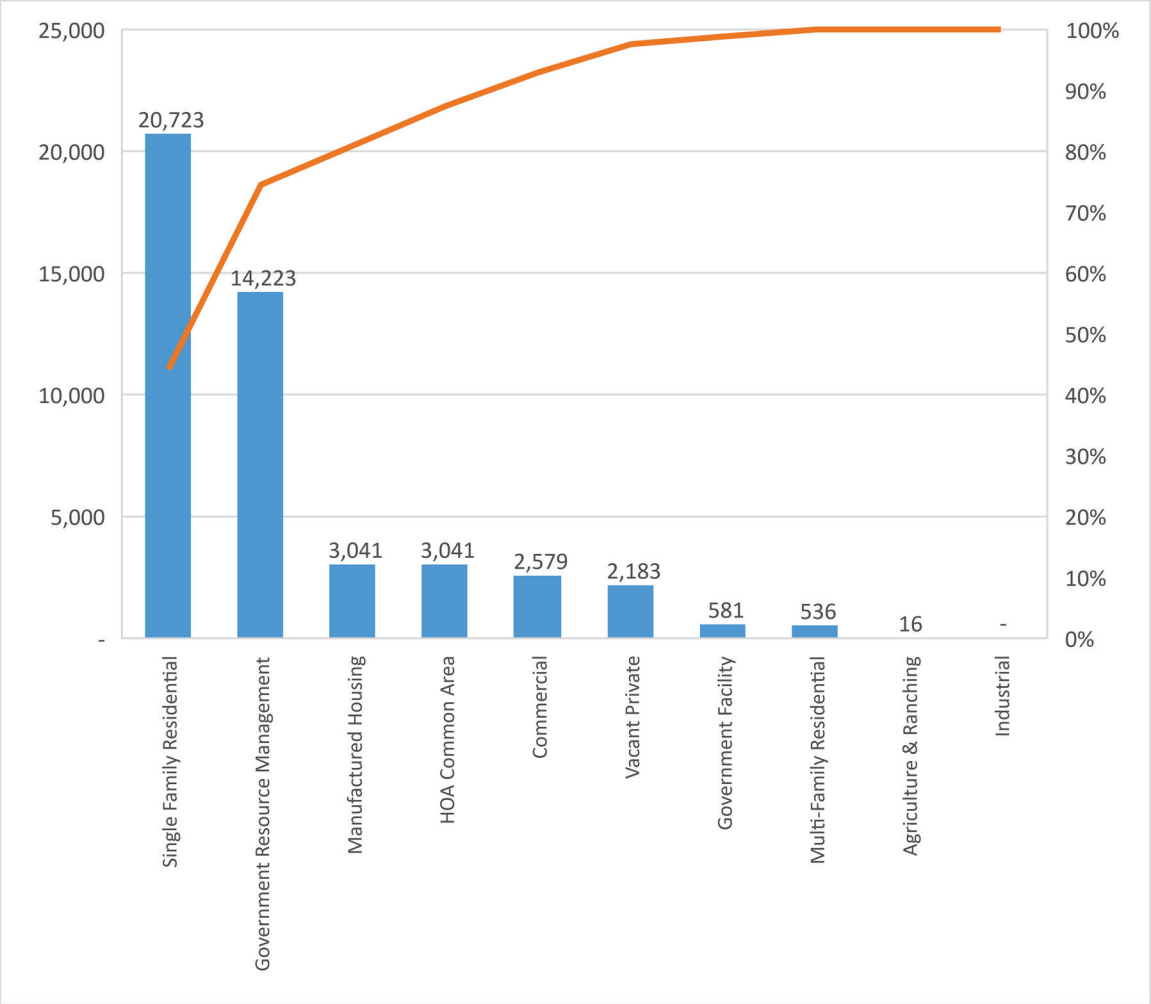


Figure 78 - Catalina Foothills Watershed Land Use in Acres

As indicated below while drainageways may be preserved, they are within common area controlled by Homeowners Associations and not public ownership.

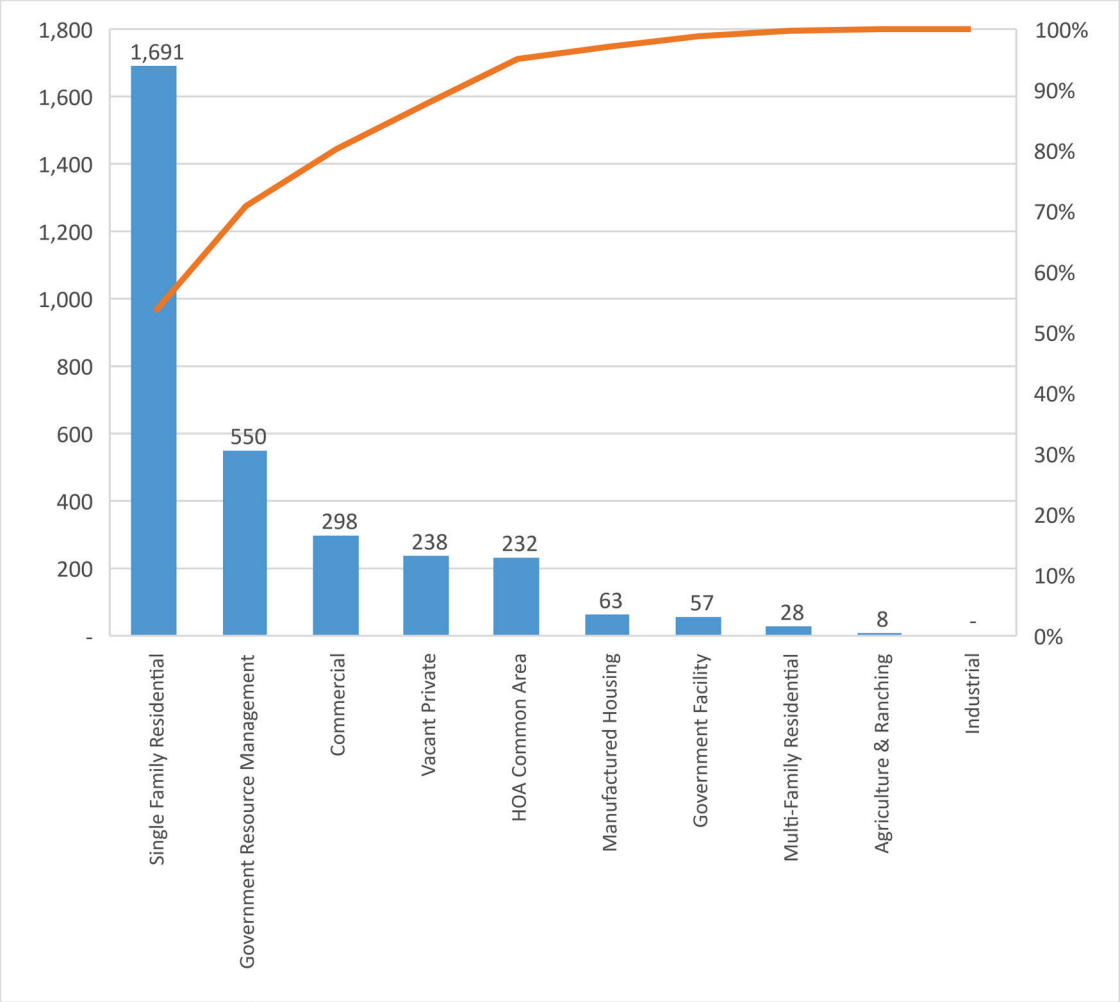


Figure 79 - Catalina Foothills Floodplain Land Use

Owners may not always dedicate floodplains to the county. There is, therefore a high percentage of residential floodplain. It is also notable that little is vacant. Preservation may depend upon regulation of and choices made by private landowners. The map below shows these patterns.

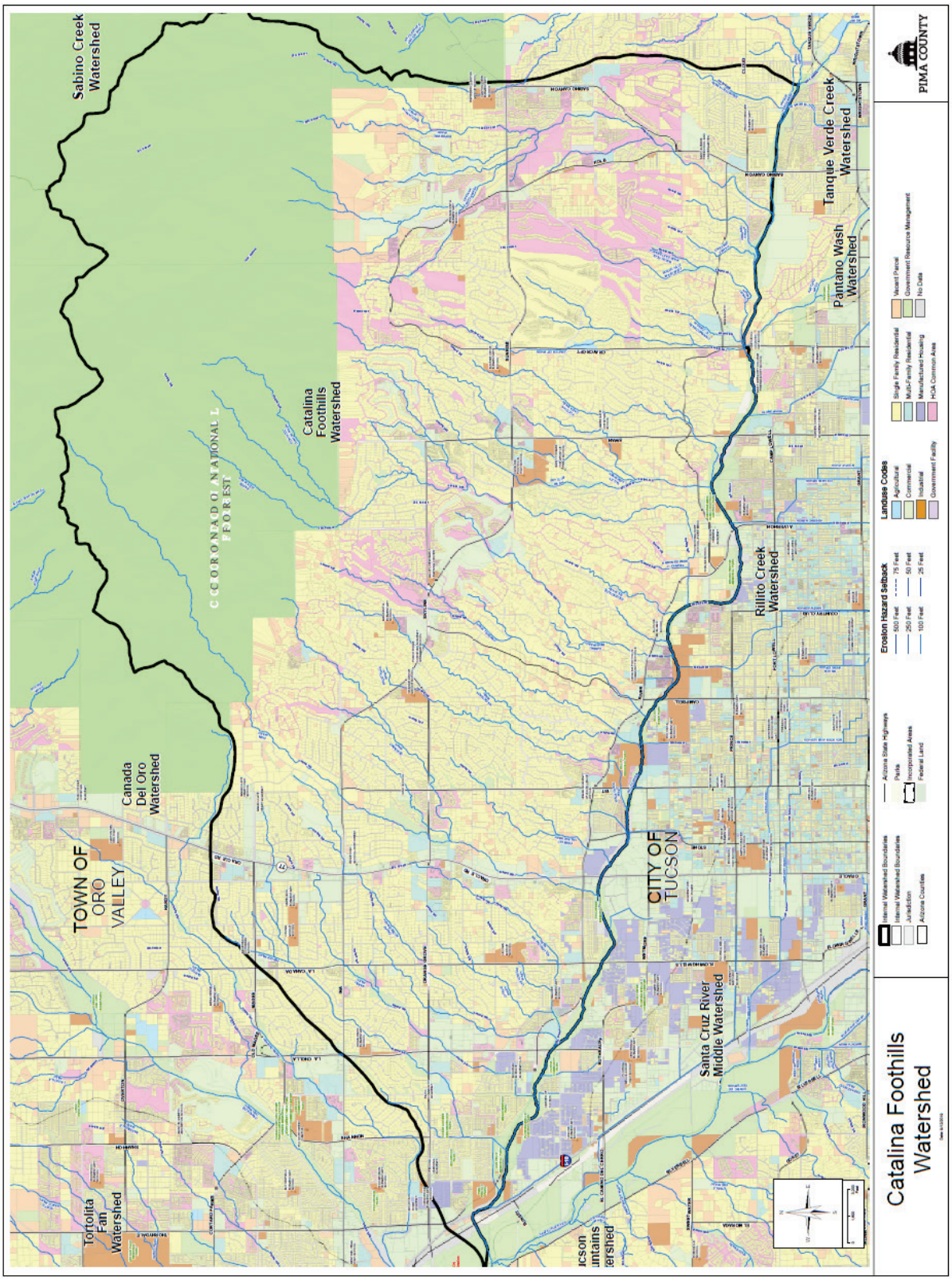


Figure 80 - Catalina Foothills Land Use Map

C.1.5.3 Riparian Habitat and Natural Areas

As shown on the bar chart below, there are 2,258 acres of Pima County Regulated Riparian Habitat in this watershed; 1,474 acres is IRA. There are also 13,215 preserved acres in this watershed, including 12 in regulatory floodplain.

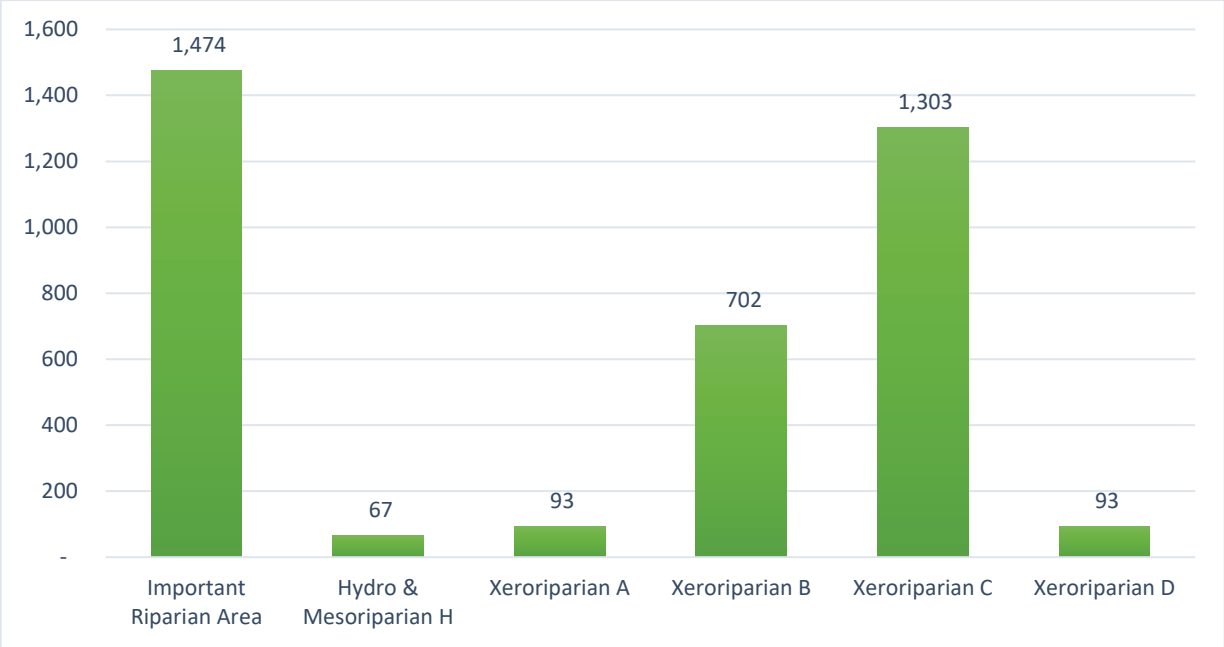


Figure 81 - Catalina Foothills Watershed Riparian Habitat in Acres

C.1.5.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

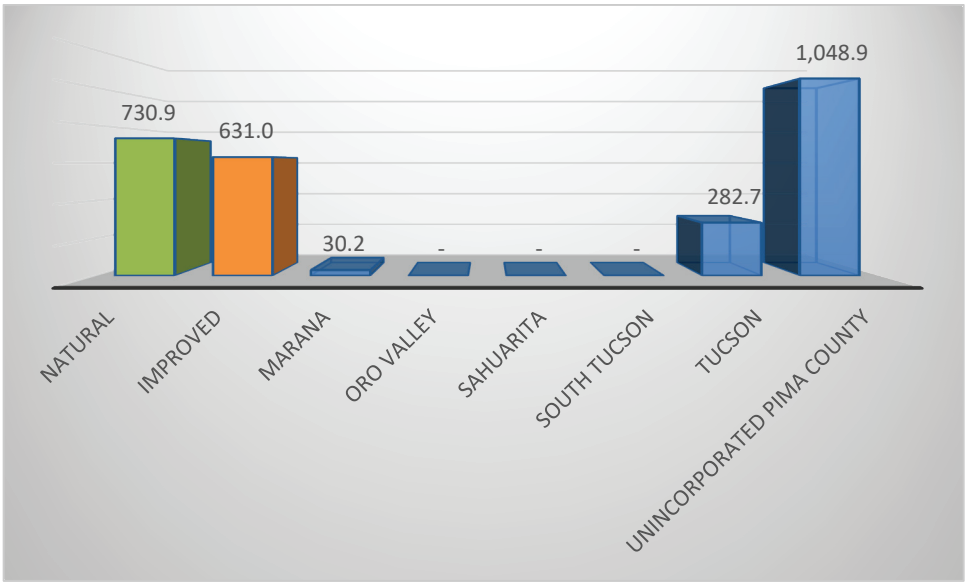


Figure 82 - Catalina Foothills Drainageway Acreage

The Camino Real Wash levee is located upstream of River Road. River Road is a component of the levee. This is an earthen (roadway) embankment and floodwall. There are two drainage outlets downstream of River Road. The County inspects roadway culverts for sedimentation. The culverts are part of the roadway and are the maintenance responsibility of the Pima County Department of Transportation.

The Casas Adobes levee consists of gunite protected earthen berm and channel along both embankments of the Casa Adobes Wash upstream of Sunset Road.

The Sotomayor Ranch levee is an earthen embankment levee that has gunite and riprap bank protection. It is located on the north side of the Sotomayor Ranch Subdivision and provides flood protection from the Pegler Wash.

C.1.5.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- N. Ventana Vista has been flooded by Esperero Wash.
- Homes near the intersection of Havasu Road and Placita Arquilla and to the north are in the bottom of the geologic floodplain of Finger Rock Wash and are likely to get damaged during large events.

Infrastructure

- There are undersized culverts under Sunrise Rd. at Esperero Wash. Water weirs over the road, forcing the road to be closed. The water gets diverted and has caused flooding damage. Gabions have been damaged downstream of Sunrise.
- Monitor and document the flood water level at the UPRR railroad crossing. If the water level appears to be within 18 inches of the crossing infrastructure, call District or 911.

C.1.5.6 Floodplain Management

Future needs identified by District staff include:

- Continue special studies where needed
- Old mapping is inaccurate 50 yr. or none mapped
- Cumulative improvements impacts on residential roads in older subdivisions built to old standards
- Lack of HOA maintenance
- Large lot splits where allowed
- Debris flows

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Bellbrook channel repairs (CF)

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify and map canyon wash floodways
- Identify debris flows

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 1.2.i Develop criteria for site design and infrastructure at major watercourse confluence areas

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

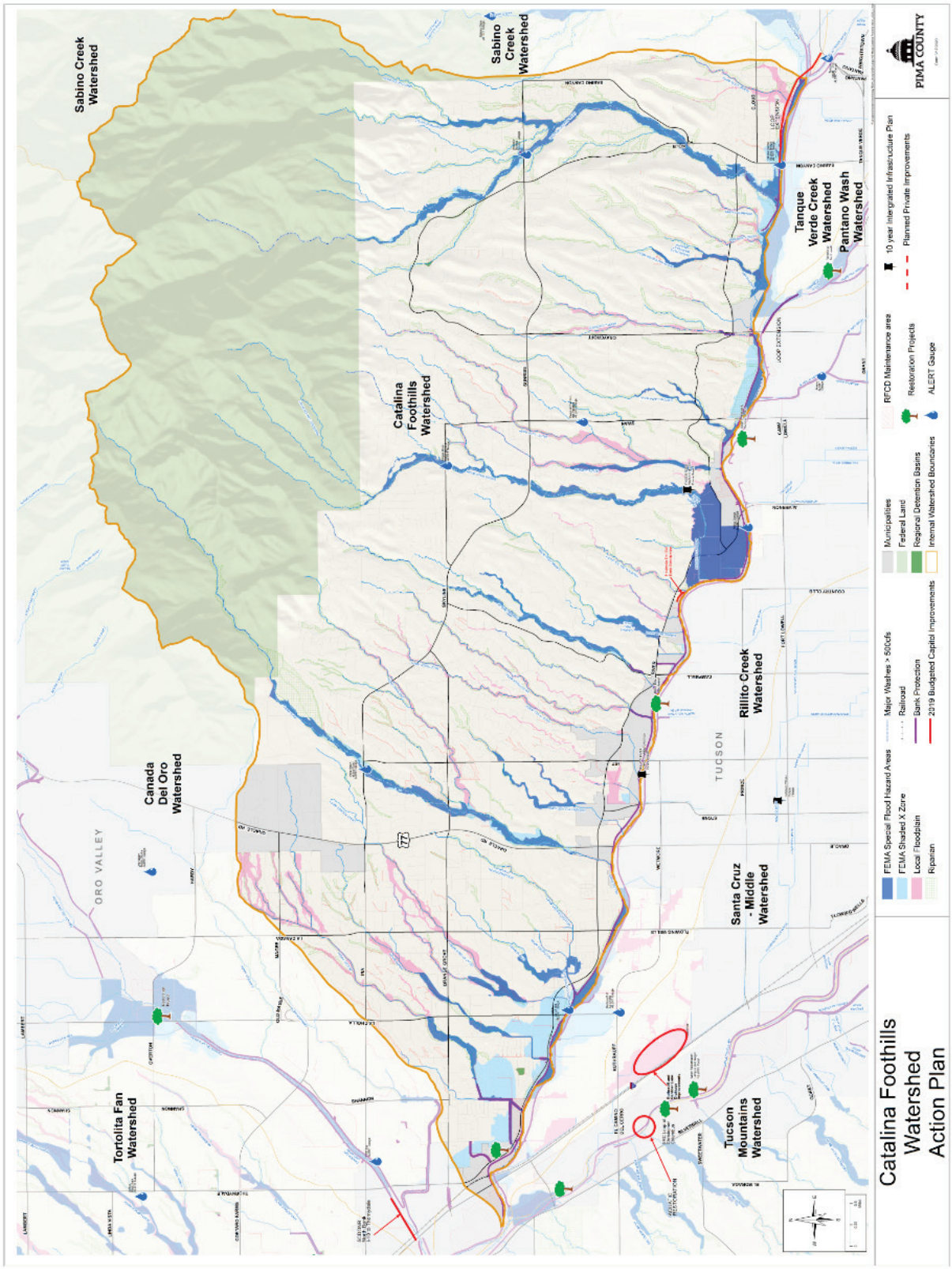


Figure 83 - Catalina Foothills Action Plan Map

C.1.6 Cienega Creek

For the purposes of this study, this watershed consists of the upper portions of the Rillito Creek HUC 08. It originates in the Canelo Hills south of the community of Sonoita in Santa Cruz County. Tributaries draining the eastern slopes of the Santa Rita Mountains and the western slopes of the Whetstone Mountains join it. Running along the east side of State Route 83 it passes under Interstate 10 and joins the Pantano at Agua Verde Creek in the community of Vail. Within unincorporated Pima County, it is comprised of 207,441 acres (324.1 square miles).

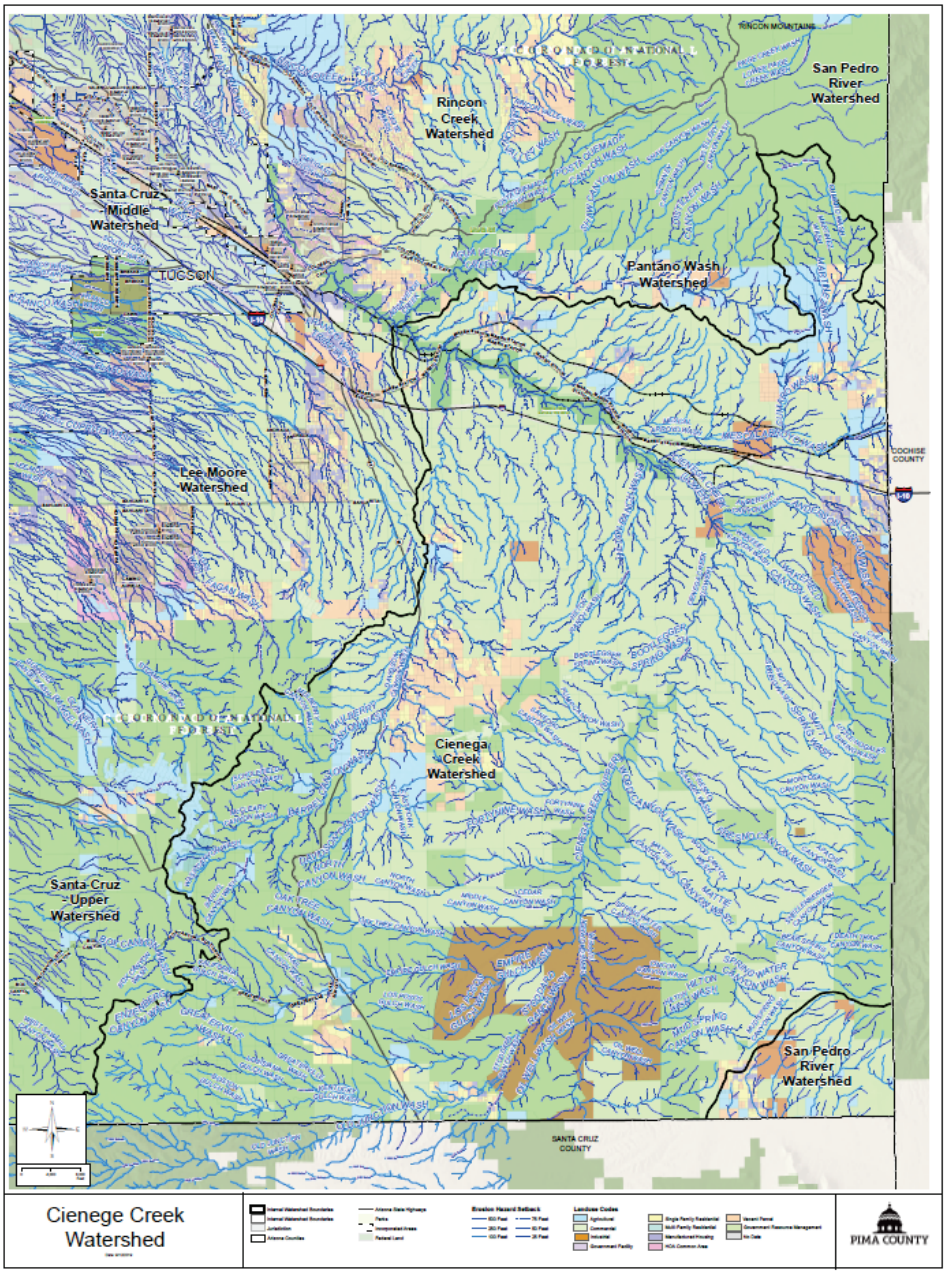


Figure 84 - Cienega Creek Watershed Map

C.1.6.1 Flood Characteristics

In addition to 7,299 acres of SFHA Zone A, there are also 511 acres of District Special Studies Floodplains in this watershed. Together that is four percent of the watershed.

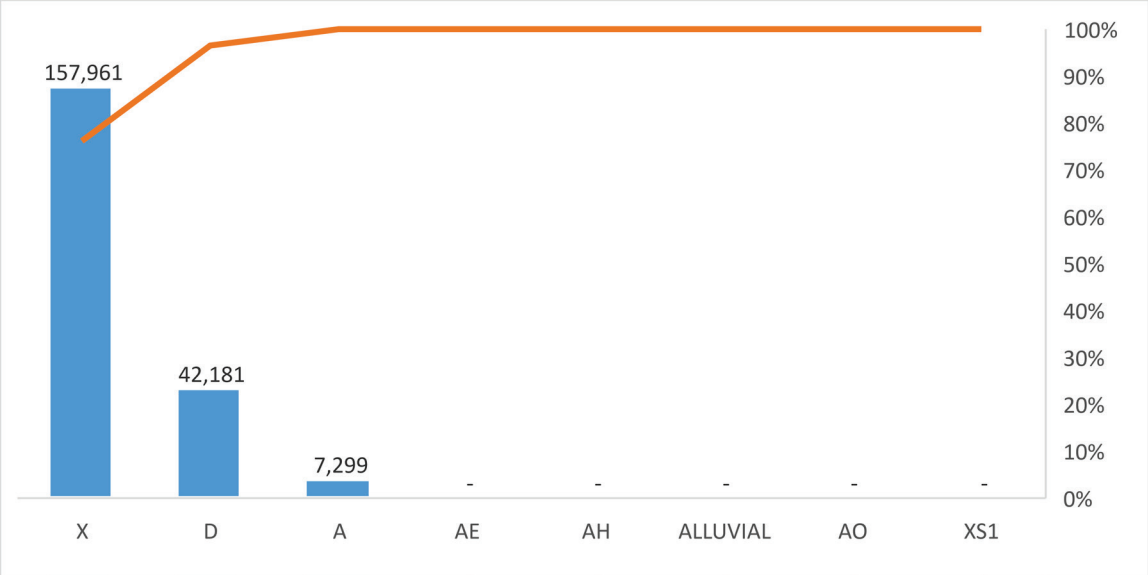


Figure 85 - Cienega Creek Watershed Federal Floodplain Designations

The majority of the watershed is undeveloped; however, the Community of Vail has, and continues to experienced high growth. There is over 6000 ft. of overall elevation change in the watershed and watercourses are predominately natural. The watershed contains the 4,000-acre Cienega Creek Natural Preserve. The creek's flow is perennial through roughly half of the preserve. The watershed lies within flood control jurisdiction of Pima County and Santa Cruz County. Storms that would trigger flooding in the watershed include intense localized summer storms and long duration winter storms. Many unmapped tributaries to Cienega Creek have steep adjacent slopes with multiple flow paths. These may be subject to flash flooding and changes in flow direction including Davidson Canyon, and Mescal Arroyo Wash.

The watercourses in the watershed with 1% annual peak discharges in excess of 10,000 cfs are Cienega Creek, Davidson Canyon and Mescal Arroyo. The table below provides a summary of historic USGS gaging station records.

Table 21 - Cienega Creek Watershed USGS Gages

USGS Gaging Station	Cienega Creek near Pantano, AZ 09484560	Cienega Creek near Sonoita, AZ 09484550	Davidson Canyon near Vail, Ariz. 09484590	Barrel Canyon near Sonoita, AZ 09484580	Mescal Arroyo near Pantano, AZ 09484570
Period of Record	1958-08-11 to 1981-07-06	2002-08-05 to 2015-09-03	1968-07-26 to 1981-07-27	1962 to 1976 (peak only) and 2009-01-23 to present	1958-08-11 to 1981-07-06
Watershed Area (sq. m)	289	198	50.5	14.1	38.4
Flood Peak of Record (cfs)	20,000	4,720	6860	1900	27,000
Date	8-11-1958	07-28-2007	07-20-1970	08-1971	08-11-1958
FIS Discharge (cfs)	NA	NA	NA	NA	NA

The table below lists Pima County ALERT gages. The locations are from the District's ALERT map.

Table 22 - Cienega Creek Watershed ALERT Streamflow Gages

Pima County Alert Gage	Cienega Creek above I-10 ID: 4283
Location (Latitude, Longitude)	(31.9825,-110.5652)
Period of Record	1987-10-22
Watershed Area (sq. m)	288.62
Flood Peak of Record (cfs)	3190
Date	07-23-2017

Table 23 - Cienega Creek ALERT Precipitation Gages

Pima County Alert Gage	Cienega Creek above I-10 ID: 4280	Mescal-Cienega Basin ID: 4290	Empire Peak-Cienega Basin ID: 4320	Haystack Mountain-Cienega Basin ID: 4410
Location (Latitude, Longitude)	(31.9825,-110.5652)	(31.9838, -110.4761)	(31.8853,-110.6389)	(31.9056,-110.4522)
Period of Record	1987-10-01 to Present	1993-03-24 to Present	1987-06-26 to Present	1993-03-25 to Present

The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 24 - Cienega Creek Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Cienega Creek @Pantano Wash	18,000		From Previous Discharge Table
Davidson Canyon Wash @Vail	19,000		From Previous Discharge Table
Mescal Arroyo @Pantano Wash	12,000		From Previous Discharge Table

The historical flood data indicate that monsoon convective storms cause the biggest floods on this watershed.

The watershed includes the 4,000-acre Cienega Creek Natural Preserve. The Preserve, located along Cienega Creek, is under ownership of the Pima County Regional Flood Control District and preserves riparian habitat, reduces peak storm water flows and facilitates groundwater recharge.

FEMA has delineated Special Flood Hazard Areas for Rincon Creek (Zone A), portions of Davidson Canyon (Zone A), Mescal Arroyo Wash (Zone A) and its tributary, Cumaro Wash (Zone A).

C.1.6.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas.

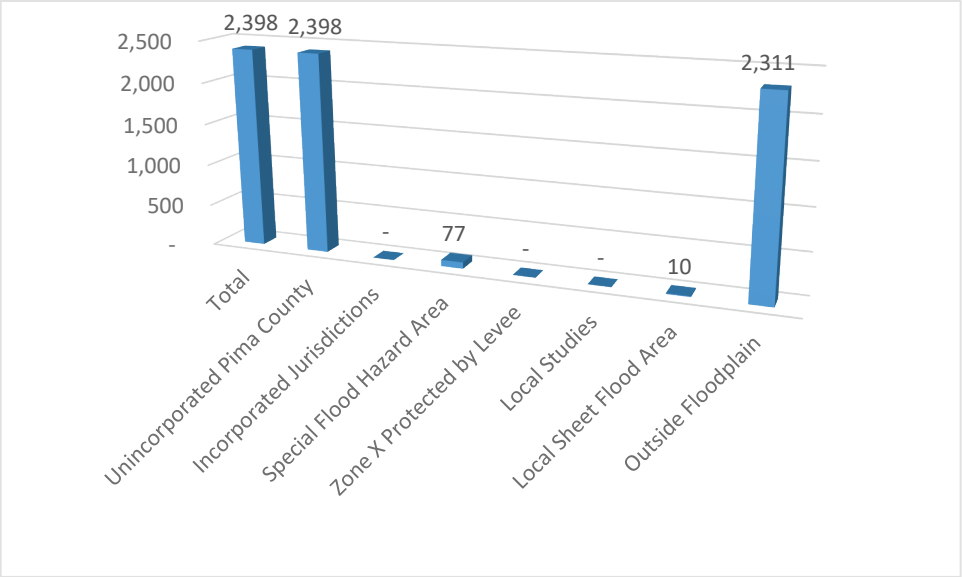


Figure 86 - Cienega Creek Watershed Population Distribution

As indicated on the figures below, while much land is vacant federal and state decisions will affect the attractive pressure on the small amount of available private land.

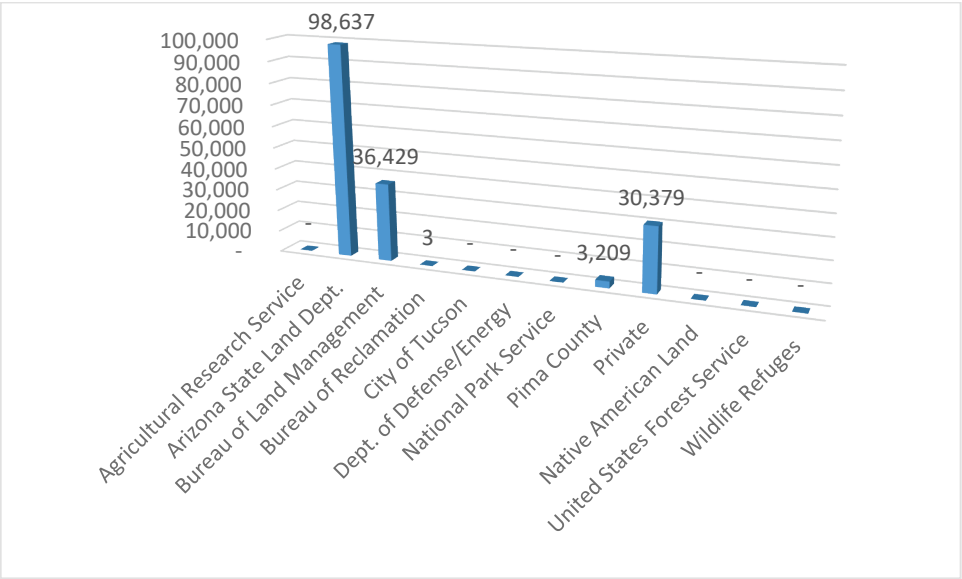


Figure 87 - Cienega Creek Watershed Ownership in Acres

All three classes of public land are largely vacant with the exception of ranching. Development for more intensive uses including open pit mining, waste disposal and residential development in the near future is possible.

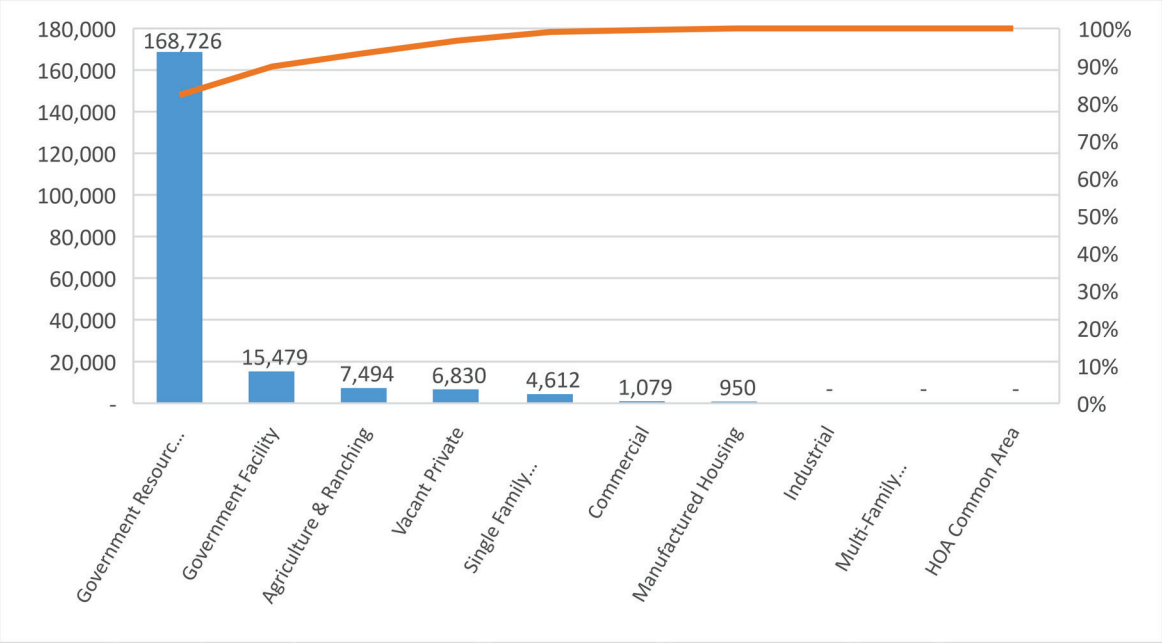


Figure 88 - Cienega Creek Watershed Land Use in Acres

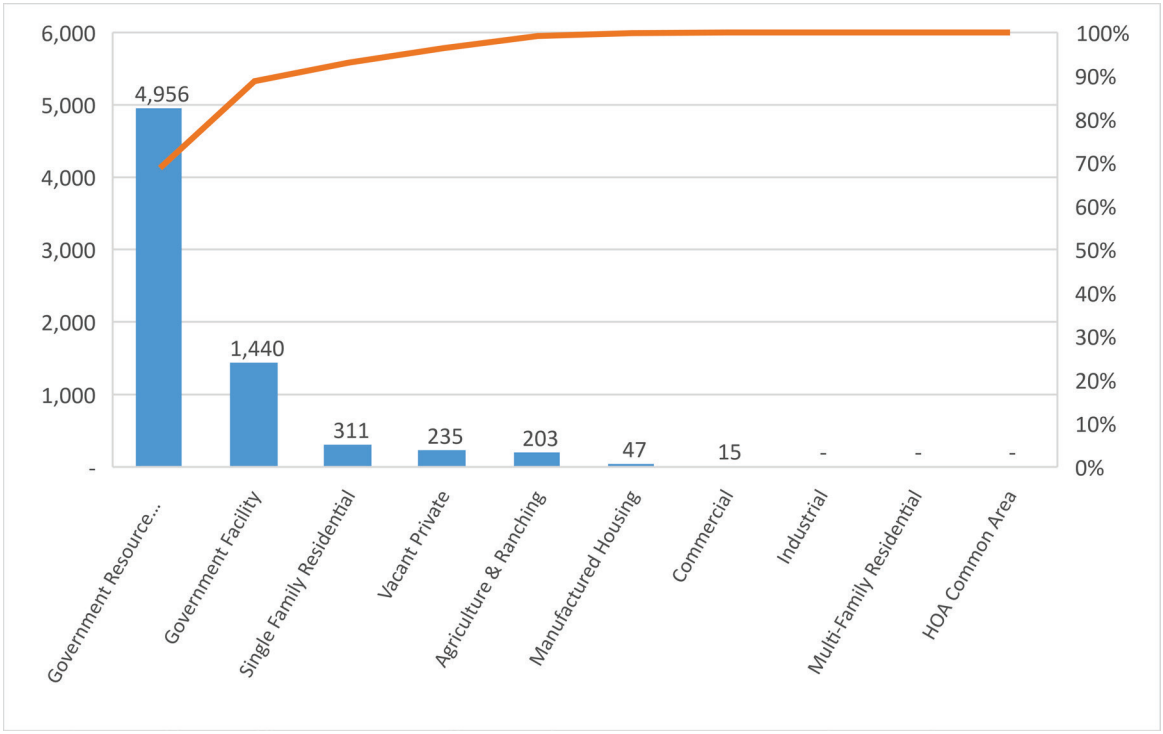


Figure 89 - Cienega Creek Floodplain Land Use

Clearly, land management decision of public entities are the driving force behind future growth and current conditions in this watershed. The map below shows the distribution of these land uses.

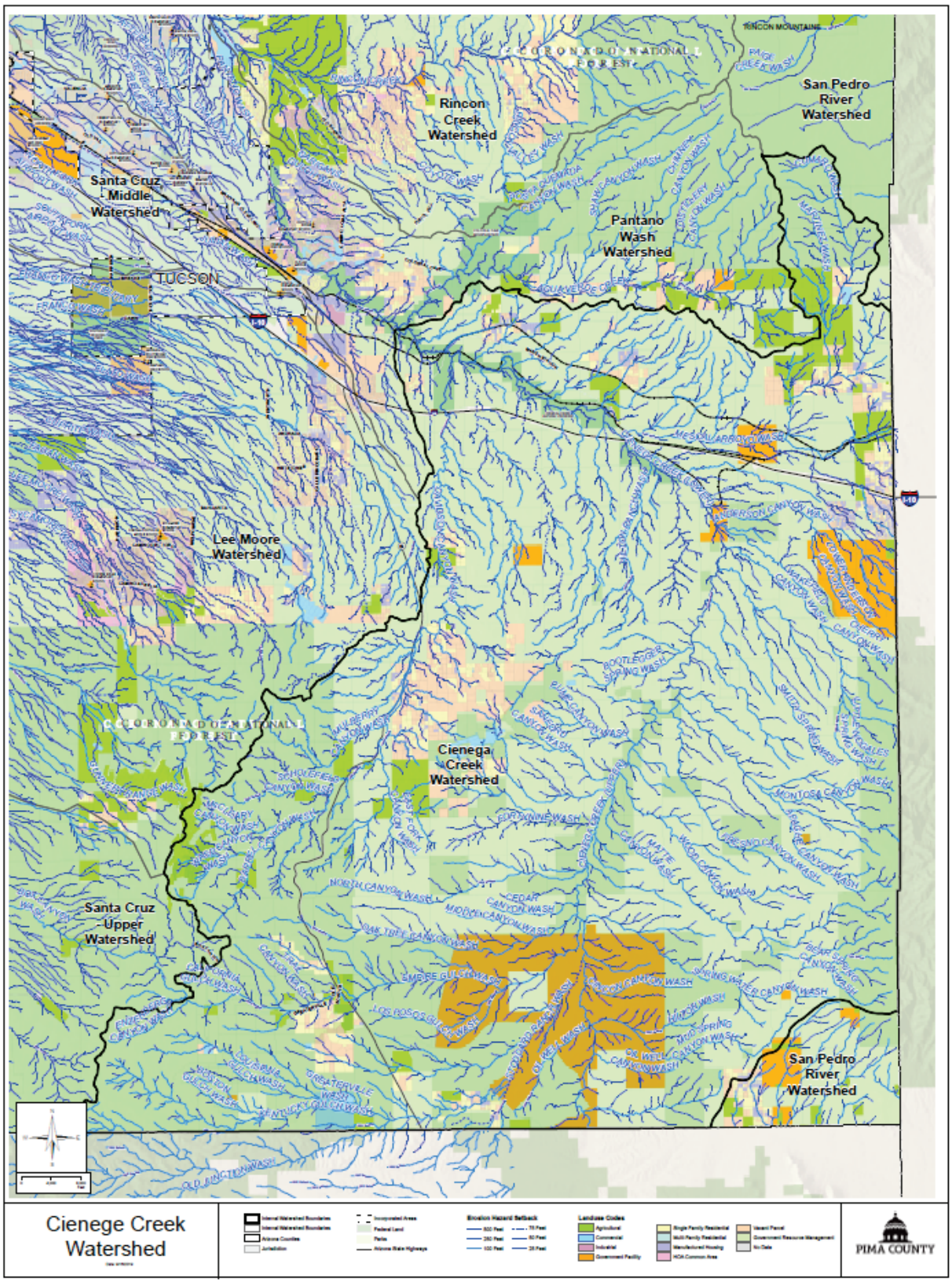


Figure 90 - Cienega Creek Land Use Map

C.1.6.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 12,810 acres of Pima County Regulated Riparian Habitat in this watershed, additionally 18,748 acres have been designated IRA. There are also 92,501 preserved acres in this watershed, including 4,286 in regulatory floodplain. This reflects the importance of the area as a high altitude land bridge across the desert between the Sierra Madre and Rocky Mountains, which increases water and habitat availability dramatically.

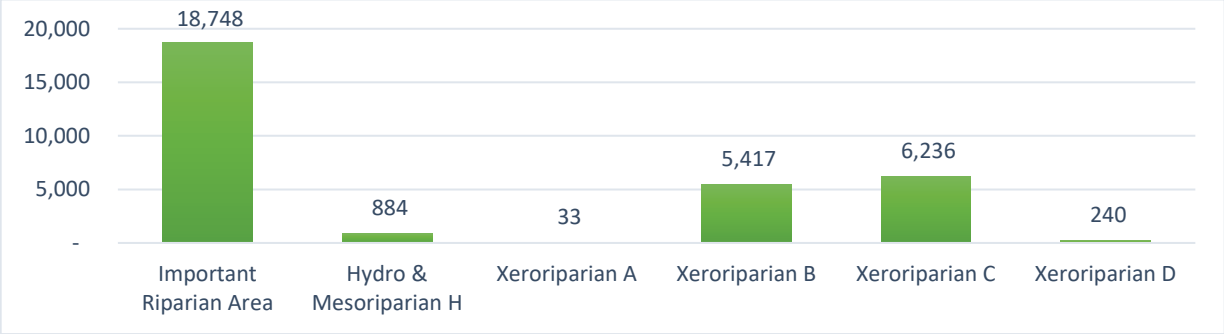
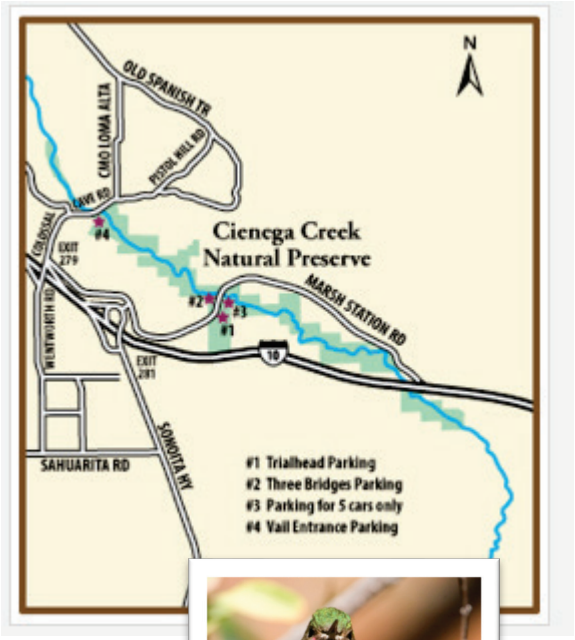


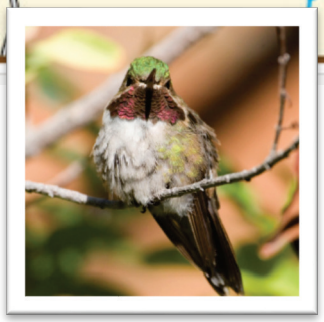
Figure 91 - Cienega Creek Watershed Riparian Habitat in Acres

The District purchased Cienega Creek Natural Preserve, encompassing approximately 4,000 acres in eastern Pima County, in 1986 to protect this reach of Cienega Creek, one of the few low-elevation perennial streams in Pima County. Stream flows and shallow groundwater along the creek, covering approximately 12 miles, help support rare and endangered fish and frogs as well as dense areas of riparian vegetation that provides shelter and forage to a wide variety of native wildlife. This area is also important to human populations due to its scenic, cultural and recreational values and is included in the Pima County Parks system, administered by Pima County Natural Resources, Parks and Recreation Department. The State recognizes both Cienega Creek and Davidson Canyon, a large tributary. Further, lands within the preserve are designated mitigation lands for the County's Multi-species Conservation Plan, thus affording the area an extra level of protection. The District has conducted an extensive monitoring program over the last 25 years that includes measurement of stream flows and groundwater levels, precipitation records and water quality analyses to help insure conservation of this valuable resource.

The area continues to support healthy cottonwood and willow (hydro-riparian) habitat, but there are large stands of mesquite trees (meso-riparian) that are dead or dying due to channel downcutting and diminishing water resources. Monitoring staff considers drought the largest stressor. Although there is little to no control over the supply of water to the system, management is investigating activities that can help mitigate the effects of drought. Mining and cattle grazing in the surrounding areas are other major stressors that the District and County have diligently worked to halt or at least reduce the effects on water resources and riparian habitats. More immediate stressors to the system are the invasion of non-native species, both vegetation (buffelgrass) and wildlife (bullfrogs), and destructive recreational practices such as off-road vehicle traffic. These can be more directly controlled through District management activities, but represent a constant threat due to increasing populations in the Vail and J-Six Ranch communities and the lack of invasive species control in the lands surrounding the preserve.

Pima County founded the Cienega Creek Natural Preserve in 1986. The District is responsible for land management practices in the Preserve, which encompasses 4,000 acres and protects 12 miles of the creek, about half of which flows perennially. The Preserve, abundant in flora and fauna, is one of the few relatively intact riparian corridors in Arizona. The Preserve the site of habitat, wildlife and shallow groundwater research. The Pima County Natural Resources and Parks Department interfaces with the public to permit recreational activities. The Preserve is a noted location for birding. The Preserve is a model for riparian habitat restoration and beneficial floodplain function. Prohibiting invasive practices, such as cattle grazing and off-road vehicular use, led to rapid habitat recovery, which supports abundant wildlife and shallow groundwater health.





C.1.6.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

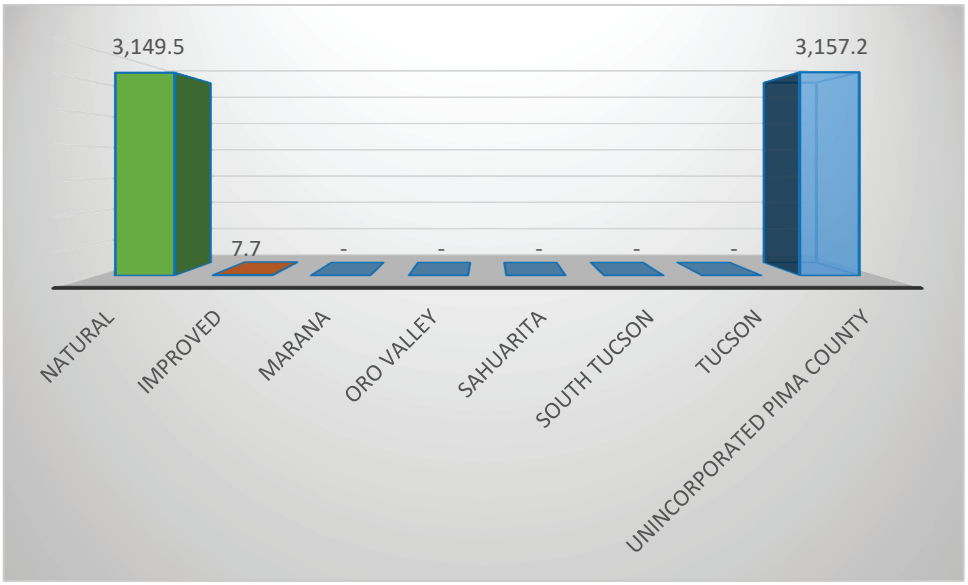


Figure 92 - Cienega Creek Drainageway Acreage

In this watershed, there are 3,149 acres of improved drainageways and 1,096 acres that are designated open space. There is also 91,464 acres of preserved open space that together with drainageways makes up 46% of the watershed.

The main approach to floodplain management in this watershed is preservation of natural corridors. Residential density is low; however, homeowners have selected sites near main flow paths, and the District has required Floodplain Use Permits for a significant number of homes. This pattern is may reflect the attractive ness of these areas. Master-planned development is absent; therefore, little drainage infrastructure for conveying flood flows exists. Primarily the communities in this watershed rely on conveyance of flow in natural flow paths, and there have been relatively few formal reports of flooding or adverse neighbor impacts.

C.1.6.5 Needs

The District monitors six stream gages in this watershed, which remains predominantly natural. Capital improvement for flood control is a low priority for District funding. The 2019 *Flood Response Field Manual* identifies no specific items of concern in this watershed.

C.1.6.6 Floodplain Management

Future needs identified by District staff include:

- Riparian Habitat Preservation
- Cultural Preservation
- Updated floodplain analyses

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Create open space management plans

Ref# 1.2.e Participate in monitoring groundwater change with other responsible parties

- Conduct groundwater depth & quality monitoring

Ref# 3.1.b Use open space management plans for monitoring, maintaining and protecting the Drainage System and Preserves in collaboration with partners

- Monitor base flows

Ref# 3.2.b Refine, expand and implement District natural resource management plans including the Multi-Species Conservation Plan

- Complete Cienega Corridor Management Plan (CC)

Ref# 5.2.e Develop alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

- Develop and implement an erosion mitigation plan using natural channel design techniques

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

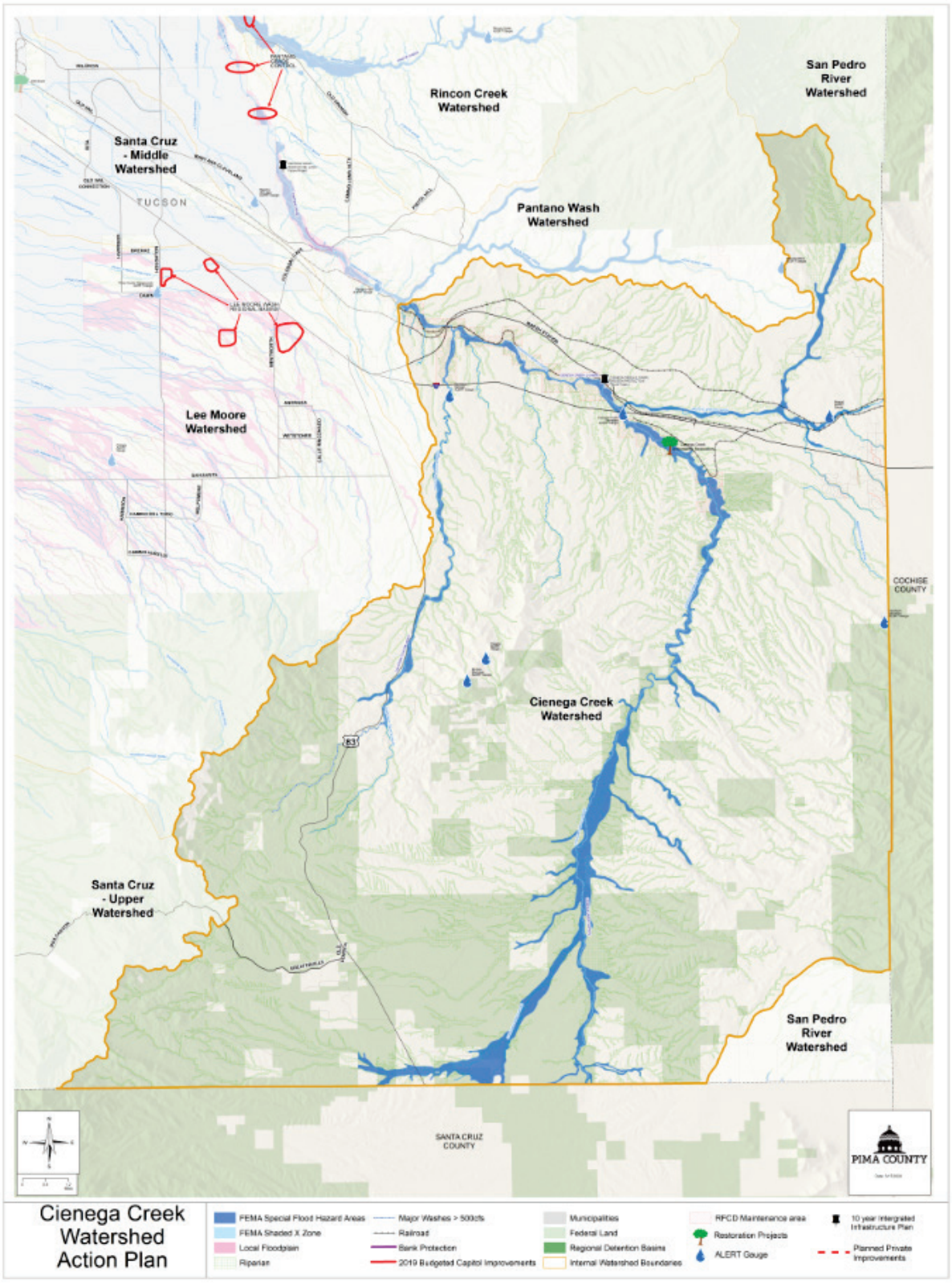


Figure 93 - Cienega Creek Action Plan Map

C.1.7 Lee Moore Wash

This watershed extends from the Santa Rita Mountain ridge in the southeast across the Santa Cruz River basin to the Sierrita Mountains in the southwest. Its northern terminus is south of Martinez Hill and Black Mountain and the northern boundary of the San Xavier District of the Tohono O'odham Nation. It is comprised of 125,939 acres (196.8 square miles), of which 24,777 (38.7 square miles) are in the City of Tucson.

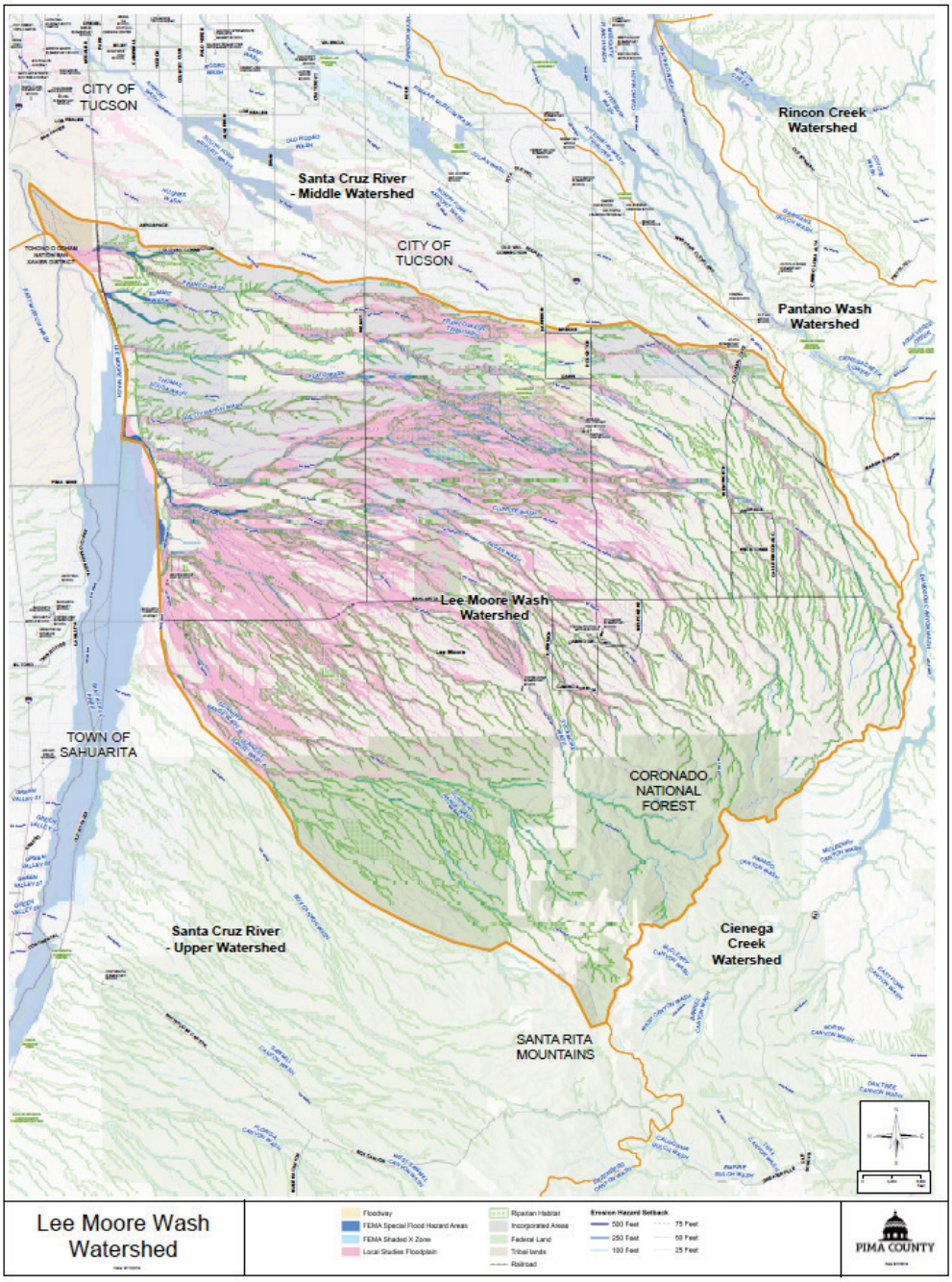


Figure 94 - Lee Moore Wash Watershed

C.1.7.1 Flood Characteristics

In addition to mountain front drainage across large alluvial fans, the Santa Cruz River enters from the south across Santa Cruz County and the international border to Mexico. Of geographic and political interest is the fact that its headwaters are also within the United States. Locally alluvial fans with distributary and sheet flood characteristics are a significant concern as indicated by the spider web of pink in the Lee Moore Watershed on the map above and the Sahuarita Farms Specific Plan map below.

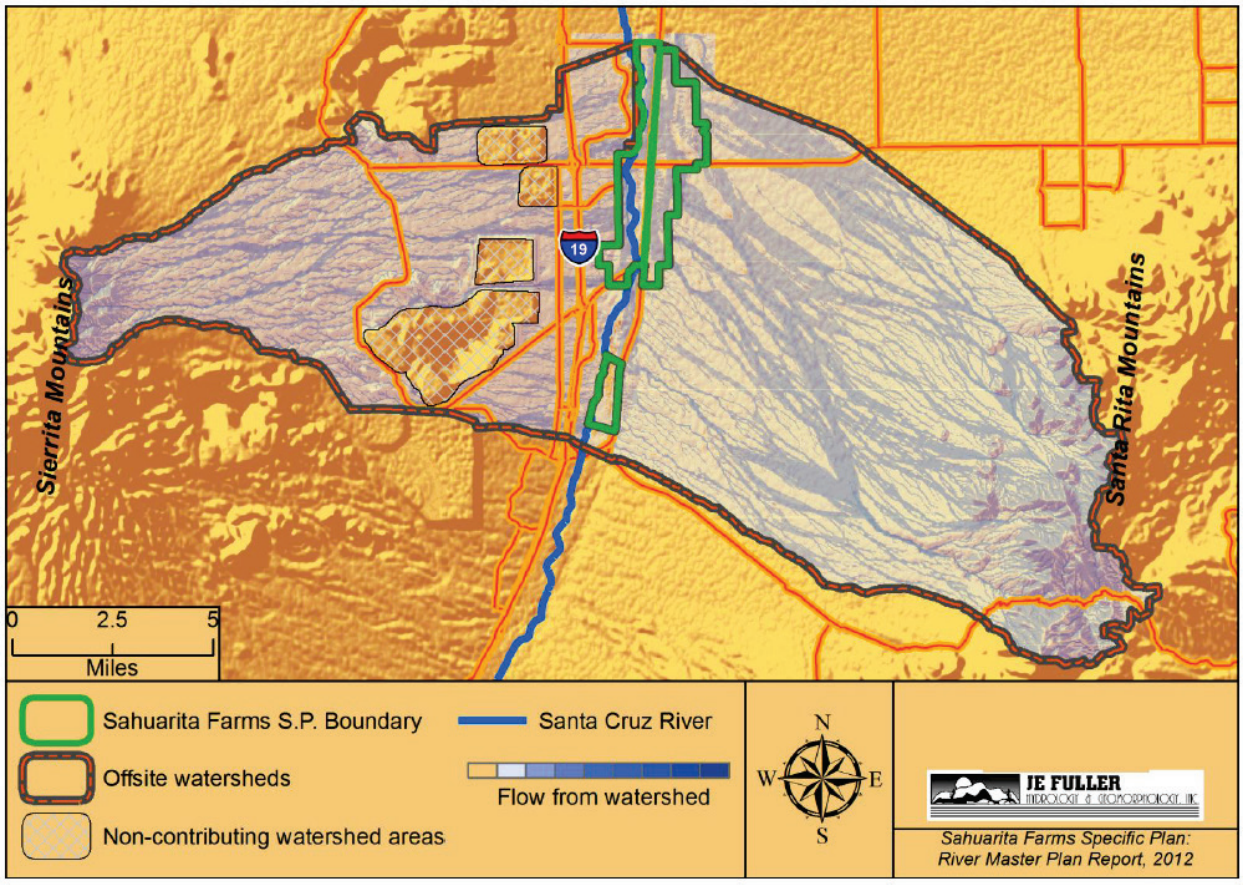


Figure 95 - Sahuarita Farms Watershed Map

In total, including incorporated areas and federal lands there are 36,561 acres of locally regulated floodplains and 349 acres of FEMA SFHA.

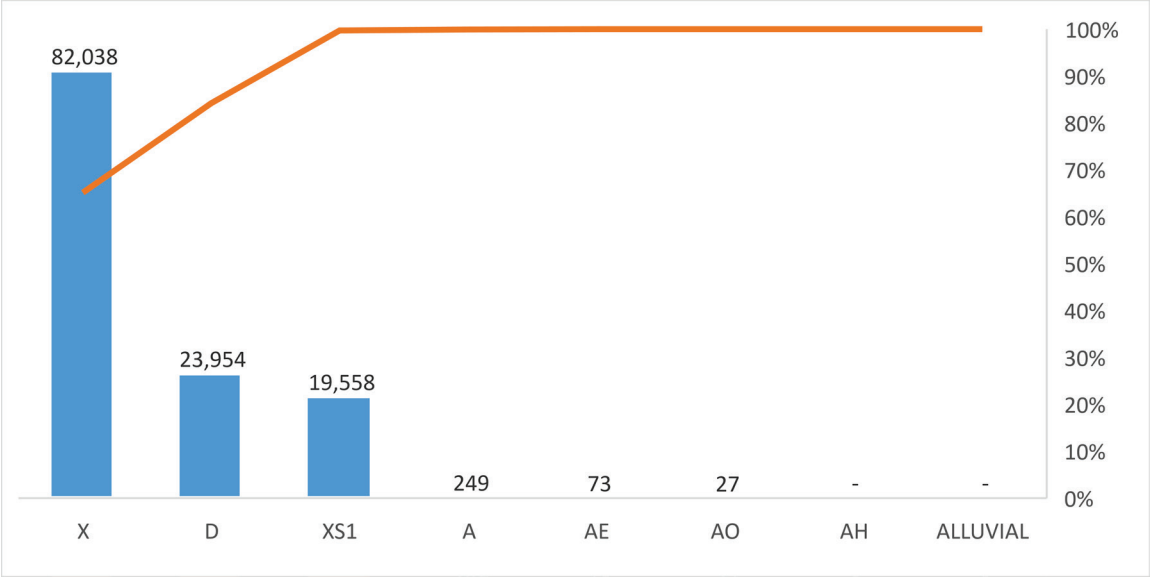


Figure 96 - Lee Moore Wash Federal Floodplain Designations in Acres

In addition to the SFHA zones, the large area of Special Studies Floodplains in this watershed due to the presence of large alluvial fans, a locally recognized hazard. In sum both unconstrained riverine flooding, cross drainage, and alluvial fans are all significant concerns. Because of the high number of road crossings in distributary flow areas without all-weather access, flash flooding is a concern in this area.

Upper Santa Cruz River Flooding

The table below provides a summary of historic USGS gaging station records.

Table 25 - Lee Moore Wash Watershed USGS Gages

USGS Gaging Station	Flato Wash near Sahuarita, AZ 09482200
Period of Record	1965-07-10 to 1981-08-13
Watershed Area (sq. m)	30.10
Flood Peak of Record (cfs)	4500
Date	00-00-1955

The table below summarizes Pima County's Alert Gages. The locations are from the District's Alert map.

Table 26 - Lee Moore Wash Watershed ALERT Streamflow Gages

Pima County ALERT Gages	Santa Cruz River below Continental Road ID: 6054	Santa Cruz River at Continental Road ID: 6053	Arroyo Chico Wash at Cherry Avenue ID: 6183
Location (Latitude, Longitude)	(31.8567, -110.98)	(31.8542,-110.9792)	(32.2164, -110.9481)
Period of Record	2014-06-25 to Present	2007-07-10 to Present	2007-07-10 to Present
Watershed Area (sq. m)	1643.87		
Flood Peak of Record (cfs)	7250	4200	1664
Date	09-18-2014	09-19-2014	07-31-2007

Table 27 - Lee Moore Wash Watershed ALERT Precipitation Gages

Pima County ALERT Gages	Wilmot Road South of I-10 - Franco Wash Basin ID: 6280	Corona de Tucson - Lee Moore Basin ID: 6290	Santa Cruz River below Continental Road ID: 6051	Santa Cruz River at Continental Road ID: 6050	Florida Canyon Santa Cruz Basin ID: 6390	Anamax Mine near Green Valley – Santa Cruz Basin ID: 6330	Santa Cruz River at Elephant Head Road ID: 6060
Location (Latitude, Longitude)	(32.045, -110.8563)	(31.9706,-110.7964)	(31.8567,-110.98)	(31.8542,-110.9792)	(31.7617,-110.7461)	(31.8786,-111.0586)	(31.7447,-111.0372)
Period of Record	2001-10-18 to Present	1987-08-20 to Present	2014-06-25 to Present	1986-08-27 to Present	2003-02-27 to Present	1987-07-31 to Present	1987-07-21 to Present

These records indicate that large floods can occur from convective monsoon storms and tropical storms in the Lee Moore watershed.

C.1.7.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. After passing into Pima County from Santa Cruz County, the river passes through the Town of Sahuarita, Sahuarita Farms (Farmers Investment Company/Green Valley Pecan Company, and the San Xavier District of the Tohono O'odham Nation.

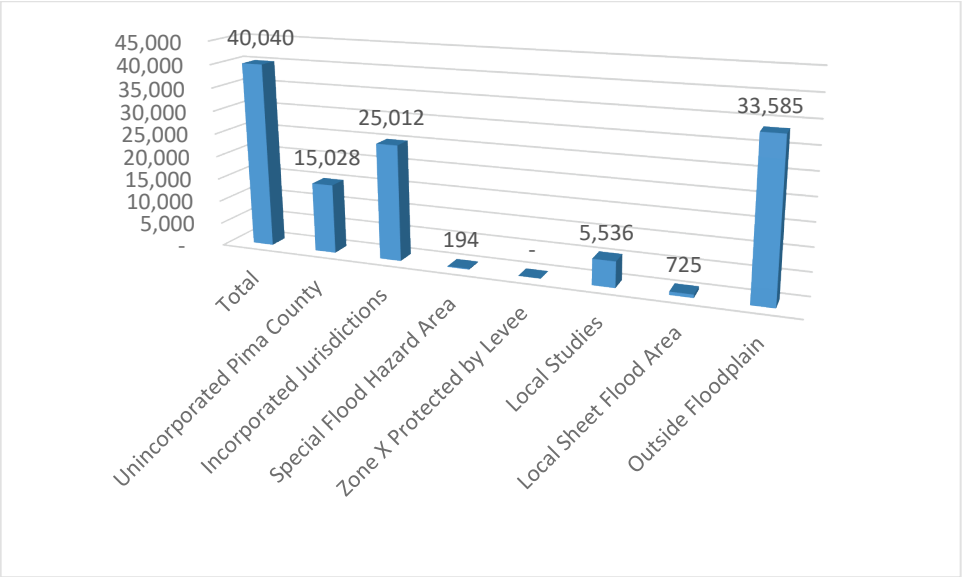


Figure 97 - Lee Moore Wash Watershed

Ownership and Land Use: East of the River the uplands including mountain escarpment and alluvial fan are largely protected natural open spaces due to inclusion within National Forest and the University of Arizona Experimental Range. While the County has purchased the historic Canoa Ranch at the upstream area of this watershed along the Pima and Santa Cruz County border most of the land along the main channel remains in private hands within Green Valley and the Town of Sahuarita.

Green Valley is not an incorporated town, but the community has a local identity for residents and the Green Valley Council keeps a keen eye on local development. The Council works regularly with Pima County staff to request construction and maintenance of drainage infrastructure. A network of constructed drainageways conveys flows from the Sieritta Mountains and mine tailings piles through Green Valley to the Santa Cruz River floodplain.

Within the formally incorporated Town of Sahuarita, the Town has floodplain management jurisdiction. The Pima County Regional Flood Control District cooperates with incorporated jurisdictions to deliver floodplain mapping and capital improvement projects following guidance from the Flood Control District Advisory Committee. The Town has also adopted the floodplain maps identified in the Lee Moore Wash Basin Management Plan.

Along the river and only partly within unincorporated County, but mostly within the Town of Sahuarita are the Farmers Investment Company (FICO) pecan orchards. At over 7000 acres, these are amongst the largest in the world. In 2015, both jurisdictions approved a long-term mixed-use residential and commercial development specific plan for the FICO property, the Sahuarita Farms Specific Plan. Under this plan, channelization will narrow much of the floodplain to facilitate the conversion from agriculture to urban use. The plan is a broad-ranging planning document including a river master plan as well as land use planning, community facilities, transportation

and utilities. The plan will guide decision-making over the next 50 years. Current demand has not motivated major implementation of plan elements yet.

Similarly, the Lee Moore Wash Basin Management Plan, although focused on floodplain planning only, is a long-term planning document to present potential impacts to existing conditions flood patterns by future development. By identifying flooding risks, appropriate flow corridors and open space, and potential drainage infrastructure, planning studies like the Lee Moore Basin Management Plan and Sahuarita Farms River Management Plan can lead to regional rather than piecemeal solutions.

The Lee Moore wash watershed lies east of the river and exhibits distributary, sometimes-unpredictable flow paths. Many residences, including a large number of manufactured homes, exist outside of platted subdivision. The District can better inform floodplain management with the information from the Lee Moore Wash Basin Management Study; however, because the study is a broad planning study, mapping is approximate. Permitting of subdivisions and commercial developments requires more detailed mapping.

Most of these uplands are private or State lands. As shown on the figure below there are 33,393 acres of private land and 64,121 acres of State Trust lands, which results in 77% of the watershed being available for long-term development.

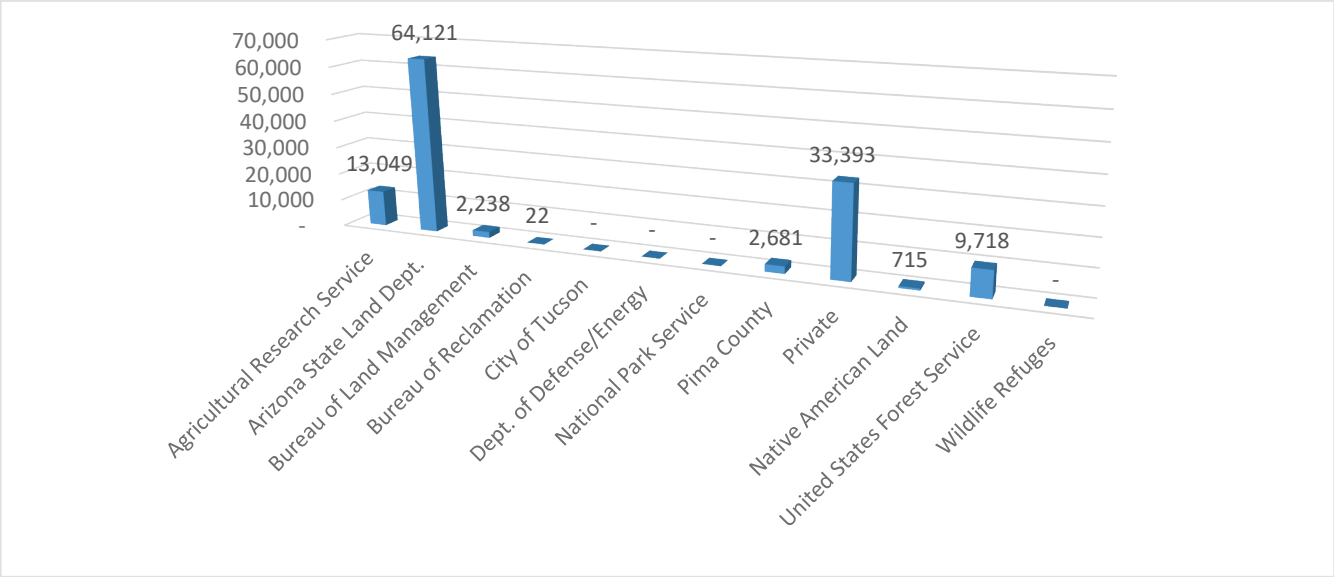


Figure 98 - Lee Moore Wash Watershed Ownership in Acres

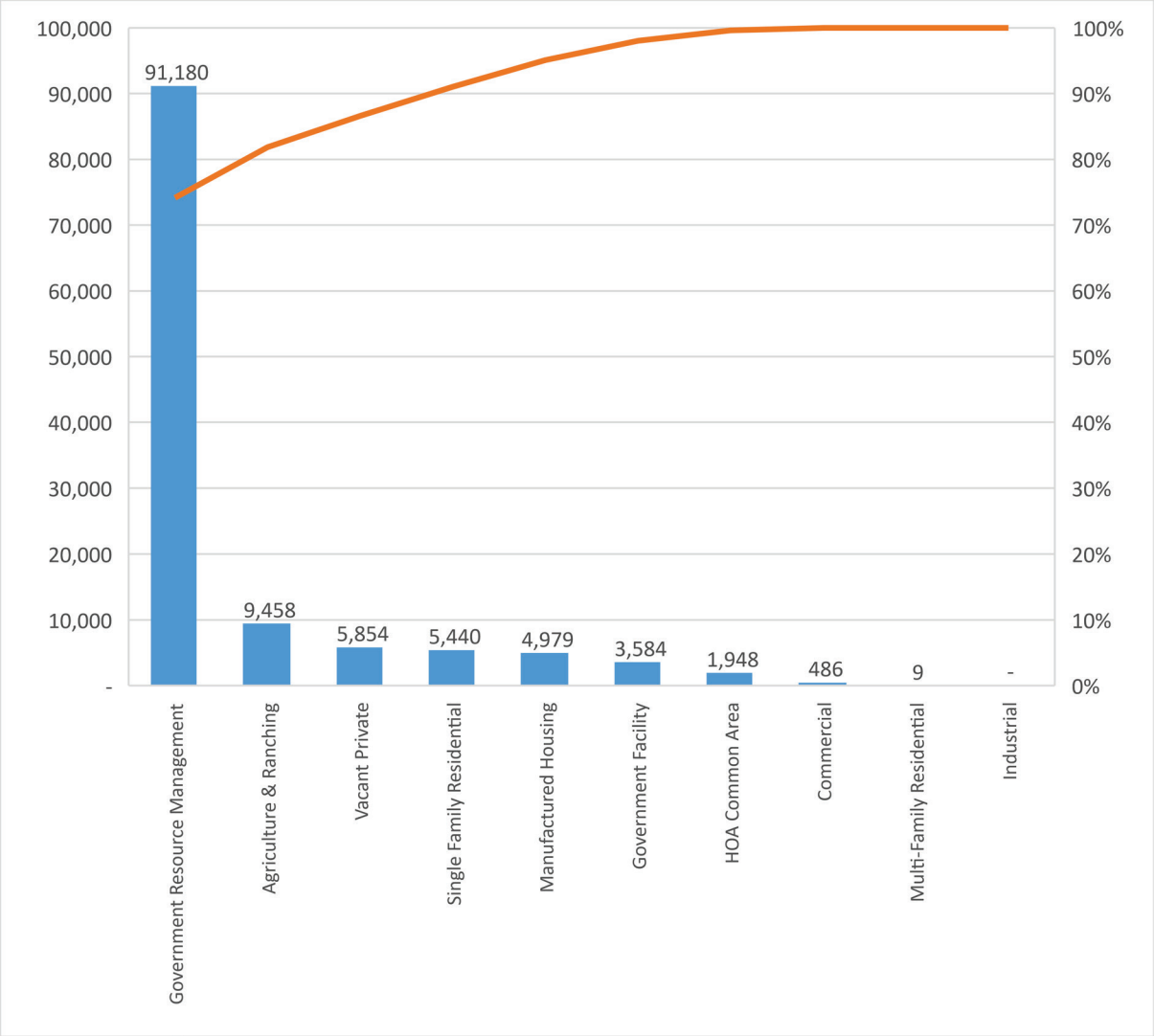


Figure 99 - Lee Moore Wash Watershed Land Use in Acres

Market factors have stalled several substantial developments in these areas. While large areas are vacant, current land uses are predominately recreational, residential, some ranching and large mining operations.

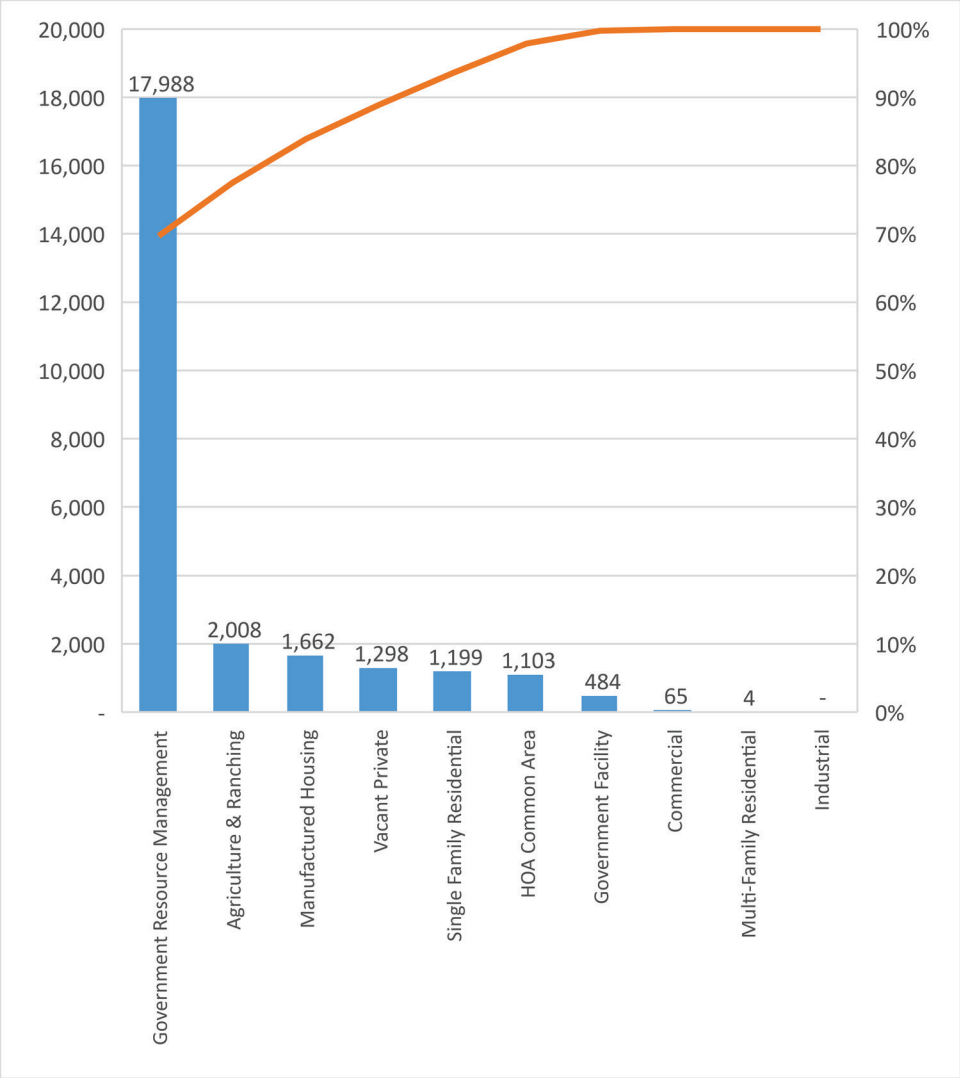
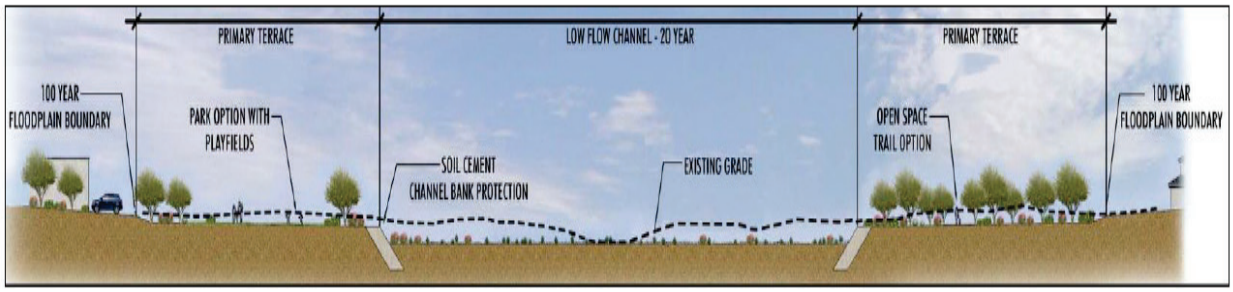


Figure 100 - Lee Moore Wash Floodplain Land Use

Within the floodplain current land use is predominately agricultural however, as noted above Pima County and the Town of Sahuarita accepted FICO's Sahuarita Farms Specific Plan. This plan includes a Management Plan. This plan features riparian restoration and recreational features in low flow overbanks and a bank protected main channel. The owners expect this development to use less groundwater than the agricultural operations.



The portion of the River extending from the Santa Cruz County line to Pima Mine Road is the least impacted by channel drainage infrastructure. In general, the floodplain is a half-mile or more wide and encroachment is minimal. South of Green Valley there is very little development along the channel or in the tributaries. From Green Valley north through Sahuarita, there is development along the west bank, but minimal bank protection. Along the east bank, there are pecan fields and some residential development. Recent hydraulic analysis has indicated that flow along the eastern edge of the floodplain through the pecan fields may be a prominent secondary flow path in a significant flood.

Within the San Xavier Reservation, the reach downstream of Martinez Hill and Interstate 19 is partially bank protected, although not by soil cement, as this was not a County project. South of I19 the channel is natural however has experienced head cutting and other erosive forces. The O'odham have begun a restoration project for the now absent massive bosques that existed prior to arrival of European enterprise. Plans are also in place for expansion of the traditional farming operation including recharge and irrigation using their water allocation.

The map below shows these land use patterns.

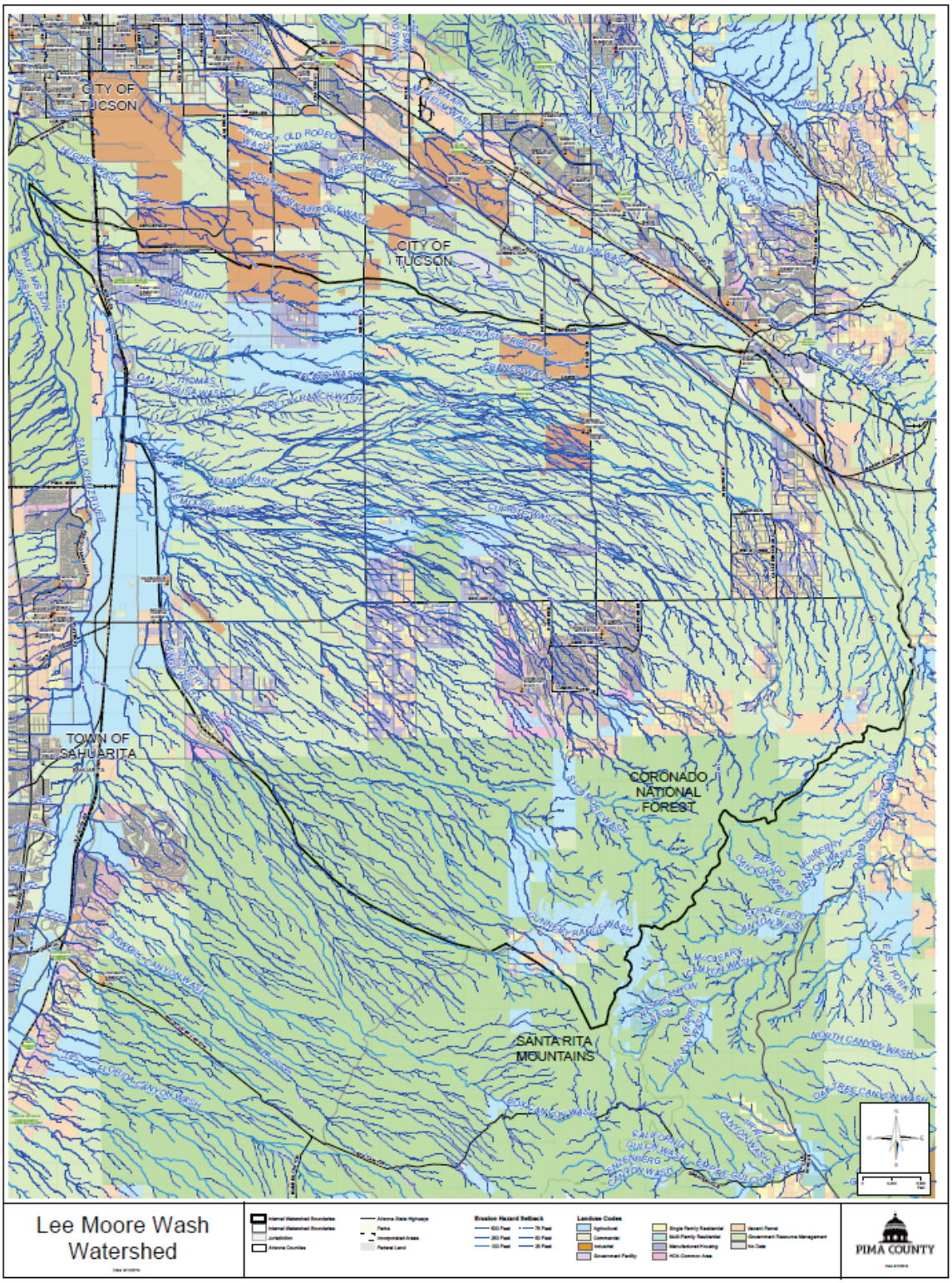


Figure 101 - Lee Moore Wash Watershed Land Use Map

C.1.7.3 Riparian Habitat and Natural Areas

There is 12,820 acres of Pima County Regulated Riparian Habitat within this watershed, along with 5,795 acres designated as IRA. There are also 23,109 preserved acres in this watershed, including 841 in regulatory floodplain. It also includes the County owned Raul M. Grijalva Canoa Ranch Conservation Park situated along both sides of the Santa Cruz River for almost 5 miles. As shown above the southeastern uplands are within the Santa Rita Experimental Range and the Coronado National Forest.

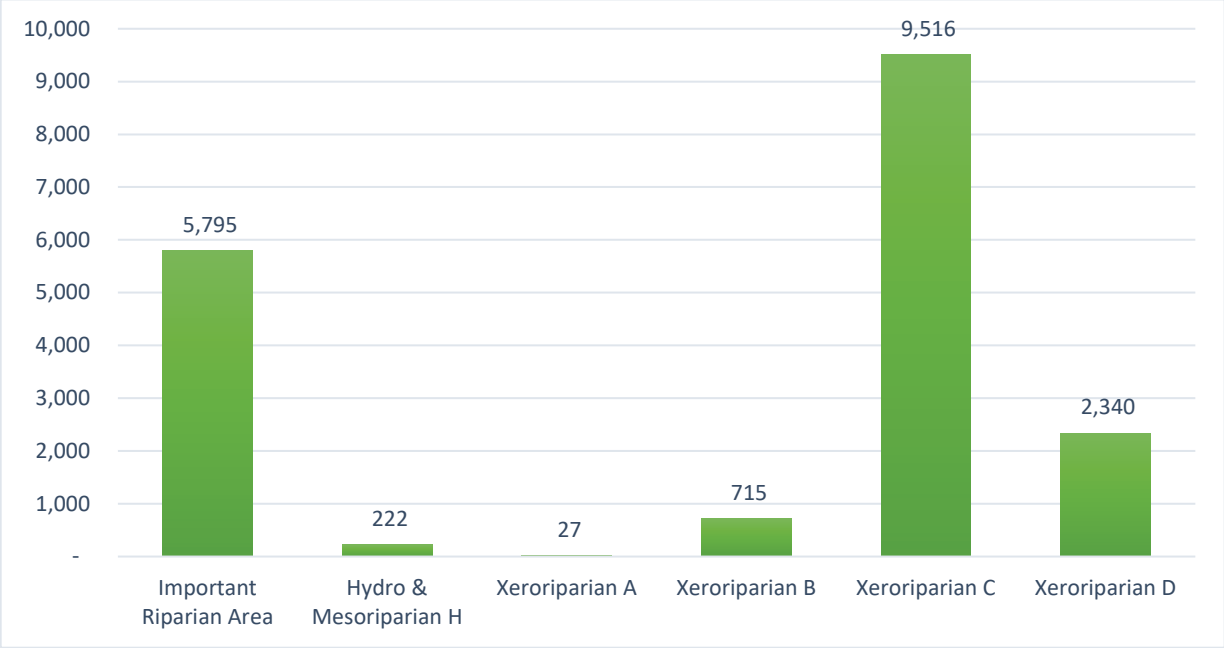


Figure 102 - Lee Moore Wash Watershed Riparian Habitat in Acres

C.1.7.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

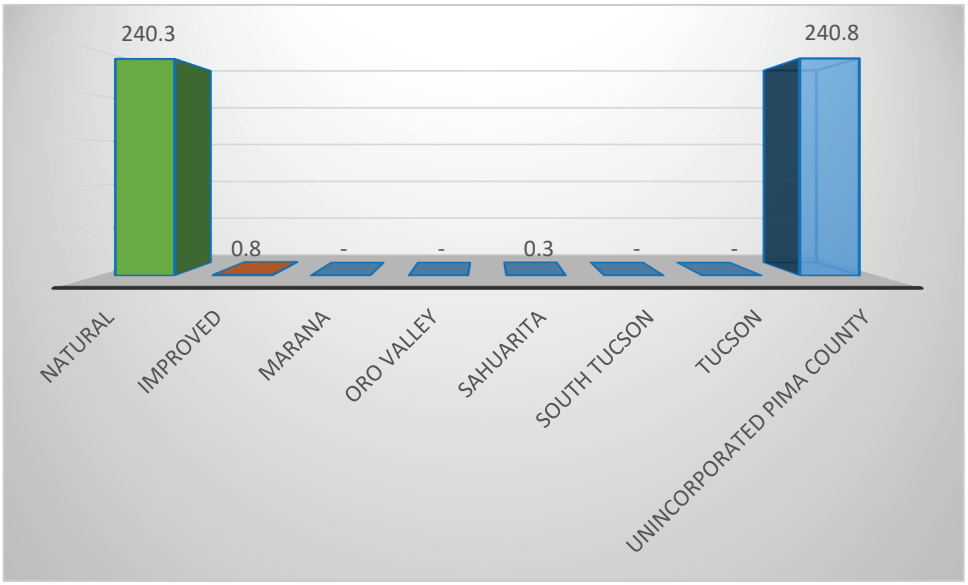


Figure 103 - Lee Moore Wash Drainageway Acreage

Franco Wash is a significant tributary, which may affect the Summit area near South Nogales Highway and Old Vail Connection road. There is one stream gauge at Swan Road (6213). The channels in this area cannot convey large amounts of flow and may affect residential structures and at-grade crossings in the Summit area. Stream gauges may not reflect sheet flow. The District has not studied travel time. However, assuming an average channel velocity of 10 fps, travel time from 6213 to Country Club Road is 20 minutes. Streamflow of 200 cfs at Franco Wash at Swan Road (6213) may affect at-grade crossings including Country Club Road, Summit Street and Old Vail Connection Road. At this rate, ALERT staff notifies PCDOT. Streamflow of 500 cfs at Franco Wash at Swan Road (6213) may affect the Summit residential area. During flood events, senior staff makes the decision as to whether District should pass the information to OEM.

C.1.7.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- S. Country Club Rd. and properties to the south and west are in the primary flood corridor of Franco Wash and subject to potentially serious flood and erosion hazards. The National Guard allegedly evacuated this property owner from the property during the 2005 flood event.
- Wooden Bucket St. was flooded during the 2005 event of Franco Wash, while under construction.
- The J D Ranch subdivision is adversely impacted by non-regulatory flows.

Infrastructure

- There is a risk of undermining and damage to the Tucson Water line and telecommunication cables downstream of the culvert. Tucson Water is aware of the problem.

C.1.7.6 Floodplain Management

Future needs identified by District staff include:

- Non permitted structures
- Gravel pits
- Head cut Lee Moore and tributaries
- Potential future development/Sonoran corridor
- Updated mapping
- Management Plan for Santa Cruz County Line to Pima Mine Road

Head Cut West of Old Nogales Highway near Placita Del Caballito

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify agriculture diversions
- Identify and monitor erosion on tributaries to the Santa Cruz River

- Work to address issue of sediment placement during road maintenance activities

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Conduct a detailed floodplain analysis of Pima County Fair Grounds

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Work with responsible parties to address flooded roads (CDO, LMW, Pantano, Rillito, Sabino, TVC, TF, TM)

Ref# 5.1.b Complete new river and basin studies to identify needs and develop alternatives

- Coordinate with the Town of Marana on implementation of their Marana Drainage Master Plan (SCRL)
- Create Basin Management Plans (BW, AV, SCRU)
- Develop Santa Cruz River Management Plan (SCRL, SCRM, SCRU)

Ref# 5.2.e Develop alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

- Develop and implement an erosion mitigation plan using natural channel design techniques

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Identify and conduct targeted outreach to areas which can get cut-off during flood events

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

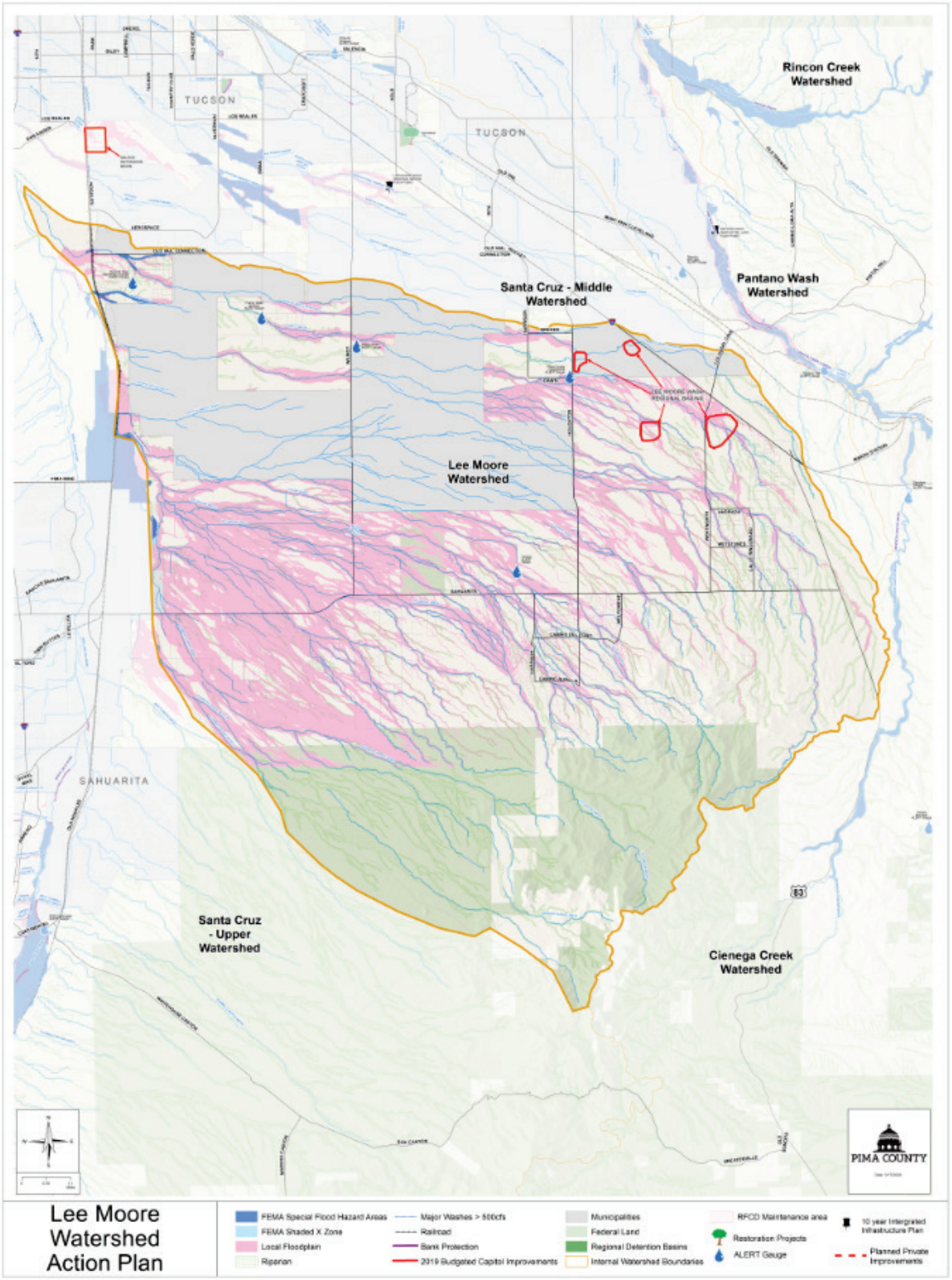


Figure 104 - Lee Moore Wash Action Plan Map

C.1.8 Pantano Wash

The Pantano Wash begins in the community of Vail at the confluence of Cienega and Agua Verde Creeks near Davidson Canyon. Below the confluence, the watershed is predominately the geologic floodplain and lower bajada associated with this major watercourse. The watershed originates high in the Rincon Mountains near Rincon Peak at over 8,000 above mean sea level and includes the sub basin flowing to the Agua Verde Creek. It is comprised of 64,649 acres (101 square miles), of which 24,815 acres are within the City of Tucson. In addition, Rincon Creek (87.3 square miles) and Cienega Creek (324.1 square mile) are tributaries to the Pantano Wash.

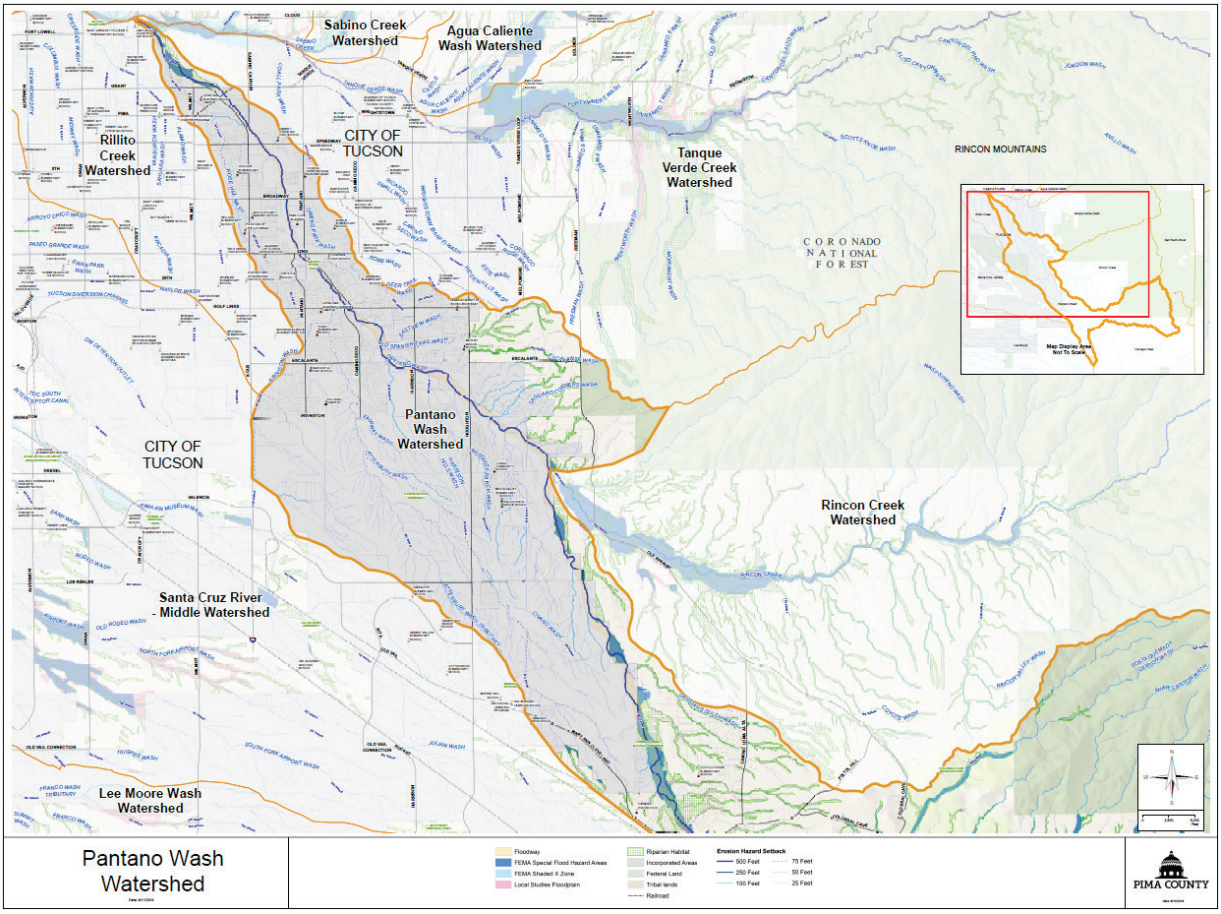


Figure 105 - Pantano Wash Watershed Map

The main stem of the Pantano Wash is a continuation of the lower Cienega Creek. The Pantano Dam impounds perennial flow from the Cienega Creek about 3,500 feet downstream of Agua Verde Creek. Del Lago LLC owns the dam and diverts runoff to a golf course about a mile downstream of the dam. With flow diverted to urban recreation, vegetation associated with the Preserve becomes much less dense and more typical of a southern Arizona ephemeral stream.

C.1.8.1 Flood Characteristics

In addition to the 4,437 acres of SFHA included on the chart above, there are also 317 acres of District Special Studies Floodplains, and 228 acres of sheet flood area in this watershed. Together these mapped floodplain areas nearly 8 percent of the total watershed area!

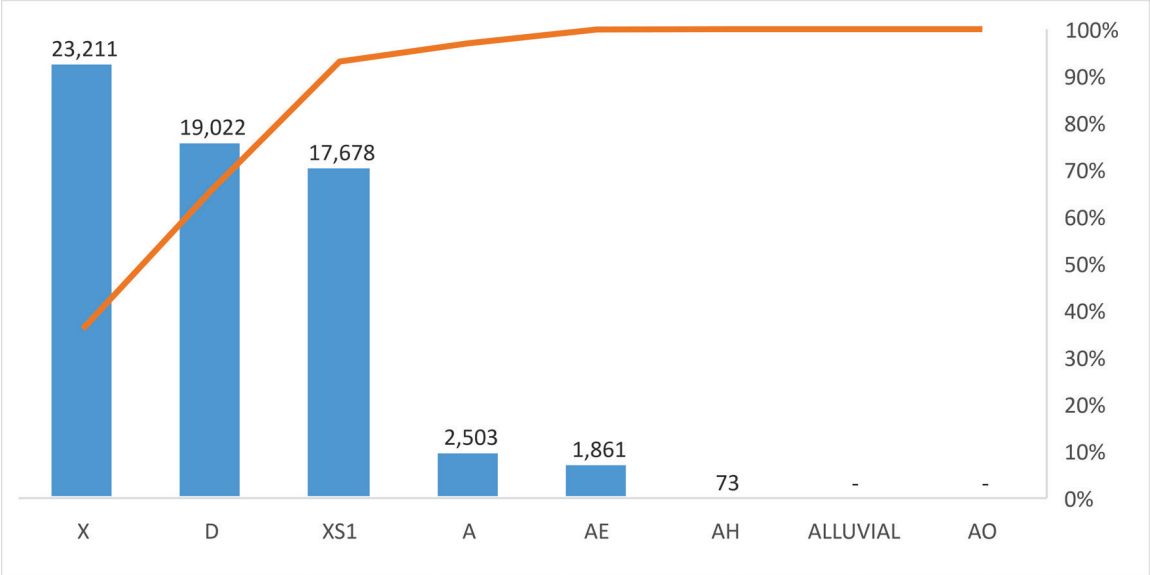


Figure 106 - Pantano Wash SFHA in Acres

The Pantano originates in the Cienega watershed southeast of Pima County in Santa Cruz County draining portions of the Empire, Santa Rita and Rincon Mountains. Major tributaries include Rincon Creek and Atterbury Wash. Upstream of the Pantano Dam, the watershed is largely undeveloped and government owned with scattered private parcels attached to ranches. In addition, future development proposals are in the pipeline in the Houghton to Pantano Dam reach, such as the proposed Rocking K development on the northeast quadrant of the Rincon/Pantano confluence.

All floods of record on the gaged stations along the Pantano occurred during the Summer Monsoon, which suggests that higher intensity shorter duration storms, such as the 3hr Type II storm would produce flood peaks on this watercourse. Longer duration storms, such as the October 1983 tropical storm can also cause flooding. Given the size of the watercourse, a regional tropical storm generating several inches of rainfall over several days could produce flooding on the Pantano. However, because of the high capacity of the Pantano to infiltrate, these storms will likely need to be quite large. Because of the long travel from tributary watersheds, especially upstream of the Pantano Dam, to the confluence with the Rillito, considerable flood attenuation can occur from transmission losses. In general, tributaries tend to discharge sequentially into the Pantano, which may be because of the elongated form of the watershed, with Cienega/Pantano system form the longest flow path, and tributaries enter on either side. In addition, because of the relatively flat slopes and good infiltration capacity flood peaks on the Pantano tend to attenuate downstream of the Pantano Dam.

The table below provides a summary of the historic USGS gauging station streamflow records.

Table 28 - Pantano Wash Watershed USGS Gages

USGS Gaging Station	Pantano Wash NR Vail, AZ 09484600	Pantano Wash at Broadway Blvd. at Tucson, AZ 09485450	Pantano Wash Near Tucson, AZ 09485500	Atterbury Wash Tributary at Tucson, AZ 09485390	Saguaro Corners Wash near Tucson, AZ 09485100
Period of Record	1958-08-11 to 2015-09-02	1978-12-18 to 2015-09-03	1940-08-13 to 1983-10-01	1976-09-25 to 1983-09-22	1965-09-12 to 1974
Watershed Area (sq. m)	457	599	602	4.97	0.17
Flood Peak of Record (cfs)	38,000	15,900	20,000	390	49
Date	8-11-1958	07-31-2006	08-12-1958	08-11-1977	08-1968
FIS Discharge (cfs)	29,000	32,000	32,000	4200	NA

The table below summarizes Pima County's ALERT Gages. The locations are from the District's ALERT map.

Table 29 - Pantano Wash Watershed ALERT Streamflow Gages

Pima County ALERT Gages	Pantano Wash at Schist ID:4263	Pantano Wash near Vail ID: 4253	Davidson Canyon Wash Above I-10 ID: 4313
Location (Latitude, Longitude)	(32.0433, -110.69)	(32.0361,-110.6767)	(31.9936, -110.6451)
Period of Record	2013-07-05 to Present	2001-07-05 to Present	1987-01-19 to Present
Watershed Area (sq. m)	458.79	455.82	50.57
Flood Peak of Record (cfs)	4832	9715.3	2855
Date	07-23-2017	07-22-2008	07-30-2010
Table of Regulatory Discharge (cfs)	NA	NA	NA

Table 30 - Pantano Wash Watershed ALERT Precipitation Gages

Pima County Alert Gage	Irvington Road near Pantano road Pantano Basin ID: 4160	Pantano Wash at Houghton Road-Pontano Basin ID: 4180	Rancho Del Lago-Pantano Basin ID: 4220	Pantano Wash at Schist ID: 4260	Pontano Wash at Vail ID: 4250	Davidson Canyon Wash Above I-10 ID: 4310	Salcido Place-Cienega Basin ID: 4270
Location (Latitude, Longitude)	(32.1622,-110.8197)	(32.1672,-110.7722)	(32.0681,-110.7303)	(32.0433,-110.69)	(32.0361,-110.6767)	(31.9936,-110.6451)	(32.0397,-110.495)
Period of Record	1994-10-25 to Present	1993-02-04 to Present	1993-03-31 to Present	2013-07-05 to Present	1987-09-01 to Present	1987-01-09 to Present	1993-03-25 to present

The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 31 - Pantano Wash Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Pantano Wash	32,000	604	FEMA Flood Insurance
@ Craycroft Rd.	31,000	570	Study
@ Houghton Rd.	29,000	475	"
Upstream of Rincon Creek Confluence			"

Downstream of the Pantano Dam to about Houghton Rd, there has been considerable down cutting, most of it associated with sand and gravel mining. Evaluation in 2014 showed active head cuts near the Valencia Road alignment. Downstream of Houghton Road, the channel is generally bank protected and grade controls stabilize the bed. The biggest risk of flood occurs downstream of Colossal Cave Rd and upstream of Houghton Road. Historically, floods from tributaries such as Rincon Creek occur from short-duration, high intensity storms, such as during the Monsoon. Furthermore, the flood of record on the Pantano occurred during the Monsoon, which originated in Rincon Creek. Because of the history of down cutting along the Pantano, grade control structures all up and down the channel are important. The Pantano Dam acts as a grade control with over a 20' drop on the downstream side. Downstream of the Dam, sand and gravel mining has contributed to instability in the Pantano.

In this reach, a sewer crossing downstream of Rincon Creek plays an important role in maintaining the base grade of the Pantano upstream of Houghton Rd.

C.1.8.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas.

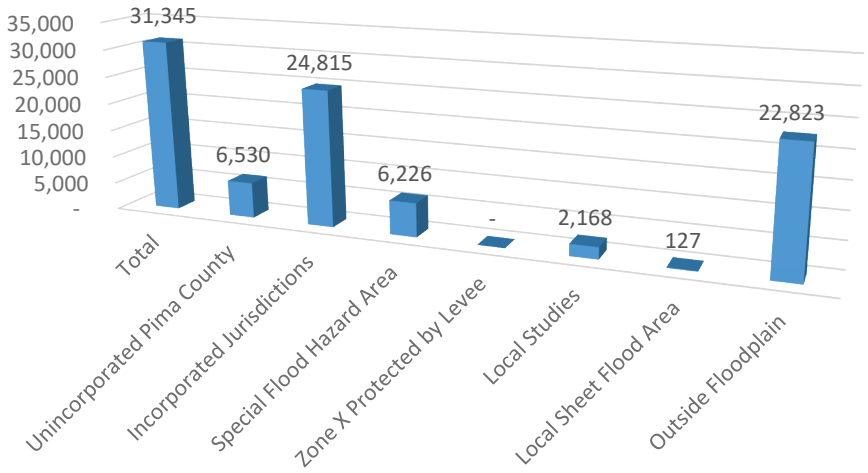


Figure 107 - Pantano Wash Watershed Population Distribution

This watershed increasingly urbanized over the previous decade. Nearly 60% is private; furthermore, Department of Defense lands are also largely urban in nature and attract industrial and commercial uses as well as off base housing. Together, private, state and defense lands are 72% of the watershed within unincorporated Pima County.

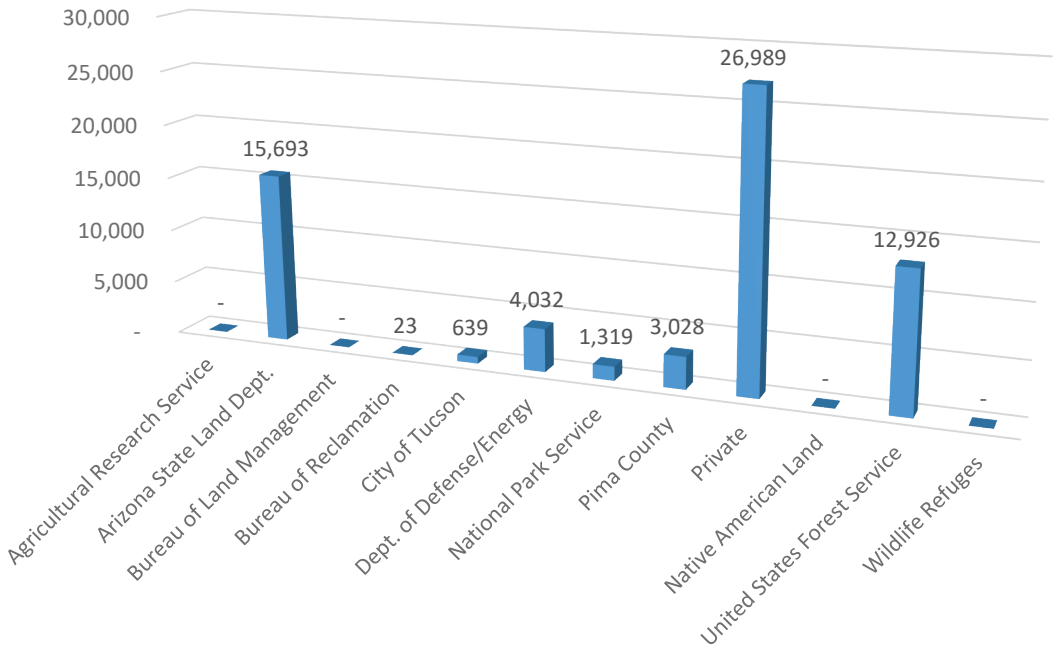


Figure 108 - Pantano Wash Watershed Ownership in Acres

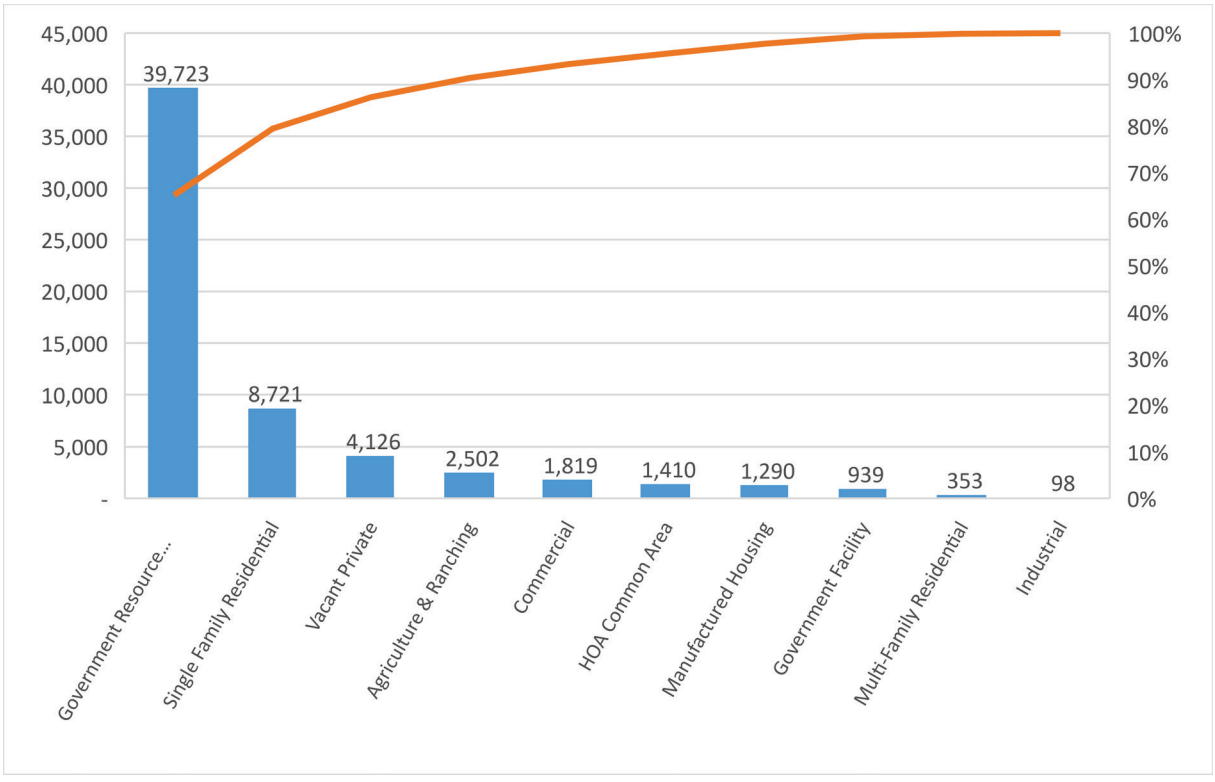


Figure 109 - Pantano Wash Watershed Land Use in Acres

While a large percentage is vacant, outside the federal lands development pressure is high.

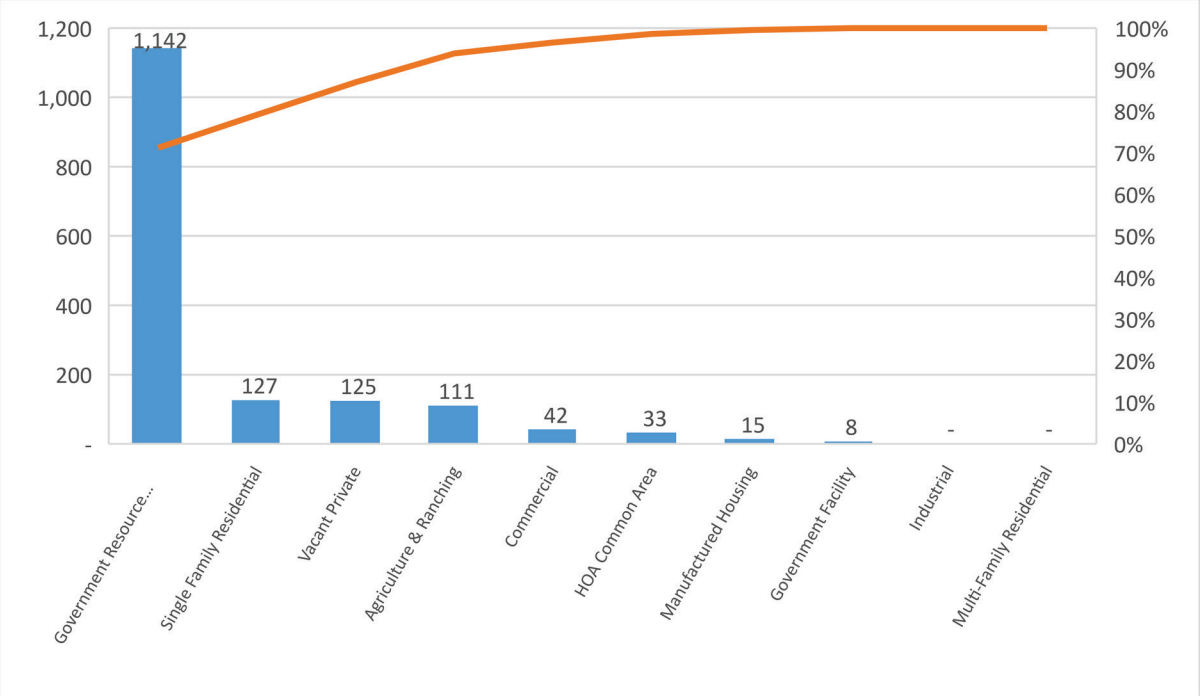


Figure 110 - Pantano Wash Floodplain Land Use

Much of the private land area is located along the Pantano Wash corridor as shown on the map below.

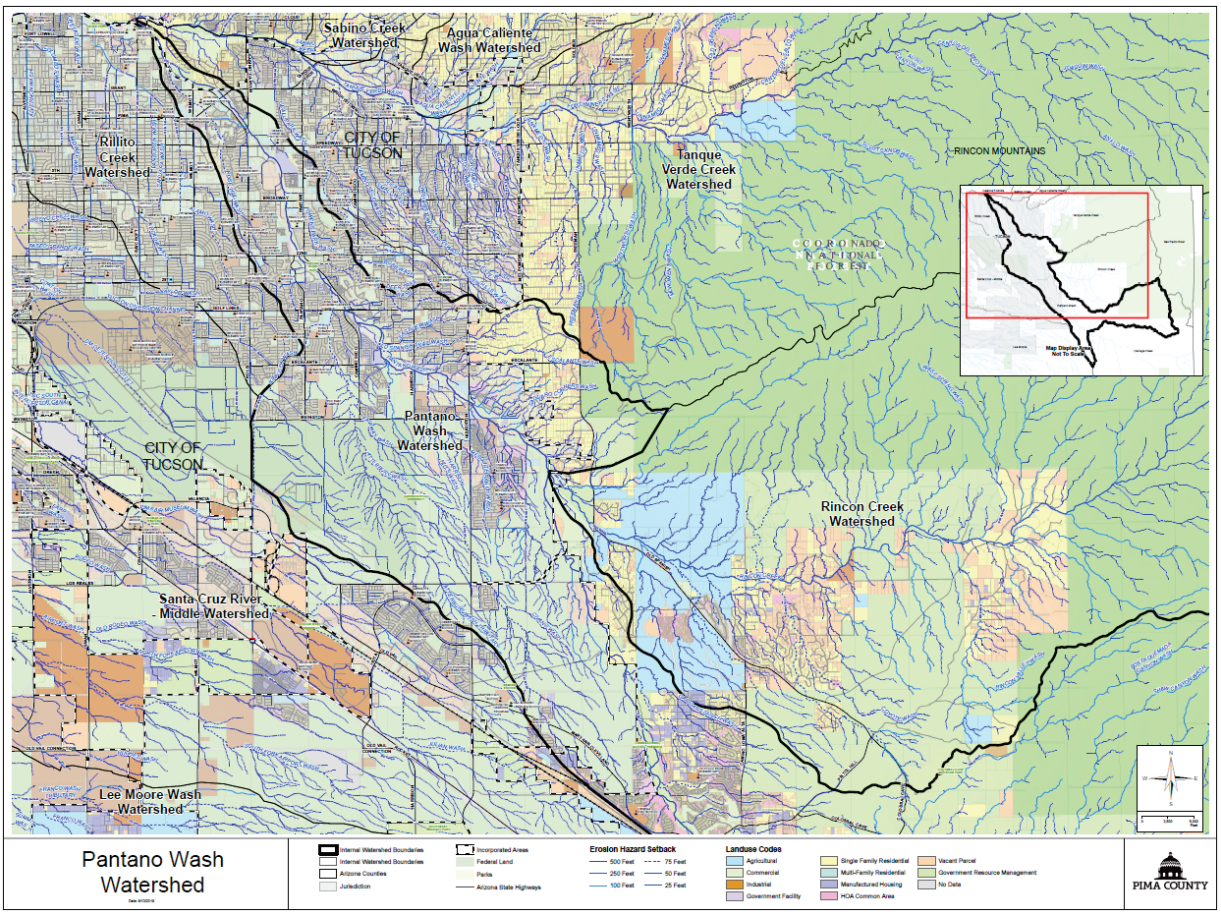
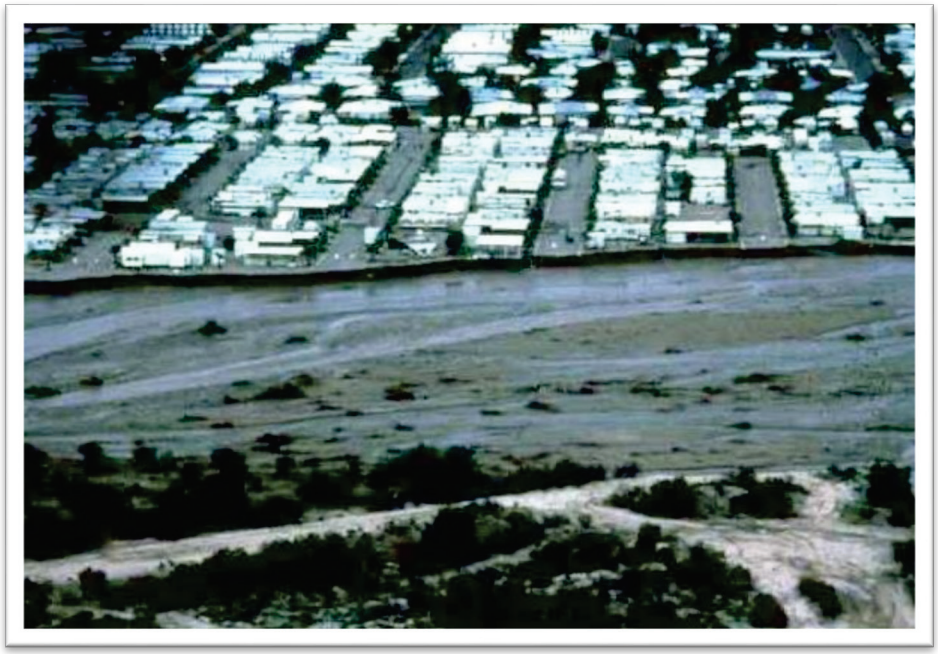


Figure 111 - Pantano Wash Land Use

Relatively high residential density characterizes the private property upstream of the City of Tucson jurisdiction. Subdivisions platted after the year 2000 typically include constructed drainage improvements to convey stormwater runoff and to reduce damage due to flooding. Subdivisions platted before that time and lots on unplanned land experience more problems from neighbor-to-neighbor flow diversion. Even relatively low flows can damage properties when infrastructure is minimal.

The District reviews drainage plans for new subdivisions for compliance with best practices to increase public safety and to protect property values.

The District has completed major projects including bank protection, maintenance, restoration and acquisition in this area. The picture on the right shows erosion after the 1983 flood and the picture below bank protection and grade control adjacent to a capped landfill.



C.1.8.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 2,605 acres of Pima County Regulated Riparian Habitat in this watershed. In addition, 3,412 acres is IRA. There are also 20,640 preserved acres in this watershed, including 1,128 in regulatory floodplain.

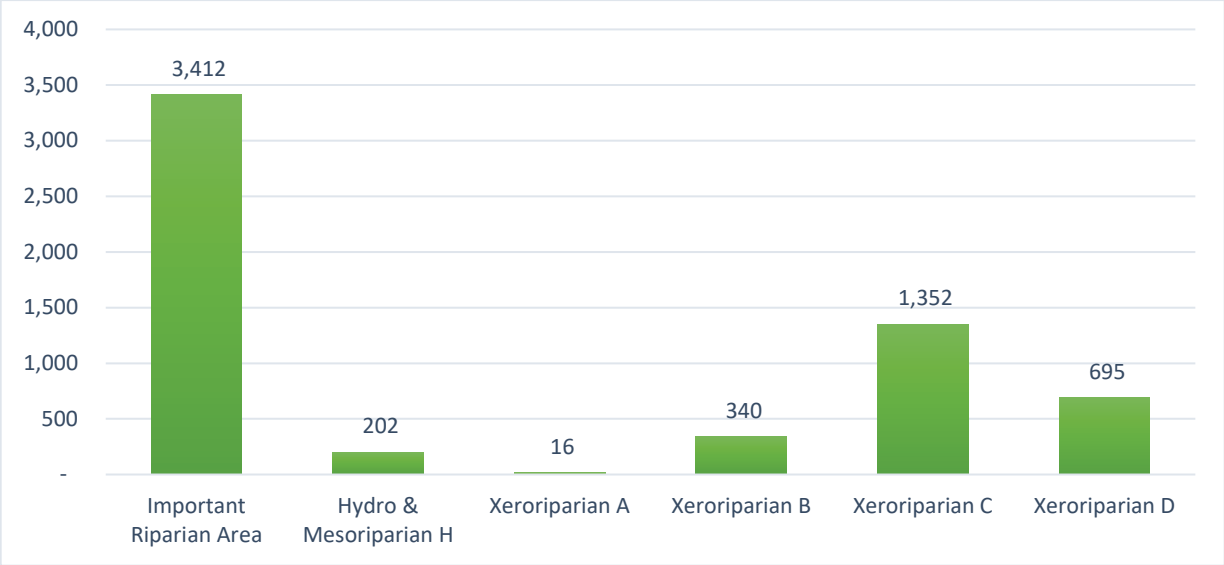


Figure 112 - Pantano Wash Watershed Riparian Habitat in Acres

C.1.8.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

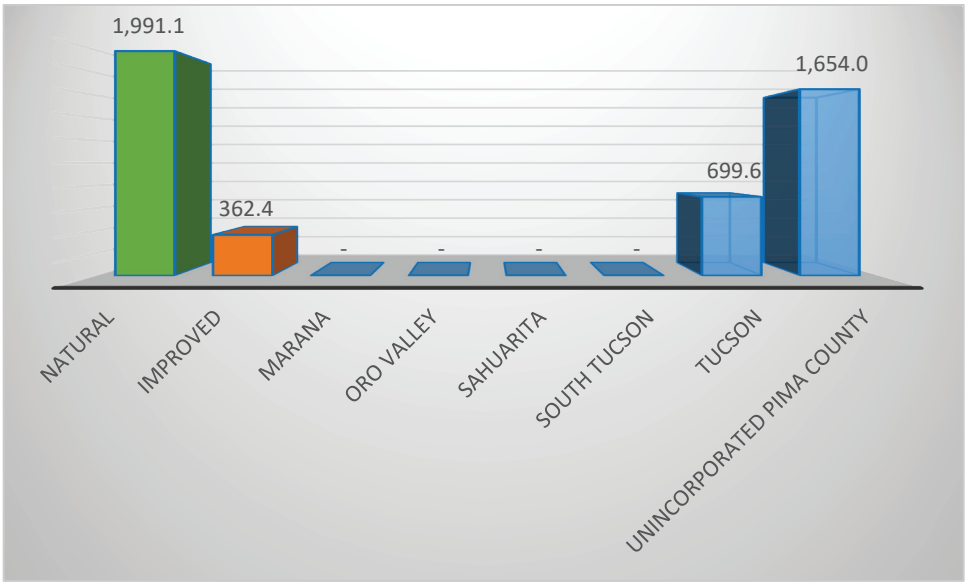


Figure 113 - Pantano Wash Drainageway Acreage

Much of this watershed and the Pantano Wash are within the City of Tucson incorporated areas (City). The City is responsible has floodplain management for permitting within its jurisdiction. Pima County owns a significant number of parcels adjacent to and including the Pantano Wash floodplain within the City. Ownership of these floodplain properties facilitates access, maintenance and control over activities. The District works with City staff and officials for effective floodplain management and funds some maintenance and construction activities.

Pantano Wash can convey large flows. Most of the urban area is bank protected, but some bank failures have occurred in large flows. The only at-grade crossing is located at Harrison Road. The stream gauge at Vail (4253) is approximately 13 miles upstream of Harrison Road. Travel time to Harrison Road is approximately 2-3 hours. Travel times change through the rainy season as the channel becomes wetted.

One major tributary, Rincon Creek, may affect flow at Harrison road. The stream gauge at the X-9 Ranch (4113) is approximately 12 miles upstream of Harrison Road. Travel time information is not available. Assuming an average channel velocity of 10 fps, travel time from 4113 is approximately 1.5-2 hours. Streamflow of 750 cfs at Vail (4253) may affect the at-grade crossing at Harrison Road. At 700 cfs ALERT staff contacts the City of Tucson, Streets Maintenance Division. Recently the District installed an additional upstream gauge (4263 Schist) 1 mile downstream of 4253.

Rampant OHV use. The surrounding neighborhoods provide easy access to the wash. Many of the access points lie on private property or HOA common area, which makes restriction of OHV activity on District land difficult to control. The Dsitrict hs installed signage and large rocks to deter OHV use, but use is still a problem and the District regularly receives complaints from the public regarding the nuisance.

C.1.8.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Infrastructure

- The sewer line crossing Atterbury Wash just upstream of the confluence with Pantano Wash was exposed. RWRD is placing a concrete cap on top of it to hopefully prevent future damage. The design scour depth over a drop for the cap is several feet greater than the toe down of the existing bank protection. While the cap toe down will be anchored to the bank protection, there is some possibility of exposure of the bank protection toe down in a very large event. Therefore, the bank protection should be inspected after large flow events.

C.1.8.6 Floodplain Management

Future needs identified by District staff include:

- Sand and gravel operators
- Unstable geomorphology
- Develop consistent property rights for effective management in and adjacent to Pantano Wash

1998 and 2008 photograph from the Pantano Wash Management Study showing lateral migration

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan include the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Mesquite Ranch Wash sediment removal
- Palo Verde Rd channel grading
- Repair Michael Perry Park bank protection
- Create Drainage System vegetation maintenance plans

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Assess unstable geomorphology
- Monitor sand and gravel operations

Ref# 1.2.c Refine local approximate sheet flood maps and identify flow corridors

- Remap Pistol Hill sheet flow floodplains (Pantano)

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Work with responsible parties to address flooded roads

Ref# 2.2.c Conduct voluntary floodprone land acquisition program outreach to areas impacted by flooding

- Acquire property rights for effective management

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Stabilize the Pantano Wash and tributaries

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Loop and Trail Enhancements
- Coordinate with City of Tucson on Proposition 407 projects

Ref# 5.2.e Develop alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

- Develop and implement an erosion mitigation plan using natural channel design techniques

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

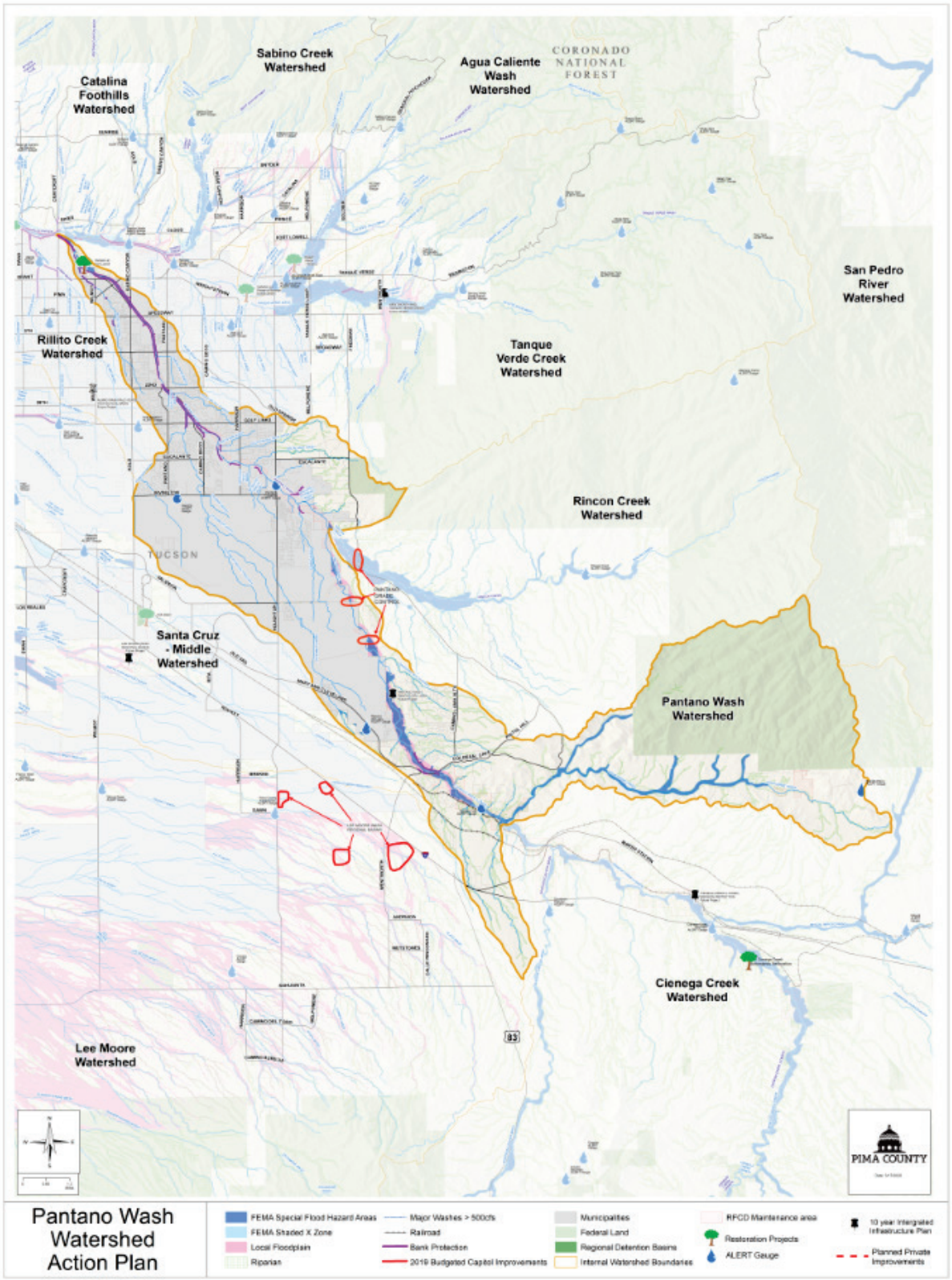


Figure 114 - Pantano Wash Action Plan Map

C.1.9 Rillito Creek

Rillito Creek begins at the confluence of Tanque Verde Creek Wash and Pantano, and includes the headwaters of the Alamo Wash, a major tributary. Its downstream terminus is the confluence with the Santa Cruz River, just within the Town of Marana. It is comprised of 15,609 acres (24.4 square miles), however nearly 14,000 acres are within The City of Tucson.

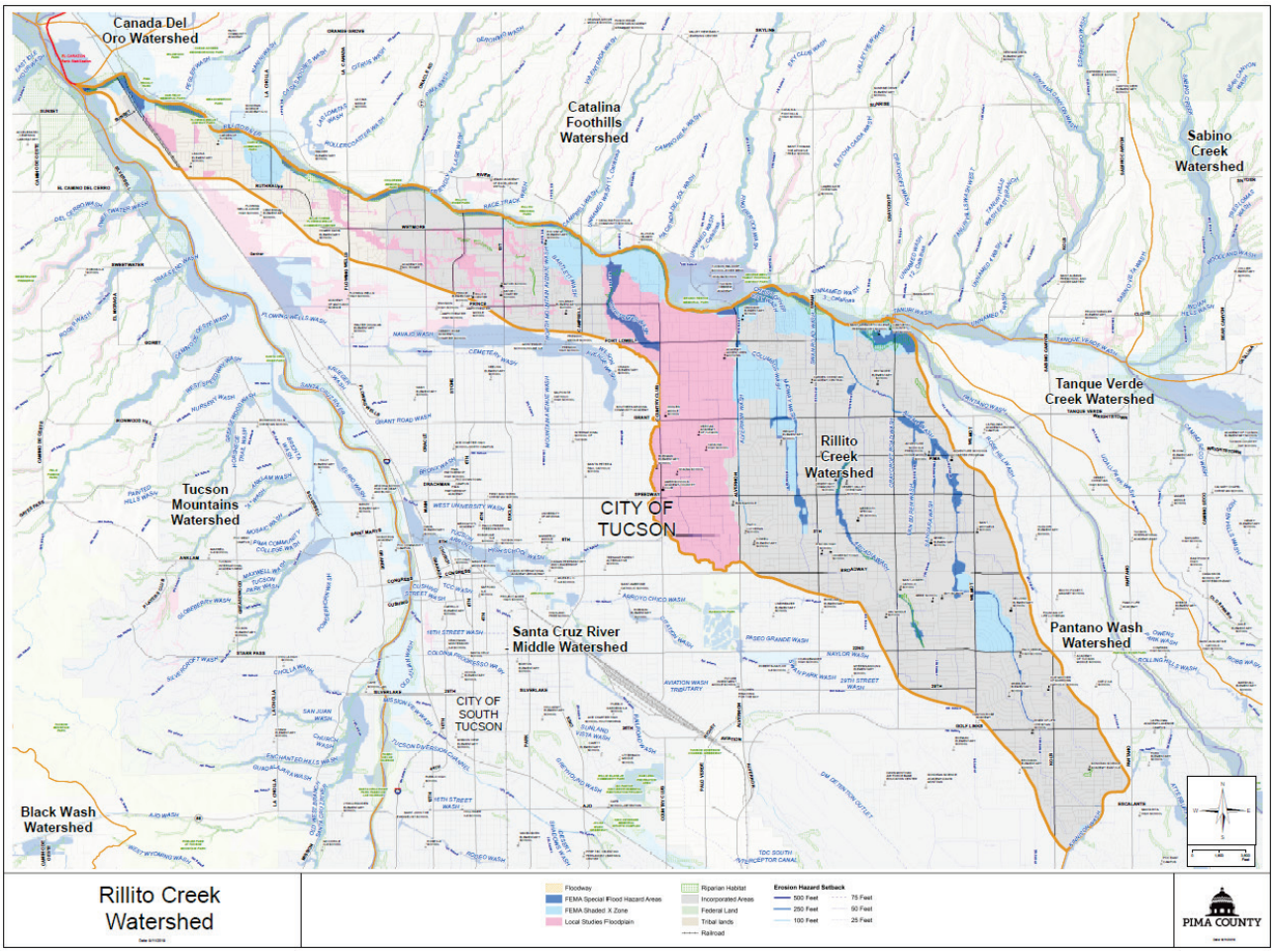


Figure 115 - Rillito Creek Watershed Map

C.1.9.1 Flood Characteristics

In addition to 855 acres of SFHA zones included on the chart above, there are also 825 acres of District Special Studies Floodplains in this watershed and no sheet flood areas in part due to urbanization including channelization and streets.

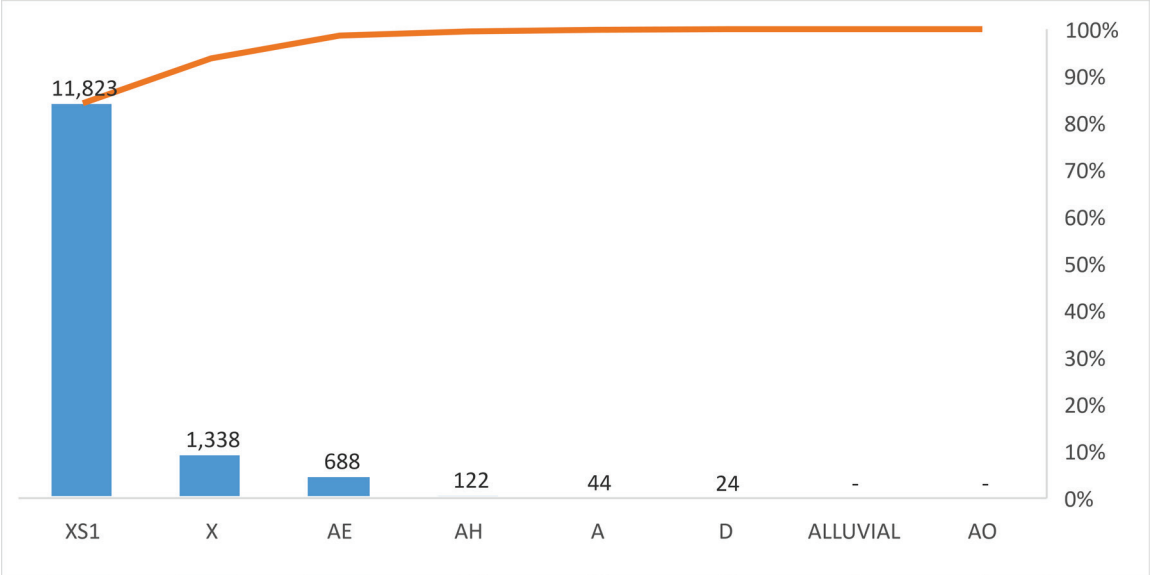


Figure 116 - Rillito Creek SFHA in Acres

Storms that would trigger flooding in the urbanized tributary watersheds outside of the main channel of the Rillito River include intense localized summer storms.

The table below provides a summary of the USGS gauging station records.

Table 117 - Rillito Creek Watershed USGS Gages

USGS Gaging Station	USGS 09486055 Rillito Creek at La Cholla Boulevard	USGS 09485700 Rillito Creek at Boulevard
Period of Record	July 1990 to January 2015	Aug. 1988 to Jan. 2015
Watershed Area (sq. m)	922	871
Flood Peak of Record (cfs)	39,000	37,900
Date	July 31, 2006	31-Jul-06
FIS Discharge (cfs)	32,000	N/A

Likewise, flood characteristics themselves vary greatly depending on whether the event is convective, such as on July 31, 2006, (which was a high intensity, shorter duration event); or a rain on snow event such as the February, 1993 event which releases a higher volume of water over a longer period. USGS does not gauge the smaller, urban tributaries, which would be subject to flooding during short duration, high intensity convective storms.

In addition, there are District ALERT stream flow gages at three locations: Rillito Creek at La Cholla Boulevard (#2360), Ruthrauff Road at La Cholla Boulevard (#2380), Rillito Creek at Dodge Boulevard (#2350), Alamo Wash at Glenn Street (#2370), Hawthorne Street at Beverly Avenue (#2320), and Golf Links Road at Kolb Road (#2330).

The table below presents excerpts from the District's Regulatory Discharge Table. The table does not include the southern tributaries within the incorporated limits of the City of Tucson.

Table 32 - Rillito Creek Watershed Regulatory Discharges

Watercourse	**Regulatory Discharge, cfs 1% Return Frequency**	**Drainage Area, sq. miles**	**Source of Discharge Information**
Rillito Creek			
Upstream of Confluence with Santa Cruz River	32,000	935.00	FEMA, Flood Insurance Study
@ First Avenue	32,000	892.00	"

The FIS for Incorporated Areas includes 1%-annual-chance (100-year) peak discharges for the Alamo Wash, Alvernon Wash, Arcadia Wash, Christmas Wash, Columbus Wash, Midway Wash, Sahuara Wash and Van Buren Wash, summarized below.

Watercourse	Concentration Point	Drainage Area (sq. miles)	1% Peak Discharge (cfs)
Alamo Wash	at Grant Rd.	5.6	5000
Alvernon Wash	at confluence with Rillito River	3.3	5310
Arcadia Wash	At Speedway Blvd.	2.26	2450
Christmas Wash	at Roger Rd.	3.1	2334
Columbus Wash	at confluence with Alvernon Wash	1.9	1885*
Midway Wash	at Speedway Blvd.	0.9	1769
Sahuara Wash	at Pima St.	0.4	622
Van Buren Wash	at confluence with Alamo Wash	0.5	941

*Per August 3, 2005 LOMR 04-09-0547P

While the District does not have regulatory jurisdiction over the incorporated areas in this watershed, the District does provide technical assistance to the City of Tucson, mapping flood hazards. This includes new studies and maintenance of the ALERT system. Furthermore, the City has adopted County critical and balanced basin standards.

Watercourses in the City of Tucson also have associated 1% annual chance peak discharges at select concentration points based upon HEC-1 analyses developed for the Tucson Stormwater Management Study (TSMS, 1995). A GIS layer is available from the City of Tucson for these concentration points.

In addition, 1% annual chance peak discharge values from 2-dimensional analyses are available at numerous locations based upon Special Study No. 2, Ruthrauff Basin Management Plan Technical Data Notebook. Completed in 2015, the Ruthrauff Basin Management Plan encompasses the urban area west of Campbell Ave.

Shallow sheet flooding presents flood risk to structures where drainageways are not constructed or are inadequate.

FEMA has delineated floodplains for the Rillito River and overbank areas and for the above-mentioned urban tributaries. Within the District's jurisdiction, overbank flooding from the Rillito River does not affect a significant amount of development although the impact to affected structures could be substantial.

The Rillito River has 100-year bank protection on both banks, and several grade control structures exist within the channel bottom. The District has documented sedimentation in the channel and regular maintenance is required to ensure the capacity of the channel. An at-grade crossing at Camino de la Tierra, is inaccessible and barricaded during flood events.

During past floods, the soil bank protection has protected public infrastructure and private property along the Rillito River from erosion and lateral migration. Approximately 225 linear feet of bank protection was damaged in 2006 by undercutting. This District has since repaired the bank protection.

For the Rillito Watershed west of Campbell Ave., The Ruthrauff Basin Management Plan Technical Data Notebook includes inundated areas by depth for the 1% annual chance. The District has identified shallow flood risk in areas upstream of Interstate 10 and the Union Pacific Railroad. At the transportation structures, depths may be higher, and mitigation through improved drainage crossings would reduce impacts. A basin management study of the Alamo Wash and its tributaries (Arcadia Wash, Sahuara Wash and Van Buren Wash) will commenced in 2016. This study provides current floodplain mapping for these watercourses.

C.1.9.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas.

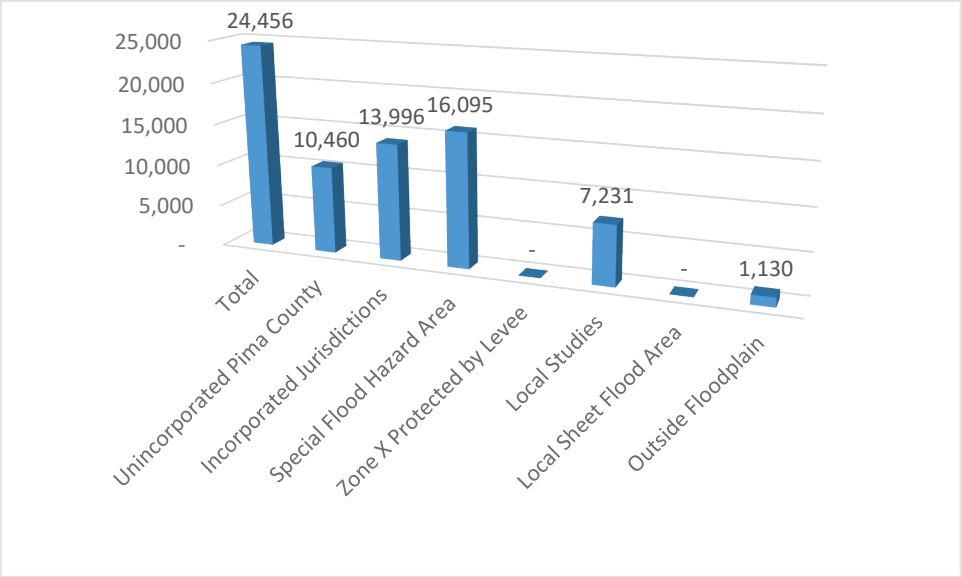


Figure 118 - Rillito Creek Watershed Population Distribution

Much of this watershed and the Rillito River are within the City. The incorporated population lives primarily within highly urbanized areas where many constructed and bank-protected drainageways exist. The District continues to cooperate with the City to identify peak discharges within the urban areas and to study feasible flood mitigation measures. Most areas of this watershed are fully developed.

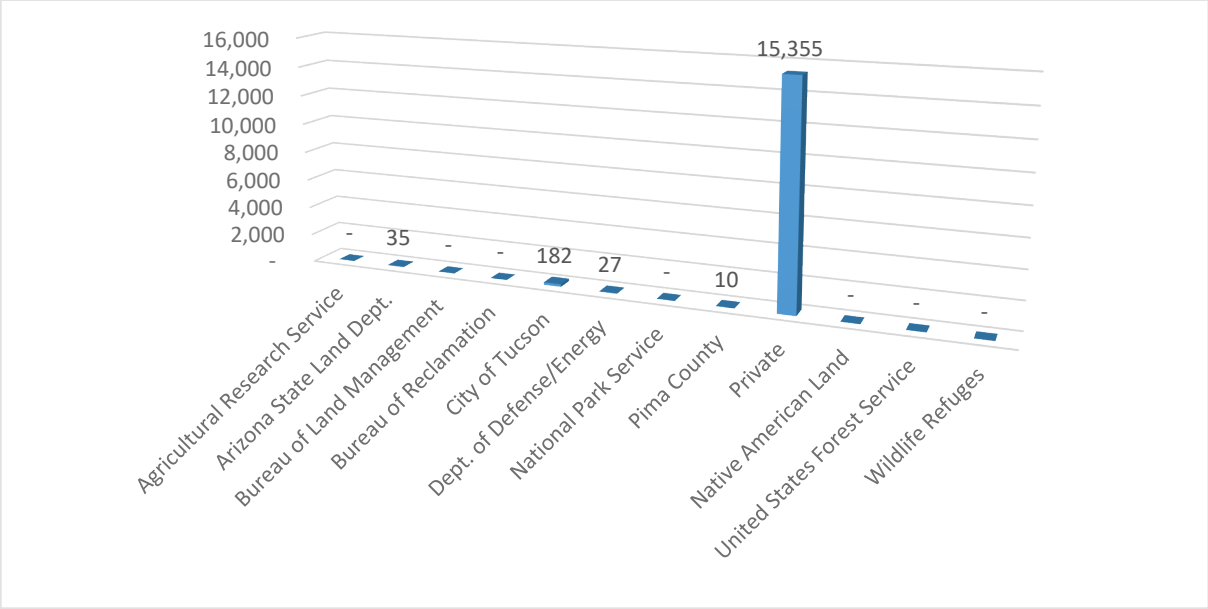


Figure 119 - Rillito Creek Watershed Ownership in Acres

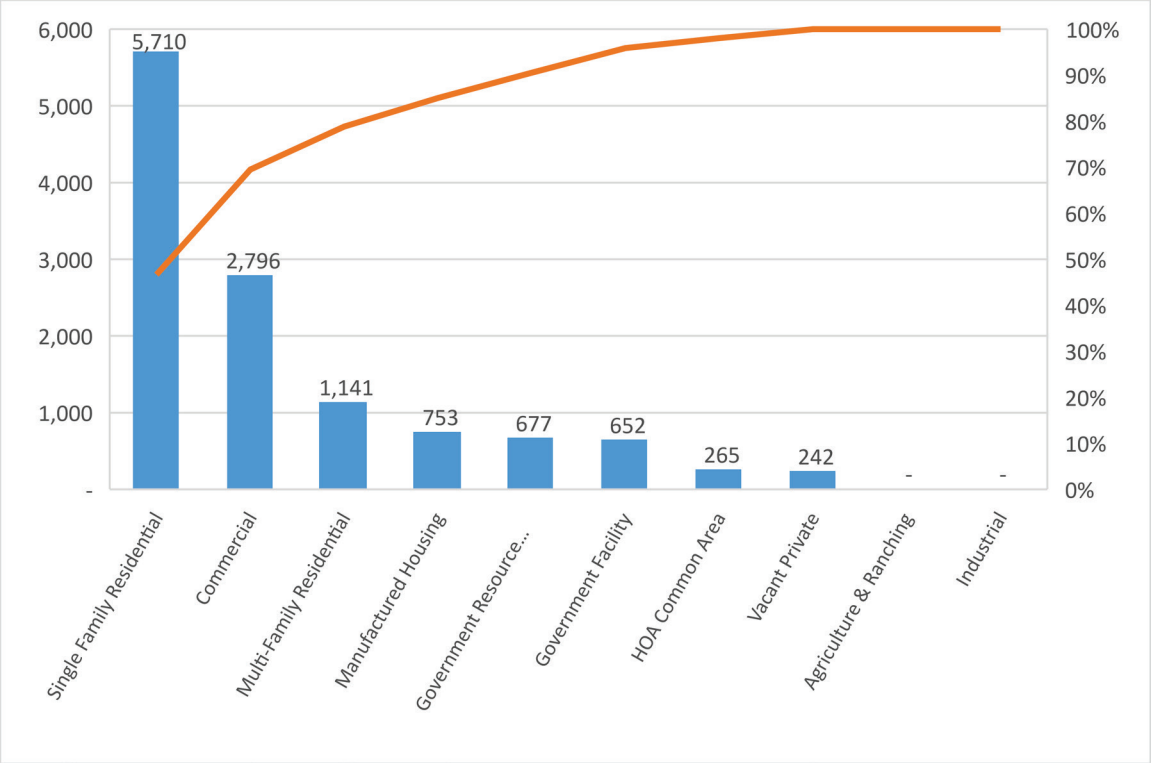


Figure 120 - Rillito Creek Watershed Land Use in Acres

2019 Flows on the Rillito River

The map below shows the distribution of these land uses.

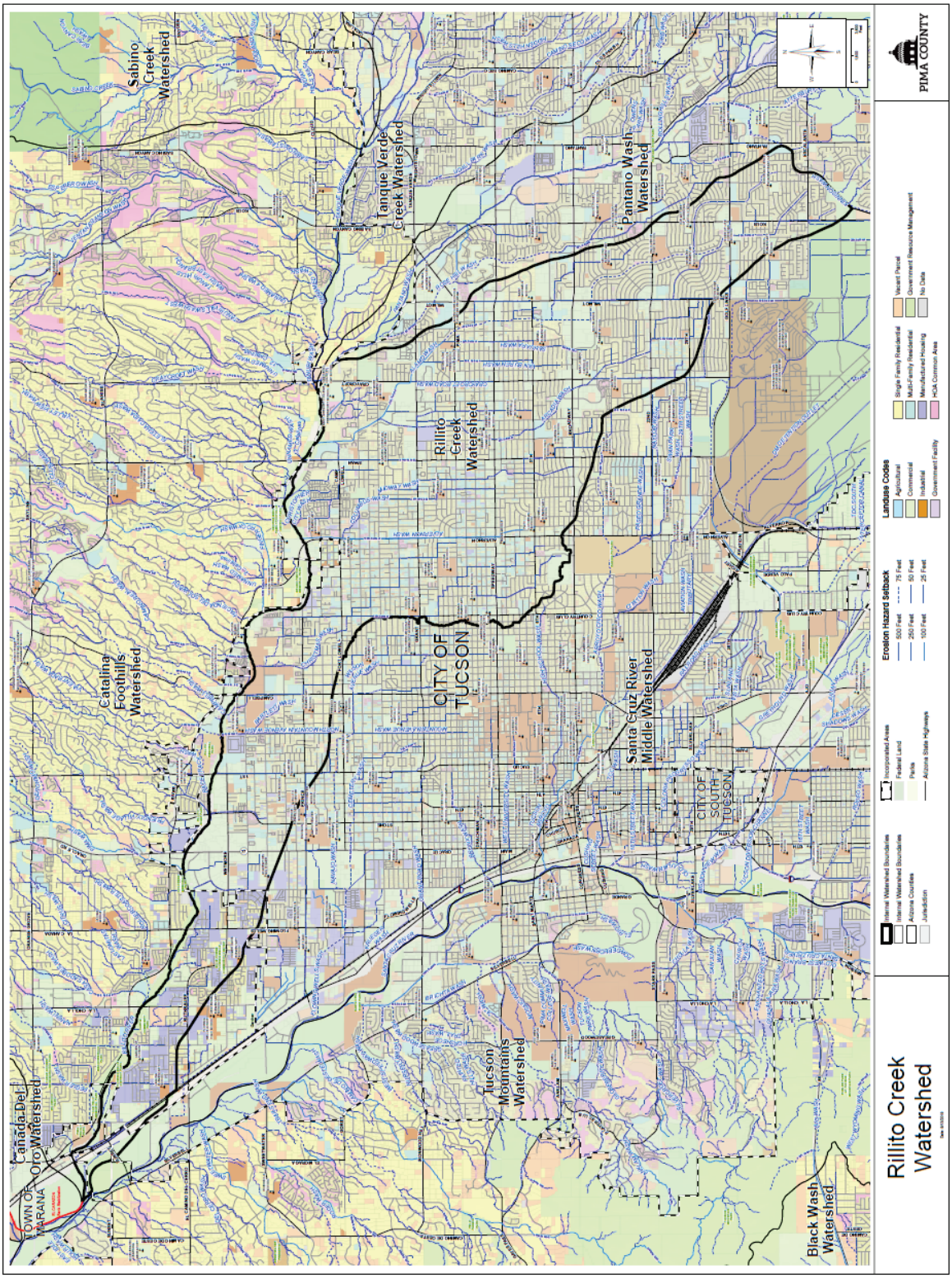


Figure 121 - Rillito Creek Land Use Map

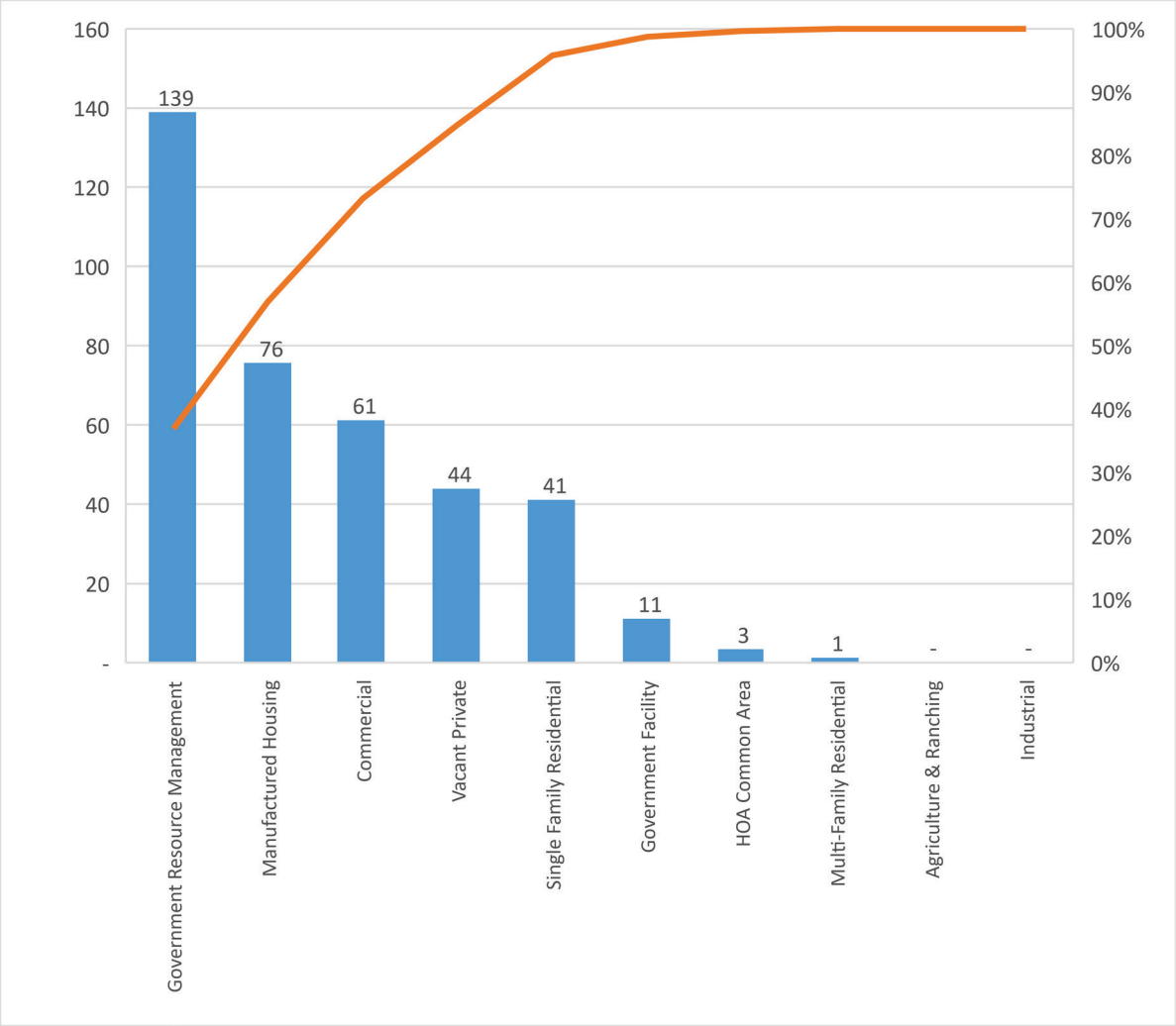


Figure 122 - Rillito Creek Floodplain Land Use

Typical Urbanized Drainage

C.1.9.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are just 48 acres of Pima County Regulated Riparian Habitat in this watershed; however, 500 have been designated IRA. This reflects the differing methodology used to create the RRH maps, which included vegetative density, and the IRA that included consideration of geohydrology, soils, and connectivity as they were for different purposes. The former preservation while the latter includes restoration and enhancement. There are also 60.4 preserved acres in this watershed, including 52 in regulatory floodplain.

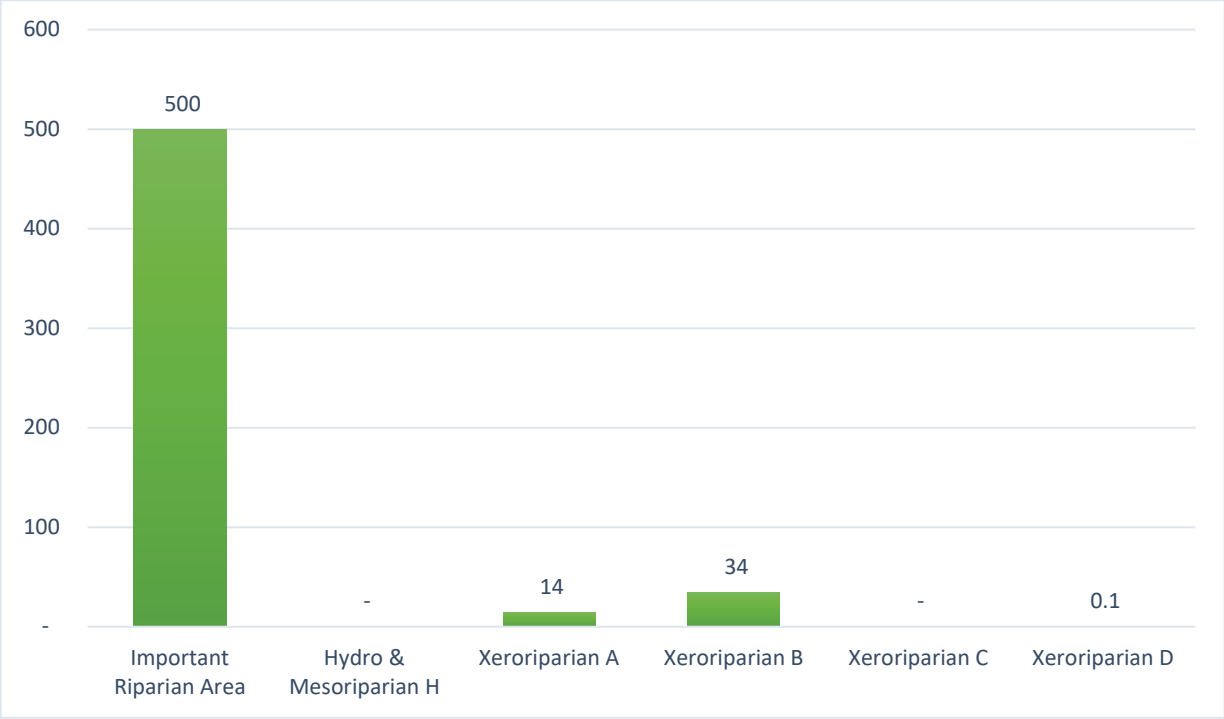


Figure 123 - Rillito Creek Watershed Riparian Habitat in Acres

Although little perennial water exists along the Rillito, its size and regional significance play a role in its designation as Important Riparian Area.

While the watershed defined for the purposes of this report includes the tributaries form the north bank numerous canyon washes originating in the Catalina and Rincon Mountains feed Rillito Creek after passing through the suburban foothills into the geologic floodplain basin. In addition to providing a wildlife and recreational corridor, the Rillito plays a very significant role in recharge and flood attenuation.

The 52–acre Swan Wetlands ecosystem restoration project was the first project in the region where the District salvaged native toads and slower-moving lizards, otherwise decimated by construction earthwork. The District's water-harvesting restoration projects and upstream efforts by the Watershed Management Group to restore surface flows to once perennial reaches will also contribute greatly to restoration efforts here.

C.1.9.4 Historic Floodplain Management Approach

A small area of the downstream portion of the watershed and a small area at the confluence of the Finger Rock Wash lies within Pima County flood control jurisdiction. As shown above, the watershed is urban with less than 400 feet of overall elevation change and flow through urban conveyances of similar slopes rather than natural watercourses.

Flooding within urbanized areas exist around constructed drainageways and other conveyances, primarily urban roads. Flood hazards associated with the urban watercourses include under-capacity infrastructure such as channels and culverts. Numerous at-grade crossings at the urban watercourses are inaccessible and barricaded during flood events. Due both to historical flooding (especially those experienced in 1983 pictured below), historic development patterns and much of the contributing area being within the City of Tucson, bank protection and maintenance responsibility have been the predominating concern for the District. The District has been able to acquire properties or drainage easements essentially along the entire reach of the Rillito River.

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

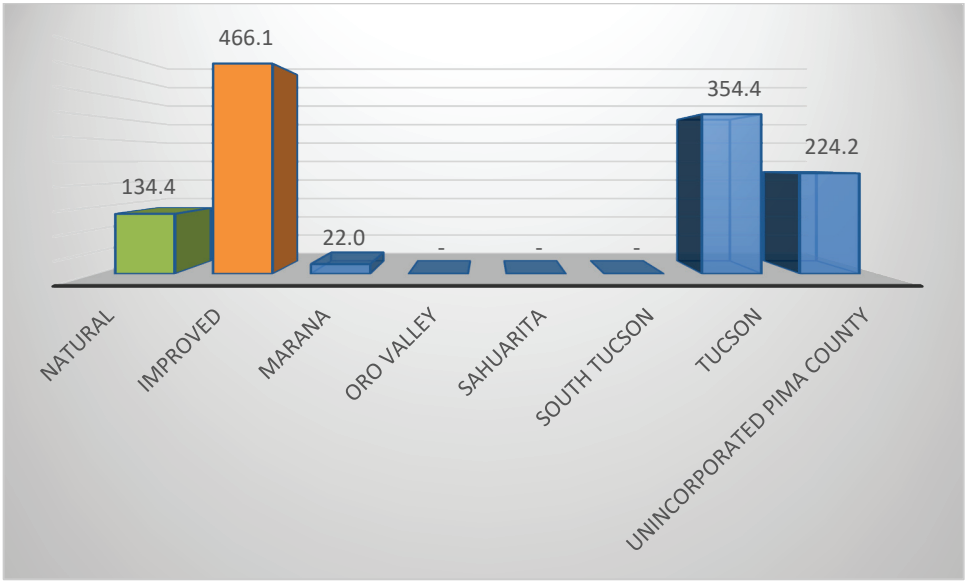


Figure 124 - Rillito Creek Drainageway Acreage

As designed Rillito Creek can convey large flows within the protected banks. All of the Rillito is bank protected. Still as pictured below without sediment management particularly after wildfires design capacity may not remain as occurred during the 2006 event pictured below. In the Dodge and Alvernon areas near the park shown in the picture, banks can overtop as indicated by FEMA mapping.

2006 Rillito Flooding at Brandi Fenton Park

The only at-grade crossing is located at Camino De La Tierra (CDLT). Sensor 2363 is approximately 1.5 miles upstream of CDLT. The stream gauge between Dodge and Alvernon (2353) is approximately 7 miles upstream of 2363. Assuming an average channel velocity of 10 fps, travel time from 2353 to 2363 is approximately 1 – 2 hours. Observed travel times in wetted conditions during monsoon 2016 was just over two hours between 2353 and 2363. Travel times are change through the rainy season as the channel becomes wetted. Observations of flows at 2363 show that if the channel is already wetted, as little as 150 cfs observed at 2363 can reach CDLT and affect traffic. Additionally we have observed that if there is heavy rain in the area, that sufficient flows can enter between 2363 and CDLT to affect traffic. Accordingly, the ALERT staff contacts the City of Tucson (COT) for very low flows at 2363 especially when there is rain in the immediate area. The City of Tucson Street Maintenance Division receives automated alarms for rising rate of 1 foot per hour at 2363. Streamflow of 1,000 cfs at Dodge (2353) and 200 cfs at La Cholla (2363) may affect at-grade crossing at El Camino De La Tierra.

C.1.9.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- Rillito River breaks-out of the channel near Alvernon Road.
- Rillito River breaks-out of the channel near Dodge Blvd.
- There are levee-like conditions upstream and downstream of Swan Road between Alamo Wash and Alvernon Wash, on the south side of the Rillito.
- East River Road Repetitive Loss Property, with losses claimed in 1993 and 1996.

Infrastructure

- Monitor and document the flood water level at the Dodge Blvd. If the water level appears to be within 18 inches of the crossing infrastructure, call the District or 911.

C.1.9.6 Floodplain Management

Future needs identified by District staff include:

- Aggradation/degradation
- Recreational destination
- Vegetation management
- Activity center/high visibility use
- Transient camps

Exposed Infrastructure

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Create Drainage System vegetation maintenance plans

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Remap floodplains to confluence with the Tanque Verde Creek
- Remap floodplains for Alamo Wash in the City of Tucson
- Remap floodplains for Christmas Wash in the City of Tucson

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Work with responsible parties to address flooded roads

Ref#4.2.e Increase pre-event technical assistance to the Office of Emergency Management and first responders including identifying reliable all weather emergency response access routes

- Utilize new streamflow gages to warn emergency services of road closures on Silverbell Road (TM)

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Construct drainage improvements within Christmas Wash and other urban watersheds
- Mitigate erosion at Hacienda del Sol confluence

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Loop and Trail Enhancements
- Coordinate with City of Tucson on Proposition 407 projects

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

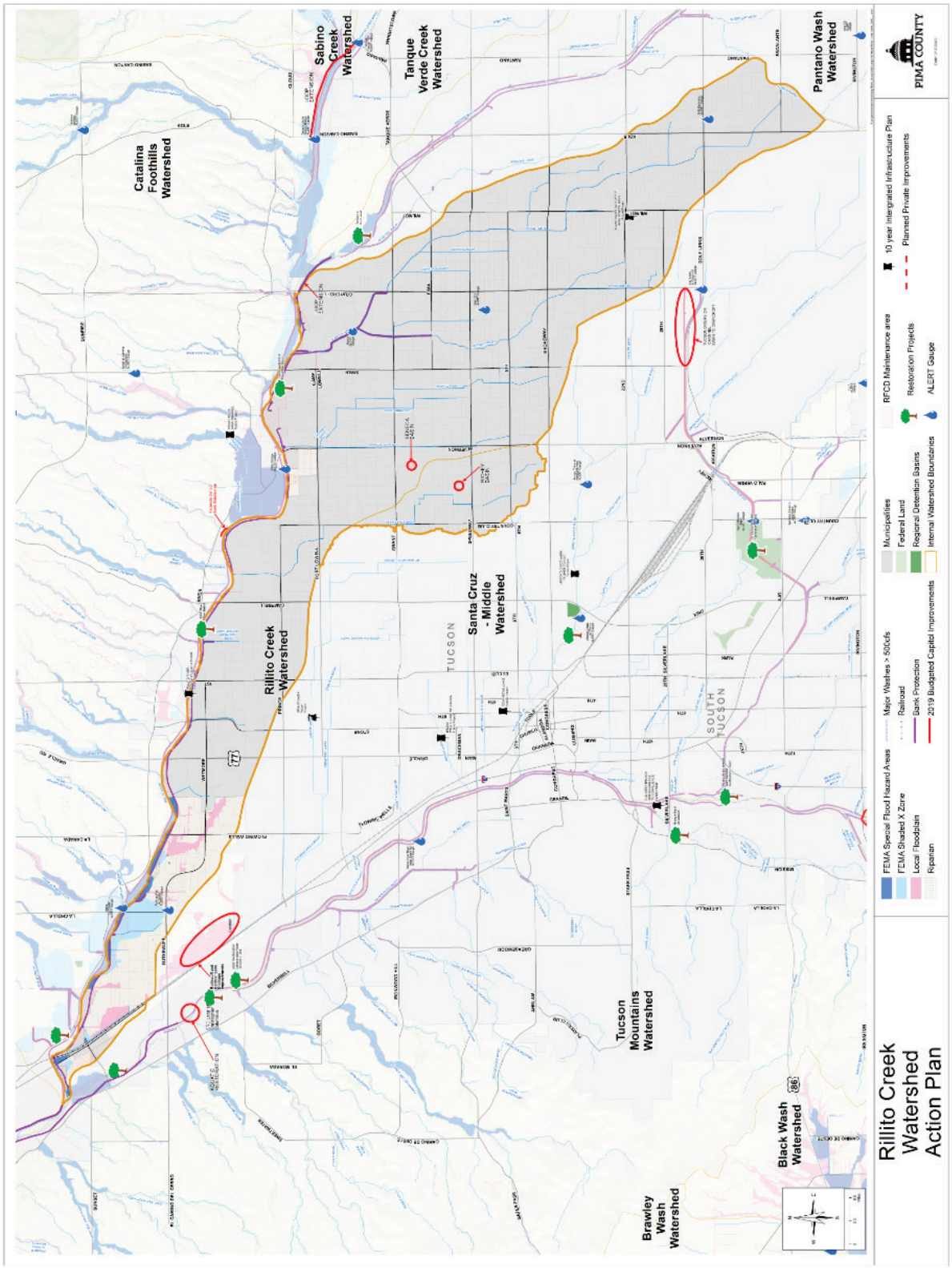


Figure 125 - Rillito Creek Action Plan Map

C.1.10 Rincon Creek

This watershed originates high in the Rincon Mountains near Rincon Peak at over 8,000 above mean sea level. It also drains the southern slopes of the Tanque Verde Mountains before passing through Rincon Valley and its confluence with Pantano Wash. It is comprised of 55,876 acres (87.3 square miles).

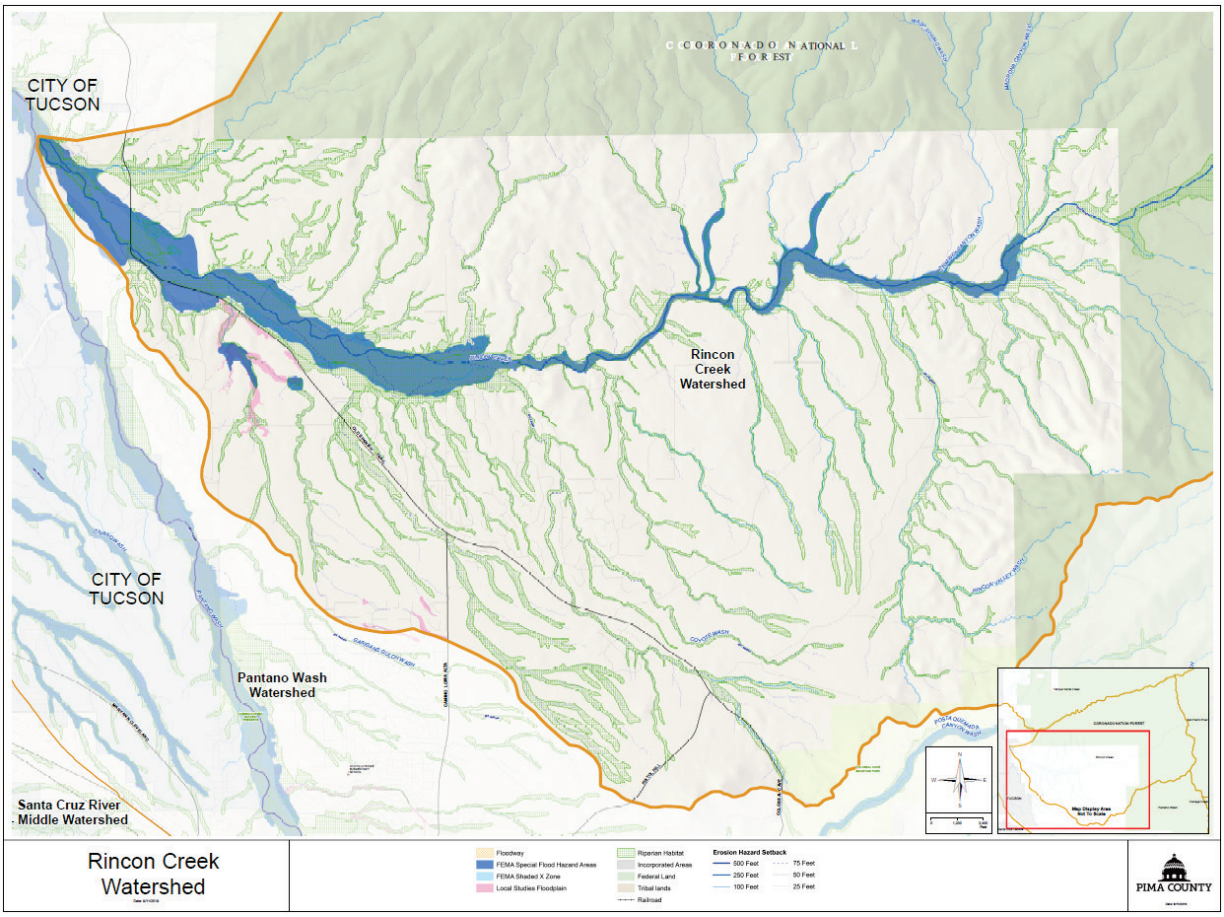


Figure 126 - Rincon Creek Watershed Map

C.1.10.1 Flood Characteristics

In addition to the 1,471 acres of SFHA zones included on the chart above, there are also 635 acres of locally mapped sheet flood area.

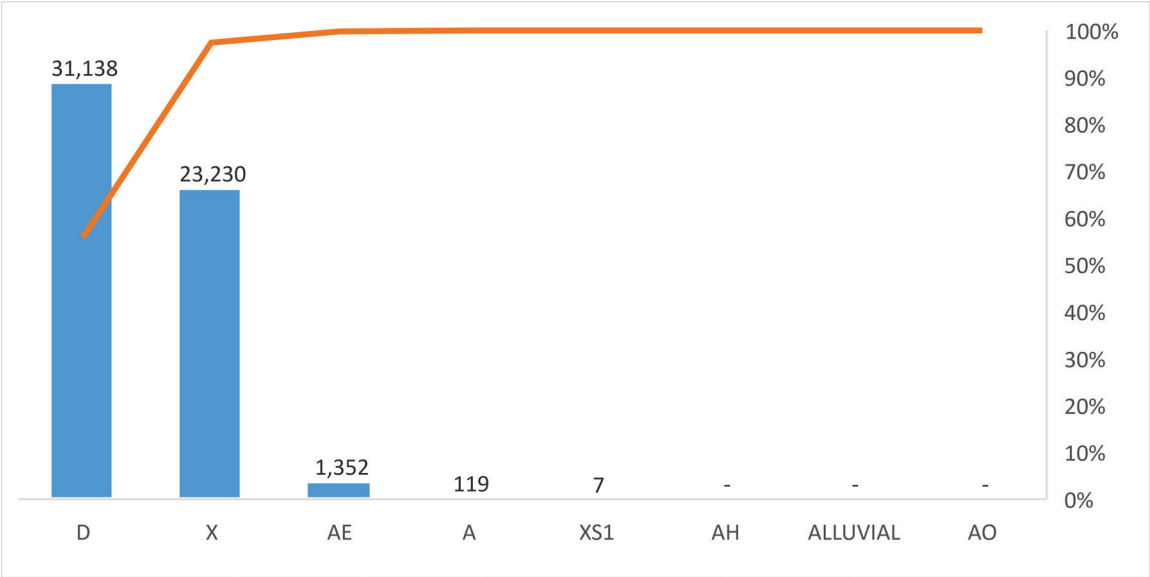


Figure 127 - Rincon Creek SFHA in Acres

The Rincon Creek watershed encompasses Chiminea Canyon Wash, Coyote Wash, Madrona Canyon Wash, Rincon Creek, Rincon Valley Wash, and Wasp Spring Wash. The majority of the watershed is undeveloped with over 5700 ft. of overall elevation change, into the Rincon Mountains. There is intermittent low-density development in the Rincon Valley. Other than transportation crossings, the watercourses are predominately natural. The watershed lies with in flood control jurisdiction of Pima County, except for a small area just upstream of the confluence with Pantano Wash. Storms that would trigger flooding in the watershed include intense localized summer storms and long duration winter storms.

The watercourse in the watershed with 1% annual peak discharges in excess of 10,000 cfs is Rincon Creek. Watercourses with discharges in over 2000 cfs, include the Coyote Wash and the Unnamed Tributary on the northern edge of the watershed. Other named watercourses in the watershed have unknown discharge rates.

The tale below provides a summary of the historic USGS gaging station records.

Table 33 - Rincon Creek Watershed USGS Gages

USGS Gaging Station	Rincon Creek near Tucson, AZ 09485000
Period of Record	1953-07-30 to 2015-08-11
Watershed Area (sq. m)	44.8
Flood Peak of Record (cfs)	15,000
Date	7-31-2006
FIS Discharge (cfs)	16,000

The table below summarizes Pima County's Alert Gages. The locations are from the District's ALERT map.

Table 34 - Rincon Creek Watershed ALERT Streamflow Gages

Pima County ALERT Gage	Rincon Creek at X-9 Ranch ID: 4113
Location (Latitude, Longitude)	(32.1298, -110.626)
Period of Record	2001-07-06 to Present
Watershed Area (sq. m)	44.66
Flood Peak of Record (cfs)	15920
Date	02-04-2011

Table 35 - Rincon Creek Watershed ALERT Precipitation Gages

Pima County ALERT Gage	Rincon Creek at X-9 Ranch ID: 4110
Location (Latitude, Longitude)	(32.1299 -110.6257)
Period of Record	1990-06-14 to Present

The table below summarizes regulatory discharge locations. The locations are from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 36 - Rincon Creek Watershed Regulatory Discharges

Rincon Creek	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Upstream of confluence with Pantano Wash	21,000	81.1	FEMA Flood Insurance Study
Upstream of Confluence with Coyote Wash	18,500	60.7	"
At USGS Gaging Station at Sentinel Butte	16,000	44.8	"

The flood of record on Rincon Creek was a convective storm in July 2006, but rain on snow events can also cause flooding of this watershed.

Flood peak timing downstream of the ALERT stream gage located approximately 8 miles upstream of Old Spanish Trail is not known. Flood hazards associated with the watercourses include sediment accumulation and access at the Old Spanish Trail and Camino Loma Alta crossings.

The Flood Insurance Rate Maps designate floodplains for Rincon Creek (AE) and portions of five unnamed tributaries (A). In addition, Rincon Creek has a mapped Floodway. The floodplain mapping utilized 1986 topography on NGVD-29 vertical datum. No additional floodplain mapping is available for the named watercourses in the watershed.

C.1.10.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas.

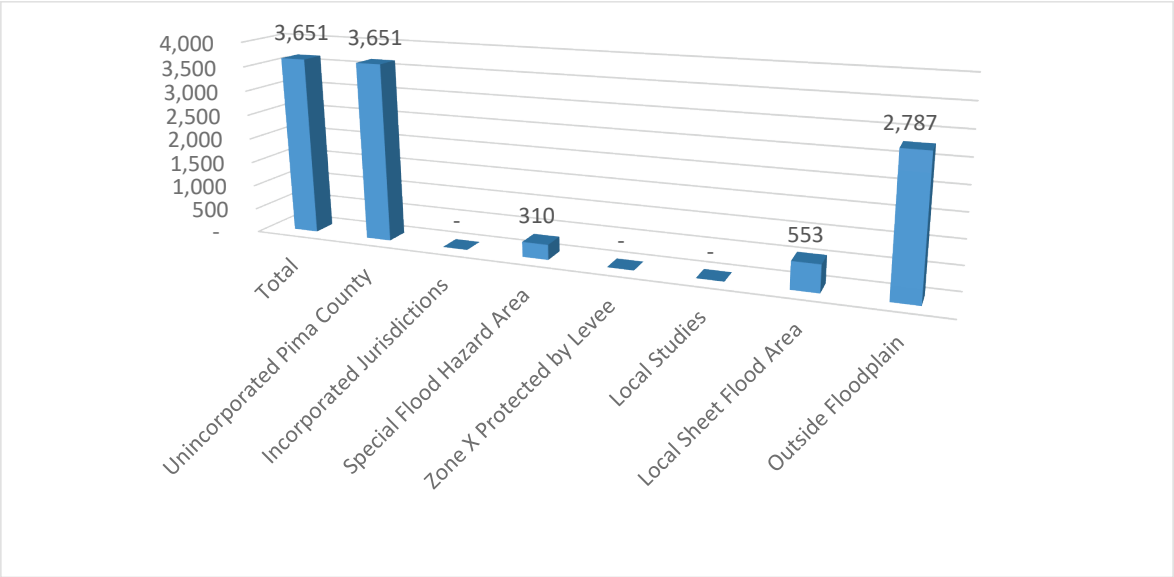


Figure 128 - Rincon Creek Watershed Population Distribution

While Saguaro National Park preserves the mountainous headwaters, the private land is located along the major wash corridor.

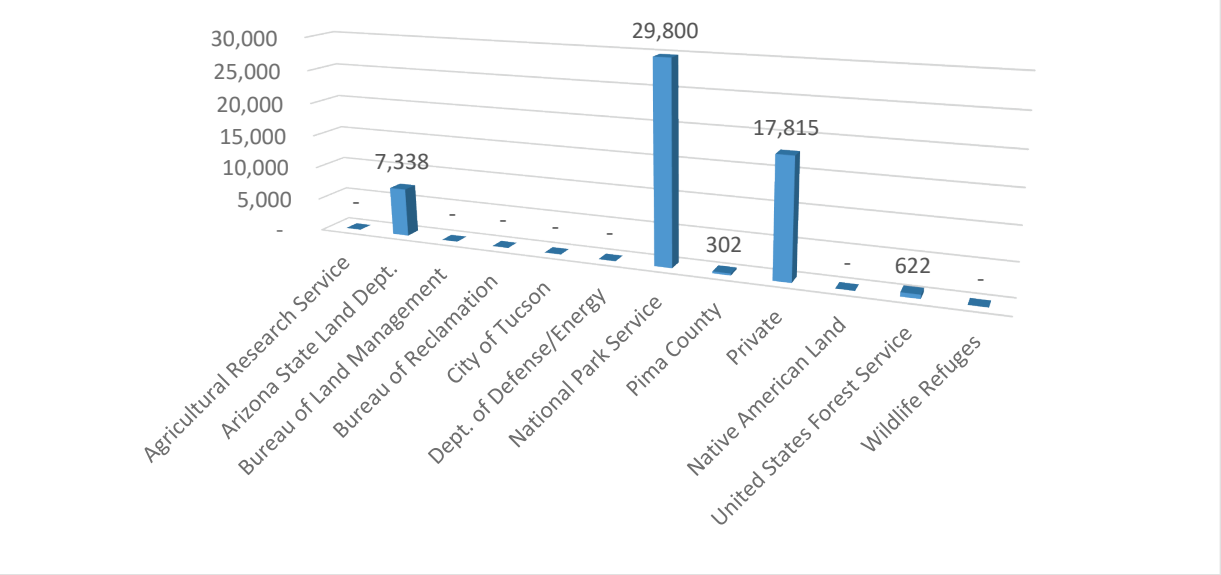


Figure 129 - Rincon Creek Watershed Ownership in Acres

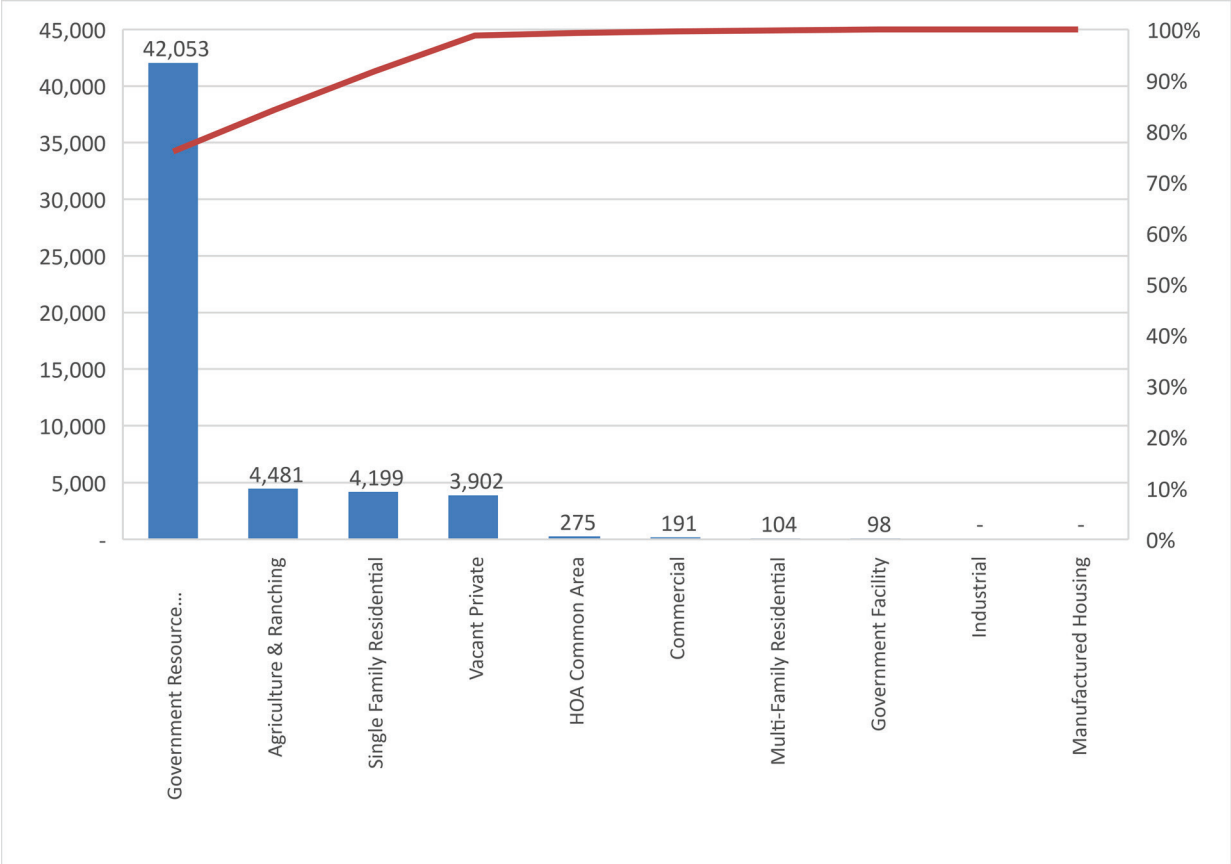


Figure 130 - Rincon Creek Watershed Land Use in Acres

The map below shows the distribution of these uses.

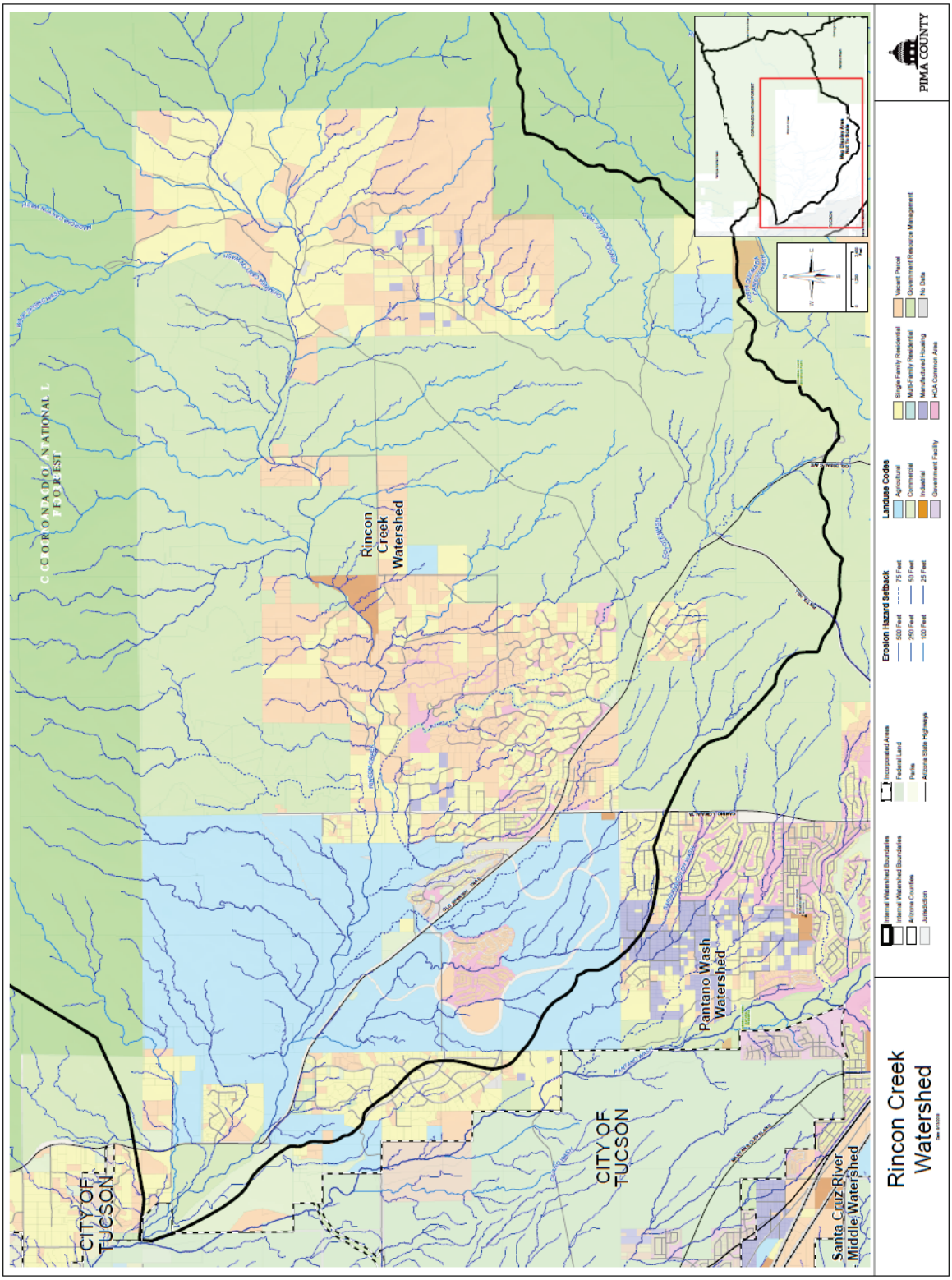


Figure 131 - Rincon Creek Land Use Map

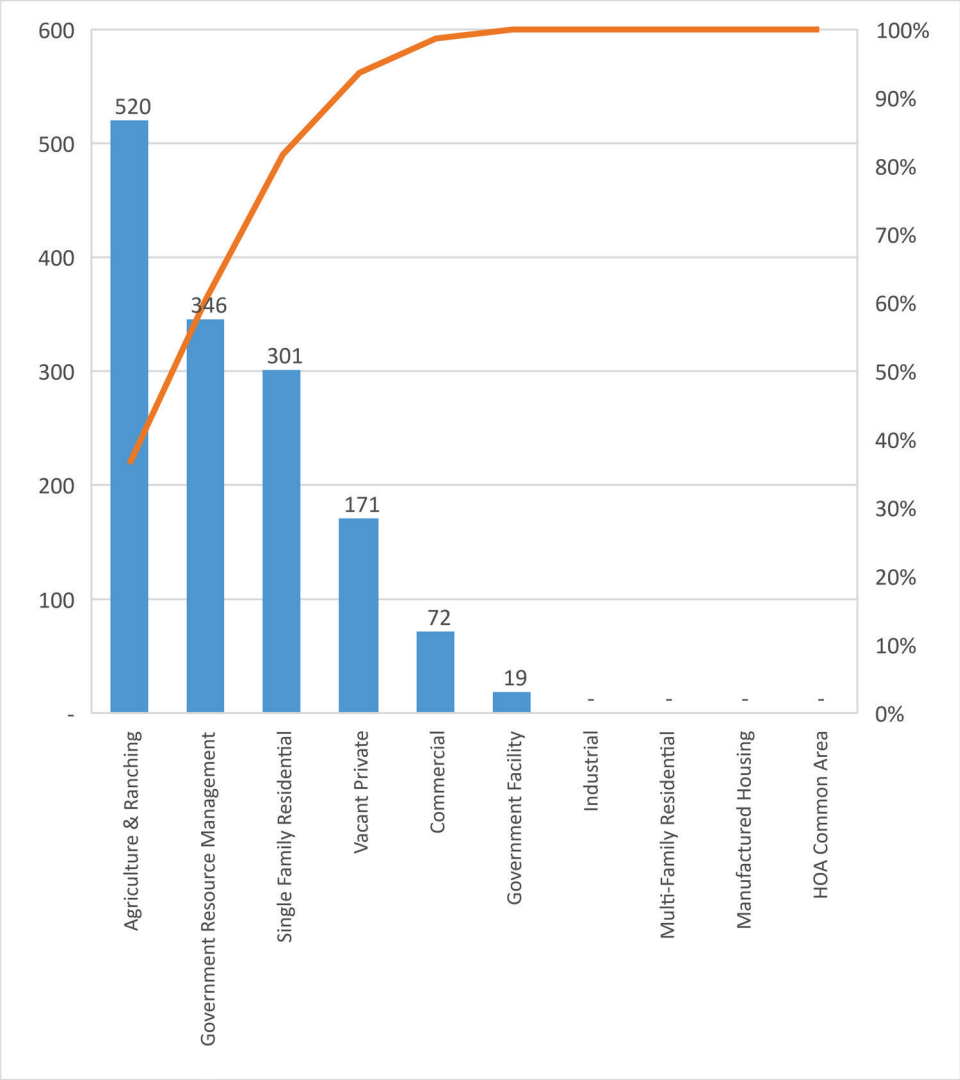


Figure 132 - Rincon Creek Floodplain Land Use

Downstream floodplain land use is still largely agricultural. Clusters of residential development exist around minor upstream tributaries that FEMA, the District nor landowners have mapped.

C.1.10.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 3,978 acres of Pima County Regulated Riparian Habitat in this watershed. There are also 34,924 preserved acres in this watershed, including 325 in regulatory floodplain.

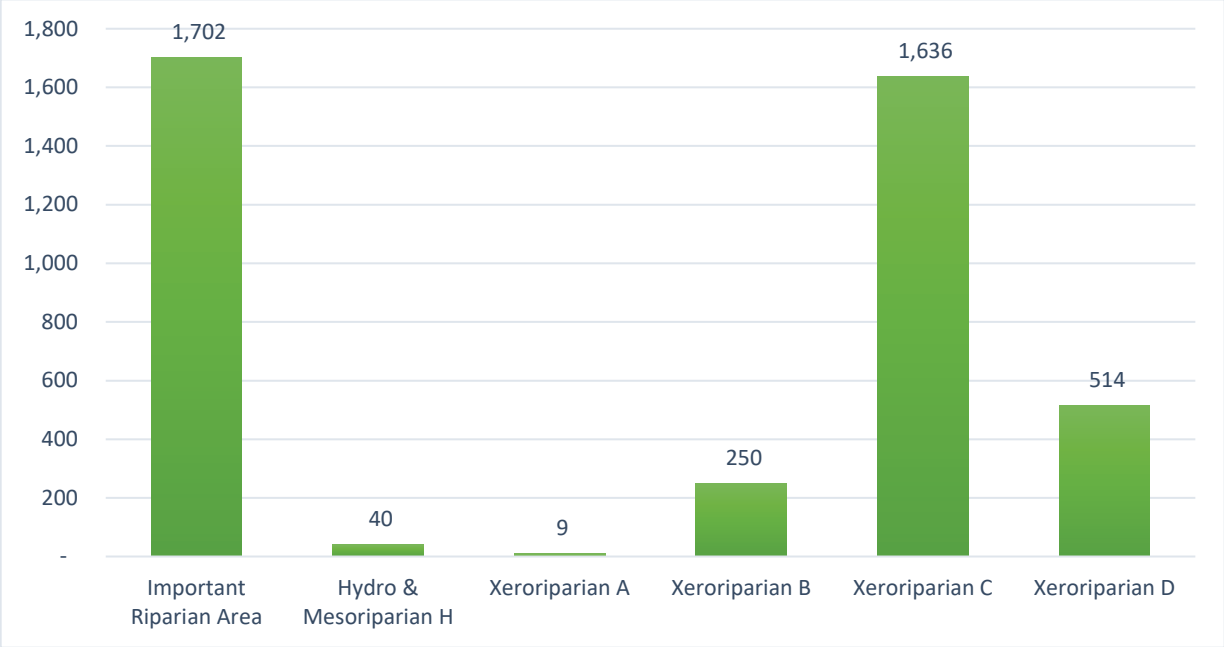


Figure 133 - Rincon Creek Watershed Riparian Habitat in Acres

The presence of water and connectivity between the Rincon Mountains and Tucson basin make the Rincon a popular wildlife corridor as evidenced by the tracks pictured below taken by District open space inspectors.

C.1.10.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

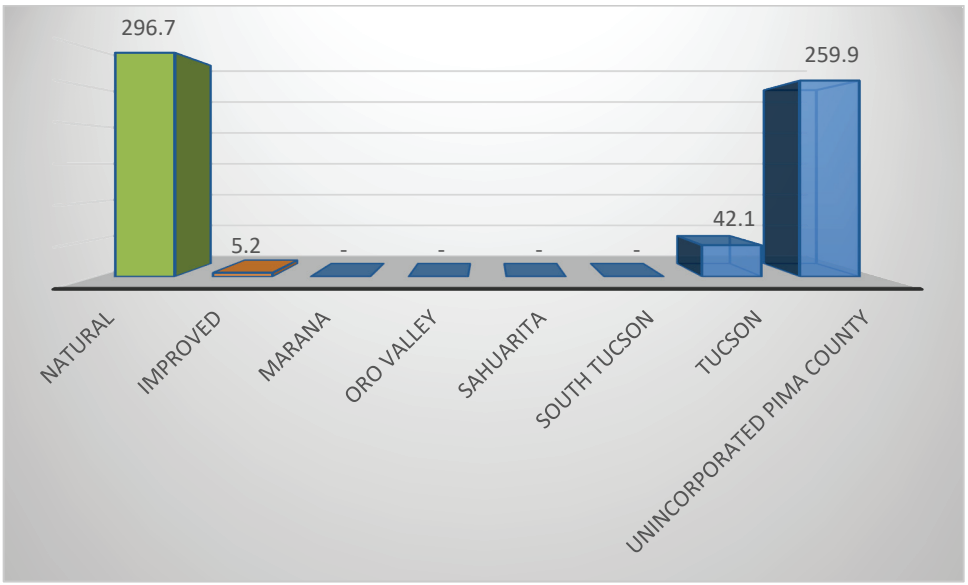


Figure 134 - Rincon Creek Drainageway Acreage

The stream gauge on this channel is located at the X-9 Ranch (4113). Very large flows may affect residential structures in the X-9 Ranch area or downstream near Old Spanish Trail at Ranchos Pequenos. Stream flow may affect the crossing at Camino Loma Alta although it is not at-grade, as well as the at-grade crossings at Old Spanish Trail and Harrison Road at Pantano Wash. Little travel time information is currently available, but assuming an average channel velocity of 10 fps, travel time from 4113 to Camino Loma Alta is approximately 45 minutes, Old Spanish Trail is approximately 70 minutes, and to Harrison Road is approximately 2 hours. Travel times change through the rainy season as the channel becomes wetted. Although the Camino Loma Alta crossing is not at-grade, culverts may be plugged causing flow to overtop the road. Streamflow of 500 cfs at Rincon Creek (4113) may affect the Camino Loma Alta and Old Spanish Trail crossings and therefore ALERT staff contacts the City of Tucson. Streamflow of 1,000 cfs at 4113 may affect at-grade crossing at Harrison Road at Pantano Wash; again, at this flow ALERT staff contacts the city Streets Maintenance Division. Streamflow of 5,000 cfs at 4113 may affect homes at Ranchos Pequenos in this case senior staff decides whether the information to contact OEM.

The County approved several residential subdivision prior or near to the year 2000. At that time, the District reviewed plats for FEMA requirements only. Other extra-department staff reviewed drainage planning for subdivisions were reviewed by other staff, and reviews did not thoroughly assess requirements for District threshold floodplains (1% chance peak discharge of 100 cfs or greater) and no adverse impacts to adjacent properties. As a result, the drainage planning for several subdivisions in this watershed did not include developer-funded drainage improvements. In some cases, every building permit along a regulatory wash required an individual Floodplain Use Permit. In 2007, the District assumed responsibility for all subdivision and commercial drainage reviews, requiring developers to map all regulatory floodplains, erosion hazard setbacks and mapped riparian limits. The Rocking K subdivision plat bounded by Camino Loma Alta and Old Spanish Trail identifies open

space floodplain areas and necessary drainage infrastructure so that individual floodplain use permits will not be a part of future development. Permitting in older subdivisions will continue to require individual permit review.

C.1.10.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- S. Avenida de la Potranca (Ranchos Pequenos, Rincon Creek)
- E. Camino del Garanon (Ranchos Pequenos, Rincon Creek)
- E. Old Spanish Trail (Ranchos Pequenos, Rincon Creek)
- A breach has occurred on a levee SE of Ranchos Pequenos on a tributary to Rincon Creek, supplying sediment downstream that is causing problems on Old Spanish Trail. There is a diversion of flow into this watershed upstream at a stock tank. The District has cleaned it out, and DOT will maintain it.

Infrastructure

- A major breach of the mine west of Old Spanish Trail could capture flows from Rincon Creek and cause severe damage to the road.

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

C.1.10.6 Floodplain Management

Future needs identified by District staff include:

- Head-cutting tied to Pantano
- Residents infrastructure demands for access along Old Spanish Trail also Jeremy Wash tributary
- Continue to require identification of floodplains, erosion hazard setbacks and mapped riparian limits at the time of subdivision platting.

Ref# 1.2.e Participate in monitoring groundwater change with other responsible parties

- Conduct groundwater depth & quality monitoring (CC, AVG, SS, Sopori)
- Operate Marana High Plains groundwater recharge project (SCRL)

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

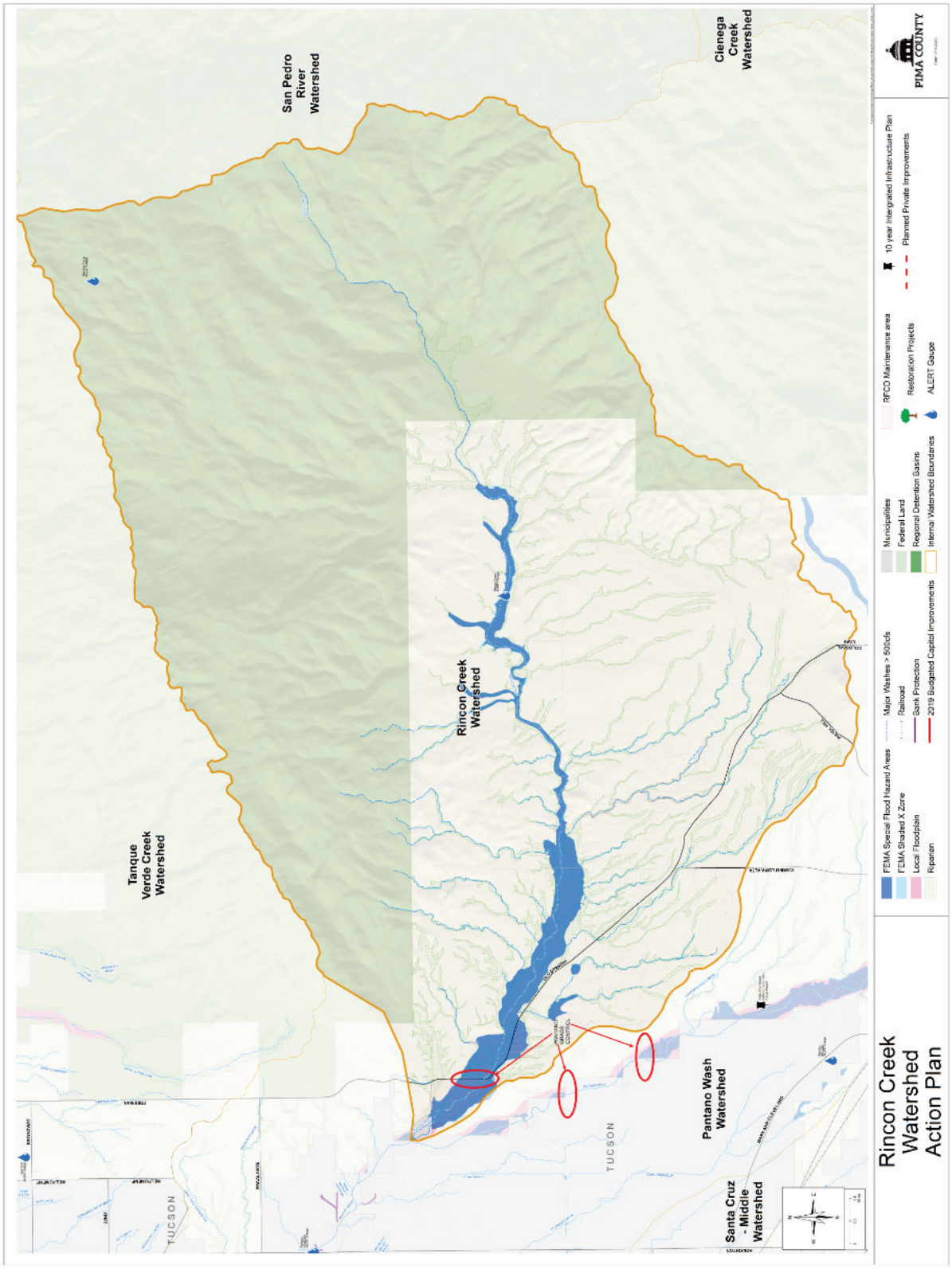


Figure 135 - Rincon Creek Action Plan Map

C.1.11 Sabino Creek

Sabino Creeks' origins are near the summit of Mount Lemmon and the community of Summerhaven. Originating at nearly 9000', it descends steeply through dramatic canyon walls before spilling out onto the bajada foothills and geologic floodplains associated with the Tanque Verde where they merge to become the Rillito Creek. Within Pima County, it is comprised of 140,539 acres (219.6 square miles).

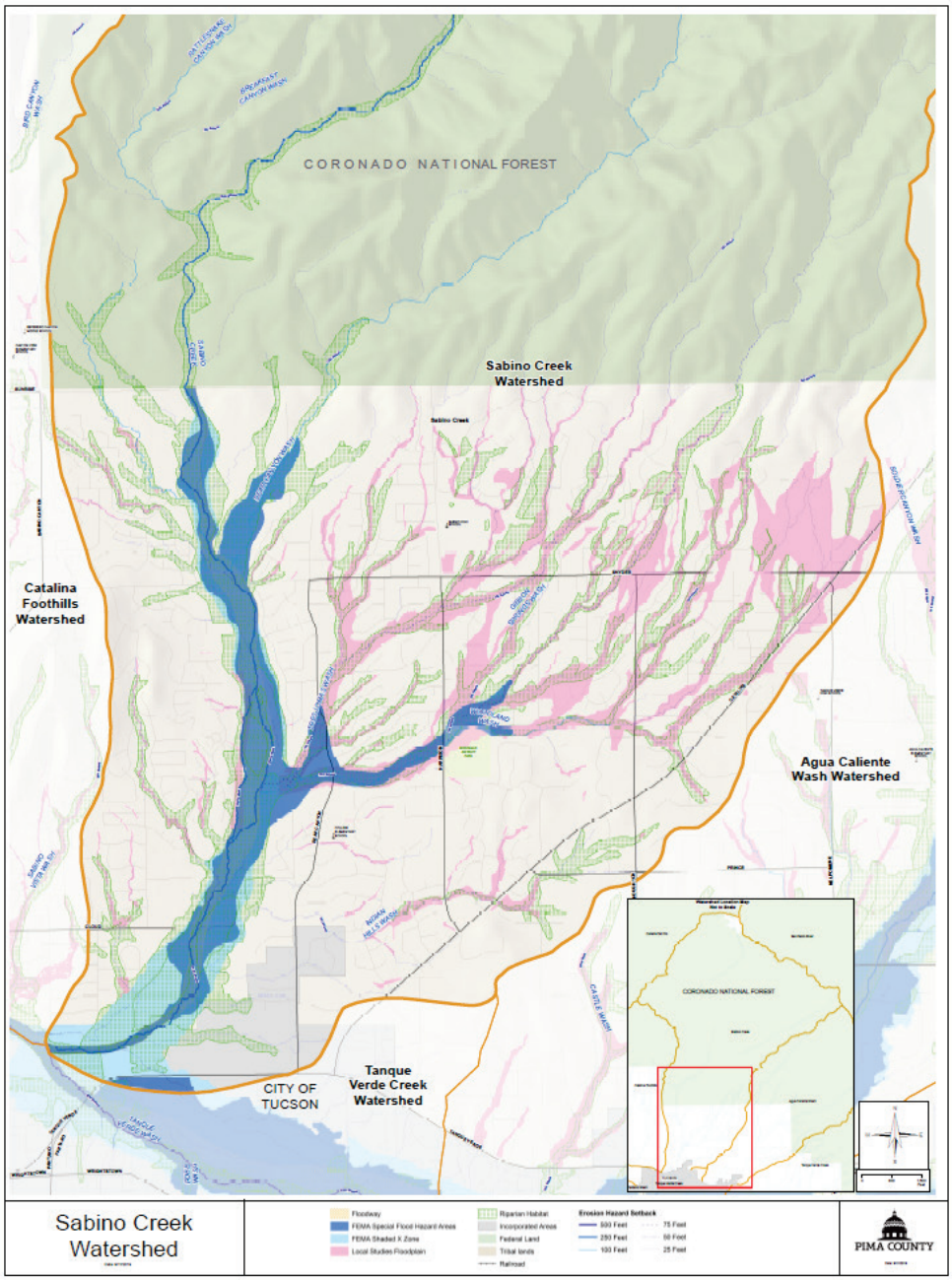


Figure 136 - Sabino Creek Watershed Map

C.1.11.1 Flood Characteristics

In addition to 522 acres of SFHA zones included on the bar chart below, there are also 844 acres of District Special Studies Floodplains in this watershed.

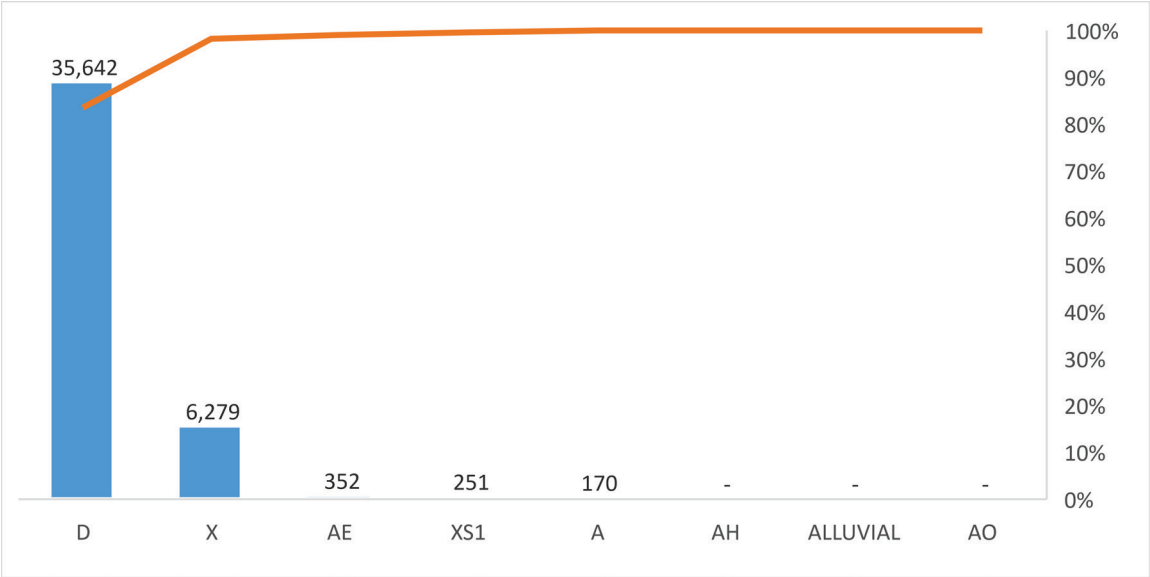


Figure 137 - Sabino Creek SFHA in Acres

Unlike most of Pima County flow, flow in these watersheds can continue for extended periods, and the upper watersheds may even experience perennial flow. Flow measurement in the Sabino Creek is more complete than many other watersheds. A summary of the USGS gaging station records is as follows:

Table 37 - Sabino Creek Watershed USGS Gages

USGS Gaging Station	USGS 09484000 SABINO CREEK NEAR TUCSON, AZ	USGS 09484200 BEAR CREEK NEAR TUCSON, ARIZ.
Period of Record	Jul. 1932 to Jan. 2015	Nov. 1960 to Dec. 1978
Watershed Area (sq. m)	35.5	16.3
Flood Peak of Record (cfs)	15,700	1,400
Date	31-Jul-06	18-Dec-78

These records indicate that floods in the Sabino Creek watershed can occur from all three of the three primary flood mechanisms that occur in Pima County, convective storms, tropical storms and frontal storms. Rain on snow events occur in this watershed when frontal storms produce rain on existing winter snow.

The table below summarizes Pima County's Alert Gages. The locations are from the District's Alert map.

Table 38 - Sabino Creek Watershed ALERT Streamflow Gages

Pima County Alert Gage	Sabino Creek near Marshall Gulch ID: 2293	Sabino Creek at USFS Dam ID:2163	Bear Creek ID: 2184
Location (Latitude, Longitude)	(32.42,-110.7519)	(32.3147,-110.8106)	
Period of Record	2003-07-17 to Present	1997-09-26 to Present	2018-06-29 to Present
Watershed Area (sq. m)	3.34	53.1	16.3
Flood Peak of Record (cfs)	355	13376	
Date	03-10-2012	07-31-2006	

Table 39 - Sabino Creek Watershed ALERT Precipitation Gages

Pima County Alert Gage	Sabino Canyon at Marshall Gulch ID: 2290	Al Marah ID: 2190	Bear Canyon Wash ID: 2180	Whitetail ID: 2150	Green Mountain ID: 2280	Sabino Creek ID 2160	Mt Lemmon ID: 1090
Location (Latitude, Longitude)	(32.2853,-110.5636)	(32.279969-110.802161)		(32.413105,-110.731905)	(32.394576,-110.687284)	(32.314635,-110.810856)	(32.44264,-110.788513)
Period of Record	2003-07-17 to Present	1994-08-06 to Present	1993-03-15 to Present	1986-08-27 to Present	1986-06-17 to Present	1987-07-02 to Present	1985-05-10 to Present

Below are excerpts for Sabino Creek and major tributaries from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 40 - Sabino Creek Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Agua Caliente Wash Upstream of confluence with Soldier Canyon Wash	12,000	28.60	FEMA Map Revision (11-09-1817S)

Flood characteristics vary greatly on the watershed. While flow is primarily constrained in mountainous channels, distributary flow patterns develop where these channels enter the valley floor at the apex of alluvial fans, and residential properties are at risk for flood damage where drainage infrastructure does not exist. Potential for overbank flow leading to flooding exists along the Sabino Creek, particularly at its confluence with Tanque Verde Creek.

Likewise, flood characteristics themselves vary greatly depending on whether the event is convective event, such as the July 31, 2006 event, which was produced by a high intensity, shorter duration event, or a rain on snow event, which can release a higher volume of water over a longer period. Tributary flooding is likely during short and long duration storms while main stem flooding typically occurs during long duration or overlapping storm events.

Sabino Creek enters the valley floor onto alluvial fans, which is where most of the development has occurred. Flows on these fans can cause erosion, deposition and channel avulsion. The July 31, 2006 also produced debris flows on these alluvial fans, which resulted in flooding of some structures that would not have been at risk if the debris flow had not altered the flow pattern at the apex in Soldier Canyon. In addition, even where flow-patterns were not altered, such as in Sabino Canyon upstream of Bear Canyon, the sediment released in the debris flow filled the channel and reduced the flood capacity.

As flows enter the valley floor in the main channel of Tanque Verde creek, flows are contained. Downstream of Sabino Creek the District has installed bank protection to limit the potential for channel migration.

C.1.11.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas.

Figure 138 - Sabino Creek Watershed Population Distribution

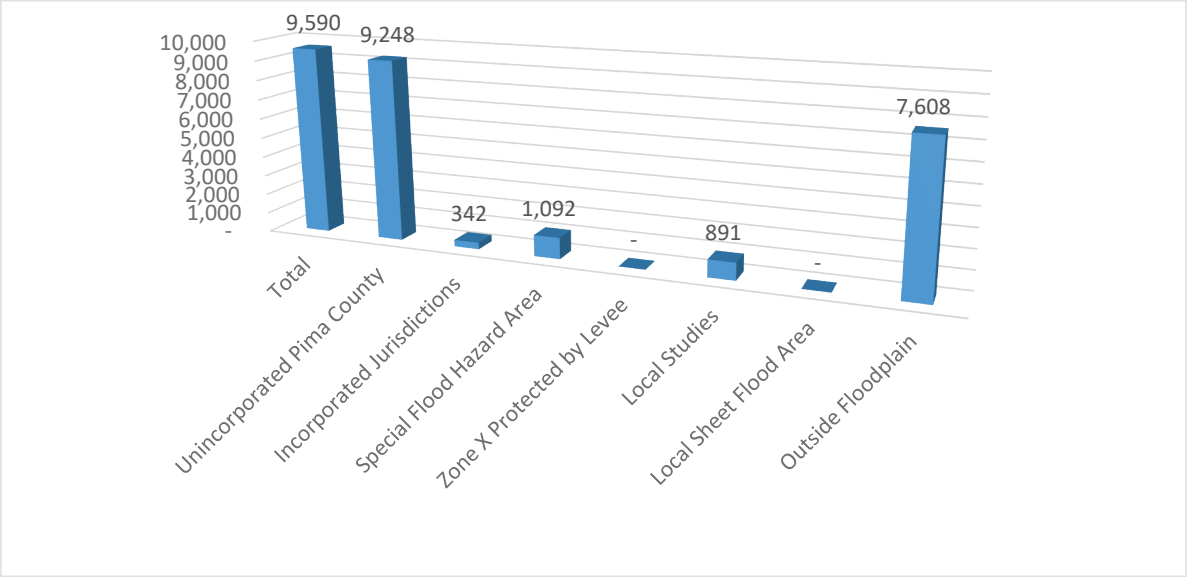
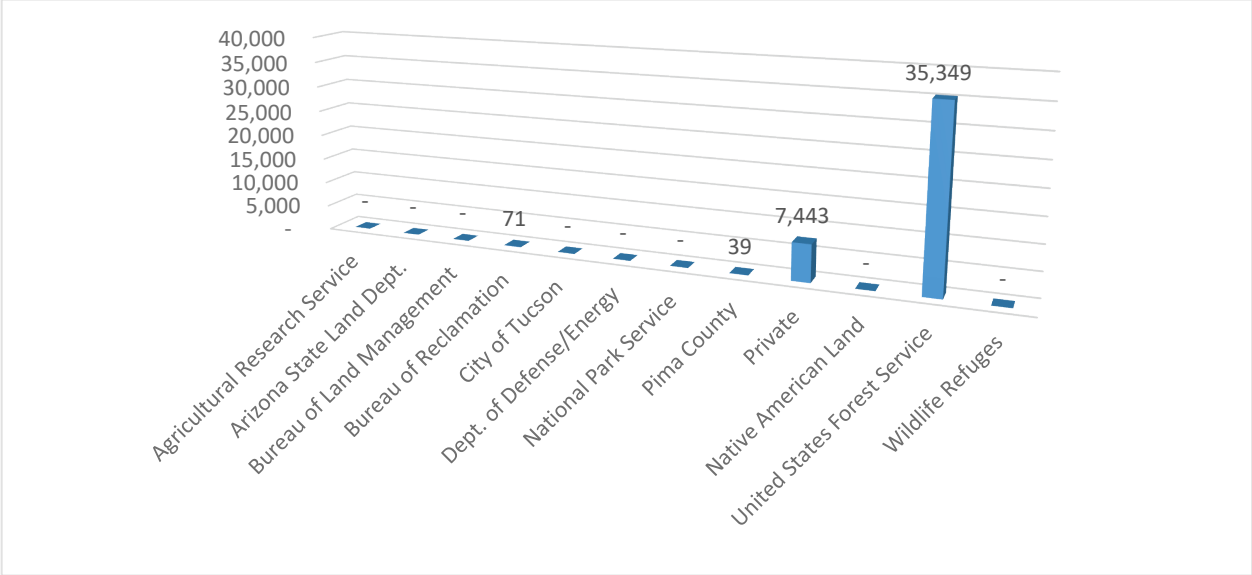


Figure 139 - Sabino Creek Watershed Ownership in Acres



Single family residential is the predominant use throughout this watershed.

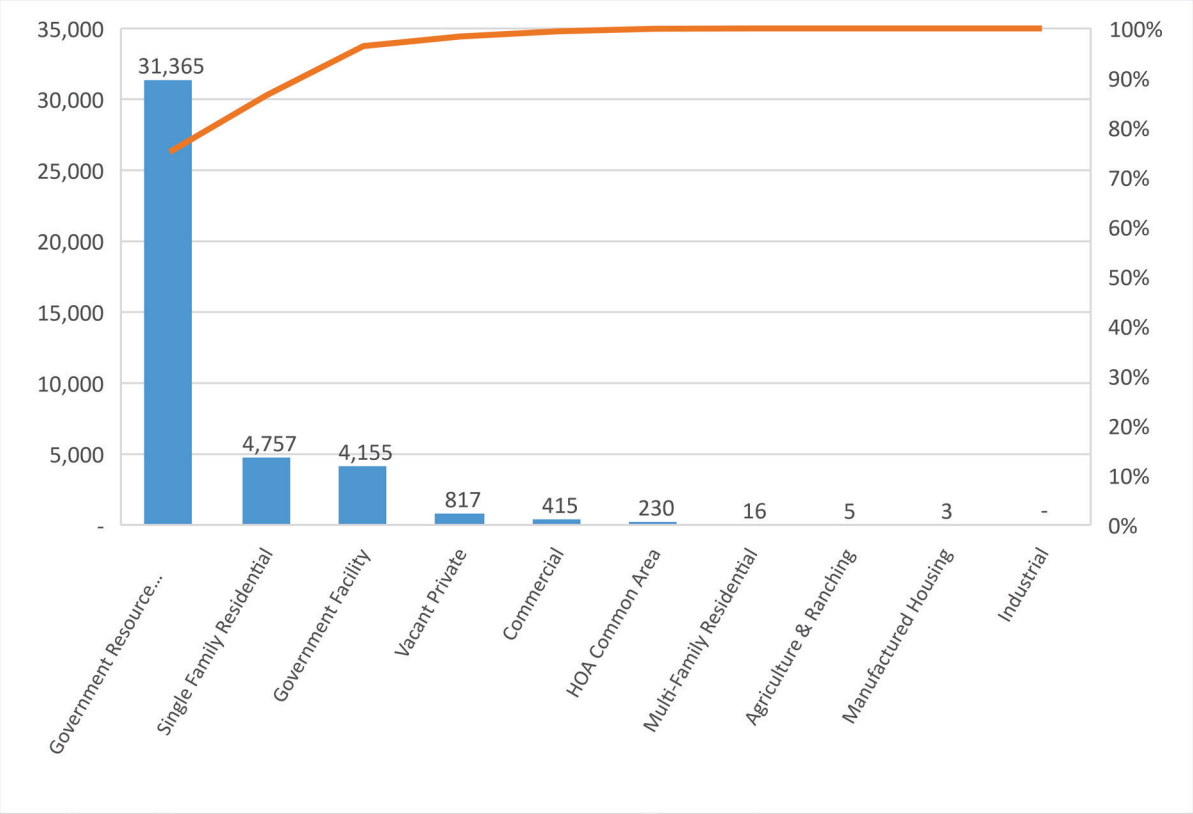


Figure 140 - Sabino Creek Watershed Land Use in Acres

In recent years, the County has approved increased densities on areas previously left open due to flood and other limitations. While build out of improved developments and some lot splitting can be expected few large tracts are available for development. Furthermore, a leading local non-governmental organization, the Watershed Management Group has embarked on a campaign to restore perennial flows in Sabino Creek by working with willing landowners to install water-harvesting features, disconnecting impervious surfaces, groundwater withdrawal management and retiring wells.

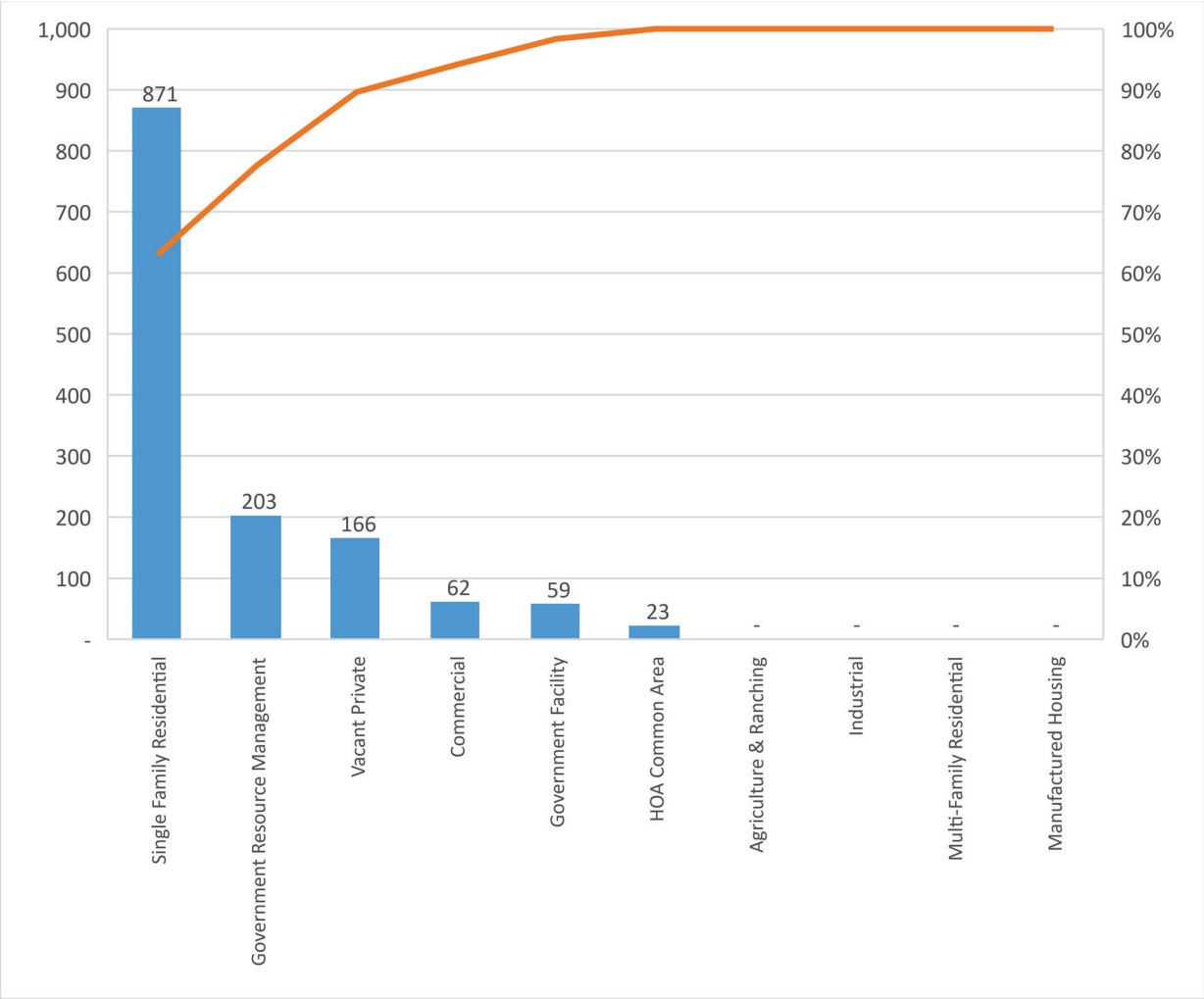


Figure 141 - Sabino Creek Floodplain Land Use

As noted above for these watersheds as a whole single family residential is the largest use of private floodplain land. The map below shows these land use patterns.

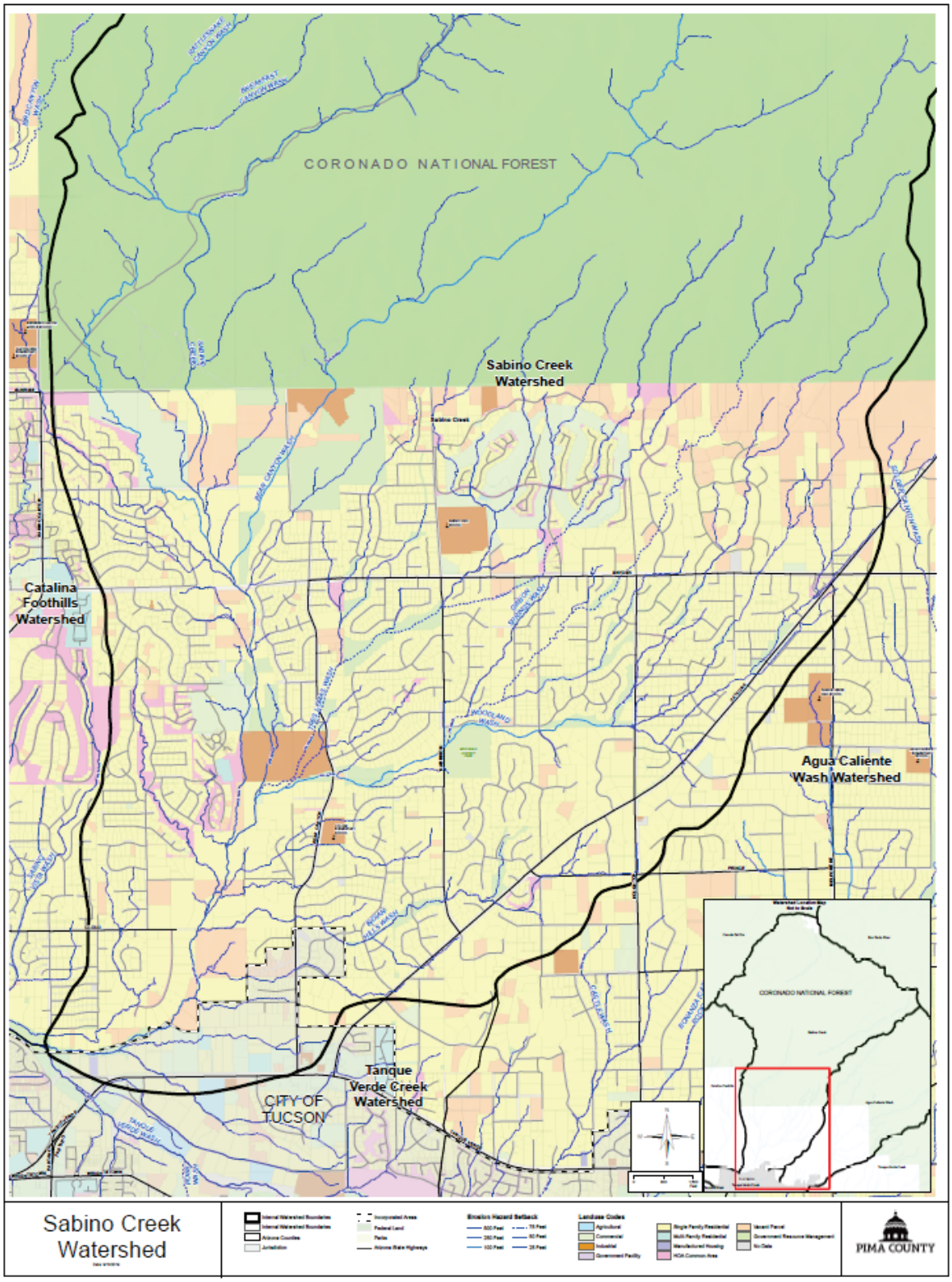


Figure 142 - Sabino Creek Watershed Land Use Map

C.1.11.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 1,112 acres of Pima County Regulated Riparian Habitat in this watershed; in addition, there is 959 acres of IRA. It is also interesting to note the quality of this habitat as reelected in the higher percentages of H, A and B. There are also 35,214 preserved acres in this watershed, including 68 in regulatory floodplain.

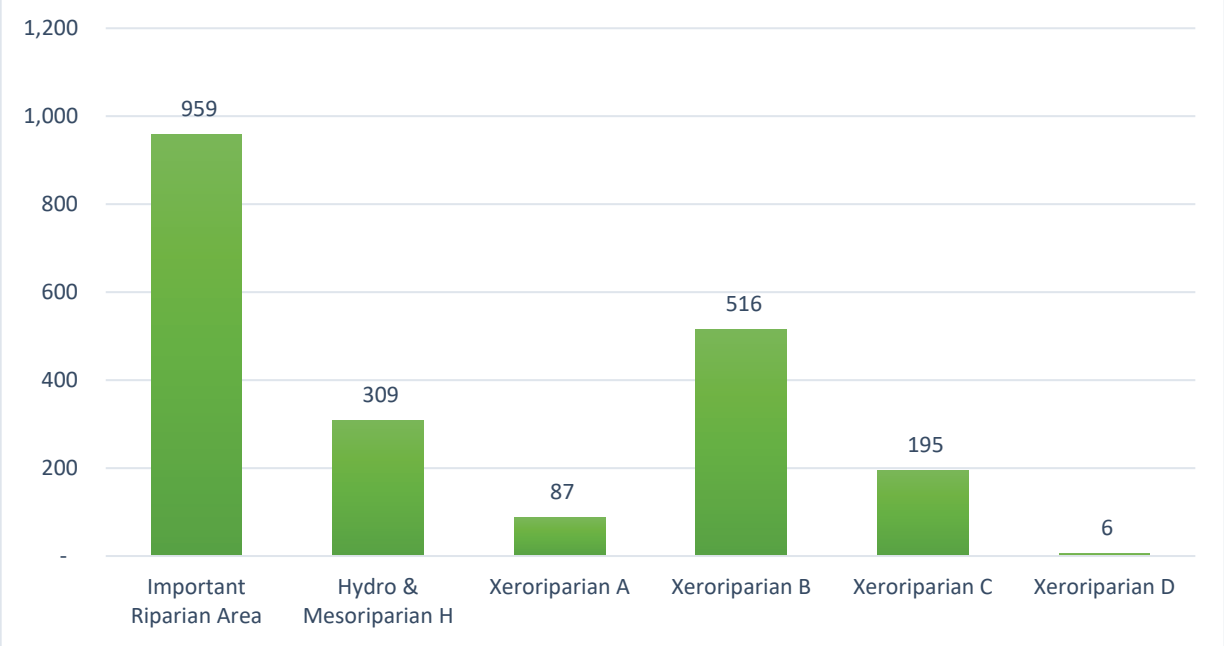


Figure 143 - Sabino Creek Watershed Riparian Habitat in Acres

The confluence with the Rillito as well as the canyon headwaters contain some of the largest networks of springs, surface flows and shallow groundwater anywhere in the County. This water availability has contributed both to the biologic, historic and cultural significance of this region as well as current high property and recreational amenity values. Today, landowners and community groups including, Friends of Redington Pass, Watershed Management Group, Coalition for Sonoran Desert Protection and Audubon Society are pursuing preservation and enhancement of these values and they warrant the full measure of protection afforded by floodplain management practices.

C.1.11.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

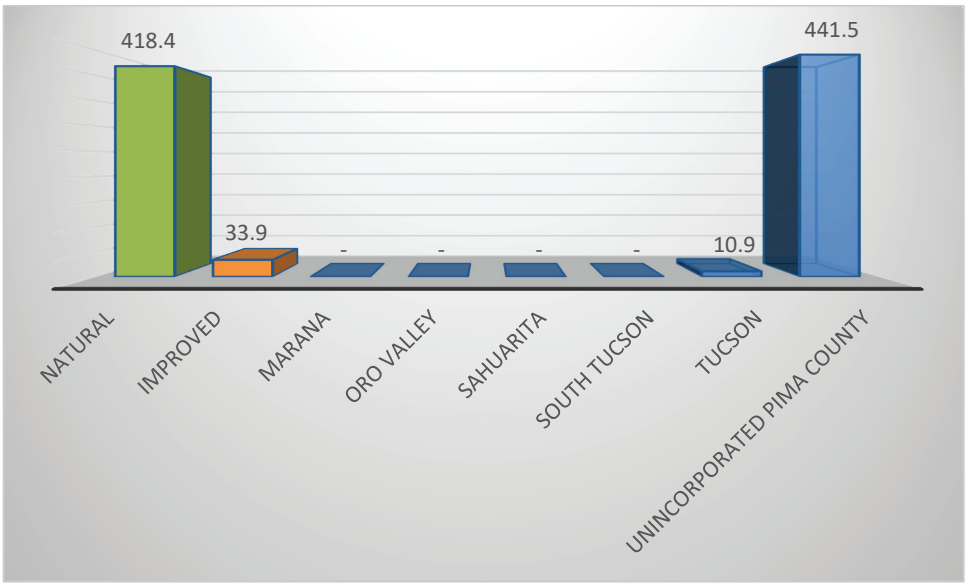


Figure 144 - Sabino Creek Drainageway Acreage

In 2010, the District began mapping tributaries to larger watercourses where typically FEMA mapping existed on the watercourse but not on the tributaries. Performing these studies at a level of detail suitable for floodplain management and permitting, allowed better-informed permitting decisions. Notification of constituents of improved floodplain information is part of the protocol for these recent mapping studies. Both the District and property owners can make decisions that decrease flood risk to safety and property.

Tanque Verde Creek can convey large amounts of flow. The Agua Caliente 2,200 (+/-) foot long soil cement levee is located on along the western embankment of the upstream of the Tanque Verde Road Bridge. The Agua Caliente spur dike is not a levee but had to pass many of the FEMA levee criteria in order for them not to map the floodplain as if the spur dike failed. It is located upstream of Tanque Verde Road along east embankment of the Agua Caliente Wash. The southern portion of the spur dike, adjacent to the channel, is soil cement. On the northern end, the structure bends to the east and becomes an earthen embankment with armoring. There is one flap gate upstream of the bridge

There are stream gauges at Chiva (ALERT ID# 2073), Tanque Verde Guest Ranch (ALERT ID# 2093), Tanque Verde Road (ALERT ID# 2109), and Sabino Canyon Road (ALERT ID# 2123). There is no bank protection upstream of Tanque Verde Road. The primary concern with higher discharges is overbank flooding resulting from high levels of flow. Locations of concern include 49's Country Club that the District has identified as a Repetitive Loss Area and the Woodland Road area. The District estimates initial breakout at 49er's to occur at 8,000 – 9,000 cfs. The district estimates initial breakout at Woodland Road at 13,000 – 15,000 cfs. The full report; Flood Hazard and Early Warning Analysis Tanque Verde Creek, includes inundation maps. Flows in the Tanque Verde that are a result of combined flows from the Tanque Verde Creek, Agua Caliente Wash, and Monument Wash impacts this area.

Impacted at-grade crossings include Wentworth Road and Tanque Verde Loop Road. At 200 cfs the COT Street Maintenance Division is contacted. Streamflow of 5,000 cfs at Chiva Tank (2073) or streamflow of 8,000 cfs at Tanque Verde Guest Ranch (2093) may affect 49's area or Woodland Road area. At these rates, senior staff decides whether to notify OEM. Due to sediment deposition near the gauge, judgment is required on the part of the Storm Monitor.

Large flows in Sabino Creek may affect numerous road crossings in the recreation area and some residential access and structures downstream of the USFS boundary. Lower flows are likely to overtop driveway access to some residential structures below the Forest Service boundary. The stream gauge on this channel is located at the dam in the US Forest Service (USFS) recreation area. No at-grade Crossings below the National Forest boundary are impacted. At streamflow of 2,000 cfs and flood stage of 3.4 feet at Sabino Canyon Dam (ALERT ID# 2163) residences in Sabino floodplain may be impacted and therefore senior staff decides whether to notify OEM.

C.1.11.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- Woodland Wash and other area channels do not have enough capacity to convey the base flood.
- N. Bear Canyon Road
- N. Camino Seco - Repetitive Loss Property, with claims in 1993 and 1999.
- E. Cloud Road
- N. Palisade Drive
- N. Hidden Valley Road
- Erosion concerns on Sabino Creek near Cloud Road
- Springs may appear and septic systems be adversely affected after significant moisture and/or sustained flows along the eastern Santa Catalina mountain front.

Infrastructure

- Snyder Road is potentially subject to damage along the eastern portion of the Santa Catalina mountain front. Snyder Road is also roughly the breakline between steep slopes and shallower slopes, and is an area of concern with respect to sediment deposition filling channels and causing flows to take unpredictable and uncertain flow paths.

C.1.11.6 Floodplain Management

Future needs identified by District staff include:

- Riparian preservation
- Shallow groundwater
- High value unprotected property
- Cumulative Improvements to non-conforming uses
- Bank reclamation
- Warning System Outreach

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan spreadsheet included as includes the following:

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify areas of shallow groundwater
- Identify debris flows

Figure 145 - Sabino Canyon Debris Flow Photo

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Provide assistance to property owners related to bank reclamation
- Work with responsible parties to address flooded roads

Ref# 5.2.e Develop alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

- Develop and implement an erosion mitigation plan using natural channel design techniques

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

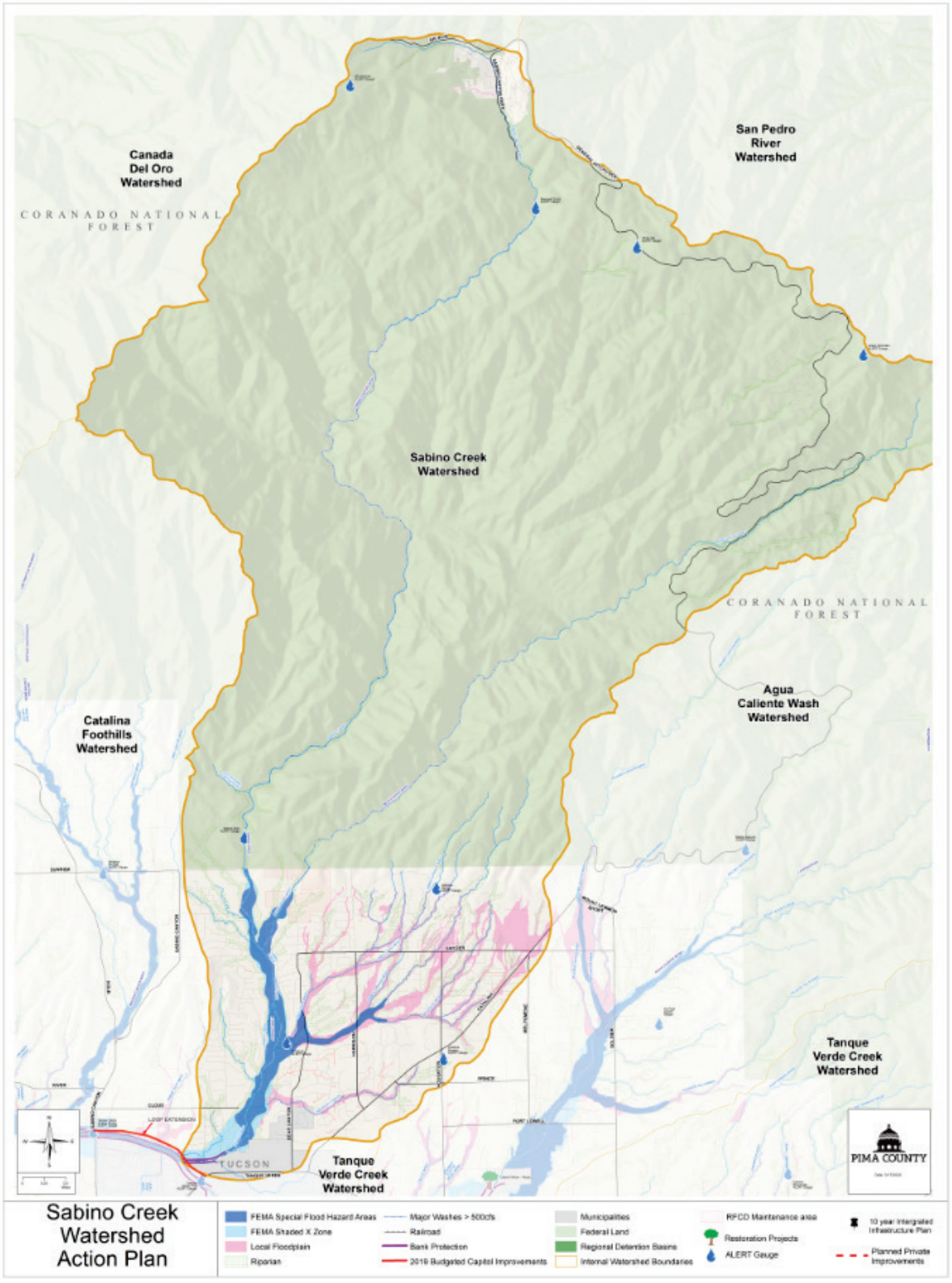


Figure 146 - Sabino Creek Action Plan Map

C.1.12 Santa Cruz River – Lower

This watershed is the smallest with the Santa Cruz River as the primary watercourse. This watershed begins immediately downstream of a bedrock high near Avra Valley Rd where the Floodplain of the Santa Cruz River is about ¼ mile wide. It then widens to several miles wide as it enters Pinal County draining over 3,600 square miles upstream of the confluence with the Brawley Wash to the west which drains an additional 1,200 square miles. The northern downstream terminus for the purposes of this plan is the Pima and Pinal County line. It is comprised of 24,990 acres (39 square miles), of which 15,266 are within the Town of Marana.

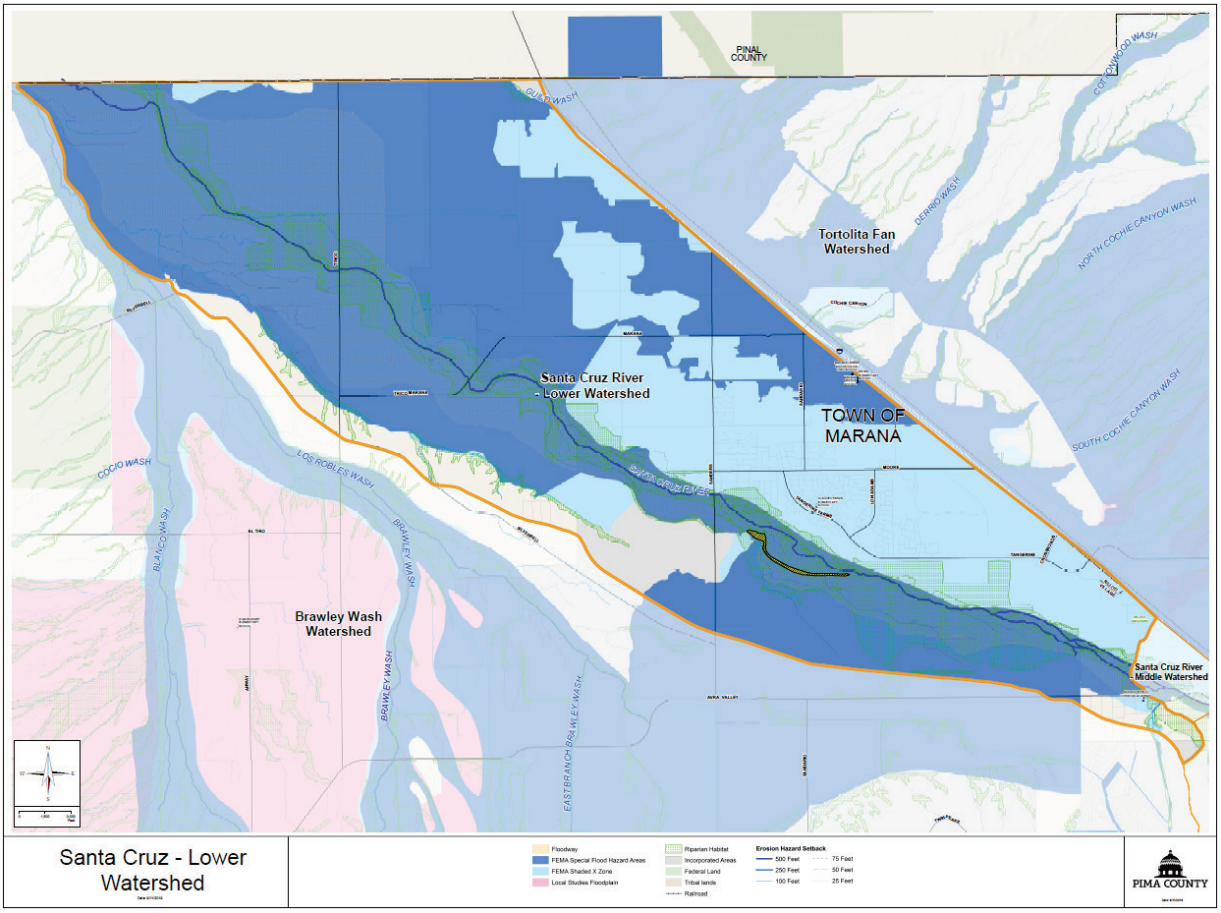


Figure 147 - Lower Santa Cruz River Watershed Map

C.1.12.1 Flood Characteristics

There are 16,147 acres of SFHA mapped for the Santa Cruz River and overbank areas, the eastern Tortolita alluvial fans, and along the Union Pacific Railroad. In addition, the overbank areas of the Santa Cruz River include shaded Zone X areas of 1% annual chance flood, average depths of less than 1 ft., and areas protected by levees from the 1% annual chance flood.

Excluding X zones, regulatory floodplains cover 65 percent of the total watershed area! This includes alluvial and riverine hazards that require different management approaches.

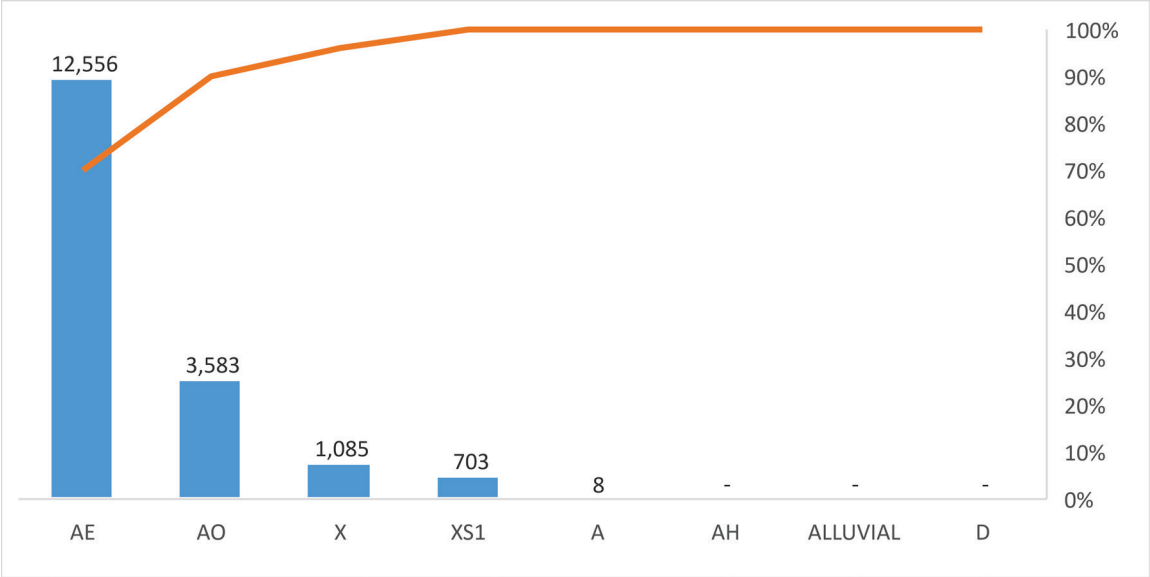


Figure 148 - Lower Santa Cruz River Watershed Federal Floodplain Designations

In 2003 the District constucted the 28-acre Marana High Plains multi-purpose effluent recharge and ecosystem restortion project utilizing Santa Cruz River effluent flows. Through staff's continued management and optimizaitons actions, the project recently reached the full water approriation permitted recharge limit of 600-acre-feet per year.

Pima County water reclamation facilities have discharged effluent to the Santa Cruz River since the 1970's. In its largest public works project, Pima County invested more than $600 million to upgrade the facilities. Completed in 2013, this project significantly improved the quality of water released. Before the facility upgrades, the river was discharging 31,000 acre-feet annually into Pinal County, resulting in a loss of water resources. Following the upgrades, the quality of the reclaimed water increased so significantly that infiltration reduced losses to 14,200 acre-feet. The District, the Pima County Wastewater Reclamation Department, the Pima County Office of Sustainability and Conservation and the Sonoran Institute collaborate to manage these water resources and to monitor health of habitat and wildlife, including four species of fish.

An estimate of discharge to the river is 15,000,000 gallons per day, or 23 cubic feet per second. This level of flow will not have a direct flooding impact; however much of the flow is at low velocities, allowing infiltration and support of heavy vegetation. The increased vegetation should increase bank stability in reaches that do not have

bank protection. Pima County monitors the stream profile and alignment for impacts created in the channel by the perennial low flow of reclaimed water.

Lower Santa Cruz River Flooding

The table below summarizes the Floods of Record at the USGS Gauging Stations on the lower Santa Cruz River.

Table 41 - Lower Santa Cruz River Watershed USGS Gages

USGS Gaging Station	USGS 09486500 SANTA CRUZ RIVER AT CORTARO, AZ	USGS 09486520 SANTA CRUZ RIVER AT TRICO ROAD, NR MARANA, AZ.
Period of Record	October 1939 to present	April 1989 to present
Watershed Area (sq. m)	3,503	3,641
Flood Peak of Record (cfs)	65,000	27,200
Date	2-Oct-83	31-Jul-06
FIS Discharge (cfs)	70,000	70,000

This record indicates that significant flooding can occur along the Santa Cruz River channel during long duration tropical storms. Flow within the river should not be problematic during short duration storms, while fan areas and flat areas without defined conveyances may be at risk for both flood, sediment deposition and erosion hazards during shorter duration storms. The table below summarizes Pima County's ALERT gages. The locations are from the District's Alert map.

Table 42 - Lower Santa Cruz River Watershed ALERT Precipitation Gages

Pima County Alert Gage	Avra Valley Air Park-Santa Cruz Basin ID: 6110
Location (Latitude, Longitude)	(32.429, -111.2251)
Period of Record	1987-08-06 to Present

The table below contains excerpts from the District's Regulatory Discharge Table for discharges that have been determined by studies within this watershed.

Table 43 - Lower Santa Cruz River Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Other Discharge Values, cfs Return Frequencies	Drainage Area, sq. miles	Source of Discharge Information
Santa Cruz River @ Cortaro Road	70,000	21,800 (10%), 48,000 (2%), 107,400 (0.2%)	3,503	FEMA, Flood Insurance Study

Flooding in this watershed area can occur along the main stem of the lower Santa Cruz River, within fan formations to the east and along major infrastructure that stands between the fan flows and the river. The significant man-made features east of the river include from west to east, Interstate-10 (I-10), Union Pacific Railroad and the Central Arizona Project (CAP) canal, with the CAP canal lying about 1 mile to the east of the transportation features. I-10 and UPRR embankments are adjacent to one another and extend into Pinal County, with the CAP canal continuing to diverge east of I-10 toward the north. At the Tangerine Road/I-10 intersection, which is approximately the southern limit of this watershed, the CAP canal turns west and extends underground beyond the river.

The majority of the watershed is within the flood control jurisdiction of the Town of Marana. The District cooperated with technical assistance during the 2008 study to support the Town in developing inundation maps for the Tortolita Fan; however, the Town is responsible for flood control regulations within its incorporated limits. The Town's 2008 study assessed flooding potential related to CAP embankments, and certain segments of the canal embankment were modeled in a breach condition. For reaches where the embankment is assumed stable, sheet flows are temporarily impounded, then diverted to overchutes and conveyed downstream of the embankment. Within about one mile, flows encounter the UPRR and I-10 where major flows are not conveyed without significant ponding through UPRR and I-10 drainage structures. Flows downstream of I-10 flow northwesterly in relatively shallow unconfined paths across agricultural lands. North of Trico Marana Road, the entire watershed is mapped as a FEMA Zone AE with depths of 2 feet or more, creating a broad floodplain unsuitable for most types of development.

While flow on this watershed below canyon slopes is characterized as largely unconfined, fan flows may be pernicious because of unpredictable flow paths. Damage from both erosion and flooding is highly likely on fans from both short and long duration storms. An additional risk can be posed for this watershed where fan flows combine across shifting boundaries and where flows arrive mostly perpendicular to man-made features and then combine and travel laterally along the features.

Unconfined flows associated with the lower Santa Cruz River are not likely to occur from fan flow alone. This most downstream reach of the Santa Cruz discussed here will overtop its banks and inundate a miles-wide area when

the majority of the entire drainage area is contributing flow to the river. Fortunately, overbank uses have historically been agricultural so that flood risk is relatively low at the most downstream reach.

Pima County has developed design storms to evaluate this reach of the Santa Cruz River. Design discharges for the Santa Cruz River were determined from simulations performed for up to the 4-day event (Pima County Memorandum: Santa Cruz River Revised Discharges, November 16, 1984), and the FIS has adopted this approach.

In the lower Santa Cruz River long duration, storms have produced the most damaging floods. In October 1983, Tropical Storm Octave produced rain over 5 days, and widespread flooding occurred along the lower Santa Cruz River. Because the area is largely unconfined, this out of bank flooding largely flows into agricultural land.

Significant flood events have also occurred during convective monsoon storms, most notably in the meso-scale convective storm of July 31, 2006, which occurred after several days of rainfall on the Santa Catalina Mountains. This storm produced the flood of record on Rillito Creek, upstream of this reach.

Pima County and the Bureau of Reclamation constructed a FEMA-certified levee upstream and within this study area between Avra Valley Road and Sanders Road. Residential development replaced agricultural uses on the east side of the river and a levee protects it. The District has installed bank protection along the east side of the river concurrently, and overbank flooding to the east is not included in FEMA maps.

FEMA has mapped Special Flood Hazard Zones (SFHA) for the Santa Cruz River and overbank areas, the eastern Tortolita alluvial fans, and along the Union Pacific Railroad. In addition, the overbank areas of the Santa Cruz River include shaded Zone X areas of 1% annual chance flood average depths of less than 1 foot, and areas protected by a levee from the 1% annual chance flood.

C.1.12.2 Existing Development & Infrastructure Trends

Within the Lower Santa Cruz River watershed, the population living within all jurisdictions is 16,437. The population of the unincorporated area is 1,172.

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. While 8,103 or nearly 50% of residents live in regulatory floodplains, another 2,200 individuals live behind a levee.

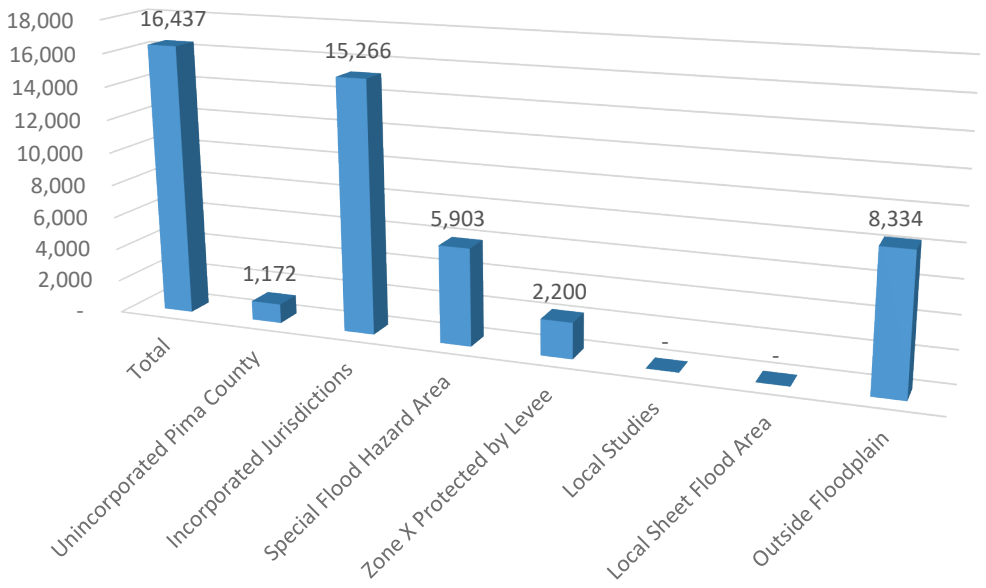


Figure 149 - Lower Santa Cruz River Watershed Population Distribution

This watershed is mostly within the Town of Marana. The portion within the incorporated area of the County is largely agricultural with the exception of the small residential areas associated with the cement plants and the County's Tortolita Mountain Park open spaces.

There are three distinct regions within the unincorporated area of this watershed. The largest consists of northernmost reaches of the Santa Cruz River that are largely not bank protected and surrounded by farmlands. South of the Town of Marana where the river meets West Avra Valley Road at Interstate 10 there is a small island of unincorporated area that includes BKW Farms, Arizona Portland Cement, and single lot residential areas. The levee and bank protection along the northeast bank protect this area. Several additional largely natural County islands are located in the northeastern portion of this watershed.

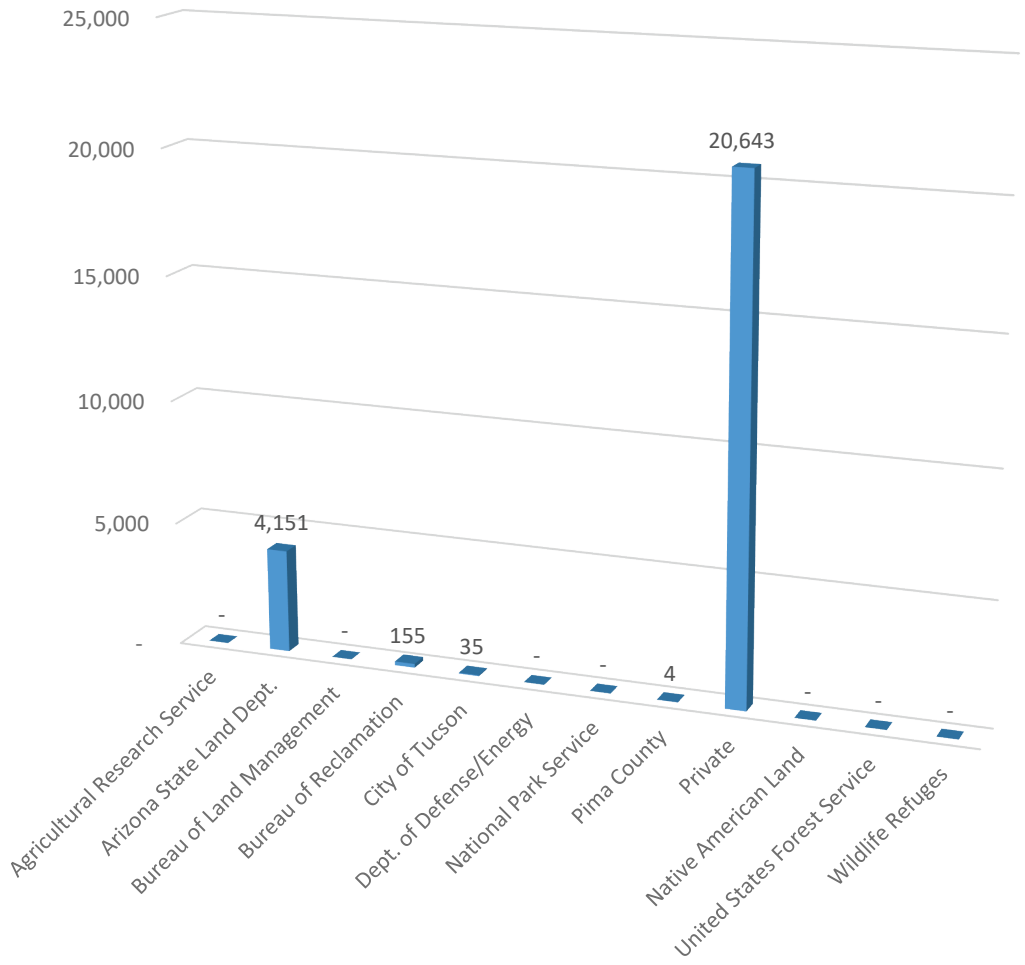


Figure 150 - Lower Santa Cruz River Watershed Ownership in Acres

There are 20,643 acres of private land, which is 82%, and 4,151 acres of State Trust land, which is 16%. In sum, developable area makes up 98% of the watershed.

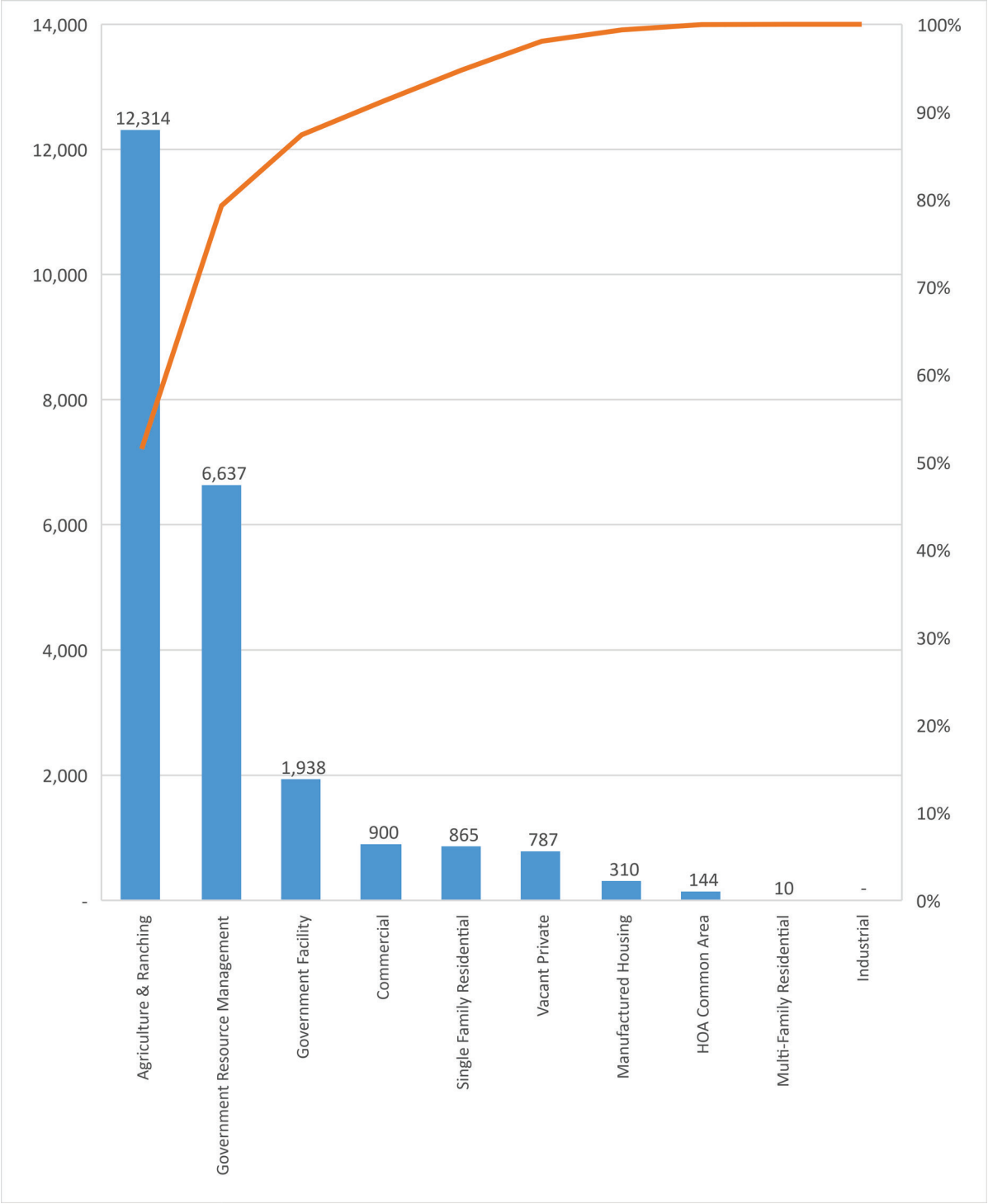


Figure 151 - Lower Santa Cruz River Watershed Land Use in Acres

The figures above show that despite large acreages of private land much remains vacant or agricultural. Furthermore, infrastructure is in place to protect the development near the highway. The figure below shows that this pattern applies within floodplains as well.

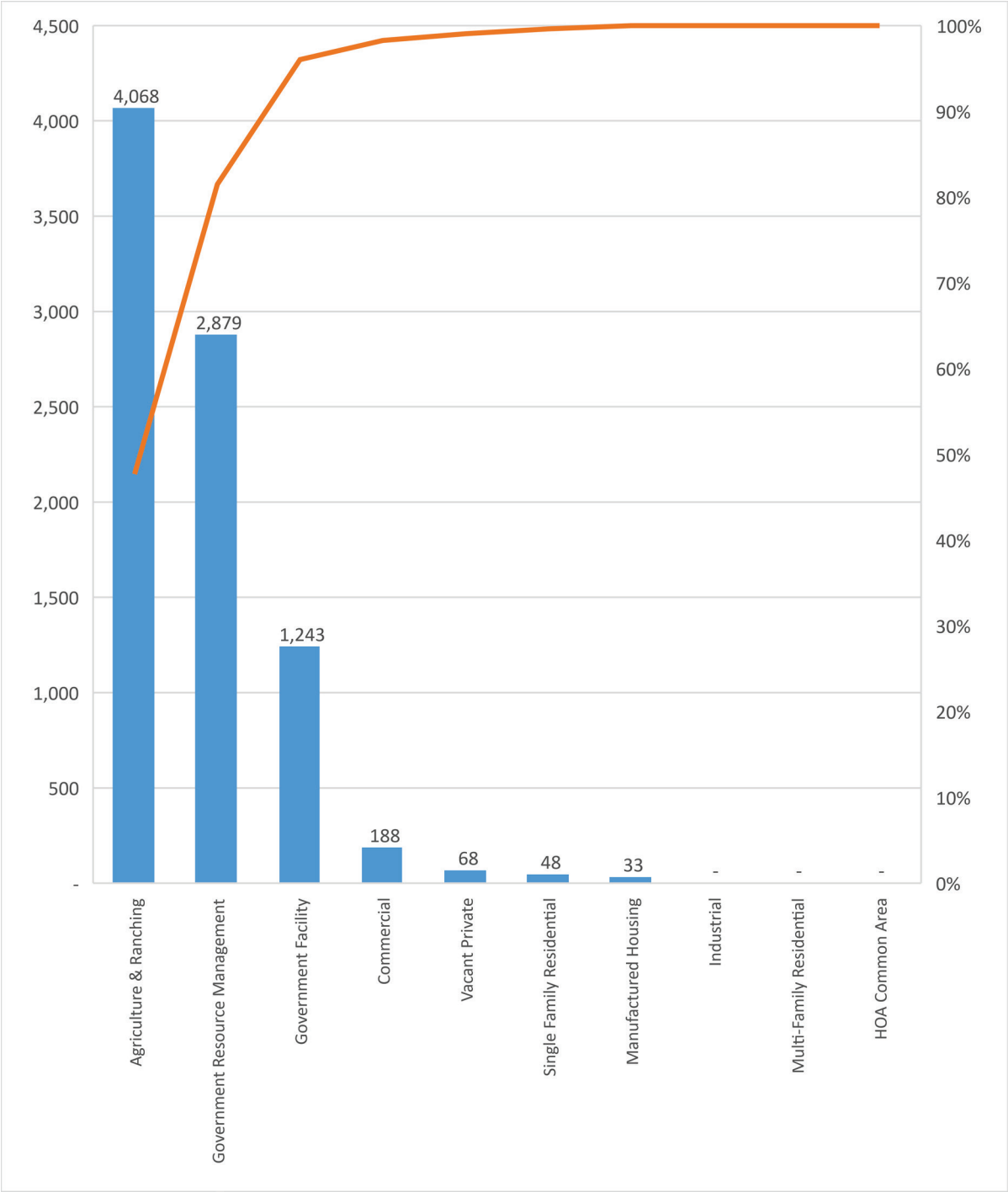


Figure 152 - Lower Santa Cruz River Floodplain Land Use

The land use distribution within floodplains is similar to the entire watershed with 76% being agricultural. In part due to these low residential densities, most frequently complaints relate to transportation infrastructure including bridges and maintenance of county owned drainage facilities and easements. However, with the exception of the Berry Acres subdivision within the Town of Marana the District's *Flood Response Field Manual* identifies no areas of special concern within this watershed. The map below shows these land use patterns.

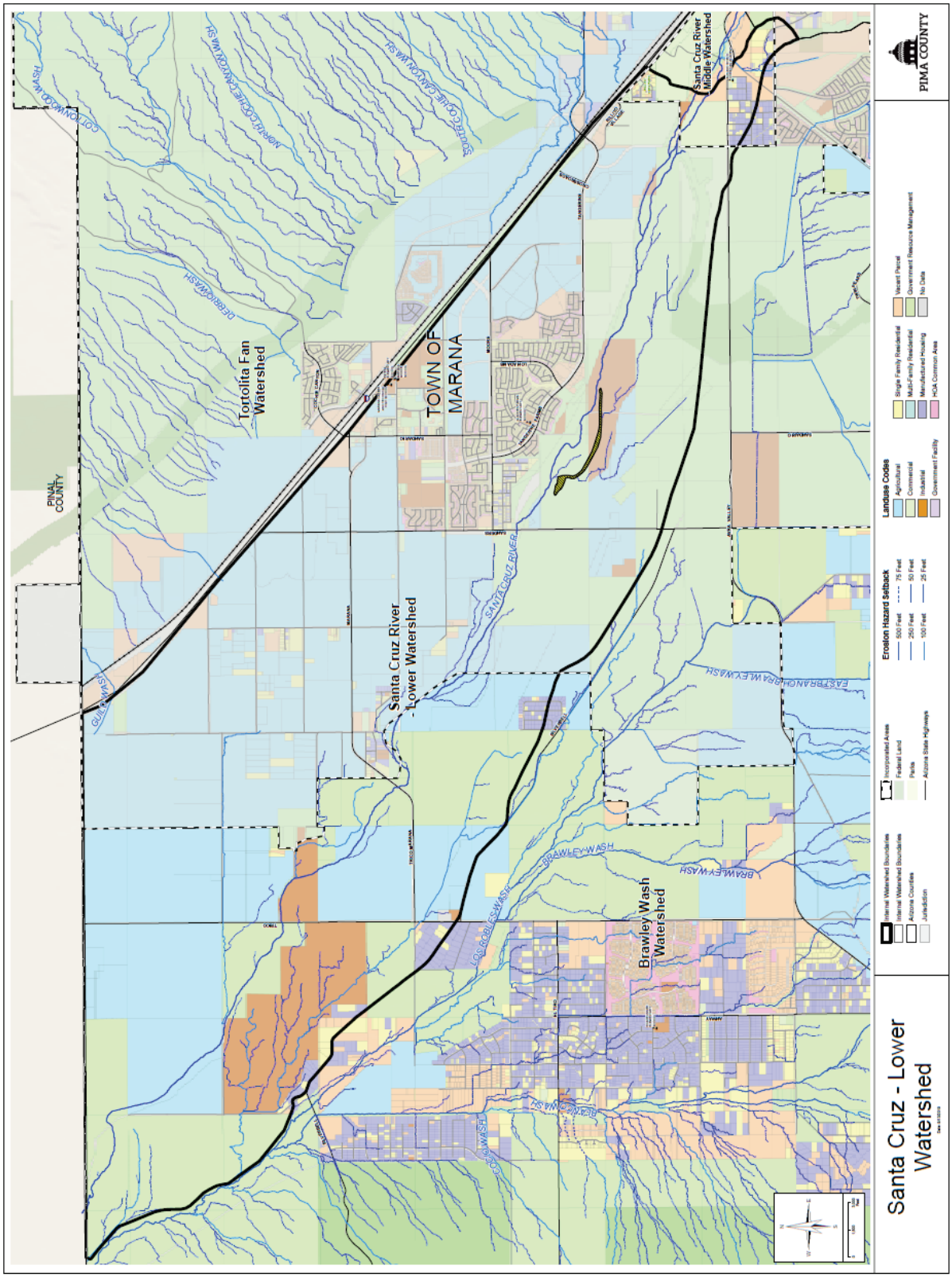


Figure 153 - Lower Santa Cruz River Land Use

C.1.12.3 Riparian Habitat and Natural Areas

There is 395 acres of Pima County Regulated Riparian Habitat within this watershed. While the County has designated 3,891 acres adjacent to and within the river as IRA connectivity to the uplands particularly to the Tortolita Fan, has been cut-off by the interstate and adjacent development. There are also 1,093 preserved acres in this watershed, including 1,084 in regulatory floodplain.

This area is a striking example of Bajada containing Ironwood and Saguaro forest that provides connectivity between the Tucson and Catalina Mountains. This loss has no doubt contributed the extirpation of Big Horn Sheep and severely hampered large mammal mobility and therefore sustainability. The Sonoran Desert Conservation Plan (SDCP) identifies a critical landscape connection for wildlife associated with the alluvial fan of the Tortolita Mountains, numerous drainage confluences with the Santa Cruz River and then to the Tucson Mountain watershed to the west. Immediately upstream of the southern terminus substantial County efforts have been made through purchases and development agreements to create a safe wildlife passage underneath I-10 at Avra Valley Road. Furthermore the Town of Marana has also cooperated on re-establishing and preserving this corridor through a variety of development agreements, land planning and infrastructure designs.

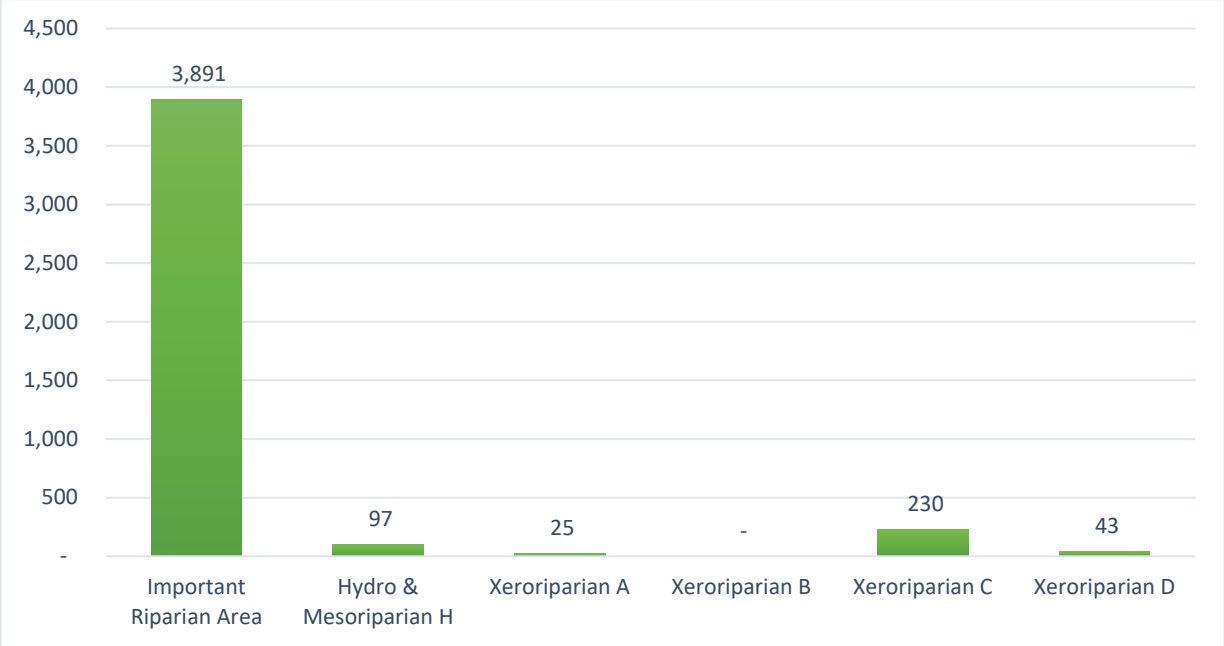


Figure 154 - Lower Santa Cruz River Watershed Riparian Habitat in Acres

Perennial reclaimed water flow supports wetland and nitrogen-tolerant plans as well as mature trees. This relationship has been the focus of the Sonoran Institute's Living River Project in which the District participates.

C.1.12.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

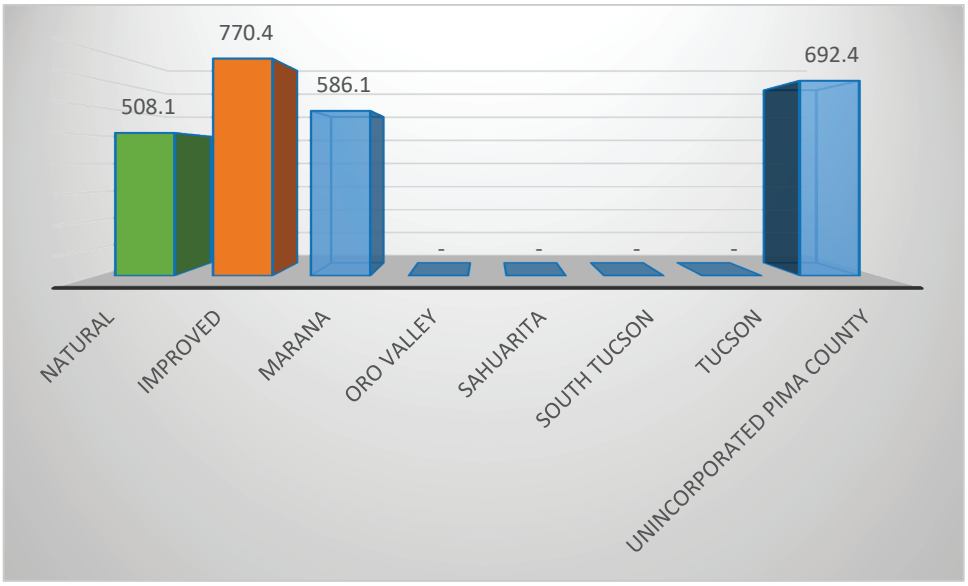


Figure 155 - Lower Santa Cruz River Drainageway Acreage

With nearly 30,000 acres of floodplain, nearly 55% of this watershed is impacted! Because 95% is in state or private ownership and is subject to development and there are only 186 acres of drainageways managed by the District for conveyance and 153 acres that are kept in their natural condition. The approach therefore has included capital improvement projects to maintain flow, prevent erosion, and channel migration within the Santa Cruz River. Residential development in this watershed lies primarily within the Town of Marana floodplain management jurisdiction.

Following the floods of 1983, the district embarked on a major program of bank protection to prohibit lateral migration of the riverbed. The eastern bank of the upstream half of this reach has been bank protected in the area of the cement plants. The levee is located downstream (West) of the Avra Valley Road Bridge on the north side of Avra Valley Road and north of the Milligan's Acres Subdivision. The levee is an earthen embankment with some erosion protection. The culverts that extend under Avra Valley Road have flap gates. While the District is responsible for the Santa Cruz throughout Pima County, much of this watershed is within the Town of Marana.

In places, the bank protection is also a certified levee. The Lower Santa Cruz River Levee is a long soil cement levee along the right embankment (looking downstream) of the Santa Cruz River from approximately the Linda Vista Road alignment to Sanders Road. The levee has flap gates.

With nearly 98% of this watershed in private or state ownership, the total acreage (339) of drainage system managed by the County is quite low. Of this system, the District maintains 55% of the acreage for conveyance.

The District has classified Santa Cruz River as a major watercourse for regulatory and planning purposes. Within the Lower Santa Cruz River Watershed development is largely agricultural and therefore bank protection is limited those small areas upstream from arterial road bridges. In order to facilitate maintenance including vegetation and sediment removal the District has created an ILF program for impacts to section 404 waters and established a baseline sediment load as noted above.

The Santa Cruz River can convey large amounts of flow and there are no at-grade crossings. Much of the reach through Tucson is bank protected. The lower Santa Cruz is where this constrained floodplain widens into agricultural flatlands at the confluence with the very broad and braided Brawley Wash system.

Along all reaches of the Santa Cruz River, there are stream gauges. They are located at Tubac (6083), Elephant Head Road (6063), Continental Road (6049/6053), Valencia Road (6043), Grant Road (6033), below the confluence with the CDO (6013/6014) and Ina Road (6023/6024). Concerns for this watercourse include bridge infrastructure, Casas Arroyo subdivision (downstream of Cañada Del Oro Wash confluence) due to potential bank erosion, and Berry Acres (Marana) due to overbank flow (40,000cfs). Flows approaching 20,000 cfs may affect the Congress Road Bridge. Marana closes Ina Road Bridge at 26,000 cfs and the per the District ALERT protocol monitors notify the Town when flows approach that magnitude. At streamflow of 10,000 cfs at any of the Santa Cruz River gauges, senior staff makes the decision as to whether to contact OEM. At streamflow of 10,000 cfs at Ina (6024), the monitor contacts the Town of Marana. At 26,000 cfs, the Town closes the bridge.

C.1.12.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (November 2016). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, summaries follow.

Frequently Flooded Structures and Properties Subject to Damage

- Berry Acres subdivision is subject to flooding when the Santa Cruz River reaches approximately 40,000 cfs (within the limits of the Town of Marana)

Infrastructure

- The Trico-Marana Road Bridge over the Santa Cruz River collects significant amounts of timber, debris and trash across the majority of the bridge opening, causing a significant obstruction to flow. This will be an ongoing occurrence after any sizable storm event due to all of the dead and dying trees in the lower Santa Cruz River from Avra Valley Bridge crossing downstream. This location should be monitored after all large flow events.

The District has not planned major new CIP at this time. Maintenance of existing infrastructure including sediment and vegetation management remains a priority. A basin study to identify current conditions and structural alternatives is ongoing.

C.1.12.6 Floodplain Management

Future needs identified by District staff include:

- Effluent
- Bank protection toe erosion
- River Management Plan for Pinal County Line to Grant Road

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Monitor and maintain bank protection
- Repair Continental Ranch bank protection erosion
- Create Drainage System vegetation maintenance plans
- Create open space management plans

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify agriculture diversions
- Monitor sand and gravel operations

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 1.2.e Participate in monitoring groundwater change with other responsible parties

- Operate Marana High Plains groundwater recharge project

Ref# 3.1.b Use open space management plans for monitoring, maintaining and protecting the Drainage System and Preserves in collaboration with partners

- Monitor base flows

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Construct bank protection for El Rio Preserve

Ref# 5.1.b Complete new river and basin studies to identify needs and develop alternatives

- Coordinate with the Town of Marana on implementation of their Marana Drainage Master Plan
- Develop Santa Cruz River Management Plan

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Loop and Trail Enhancements

Ref# 5.2.e Develop and implement alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

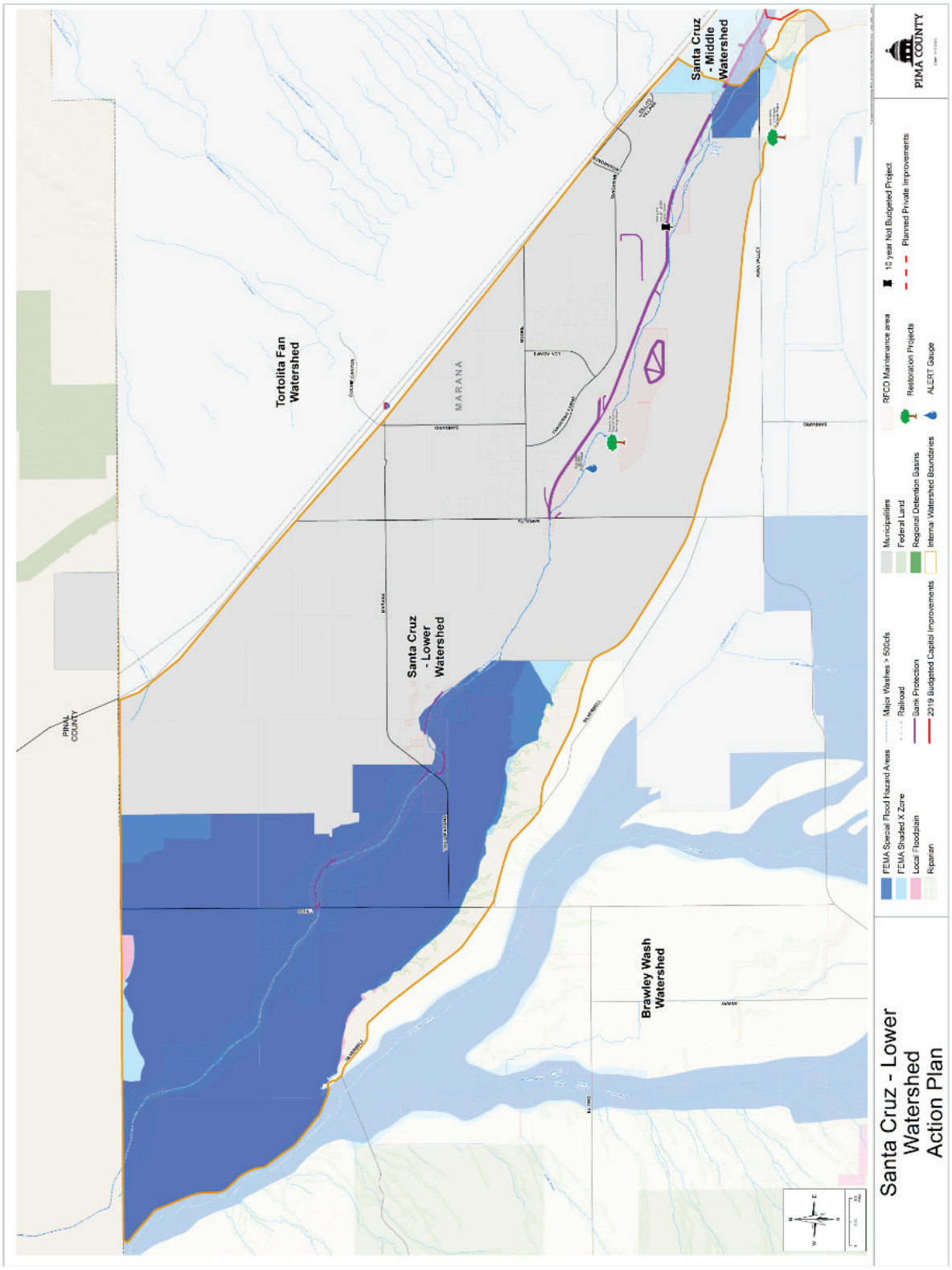


Figure 156 - Lower Santa Cruz River Action Plan Map

C.1.13 Santa Cruz River - Middle

This watershed extends southerly across the San Xavier District of the Tohono O'odham Nation along a lengthy tributary of East Mission Wash along Mission Road to the Sierrita Mountains in the southwest and the Julian Wash along the Interstate 10 Corridor to State Route 83 in the southeast. These branches coalesce along the Santa Cruz River near Valencia. Its northern terminus is Avra Valley Road. It is comprised of 107,767 acres (168.4 square miles), of which 66,005 (103 square miles) is in the City of Tucson, 2,332 in the Town of Marana and 655 in the City of South Tucson.

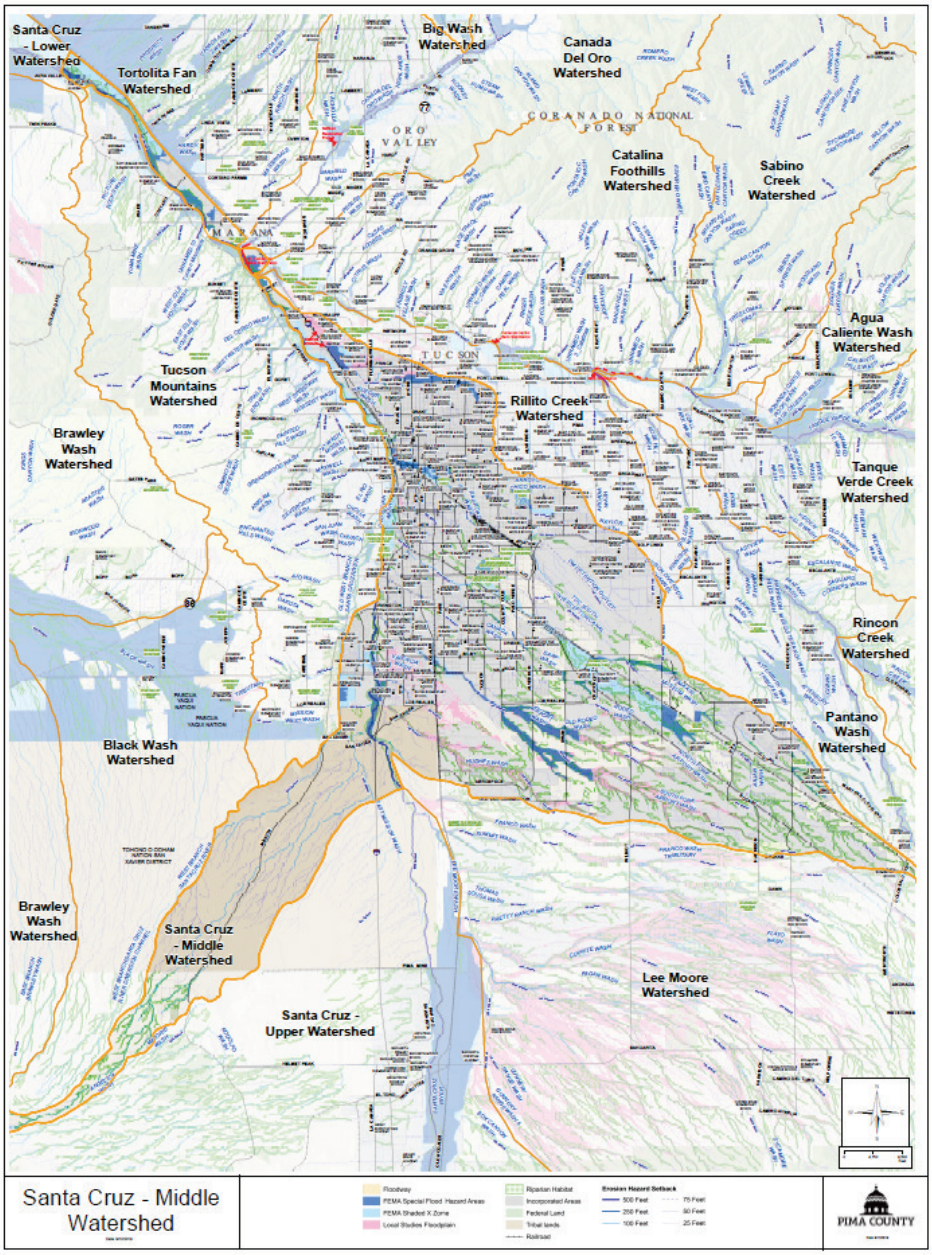


Figure 157 - Middle Santa Cruz River Watershed Map

C.1.13.1 Flood Characteristics

There are 4,942 acres of FEMA Special Flood Hazard Area. The FEMA Flood Insurance Study (FIS) indicates a peak discharge of 60,000 cfs at Congress Street near the midway point and 70,000 cfs upstream of the confluence with the Canñada del Oro Wash. Interestingly it is also 70,000 downstream of the confluence at Cortaro Farms Road near the downstream terminus. The FIS drainage area is 3,503 square miles at this location.

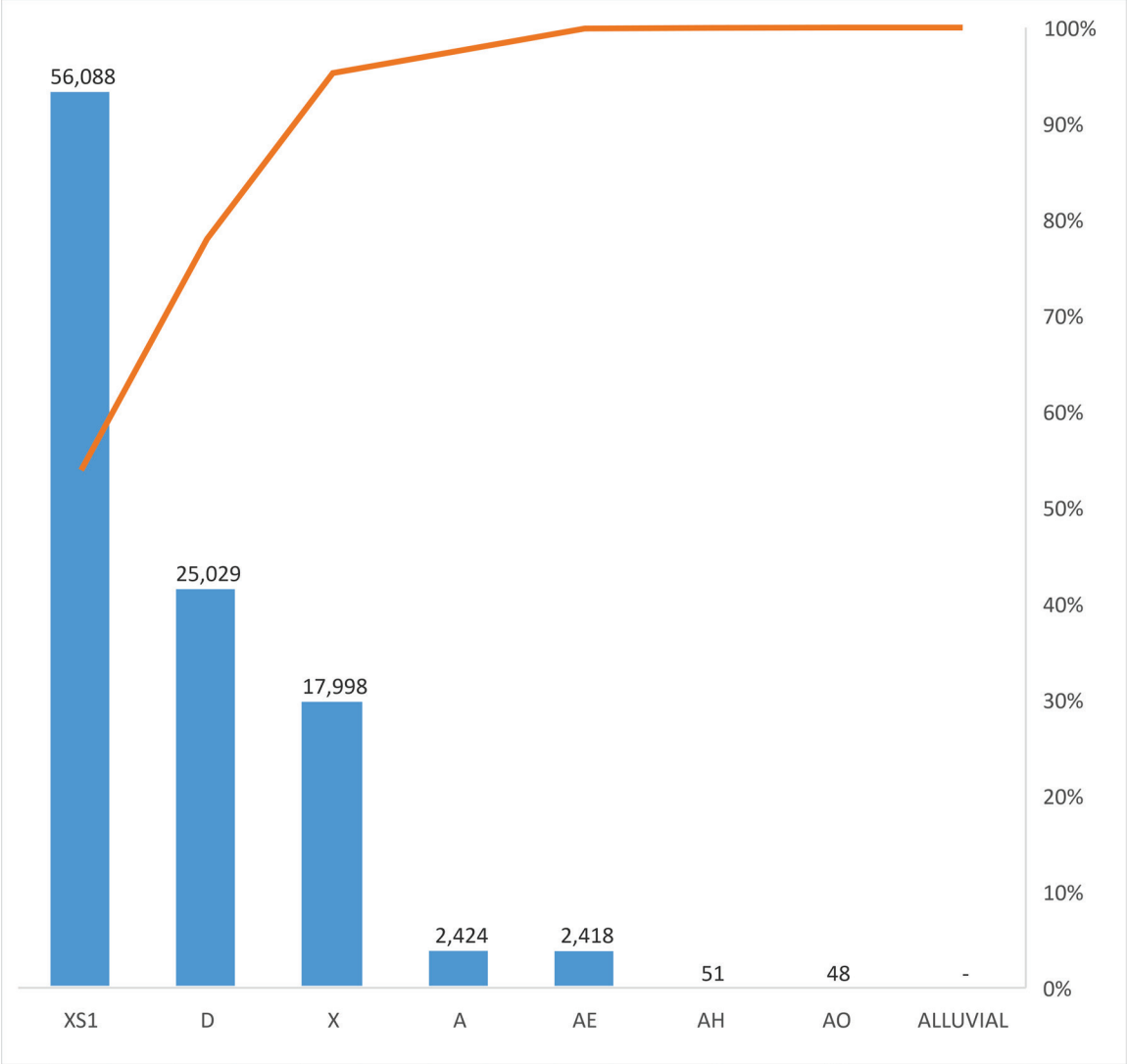


Figure 158 - Middle Santa Cruz River SFHA in Acres

In addition to the SFHA zones included on the chart above, there are also 6,145 acres of District Special Studies Floodplains, and 682 acres of sheet flood area in this watershed. Special studies floodplains in distributary areas in the downstream reaches date to 2 decades ago. Distributary flow modeling can better assess flood hazards in these areas. The Santa Cruz River floodplain and floodway south of Los Reales Road and west of Interstate 19 within the San Xavier District of the Tohono O'odham Nation is the only tribal land that FEMA has mapped.

The table below provides a summary of historic USGS gaging station records.

Table 44 - Middle Santa Cruz River Watershed USGS Gages

USGS Gaging Station	South Fork Airport Wash near Tucson, AZ 09482350	North Fork Airport Wash near Tucson, AZ 09482370	West Branch Santa Cruz River at Tucson, AZ 09482450	Airport Wash at Tucson, AZ 09482400	Rodeo Wash at Tucson, AZ 09482410	Julian Wash at Tucson, AZ 09482420
Period of Record	1966-07-28 to 1980-09-07	1961-08-22 to 1980-09-07	1966-08-19 to 1981-07-29	1966-09-11 to 1988-07-27	1970-07-20 to 1981-07-29	1970-07-19 to 1981-03-02
Watershed Area (sq. m)	9.78	6.65	23.60	23	7.24	26.50
Flood-Peak of Record (cfs)	1890	1350	910	2900	898	1270
Date	07-08-1974	08-22-1961	09-25-1976 and 10-06-1977	10-01-1983	07-20-1970	07-19-1970

USGS Gaging Station	Pumping Wash near Vail, AZ 09482330	Railroad wash at Tucson, AZ 09482950	Tucson Arroyo at Vine Ave at Tucson, AZ 09483000	High School Wash at Tucson, AZ 09483010	Santa Cruz River at Tucson, AZ 09482500	Cemetery Wash at Tucson, AZ 09483042
Period of Record	1966-08-16 to 1981-07-25	1970-07-20 to 1983-01-29	1940-08-13 to 1981-06-25	1968-08-10 to 1983-08-16	1915-12-23 to 2015-07-28	1966-08- to 1990-07-24
Watershed Area (sq. m)	.81	2.30	8.20	.95	2222	1.17
Flood-Peak of Record (cfs)	337	1590	5000	800	52700	600
Date	07-00-1971	07-19-1971	07-22-1961	08-12-1972	10-02-1983	08-20-1968

USGS Gaging Station	Flowing Wells Wash at Tucson, AZ 09483045	Santa Cruz River at Ina Road near Tucson, AZ09486490	Santa Cruz River at Cortaro, AZ09486500
Period of Record	1971-08 to 1990-07-24	1991-03-01 to 1992-08-24	1940-08-14 to 2015-01-31
Watershed Area (sq. m)	3.53	2612.31	3503
Flood-Peak of Record (cfs)	1470	6360	65000
Date	08-23-1982	03-01-1991	10-02-1983
Table of Regulatory Discharge (cfs)	NA	NA	70000

The table below summarizes Pima County's ALERT Gages. The locations are from the District's Alert map.

Table 45 - Middle Santa Cruz River ALERT Streamflow Gages

Pima County Alert Gage	Santa Cruz River below Cañada Del Oro Wash ID: 6014	Santa Cruz River above Grant Road ID: 6033	Arroyo Chico Wash at Cherry Avenue ID: 6183	Arroyo Chico Wash at Randolph Park ID: 6193	Tucson Diversion Channel at Ajo Detention Basin ID: 6233	Santa Cruz River at Valencia Road ID: 6043	Franco Wash at Swan Road ID: 6213
Location (Latitude, Longitude)	(32.3282, -111.0686)	(32.2468,-110.9969)	(32.2164, -110.9481)	(32.2147, -110.9183)	(32.1833, -110.9269)	(32.1342, -110.9919)	(32.0547, -110.8933)
Period of Record	2015-07-19 to Present	2015-07-19 to Present	2007-07-10 to Present	2007-07-10 to Present	2002-11-08 to Present	2002-05-17 to Present	2006-09-05 to Present
Watershed Area (sq. m)	3451.3	2207.36	7.61	1.57	14.37	2046.08	21.51
Flood Peak of Record (cfs)	16000	6885	1664	205	4746.8	26493	551.4
Date	08-09-2016	08-09-2016	07-31-2007	09-08-2014	07-31-2007	09-08-2014	08-01-2007

Table 46 - Middle Santa Cruz River ALERT Streamflow Gages

Pima County Alert Gage	Santa Cruz River above Grant Road ID: 6030	Mission Road near Silverlake Road - Santa Cruz Basin ID: 6100	Arroyo Chico Wash at Cherry Avenue ID: 6180	Arroyo Chico Wash at Randolph Park ID: 6190	Tucson Diversion Channel at Ajo Detention Basin ID: 6230	Kino Medical - Tucson Diversion Basin (DEQ) ID: 6240	Tucson Electric Power Plant - Julian Wash Basin ID: 6260	Santa Cruz River at Valencia Road ID: 6040	Pima Air Museum - Julian Wash Basin ID: 6270
Location (Latitude, Longitude)	(32.2468, -110.9969)	(32.2015, -110.9934)	(32.2164, -110.9481)	(32.2147, -110.9183)	(32.1833, -110.9269)	(32.1729, -110.9261)	(32.1622, -110.8967)	(32.1342, -110.9919)	(32.1414,-110.8642)
Period of Record	2015-07-19 to Present	2006-09-11 to Present	2007-04-03 to Present	2007-04-05 to Present	2002-08-22 to Present	2000-10-20 to Present	2002-08-23 to Present	1989-11-14 to Present	2002-08-22 to Present

The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Tables of Regulatory Discharges.

Table 47 - Middle Santa Cruz River Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Airport Wash @confluences with Santa Cruz River	8,100	23.50	FEMA, Flood insurance Study
@Cortaro Road	70,00	3503	" "
Julian Wash	3,360	24.90	FEMA Map Revision (99-09-1084P)

Along the main stem of the Santa Cruz, tropical storms have caused significant flooding. Along the tributary watersheds, convection storms have caused flooding.

C.1.13.2 Existing Development & Infrastructure Trends

Within the Middle Santa Cruz River watershed, the population living within all jurisdictions is 93,918 making it the most populated. The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. Nearly half live in regulatory floodplains! In addition, nearly 1,700 individuals live behind a levee.

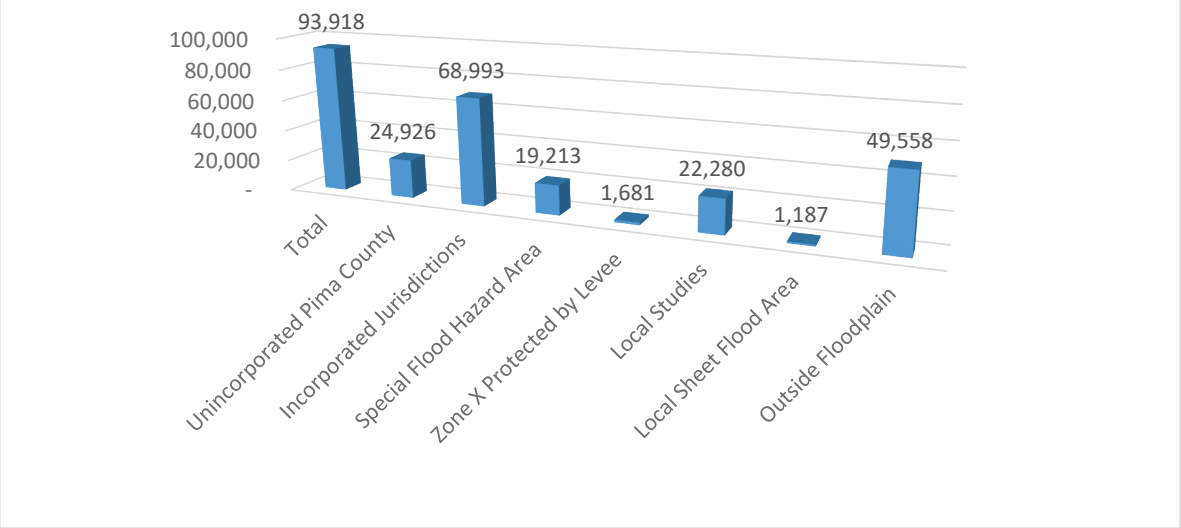


Figure 159 - Middle Santa Cruz River Watershed Population Distribution

This watershed includes the Cities of Tucson and South Tucson and includes downtown and the interstate corridors that are the urban core of the County. It also includes the community center of the San Xavier District of the Tohono O'odham Nation. As shown on the figure below, there are 67,223 acres of private lands, and 12,955 acres of State Trust lands, which is 74% of the watershed.

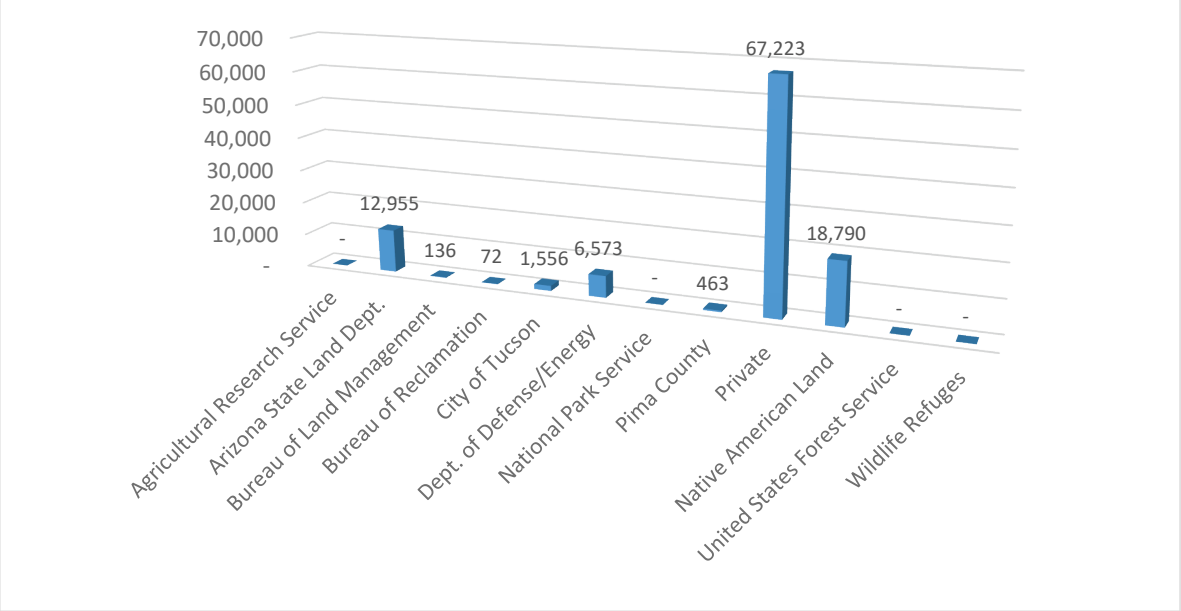


Figure 160 - Middle Santa Cruz River Watershed Unincorporated Pima County Land Ownership in Acres

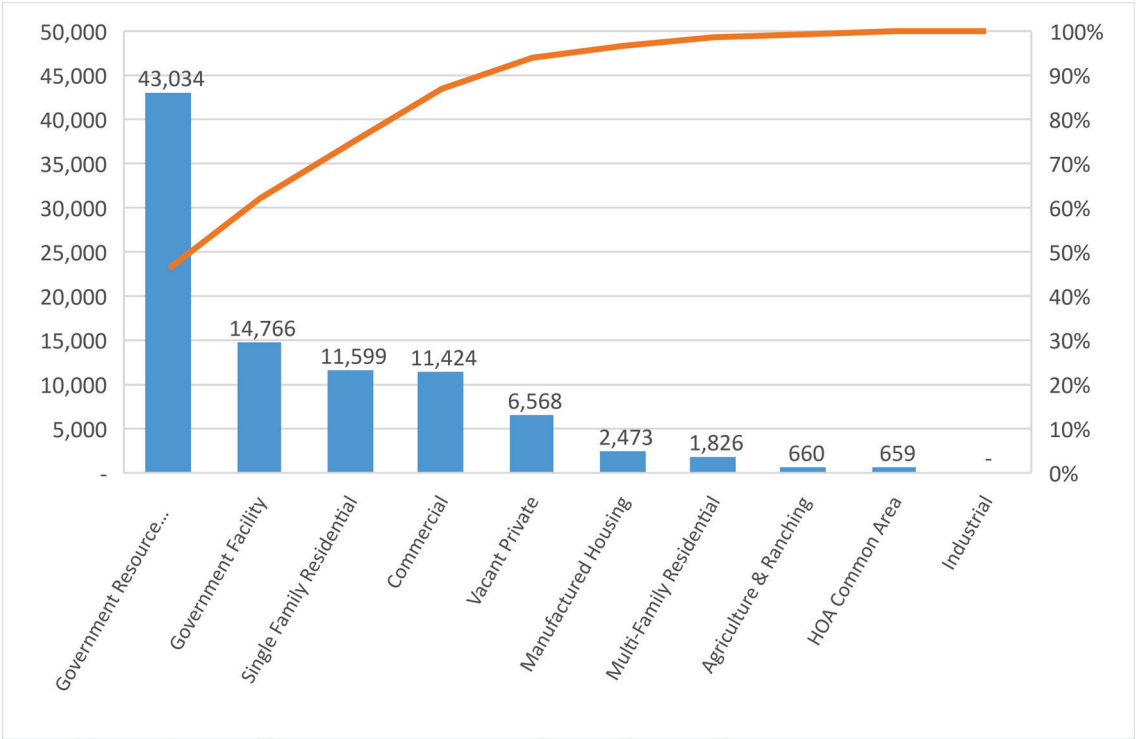
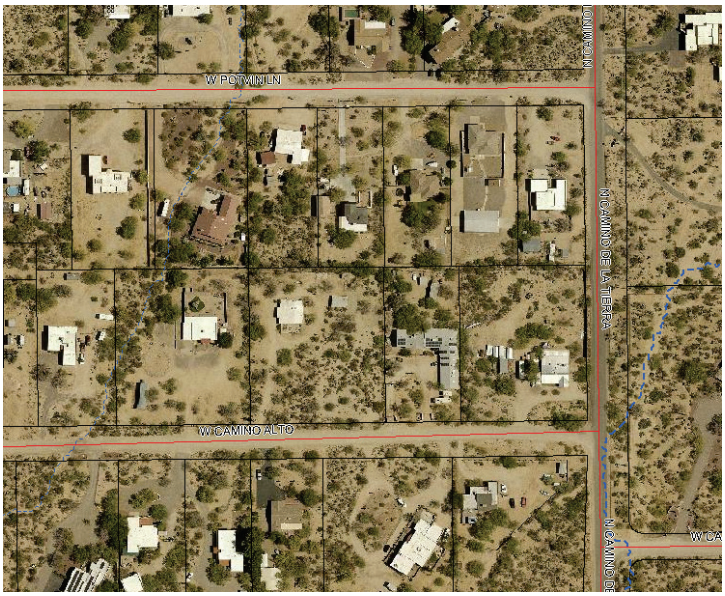


Figure 161 - Middle Santa Cruz River Watershed Land Use in Acres

With the exception of the major river floodways much of this watershed was developed without setting side floodplains and in some cases the watercourses themselves, instead using roads as drainageways. The result has been the need for significant capital projects including installation of bank protection and grade control to prevent erosion and channel migration in addition to culverts and storm drains. Even within the high-density transportation

network of this urbanized watershed, flooded roads can create hazardous situations combined with motorist behavior and requiring annual swift water rescues and vehicle recovery.

Most intense development is within the floodplain management jurisdiction of the City of Tucson or the Town of Marana. Within unincorporated Pima County, much residential development is within lots outside of platted subdivisions. The picture shows typical larger lots with no planned drainage infrastructure in distributary flow areas. The map below shows the land use and drainage patterns.



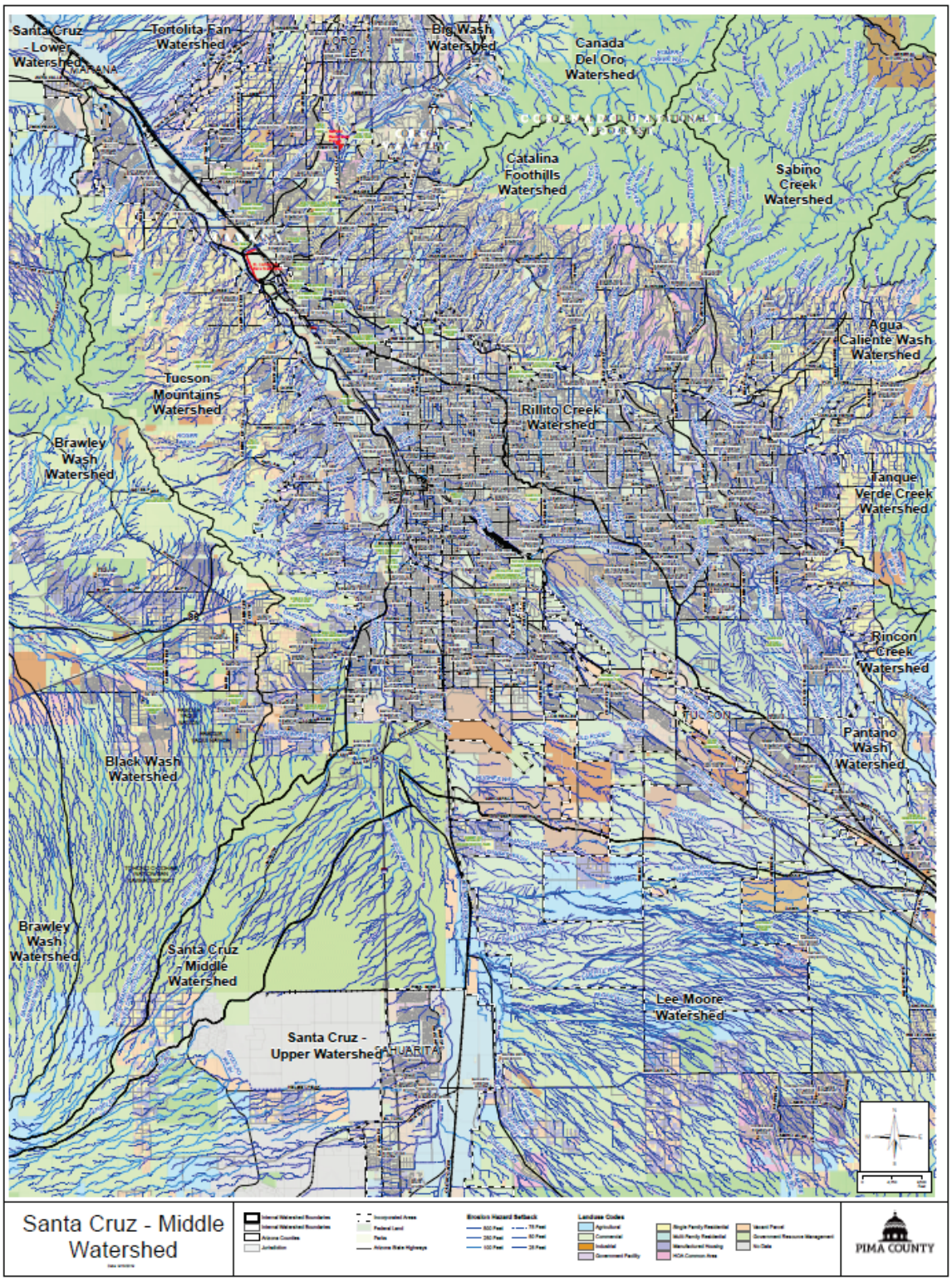


Figure 162 - Middle Santa Cruz River Land Use Map

The following chart shows the land use mix within floodplains in this watershed.

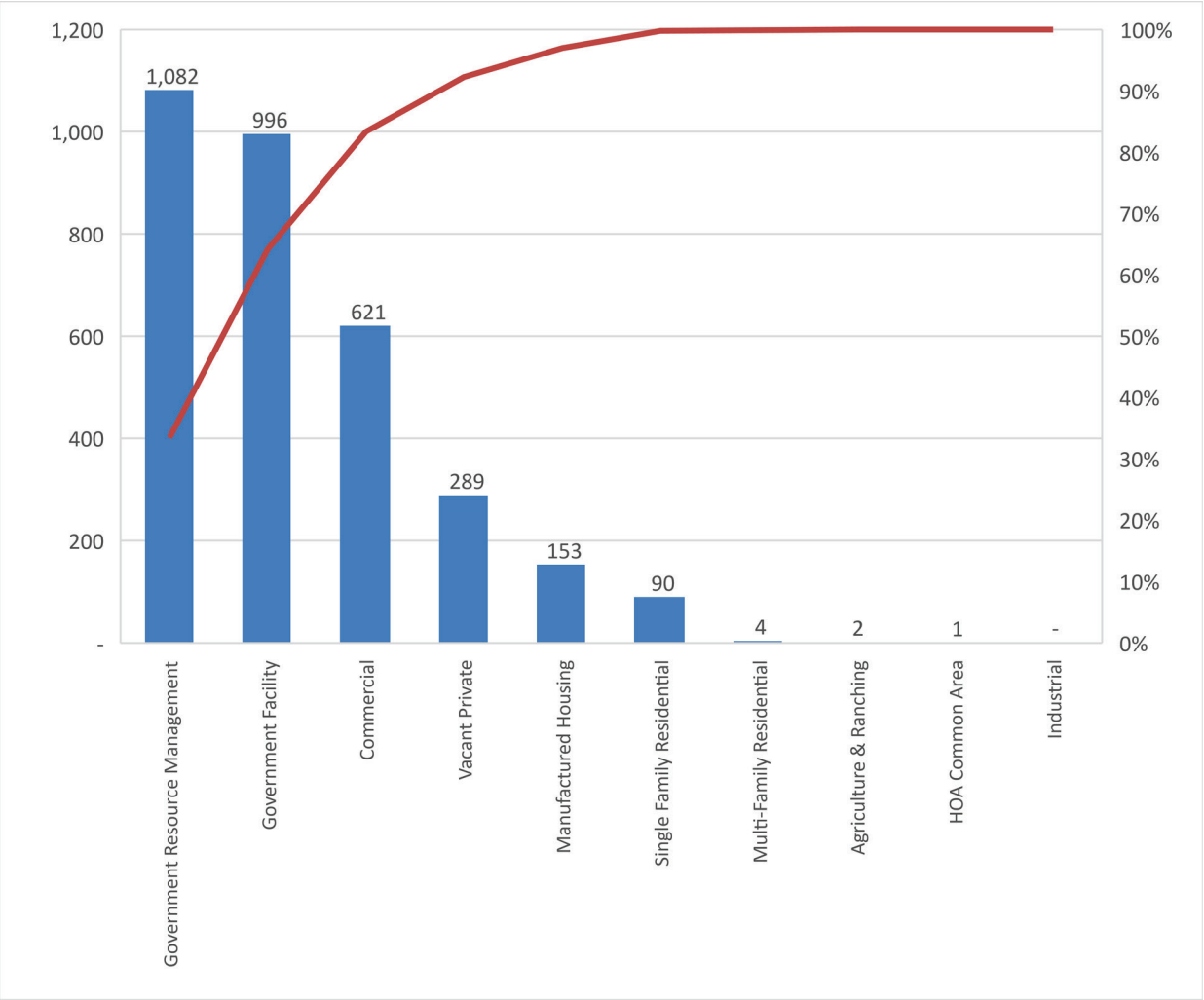


Figure 163 - Middle Santa Cruz River Floodplain Land Use

As noted above both major transportation corridors serving Tucson; Interstates 10 and 19, and the railway parallel the river and explains the relatively higher percentage occupied by commercial and industrial sectors as well as multi-family housing.

In historic times, significant entrenchment occurred along the Santa Cruz from San Xavier road to the confluence of the Rillito, which has acted as a pivot point. Most of this reach is urbanized on both sides and bank protected. Through the most northern part of the reach from Cushing Street to Grant Road, where the older structures are, the channel is more encroached and constrained. A levee exists on the eastern bank about ½ mile upstream of Grant Rd and extends about a mile downstream of Grant into the downstream reach.

Bank Protection Construction, Low and High Flow

C.1.13.3 Riparian Habitat and Natural Areas

There is 3,640 acres of Pima County Regulated Riparian Habitat and 1,908 acres of IRA within this watershed. There are also 211 preserved acres in this watershed, 143 of which is in regulatory floodplain. Jurisdictions involved have preserved little herein with the exception of urban parks and the river corridor itself.

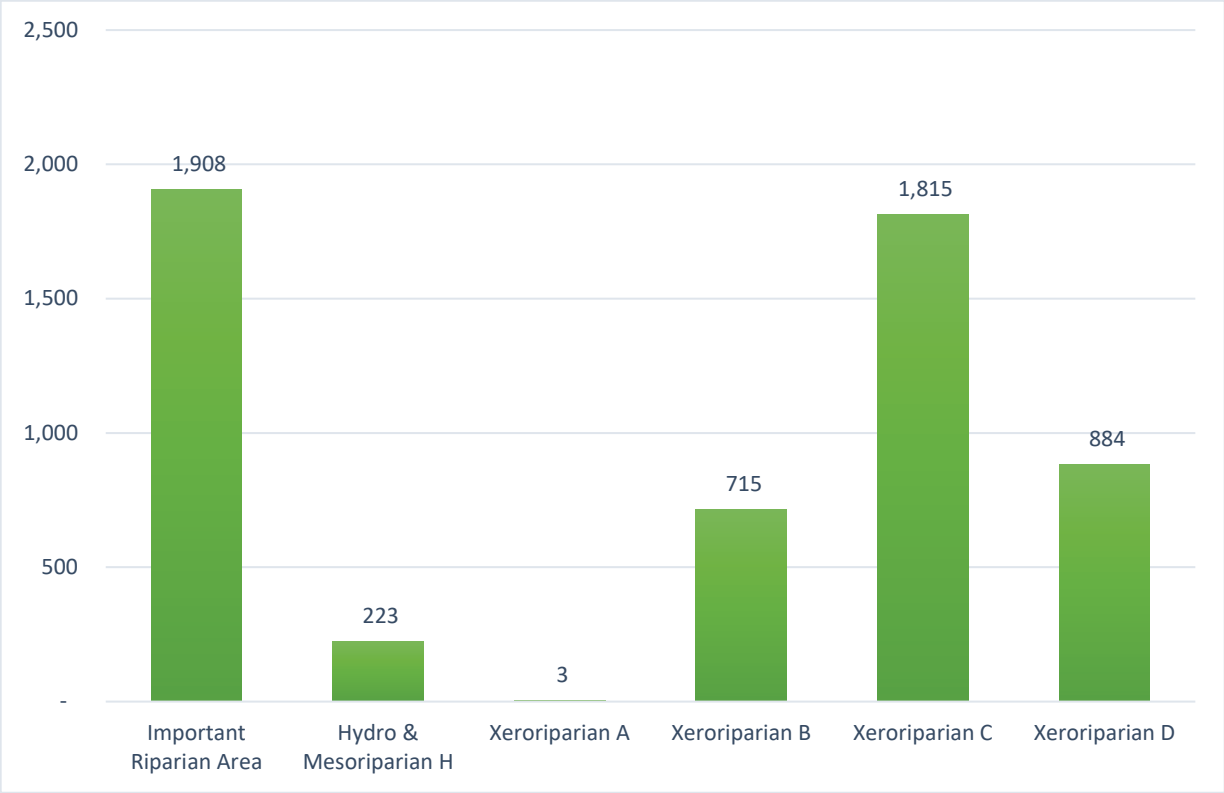


Figure 164 - Middle Santa Cruz River Watershed Riparian Habitat in Acres

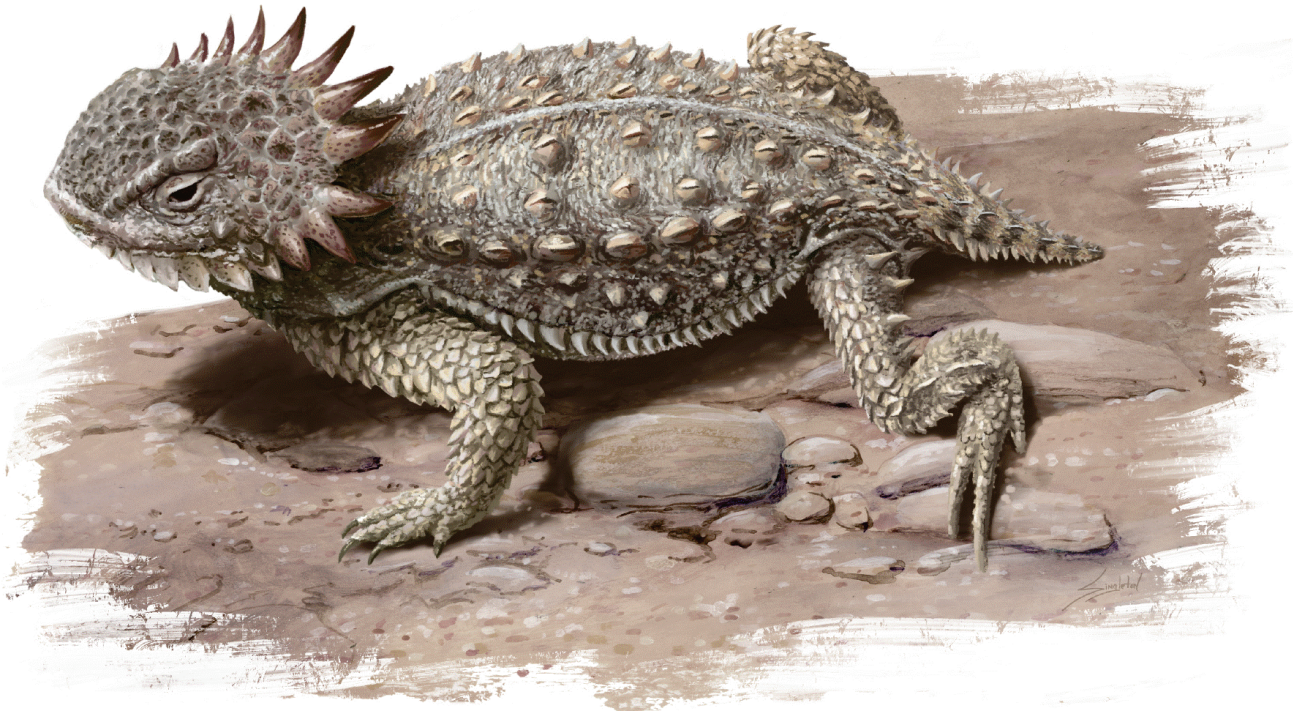
Figure 165 - Paseo de las Iglesias Multi-Purpose Restoration Project

Due to location along major transportation corridors and diverse and predominantly private land ownership, the Julian Wash remains highly infested with fire-loving buffelgrass, creating threats to both public safety and biotic diversity.

The largest habitat restoration efforts of the District in this area include the 120-acre Kino Environmental Restoration project and the 350-acre Paseo de las Iglesias along the Santa Cruz River. The former project, constructed in a pre-existing detention basin, contains a series of ponds and native vegetation plus a pumping system that both circulates stormwater within the basin and removes excess stormwater to irrigate turf at the Kino Sports Complex and surrounding landscape areas. Due to a limited urban encroachment, the Paseo de las Iglesias project takesa softer approach to major urban river management by introducing habitat restoration on the overbanks and broad terraces and relys less on bank protection. This project enhanced a pre-existing ephemeral toad-breeding habitat that supports six species of native toads.

The District completed enhancements along much of the Chuck Huckleberry Loop for ecosystem benefits, and one of the best examples of is east of Christopher Columbus Park, where water-harvesting earthworks, well timed plantings, and timely rainfall sustained revegetation without use of supplemental irrigation.

In partnership with the District, the U.S. Army Corps of Engineers constructed Tucson Drainage Area/Arroyo Chico Multi-Use Project, which included extensive environmental mitigation components. The District salvaged and relocated regal horned lizards ahead of construction, then added two ephemeral toad breeding pond and habitat amenities for returning regal horned and other native lizards.



C.1.13.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

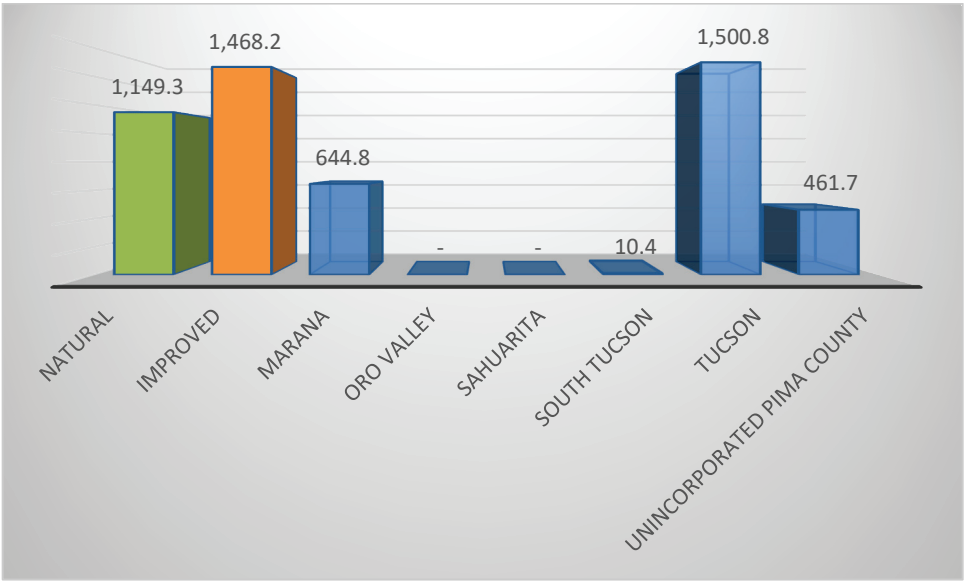


Figure 166 - Middle Santa Cruz River Drainageway Acreage

In upper, more urbanized reaches, following the floods of 1983, the district embarked on a major program of bank protection to prohibit lateral migration of the riverbed. Currently most of this reach has been bank protected. However, as mentioned above in the more recent projects, wherever possible a wider floodplain maintained to facilitate habitat restoration as well as reduction of encroachment, and bank protection height. While the District is responsible for the Santa Cruz throughout Pima County, much of this watershed is within the City of Tucson.

In places, the bank protection is also a certified levee. The Grant Road Levee is upstream and downstream of Grant Road along the east embankment of the Santa Cruz River. The levee has flap gates.

The Mission West Levee is a CMU concrete reinforced floodwall south of the Mission West Subdivision.

The Roger Road Sewage Treatment Plant Levee is a soil cement levee along the east embankment of the Santa Cruz River upstream and downstream of the Roger Road Sewage Treatment Plant. There are flap gates. The effluent spillway and associated plunge pool should be included in inspections. Agua Nueva Water Reclamation Facility replaced Roger Road, and discharge quality improvements have changed river dynamics.

In order to prevent tributary flooding behind the levee in frequent minor events, where there are flap gates, the district must monitor aggradation and remove it regularly to allow gates to open.

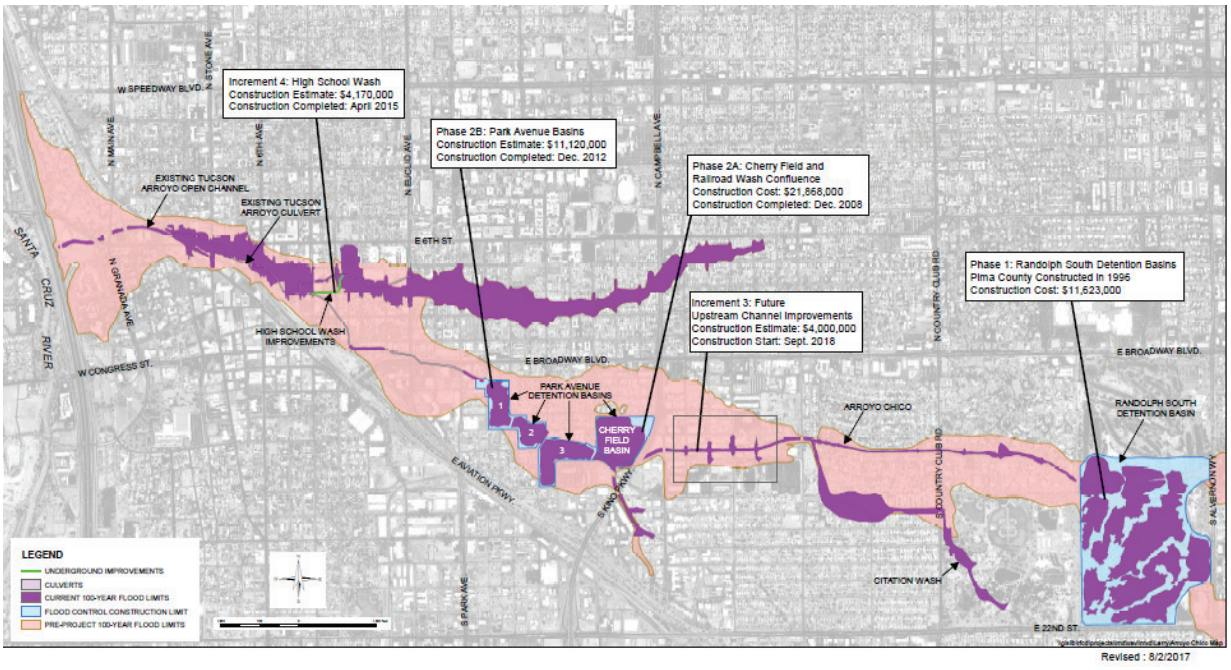
The US Army Corps of Engineers constructed the Tucson Diversion Channel Levee was constructed in the early 1960's. It lies north of Golf links Road north of the Davis-Monthan Air Force Base.

In addition to these levees and bank protection, there are several dams within this watershed.

The Ajo Detention Basin is a flood control reservoir on the Tucson Diversion Channel north of Ajo Way and upstream of the Julian Wash confluence. The dam structure is an earthen berm with a concrete inlet and outlet. The pump system is not part of the flood control function but serves as a water-harvesting component of the basin.

Pima County Regional Flood Control District and the City of Tucson in cooperation with the U.S. Army Corps of Engineers (ACOE) constructed a multi-phase flood control, environmental restoration and recreation project called the Tucson Drainage Area/Arroyo Chico Multi-Use Project. The project area encompasses approximately 4.8 miles of the Tucson Arroyo/Arroyo Chico Wash from Alvernon Way to its confluence with the Santa Cruz River near St. Mary Road. The phases of the project are:

- Phase 1, Randolph South Detention Basins, which were completed in April 1996 by the Pima County Regional Flood Control District and the City of Tucson
- Phase 2A, Cherry Field Detention Basin, which was completed in December 2008 by the ACOE; and
- Phase 2B, Park Avenue Detention Basin Complex, which the ACOE completed in December 2012.
- Increment 3 (Upstream Channel Improvements) is to be redesigned to provide channel capacity and ecosystem mitigation, and is anticipated to go to construction in September 2018.
- Increment 4 (High School Wash Storm Drain) was completed April 2015.

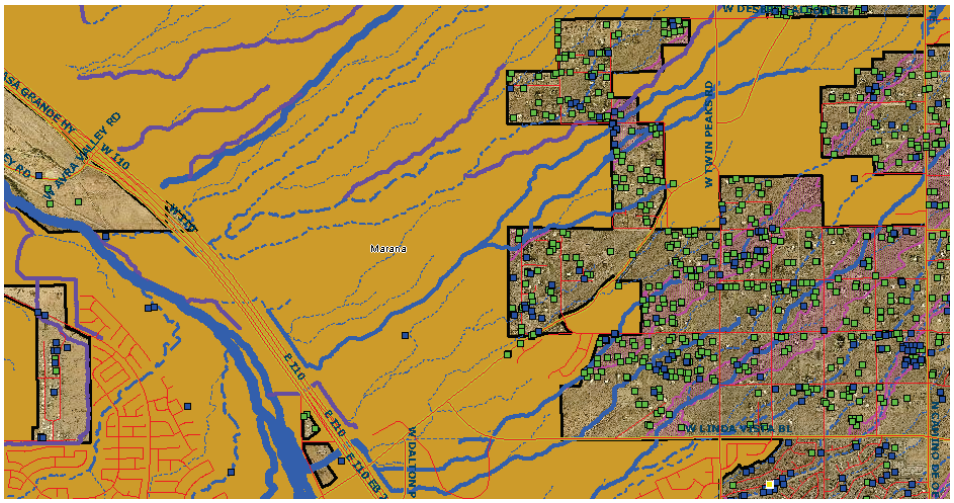


Park Avenue Basin #1- This is the first flood control reservoir on Arroyo Chico upstream of Broadway Boulevard. The basin has two sub-basins, earthen embankments, with buried Gabion mattresses, and security grates at storm drain inlets.

Park Avenue Basin #2- This is the second flood control reservoir on Arroyo Chico upstream of Broadway Boulevard. The basin has earthen embankments, with buried Gabion mattresses and security grates at storm drain inlets.

Park Avenue Basin # 3- This is the third flood control reservoir on Arroyo Chico upstream of Broadway Boulevard. The basin has earthen embankments -with Gabion mattresses (buried), security grates at storm drain inlets. Highland Avenue is a component of the earthen embankment and spillway.

Cherry Field Basin- This flood control reservoir is located at the confluence of the Railroad Wash and Arroyo Chico. It includes the drainage infrastructure for the Railroad Wash. It consists of a floodwall, an earthen embankment- with Gabion mattresses (buried), CMU retaining wall along the west side next to Cherry Avenue , manual gates, spillway (concrete bleaches south of the ball fields) , and security grates at storm drain inlets. County maintenance staff must manually operate gates to drain stored floodwaters.



In the downstream less urbanized reaches of the watershed, infrastructure is limited. The MapGuide excerpt below shows typical residential development without planned infrastructure. The green squares mark the locations of individual floodplain use permits. When project-scale or regional infrastructure is has been put in place by the District of private developers, flood hazards have been defined and mitigated during project development by the District, and it is not necessary to issue numerous individual permits.

The District has classified the Santa Cruz River as a major watercourse for regulatory and planning purposes.

Please see the Lower Santa Cruz River watershed appenix for a complete discussion of ALERT gauges and notification levels for this watershed.

C.1.13.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- The Casas Arroyo subdivision is located on the outside of a bend in the Santa Cruz River and may experience flooding and erosion problems.
- Tetakusim Road and Settler Avenue
- The homes along Oriole Circle and Mayes Place are some of the most frequently flooded structures in Pima County. Water in structures up to 18 inches deep due to Valencia Wash.
- Homes south of Irvington Rd. and east of San Joaquin Ave flood.
- Wyoming Wash at Irvington Rd. and La Cholla Boulevard flows approximately 300 feet wide across Sindle Place.

Infrastructure

- Flow of approximately 4-5 feet stage depth, equivalent to roughly the 25-year event, approximately 20,000 cfs shuts down the Ina Road bridge. This issue is in the Town of Marana.
- The storm grate on the west side of Westover Ave. between Drexel Rd. and Canada St. has been subject to getting plugged up and causing flooding on nearby properties. In 2006, the grate was improved.
- Erosion has affected the earthen channel of the Santa Cruz West Branch where Dakota Wash enters it east of Mission Road and south of Irvington Road.
- The floodwall for Mission West II subdivision is on private lots and maintenance not guaranteed.
- The base flood overtops the earthen embankment near the NW corner of San Xavier Estates.
- Santa Cruz River: Lots along North Silverbell Road are subject to channel bank migration. Based on the Sunset Road Bridge Study staff expects that the bulk of the vegetation will washed away at 21,800 cfs. That vegetation is at the toe of the cut-slope and at a gentle outside meander. A home on North Silverbell Road is less than 100 feet from what will be a 30-foot cut-slope.

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

C.1.13.6 Floodplain Management

Future needs identified by District staff include:

- Vegetation Management
- Homeless Camps
- Lot splits where west bank protection lacking near Casas Arroyo
- Sunset Road Bridge remapping - done
- Gravel pits
- Agua Dulce Coordination
- Interjurisdictional Maintenance Coordination
- Aggradation/degradation

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Mitigate Los Reales erosion
- Monitor and remove vegetation
- Repair SCR Old West Branch Bank protection erosion at Silverlake
- Create Drainage System vegetation maintenance plans

Ref# 1.1g Participate in regional watershed planning activities to promote uniform standards

- Coordinate with the City of Tucson for the Santa Cruz River Heritage groundwater recharge project and One Water efforts

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify agriculture diversions
- Identify and map canyon wash floodways
- Monitor sand and gravel operations
- Identify and monitor erosion on tributaries to the Santa Cruz River

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Conduct detailed mapping of approximate FEMA Special Flood Hazard Areas
- Conduct floodplain modeling for City of South Tucson
- Remap floodplains for Bronx Wash in the City of Tucson
- Remap floodplains for Flowing Hills Wash in the City of Tucson
- Remap floodplains for Silvercroft Wash in the City of Tucson
- Remap floodplains for the Wyoming and Dakota Washes

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 1.2.i Develop criteria for site design and infrastructure at major watercourse confluence areas

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Conduct drainage infrastructure mapping for City of South Tucson
- Construct drainage improvements in the El Vado Watershed in the City of Tucson
- Construct drainage improvements in the Ruthrauff/Gardner Lane area
- Construct El Rio Golf Course drainage improvements

Ref# 2.2.c Conduct voluntary floodprone land acquisition program outreach to areas impacted by flooding

- Target floodways and flow corridor areas

Ref# 3.1.b Use open space management plans for monitoring, maintaining and protecting the Drainage System and Preserves in collaboration with partners

- Monitor base flows

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Construct drainage improvements within Christmas Wash and other urban watersheds
- Coordinate with the City of Tucson and stakeholders on planned drainage improvements along Silverbell Road
- Ruthrauff area drainage improvements

Ref# 5.1.b Complete new river and basin studies to identify needs and develop alternatives

- Develop Santa Cruz River Management Plan

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Loop and Trail Enhancements
- Coordinate with City of Tucson on Proposition 407 projects

Ref# 5.2.e Develop and implement alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Promote flood insurance with Increased Cost of Compliance coverage for homes in the vicinity south of Irvington Rd. and east of San Joaquin Avenue
- Provide outreach on the availability of private road and drainage easement technical assistance
- Provide outreach promoting assistance available to homeowners in the vicinity of Oriole Circle and Mayes Place
- Provide outreach promoting assistance available to homeowners in the vicinity of TRS1332

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

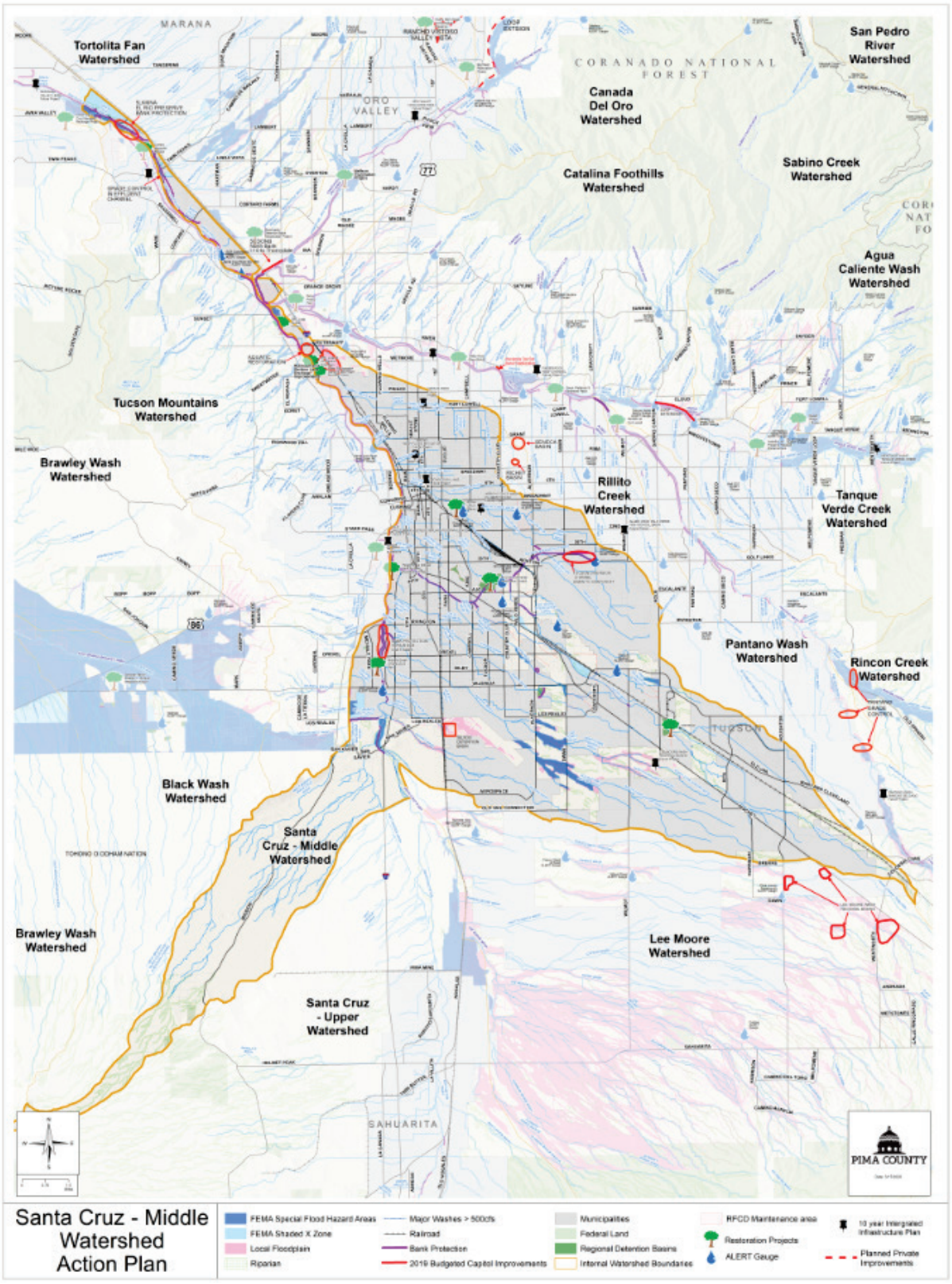


Figure 167 - Middle Santa Cruz River Action Plan Map

C.1.14 Santa Cruz River – Upper

This watershed extends from the Santa Rita Mountain ridge in the southeast across the Santa Cruz River basin to the Sierrita Mountains in the southwest. Its northern terminus is south of Martinez Hill and Black Mountain and the northern boundary of the San Xavier District of the Tohono O'odham Nation. It is comprised of 232,084 acres (362.6 square miles), 19,754 of which are in the Town of Sahuarita.

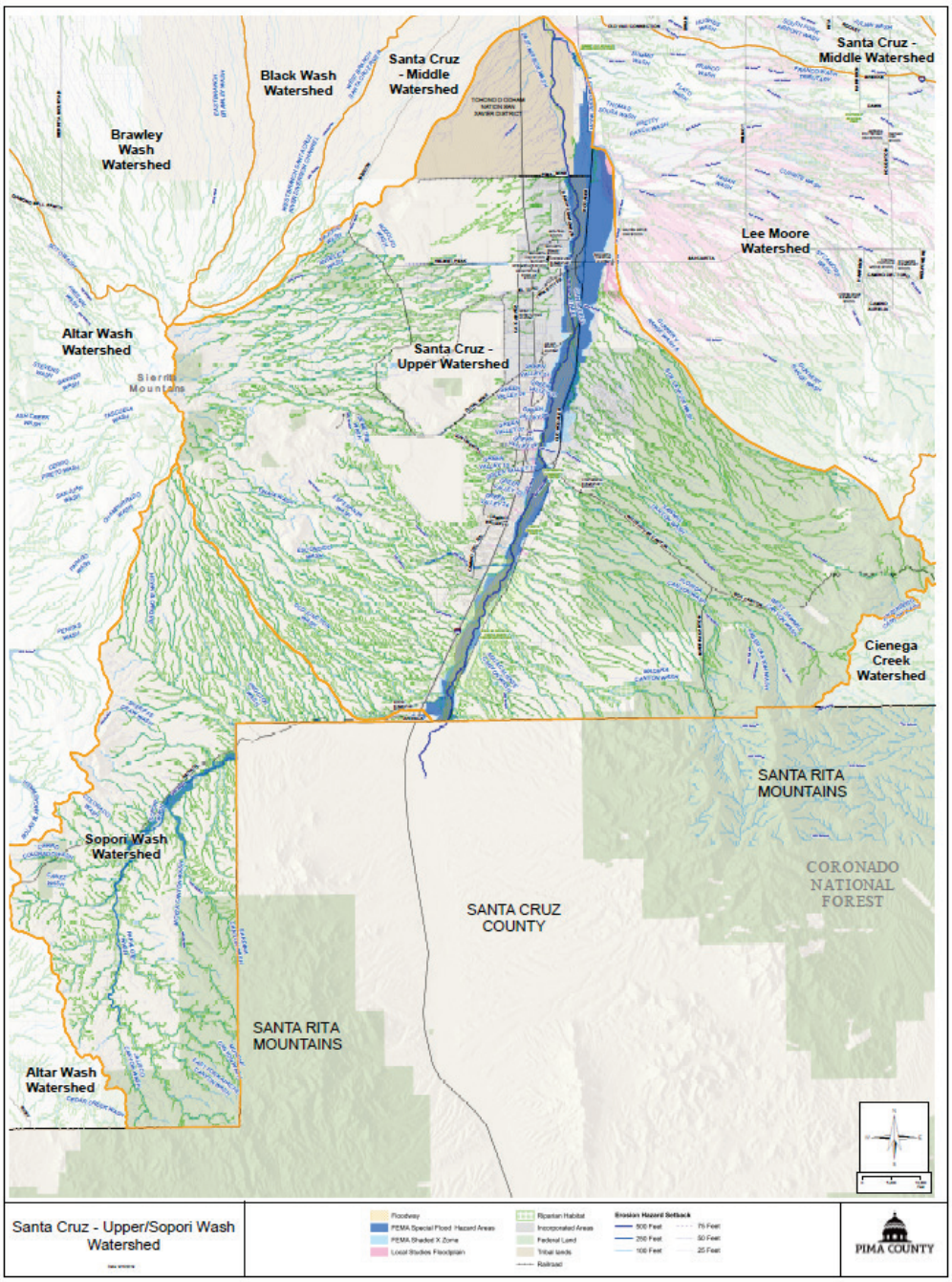


Figure 168 - Upper Santa Cruz River Watershed

C.1.14.1 Flood Characteristics

In addition to mountain front drainage across large alluvial fans, the Santa Cruz River enters from the south across Santa Cruz County and the international border to Mexico. Of geographic and political interest is the fact that its headwaters are also within the United States

In total, including incorporated areas and federal lands there are 11,194 acres of SFHA and 264 acres of Special Study floodplains and 1,630 acres of locally mapped sheet flood area. The FEMA Flood Insurance Study (FIS) indicates a peak discharge of 60,000 cubic feet per second (cfs) at Drexel Road over three miles downstream of the watersheds terminus with a drainage area of 2,101 square miles. On the upstream side of the watershed, but over 9 miles downstream of the County line, the FIS indicates a peak discharge of 45,000 cfs at Continental Road with a drainage area of 1,162 square miles. This is by far the largest flow entering the County.

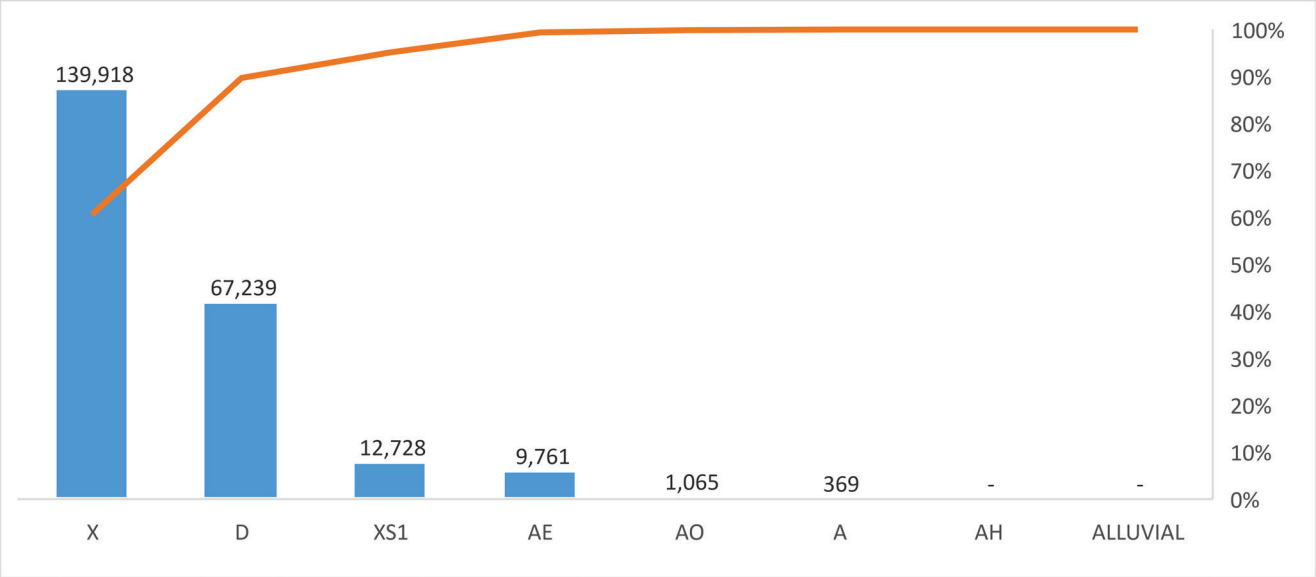


Figure 169 - Upper Santa Cruz River SFHA in Acres

In sum both unconstrained riverine flooding and cross drainage are all significant concerns.

The FEMA Flood Insurance Study (FIS) indicates a peak discharge of 60,000 cubic feet per second (cfs) at Drexel Road over three miles downstream of the watersheds terminus with a drainage area of 2,101 square miles. On the upstream side of the watershed, but over 9 miles downstream of the County line, the FIS indicates a peak discharge of 45,000 cfs at Continental Road with a drainage area of 1,162 square miles. This is by far the largest flow entering the County.

The table below summarizes historic USGS gaging station records.

Table 48 - Upper Santa Cruz River USGS Gages

USGS Gaging Station	Demetrie Wash near Continental, AZ 09481800	Santa Cruz River at Continental, AZ 09482000	Ocotillo Wash near Continental, AZ 09481900	Santa Cruz River near Amado, AZ 09481770
Period of Record	1965-07-10 to 1981-09-18	1982-08-23 to 1990-07-24	1965-07-10 to 1981-07-21	1965-07-10 to 1981-08-13
Watershed Area (sq. m)	.15	1682	3.60	1460
Flood Peak of Record (cfs)	110	45000	1840	7770
Date	09-07-1975	10-02-1983	07-00-1964	07-19-2007
Table of Regulatory Discharge (cfs)	NA	NA	NA	NA

The table below summarizes Pima County's Alert Gages. The locations are from the District's Alert map.

Table 49 - Upper Santa Cruz River Watershed ALERT Streamflow Gages

Pima County ALERT Gages	Santa Cruz River below Continental Road ID: 6054	Santa Cruz River at Continental Road ID: 6053
Location (Latitude, Longitude)	(31.8567, -110.98)	(31.8542,-110.9792)
Period of Record	2014-06-25 to Present	2007-07-10 to Present
Watershed Area (sq. m)	1643.87	
Flood Peak of Record (cfs)	7250	4200
Date	09-18-2014	09-19-2014

Table 50 - Upper Santa Cruz River Watershed ALERT Precipitation Gages

Pima County Alert Gage	Santa Cruz River below Continental Road ID: 6051	Santa Cruz River at Continental Road ID: 6050	Florida Canyon Santa Cruz Basin ID: 6390	Anamax Mine near Green Valley –Santa Cruz Basin ID: 6330	Santa Cruz River at Elephant Head Road ID: 6060
Location (Latitude, Longitude)	(31.8567,-110.98)	(31.8542,-110.9792)	(31.7617,-110.7461)	(31.8786,-111.0586)	(31.7447,-111.0372)
Period of Record	2014-06-25 to Present	1986-08-27 to Present	2003-02-27 to Present	1987-07-31 to Present	1987-07-21 to Present

The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Tables of Regulatory Discharges.

Table 51 - Upper Santa Cruz River Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Santa Cruz River @Continental Road	45000	1682	FEMA, Flood Insurance Study

C.1.14.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. Over 16 percent of the residents live within regulatory floodplains and 70 individuals live behind a levee.

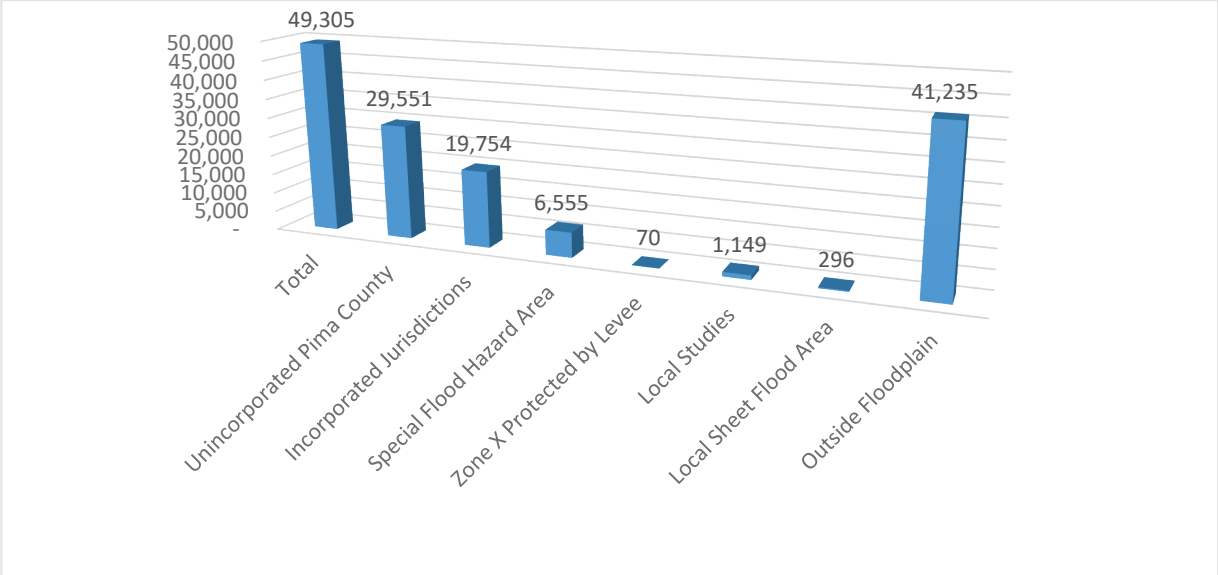


Figure 170 - Upper Santa Cruz River Watershed

After passing into Pima County from Santa Cruz County, the river passes through the Town of Sahuarita, Sahuarita Farms (Farmers Investment Company/Green Valley Pecan Company, and the San Xavier District of the Tohono O'odham Nation.

East of the River, the uplands including mountain escarpment and alluvial fan are largely protected natural open spaces due to inclusion within National Forest and the University of Arizona Experimental Range. While the County has purchased the historic Canoa Ranch at the upstream area of this watershed along the Pima and Santa Cruz County border most of the land along the main channel remains in private hands within Green Valley and the Town of Sahuarita.

Green Valley is not an incorporated town, but the community has a local identity for residents and reviews activity within a Green Valley Council. The Council works regularly with Pima County staff to request construction and maintenance of drainage infrastructure. A network of constructed drainageways conveys flows through Green Valley to the Santa Cruz River floodplain.

Within the formally incorporated Town of Sahuarita, the Town has floodplain management jurisdiction. The Pima County Regional Flood Control District cooperates with incorporated jurisdictions to deliver floodplain mapping and capital improvement projects following guidance from the Flood Control District Advisory Committee.

Along the river and only partly within unincorporated County, but mostly within the Town of Sahuarita are the Farmers Investment Company (FICO) pecan orchards. At over 7000 acres, these are amongst the largest in the world.

In 2015, both jurisdictions approved a long-term mixed-use residential and commercial development specific plan for the FICO property, the Sahuarita Farms Specific Plan. Under this plan, channelization will narrow much of the floodplain to facilitate the conversion from agriculture to urban use. The plan is a broad-ranging planning document including a river master plan as well as land use planning, community facilities, transportation and utilities. The plan will guide decision-making over the next 50 years. Development pressure now does not motivate major implementation of plan elements in the near future. The District has recommended the use of compound channel design to protect the natural and beneficial functions of floodplains and to address future conditions.

Most of these uplands are private or State lands. As shown on the figure below, there are 106,753 acres of private lands and 46,916 acres of State Trust lands, which is 66% of the watershed.

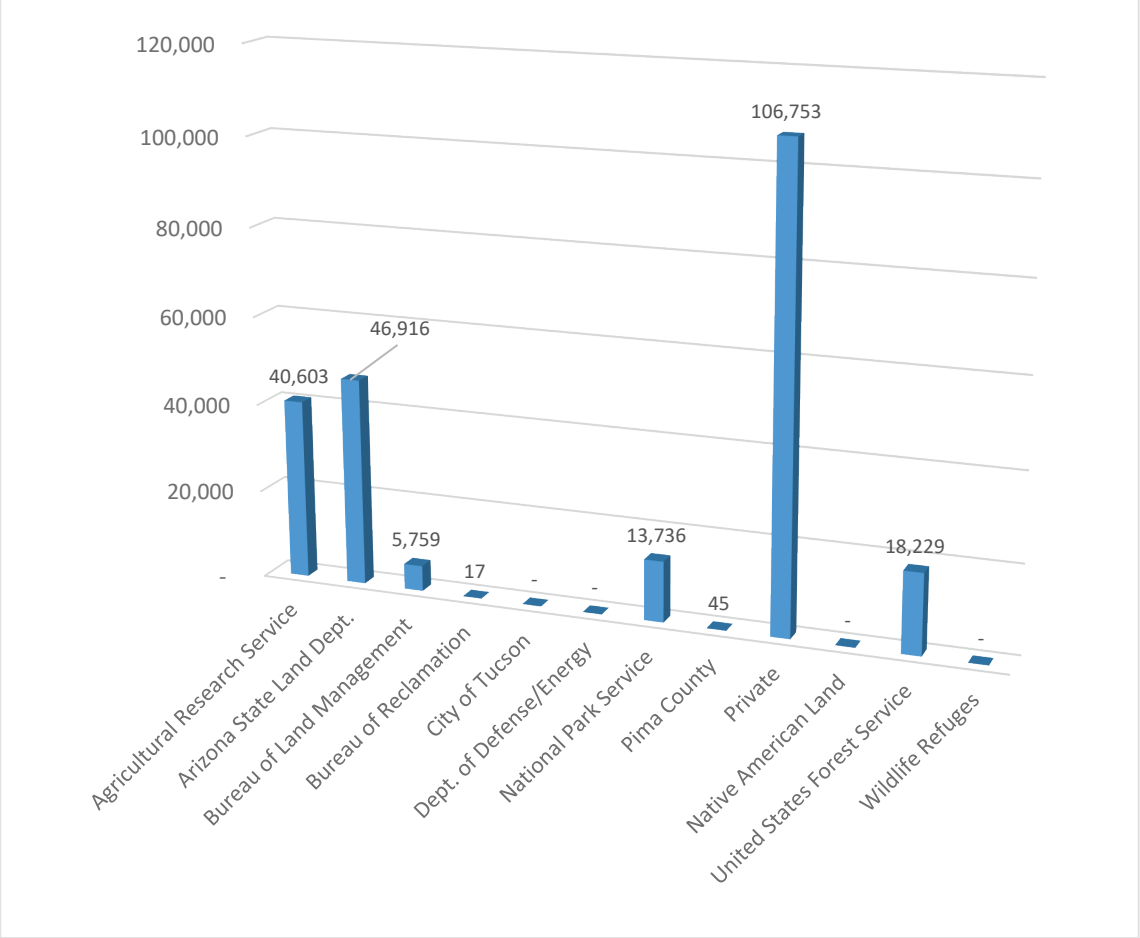


Figure 171 - Upper Santa Cruz River Watershed Ownership in Acres

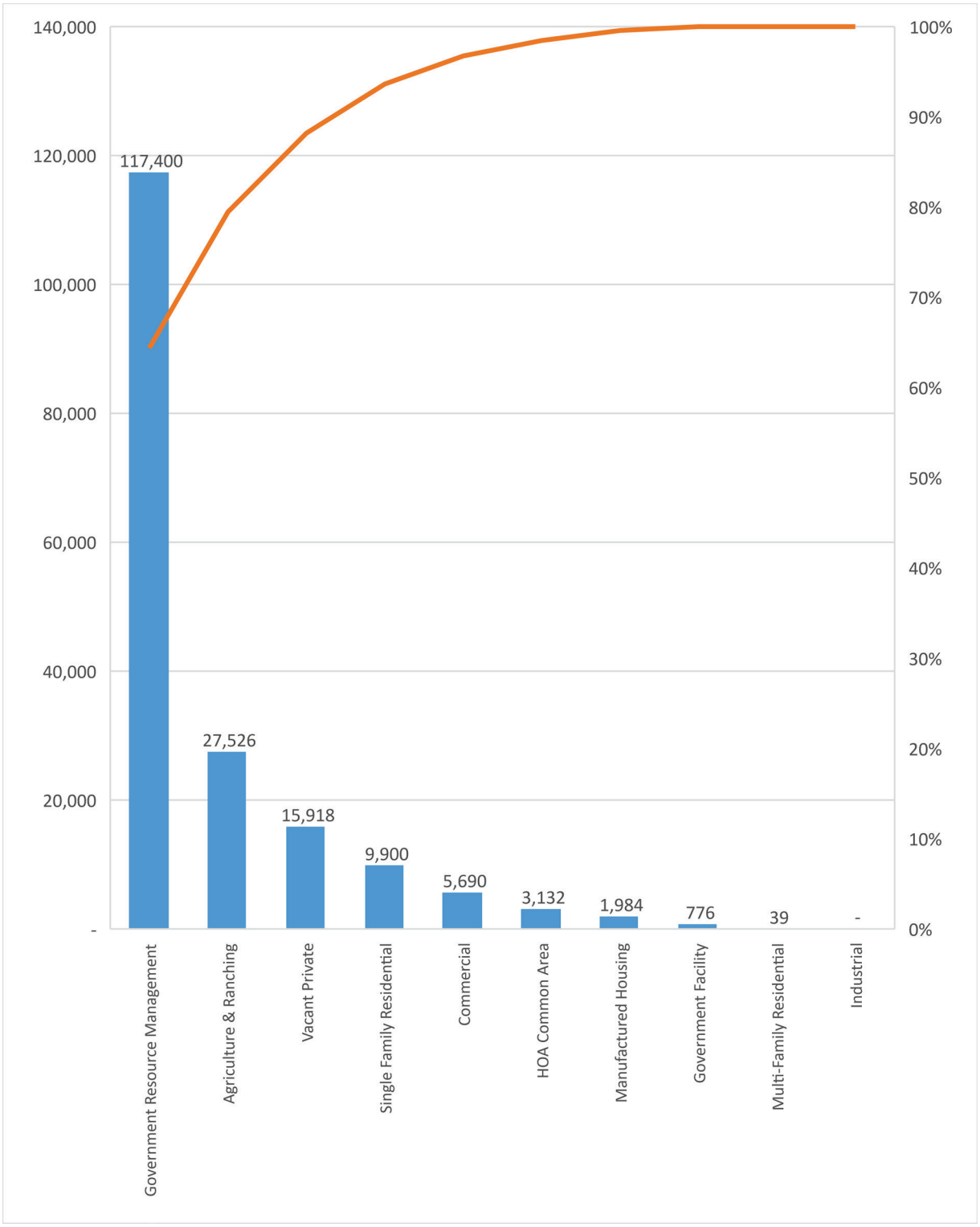


Figure 172 - Upper Santa Cruz River Watershed Land Use in Acres

Market factors have stalled several substantial developments in these areas. While large areas are vacant, current land uses are predominately recreational, residential, some ranching and large mining operations. The large amount of HOA common area is notable as they are private maintained and protected. In many cases, these include drainageways and watercourses.

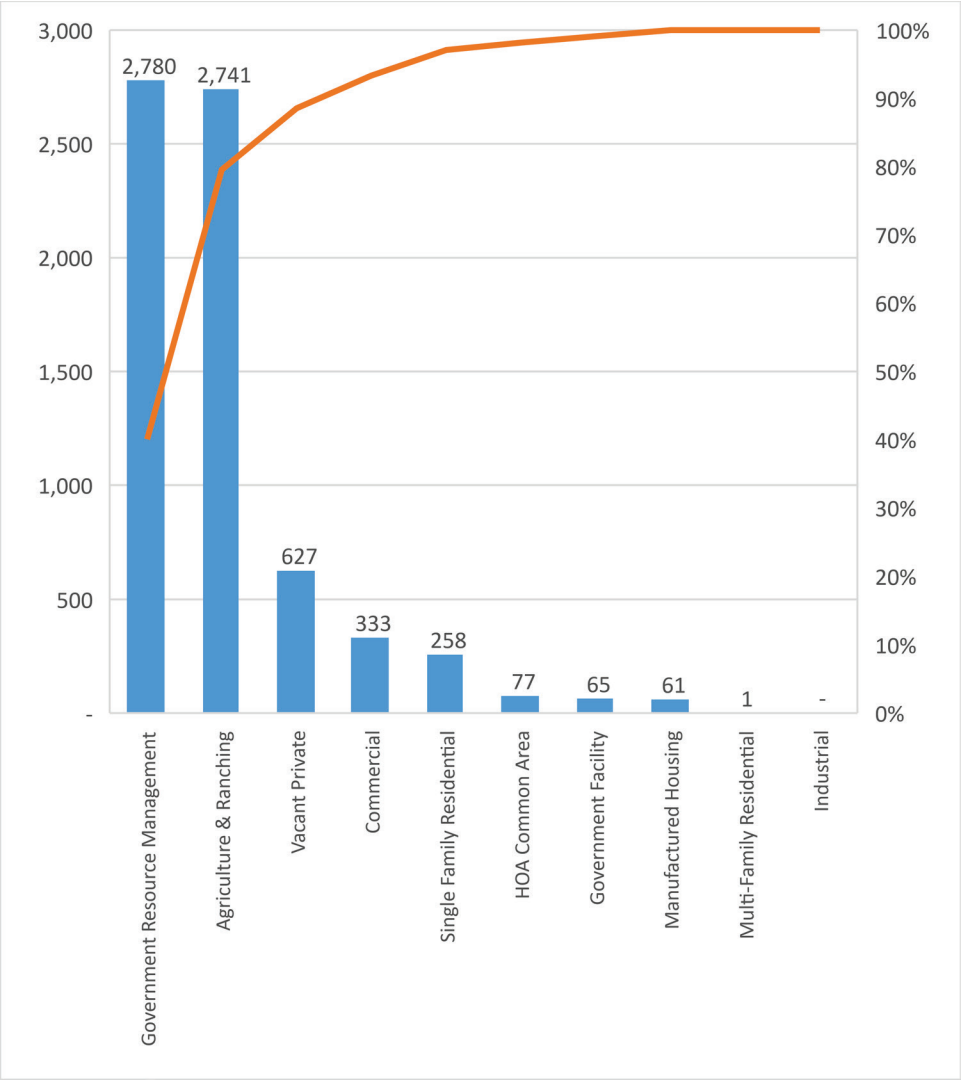
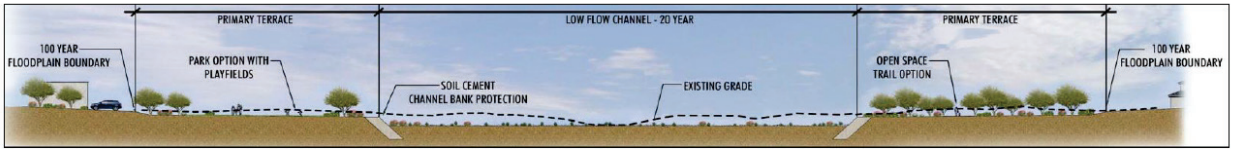


Figure 173 - Upper Santa Cruz River Watershed Floodplain Land Use

Within the floodplain land use is predominately agricultural however as noted above Pima County and the Town of Sahuarita accepted FICO's Sahuarita Farms Specific Plan. This plan includes a River Management Plan. This plan features riparian restoration and recreational features in low flow overbanks and a bank protected main channel. The owners expect this development to use less groundwater than the agricultural operations.



The portion of the River extending from the Santa Cruz County line to Pima Mine Road is the least impacted by channel drainage infrastructure. In general, the floodplain is a half-mile or more wide and encroachment is minimal. South of Green Valley there is very little development along the channel or in the tributaries. From Green Valley north through Sahuarita, there is development along the west bank, but minimal bank protection. Along the east bank, there are pecan fields and some residential development. Recent hydraulic analysis has indicated that flow along the eastern edge of the floodplain through the pecan fields may be a prominent secondary flow path in a significant flood. Within the San Xavier Reservation, the reach downstream of Martinez Hill and Interstate 19 is partially bank protected, although not by soil cement, as this was not a County project. South of Interstate 19 the channel is natural however has experienced head cutting and other erosive forces. The O'odham began a restoration project over a decade ago for the now absent massive bosques that existed prior to arrival of European enterprise. Vegetation and surface water has begun to rebound and a major farm expansion and recharge project is planned which will have additional natural floodplain function benefit.

The map below shows the land use patterns in this watershed.

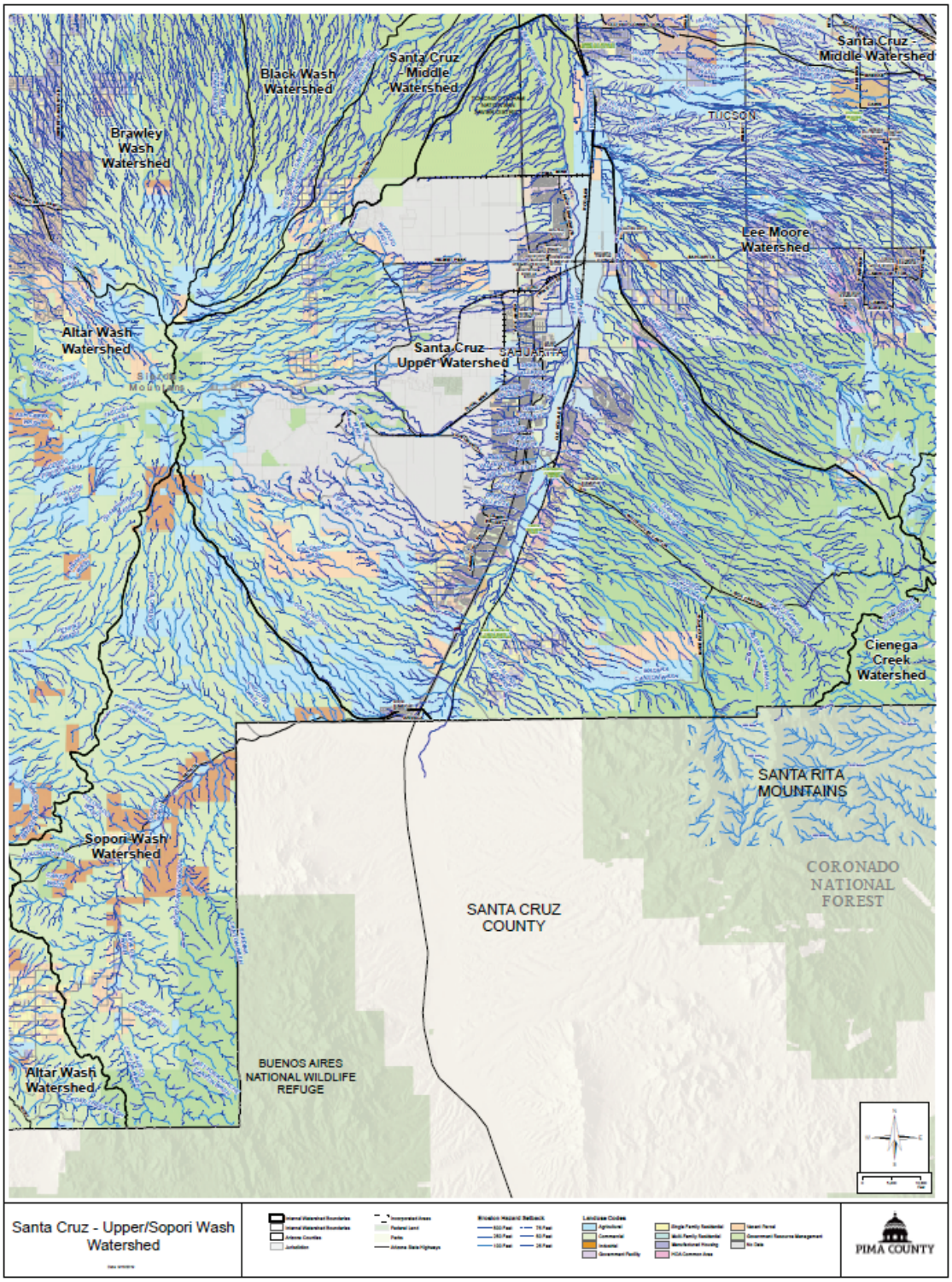


Figure 174 - Upper Santa Cruz River Land Use Map

C.1.14.3 Riparian Habitat and Natural Areas

There is 20,267 acres of Pima County Regulated Riparian Habitat within this watershed and 11,054 acres designated as IRA. There are also 61,414 preserved acres in this watershed, including 1,694 in regulatory floodplain. It also includes the County owned Raul M. Grijalva Canoa Ranch Conservation Park situated along both sides of the Santa Cruz River for almost 5 miles. As noted above the southeastern uplands are within the Santa Rita Experimental Range and the Coronado National Forest. While tribal lands are sovereign, with the exceptions of current mining and gaming enterprises, the population is small (2,053 per the 2000 Census) and the land use predominately ranching or vacant.

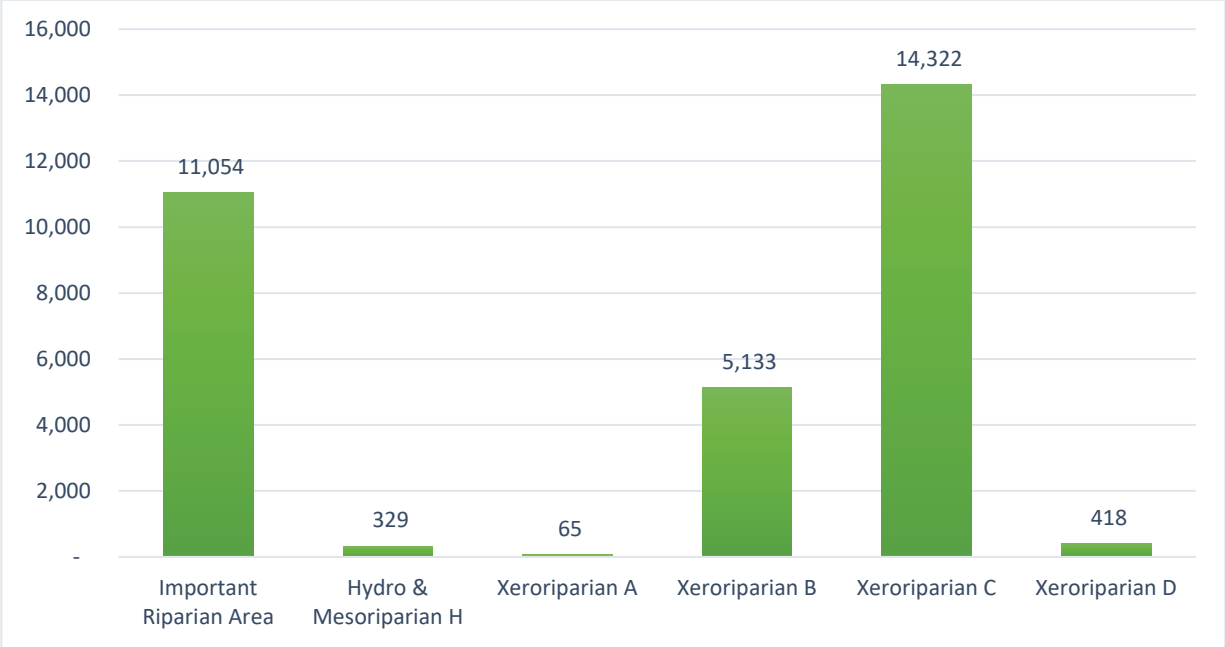


Figure 175 - Upper Santa Cruz River Watershed Riparian Habitat in Acres

Pima County acquired the Historic Canoa Ranch in 2001 (now designated as "Raul M Grijalva Conservation Park") with the goal of preserving cultural and historic features. The ranch lands encompass 4800 acres along the SCR extending north of the Pima-Santa Cruz county line. The District, as Program Sponsor of an Army Corps of Engineers' (USACE) In-Lieu Fee (ILF) Program within southern Arizona, is proposing to restore natural riverine and aquatic resource functions within Canoa Ranch. As part of this effort, restoration of the historic lake completed in 2018 provides 2.5 acres of open water habitat and passive recreation for visitors. This location is quickly becoming a premiere birding location in AZ. Continuing the habitat restoration efforts a cienega will be created adjacent to the lake, 10 acres of pollinator garden and grassland plus 30 acres of open mesquite woodland and riparian shrub habitat restoring natural floodplain function to abandoned agricultural fields on the floodplain terrace is planned through 2021. Stewardship of the Canoa Ranch includes protecting the rich natural resources by prohibiting human activity detrimental to the ecosystem.

C.1.14.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

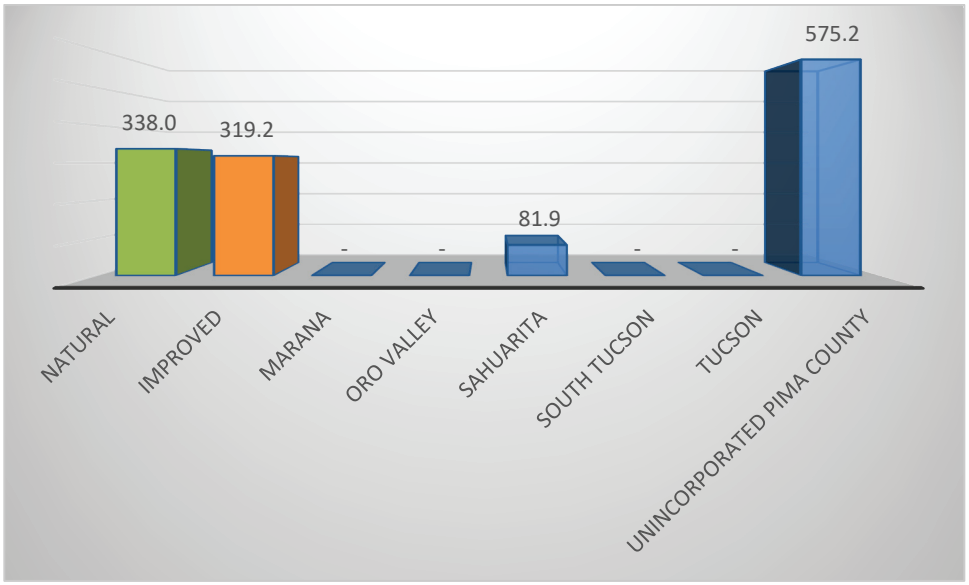


Figure 176 - Upper Santa Cruz River Improved vs. Open Space Drainageways in Acres

This 1983 flood photograph was taken looking south along the Upper Santa Cruz River watershed with Martnez Hill on the left, shows bank collapse caused by the natural processes of aggredation, degradation, flow splits and lateral migration. As development has encorached upon this floodplain increased bank protection has been required as has been done more completely downstream of this point through the middle reach of the Santa Cruz River until it is partially released again onto the farmland flooplains of Marana.

1983 Flood Photo by Peter Kresan looking south from Martinez Hill

The District has classified the Santa Cruz River has been classified as a major watercourse for regulatory and planning purposes.

Please see the Lower Santa Cruz River watershed appendix for a complete discussion of ALERT gauges and notification levels for this watershed.

Franco Wash is a significant tributary, which may affect the Summit area near South Nogales Highway and Old Vail Connection road. There is one stream gauge at Swan Road (6213). The channels in this area cannot convey large amounts of flow and may affect residential structures and at-grade crossings in the Summit area. Stream gauges may not reflect sheet flow. The District has not studied travel time. However, assuming an average channel velocity of 10 fps, travel time from 6213 to Country Club Road is 20 minutes. Streamflow of 200 cfs at Franco Wash at Swan Road (6213) may affect at-grade crossings including Country Club Road, Summit Street and Old Vail Connection Road. At this rate, ALERT staff notifies PCDOT. Streamflow of 500 cfs at Franco Wash at Swan Road (6213) may affect the Summit residential area. During flood events, senior staff makes the decision as to whether District should pass the information to OEM.

C.1.14.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- The Lee Moore Wash and tributaries to the Lee Moore have created head cuts and other erosional features that are a potential threat to structures near Camino San Matias and Calle San Julian.
- The Madera Highlands subdivision design of may not have been adequate to deal with flooding from the Santa Cruz River and Sawmill Canyon Wash.

Infrastructure

- Kolb Basin - Damage has occurred to both the riprap splash pads at the bottom of the east side inlets.
- Kolb Basin - Some bank rill erosion has been getting deep along the north bank and some small riprap drainage spillways at these locations is warranted.

- Arroyo Chico basin complex - The outlet splash pad into Basin # 3 has a sizeable scour hole, four to five foot deep across the length of the concrete splash pad. The District completed repairs in 2016/17 by adding more very large riprap boulders.
- Arroyo Chico basin complex - The arch culvert outlet off of basin #1 collects sediment on the outlet splash pad which needs to be monitored and possibly removed to keep low flow events from stacking material in the arch culvert.

C.1.14.6 Floodplain Management

Future needs identified by District staff include:

- Non permitted structures
- Gravel pits
- Head cut Lee Moore and tributaries
- Potential future development/Sonoran corridor
- Updated mapping
- Management Plan for Santa Cruz County Line to Pima Mine Road

Head Cut West of Old Nogales Highway near Placita Del Caballito

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Create open space management plans

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify agriculture diversions
- Identify and monitor erosion on tributaries to the Santa Cruz River

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Complete RiskMap
- Identification of flood risks at Sopori and SCR Confluence

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 4.2.c Expand and update the District's flood threat recognition and integrate it with warning system

- Coordinate with other jurisdiction including the Tohono O'odham Nation on flood warning needs

Ref# 5.1.b Complete new river and basin studies to identify needs and develop alternatives

- Create Basin Management Plans
- Develop Santa Cruz River Management Plan

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Loop and Trail Enhancements

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

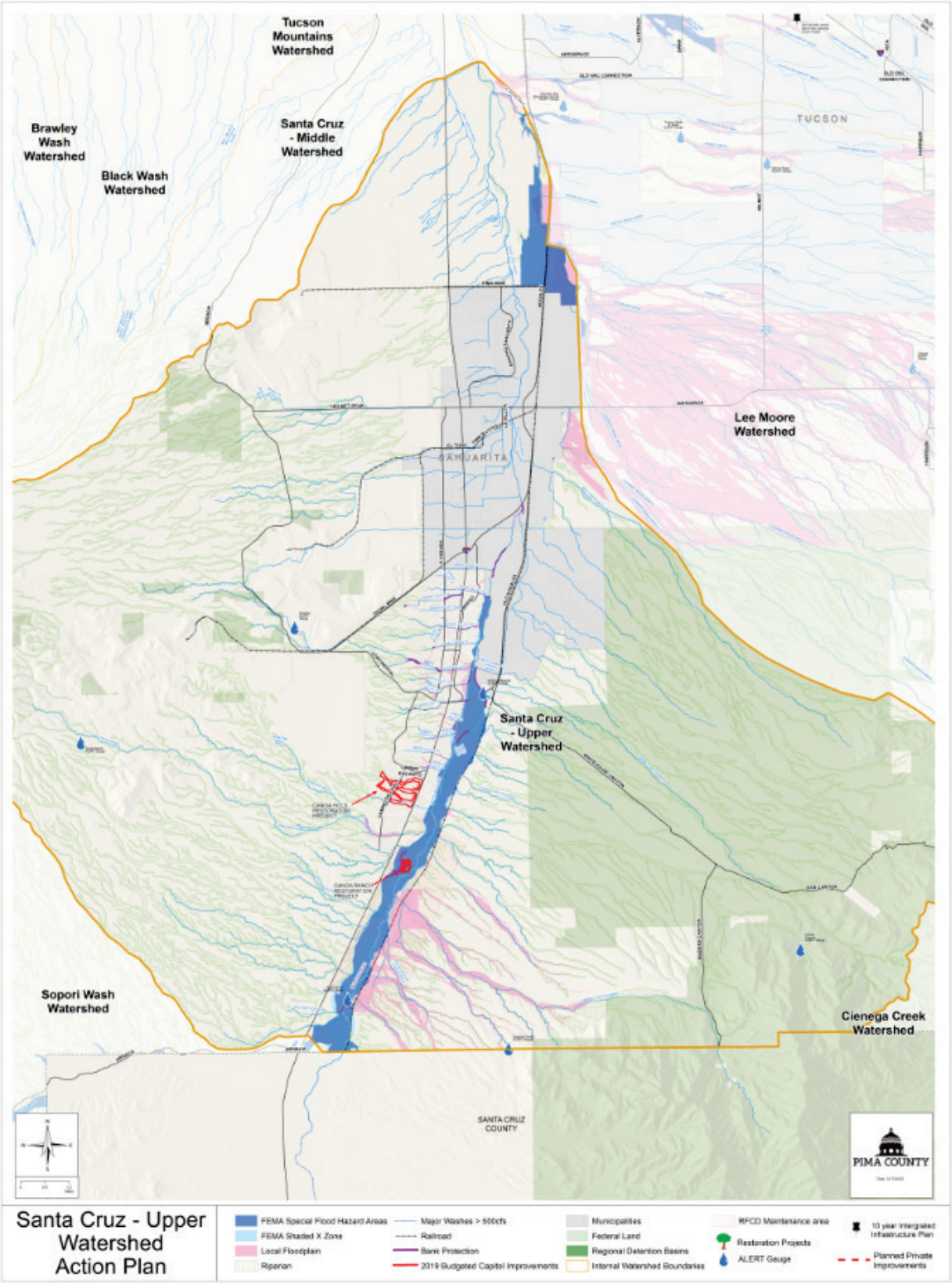


Figure 177 - Upper Santa Cruz River Action Plan Map

C.1.15 Tanque Verde Creek

Tanque Verde Creeks' headwaters are on both sides of Redington Pass in the Rincon and Santa Catalina Mountains. Originating at nearly 9000', it descends steeply through dramatic canyon walls before spilling out onto the bajada foothills and geologic floodplains associated with the Agua Caliente Wash and Sabino Creek, where they merge to become Rillito Creek. Within Pima County, it is comprised of 70,188 acres (109.7 square miles), including 9,408 within the City of Tucson.

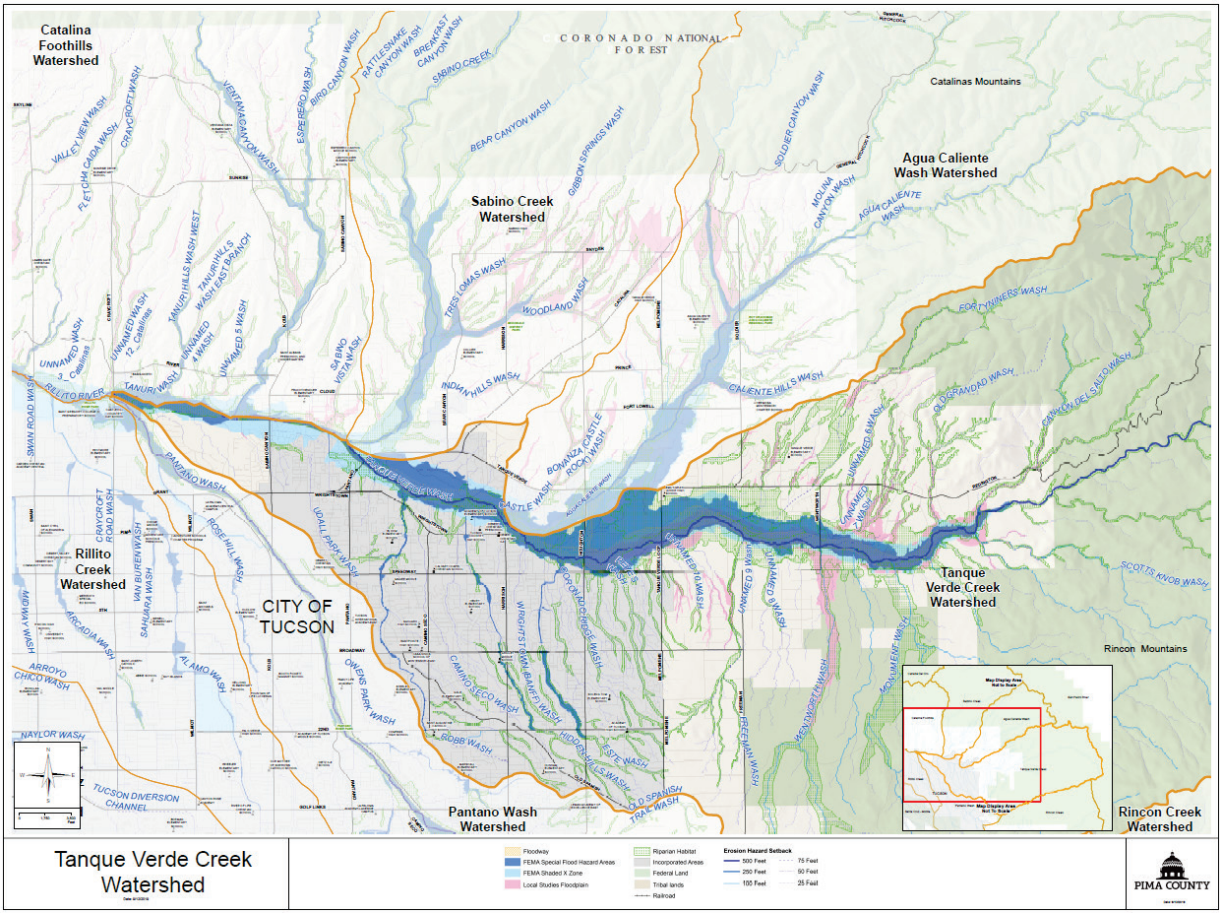


Figure 178 - Tanque Verde Wash Watershed Map

C.1.15.1 Flood Characteristics

In addition to the 2,354 acres of SFHA zones included on the chart above, there are also 1,179 acres of Special Studies Floodplains in this watershed.

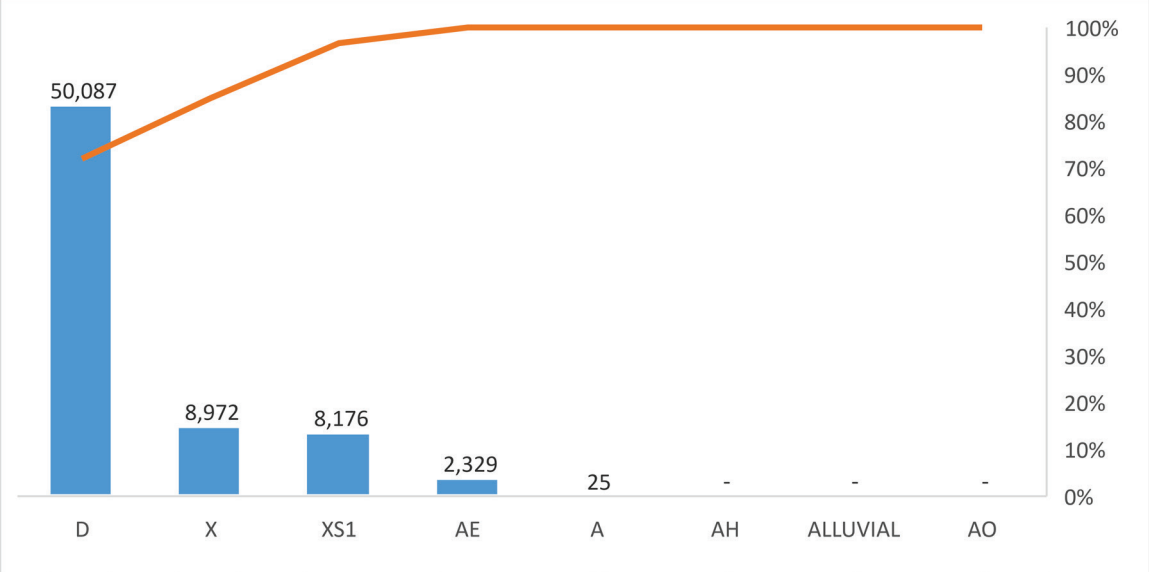


Figure 179 - Tanque Verde Creek Federal Floodplain Designations in Acres

The Tanque Verde Creek watershed originates at higher elevations in the Coronado National Forest, areas subject to snowfall, higher annual rainfall and more frequent runoff events than other parts of Pima County. The watershed is relatively static resulting in stable hydrologic response over time. However, vegetation, slope and rainfall characteristics change dramatically from the upper parts of the watershed, which receive more than twice as much rainfall as the lower portions of the watershed, to the lower portions of the watershed. Lower portions of this watershed south of Tanque Verde Creek are more densely developed and lie primarily within the flood control jurisdiction of the City of Tucson. Twenty-one ALERT Gauges are in place to provide advance warning and monitoring of flow rates, depths and rainfall.

Unlike most of Pima County flow, flow in these watersheds can continue for extended periods, and the upper watersheds may even experience perennial flow. Flow measurement in the Tanque Verde is more complete than many other watersheds. A summary of the USGS gauging station records on the Tanque Verde Creek is as follows:

Table 52 - Tanque Verde Creek Watershed USGS Gages

USGS Gages	USGS 09483100 TANQUE VERDE CREEK NEAR TUCSON, ARIZ	USGS 09484500 TANQUE VERDE CREEK AT TUCSON, AZ.
Period of Record	Nov. 1960 to Dec. 2012	Aug. 1940 to Jan. 2015
Watershed Area (sq. m)	43	219
Flood Peak of Record (cfs)	8,600	26,600
Date	2-Oct-83	31-Jul-06
FIS Discharge (cfs)	16,000	34,000

These records indicate that floods in the Tanque Verde can occur from all three of the three primary flood mechanisms that occur in Pima County, convective storms, tropical storms and frontal storms. Rain on snow events occur in this watershed when frontal storms produce rain on existing winter snow.

The table below summarizes Pima County's Alert Gages. The locations are from the District's Alert map.

Table 53 - Tanque Verde Creek Watershed ALERT Streamflow Gages

Pima County Alert Gage	Tanque Verde Creek at Chiva Tank ID: 2073	Tanque Verde Creel at Tanque Verde Guest Ranch ID: 2093
Location (Latitude, Longitude)	(32.2675, -110.6069)	(32.246,-110.6827)
Period of Record	1987-01-05 to Present	1987-08-03 to Present
Watershed Area (sq. m)	43.07	43.18
Flood Peak of Record (cfs)	7768.3	33542.9
Date	07-27-2017	12-05-1994

Table 54 - Tanque Verde Creek Watershed ALERT Precipitation Gages

Pima County Alert Gage	Park Tank-Tanque Verde Basin ID:2020	Italian Trap-Tanque Verde Basin ID: 2030	White Tank-Tanque Verde Basin ID: 2040	Tanque Verde Creek at Chiva Tank ID:2070	Tanque Verde Creek at Tanque Verde Guest Ranch ID: 2090
Location (Latitude, Longitude)	(32.2625 -110.5464)	(32.2853,-110.5636)	(32.3044,-110.5708)	(32.2675,-110.6069	(32.2458,-110.6827)
Period of Record	1985-07-02 to Present	1985-07-02 to Present	1985-06-27 to Present	1986-06-17 to Present	1987-07-02 to Present

Below are excerpts for Tanque Verde Creek and major tributaries from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 55 - Tanque Verde Creek Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Agua Caliente Split Flow @ Divergence from Agua Caliente Wash @ Confluence with Tanque Verde Creek	 3,360 5,820		 FEMA Map Revision (11-09-1817S) "
Forty-Niners Wash @ National Forest Boundary @ Tanque Verde Road	 4,578 3,500		From Previous Discharge Table "

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Old Grandad Tank Wash: @ Tanque Verde Creek Confluence	3,942	2.02	Pima County Regional Flood Control District Special Study (#57)
Tanque Verde Creek: Upstream of Confluence with Rillito Creek	34,000	241.0	FEMA, Flood Insurance Study
Upstream of Confluence with Sabino Creek	28,000	149.0	"
Near the confluence with the Agua Caliente Wash	23,000	99.60	"
Wentworth Wash: Upstream of Speedway Boulevard	4,719	5.3	Pima County Regional Flood Control District Special Study (#58)

Flood characteristics vary greatly on the watershed. While flow is primarily constrained in mountainous channels, distributary flow patterns develop where these channels enter the valley floor at the apex of alluvial fans, and residential properties are at risk for flood damage where drainage infrastructure does not exist. Potential for overbank flow leading to flooding exists along the Tanque Verde Creek, particularly at its confluence with Agua Caliente Wash. Potential overbank flow conditions along Sabino Creek affect fewer residential properties

Likewise, flood characteristics themselves vary greatly depending on whether the event is convective, such as the July 31, 2006 event, which was produced by a high intensity, shorter duration event, or a rain on snow event, which can release a higher volume of water over a longer period. Tributary flooding is likely during short and long duration storms while main stem flooding typically occurs during long duration or overlapping storm events.

Floods from the Tanque Verde Creek have posed the greatest risk downstream of Wentworth Road, particularly for many homes on the north bank at Forty-niners Country Club Estates, which are in the mapped FEMA floodplain. Some of these have been flooded more than once and are a Repetitive Loss Area.

Downstream of North Tanque Verde Loop Road, properties south of Tanque Verde Creek generally lie within the flood control jurisdiction of the City of Tucson.

Agua Caliente Creek and Sabino Creek and tributaries to these sub-watersheds enter the valley floor onto alluvial fans, which is where most of the development has occurred. Flows on these fans can cause erosion, deposition and channel avulsion. The July 31, 2006 also produced debris flows on these alluvial fans, which resulted in flooding of some structures that would not have been at risk if the debris flow had not altered the flow pattern at the apex in Soldier Canyon. In addition, even where flow-patterns were not altered, such as in Sabino Canyon upstream of Bear Canyon, the sediment released in the debris flow filled the channel and reduced the flood capacity.

As flows enter the valley floor in the main channel of Tanque Verde creek, flows are contained. Downstream of Sabino Creek the District has installed bank protection to limit the potential for channel migration.

In general, the watercourses have been well-mapped as indicated by 92% of the SFHA from detailed studies and only about 8% in approximate studies.

C.1.15.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. Almost 50% of watershed residents live in a floodplain.

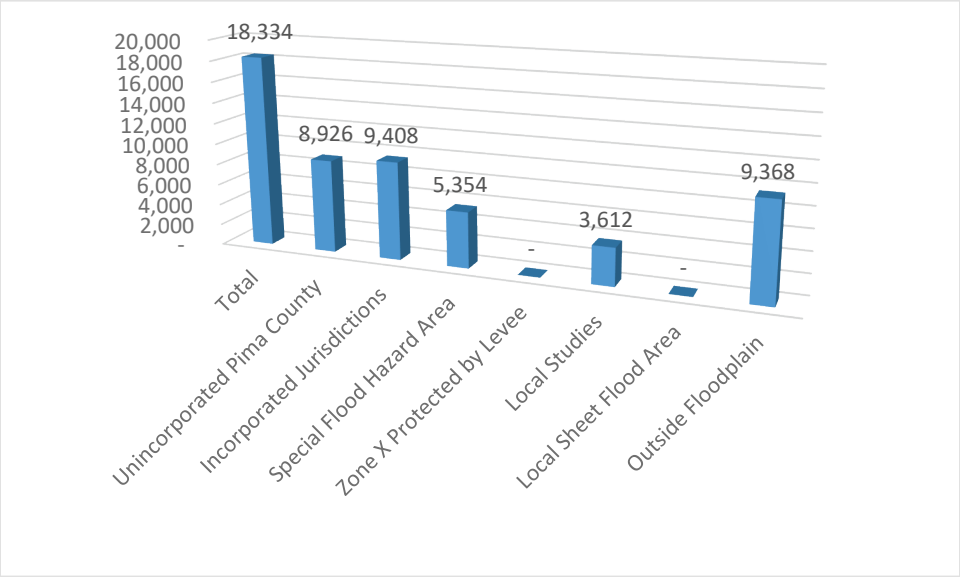


Figure 180 - Tanque Verde Creek Watershed Population Distribution

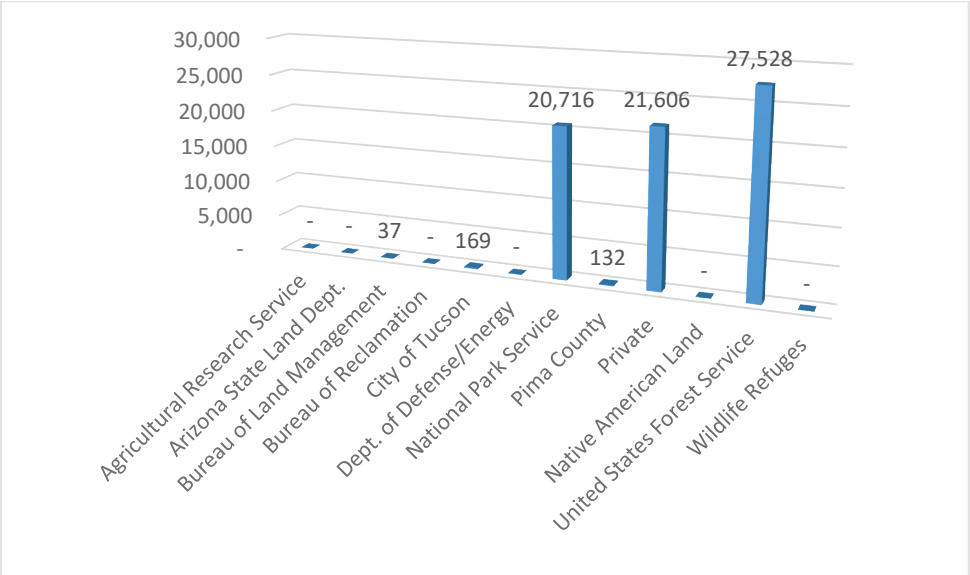


Figure 181 - Tanque Verde Creek Watershed Ownership in Acres

Outside the National Park, single family residential is the predominant use throughout this watershed.

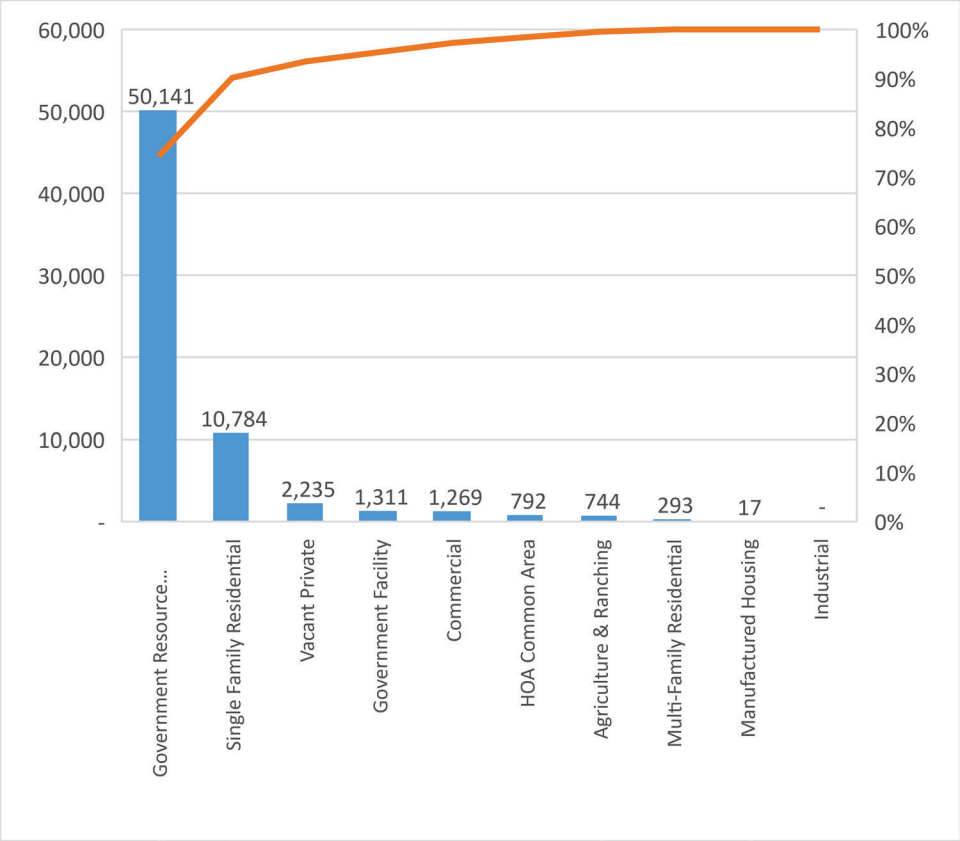


Figure 182 - Tanque Verde Creek Watershed Land Use in Acres

In recent years, the County has approved increased densities on areas previously left open due to flood and other limitations. While build out of improved developments and some lot splittig can be expected few large tracts are available for development. The low density of current development does suggest that density increases are due to the attractiveness of the area, which is tied to the riparian characteristics.

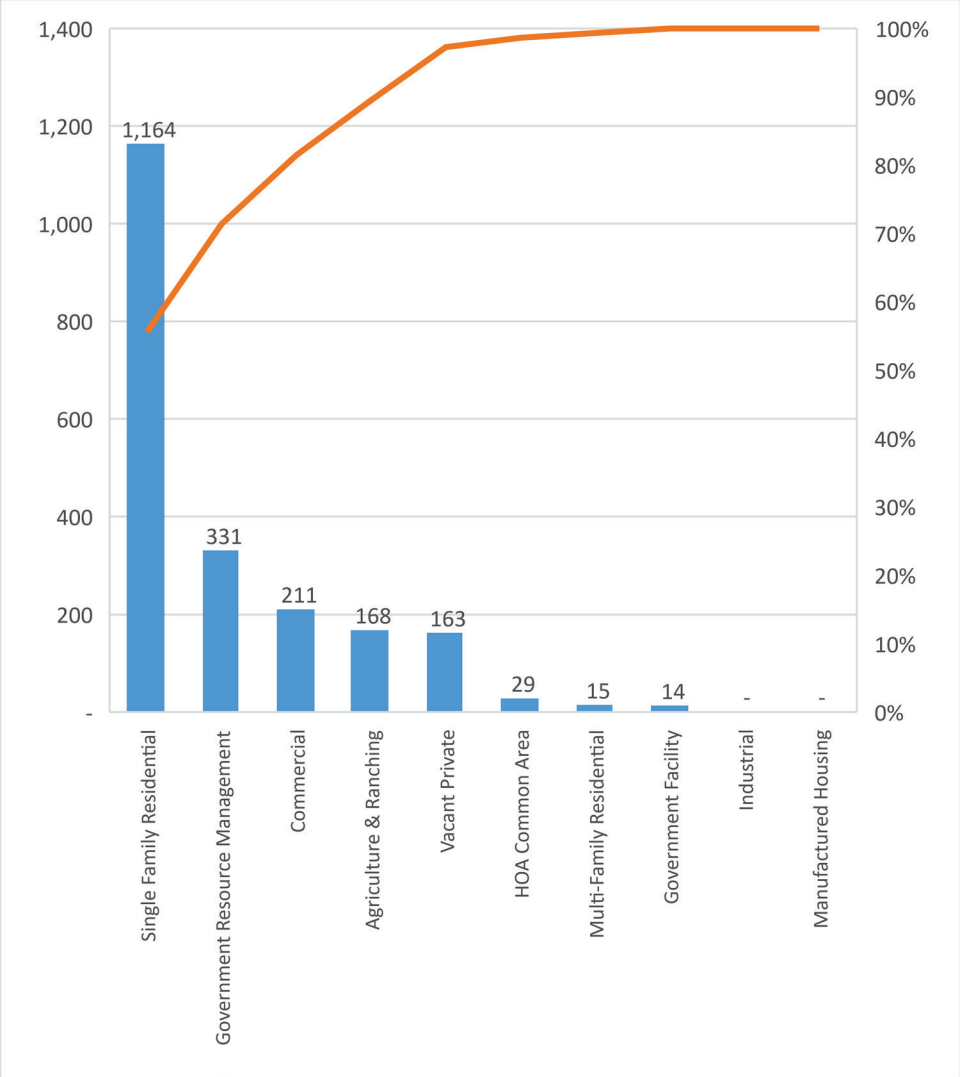


Figure 183 - Tanque Verde Creek Floodplain Land Use

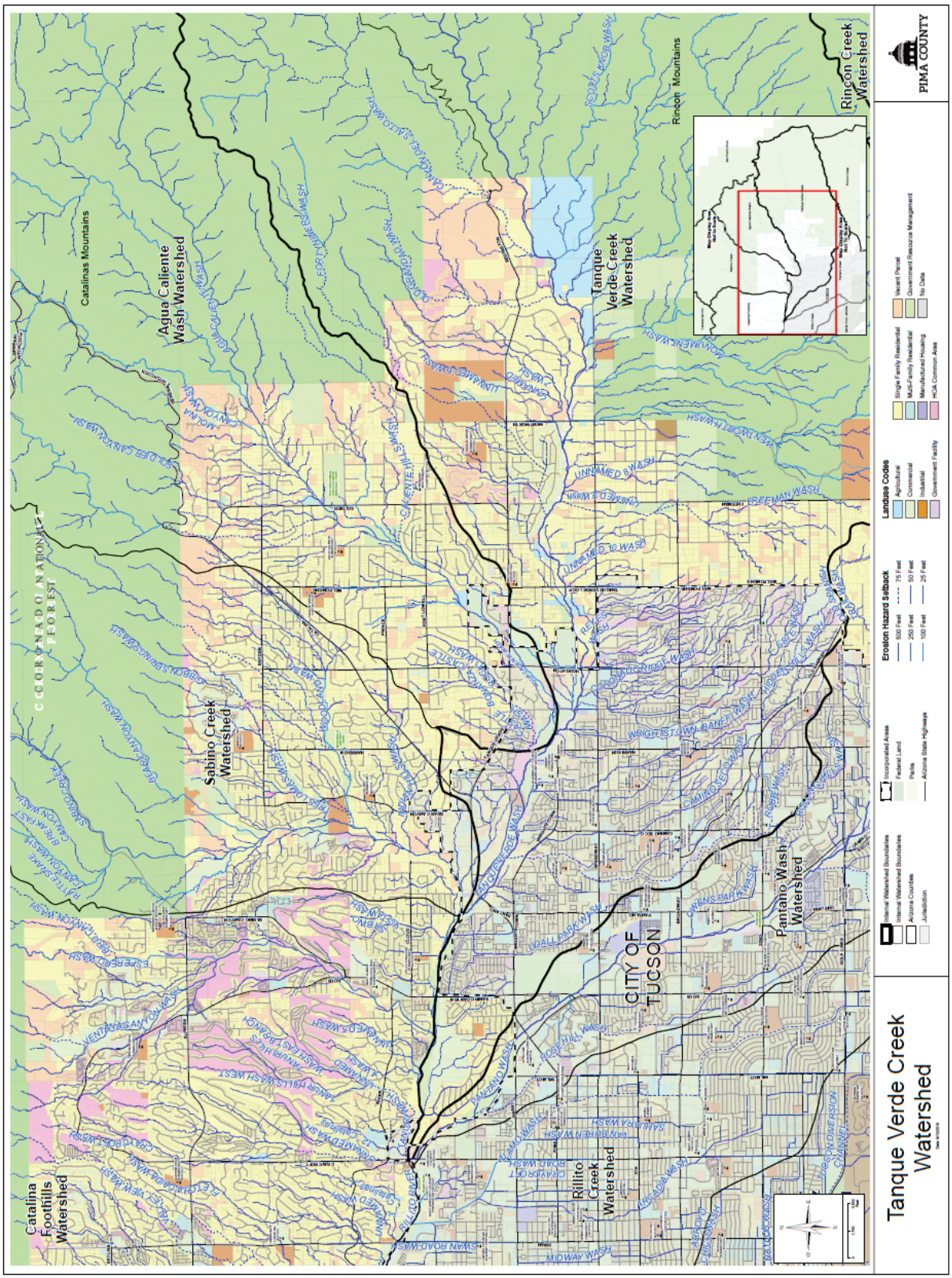


Figure 184 - Tanque Verde Creek Land Use Map

C.1.15.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 3,699 acres of Pima County Regulated Riparian Habitat in this watershed and 2,800 acres of IRA. There are also 50,508 preserved acres in this watershed, including 597 in regulatory floodplain.

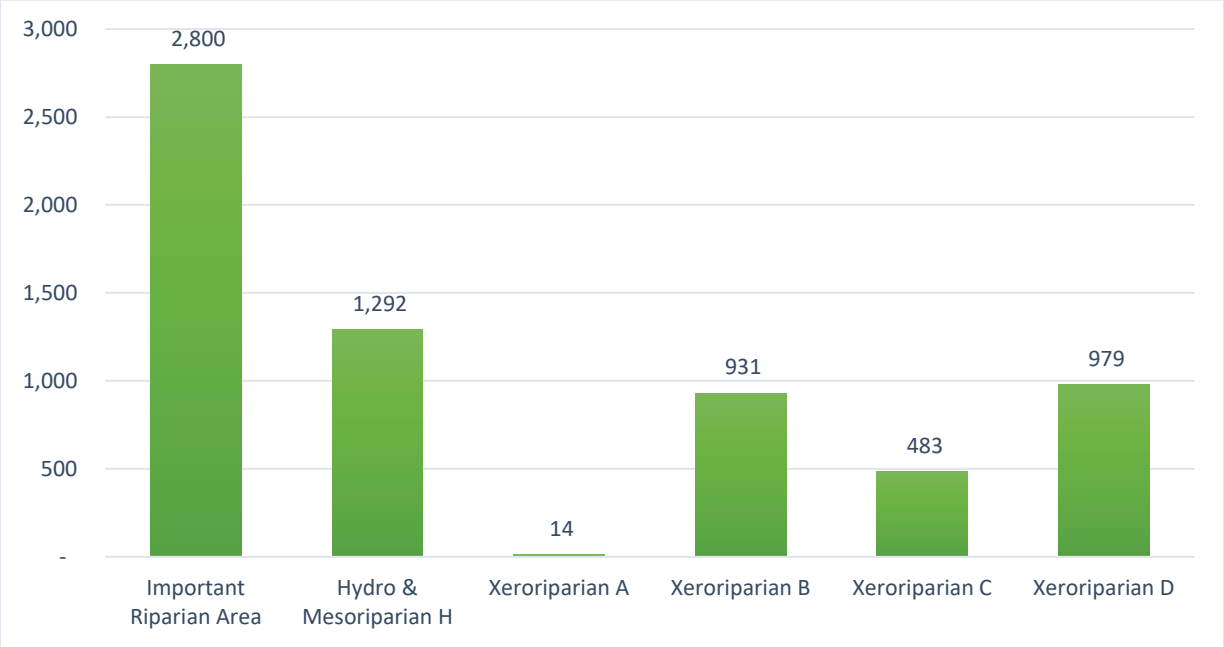


Figure 185 - Tanque Verde Creek Watershed Riparian Habitat in Acres

The confluence with the Rillito as well as the canyon headwaters contain some of the largest networks of springs, surface flows and shallow groundwater anywhere in the County. This water availability has contributed both to the biologic, historic and cultural significance of this region as well as current high property and recreational amenity values. Today, landowners and community groups including, Friends of Redington Pass, Watershed Management Group, Coalition for Sonoran Desert Protection and Audubon Society are pursuing preservation and enhancement of these values and they warrant the full measure of protection afforded by floodplain management practices.

C.1.15.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

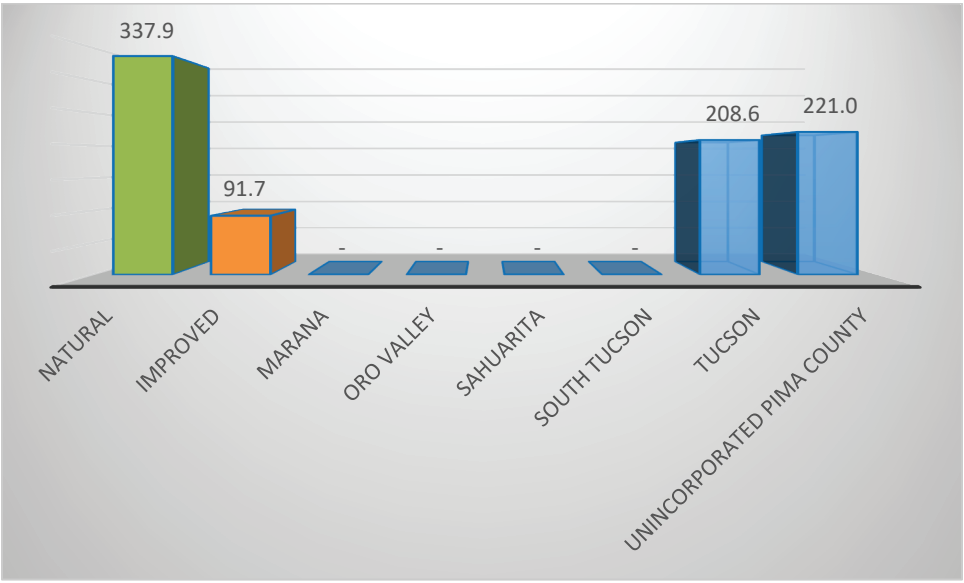


Figure 186 - Tanque Verde Creek Drainageway Acreage

In 2010, the District began mapping tributaries to larger watercourses where typically FEMA mapping existed on the watercourse but not on the tributaries. Performing these studies at a level of detail suitable for floodplain management and permitting, allowed better-informed permitting decisions. Notification of constituents of improved floodplain information is part of the protocol for these recent mapping studies. Both the District and property owners can make decisions that decrease flood risk to safety and property.

Tanque Verde Creek can convey large amounts of flow. The Agua Caliente 2,200 (+/-) foot long soil cement levee is located on along the western embankment of the upstream of the Tanque Verde Road Bridge. The Agua Caliente spur dike is not a levee but had to pass many of the FEMA levee criteria in order for them not to map the floodplain as if the spur dike failed. It is located upstream of Tanque Verde Road along east embankment of the Agua Caliente Wash. The southern portion of the spur dike, adjacent to the channel, is soil cement. On the northern end, the structure bends to the east and becomes an earthen embankment with armoring. There is one flap gate upstream of the bridge

There are stream gauges at Chiva (ALERT ID# 2073), Tanque Verde Guest Ranch (ALERT ID# 2093), Tanque Verde Road (ALERT ID# 2109), and Sabino Canyon Road (ALERT ID# 2123). There is no bank protection upstream of Tanque Verde Road. The primary concern with higher discharges is overbank flooding resulting from high levels of flow. Locations of concern include 49's Country Club that the District has identified as a Repetitive Loss Area and the Woodland Road area. The District estimates initial breakout at 49er's to occur at 8,000 – 9,000 cfs. The district estimates initial breakout at Woodland Road at 13,000 – 15,000 cfs. The full report; Flood Hazard and Early Warning Analysis Tanque Verde Creek, includes inundation maps. Flows in the Tanque Verde that are a result of combined flows

from the Tanque Verde Creek, Agua Caliente Wash, and Monument Wash impacts this area. Impacted at-grade crossings include Wentworth Road and Tanque Verde Loop Road. At 200 cfs the COT Street Maintenance Division is contacted. Streamflow of 5,000 cfs at Chiva Tank (2073) or streamflow of 8,000 cfs at Tanque Verde Guest Ranch (2093) may affect 49's area or Woodland Road area. At these rates, senior staff decides whether to notify OEM. Due to sediment deposition near the gauge, judgment is required on the part of the Storm Monitor.

Large flows in Sabino Creek may affect numerous road crossings in the recreation area and some residential access and structures downstream of the USFS boundary. Lower flows are likely to overtop driveway access to some residential structures below the Forest Service boundary. The stream gauge on this channel is located at the dam in the US Forest Service (USFS) recreation area. No at-grade Crossings below the National Forest boundary are impacted. At streamflow of 2,000 cfs and flood stage of 3.4 feet at Sabino Canyon Dam (ALERT ID# 2163) residences in Sabino floodplain may be impacted and therefore senior staff decides whether to notify OEM.

C.1.15.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

- Tanque Verde Creek breaks-out on the right overbank onto Woodland Road at 13,000- 15,000 cfs. There is an ALERT system trigger for this discharge.
- Based on modeling, Tanque Verde Creek breaks-out of the main channel at Tanque Verde Loop Road between 14,000-16,000 cfs.
- Based on modeling, Tanque Verde Creek breaks-out of the main channel at Houghton Road between 12,000-14,000 cfs.
- The south half of Forty Niners subdivision, a Repetitive Loss Area is subject to overbank flooding from Tanque Verde Creek at around 14,000-16,000 cfs.

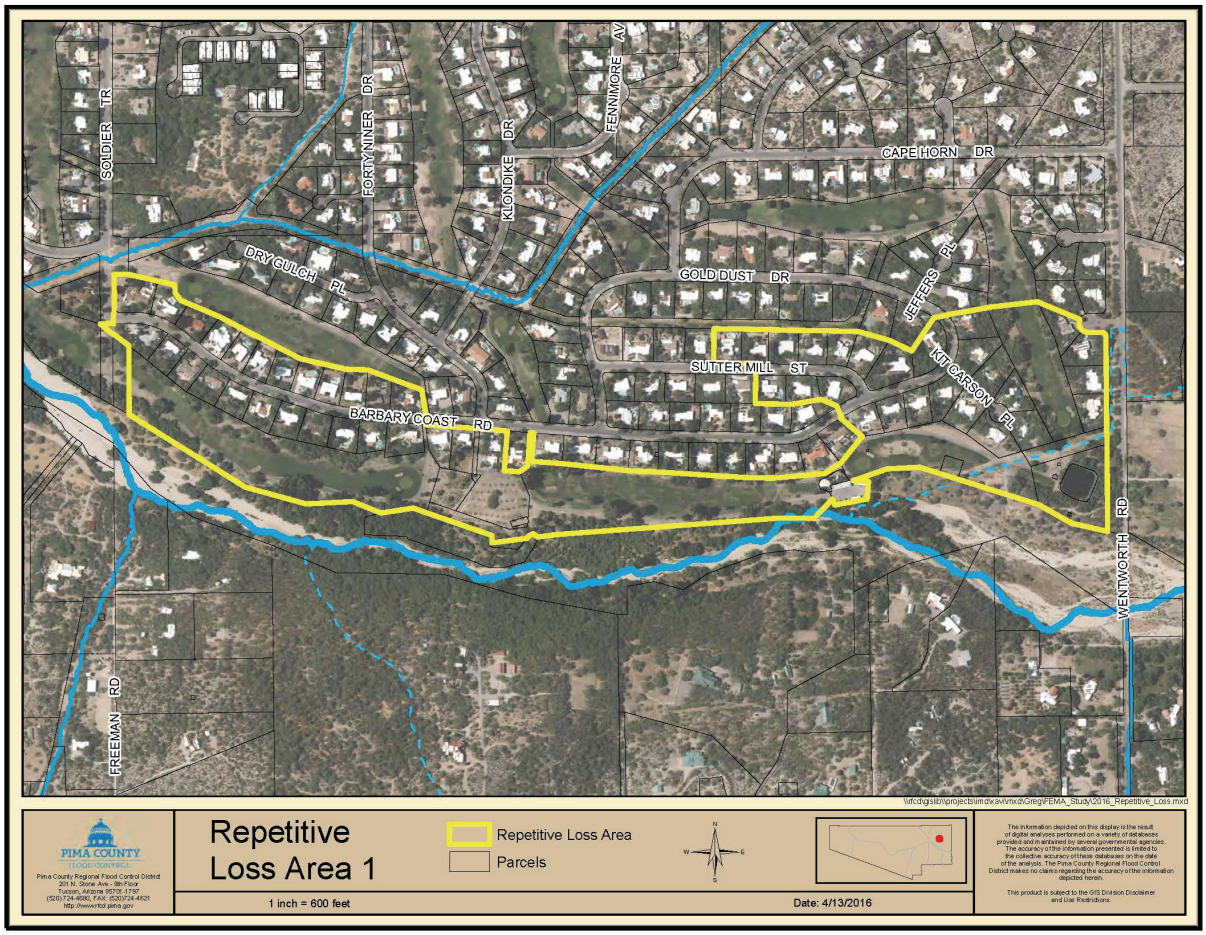
Infrastructure

- Washes within Forty Niners subdivision fill with sediment and the reduced channel capacity may increase flooding, especially west of the bend in Gold Dust Drive. The washes are public except for one.
- An interceptor sewer follows the north bank of Tanque Verde Creek upstream of Sabino. There is no bank protection for this infrastructure.

C.1.15.6 Floodplain Management

Future needs identified by District staff include:

- Riparian preservation
- Shallow groundwater
- High value unprotected property
- Repetitive Loss Properties
- Cumulative Improvements to non-conforming uses
- Bank reclamation
- Warning System Outreach
- Development upstream of Fortyniners Wash has caused problems southwest of Redington Road and Wentworth in the area around Calle Tatita and Calle Tango



Repetitive Loss Area Map

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Create open space management plans

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Identify areas of shallow groundwater

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Develop floodplain maps for Rincon Foothills Unnamed Wash #s 8, 9 and 10

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Provide assistance to property owners related to bank reclamation
- Work with responsible parties to address flooded roads

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Construct Wentworth Wash Channel (TVC)

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Conduct targeted outreach about improvements to nonconforming use structures

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

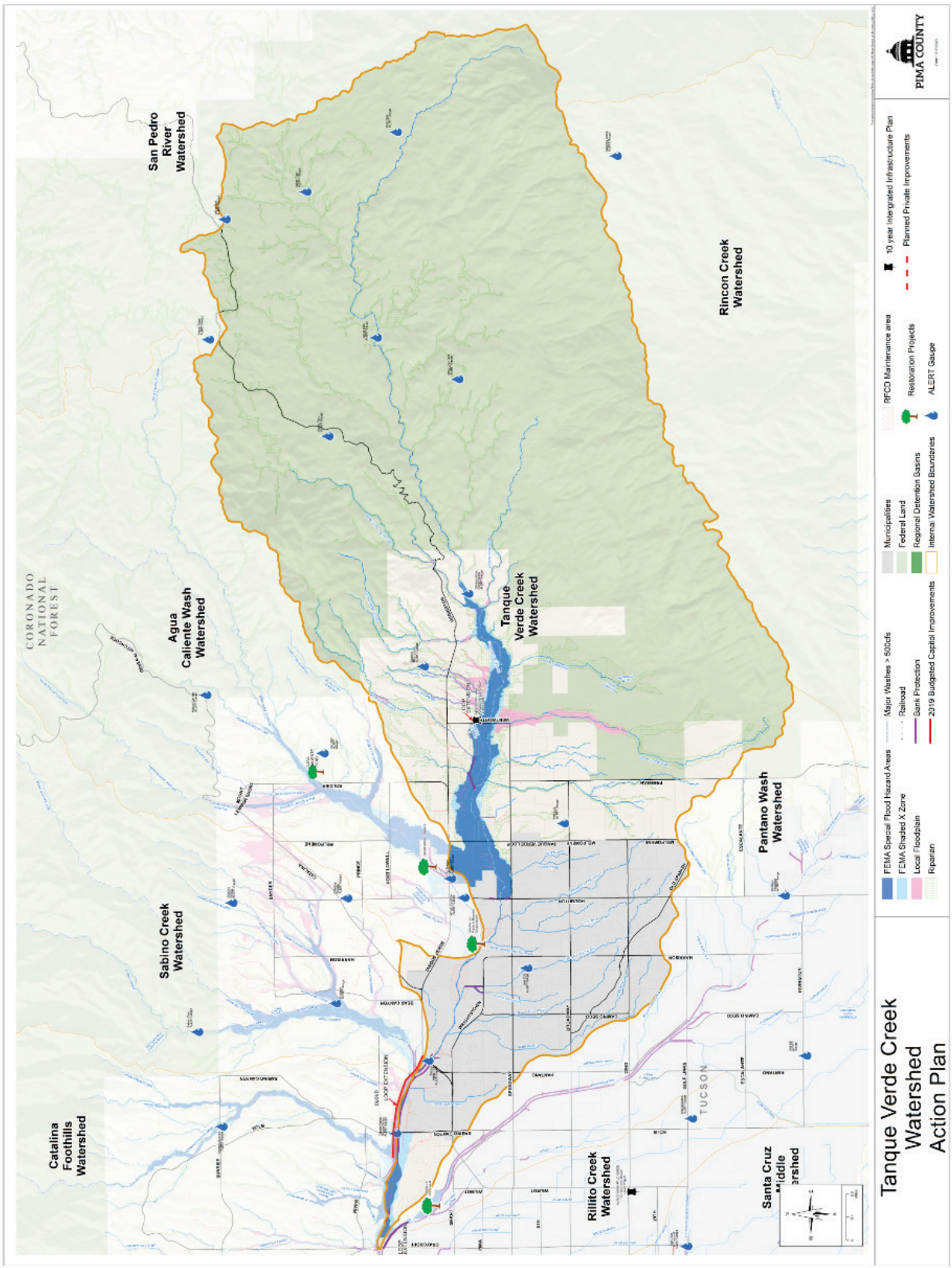


Figure 187 - Tanque Verde Creek Action Plan Map

C.1.16 Tortolita Fan

This watershed includes numerous washes draining the southwestern slopes of the Tortolita Mountains. These include Cottonwood, Prospect, Cañada Agua and Hardy Washes. Originating on the relatively gentle slopes of alluvial fans, these terminate in the geologic floodplains of the Santa Cruz River. The railway and Interstate as well as the natural geomorphology have reduced direct connection. Within Pima County, it is comprised of 64,682 acres (101 square miles), of which 44,630 are in the Town of Marana and 1,913 in the Town of Oro Valley. Soils are sandy and deep and often require special engineering. This geographic feature helps define the northwestern terminus of the Tucson basin itself and along with the northern arm of the Tucson Mountains creates what known locally as the Santa Cruz River narrows.

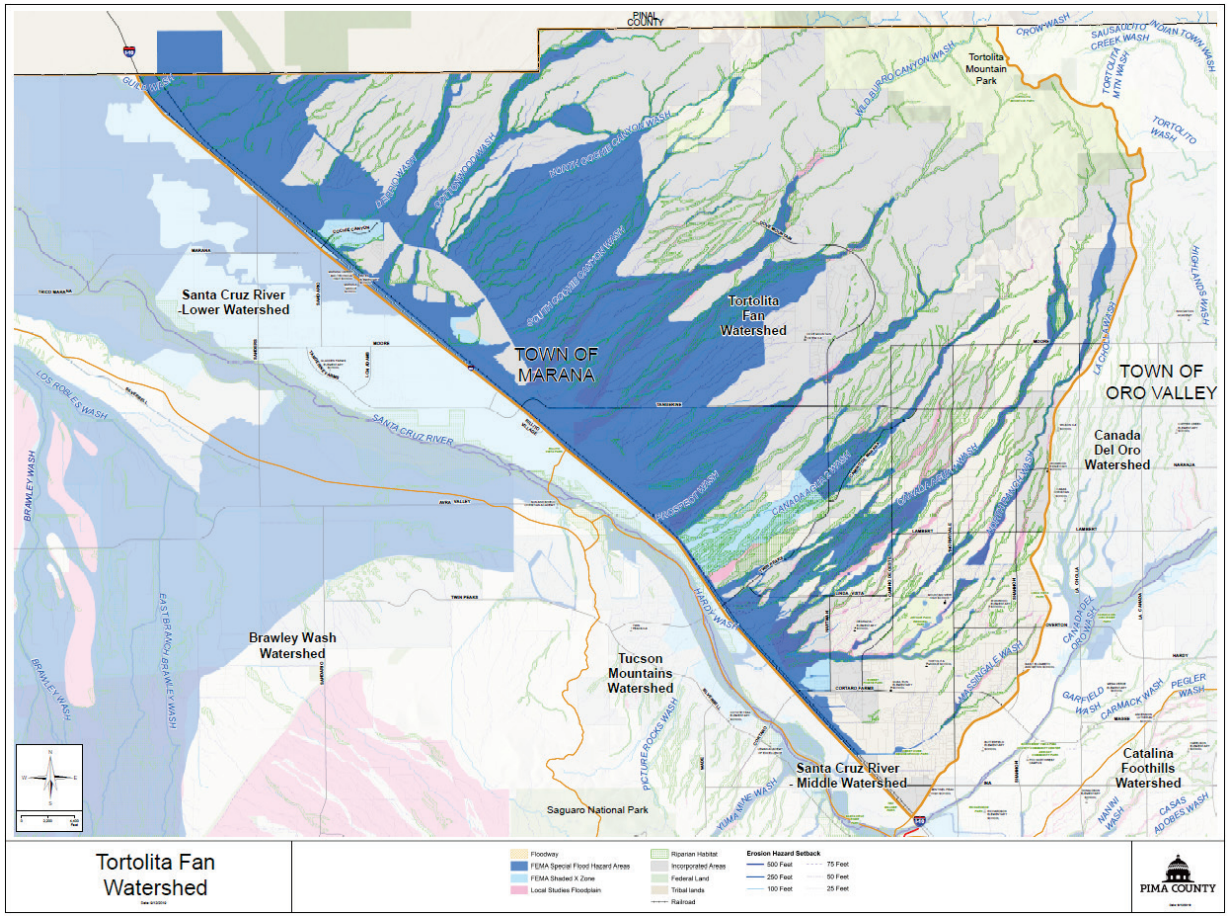


Figure 188 - Tortolita Fan Watershed Map

C.1.16.1 Flood Characteristics

The geomorphology of the Tortolita Fan to the east was evaluated in Special Study #19 (Arizona Geological Survey, 1992) and determined to be an active alluvial fan with possibility for channel migration and avulsion. For the Tortolita Fan to the east was evaluated using a 24-hour Type I storm to identify the flood risk on the active alluvial fan (CMG Drainage, 2008) which drains about 165 square miles. Since most of the fan is active, small tributary watersheds, which might have critical storms shorter than 24 hours were not included in this study. This study updated two previous studies that looked at flooding from the Fan. Special Study #24, Tortolita Area Basin Management Plan, Phase 1, Phase IIB (Cella Barr Associates, 8\3\1993) identifies 1%-annual-chance discharge values for the Tortolita fan area near the watershed's southeastern boundary. Special Study #44, Central Arizona Project (CAP) Tucson Aqueduct (Bureau of Reclamation, U.S. Dept. of the Interior, Reach 3 May 1982, Reach 4 April 1984, Reach 5 June 1983) identified 1%-annual-chance discharge values at select locations along the Central Arizona Project (CAP) canal within the alluvial fan area east of Interstate 10 and west of the Santa Cruz River.

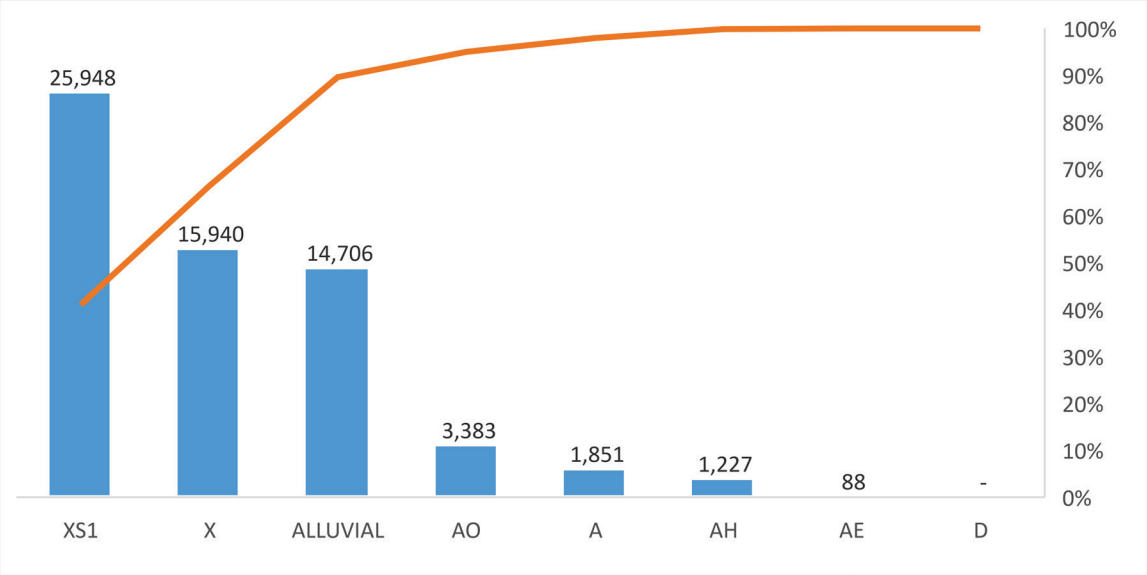


Figure 189 - Tortolita Fan SFHA in Acres

In addition to the 21,255 acres of SFHA zones included on the chart above, there are also 935 acres of District Special Studies Floodplains and 2,955 acres of sheet flood area in this watershed. Distributory alluvial flows on unstable soils impacts much of the watershed, 39% of the watershed is within mapped floodplains. In addition to these floodplains, the District has also mapped alluvial soils requiring special engineering prior to development.

Tortolita Fan Soils

Flow across the upper Tortolita Alluvial Fan originates in the Tortolita Mountains, which lie primarily in Pinal County. Upper elevations are at about 4,000 feet typically populated by Saguaro and rocky slope faces rather than traditional forests. Canyon formations transition to fan formations at about 2,500 feet and slope at about 3% to Interstate-10 at the base of the fan at approximately 2,000 feet. Soils in the mountains tend to infiltrate less rainfall, and canyon flows are relatively contained. Resulting mountain-front flows at the fan apexes diverge along parallel contours and may avulse and re-distribute over a period of time or during a significant storm event.

The Town of Marana Tortolita Alluvial Fan Study dated April 25, 2008, includes hydrologic analyses for the watersheds above the fan apexes. According to this study, a series of four canyon watersheds each can deliver between 3,000 to 7,000 cfs in a 24-hour storm to the piedmont. Two-dimensional modeling in the study assessed flows delivered to the piedmont combined with flows resulting from rainfall on the fan formations. The study determined that the critical storm, the storm predicted to have the highest peak discharge, should be considered the 24-hour storm. Short duration storms should not produce fan-wide flooding; however, short duration storms would be associated with establishment of flow paths on the piedmont. These flow paths would be subject to change and complete inundation during a large storm event. Most of the fan is undeveloped, and future development would be subject to somewhat unpredictable flood and erosion risk. Development should be restricted to uses compatible with significant unconfined flows. Fan areas and flat areas without defined conveyances may be at risk for both flood, sediment deposition and erosion hazards during shorter duration storms.

There are no USGS gaging stations on the Tortolita Fan.

Table 56 - Tortolita Fan ALERT Rainfall Gages

USGS Gaging Station	Cañada Del Oro near Tucson, AZ 09486300
USGS Gaging Station	**Cañada Del Oro Near Tucson, AZ 09486300**
Period of Record	1959-07-21 to 1983-10-01
Watershed Area (sq. m)	250
Flood-Peak of Record (cfs)	17000
Date	07-21-1959
Table of Regulatory Discharge (cfs)	22100

Table 57 - Tortolita fan ALERT Precipitation Gages

Pima County Alert Gage	Moore Rd at La Cholla Blvd- Cañada Del Oro Basin ID: 1240	Arthur Pack Park- Santa Cruz Basin ID: 1000
Location (Latitude, Longitude)	(32.4381, -111.0119)	(32.376,-111.0476)
Period of Record	2001-10-18 to Present	2015-08-22 to Present

Avulsion and distributary flows are prevalent within this watershed. The table below contains excerpts from the District's Regulatory Discharge Table for discharges that have been determined by studies within this watershed.

Table 58 - Tortolita Fan Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Tortolita Fan (discharge values are at the fan apex of each sub-basin)			
@ Cañada Agua Canyon East	3,623 (x-sec 2, T11,R13, Sec 21)		Pima County Regional Flood Control District Special Study (#22)
@Cañada Agua Canyon West	1,030 (x-sec 2, T11, R13, sec 29)		" "
@North Ranch	1,123 (x-sec 1, T11, R13, Sec 27		" "
@Prospect Wash	5,912 prospect (x-sec 2, T11, R13, Sec 30)		" "

Flooding in this watershed area can occur along the main stem of the lower Santa Cruz River, within fan formations to the east and along major infrastructure that stands between the fan flows and the river. The significant man-made features east of the river include from west to east, Interstate-10 (I-10), Union Pacific Railroad and the Central Arizona Project (CAP) canal, with the CAP canal lying about 1 mile to the east of the transportation features. I-10 and UPRR embankments are adjacent to one another and extend into Pinal County, with the CAP canal continuing to diverge east of I-10 toward the north. At the Tangerine Road/I-10 intersection, which is approximately the southern limit of this watershed, the CAP canal turns west and extends underground beyond the river.

The majority of the watershed is within the flood control jurisdiction of the Town of Marana. The District cooperated with technical assistance during the 2008 study to support the Town in developing inundation maps for the Tortolita Fan; however, the Town is responsible for flood control regulations within its incorporated limits. The Town's 2008 study assessed flooding potential related to CAP embankments, and certain segments of the canal embankment were modeled in a breach condition. For reaches where the embankment is assumed stable, sheet flows are temporarily impounded, then diverted to overchutes and conveyed downstream of the embankment. Within about one mile, flows encounter the UPRR and I-10 where major flows are not conveyed without significant ponding through UPRR and I-10 drainage structures. Flows downstream of I-10 flow northwesterly in relatively shallow unconfined paths across agricultural lands. North of Trico Marana Road, the entire watershed is mapped as a FEMA Zone AE with depths of 2 feet or more, creating a broad floodplain unsuitable for most types of development.

While flow on this watershed below canyon slopes is largely unconfined, fan flows may be pernicious because of unpredictable flow paths. Damage from both erosion and flooding is highly likely on fans from both short and long duration storms. An additional risk can be posed for the watershed where fan flows combine across shifting boundaries and where flows arrive mostly perpendicular to constructed features and then combine and travel laterally along the features.

C.1.16.2 Existing Development & Infrastructure Trends

The chart below shows the population distribution between incorporated and unincorporated areas. This chart also shows the distribution of residents within known floodplains. Almost 20% of residents live within floodplains and another 279 behind a levee.

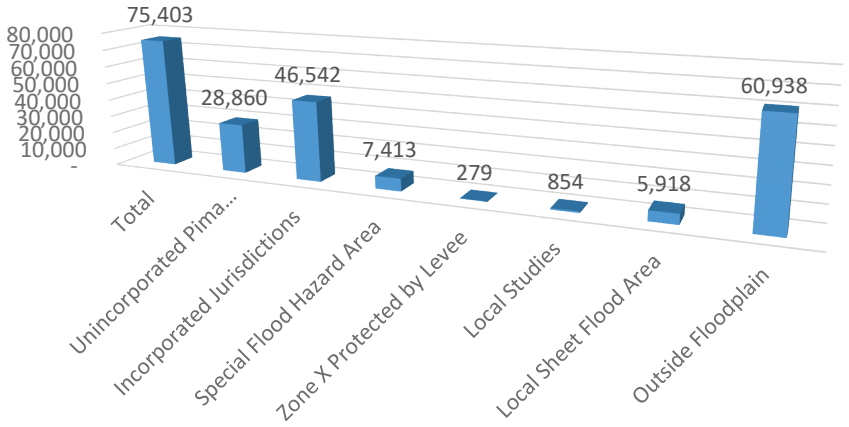


Figure 190 - Tortolita Fan Watershed Population Distribution

Although urbanized due to proximity to the interstate and railway corridors, this watershed is one of the few urban watershed with large amounts of private land that is vacant.

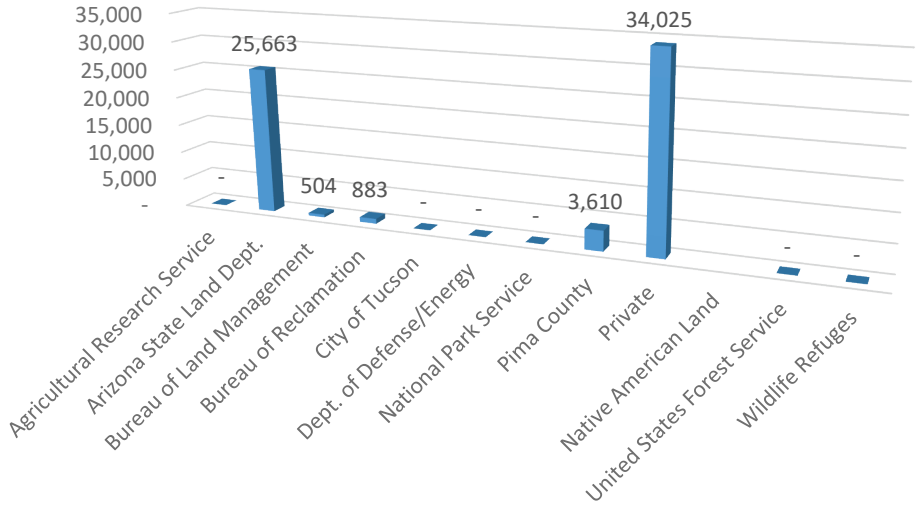


Figure 191 - Tortolita Fan Watershed Ownership in Acres

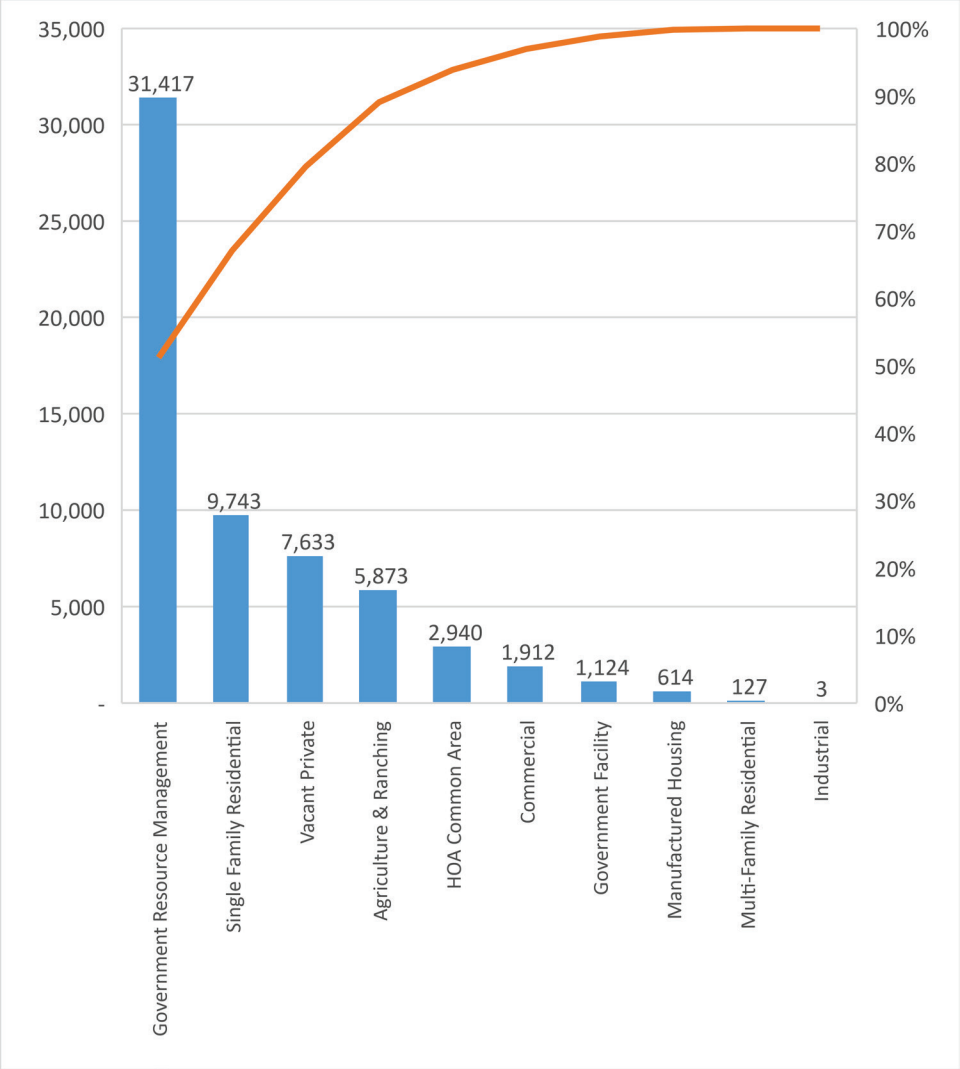


Figure 192 - Tortolita Fan Watershed Land Use

Although grazing was a traditional use of this area until recently and remains outside Oro valley, the increased intensity of commercial and residential uses on unstable soils and distributory flows paths has required large channels, basins, and road crossing infrastructure, as indicated by the large amount of HOA common area.

Figure 193 - Twin Peaks Road Culverts Photo

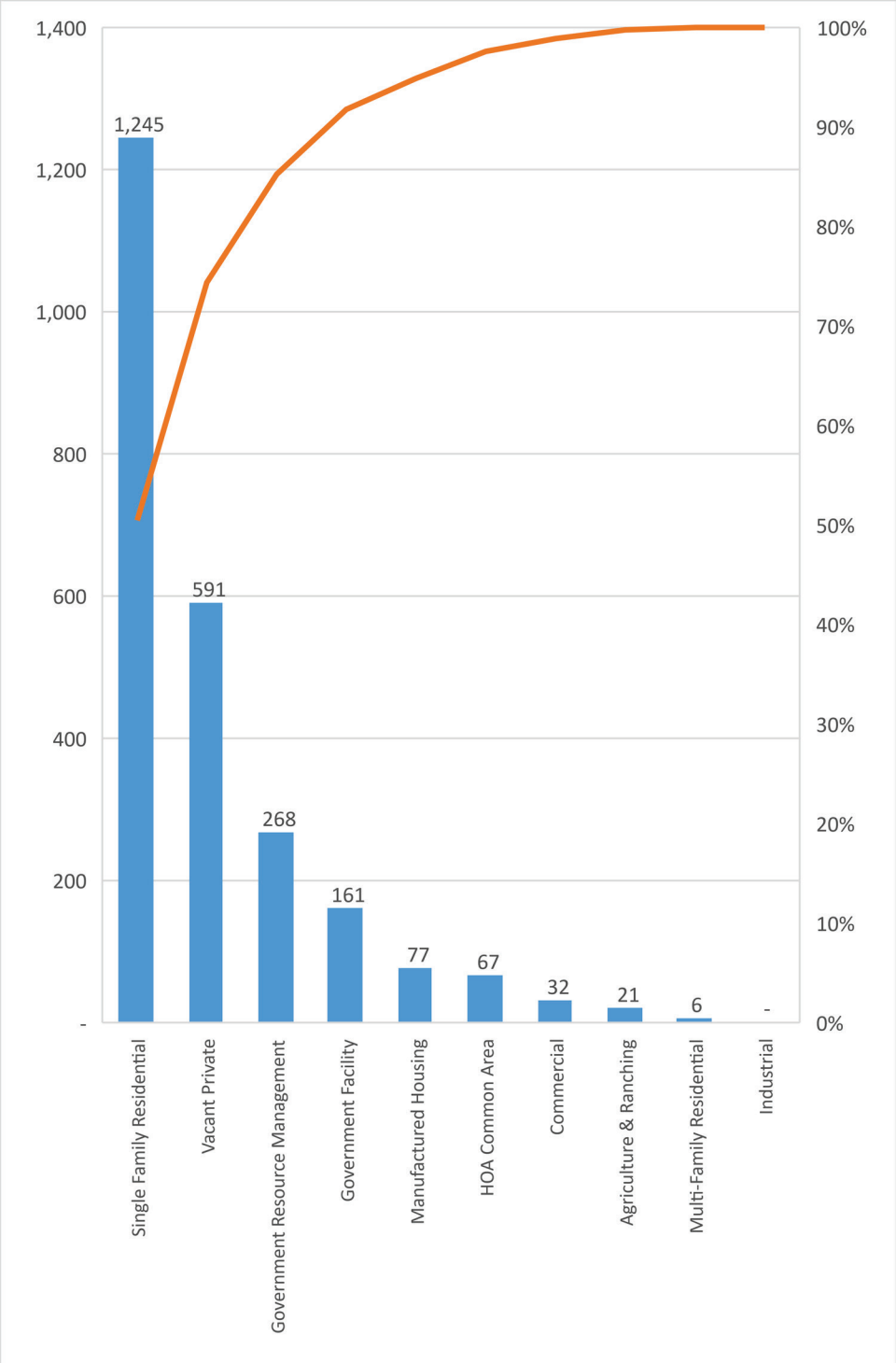


Figure 194 - Tortolita Fan Floodplain Land Use

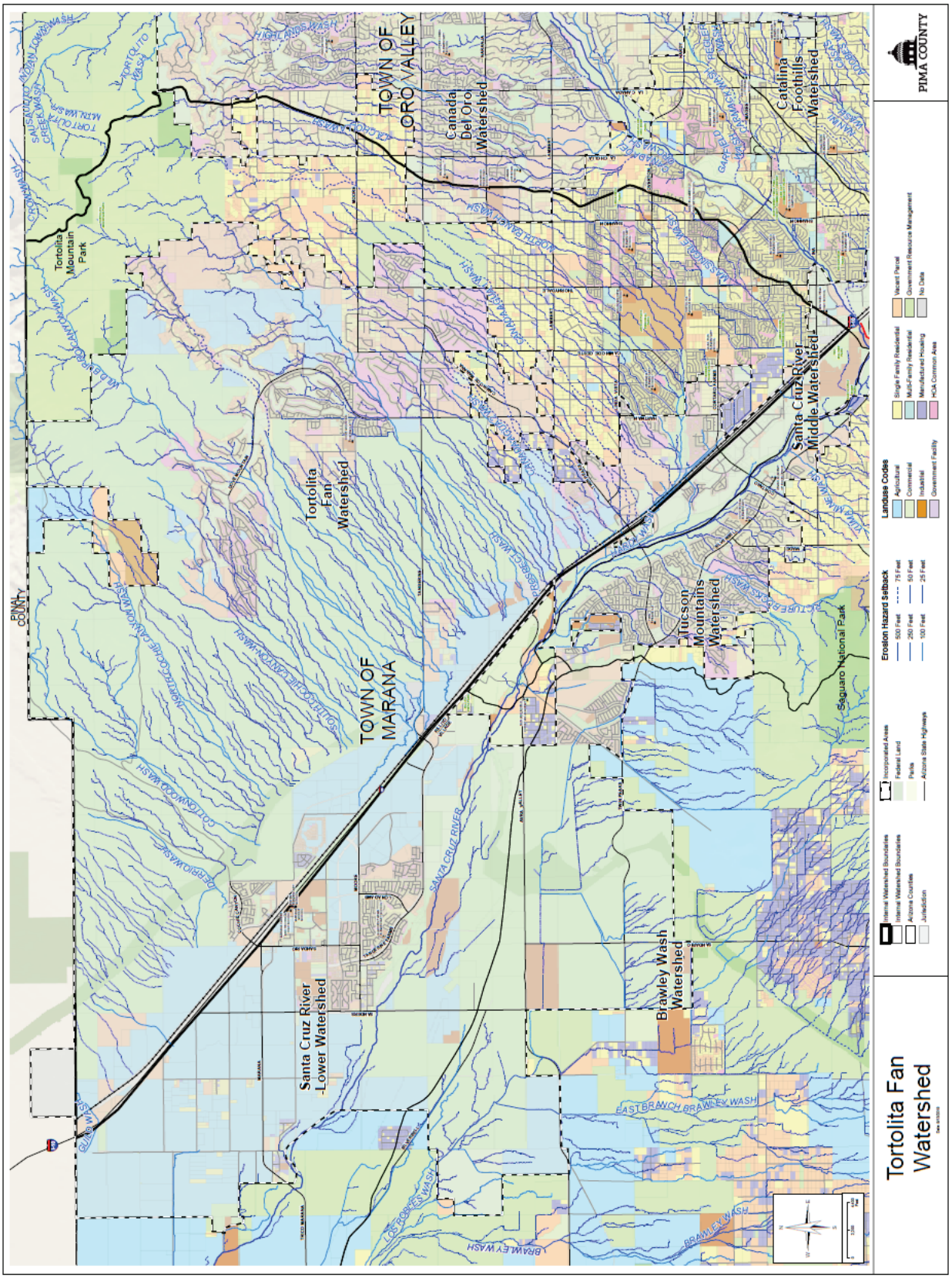


Figure 195 - Tortolita Fan Land Use Map

C.1.16.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 4,974 acres of Pima County Regulated Riparian Habitat in this watershed, as well as 5,735 acres of IRA. The low quality of the habitat reflects the sandy nature of these major river corridors. There are also 8,887 preserved acres in this watershed, including 2,628 in regulatory floodplain.

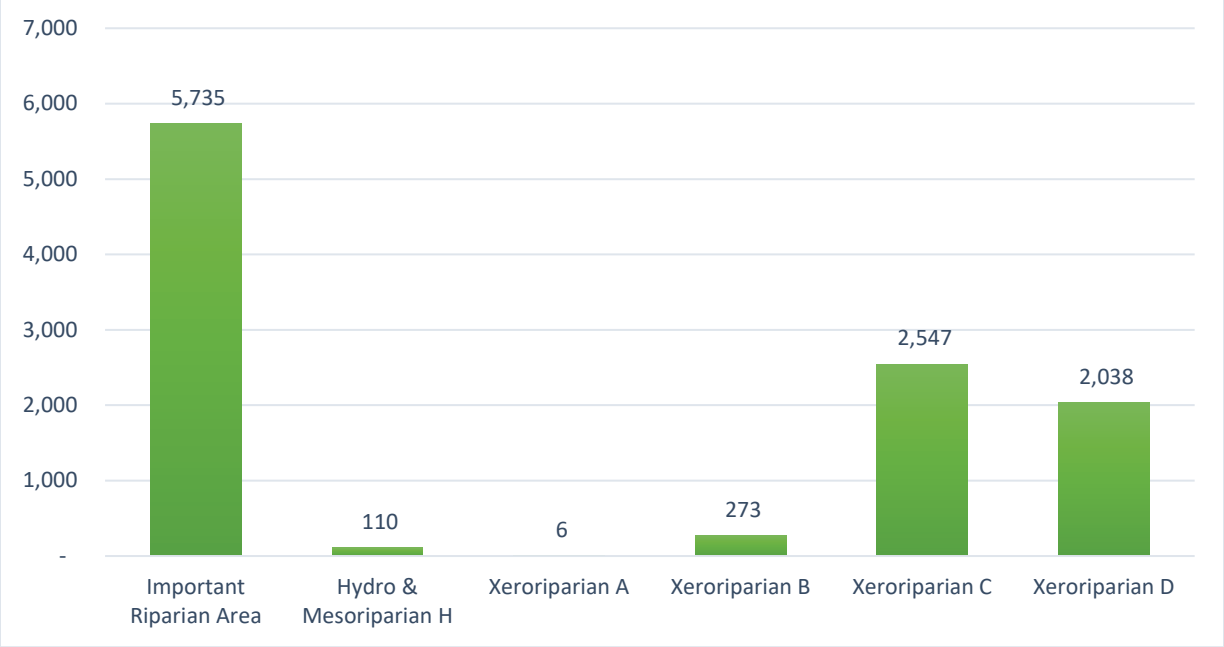
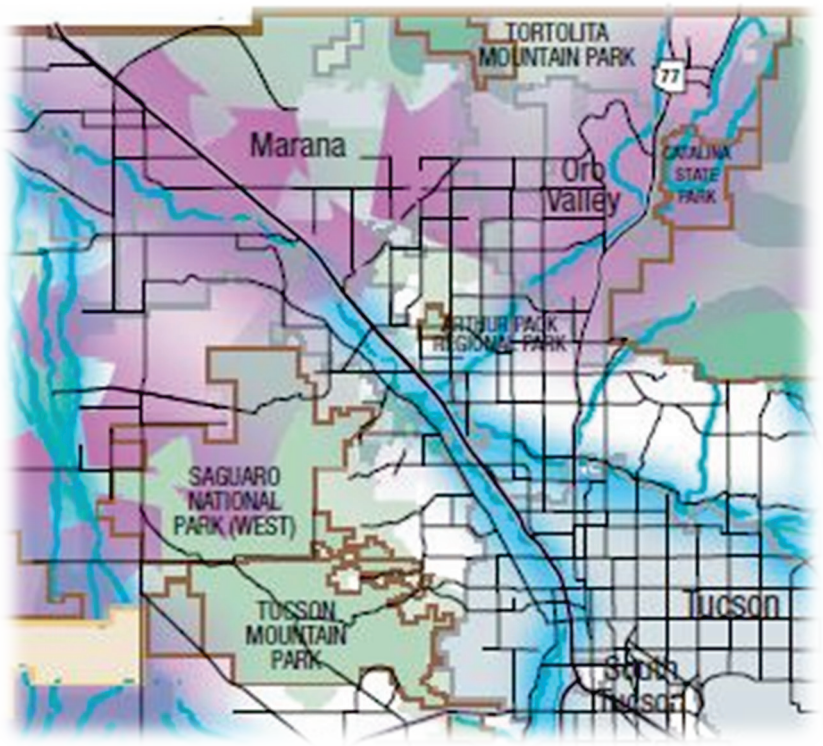


Figure 196 - Tortolita Fan Watershed Riparian Habitat in Acres

The large amount and percentage of IRA is due to significance as connectivity between the Tortolita mountains and Tucson Mountains and therefore ultimately between the Catalina and Tucson Mountains as a well.



C.1.16.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

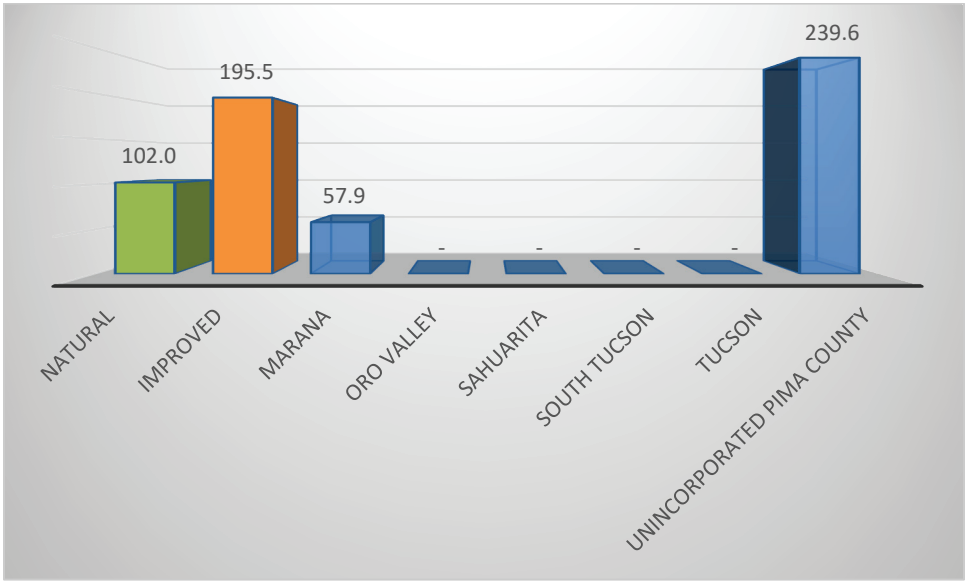
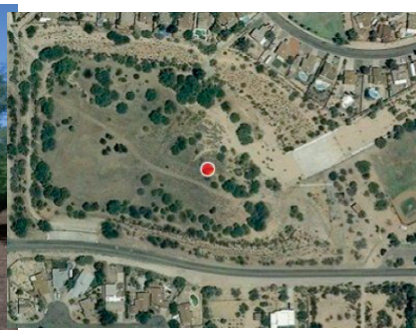


Figure 197 - Tortolita Fan Drainageway Acreage

The District has designated the Tortolita Fan as Critical Basin. New development located with a Critical Basin must provide a sufficient combination of retention and detention to reduce the post-developed 2-, 10-, and 100-year peak discharge rates to 90% of the pre-developed peak discharge rates. The Floodplain Administrator may specify other reductions. The District considers a watershed Balanced, unless it has been determined to be a Critical Basin. New development located within a Balanced Basin must provide a sufficient combination of retention and detention to reduce the post-developed 2-, 10- and 100-year peak discharge rates to the pre-developed rates. As noted above the intensity of land use in this sensitive area has relied upon large channelization and detention projects such as the Massingale Basin.



C.1.16.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Infrastructure

- Drainageway # 1841 in Countryside subdivision experienced bank erosion in heavy 2018 monsoon season, requiring repairs.
- Drainageway # 3236 in Orangewood North subdivision experienced bank erosion in heavy 2018 monsoon season, requiring repairs.
- Drop structures, grates and other infrastructure on Drainageway #s 2718, 666 in Sunset Point Number 2A subdivision requires inspection after every intense storm event in the area, as the grate often clogs with debris, causing ponding. In 2018, water nearly entered a garage due to the ponding.

C.1.16.6 Floodplain Management

Future needs identified by District staff include:

- Soils/fans
- Geologic floodplain canyon development
- Corridors
- Lot splits cumulative impacts
- Riparian disturbances rural uses
- PCDOT sediment placement/drainage complaints
- Interjurisdictional Coordination
- Potential for retrofits with green infrastructure to reduce detention storage volume
- Sand and gravel mining in the Santa Cruz River floodplain

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Establish alluvial fan flow corridors (TF)
- Work to address issue of sediment placement during road maintenance activities

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Conduct detailed mapping of approximate FEMA Special Flood Hazard Areas

Ref# 1.2.c Refine local approximate sheet flood maps and identify flow corridors

- Conduct detailed mapping for remaining local approximate sheetflow floodplains

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 1.2.i Develop criteria for site design and infrastructure at major watercourse confluence areas

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Work with responsible parties to address flooded roads

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Conduct targeted outreach about protection of vegetation and riparian habitat to prevent or reduce drainage runoff problems

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital

improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

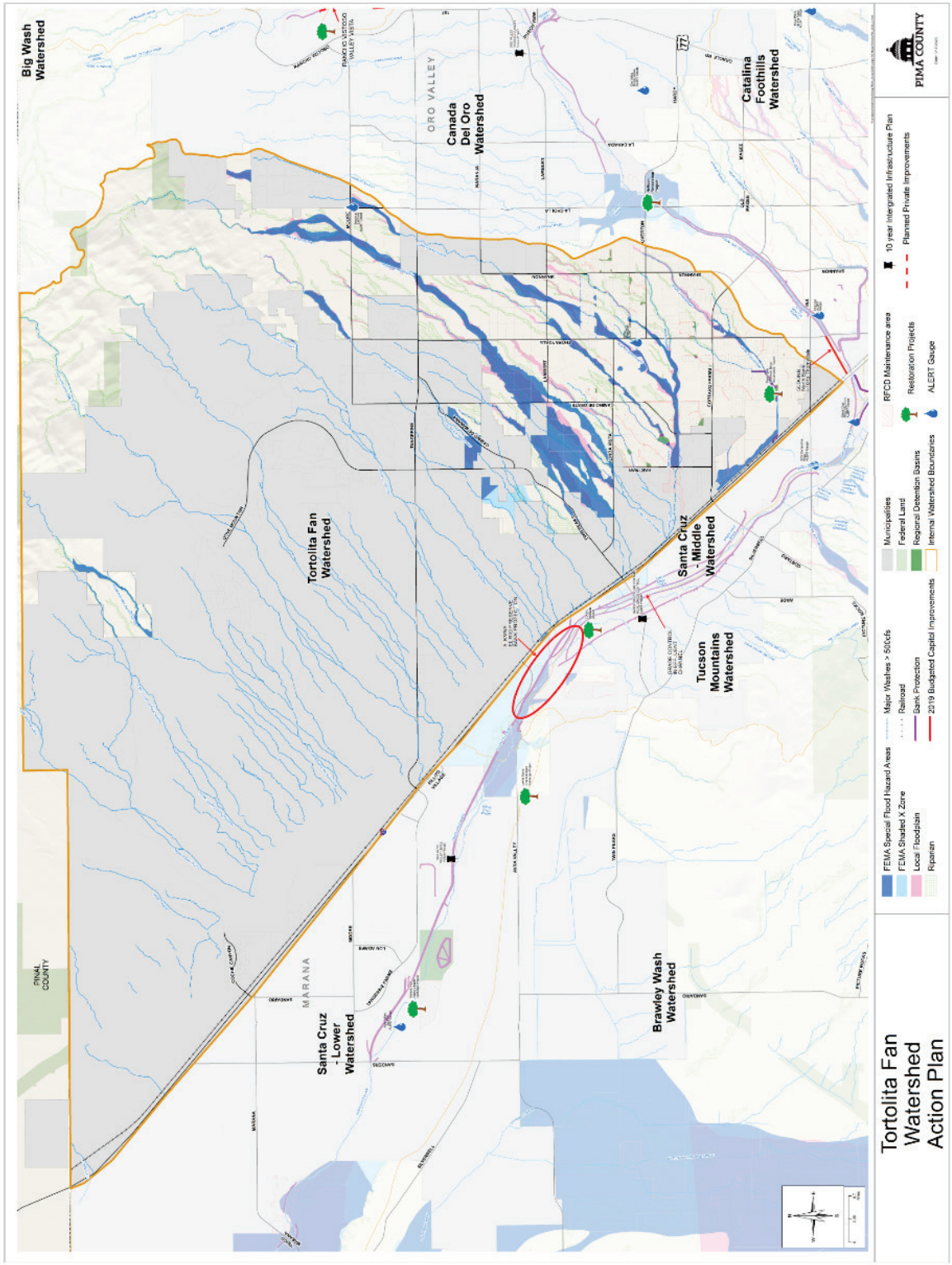


Figure 198 - Tortolita Fan Action Plan

C.1.17 Tucson Mountains

This watershed, which is primarily within unincorporated Pima County, drains the eastern slopes of the Tucson Mountains and includes numerous washes that are tributary to the Santa Cruz River, which is almost entirely within the jurisdictions of the City of Tucson and Town of Marana. While not as tall as the Santa Catalina and Rincon Mountains on the eastern edge of the Tucson basin, these too are rocky and have steep canyons that spill out onto alluvial fans before widening further onto the geologic floodplain under natural conditions. Unlike the Tortolita Fan watershed to the east on the other side of the river, development in the upper portions of the watershed is primarily residential on large lots with minimal drainage channelization. In the downstream portion of the watershed, Silverbell Road includes cross-drainage structures maintained by other jurisdictions. Within Pima County, it is comprised of 34,339 acres (53.6 square miles).

C.1.17.1 Flood Characteristics

In addition to the 4,106 acres of SFHA zones included on the chart above, there are also 319 acres of District Special Studies Floodplains and 469 acres of sheet flood area in this watershed.

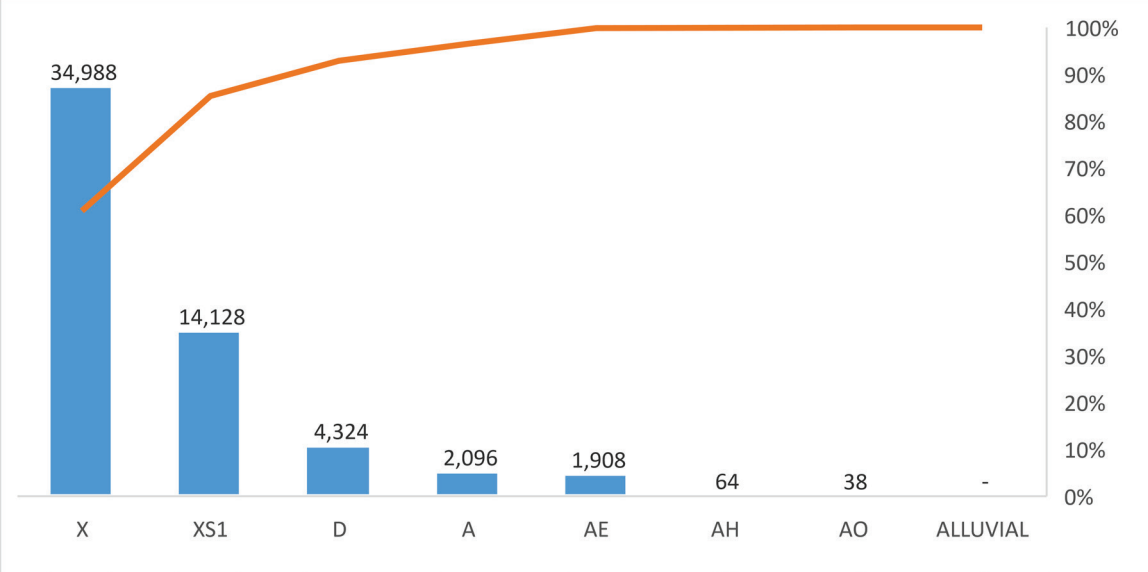


Figure 199 - Tucson Mountains SFHA in Acres

Typically, monsoons are the highest contributor towards flooding. Tropical storms have also contributed towards flooding. Below is a summary of historic USGS gaging station records.

Table 59 - Tucson Mountains Watershed USGS Gages

USGS Gaging Station	Big Wash at Tucson, AZ 09482480	Cholla Wash at Mission Road near Tucson, AZ 09482485	Silvercroft Wash at Tucson, AZ 09483025	Anklam Wash at Tucson, AZ 09483030	West Speedway Wash near Tucson, AZ 09483040
Period of Record	1965-07-10 to 1981-09-18	1982-08-23 to 1990-07-24	1965-07-10 to 1981-07-21	1965-07-10 to 1981-08-13	1965-07-10 to 1981-08-13
Watershed Area (sq. m)	2.94	1.27	2.74	2.11	.46
Flood-Peak of Record (cfs)	3000	1470	1500	2420	240
Date	08-17-1971	08-23-1982	07-20-1970	08-17-1971	09-25-1976
Table of Regulatory Discharge (cfs)	NA	NA	NA	NA	NA

There are no ALERT streamflow gages in this watershed. The table below lists precipitation gages.

Table 60 - Tucson Mountains Watershed ALERT Precipitation Gages

Pima County Alert Gage	Picture Rocks Community Center-Brawley Basin ID: 6460	Tucson Water Treatment Plant-Brawley Basin ID: 6470
Location (Latitude, Longitude)	(32.3092,-111.2356)	(32.1711, -111.0872)
Period of Record	2001-10-19 to Present	2006-11-09 to Present

C.1.17.2 Existing Development & Infrastructure Trends

The chart below shows the population distribution between incorporated and unincorporated areas. This chart also shows the distribution of residents within known floodplains.

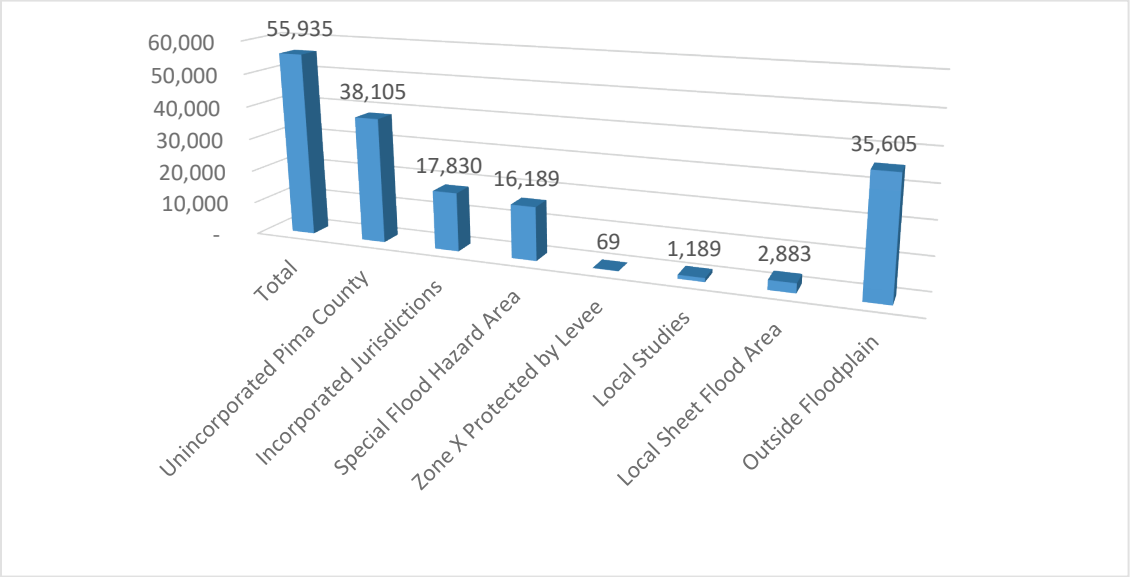


Figure 200 - Tucson Mountains Watershed Population Distribution

While the County's Tucson Mountain Park has supplemented the open spaces preserved in the Tucson Mountains by Saguaro National Park, private individuals own much of the foothills leading down to the Santa Cruz River geologic floodplain. The exception to this is the band of parks and other government facilities east of Silverbell in the geologic floodplain of the Santa Cruz River.

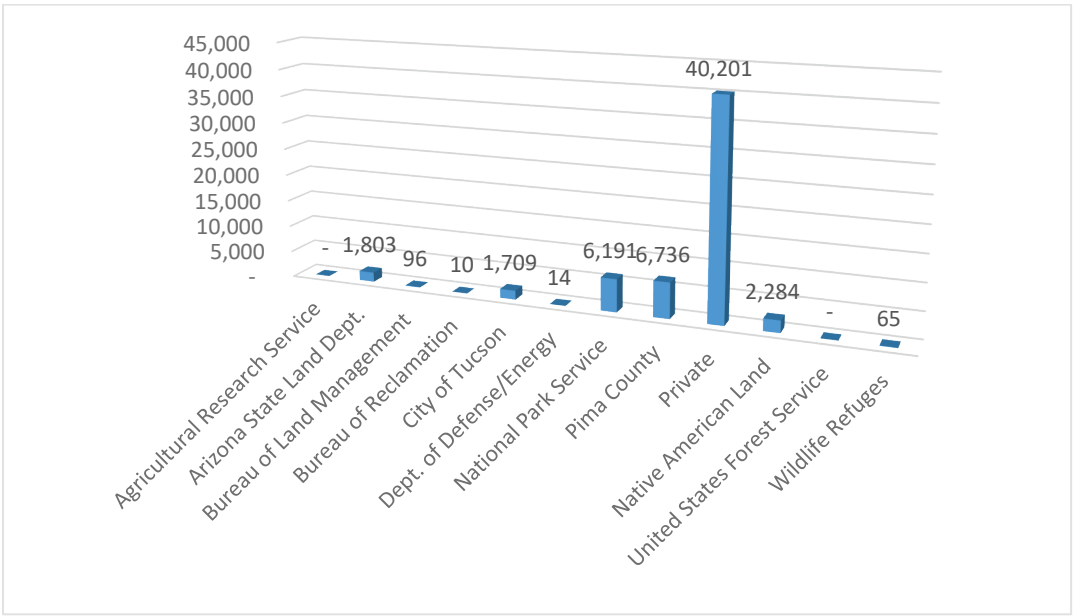


Figure 201 - Tucson Mountains Watershed Ownership in Acres

Sixty eight percent of this watershed is private.

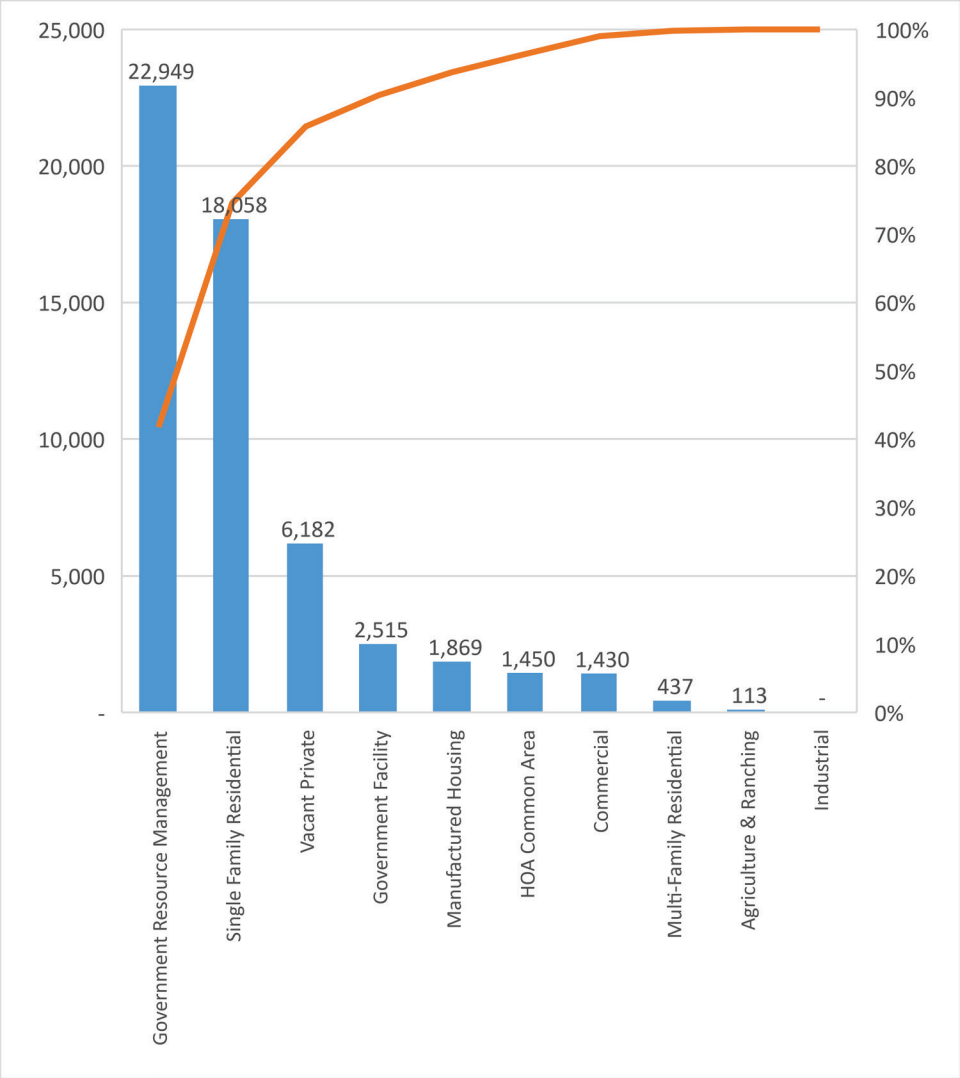


Figure 202 - Tucson Mountains Watershed Land Use in Acres

The large percentage of private land parallels the largest land use as single family residential. As in other foothills watersheds within unincorporated areas large lot development predominates along with significant HOA common area open space.

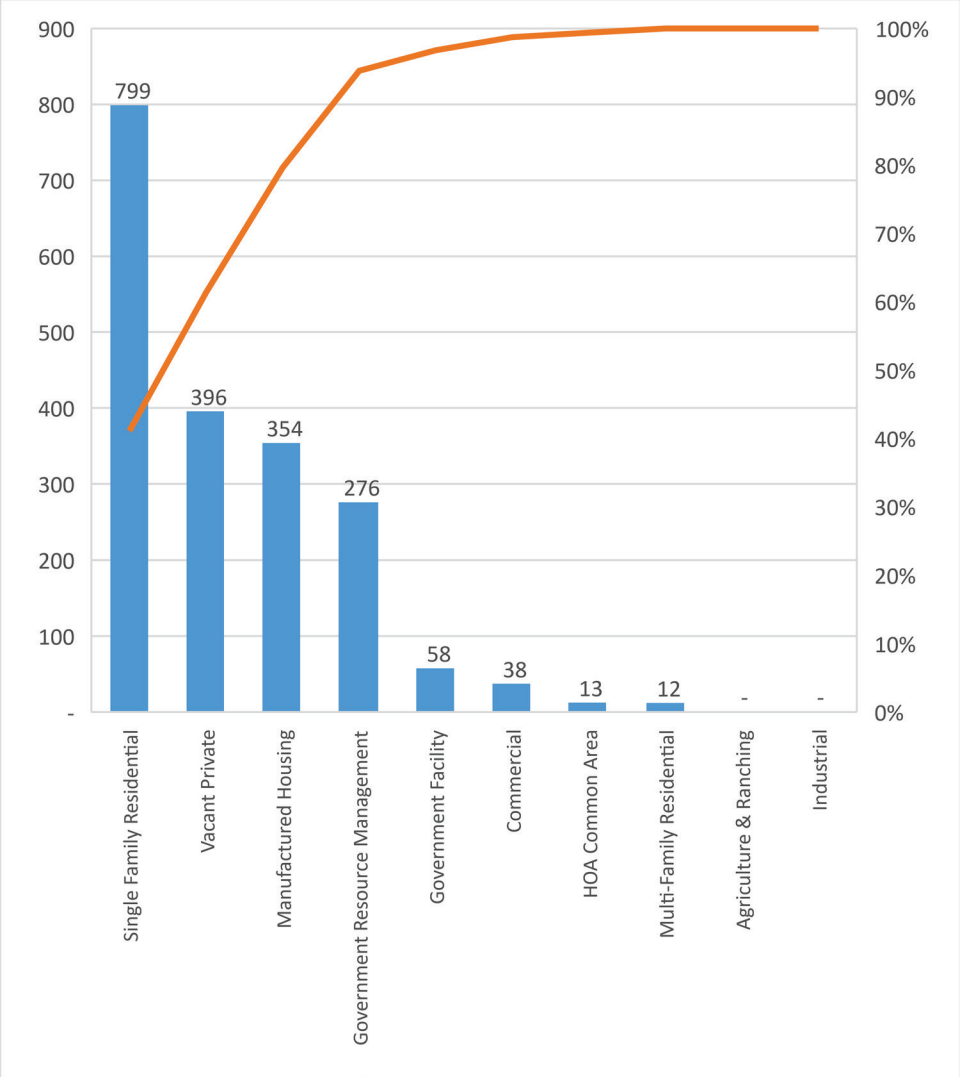


Figure 203 - Tucson Mountains Floodplain Land Use

As with the Catalina Foothills watersheds, the predominant land use is single family residential and this trend will continue. Few large parcels remain undeveloped and there are few mass graded subdivisions with the exception of those adjacent to Silverbell Road within the Santa Cruz River geologic floodplain.

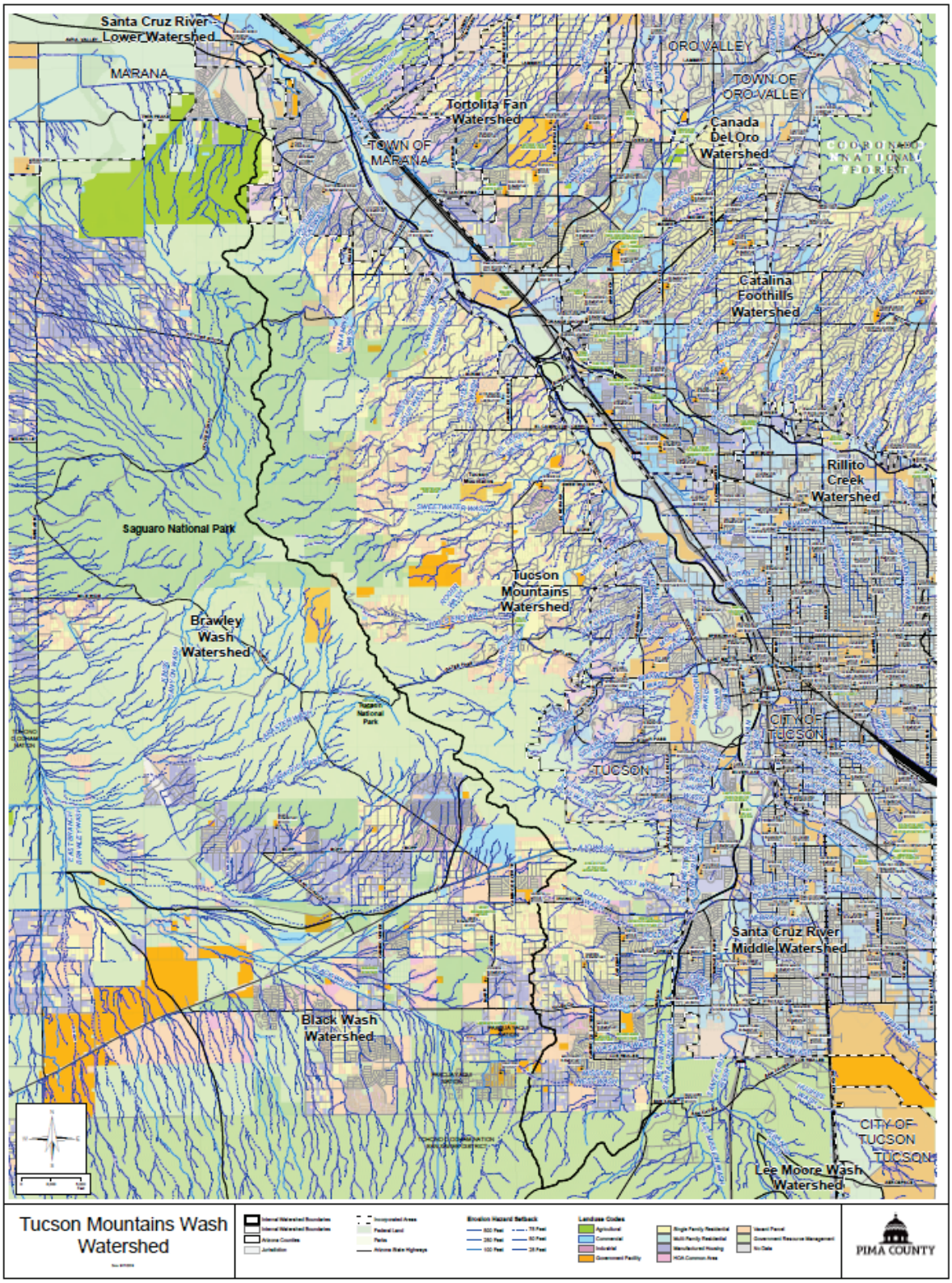


Figure 204 - Tucosn Mountains Land Use

C.1.17.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 1,948 acres of Pima County Regulated Riparian Habitat in this watershed and 3,283 of IRA. There are also 18,022 preserved acres in this watershed, including 438 in regulatory floodplain.

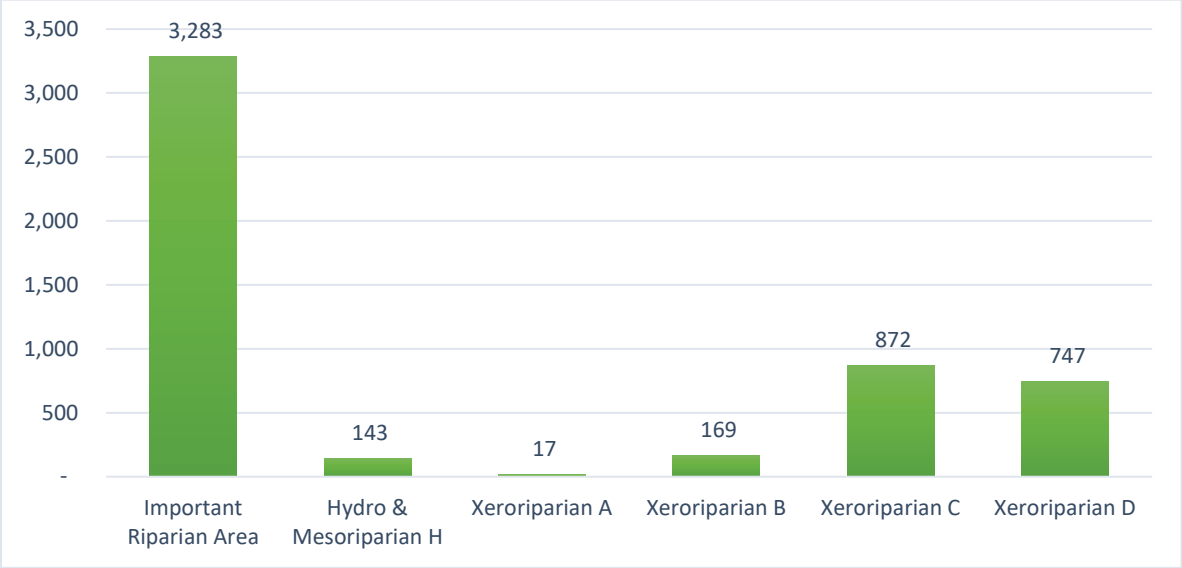


Figure 205 - Tucson Mountains Watershed Riparian Habitat in Acres

As in the Tortolita watershed to the east the large amount and percentage of IRA is due to significance as a wildlife corridor although is also a significant source of local recharge.

C.1.17.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

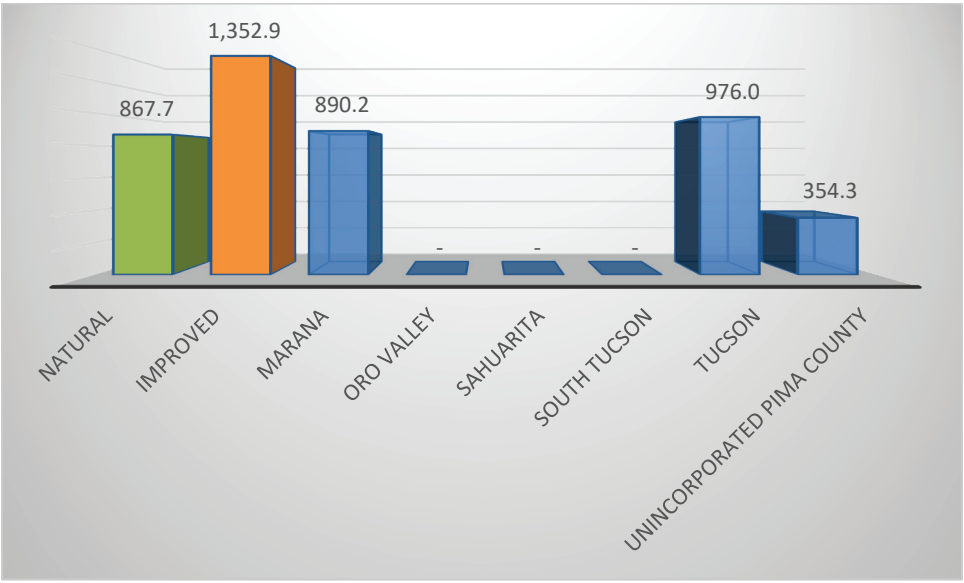


Figure 206 - Tucson Mountains Drainageway Acreage

Little floodplain information is available for this watershed, except for some downstream reaches where the District worked with the City of Tucson to identify floodplains along Silverbell Road. Where residences cluster near washes, floodplain management relies on approximate methods, avoidance of riparian habitat or detailed study by individual property owners.

C.1.17.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

C.1.17.6 Floodplain Management

Future needs identified by District staff include:

- Geologic floodplain canyon development
- Corridors
- Lot splits cumulative impacts
- Sheet flood nuisance flow diversion
- Riparian disturbances rural uses
- PCDOT sediment placement/drainage complaints
- Silverbell Road dips
- Floodplain mapping

The Tucson Mountain Association also identified the following recommendations for specific problem locations:

Sweetwater Wash, Roger Wash, and Santa Cruz River - Grant Road to Cortaro Road

- Update the old mapping of Pima County Regulated Riparian Habitat.

Camino de Oeste Wash

- W. Placita Graciosa adjacent private properties experience severe bank erosion along curved wash threatening property and structures (T13S R13E Sec. 32). Provide Engineering Technical Assistance for property protection by future Urban Drainage Projects.

East Idle Hour Wash

- Provide all weather access drainage crossing useable by wildlife, to maintain connectivity from mountains to the Santa Cruz River, at a narrow at-grade crossing with steep roadways that impacts driver safety (T13S R12E Sec. 13).

West Idle Hour Wash

- Provide all weather access drainage crossing to improve driver safety at flat, wide federal (SFHA) floodplain crossing with sediment issues (T13S R12E Sec. 22).

Roger Wash

- N. Camino de Oeste properties affected by wash diversions causing safety concerns at road crossings and private driveways (T13S R13E Sec. 31).

Camino de Oeste Wash

- Provide better all-weather access at Lloyd Bush Drive near W. Placita Graciosa in conjunction with Engineering Technical Assistance, since there are several at-grade drainage crossings without culverts affecting the safety of many residents (T13S R13E Sec. 32).

Sweetwater Wash

- Provide better all-weather access across Oxbow Road and reduce erosion and sedimentation at the road crossing affecting the residents where there are many private roads not regularly maintained (T13S R13E Sec. 19).

East and West Idle Hour Hour Washes

- Protect and preserve the natural washes and riparian habitat for the wildlife connectivity from the mountains to the junction of the Santa Cruz River, Rillito Creek, and Cañada del Oro Wash (T13S, R12E Sec. 12).

Sweetwater Wash

- Protect and preserve the natural washes and riparian habitat for the wildlife connectivity from the mountains to the Santa Cruz River, and ensure future cross-drainage improvements at Silverbell Road allow for the wildlife corridors (T13S R13E Sec. 20).

Speedway Wash

- Require future development to preserve all floodplains as open space to protect natural habitats, and encourage cluster development to ensure low density development in property close to the more dense development in the City of Tucson (T13S R13E Sec. 33).

Valencia Wash

- Protect the upstream natural wash and riparian habitat (T13S R13E Secs. 7, 8 & 13) and enhance the riparian or other vegetation along the channelized portion (T13S R13E Secs. 16 & 17) to improve wildlife connectivity to the IRA at the West Branch Santa Cruz River in the San Xavier District Indian Reservation (T13S R13E Sec 9).

Silverbell Road Flood Damages

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.2.a Identify diversions, alluvial fans, debris flows, local floodways and other geomorphic hazard areas

- Expand riparian habitat maps to excluded watercourses
- Identify and map canyon wash floodways
- Identify and monitor erosion on tributaries to the Santa Cruz River

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Conduct detailed mapping of approximate FEMA Special Flood Hazard Areas

- Remap floodplains for the Wyoming and Dakota Washes

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding
- Ref# 1.2.i Develop criteria for site design and infrastructure at major watercourse confluence areas
- Ref# 1.2.i Develop criteria for site design and infrastructure at major watercourse confluence areas

Ref# 1.2.i Develop criteria for site design and infrastructure at major watercourse confluence areas

Ref# 2.2.b Identify areas of flooding problems related to existing development and identify property protection funding or technical assistance

- Provide assistance to property owners related to bank reclamation
- Evaluate cumulative impacts of lot-splits and identify mitigation
- Work with responsible parties to address flooded roads

Ref#4.2.e Increase pre-event technical assistance to the Office of Emergency Management and first responders including identifying reliable all weather emergency response access routes

- Utilize new streamflow gages to warn emergency services of road closures on Silverbell Road (TM)

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Coordinate with the City of Tucson and stakeholders on planned drainage improvements along Silverbell Road

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Identify and conduct targeted outreach to areas which can get cut-off during flood events
- Provide outreach on the availability of private road and drainage easement technical assistance

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

Figure 207 - Tucson Mountains Action Plan

C.2 Rural Watersheds

C.2.5.1 Aguirre Valley and Greene Wash

The watershed originates at Kitt Peak in the Coyote and Quinlan Mountains. The Roskruge Mountains and Silver Bell Peak bound it on the east. On the west, the North Comobabi and Santa Rosa Mountains bound it. The washes draining this watershed disappear into deep alluvium just north of the County border south of Tat Momoli Dam at mostly dry Lake St Claire. For the purposes of this study, Greene wash watershed is included with Aguirre Valley.

This watershed is tributary to the Lower Santa Cruz River. It originates just north of the Tohono O'odham Nation boundary and terminates south of the community of Arizona City in Pinal County. The Greene Wash watershed drains the Sawtooth Mountains on the West and the Santa Cruz River Flats on the east Not sure I understand this sentence. Beyond the Tohono O'odham traditional farming community of Chu Chui and Arizona City, the USGS maps do not show the wash as it sinks into the deep alluvium farmlands. Much of this watershed is within the Tohono O'odham Nation; it is comprised of 478,336 acres (747.4 square miles).

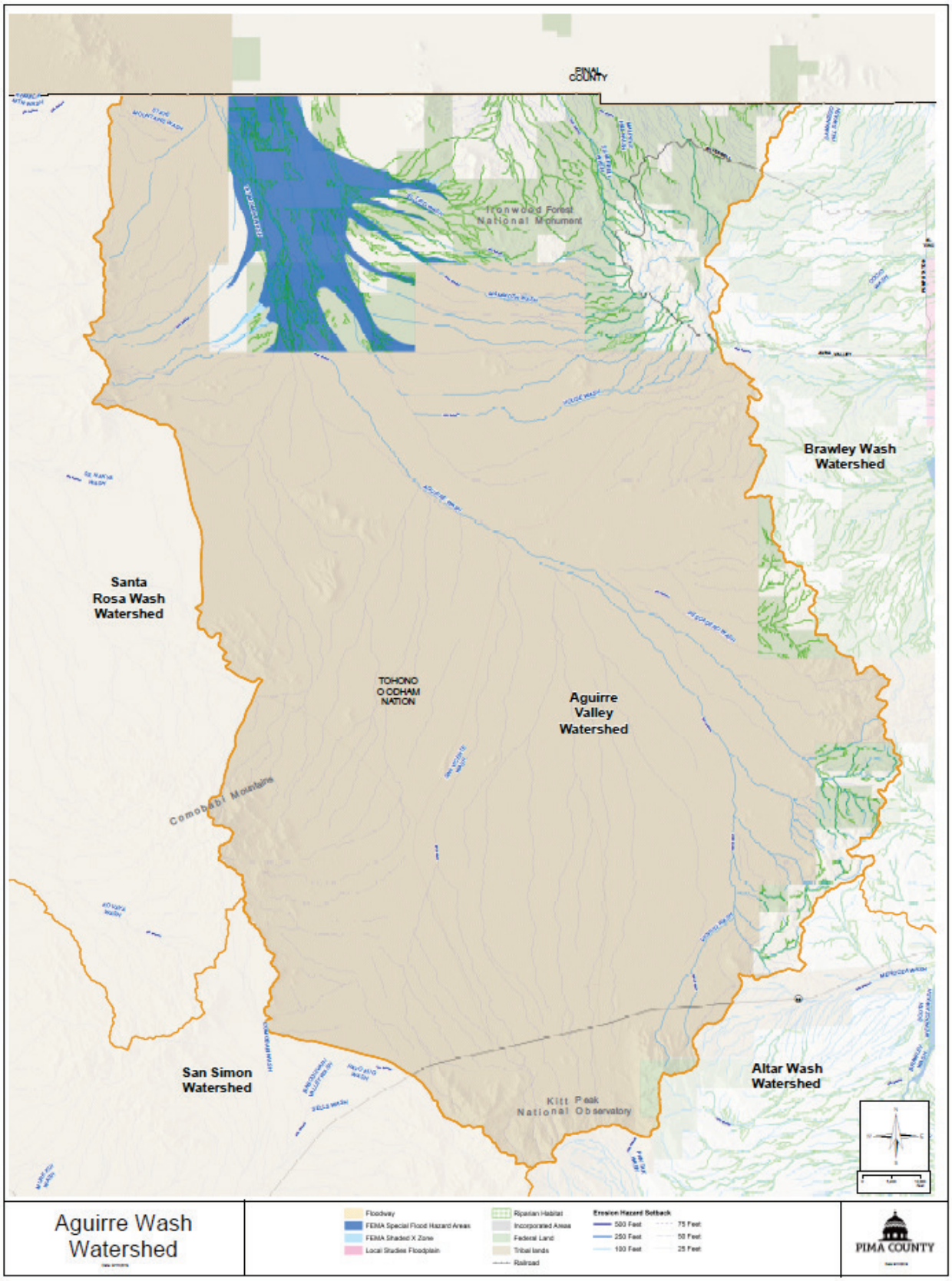


Figure 208 - Aguirre Valley Watershed Map

C.2.1.1 Flood Characteristics

There is 22,206 acres of SFHA Zone A in this watershed.

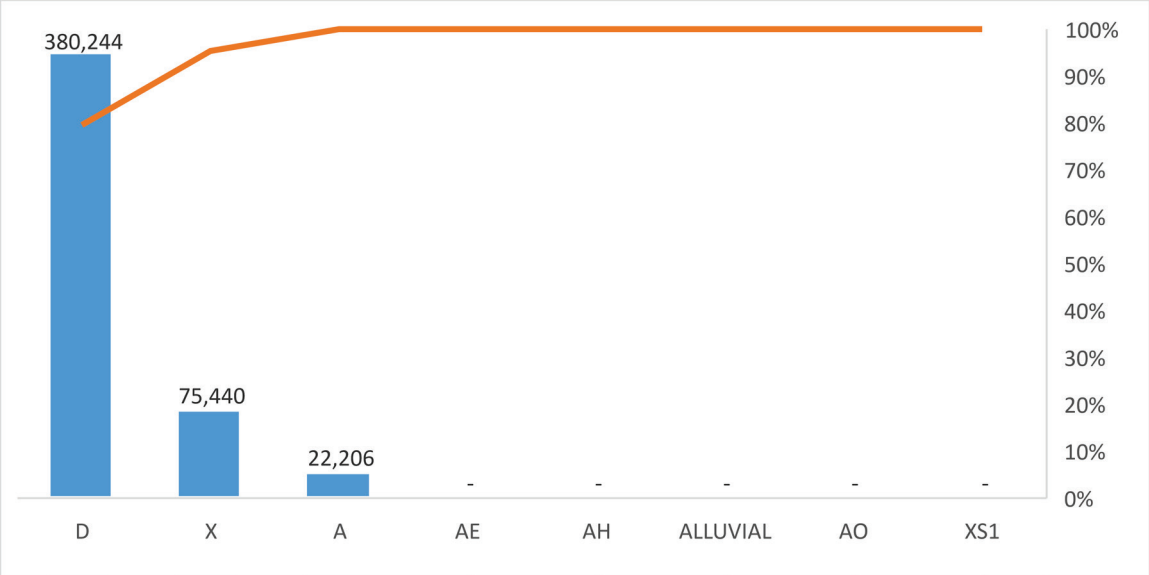


Figure 209 - Aguirre Valley Watershed Federal Floodplain Designations

There are no USGS station, ALERT gages or regulatory discharge locations within the Greene Wash watershed.

C.2.1.2 Existing Development & Infrastructure Trends

The chart below shows the population distribution between incorporated and unincorporated areas. This chart also shows the distribution of residents within known floodplains.

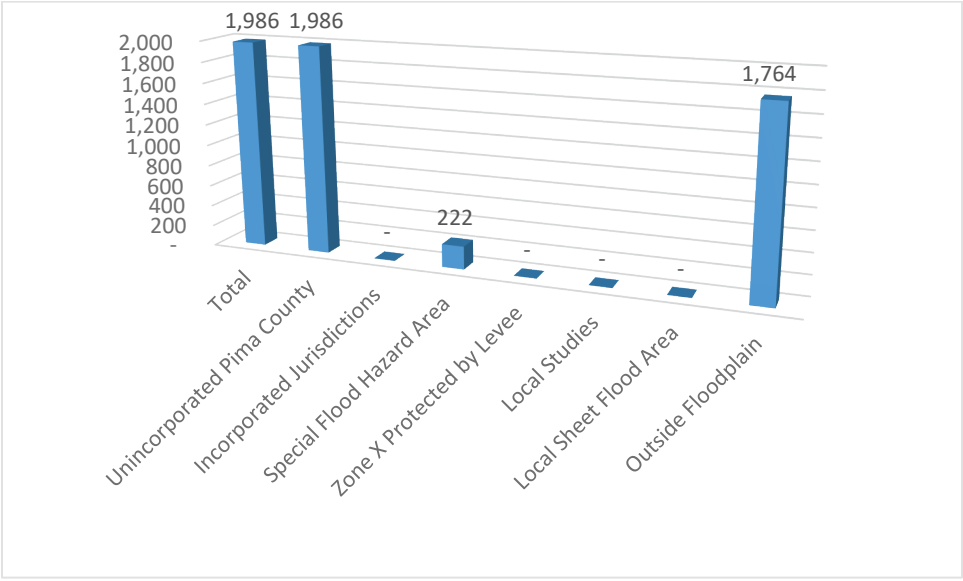


Figure 210 - Aguirre Valley & Greene Wash Watershed Population Distribution

The following figures show ownership and land use distribution in this watershed.

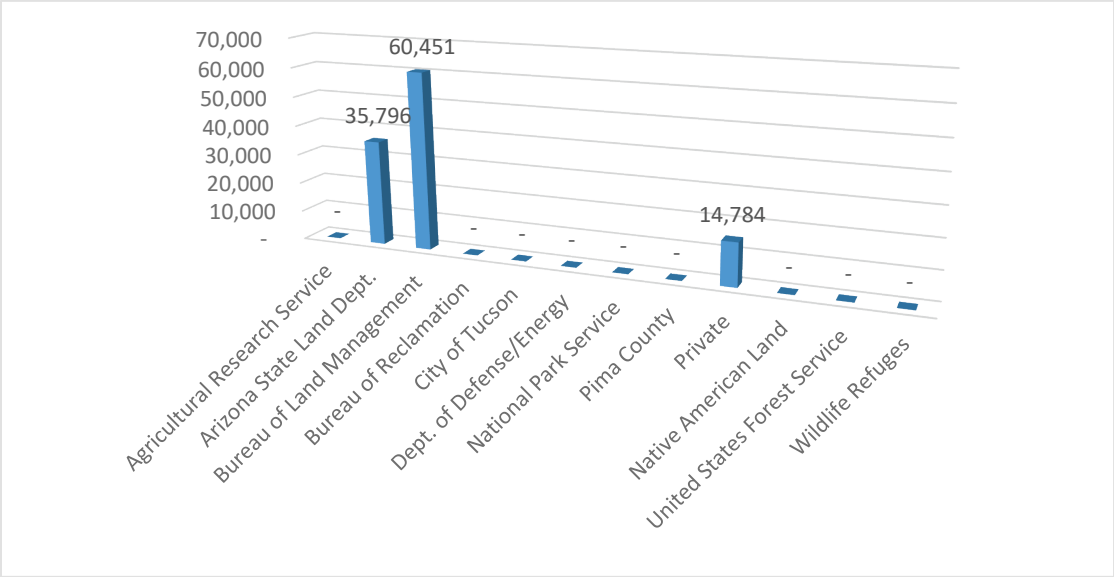


Figure 211 - Aguirre Valley & Greene Wash Watershed Ownership in Acres

Clearly public lands management and farmland are the land use drivers in this watershed.

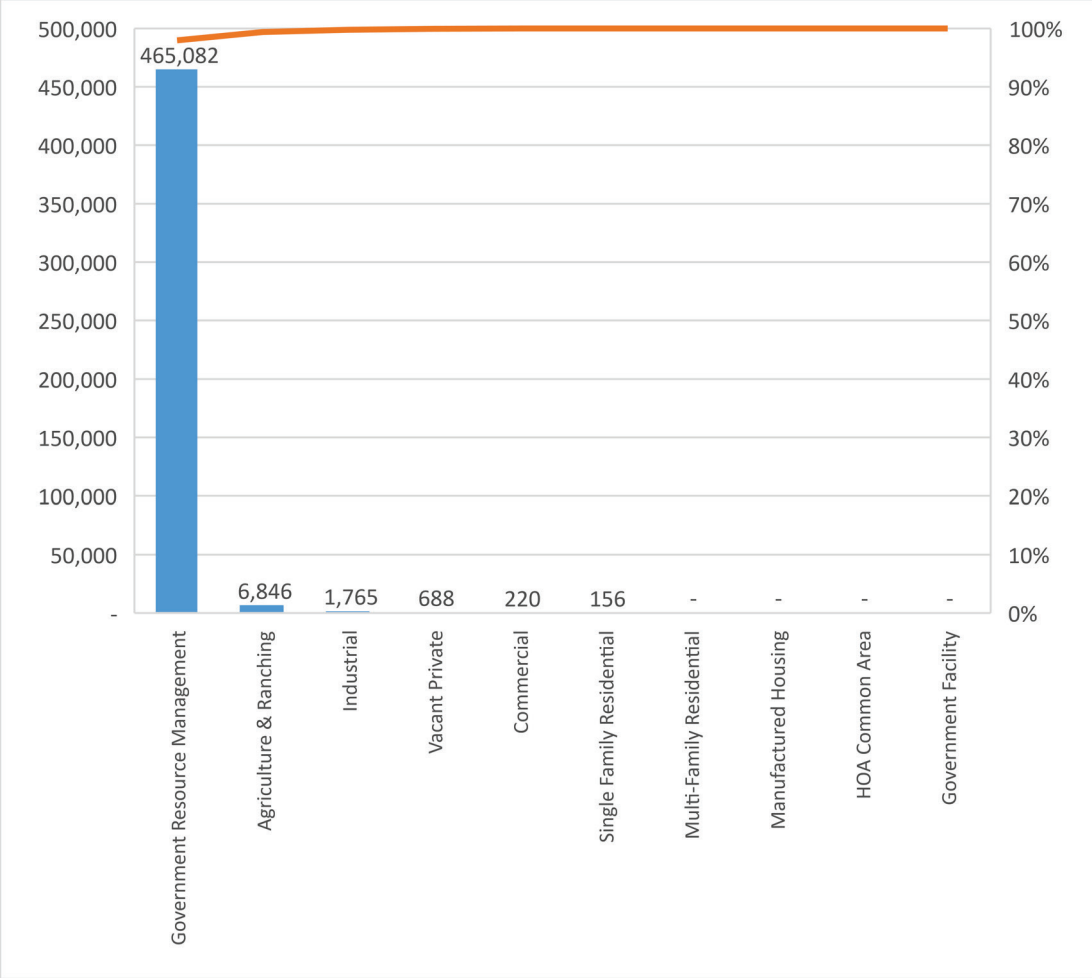
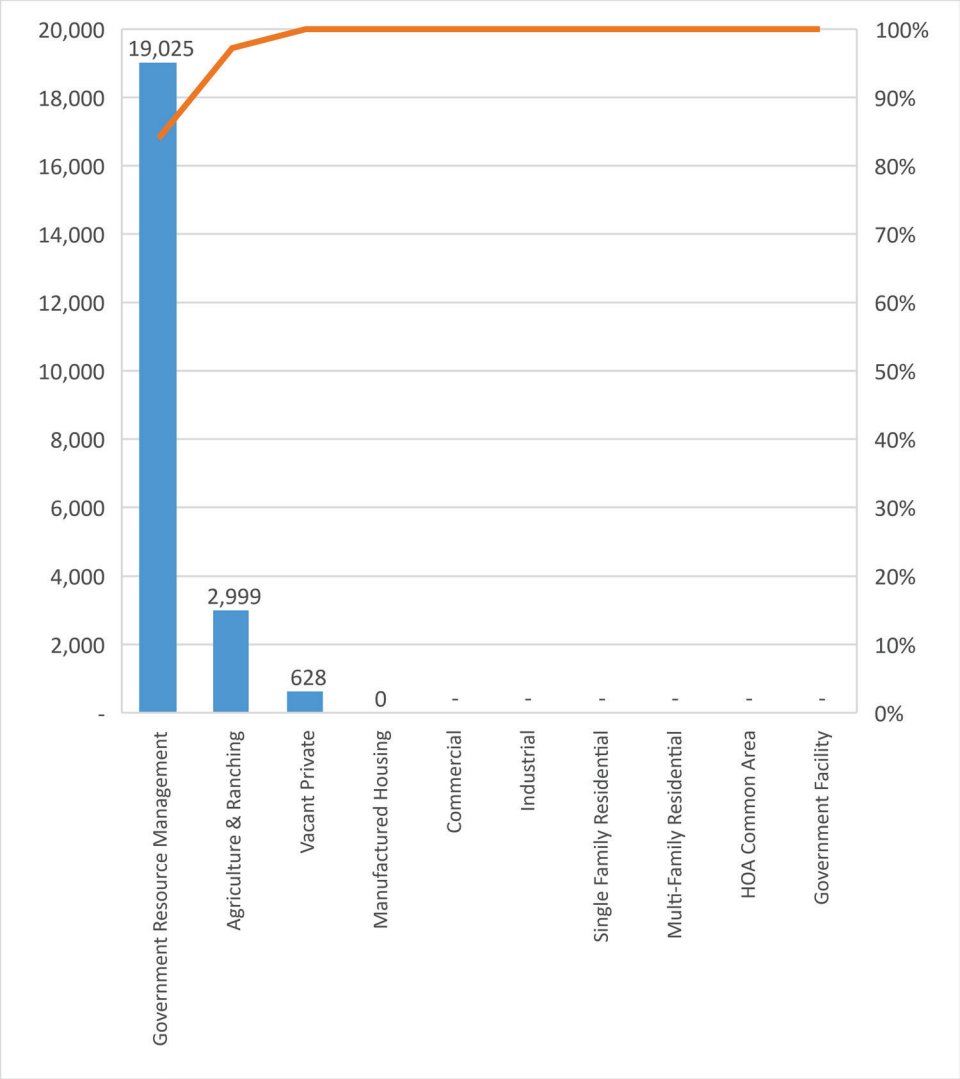


Figure 212 - Aguirre Valley Watershed Land Use in Acres

Figure 213 - Aguirre Valley and Greene Wash Floodpain Land Use



There is 3,182 acres of agricultural land uses within federal floodplains in this watershed. As indicated on the land use map below most of the watershed is within the Tohono O'odham Nation and is undeveloped with the exception of scattered villages, grazing and limited mining. As shown on the land use map, remaining areas within unincorporated Pima County are either agricultural, federal preserves, or vacant desert.

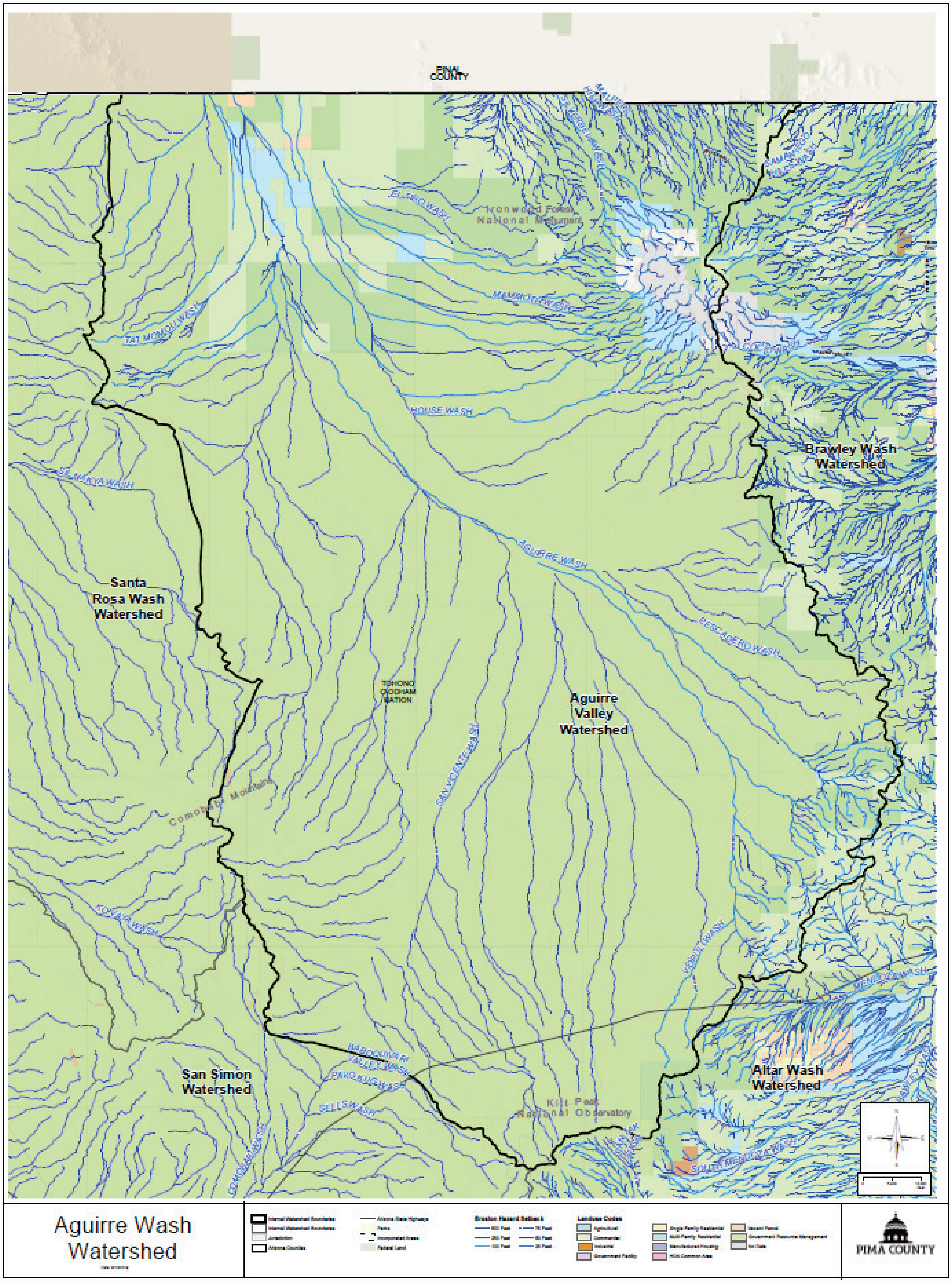


Figure 214 - Aguirre Valley Land Use Map

C.2.1.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 6,845 acres of Pima County Regulated Riparian Habitat in this watershed. There are also 52,319 preserved acres in this watershed, including 8,564 in regulatory floodplain.

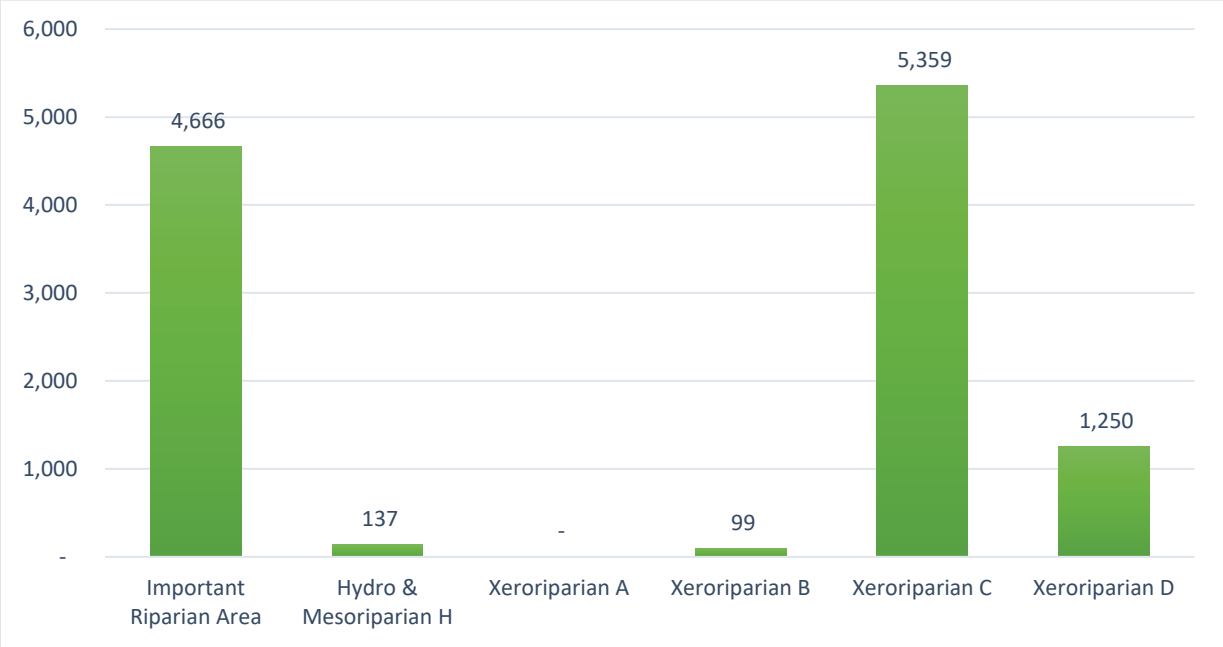


Figure 215 - Aguirre Valley & Greene Wash Watershed Riparian Habitat in Acres

C.2.1.4 Historic Floodplain Management Approach

There is no District maintenance responsibility in this watershed. There are also no USGS stations or Pima County ALERT gages in this area

Because this watershed is predominately rural, the management approach has been limited. Identification of flood risk is limited to the approximate FEMA flood zone and the dam inundation map(s). The District specifies an erosion hazard setback from the top of bank of Arivaca Creek of 100 feet, and has not completed a detailed floodplain study. The Program for Public Information identifies a need to expand outreach in rural areas wherein permitting and accessibility are frequent concerns.

C.2.1.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

The protocol identifies no data gathering needs, frequently flooded structures, and properties subject to damage or infrastructure issues.

The District completed no projects during the prior five years, and none planned for the next five years.

C.2.1.6 Floodplain Management

Future needs identified by District staff include:

- Wide A Zone
- Access

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Identify and conduct targeted outreach to areas which can get cut-off during flood events

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

Figure 216 - Aguirre Valley and Greene Wash Action Plan Map

C.2.2 Altar Wash and Arivaca

The Altar Wash drains the eastern slopes of the Baboquivari Mountains as well as the western slopes of the Sierrita Mountains south of State Route 86 and extends southerly over 30 miles to Mexico near Mormon and Aguirre Lakes which are within the Buenos Aires National Wildlife Refuge It is tributary to the Brawley and Blanco Wash systems. All within unincorporated Pima County, it is comprised of 522,549 acres (816.5 square miles).

For the purposes of this plan, Arivaca Wash Watershed has also been included with the Altar Wash Watershed. This HUC 10 watershed is tributary to Altar Wash. It originates near the historic community of Ruby and passes through the small town of Arivaca. It is confluence with Altar Wash is near west Arivaca-Sasabe Road.

Figure 217 - Altar Wash Watershed Map

C.2.2.1 Flood Characteristics

There are 19,025 acres of SFHA Zone A, 1,023 acres of Special Studies Floodplains, and 85,585 acres of sheet flood area in this watershed.

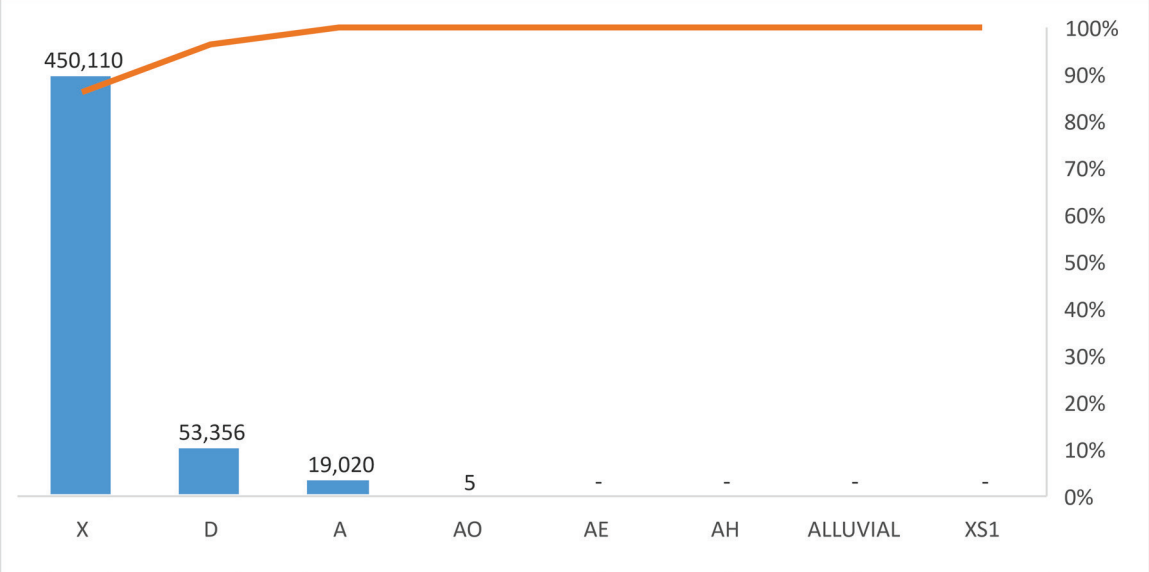


Figure 218 - Altar Wash Watershed Federal Floodplain Designations

In addition to the SFHA associated with the Wash, the District has mapped much of the private land as impacted by sheet flooding in order to flag permits for further analysis. Distributory sheet flows associated with alluvial fans also affect the public lands in this watershed. As noted above, there are over 1000 acres of local Special Studies Floodplains and over 85,000 acres of District sheet flood area.

Arivaca Creek and its tributaries drain from south to north from Santa Cruz County to a midpoint in the Altar Wash distributed flow system. Major tributaries to Arivaca Creek include Cedar Creek, Amigo Wash, and Wilbur Wash. Vegetation consists primarily of desert brush on slopes. Soils on milder slopes typically consist of less permeable somewhat clayey soils. Hillsides and steeper slopes may exhibit rock outcrops and the more permeable, loamy soils. Within washes and overbanks, loamy and sandy soils are present.

Arivaca Lake is a reservoir near the Santa Cruz County line, about 6 miles southeast of the Town of Arivaca. The Arizona Department of Water Resources operates the reservoir. Arivaca Lake drains 14.0 square miles of undeveloped land, located within the Coronado National Forest. According to the dam breach analysis completed in 2008, the probable maximum precipitation for the contributing watershed is 14.1 inches over a six-hour period.

The table below provides a summary of historic USGS gaging station records.

Table 61 - USGS Gages

USGS Gaging Station	Arivaca Wash near Arivaca, AZ 09486600	Arivaca Creek at Arivaca, AZ 09486580	Arivaca Creek near Arivaca, AZ 09486590
Period of Record	1965-12-24 to 1972-07-17	1996-08-30 to 2001-12-11	2000-10-23 to 2013-08-23
Watershed Area (sq. m)	78.4	56.8	43.0
Flood Peak of Record (cfs)	15,900*	1,470	2,200
Date	12-24-1965	07-20-1998	07-25-2007
FIS Discharge (cfs)	NA	NA	NA

*Discharge affected by dam failure. Next peak discharge of 3,550 cfs occurred on 12-20-1967

This record indicates that a winter frontal storm contributed to dam failure, while other storms of record occurred during the summer monsoon.

There is one Pima County ALERT rainfall gage in this watershed. The table below shows its location and period of record.

Table 62 - ALERT Gages

Pima County Alert Gage	Arivaca - Altar Basin ID: 6370
Location (Latitude, Longitude)	(31.6044, -111.3411)
Period of Record	2001-10-19 to Present

There are no entries for this watershed on the District's Table of Regulatory Discharges (Revised October 28, 2014). Table 2 presents a discharge point from the District's GIS regulatory discharge point layer.

Table 63 - Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Tributary to Arivaca Creek 2 miles NW of Arivaca	3,847	Unknown	Floodplain Use Permit 07-177

The most significant hydraulic structure within this watershed is the Arivaca Reservoir. The dam crest storage capacity is 2,915 acre-feet. The primary outlet is a 12" diameter reinforced concrete pipe. A concrete trapezoidal channel functions as an emergency spillway. The outlet discharges into Cedar Creek, which drains to Arivaca Creek. The Arizona Game and Fish Department has completed an Emergency Action Plan for the dam including an inundation map, and very few residents are within the inundation limits.

A dam forms Arivaca Lake about five miles upstream of the town of Arivaca and the Arizona Department of Water Resources considers it a "significant hazard". The Arizona Game and Fish Department has completed an Emergency Action Plan for this dam including inundation maps and very few resident are within it. The sample map below is for the full failure scenario.

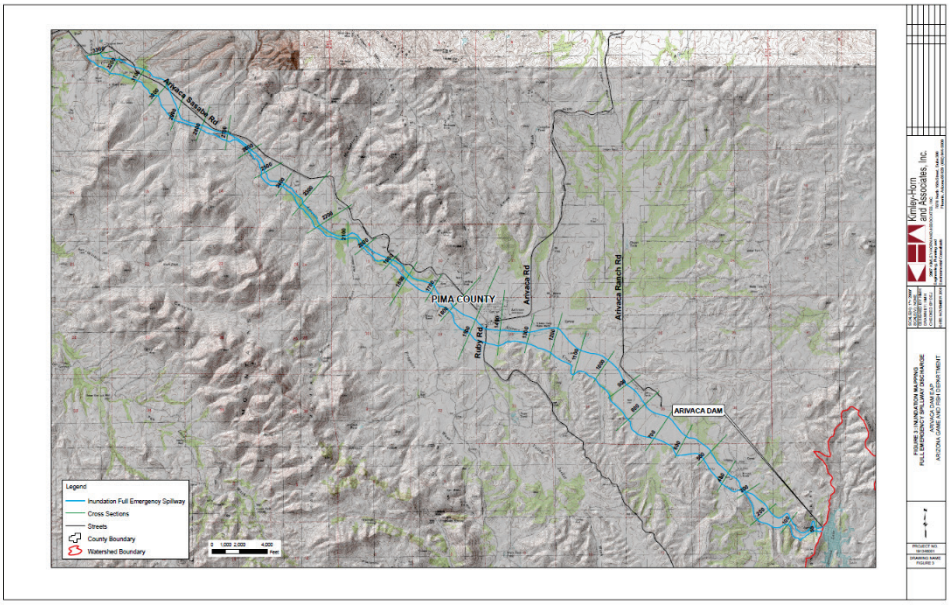


Figure 219 - Arivaca Dam Inundation Map

Arivaca Creek runs along the south side of the Town of Arivaca and crosses only one major road, S. Ruby Road, where there is a low water road crossing. This road crossing may be unpassable during high flows. Just upstream of S. Ruby Road is where SFHA mapping begins.

C.2.2.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. Arivaca watershed is rural and mostly undeveloped, the only town being the Town of Arivaca, which has a population of approximately 700 residents.

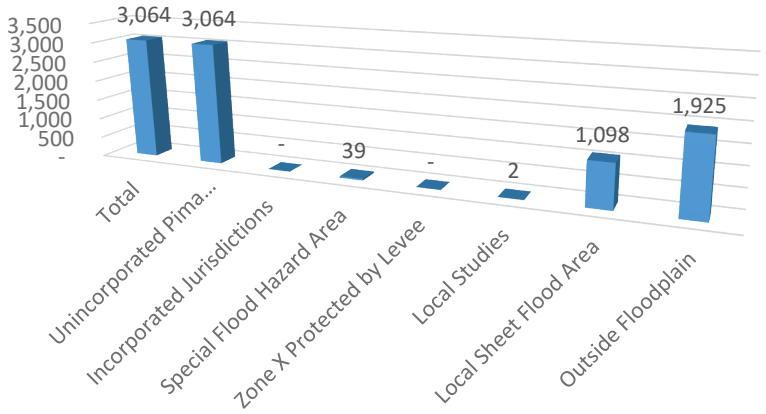


Figure 220 - Altar Wash Watershed Population Distribution

The Buenos Aires Wildlife Refuge has preserved significant portions of the upper watershed floodplains as indicated on the bar chart below. State trust land, while reserved for future development is currently mostly vacant with the exception of grazing leases and utility rights of way. It will likely remain as such into the near future due to it's remoteness. The limited extent of development supports preservation of habitat and open space without floodplain encroachment.

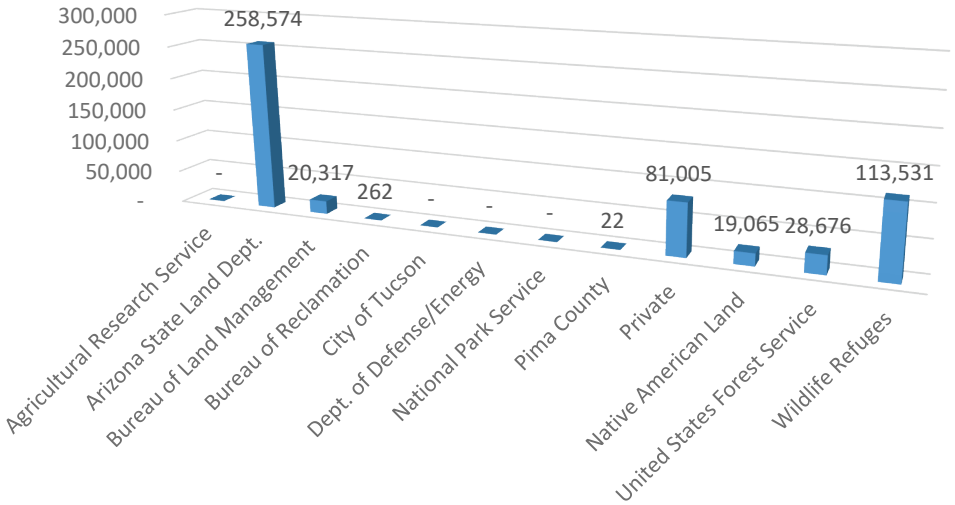


Figure 221 - Altar Wash Watershed Ownership in Acres

Adjacent to the Town of Arivaca the Buenos Aires Wildlife Refuge features broad grasslands, Fremont Cottonwood gallery forest along the washes and even a Cienega boardwalk.

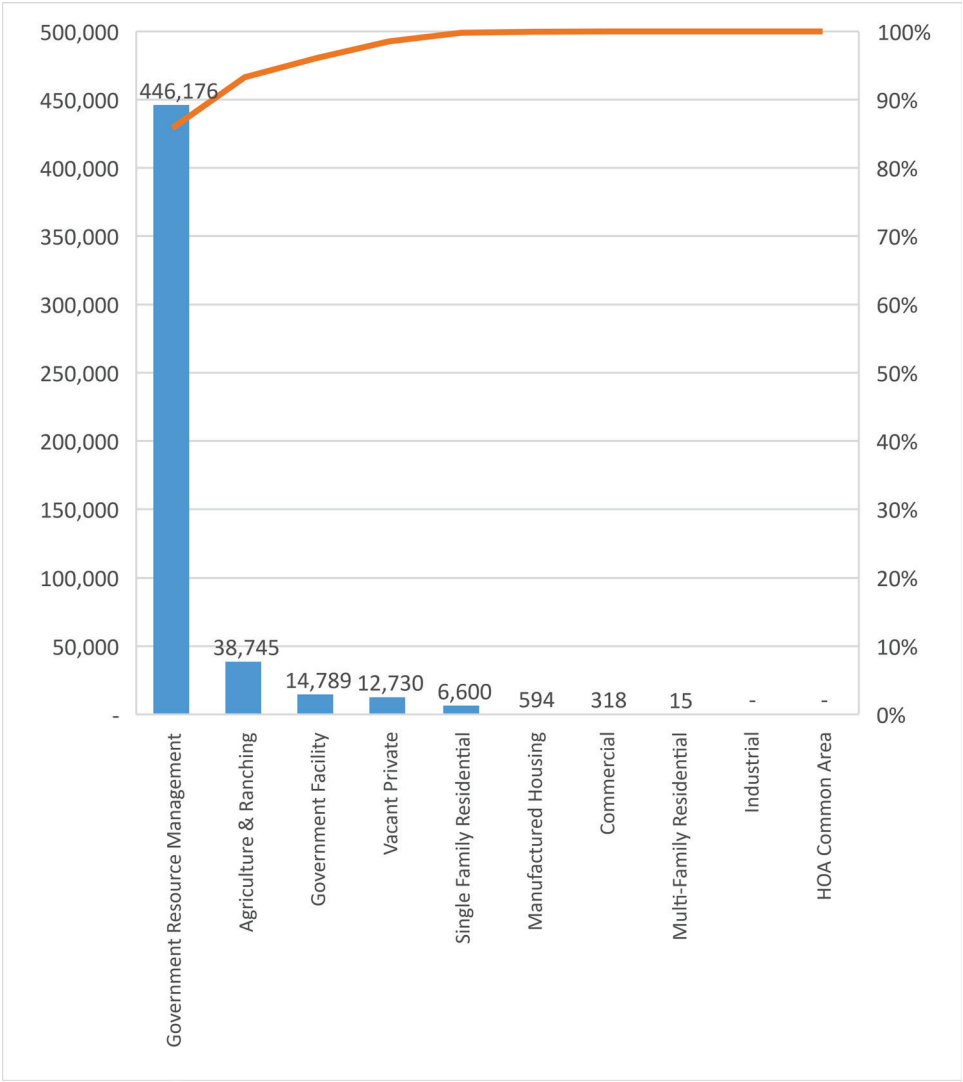


Figure 222 - Altar Wash Watershed Land Use in Acres

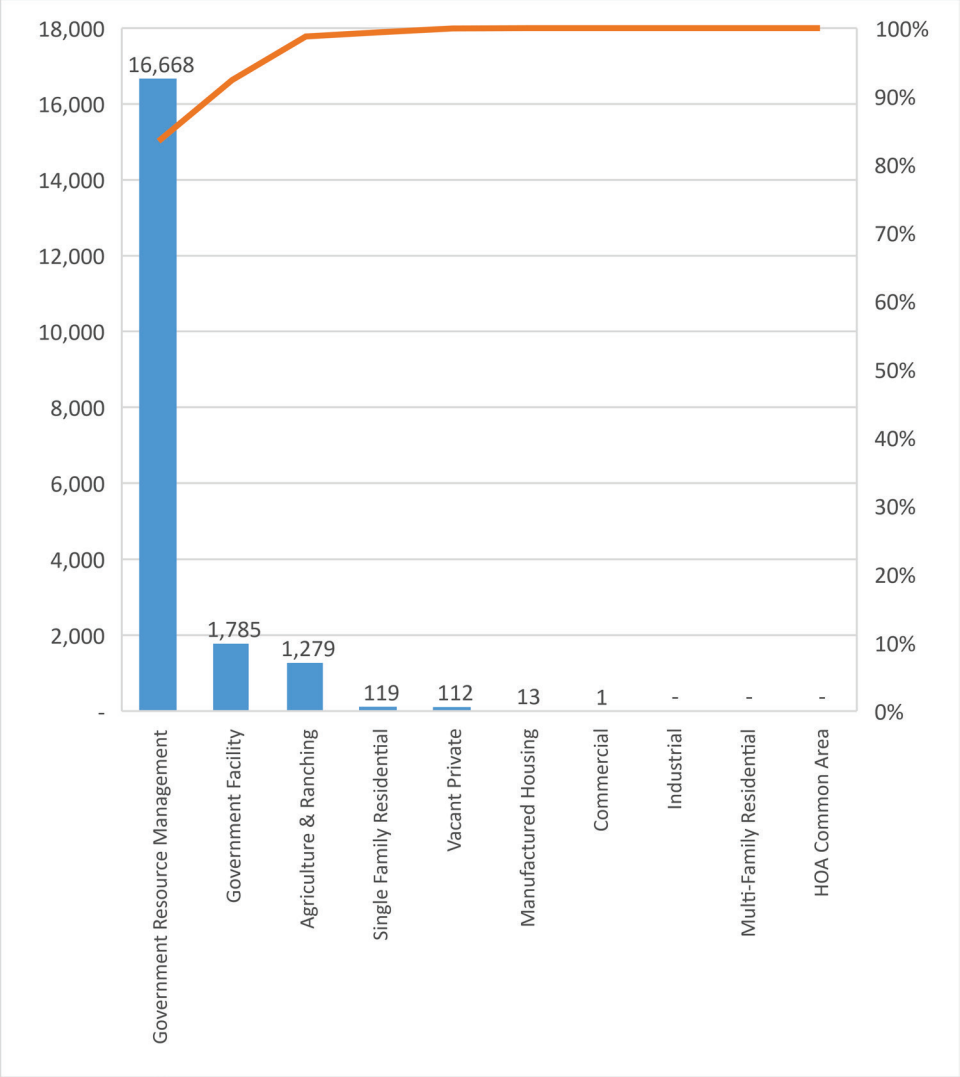


Figure 223 - Altar Wash Floodplain Land Use in Acres

While there are scattered residential and commercial areas this watershed is predominately rural. The floodplain in this watershed is mostly used for agriculture and ranching.

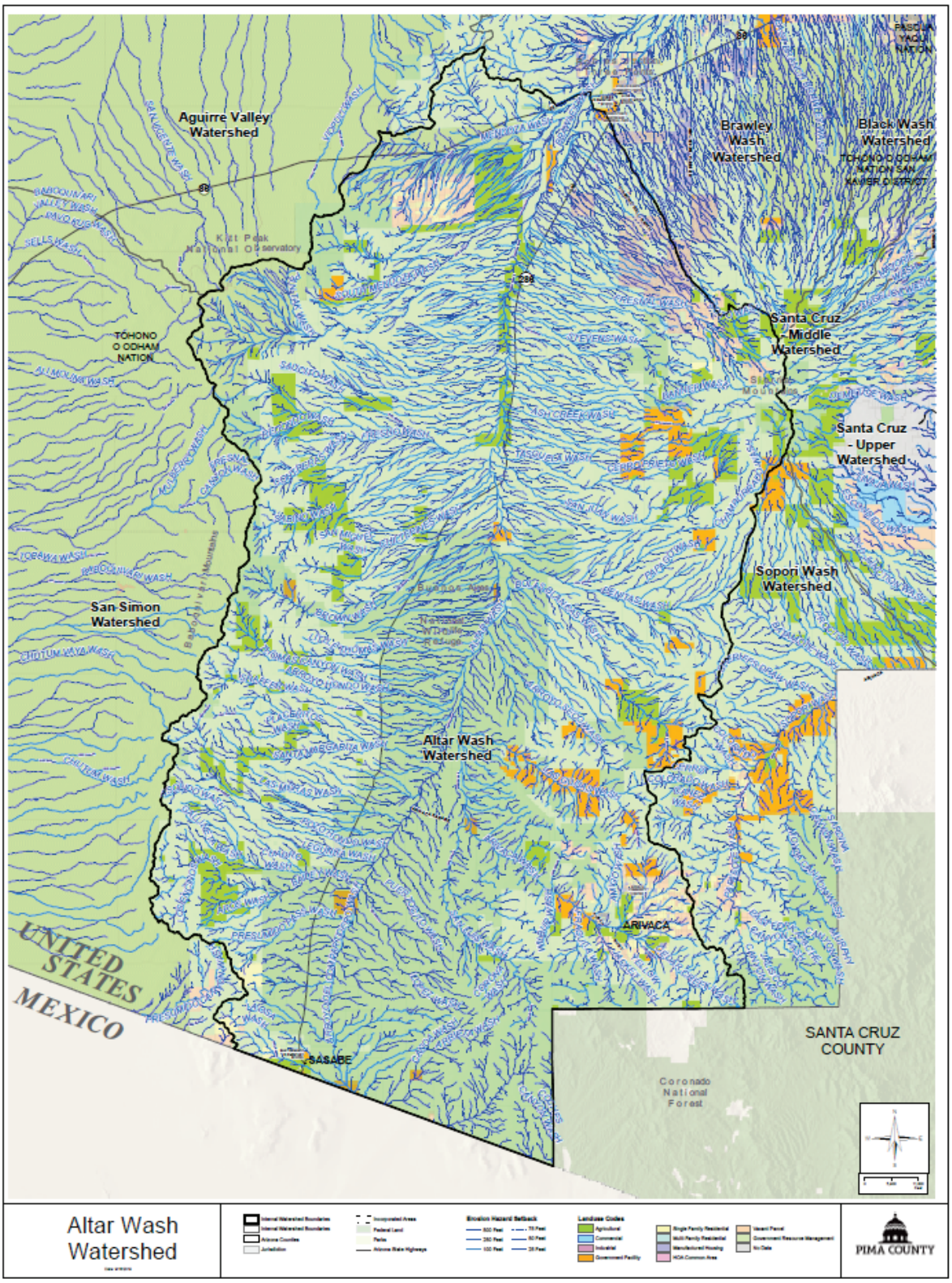


Figure 224 - Altar Valley Land Use

C.2.2.3 Riparian Habitat and Natural Areas

As shown the figure below there are 53,136 acres of Pima County Regulated Riparian Habitat in this watershed. The IRA designation overlays RRH in most cases but is reported separately due to differences in regulation. Vegetation tends toward herbaceous in piedmont and riparian areas. Creeks and tributaries support mesquite bosques, creating abundant resources for wildlife. There are also 211,308 preserved acres in this watershed, including 13,916 in regulatory floodplain.

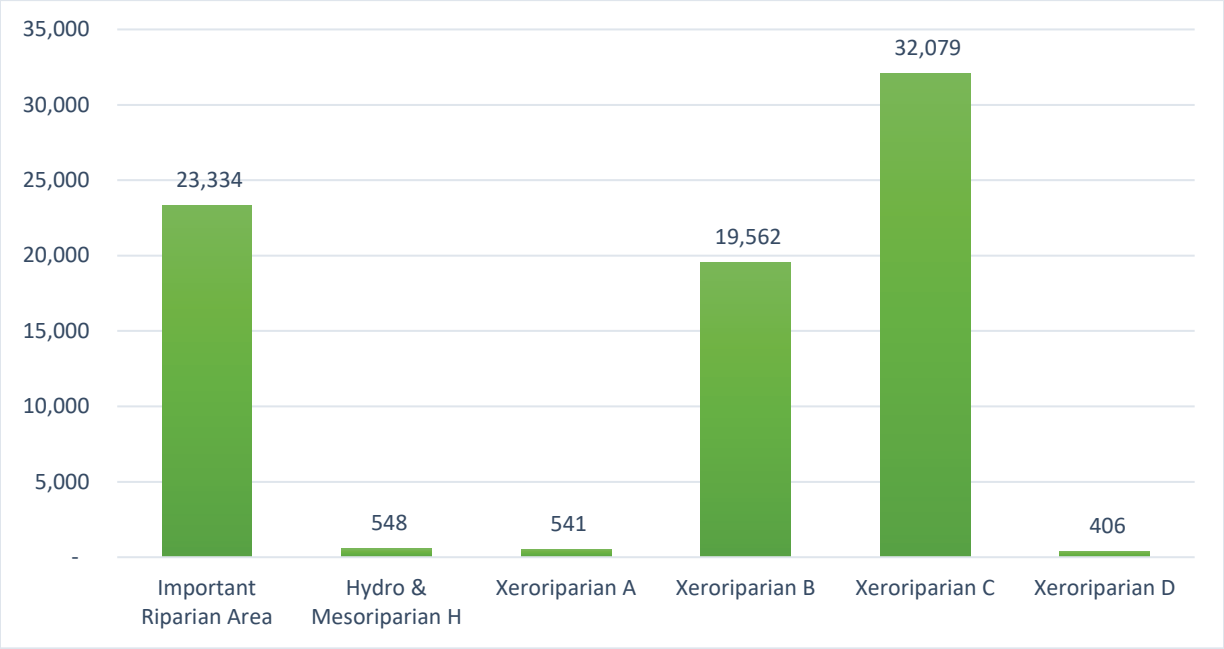


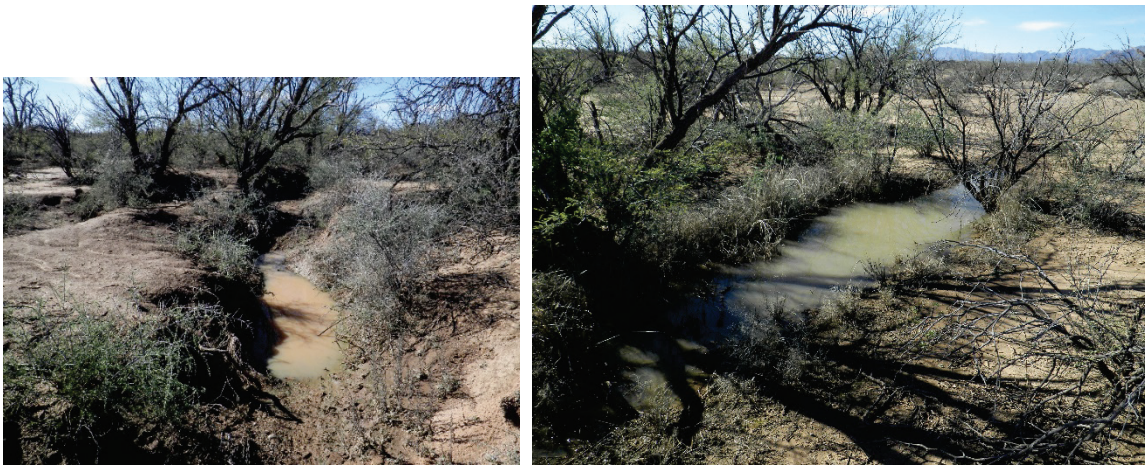
Figure 225 - Altar and Arivaca Washes Watershed Riparian Habitat in Acres

Harris (2001) classifies the riparian areas as Sonoran Desertscrub biome (BLP #154.1) (Harris, 2001). The Sonoran Desertscrub can be further divided into the Arizona Upland Subdivision, which is characterized by a diverse assemblage of cacti, trees and shrubs, and the Lower Colorado River Valley Subdivision, which is primarily characterized by creosotebush (*Larrea tridentata*) and bursage (*Ambrosia deltoidea*). Both plant communities are found in this watershed.

The Sonoran Desertscrub Subdivision is further classified as desert riparian shrub or xeroriparian along the washes. This vegetation community contains similar tree and shrub species found in upland sites such as paloverde, velvet mesquite, and ironwood.

Sonoran Desertscrub, Arizona Upland Subdivision (left) and Lower Colorado River Valley Subdivision (right)

A unique natural resource in this watershed is distributary flow areas that contain ephemeral water features, located in both the floodplain overbank and in-channel. These features fill with water during flood events, and due to the deposition of fine sediments, hold water for a period of time afterwards, providing a water source for wildlife.



In-channel ephemeral water (left) and floodplain overbank ephemeral water (right)

The Altar wash serves as an important wildlife corridor and provides habitat for native wildlife. It is common to see evidence of mule deer, javalina, jackrabbits, bobcat, coyote, and various amphibians and reptiles. In addition to supporting abundant vegetation and wildlife, there is evidence of prehistoric people throughout the watershed.

Bobcat tracks (left), pot sherds (center), and juvenile Sonoran Desert toad (right)

The watershed has been impacted by human development, including flow diversions due to roads and past agricultural activities, which has led to erosion. Channelization of the main stem of the Altar wash has disconnected the floodplain from the overbank, causing vegetation die-off, although vegetation on the District's property is primarily supported by flows entering from the west and south. Other natural and human activities that threaten natural and cultural resources in the watershed include cattle grazing, invasive species, minor illegal dumping, and OHV use due to border activity (i.e., Border Patrol). As resources allow, the District will work with NRPR to actively manage these threats through placement of fencing, signage, and enforcement when required.

Bermudagrass (above) and soil erosion (right)

C.2.2.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

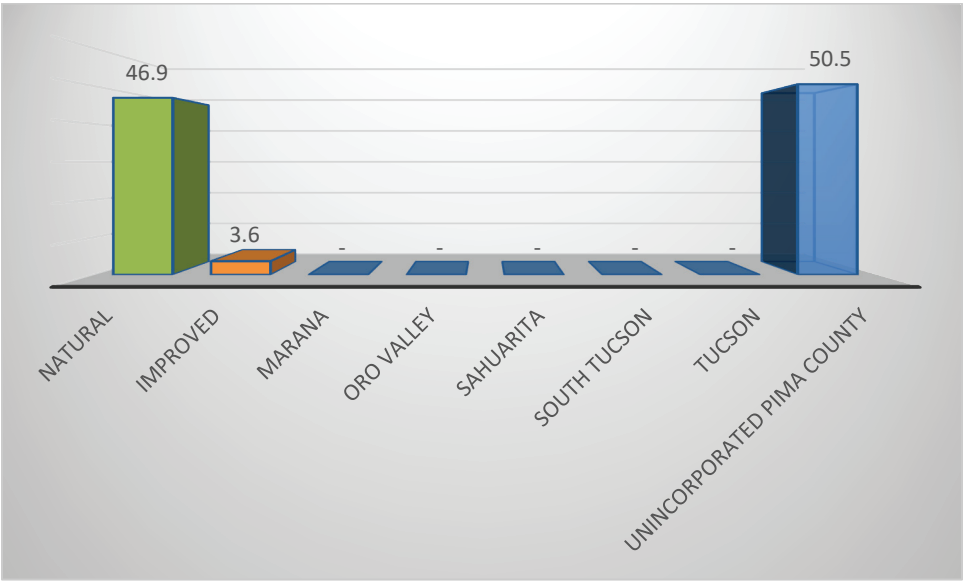


Figure 226 - Altar Wash Drainageways

Because this watershed is predominately rural, the management approach has been limited to responding to complaints regarding all weather access and managing wash erosion including head cutting as it migrates up tributaries. As noted below this has involved coordinating with local landowners as well as the Altar Valley Conservation Alliance.

The District manages 546 acres of open space lands in the Altar Wash watershed. Acquired through the Floodprone Land Acquisition Program (FLAP), the property and is located directly southwest of the community of 3-points, south of Buckelew farm and adjacent to the King 98 Ranch. Pima County Natural Resources Parks and Recreation staff manage the property for the District through a Memorandum of Understanding, which includes annual inspections to inventory infrastructure (if present), natural resources and identify threats and stressors. There are many opportunities for restoration and land stewardship projects throughout the watershed.

C.2.2.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. The District has not identified any site-specific concerns in this watershed.

The District completed no projects during the prior five years, and none planned for the next five years.

C.2.2.6 Floodplain Management

District staff is involved with erosion control projects including those to reduce head cutting and to induce meandering in coordination with public and private landowners including within Buenos Aries National Wildlife Refuge and on ranches. The District participates in review of utility facilities including Environmental Impact Statements associated with gas pipelines. This watershed has one such pipeline running along the Altar Wash to Mexico that enters the watershed near Three Points on State Route 86. As part of monitoring for erosion at the numerous washes crossed by the Route, the developer has agreed to provide annual imagery. This imagery will improve the ability to monitor overall watershed condition in the future.

The PPI identified a need for greater presence, and detailed floodplain mapping can better define flood risk.

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Arivaca Lake

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Conduct detailed mapping of approximate FEMA Special Flood Hazard Areas

Ref# 3.1.c Identify, acquire, preserve, restore and enhance the Drainage System and Preserves including riparian habitat and wildlife corridor areas

- Support work for the Altar Valley Watershed Management Grant

Ref# 5.2.a Identify potential locations for Green Infrastructure/Low Impact Development projects

- Coordinate with the Altar Valley Conservation Alliance to implement watershed restoration

Ref# 5.2.e Develop alternative construction techniques and site designs to protect from flood hazards by mimicking natural conditions (e.g. compound channels, distributed retention)

- Develop and implement an erosion mitigation plan using natural channel design techniques

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

Figure 227 - Altar Wash and Arivaca Action Plan Map

C.2.3 Rio Sonoyta

The watershed extends from both sides of the Ajo Mountains. It includes Pia Oik Wash draining the eastern slopes that supplies Menager's Lake within the Tohono O'odham Nation. As well as a series of washes that drain across the Sonoyta Valley west of the mountains toward Lukeville and eventually the Sonoita River within the Mexican State of Sonora. Within Pima County, it is comprised of 267,022 acres (417.2 square miles).

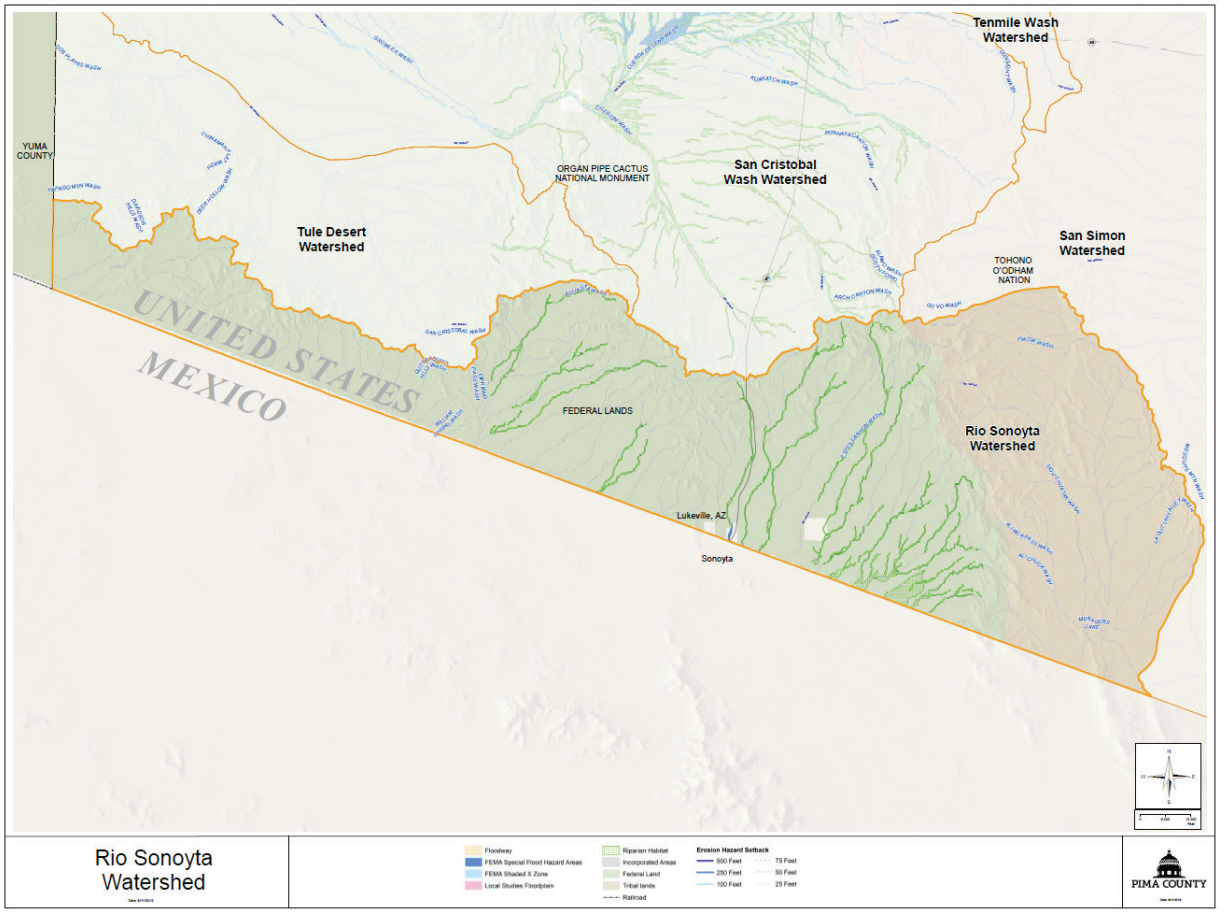


Figure 228 - Rio Sonoyta Watershed Map

C.2.3.1 Flood Characteristics

There is 45 acres of SFHA Zone A in this watershed.

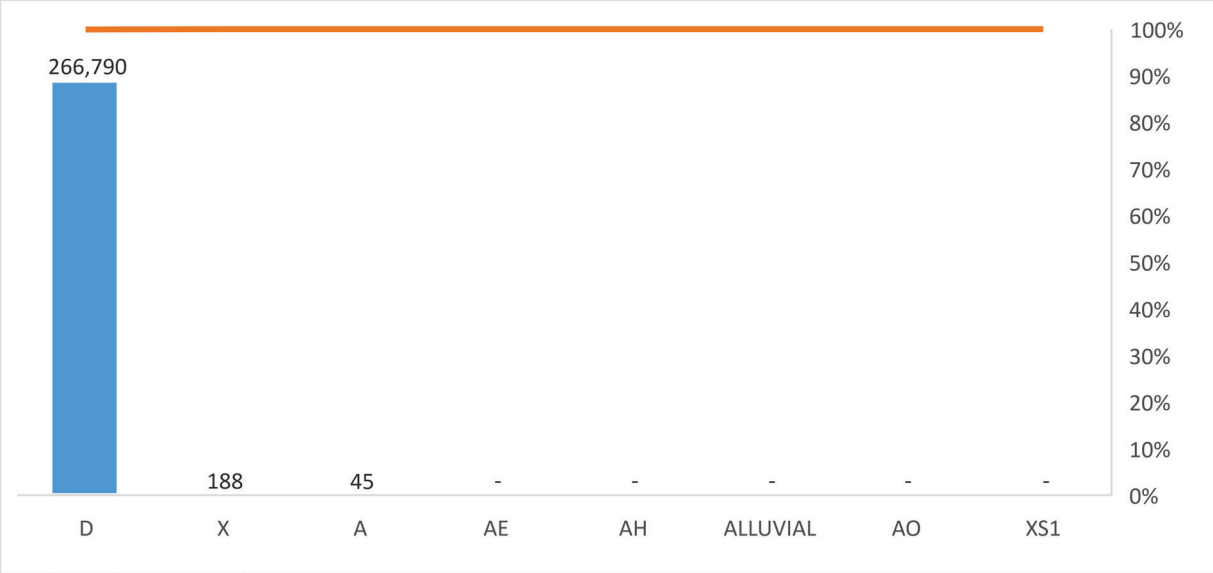


Figure 229 - Rio Sonoyta Watershed Federal Floodplain Designations

The table below summarizes historic USGS gaging station records.

Table 64 - Rio Sonoyta Watershed USGS Gages

USGS Gaging Station	Quitobaquito Spring near Lukeville, AZ
Period of Record	1982 to 1993
Watershed Area (sq. m)	NA
Flood Peak of Record (cfs)	3865
Date	NA

There are currently no Pima County ALERT gages or regulatory discharges in this watershed.

C.2.3.2 Existing Development & Infrastructure Trends

The chart below shows population distribution between incorporated and unincorporated areas. This chart also shows the distribution of residents within known floodplains.

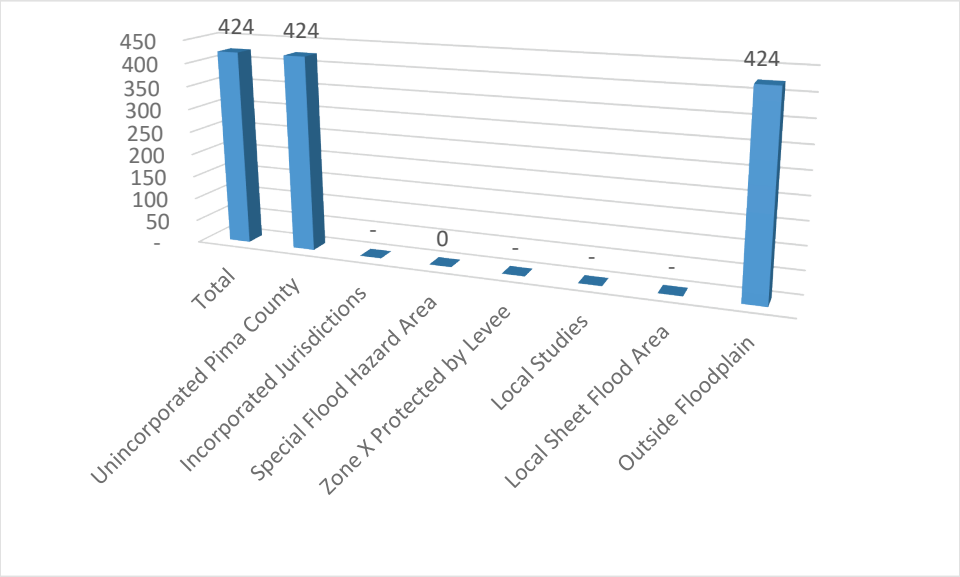


Figure 230 - Rio Sonoita Watershed Population Distribution

`With the exception of a few businesses and government facilities at Lukeville border crossing on State Highway 85 the entire watershed is within the Tohono O'odham Nation and Organ Pipe National Monument.

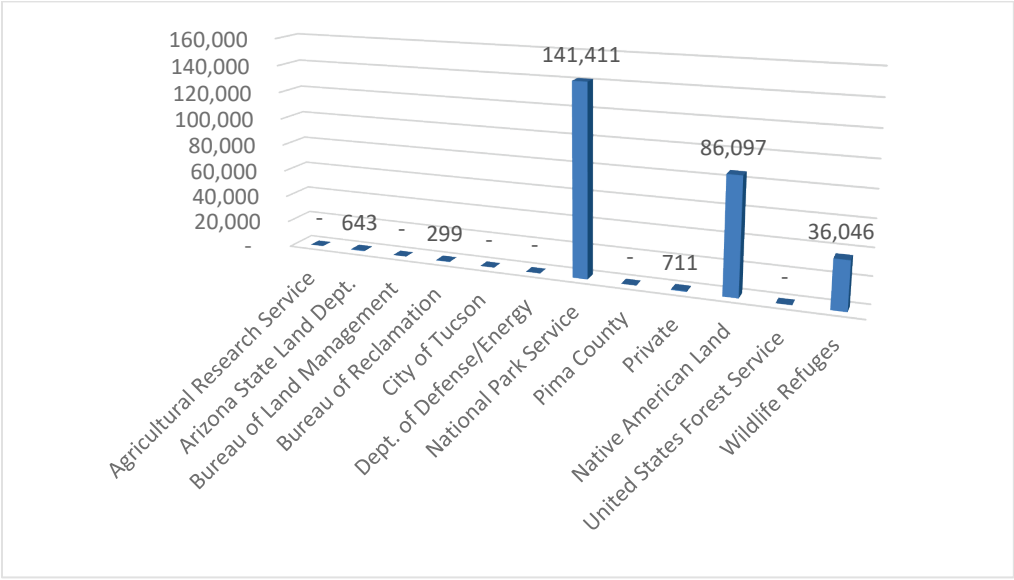


Figure 231 - Rio Sonoyta Watershed Ownership in Acres

Federal land management is the primary driver here as both wildlife sanctuary and a border community.

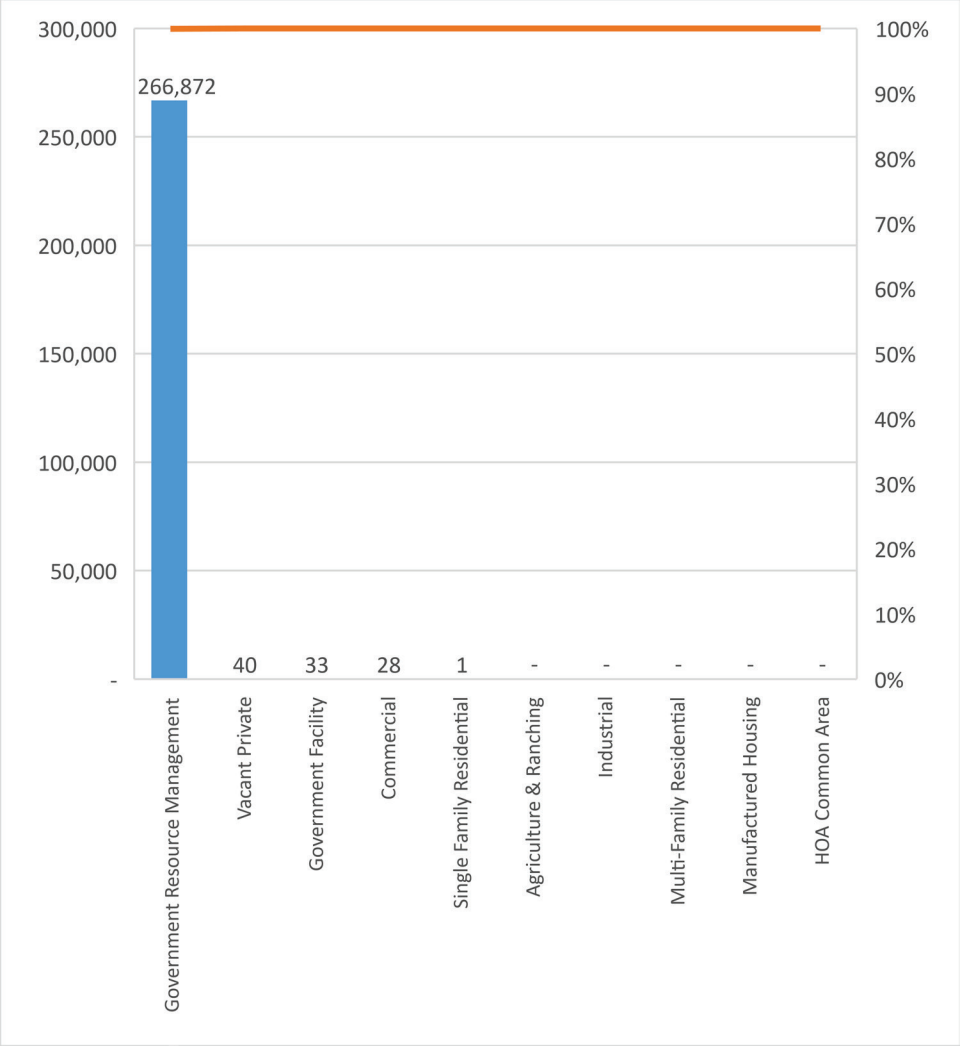


Figure 232 - Rio Sonoyta Watershed Land Use in Acres

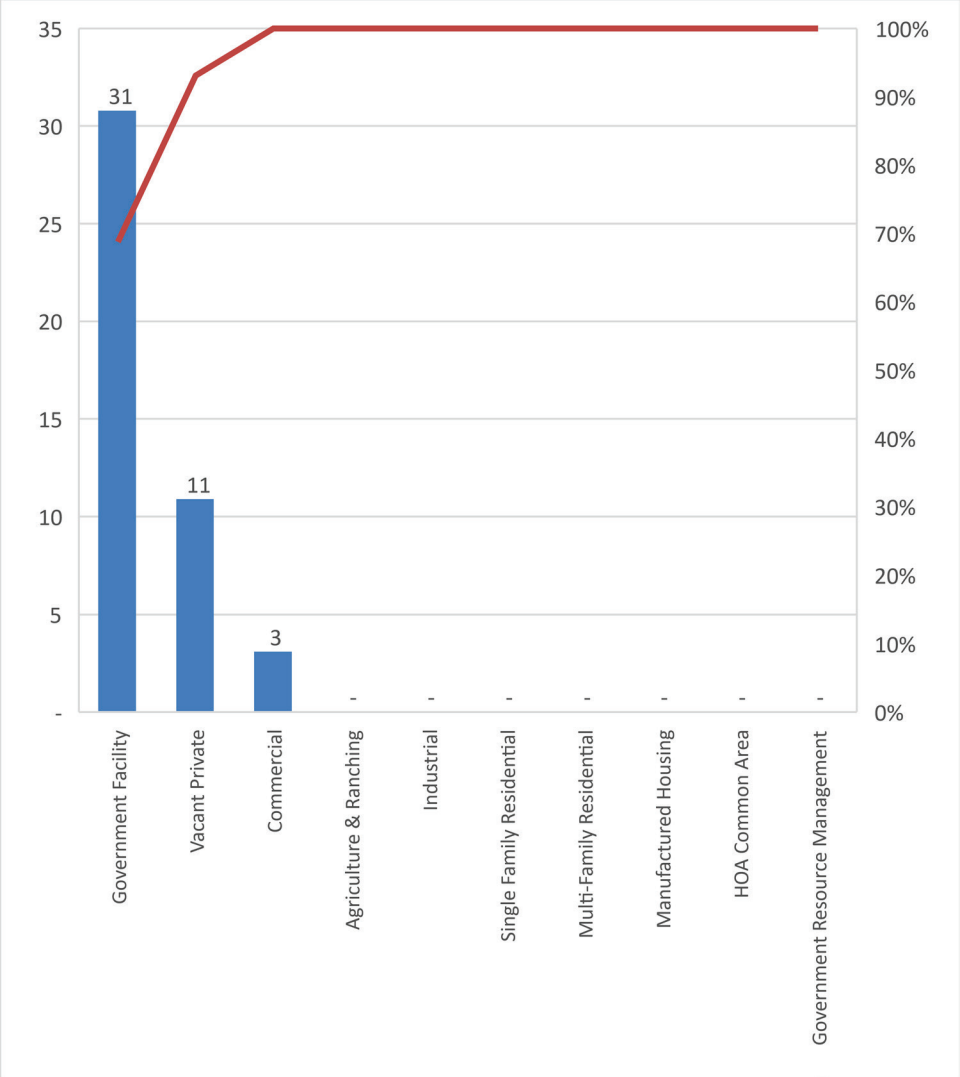


Figure 233 - Rio Sonoyta Floodplain Land Use

While there is one small village within the tribal lands and the aforementioned border crossing, other than the Organ Pipe campground facilities the entire area is vacant. Even grazing is limited in this area of the county as indicated on the land use map.

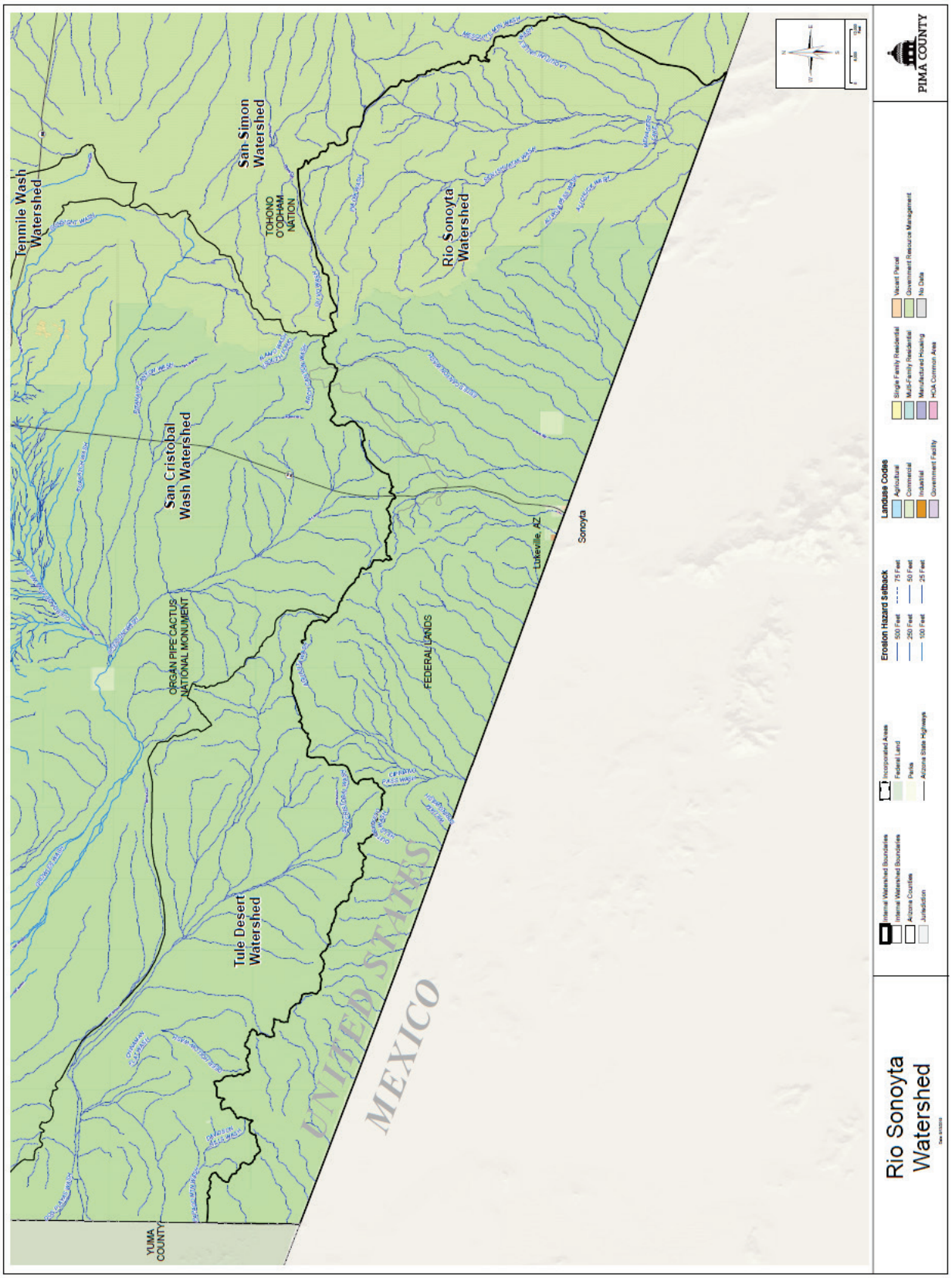


Figure 234 - Rio Sonoyta Land Use Map

C.2.3.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 5,345 acres of Pima County Regulated Riparian Habitat in this watershed. There are also 180,197 preserved acres in this watershed, including 45 in regulatory floodplain.

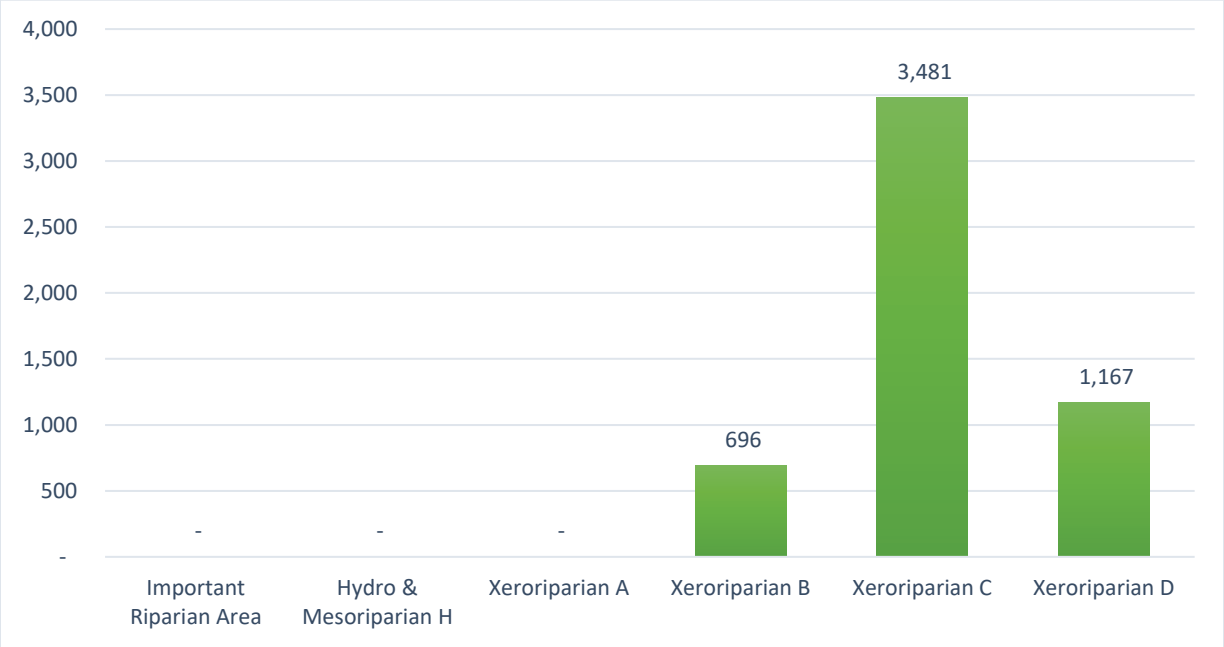


Figure 235 - Rio Sonoyta Watershed Riparian Habitat in Acres

One unique feature is Quitobaquito Oasis thought to have been visited by Spanish Jesuit priest Eusibio Kino in 1698 and a culturally significant site for the Tohono and Hia:Ced O'0dham amongst others. It is home to endangered species including the Quitobaquito Pupfish and Sonoran Mud Turtle and a popular historic stop along the Camino Del Diablo.

C.2.3.4 Historic Floodplain Management Approach

Pima County utilizes three approaches to floodplain and drainage system management. They are regulation, maintenance and preservation. The District puts substantial effort into mapping new regulatory floodplains and requiring developers to do so. Just as regulatory floodplains are those with a peak discharge of 100 cfs during the 100-year event, those watercourses considered part of the drainage system for CRS purposes are those with a flow in excess of 100 cfs. There is no District maintenance responsibility in this watershed.

C.2.4.5 Needs

The District completed no projects during the prior five years, and none planned for the next five years. The 2019 *Flood Response Manual* identifies no specific items of concern in this watershed.

C.2.3.6 Floodplain Management

The plan identifies no future needs.

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 4.2.c Expand and update the District's flood threat recognition and integrate it with warning system

- Coordinate with other jurisdiction including the Tohono O'odham Nation on flood warning needs

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

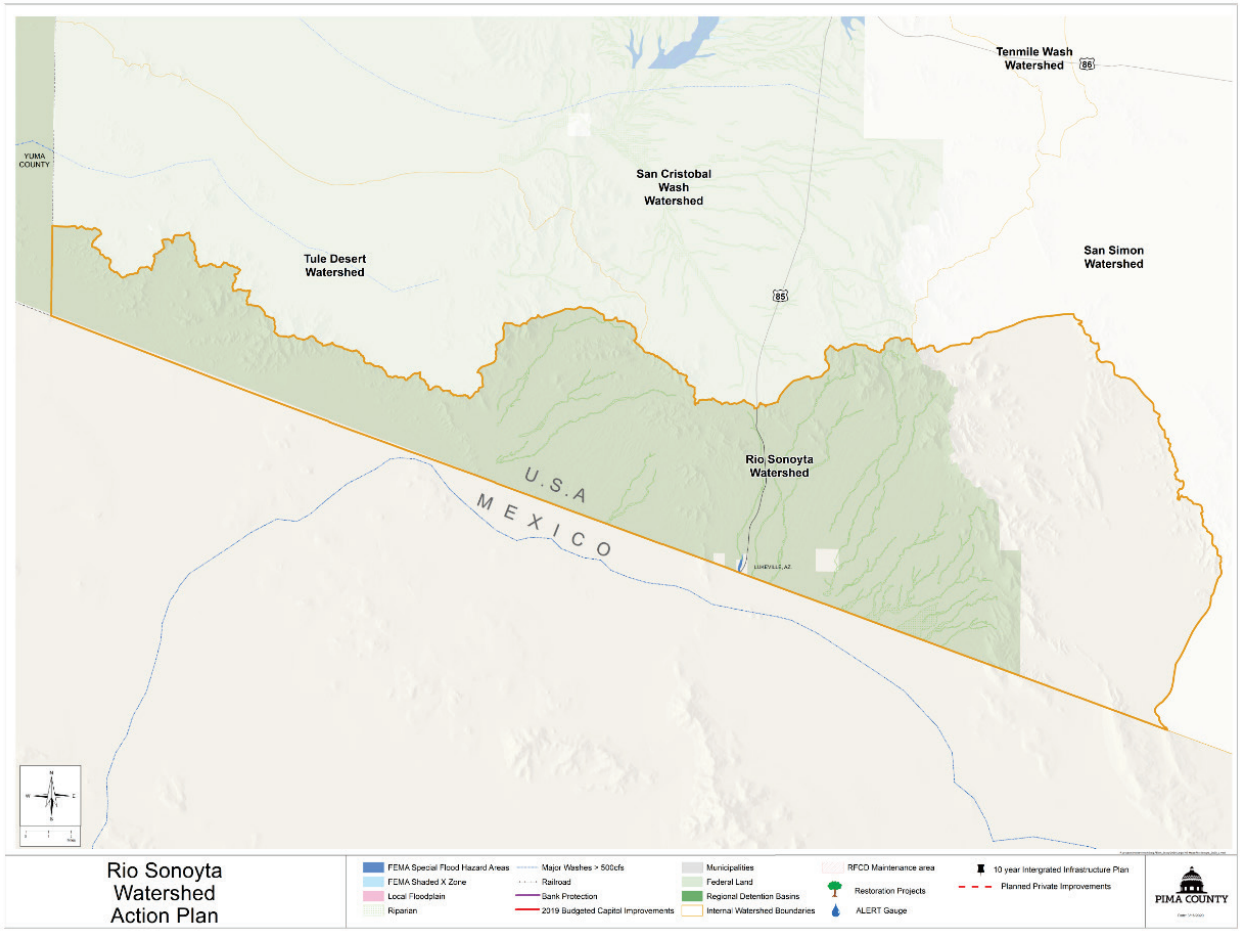


Figure 236 - Rio Sonoyta Action Plan Map

C.2.4 San Cristobal

The watershed includes the Growler Valley drainage system that extends from Ajo Mountain east of State Route 85 at the Western edge of the Tohono O'odham Nation across Valley of the Ajo, past the Growler Mountains and then Granite Mountains where it joins the San Cristobal. From these Valley Basins, this watershed then drains northward into Maricopa and Yuma Counties. The United States Geological Survey Near does not show San Cristobal Wash beyond the northwest terminus of the watershed as flows disappear into deep alluvium south of the theoretical confluence with the Gila River near Interstate 8, the communities of Dateland, Stoval, Mohawk and Kofa. Within Pima County, it is comprised of 579,168 acres (905 square miles).

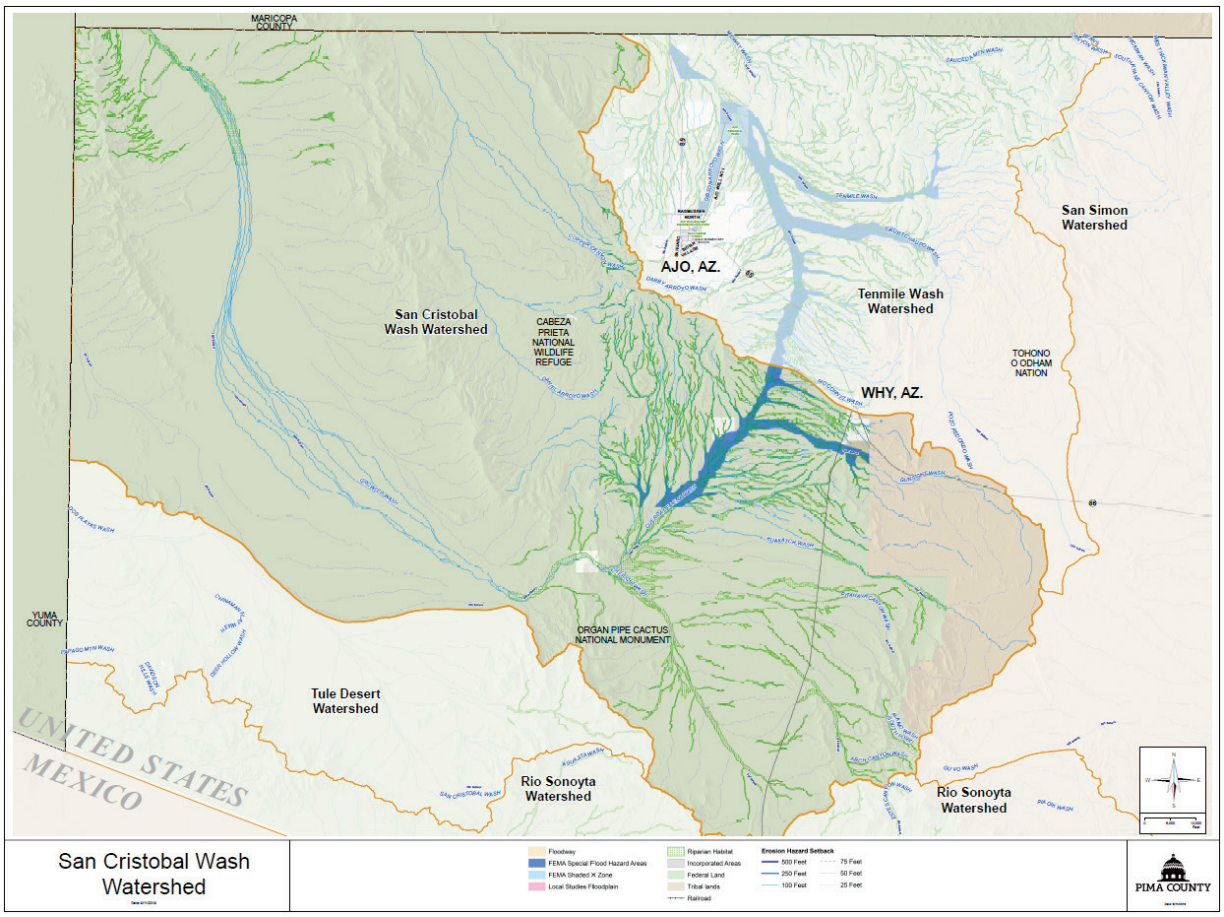


Figure 237 - San Cristobal Watershed Map

C.2.4.1 Flood Characteristics

There is 5,432 acres of SFHA Zone A and no other mapped floodplains in this watershed. The table below provides a summary of historic USGS gaging station records.

Tablee 238 - San Cristobal Watershed USGS Gages

USGS Gaging Station	**Alamo Wash TRIB near Ajo, AZ 09520300**
Period of Record	1963-08-15 to 1993-08-27
Watershed Area (sq. m)	.90
Flood Peak of Record (cfs)	510
Date	08-31-1972

There are no Pima County ALERT gages or regulatory discharges in this watershed.

C.2.4.2 Existing Development & Infrastructure Trends

Most of this watershed is located within the Cabeza Prieta Wildlife Refuge that is also a part of the Barry M Goldwater Missile Range and is therefore largely vacant.

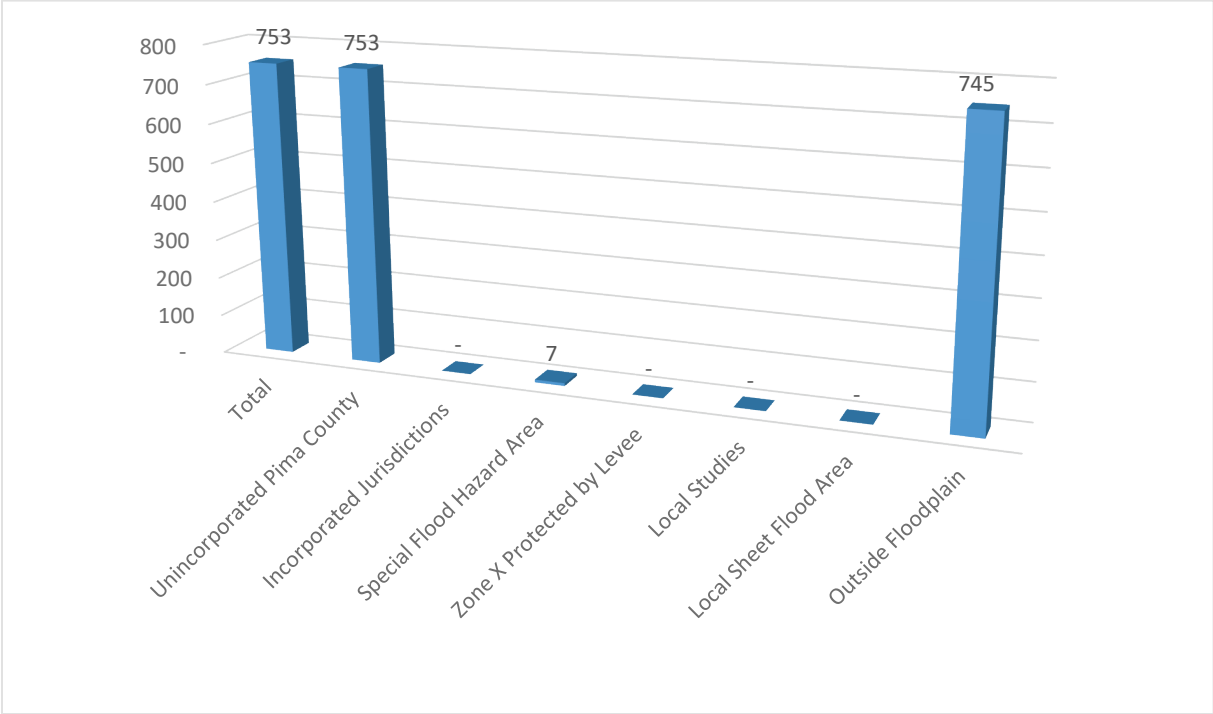


Figure 239 - San Cristobal Watershed Population Distribution

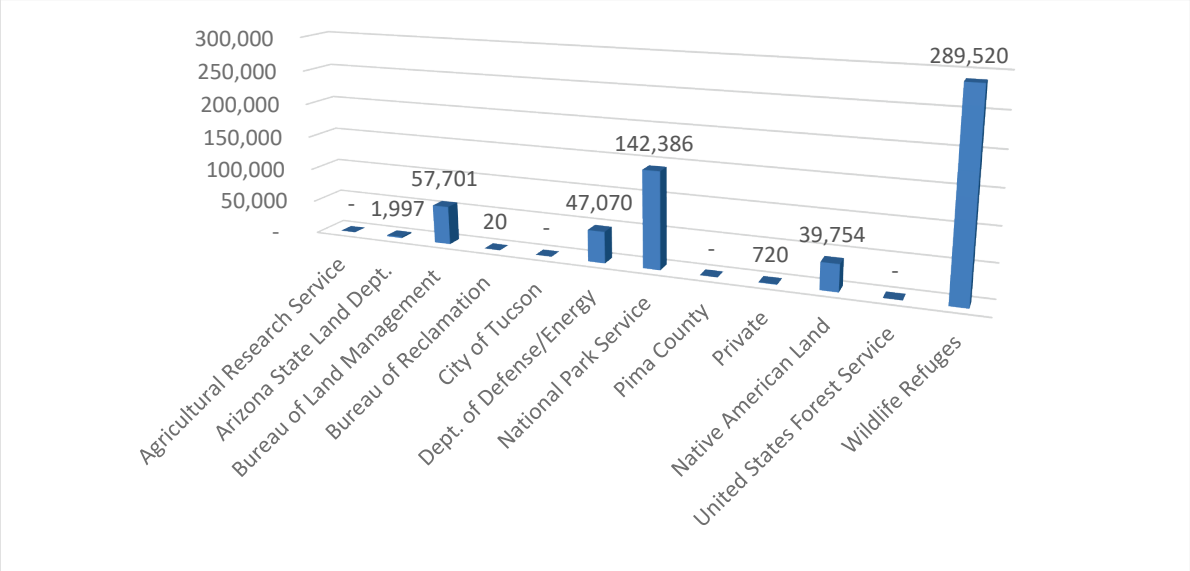


Figure 240 - San Cristobal Ownership in Acres

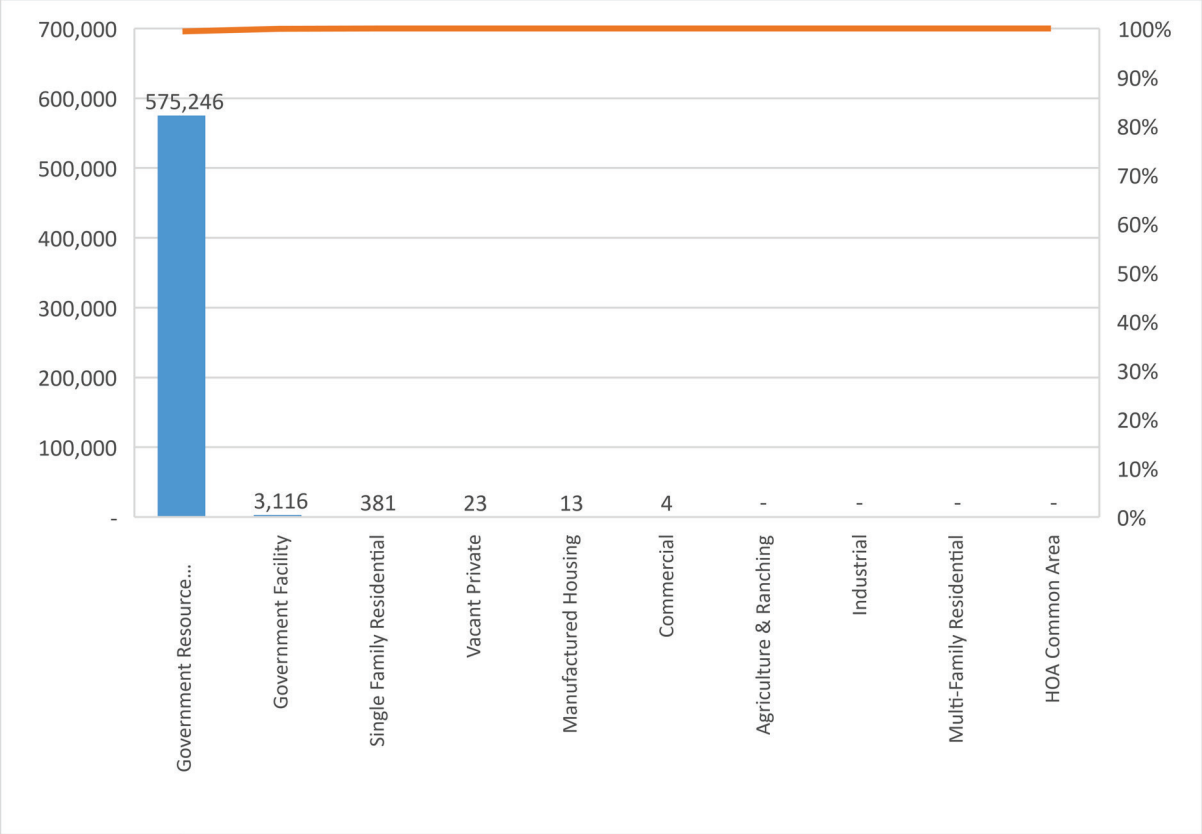


Figure 241 - San Cristobal Watershed Land Use in Acres

Government land uses predominate here and wildlife and Air Force practice space co-exist.

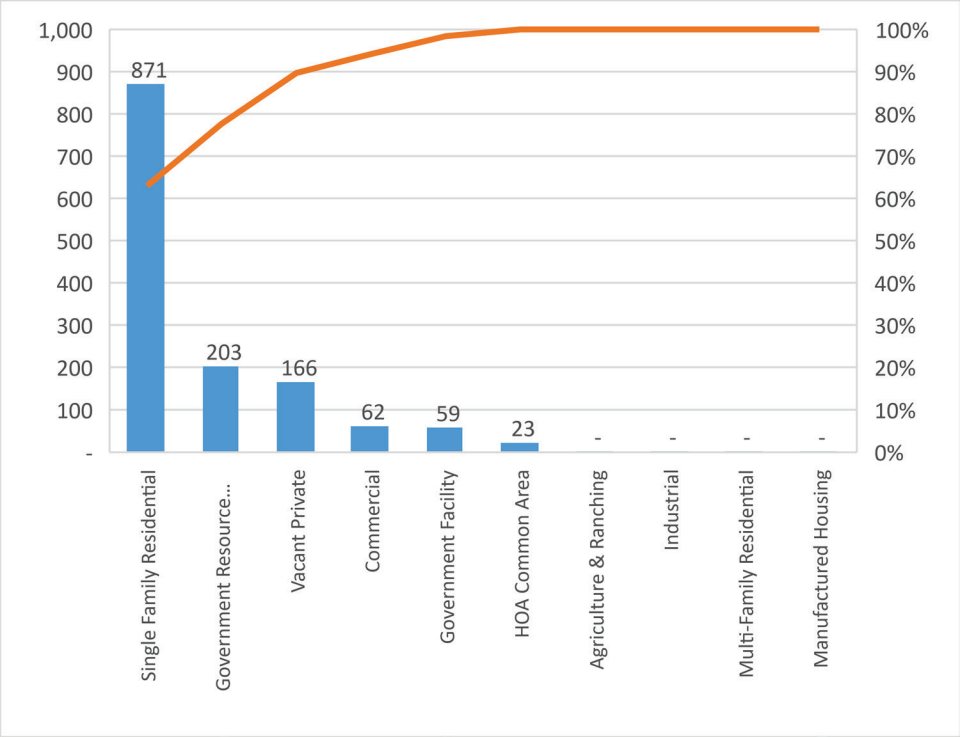


Figure 242 - San Cristobal Wash Floodplain Land Use

The chart below shows population distribution between incorporated and unincorporated areas. This chart also shows the distribution of residents within known floodplains.

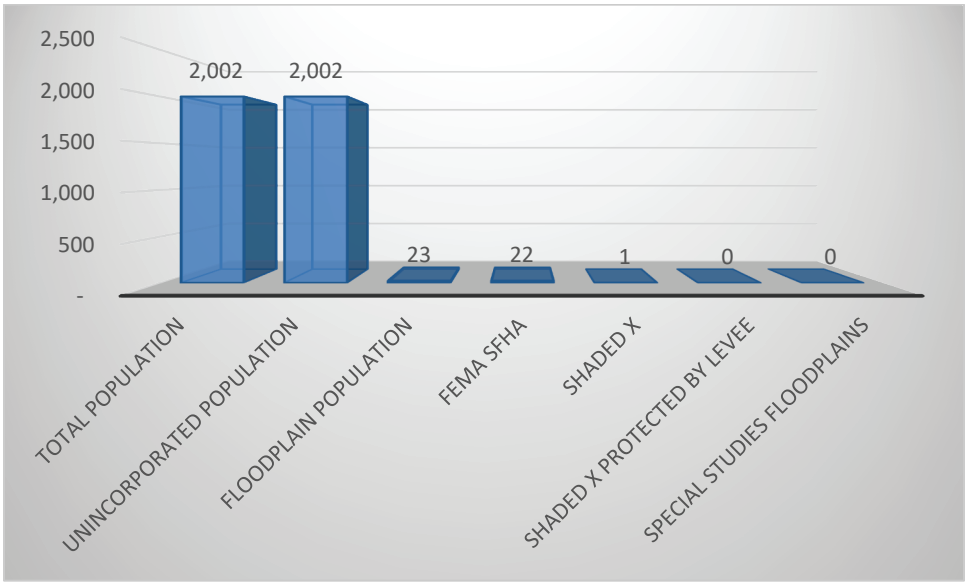


Figure 243 - San Cristobal Wash Watershed Population Distribution

As indicated on the Land Use map below the inhabited area is in the southern half of the community of Why. This town serves travelers including ex-patriots living in Mexico, border workers and a small number of seasonal residents.

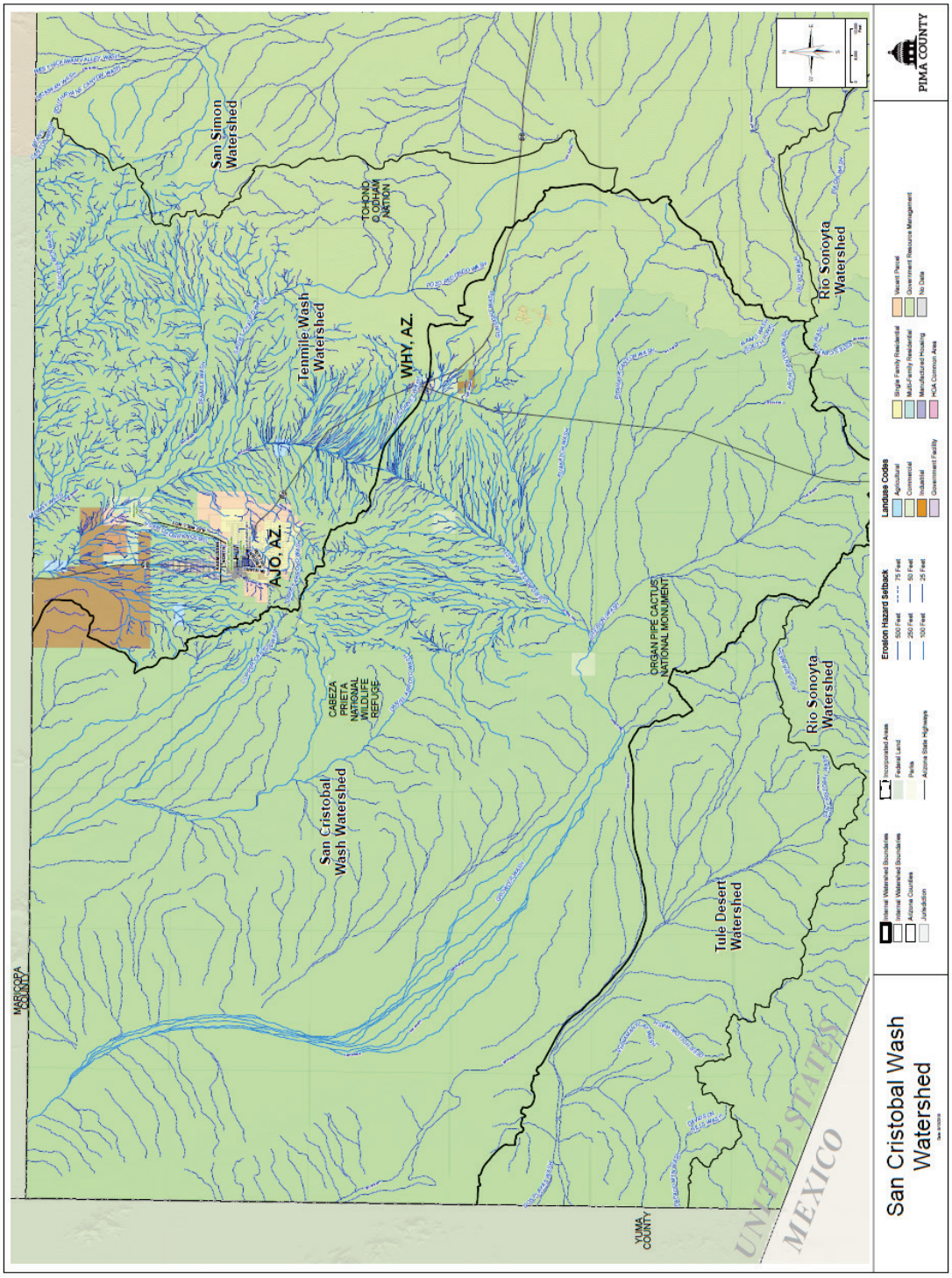


Figure 244 - San Cristobal Wash Watershed Land Use

C.2.4.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 20,538 acres of Pima County Regulated Riparian Habitat in this watershed. There are also 479,560 preserved acres in this watershed, and there is no regulatory floodplain.

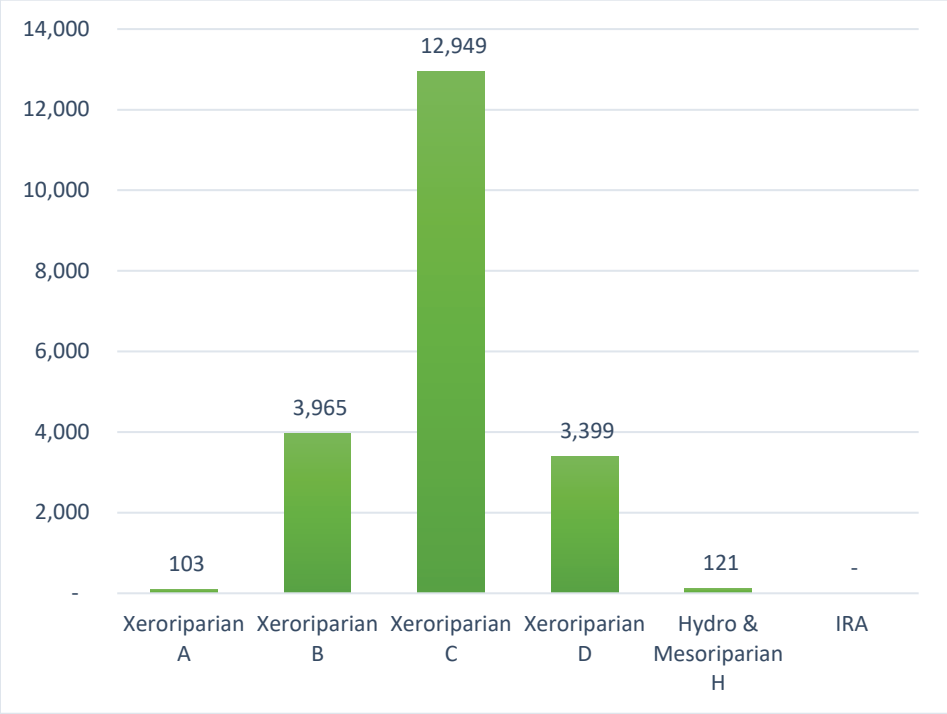


Figure 245 - San Cristobal Watershed Riparian Habitat in Acres

C.2.4.4 Historic Floodplain Management Approach

While there are no drainageways in this watershed, there is 479,561 acres of preserved open space that is 83% of the whole area.

C.2.4.5 Needs

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). This manual identifies no specific items of concern in this watershed.

C.2.4.6 Floodplain Management

Future needs identified by District staff include:

- Historic and ADOT Berms
- Unpermitted development

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Identify and conduct targeted outreach to areas which can get cut-off during flood events

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

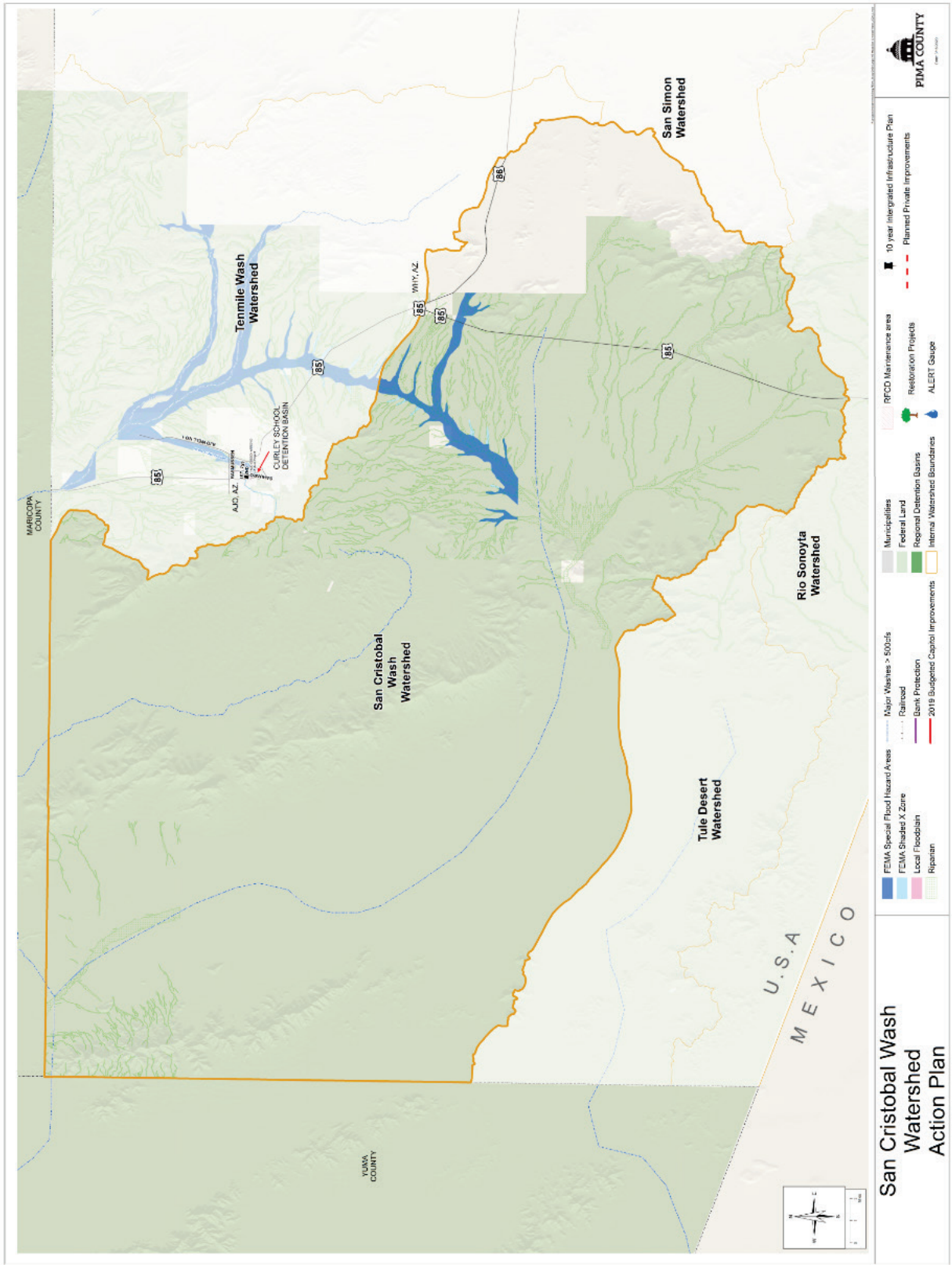


Figure 246 - San Cristobal Action Plan Map

C.2.5 San Pedro River

The River originates in Mexico south of the community of Palominas in Cochise County. It drains the eastern slopes of the Huachuca Mountains, and the western slopes of the Mule Mountains. Within this broad basin, the San Pedro passes the City of Sierra Vista and Tombstone, and drains the eastern slopes of the Whetstone Mountains, and the western slopes of the Dragoon Mountain range before passing under Interstate 10 at the Town of Benson. Running northward, it eventually enters Pima County south of Redington. Numerous tributaries contribute substantial flows from in the Santa Catalina, Rincon, Galiuro and Winchester Mountains. It exits Pima County into Pinal County south of the community of San Manuel. Within Pima County, it is comprised of 181,808 acres (284 square miles), while approximately 3100 square miles drain from the upstream watershed to Pima County.

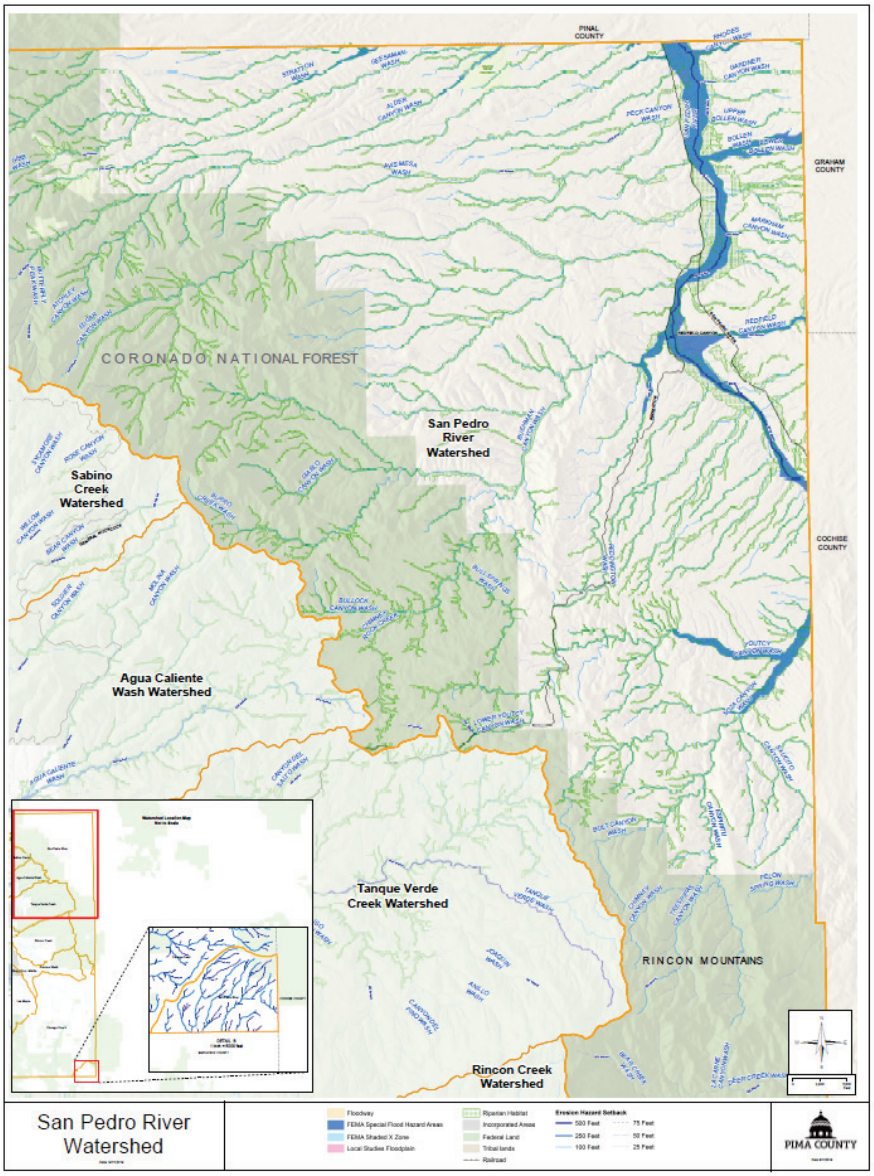


Figure 247 - San Pedro River Watershed Map

C.2.5.1 Flood Characteristics

In addition to 3,229 acres of SFHA Zone A, there are also 1,674 acres of sheet flood area in this watershed.

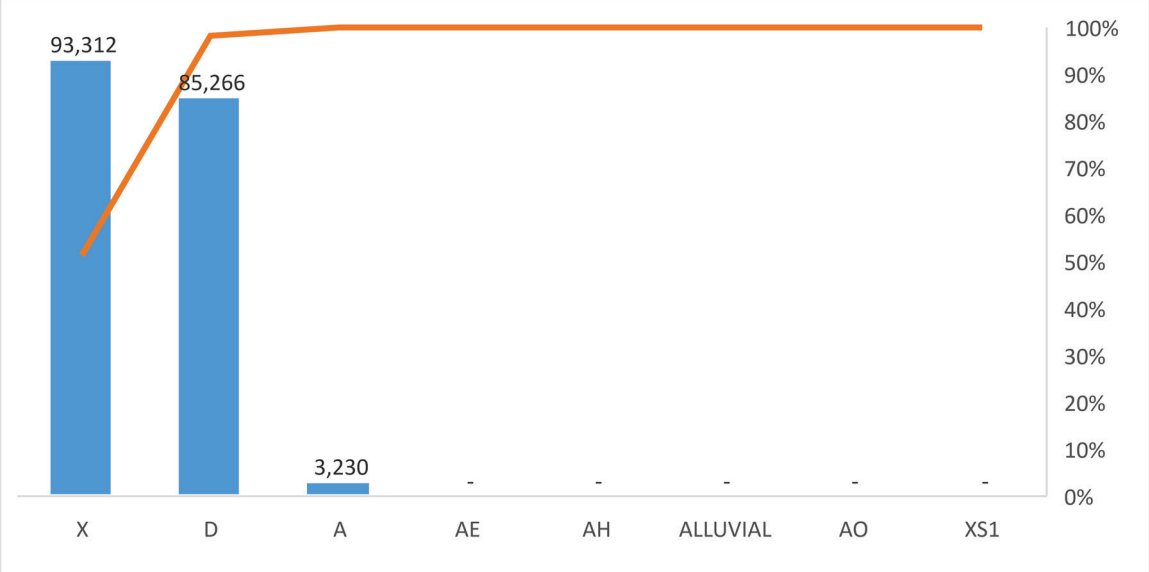


Figure 248 - Sand Pedro River Watershed Federal Floodplain Designations

The San Pedro River Watershed delineated encompasses a portion of the San Pedro River and numerous named washes including, Alder Canyon Wash, Bollen Wash, Buehman Wash, Edgar Canyon Wash, Redfield Canyon Wash, Redington Wash and Stratton Wash. The watershed is predominately undeveloped; the valley adjacent to the San Pedro River consists of farms and scattered residential uses. There is over 5000 ft. of overall elevation change in the watershed and watercourses are predominately natural.

The watershed contains the County owned 285-acre Bingham Cienega Natural Preserve, 6,258 acres of the A7 Ranch, and 3,330 acres of the Six Bar Ranch. Bingham Cienega consists of a spring-fed marsh, with perennial flow. The watershed lies within flood control jurisdiction of Pima County. Storms that would trigger flooding in the watershed include intense localized summer storms in the mountain tributaries and long duration winter storms within the upstream reaches of the San Pedro. The table below provides a summary of historic USGS gaging station records.

Table 65 - San Pedro River Watershed USGS Gages

USGS Gaging Station	San Predro River at Redington Bridge near Redington, AZ 09472050	Peck Canyon Tributary near Redington, AZ 09472100
Period of Record	1998-07-21 to current	1968-08-09 to 1981-07-20
Watershed Area (sq. m)	3096	8.02
Flood Peak of Record (cfs)	19600	4340
Date	9-20-2014	08-12-1972

There are no ALERT gauges in this watershed. The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 66 - San Pedro River Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
San Pedro River @ Redington Rd.	50,000		From Previous Discharge Table

The approximately 12,000 acres of County owned designated open space areas preserve habitat and reduce peak storm flows in the watershed.

Federal Insurance Rate Maps delineate Zone A for Alder Canyon Wash, Bollen Wash, Buehman Canyon Wash, Redfield Canyon Wash, Redington Wash, Rhodes Canyon Wash, Soza Canyon Wash, Stratton Wash, and Youtcy Canyon Wash.

C.2.5.2 Existing Development & Infrastructure Trends

The chart below shows population distribution between incorporated and unincorporated areas. This chart also shows the distribution of residents within known floodplains.

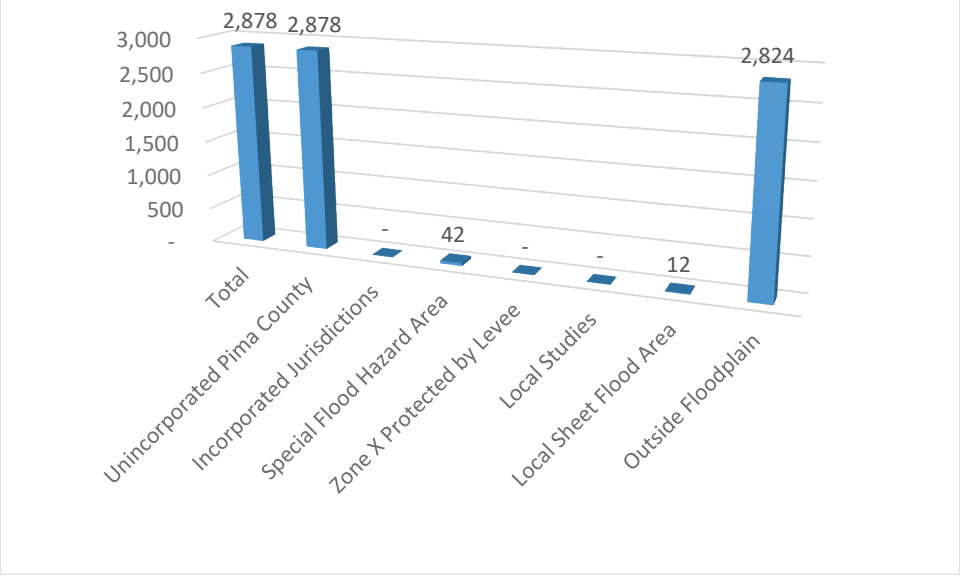


Figure 249 - San Pedro River Watershed Population Distribution

While this watershed includes many pristine tributaries within the Catalina and Rincon Mountains to the west, there is rural private and state land located along the river corridor. The County manages much of this state land as part of the Sonoran Desert Conservation Plan in order to preserve habitat, ranching heritage and water.

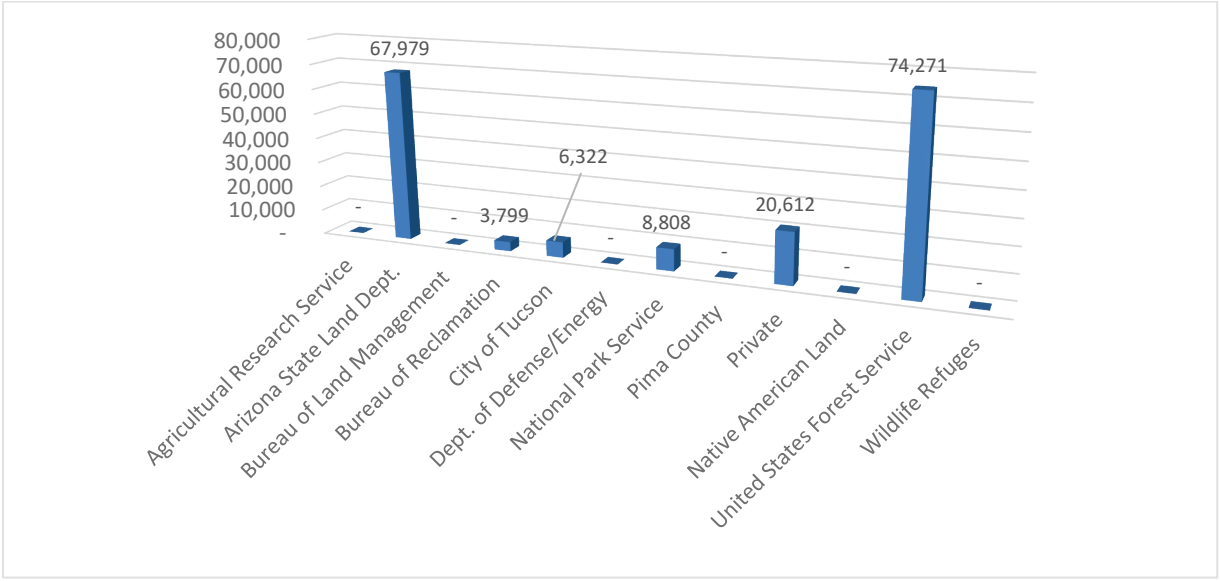


Figure 250 - San Pedro River Watershed Ownership in Acres

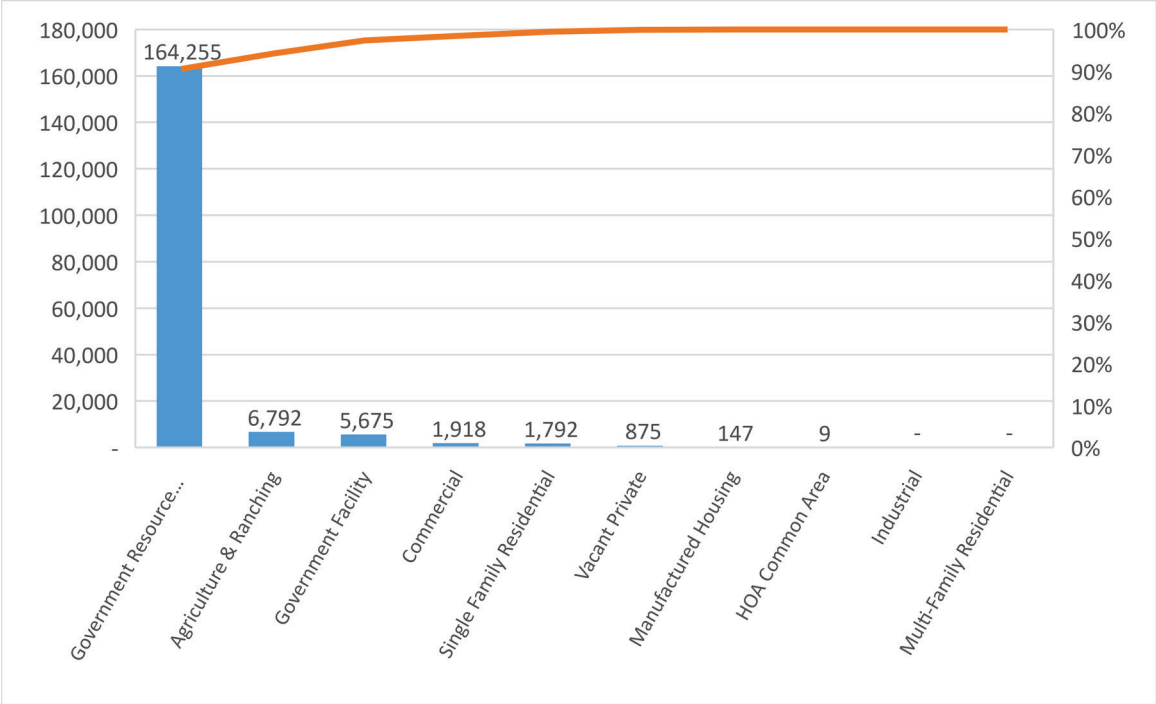


Figure 251 - San Pedro River Watershed Land Use in Acres

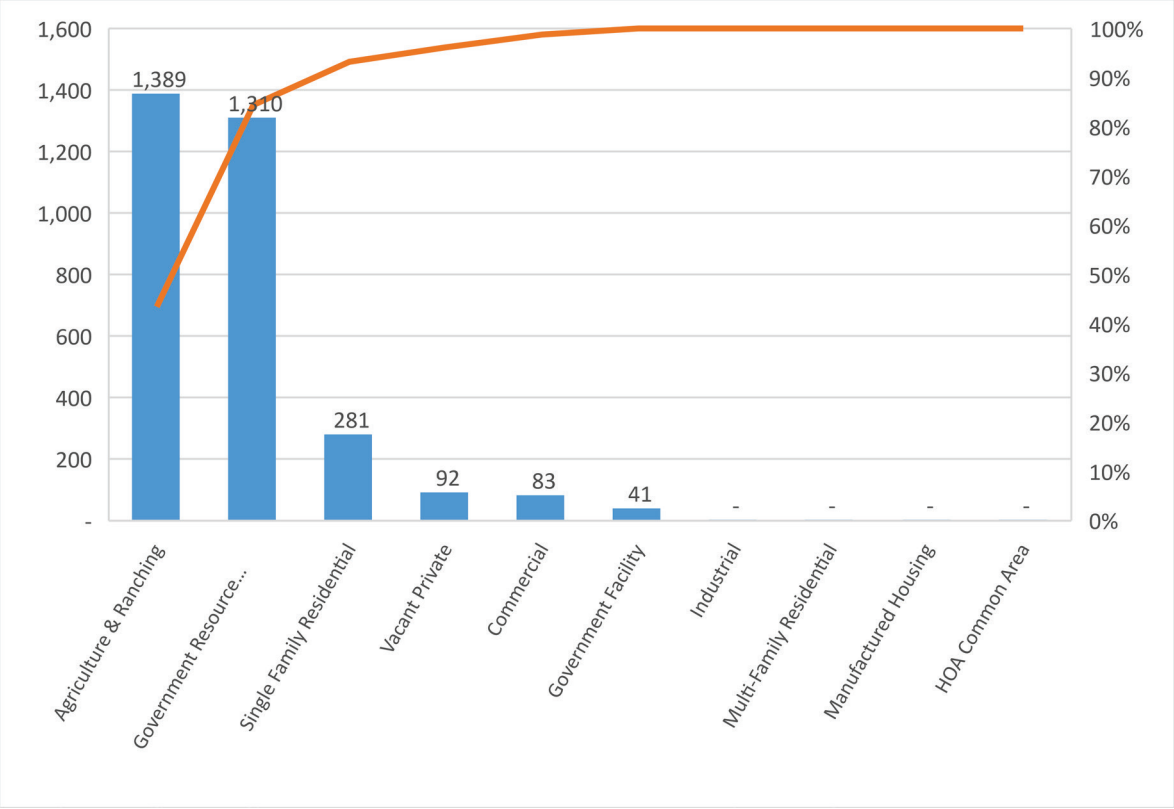


Figure 252 - San Pedro River Floodplain Land Use

As noted above the limited amount of developed private land along the river corridor is low-density residential uses and agriculture. The County has also preserved land as open space in the river floodplain via acquisition. The map below shows these land uses as well as relationship to other jurisdictions.

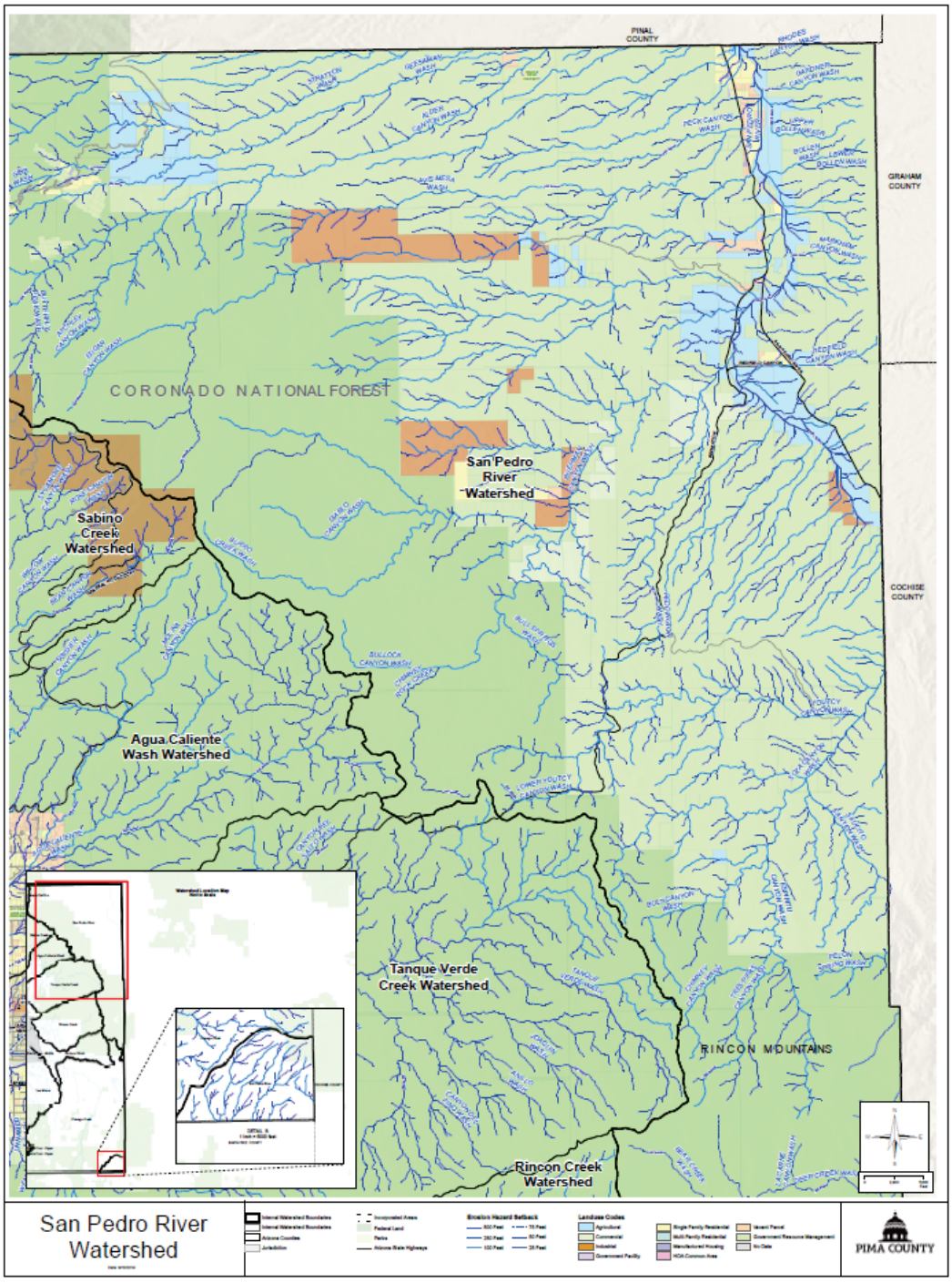


Figure 253 - San Pedro Land Use Map

C.2.5.3 Riparian Habitat and Natural Areas

As shown on the bat chart below there are 6,480 acres of Pima County Regulated Riparian Habitat in this watershed, and 8,874 acres of IRA. There are also 148,744 preserved acres in this watershed, including 854 in regulatory floodplain.

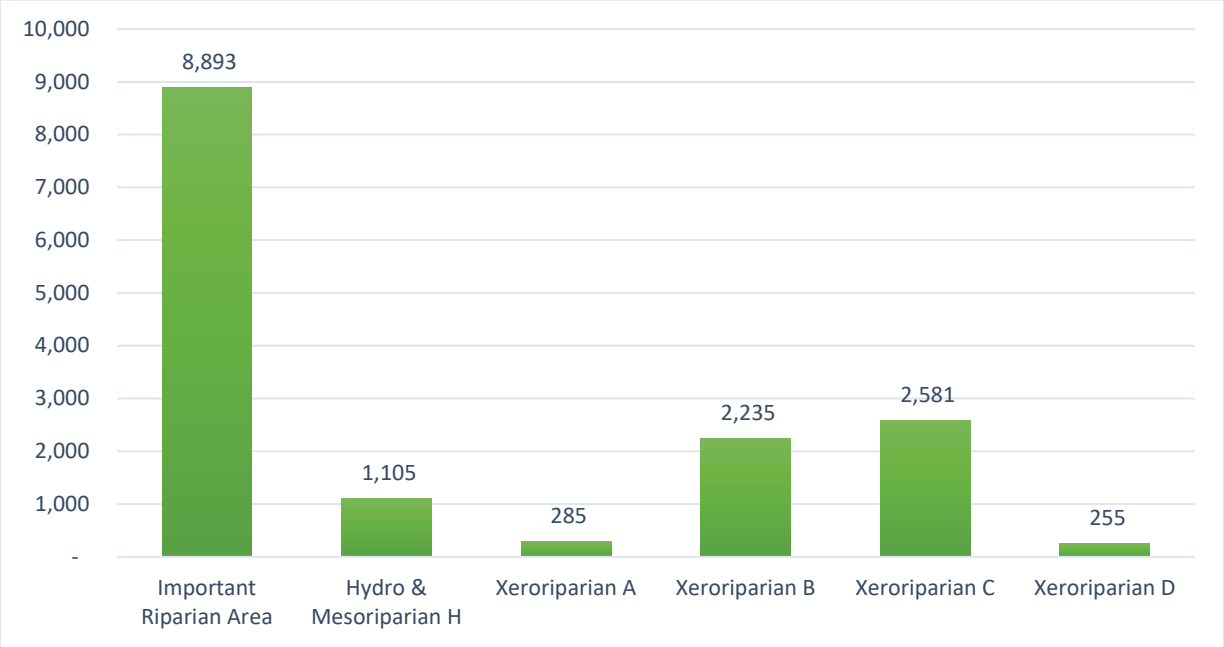


Figure 254 - San Pedro River Watershed Riparian Habitat in Acres

One of the ealiest ecosystem restoration projects done by the District is located on the Bingham Cienega Natural Preserve, located in the San Pedro floodplain north of Redington. Over the past 20 years, the natural spring on the property has gone dry and the water table continues to decline. The rich bosque and ash-cottowood forests are collapsing. The District has recently invested in creating defensible fire lanes and fire preparedness amenities. Resarch undertaken by the District and others indicated that the spring was primarily fed by Edgar and Buehman Canyon recharge mixed with adjacent San Pedro River sub-flow. The Bingham Cienega Natural Preserve and adjacent District and County owned properties were the first lands set aside as compensatory mitigation credit for Pima County's Section 10 permit and Multi-species Conservation Plan approved by the U.S. Fish and Wildlife Service.

Bingham Cienega

C.2.5.4 Historic Floodplain Management Approach

There are 303.8 acres of natural drainageways in this watershed all in unincorporated Pima County.

C.2.5.5 Needs

The District completed no projects during the prior five years, and none planned for the next five years. The 2019 *Flood Response Manual* identifies no specific items of concern in this watershed.

C.2.5.6 Floodplain Management

Future needs identified by District staff include:

- Access
- FLAP/Habitat Management
- Riparian disturbances rural uses
- Utility Corridor

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.1.c Operate, inspect and maintain Flood Control lands and facilities

- Create open space management plans

Ref# 2.2.c Conduct voluntary floodprone land acquisition program outreach to areas impacted by flooding

- Target floodways and flow corridor areas

Ref# 4.2.d Expand inundation mapping coverage for flood warning for use in flood warning system

- Create inundation mapping for Black Wash and Gibson Arroyo (BW, Ajo)

Ref#4.2.e Increase pre-event technical assistance to the Office of Emergency Management and first responders including identifying reliable all weather emergency response access routes

- Utilize new streamflow gages to warn emergency services of road closures on Silverbell Road (TM)

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Identify and conduct targeted outreach to areas which can get cut-off during flood events

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

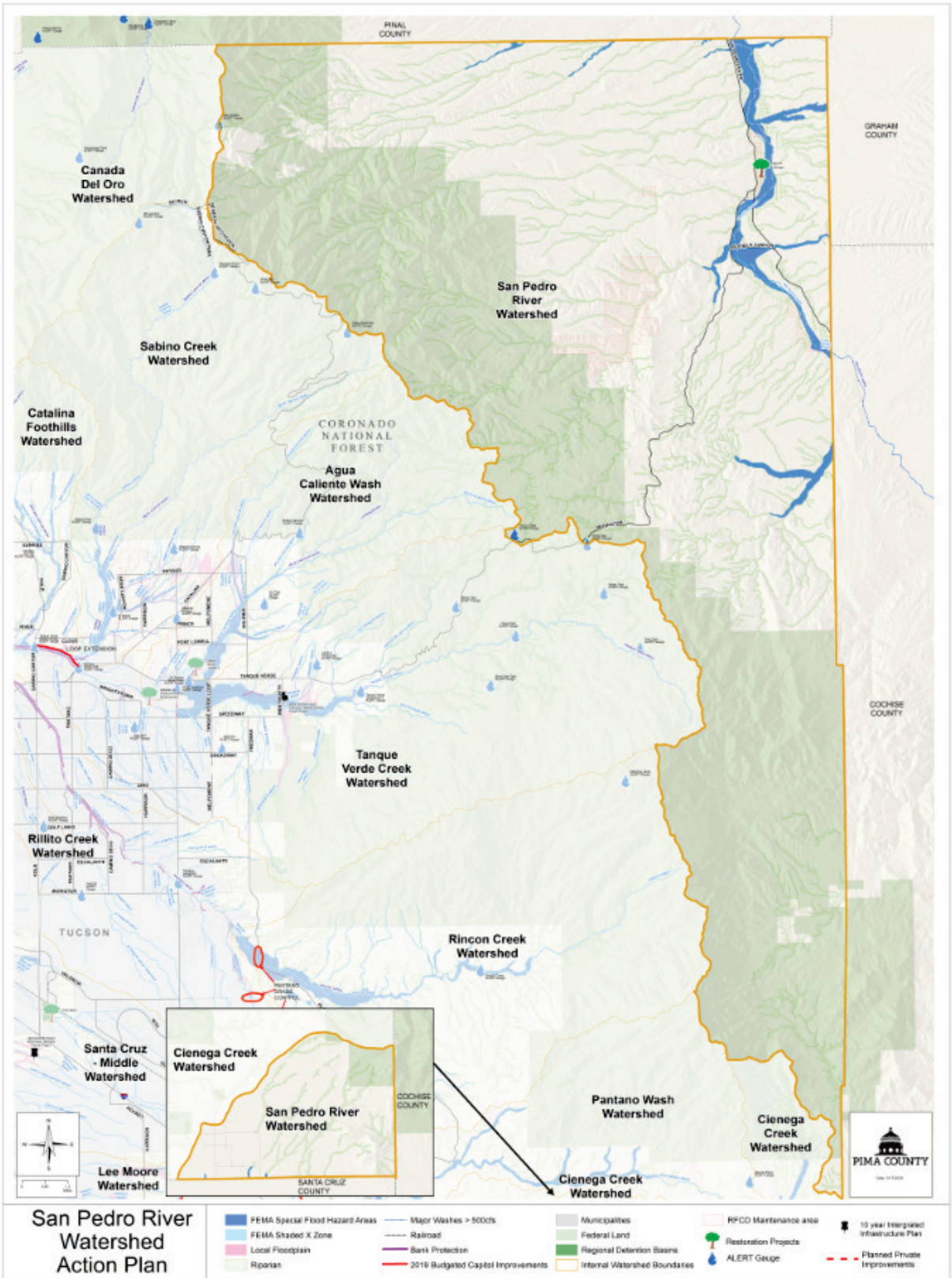


Figure 255 - San Padro River Action Plan Map

C.2.6 San Simon

The watershed and its namesake watercourse San Simon Wash originates just north of the County line in Maricopa County in the Sauceda Mountains and drains over 60 miles southward to Mexico. Its eastern edge is the Baboquivari Mountains over 60 miles to the east of the wash as it passes into Mexico. Almost, entirely within the Tohono O'odham Nation, within Pima County it is comprised of 1,370,641 acres (2,141.6 square miles).

Figure 256 – San Simon Watershed Map

C.2.6.1 Flood Characteristics

This watershed is almost entirely within the Tohono O'odham Nation, classified as Zone D indicating that it like other federal lands has not generally had flood risk mapping completed under the National Flood Insurance Program. Mining claim inholdings, that pre-date establishment of the Reservation system including Trust and Allotted Lands are also present.

The table below provides a summary of historic USGS gaging station records.

Table 67 - San Simon Watershed USGS Gages

USGS Gaging Station	Sells Wash TRIB at Sells, AZ 09535200	Vamori Wash at Kom Vo, AZ 09535300	San Simon Wash near Pisinimo, AZ 09535100
Period of Record	1962-09-26 to 1976	1972-08-10 to 2014-10-09	1972-08-09 to 2014-10-09
Watershed Area (sq. m)	26.80	1250	569
Flood Peak of Record (cfs)	2800	10400	12500
Date	09-13-1966	10-03-1983	09-24-1976

There are currently no Pima County ALERT gages or regulatory discharges in this area.

C.2.6.2 Existing Development & Infrastructure Trends

Population distribution between incorporated and unincorporated areas shown below. This chart also shows the distribution of residents within known floodplains.

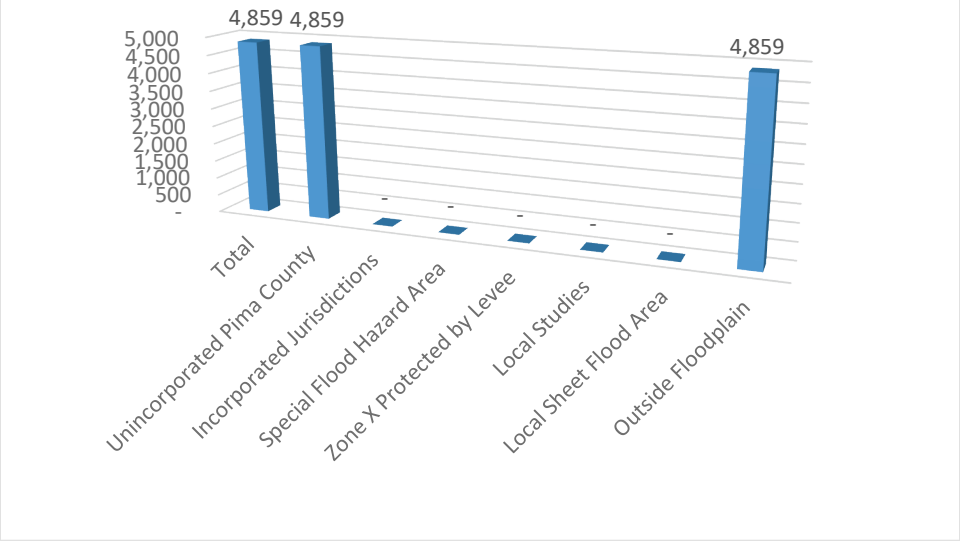


Figure 257 - San Simon Wash Watershed Population Distribution

This watershed is entirely within the Tohono O'odham Nation and therefore classified as vacant under the Pima County Assessor's Land Use Code. It includes housing, ranching, irrigated agriculture, a museum, college, hospital, long-term care and other facilities governed and operated by the Nation. This watershed includes the communities of Sells, San Simon, Pisinimo, Gu:Vo, Hickiwan and many others and extends from the Maricopa County line to Mexico encompassing over 50 by 50 miles. Manger's dam, a community in Go:Vo District is the site of a historic dam. In 2019, this dam overtopped and required sandbagging to prevent flooding of the village and communities in Mexico. The National Weather Service is coordinating a rainfall and streamflow monitoring system with the Nation's emergency responders.

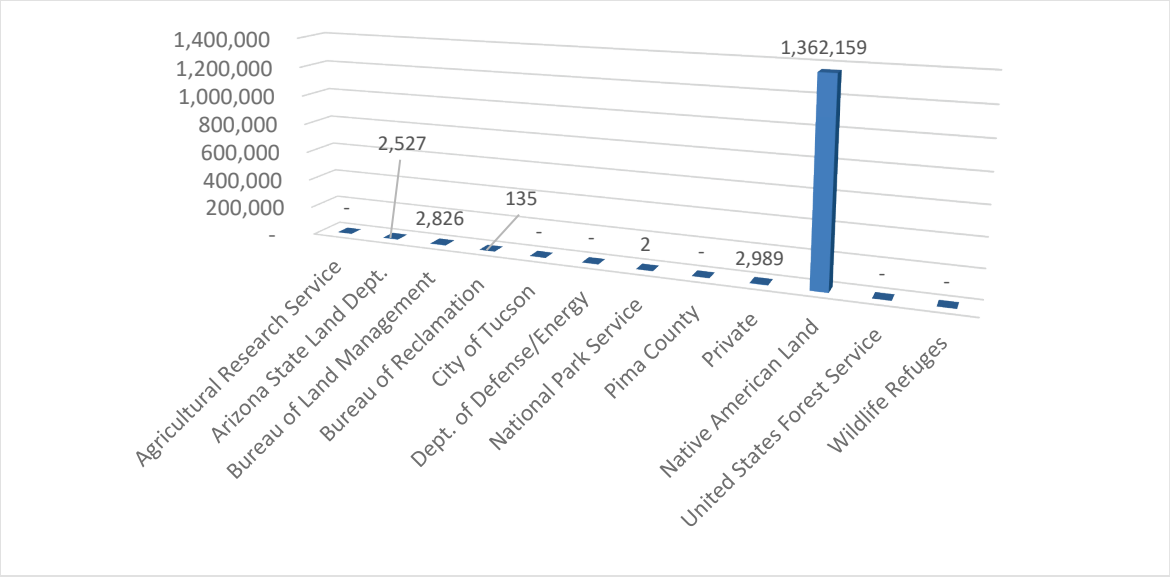


Figure 258 - San Simon Watershed Ownership in Acres

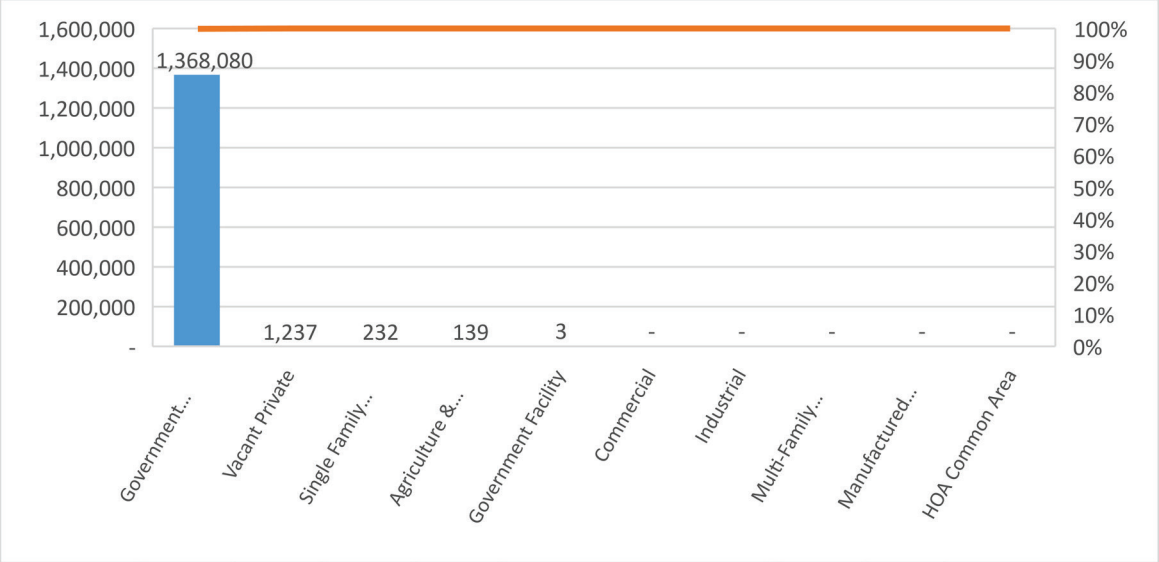


Figure 259 - San Simon Watershed Land Use in Acres

Because it is within federal land, FEMA has mapped no floodplains. The land uses on the chart includes areas of private land outside the Nation's boundary and a few inholdings. Many of the Nation's largest communities are within this watershed including the capitol Sells, traditionally known as Turtle Got Stuck. Sells includes the hospital, schools, waste treatment facilities, and extensive housing. Traditionally the O'odham were floodwater farmers. Flooding still affects many of the tribal communities. The Nation has participated in development of the Pima County Inter-Jurisdictional Multi-Hazard Mitigation Plan in the past and has embarked upon significant roads improvements including those completed in cooperation with the State of Arizona on Route 86. This has greatly improved all accessibility during times of flooding for residents of the unincorporated portions of the County west of the reservation. The map below shows land uses within the limited amount of unincorporated area.

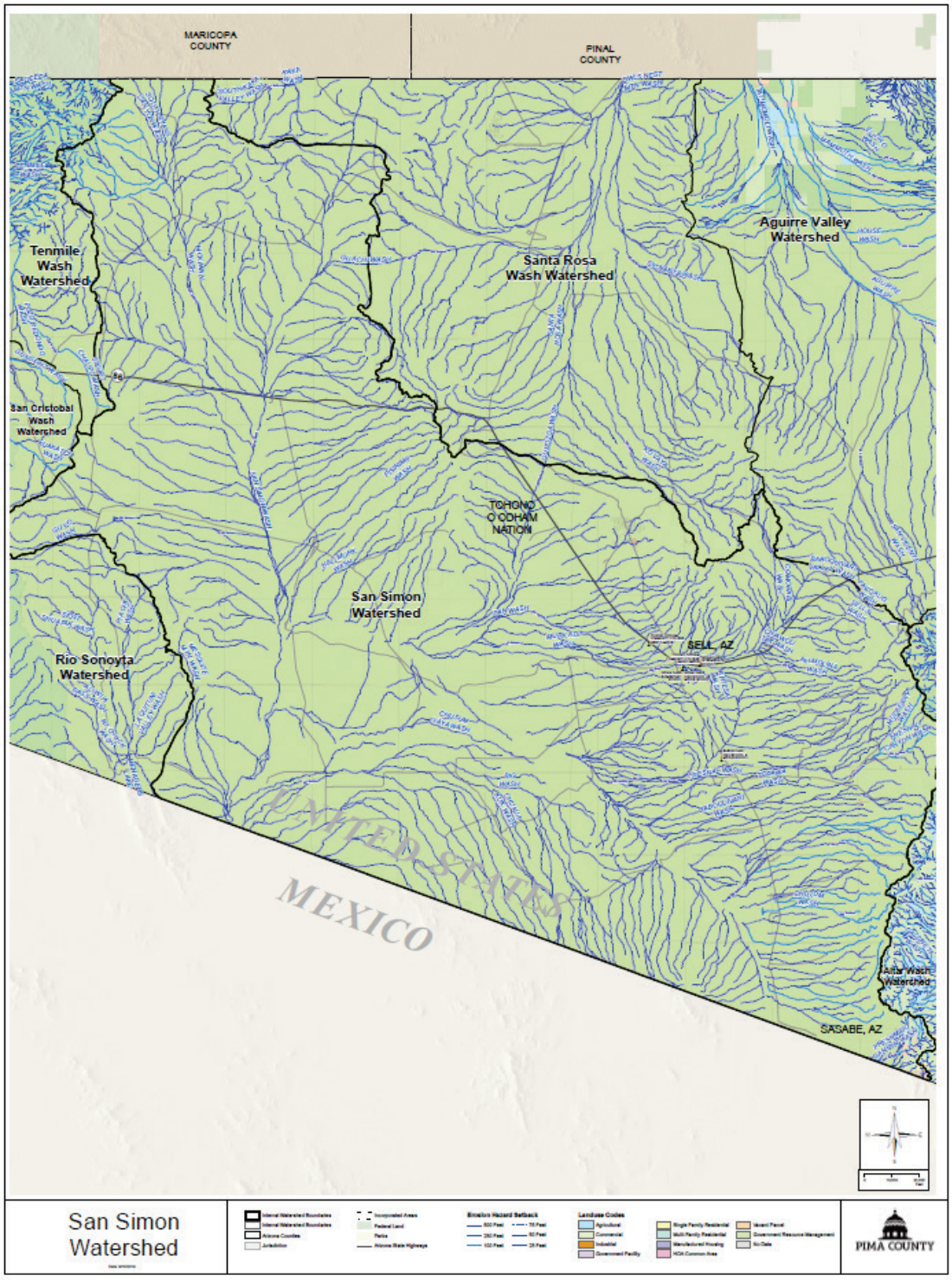


Figure 260 - San Simon Land Use

C.2.6.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 255 acres of Pima County Regulated Riparian Habitat in this watershed, and 115 acres of IRA. There are also 44 preserved acres in this watershed and there is no regulatory floodplain.

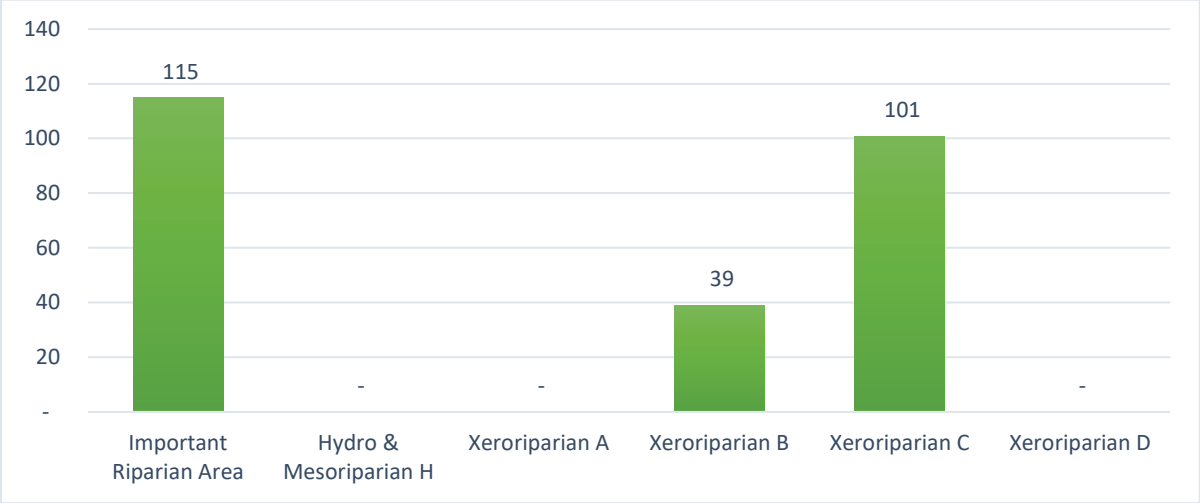


Figure 261 - San Simon Watershed Riparian Habitat in Acres

It is interesting to note that the area around the confluence of the two major watercourses within this watershed is a significant and diverse bosque.

Satellite Image of Bosque at the Confluence of the Vamori and San Simon Wash

C.2.6.4 Historic Floodplain Management Approach

The watershed is almost entirely within the Tohono O'odham Nation and there is no District maintenance responsibility.

C.2.6.5 Needs

The District completed no projects during the prior five years, and none planned for the next five years. The 2019 *Flood Response Manual* identifies no specific items of concern in this watershed.

C.2.6.6 Floodplain Management

Although this watershed is entirely within the Tohono O'odham Nation (Nation) and therefore access was the only future need identified, it is also worth noting that the Arizona Department of Transportation has completed significant improvements to State Highway Route 86 that traverses the Nation. This includes replacement of numerous dip sections with culverts and bridges as well as addition of fencing and wildlife crossings. While this has greatly improved all weather, accessibility to western Pima County many villages within the Reservation remain isolated during flood events. The Nation has also completed improvements along Route 86 to improve accessibility and reduce flooding from Gunsight Wash in the village of Schuchulik just east of Why.

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.2.e Participate in monitoring groundwater change with other responsible parties

- Conduct groundwater depth & quality monitoring

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Identify and conduct targeted outreach to areas which can get cut-off during flood events

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

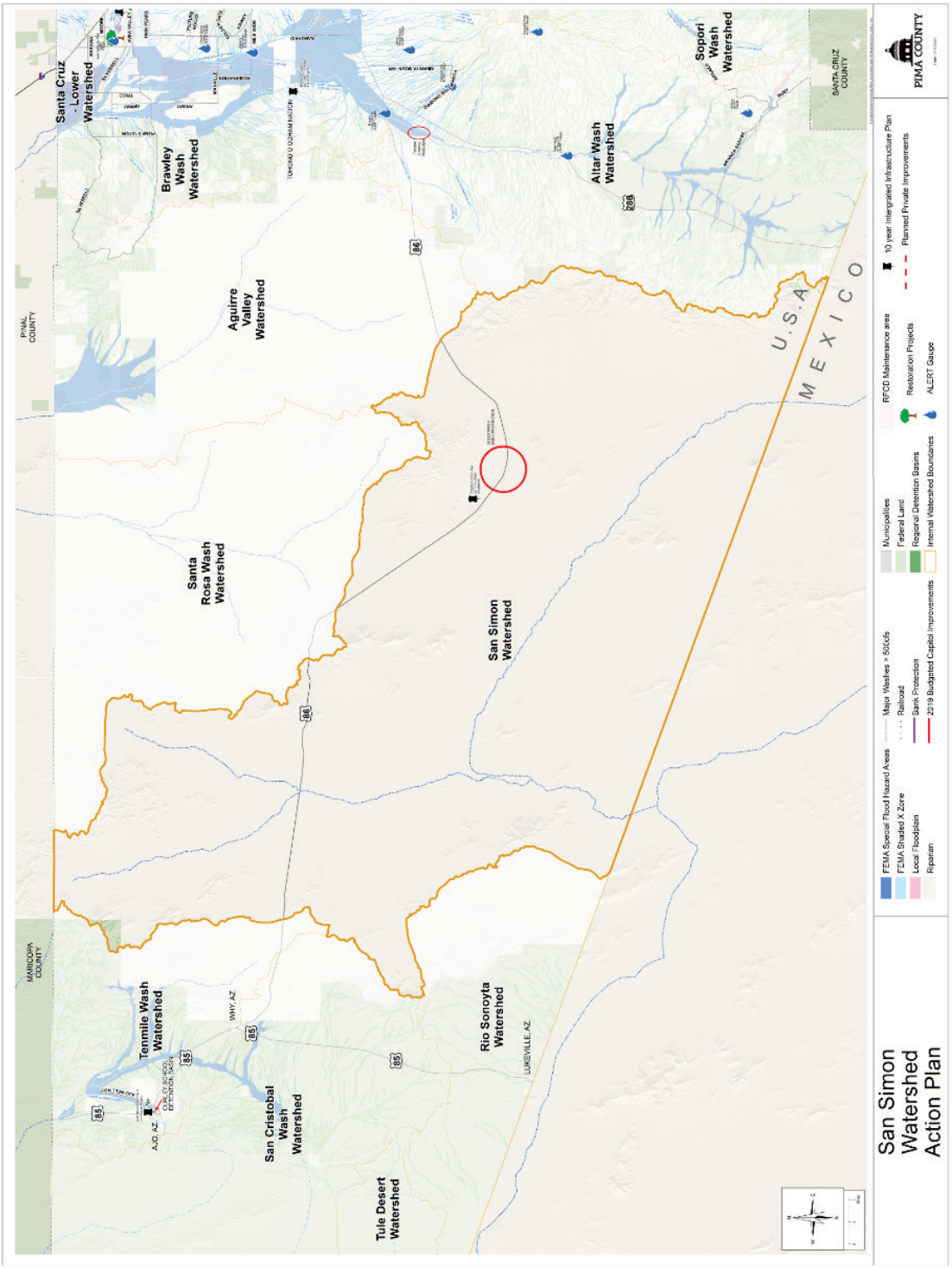


Figure 262 - San Simon Action Plan Map

C.2.7 Santa Rosa Wash

The watershed and its namesake watercourse, the Santa Rosa Wash, originate just north of the Tohono O'odham Community of Sells in the Comobabi and Quijotoa Mountains. It feeds the mostly dry, Lake St. Claire, site of one of the longest earthen dams in the world according to Tribal authorities. It is the location of O'odham farming operations, which have been ongoing for centuries. It drains northward to Pinal and Maricopa County where it joins the Santa Cruz River northwest of the City of Casa Grande. Almost entirely within the Tohono O'odham Nation, the portion within Pima County is comprised of 449,904 acres (703 square miles).

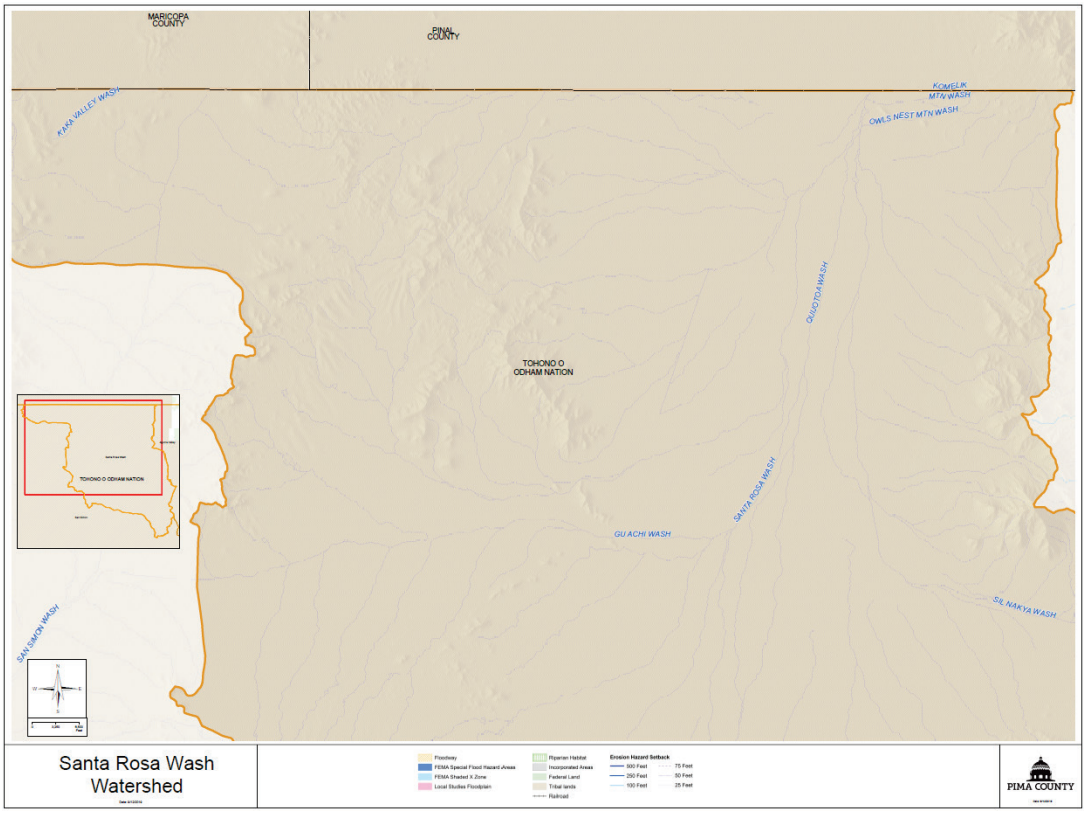


Figure 263 - Santa Rosa Wash Watershed Map

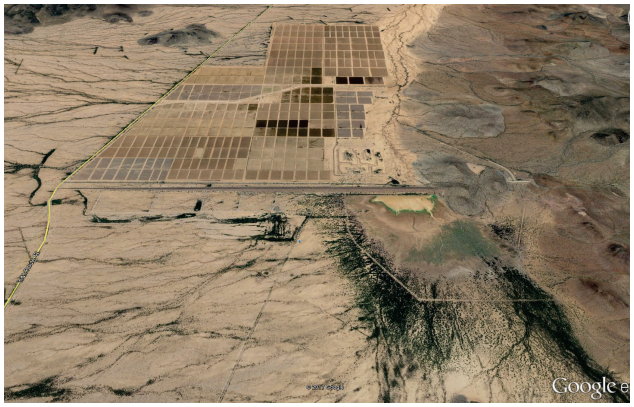


Figure 264 - Aerial Photograph of O'odham farms at Tat Mamolikit Dam

C.2.7.1 Flood Characteristics

This watershed is almost entirely within the Tohono O'odham Nation and therefore classified as Zone D, indicating that it like other federal lands has not generally had flood risk mapping completed under the National Flood Insurance Program. Construction of Tat Momolokit Dam included flow gauge installation. The table below summarizes historic USGS gaging station records.

USGS Gaging Station	**Quijotoa Wash TRIB near Quijotoa, AZ 09487400**
Period of Record	1963 to 1975-08-26
Watershed Area (sq. m)	2.44
Flood Peak of Record (cfs)	715
Date	07-24-1964

The data from the USGS suggests that Tropical storms have caused the largest floods. There are currently no Pima County ALERT gages or regulatory discharges in this watershed. The Tohono O'odham Nation operates a network of gages however, tribal authorities have not granted access to these records.

C.2.7.2 Existing Development & Infrastructure Trends

The graph below shows population distribution between incorporated and unincorporated areas. This chart also shows the distribution of residents within known floodplains.

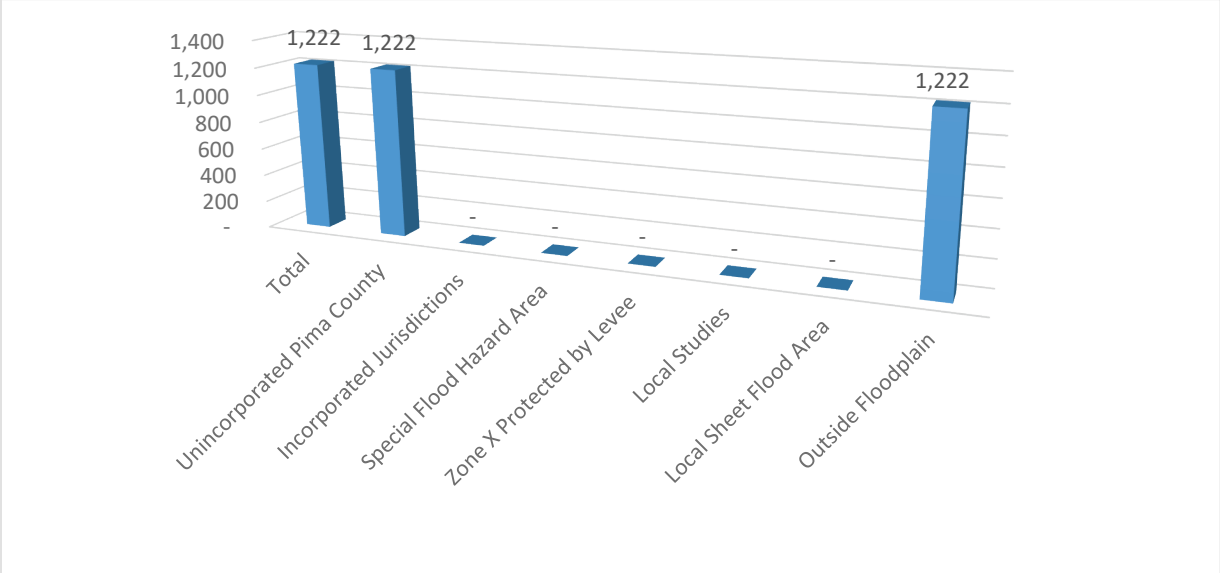


Figure 265 - Santa Rosa Wash Watershed Population Distribution

This watershed is entirely within the Tohono O'odham Nation and therefore classified as vacant under the Pima County Assessor's Land Use Code. It includes housing, ranching, irrigated agriculture, a nursing home and mines governed by the Nation.

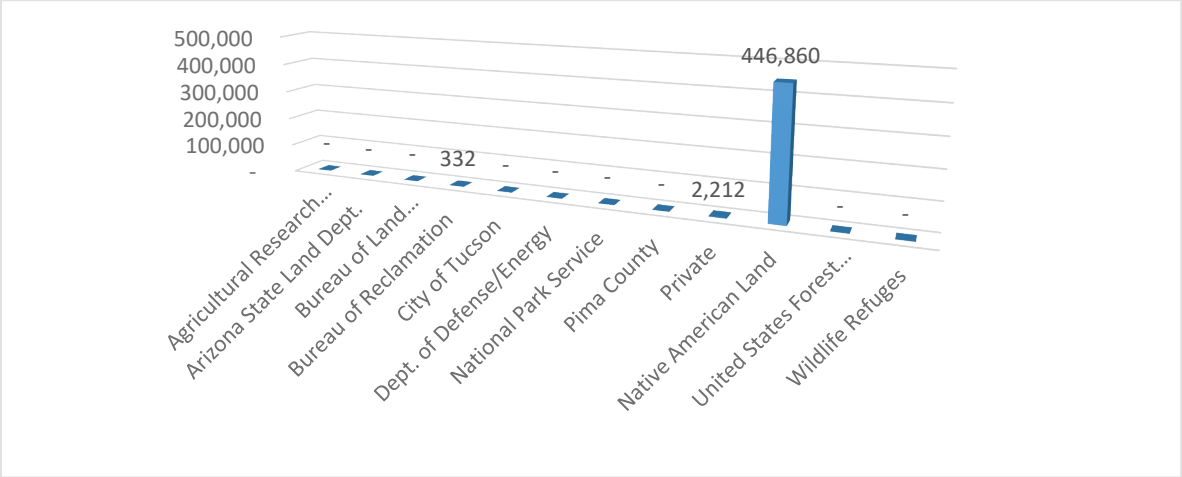


Figure 266 - Santa Rosa Wash Watershed Ownership in Acres

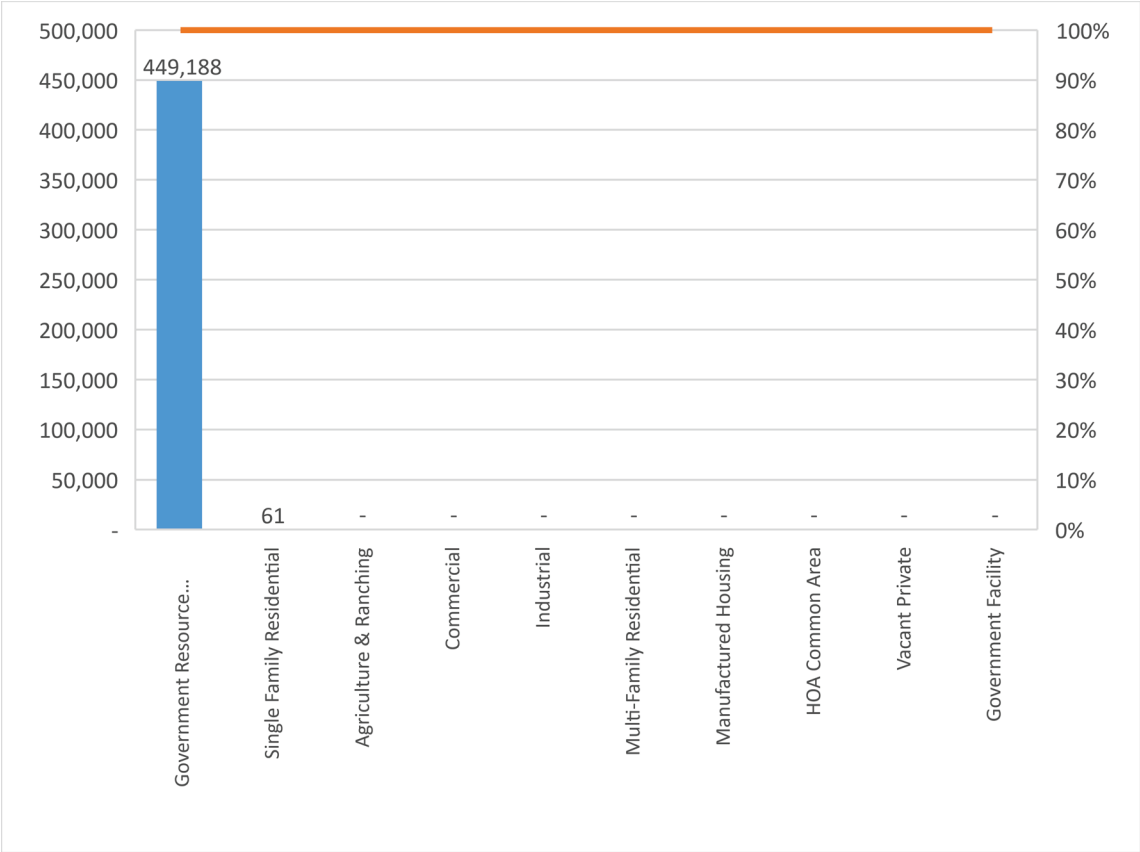


Figure 267 - Santa Rosa Wash Watershed Land Use in Acres

FEMA does not provide flood insurance rate maps for this area because it is within federal land. Traditionally the O'odham were floodwater farmers and therefore floods continue to affect their communities. The Nation has participated in development of the Pima County Inter-Jurisdictional Multi-Hazard Mitigation Plan and has embarked upon significant roads improvements including those completed in cooperation with the State of Arizona on Route 86 and the Bureau of Indian Affairs along Indian Route 15. This has greatly improved all accessibility during times of flooding for residents of the unincorporated portions of the County west of the reservation.

C.2.7.3 Riparian Habitat and Natural Areas

Santa Rosa wash watershed is entirely within the Tohono O'odham Nation and as such, the District has not mapped habitats for regulatory purposes.

C.2.7.4 Historic Floodplain Management Approach

Because the watershed is entirely within tribal lands. There are no drainageways or preserved open spaces in this watershed within District control. For the O'odham floodwater, farming is a traditional way of life. Record of some of the longest continual agricultural use in the world exits there. Many villages are therefore located in floodplains, which traditional agricultural practices changed. Furthermore, traditionally the O'odham have built homes at grade. These communities are also very remote along long stretched of paved and unpaved roads lacking adequately sized bridges. With tribal involvement in transportation infrastructure, this has begun to change however; all-weather access remains a problem.

C.2.7.5 Needs

The 2019 *Flood Response Manual* identifies no specific items of concern in this watershed. Although this watershed is entirely within the Tohono O'odham Nation (Nation), voters approved a Bond project in 2004. The Nation completed phase one of this project substantially under budget. It consisted of a system of storm drains and basins for the Sells community. The project helped resolve flooding issues at the Indian Oasis School, Johnson O'Malley Library, recreation center, government offices and Veteran's Memorial. Phase 2, the Natural Resources Conservation District (NRCS) has designed bank protection for the Sells Wash for completion with the remaining funds however; the Tribe has yet to implement an Intergovernmental Agreement in order to complete construction.

It is also worth noting that the Arizona Department of Transportation has completed significant improvements to State Highway Route 86 that traverses the Nation. This includes replacement of numerous dip sections with culverts and bridges as well as addition of fencing and wildlife crossings. While this has greatly improved, accessibility in all weather, to western Pima County many villages within the Reservation remain isolated during flood events and this is particularly true here.

C.2.7.6 Floodplain Management

This report identifies no future needs as the entire watershed is within the Tohono O'odham Nation with the exception of ALERT coordination.

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 4.2.c Expand and update the District's flood threat recognition and integrate it with warning system

- Coordinate with other jurisdiction including the Tohono O'odham Nation on flood warning needs

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Identify and conduct targeted outreach to areas which can get cut-off during flood events

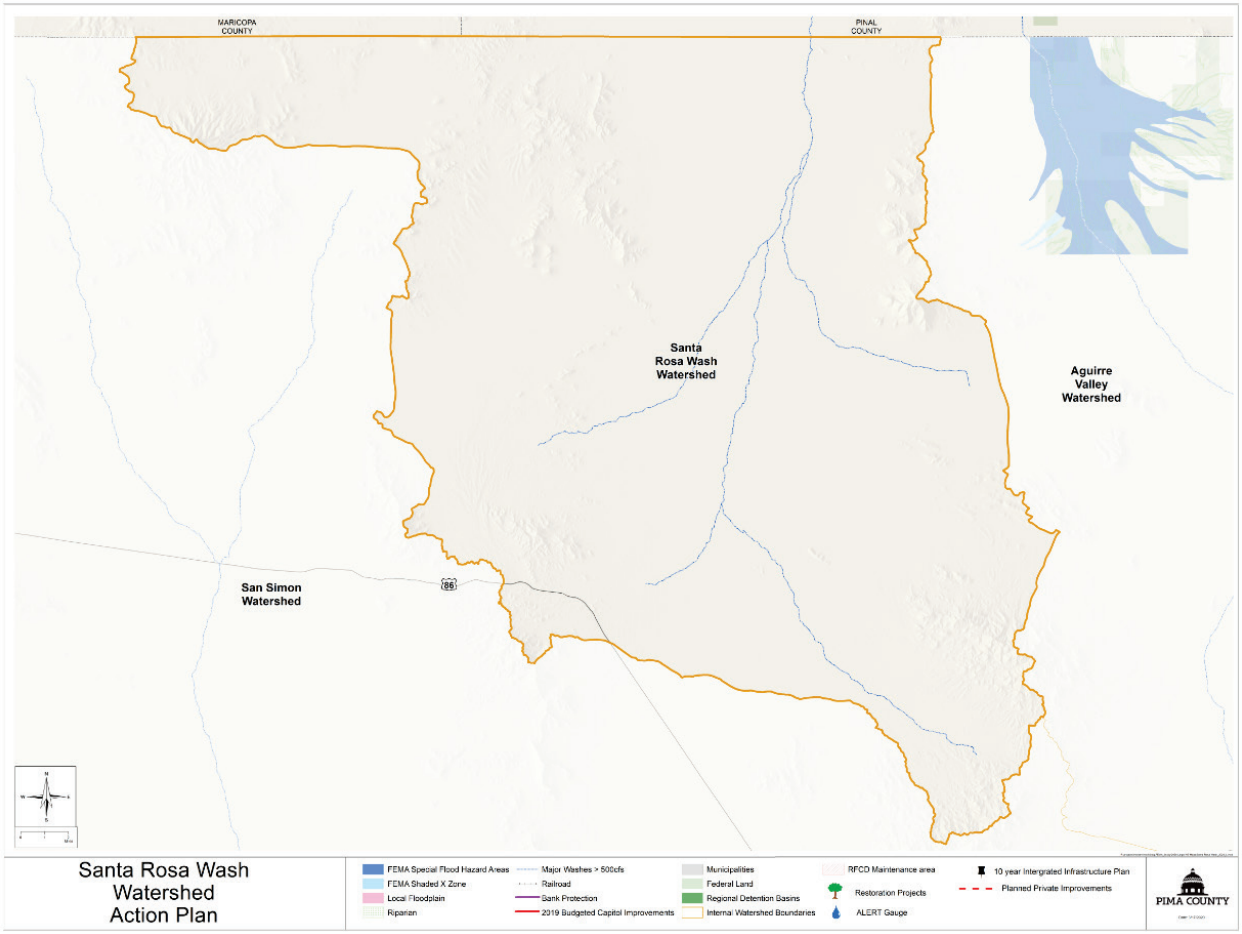


Figure 268 - Santa Rosa Wash Action Plan

C.2.8 Sopori Wash

This watershed originates in Santa Cruz County on the western slopes of the Tumacacori Mountains, passes the eastern slopes of the Cerro Colorado, and then joins the Upper Santa Cruz River at Arivaca Junction. Within Pima County, it is comprised of 80,756 acres (126 square miles).

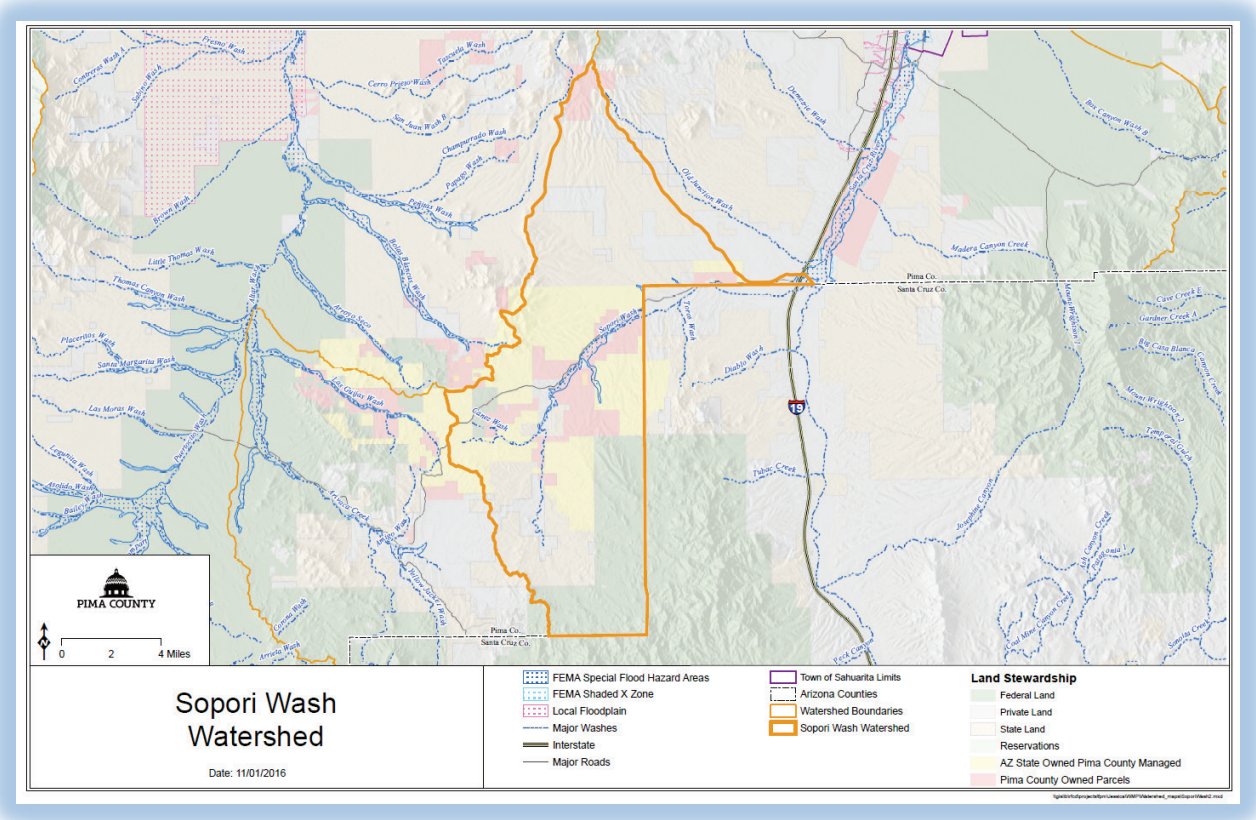


Figure 269 - Sopori Wash Watershed Map

C.2.8.1 Flood Characteristics

There are 1,130 acres of SFHA Zone A in this watershed. In September 2018 the community of Arivaca Junction experienced significant flooding and the District and Santa Cruz County are working on assessing these floodplains further.

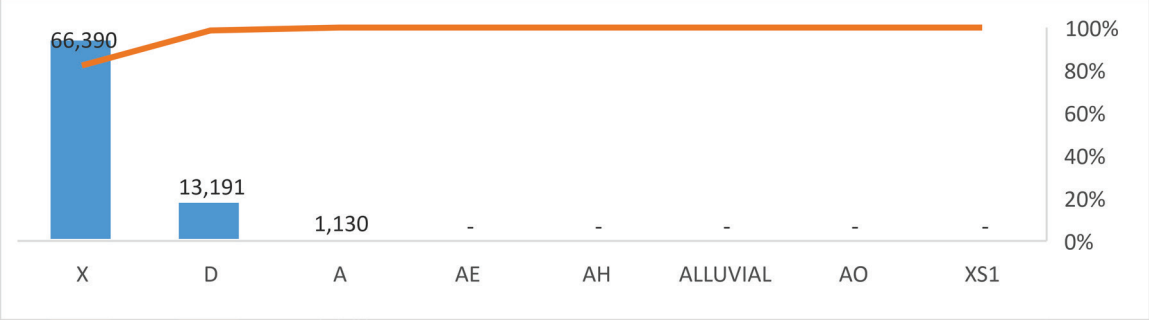


Figure 270 - Sopori Wash Watershed Federal Floodplain Designations

Types of storms that caused flooding in the watershed are monsoons. The table below provides a summary of historic USGS gaging station records.

Table 68 - Sopori Wash USGS Gaging Stations

USGS Gaging Station	Sopori Wash at Amado, AZ 09481750
Period of Record	1948-08-15 to 1977-10
Watershed Area (sq. m)	176
Flood-Peak of Record (cfs)	16000
Date	08-15-1948

There are currently no Pima County ALERT gages in this watershed. The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Table of Regulatory Discharges.

Table 69 - Sopori Wash ALERT Gages

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Sopori Wash @ U.S Highway 89	19,990	164	FEMA, Flood Insurance Study

A special consideration for Sopori Wash was made as the floodplain limit, when nearing West Fontage Road, crosses outside the study are and into Pima County. Under this condition it was determined that to provide a conservative estimate of the base flood elevation, it would be assumed that the Santa Cruz/Pima county boundary would serve as a virtual floodwall.

C.2.8.2 Existing Development & Infrastructure Trends

The chart below shows population distribution between incorporated and unincorporated areas. This chart also shows the distribution of residents within known floodplains.

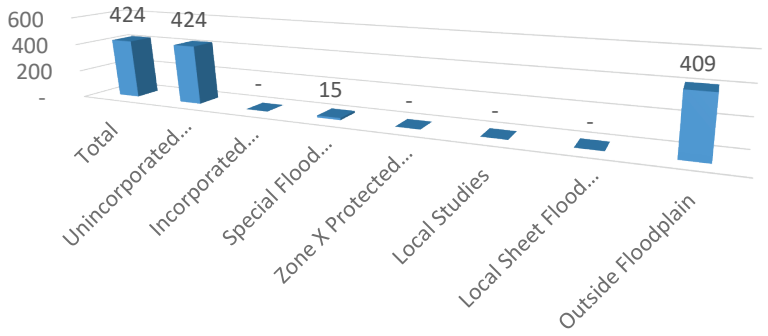


Figure 271 - Sopori Wash Watershed Population Distribution

This watershed is mostly vacant with grazing and small mining operations along with recreation being the most common land uses surrounding the small community of Arivaca Junction along the wash corridor.

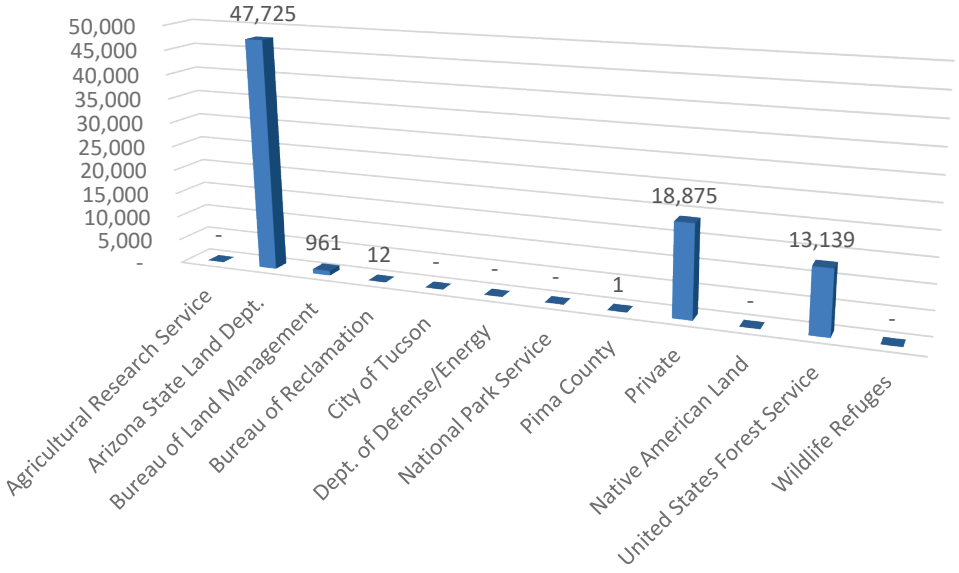


Figure 272 - Sopori Wash Watershed Ownership in Acres

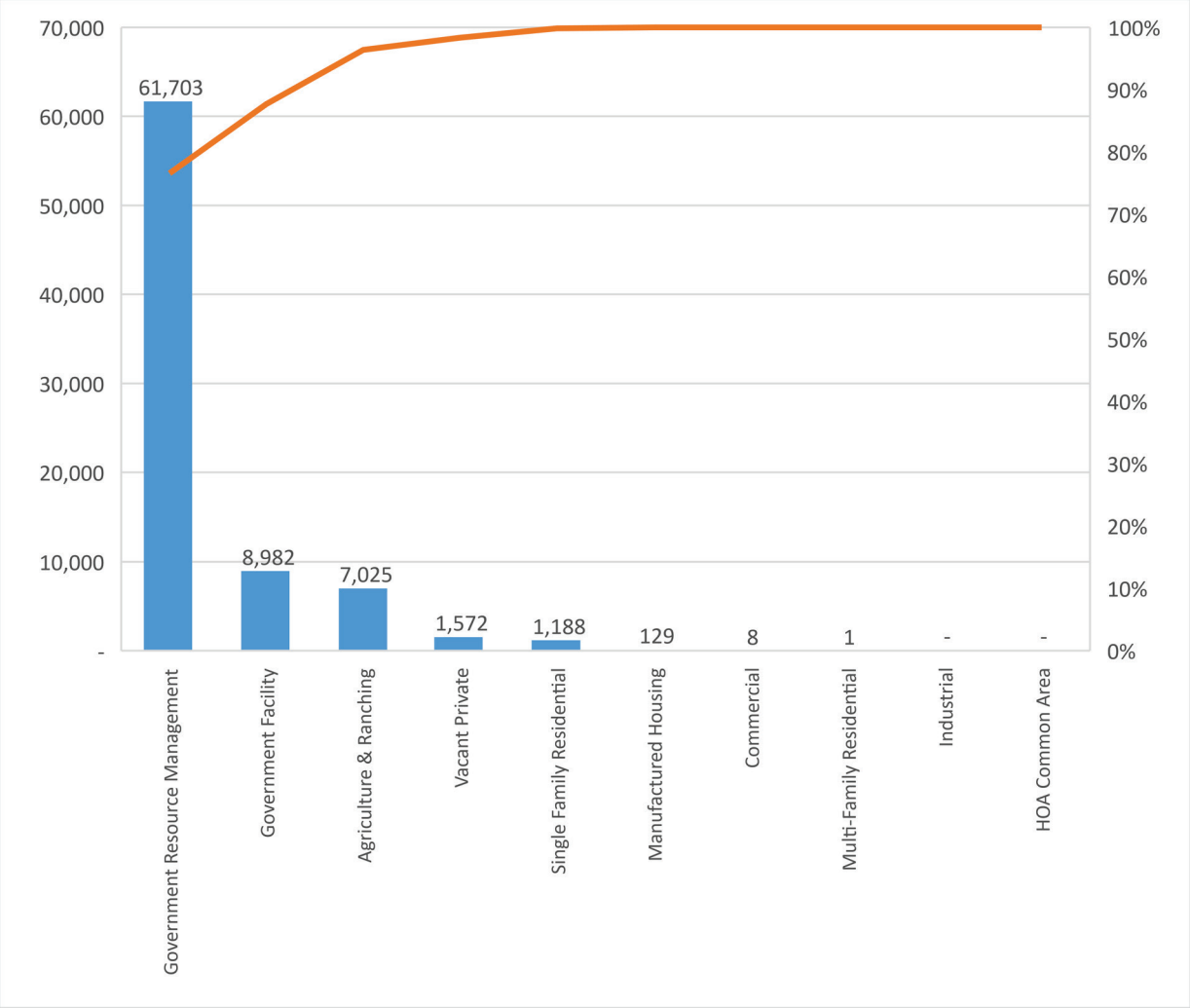


Figure 273 - Sopori Wash Watershed Land Use in Acres

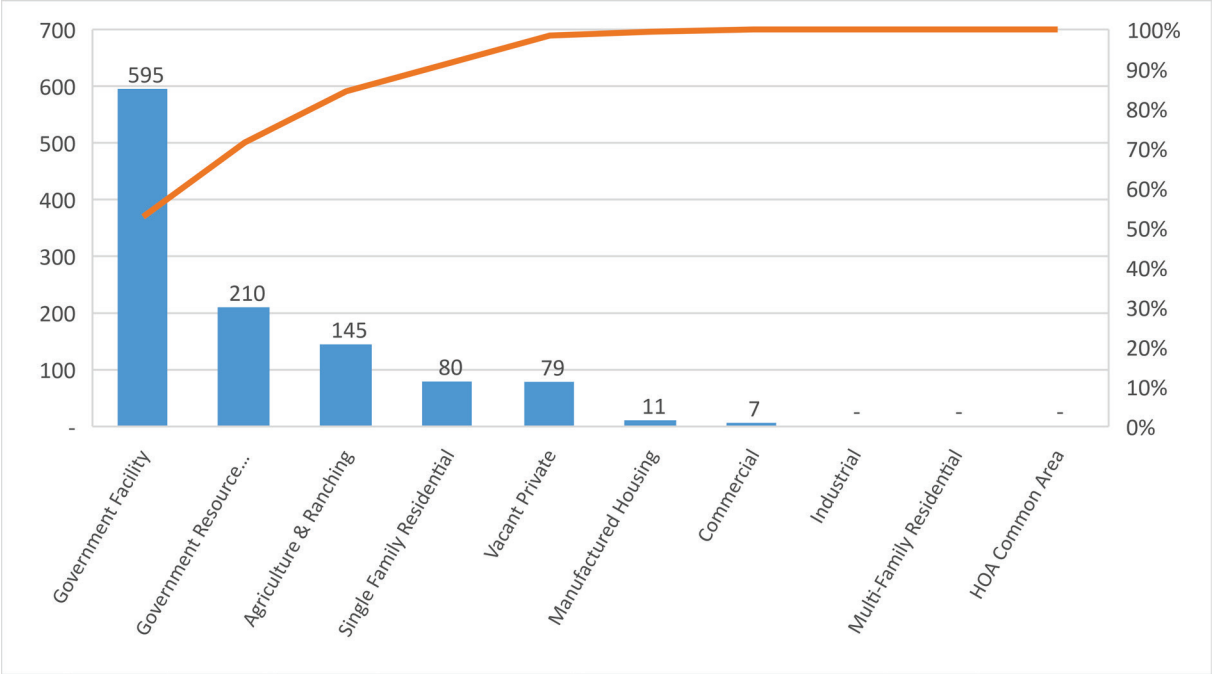


Figure 274 - Sopori Wash Floodplain Land Use

Agriculture is by far the most significant floodplain land use in this watershed. While landowners have sought entitlements to attract increased development it has largely not occurred and planers do not expect this to change in the near future. As with all rural watersheds discussed in this report accessibility during times of flooding will likely remain the primary concern, along with flooding in the commercial center.

C.2.8.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 13,359 acres of Pima County Regulated Riparian Habitat in this watershed, and 6,650 acres of IRA. There are also 45,180 preserved acres in this watershed, including 805 in regulatory floodplain.

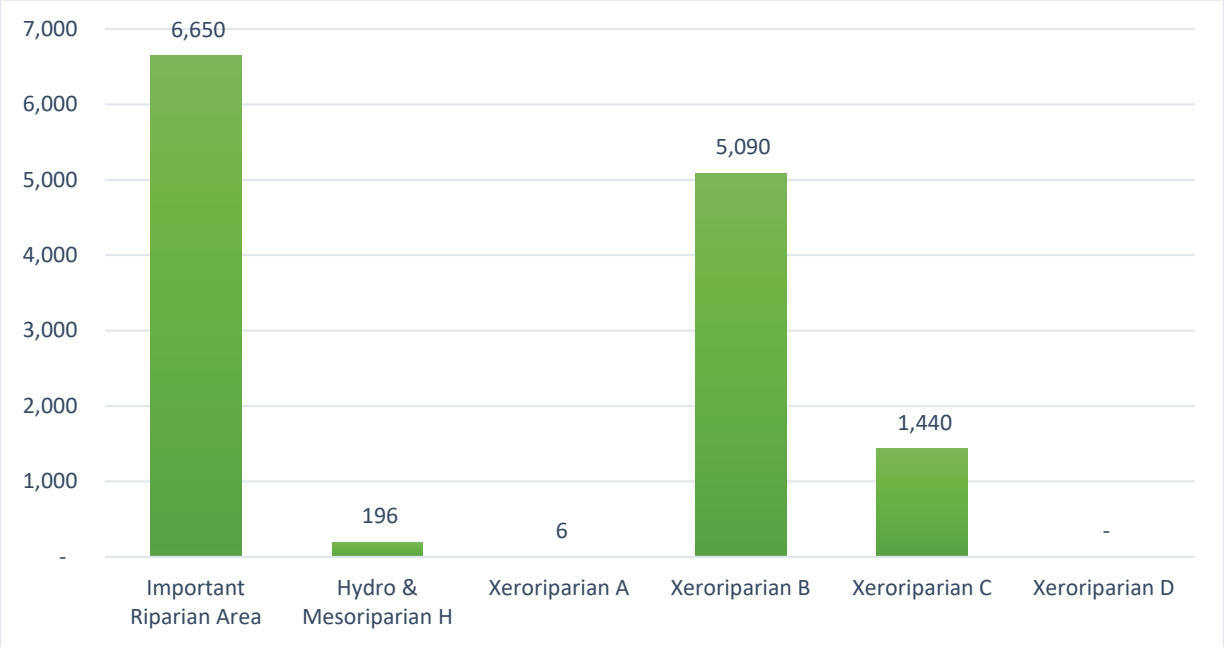


Figure 275 - Sopori Wash Watershed Riparian Habitat in Acres

C.2.8.4 Historic Floodplain Management Approach

There are 30.8 acres of natural drainageways in this watershed for which the District is responsible.

C.2.8.5 Needs

The District completed no projects during the prior five years, and none planned for the next five years. The 2019 *Flood Response Manual* identifies no specific items of concern in this watershed.

C.2.8.6 Floodplain Management

Future needs identified by District staff include:

- Rural use complaints (fencing, grading rip)
- Unpermitted residences
- Riparian disturbances rural uses
- Lack of topo and accurate discharges
- Identification of flood risks at Interstate 19

Ref# 1.2.b Improve floodplain hazard mapping (e.g. new delineations, revise out of date mapping)

- Identification of flood risks at Sopori and SCR Confluence

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 1.2.e Participate in monitoring groundwater change with other responsible parties

- Conduct groundwater depth & quality monitoring

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

Figure 276 - Sopori Wash Action Plan Map

C.2.9 Tenmile Wash

This watershed includes Gibson Arroyo within the community of Ajo that is within Tenmile Wash watershed. While the watershed is mostly rural, the Town of Ajo, while remote, is urbanized. This watershed also includes roughly the northern half of the community of Why. The watershed extends from the Pozo Redondo and Batamote Mountains in the east across the basin floor to the Little Ajo and Childs Mountains in the west. From these headwaters, this watershed then drains northward into Maricopa County. It is tributary to the Gila River and the confluence is approximately 40 miles west of Gila Bend. The entire watershed is within unincorporated Pima County and is 207,096 acres (323.6 square miles).

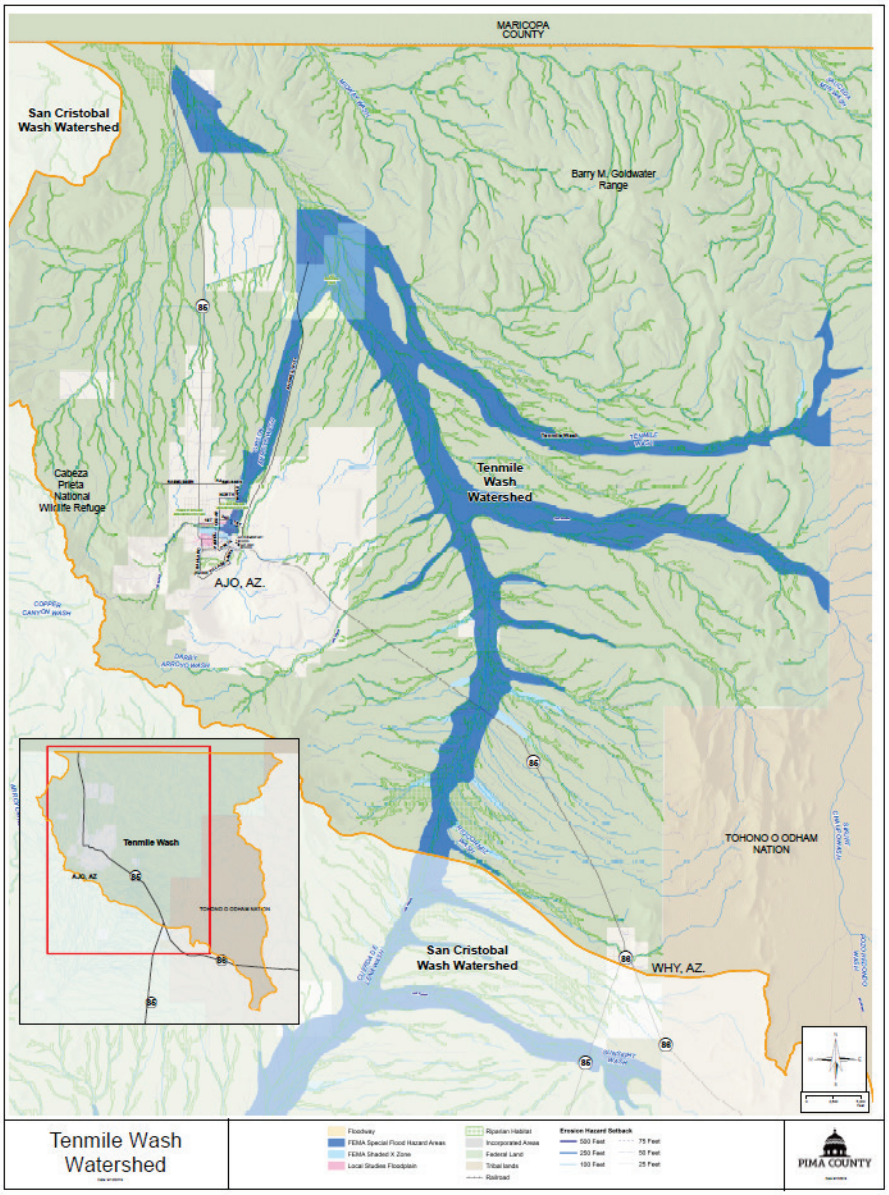


Figure 277 - Ajo Watershed Map

C.2.9.1 Flood Characteristics

While the majority of mapped regulatory floodplains in this watershed are SFHA Zone A (11,707 acres), the District has conducted Special Studies in the urbanized areas most impacted by flooding including Gibson Arroyo in downtown Ajo, where there are 54 acres of Special Studies Floodplains.

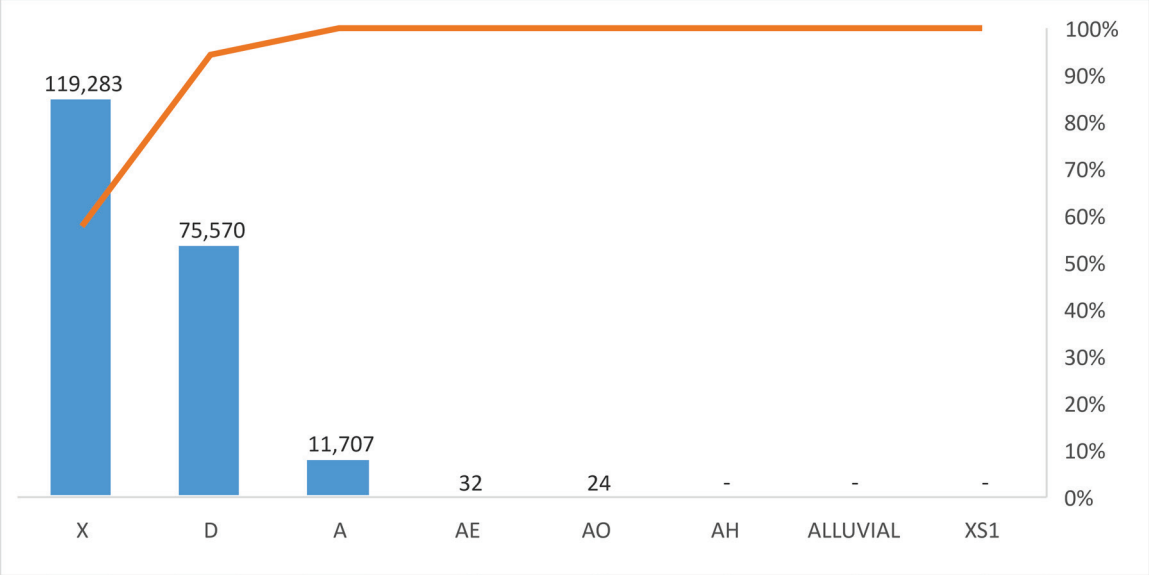


Figure 278 - Tenmile Watershed Federal floodplains

Tenmile Wash watershed upstream of the confluence with Gibson Arroyo is undeveloped desert valley. The main watercourses of Tenmile Wash are FEMA Zone A floodplain. Data along Tenmile Wash is limited due to its remote geographical location. Tenmile Wash's largest tributary is the Gibson Arroyo.

Gibson Arroyo originates southwest of the community of Ajo, to the west of the now inactive copper mine, in the Little Ajo Mountains. Upstream of Ajo, the watershed is undeveloped with steep slopes. Within Ajo, land use the watershed is predominately moderately dense single-family residences and small commercial buildings.

Flooding occurred in Ajo along the Gibson Arroyo on July 29, 2003, when a storm centered over the western portion of Ajo in the areas identified by the Special Study. Rainfall data associated with this storm is unofficial, due to lack of radar data and rainfall gauges. However, unofficial reports claim rainfall ranged from 2.7 to 4.0 inches of rain in approximately one hour. This high intensity event caused flooding throughout the community of Ajo, including many residences. The greatest flood depths occurred on the eastern end of Arroyo Avenue, west of the railroad. Tetra Tech analyzed peak flow rates from this storm event. They estimated a peak flood of 3,100 cfs for the Gibson Arroyo at Sartillion Ave. The flood-recurrence estimate was slightly greater than once every 500 years, on average. With the Special Study data available, the District has been able to inform property owners about the magnitude of flood risk to existing development and to provide flood depths when landowners propose new development within the Special Study floodplains.

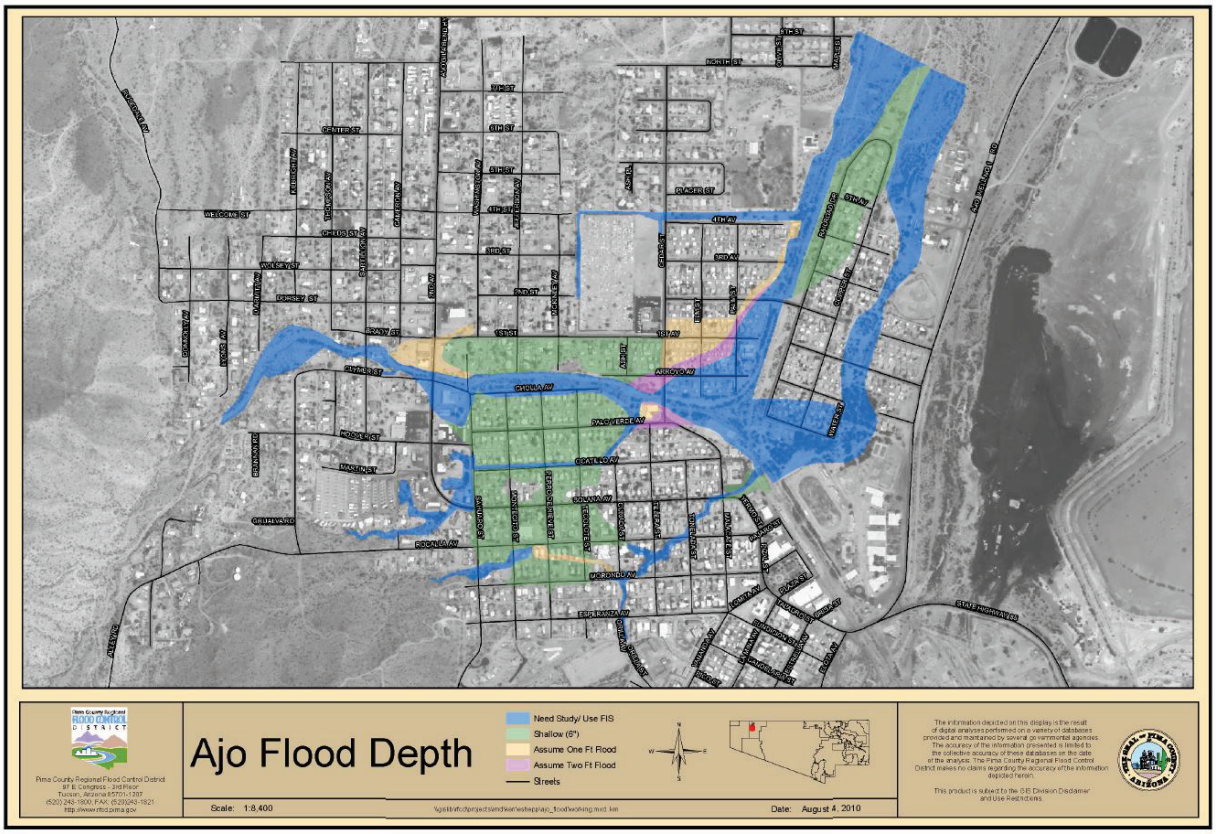


Figure 279 - Ajo Flood Map

The Gibson Arroyo travels thorough Ajo in what looks to be a natural flow path until the arroyo intersects the railroad. Once intersecting the railroad the wash makes almost a 90 degree bend to then parallel the railroad tracks and flow northward. In the July 2003 flood, this location was subject to the greatest flow depths, and the railroad tracks were overtopped. Sediment transport is a concern within the Gibson Arroyo. In the July 2003 flood, sediment and debris blocked the bridge at E. 2nd Avenue. Tetra Tech estimated that the storm event yielded 4.61 acre-feet of sediment at Sartillion Ave. In 2007, the County replaced the bridge with a new con arch bridge designed to contain the channel's capacity, but not the 1% annual chance discharge. It was determined that the new bridge decreased the downstream water surface elevation by about 1.5 feet. The removal of the piers should decrease blockage from debris.

The table below provides a summary of historic USGS gaging station records.

Table 70 - Tenmile wash Watershed USGS Gages

USGS Gaging Station	Hot Shot Arroyo near Ajo, AZ 09520110	Darby Arroyo near Ajo, AZ 09520130	Gibson Arroyo at Ajo, AZ 09520160	Rio Cornez near Ajo, AZ 09520170
Period of Record	1966-09-13 to 1981-01-12	1966-09-13 to 1981-08-23	1967-07-22 to 1981-08-23	1967-07-09 to 1980
Watershed Area (sq. m)	0.44	4.72	2.18	243
Flood Peak of Record (cfs)	240	1,670	1,800	8,030
Date	09-05-1976	09-06-1967	08-02-1970	09-04-1976
FIS Discharge (cfs)	NA	NA	2,400	NA

The table below summarizes regulatory discharge locations within the watershed. The locations are from the District's Table of Regulatory Discharges (Revised October 28, 2014). *There are currently no Pima County ALERT gages in this. UPDATE*

Table 71 - Tenmile Wash Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Gibson Arroyo			
@ West 2nd Ave, Ajo, AZ	2,400	2.20	FEMA Flood Insurance Study
@ State Hwy 85, Ajo, AZ	3,990	1.70	FEMA Flood Insurance Study

C.2.9.2 Existing Development & Infrastructure Trends

The population of this watershed is 2,523. There are 620 people living within mapped floodplains. It is entirely within unincorporated Pima County. The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas.

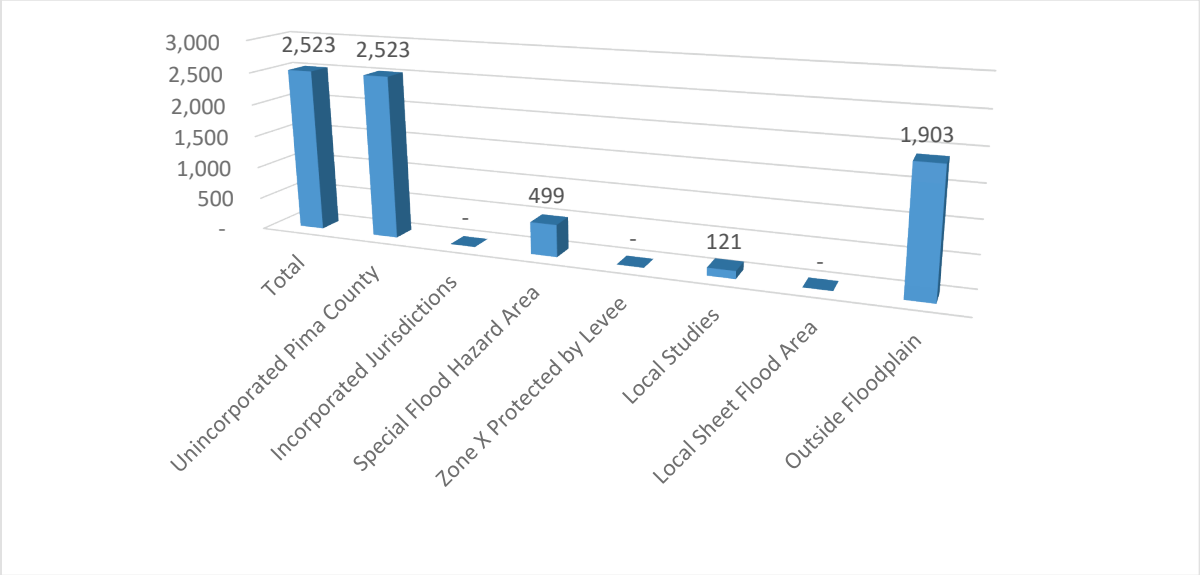


Figure 280 - Tenmile Wash Watershed Population Distribution

This watershed contains the communities of Why and Ajo. The latter is an architecturally unique rural community with its planned town center built by the mine operators.

With recent growth in Rocky Point, the Town is becoming much less of a shopping destination. The mine, which has been unproductive for years, continues only maintenance level operations.

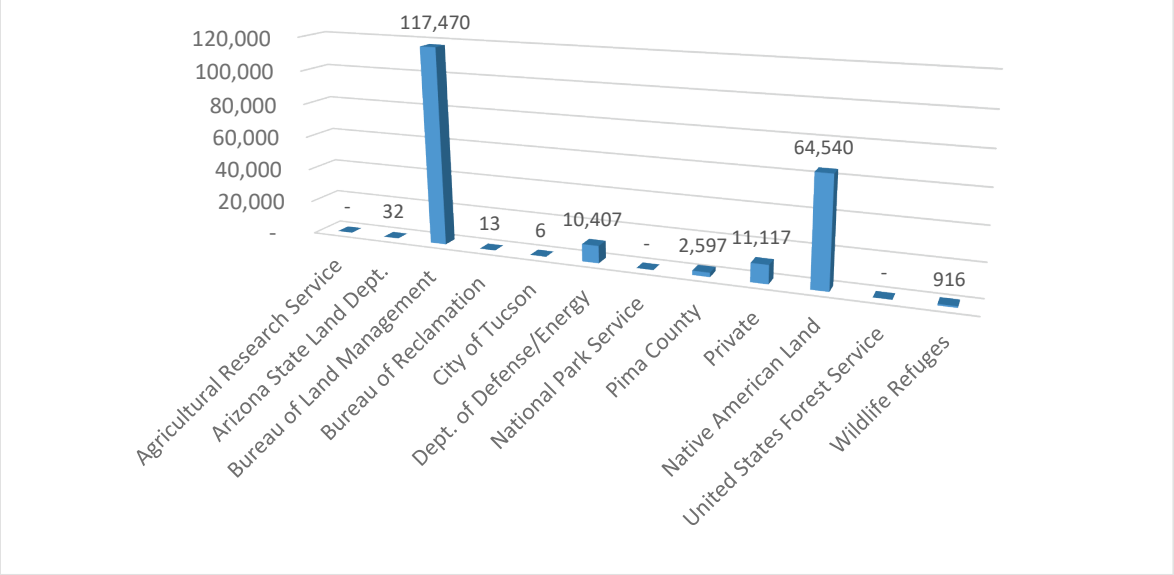


Figure 281 - Ajo including Gibson Arroyo & Tenmile Wash Ownership in Acres

As shown in the figure above the Bureau of Land Management or the Tohono O'odham Nation, manage most of the public land. Although neither entity manages lands solely for open space, they are currently predominately natural. Still significant private land remains available for development.

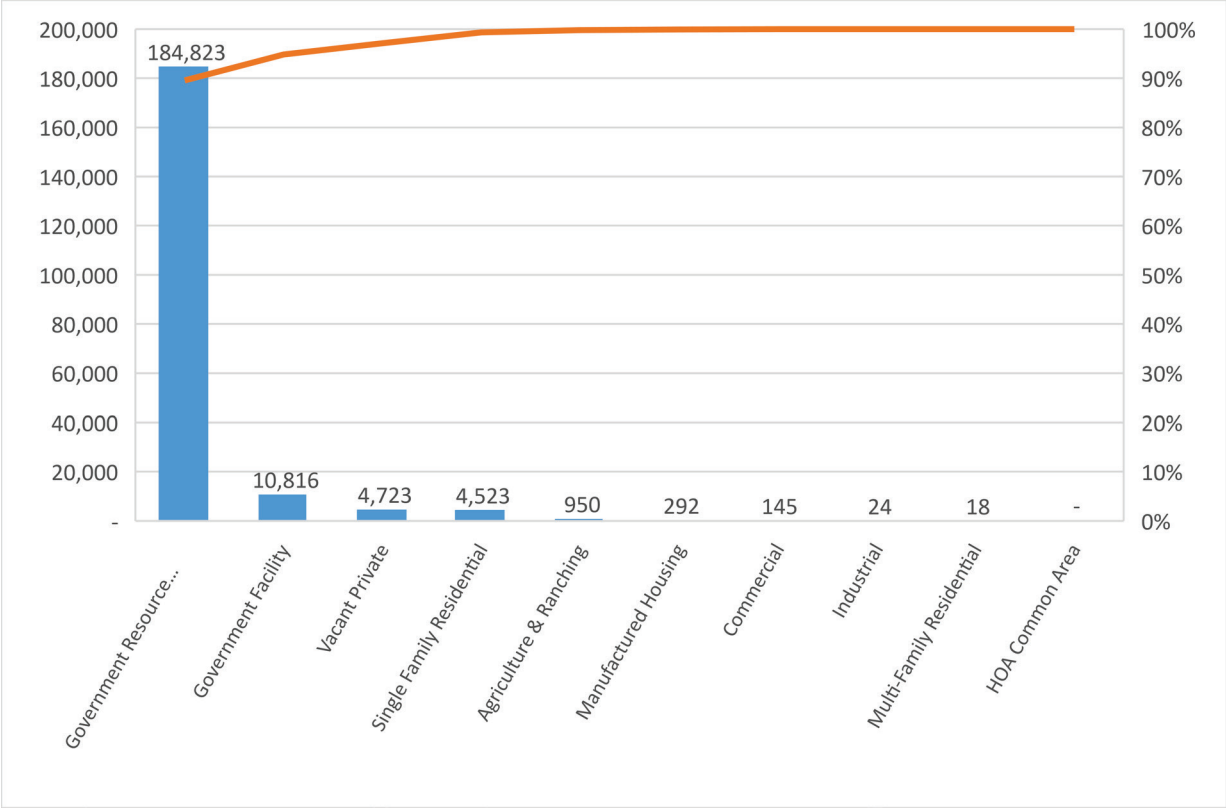


Figure 282 - Tenmile Wash Watershed Land Use in Acres

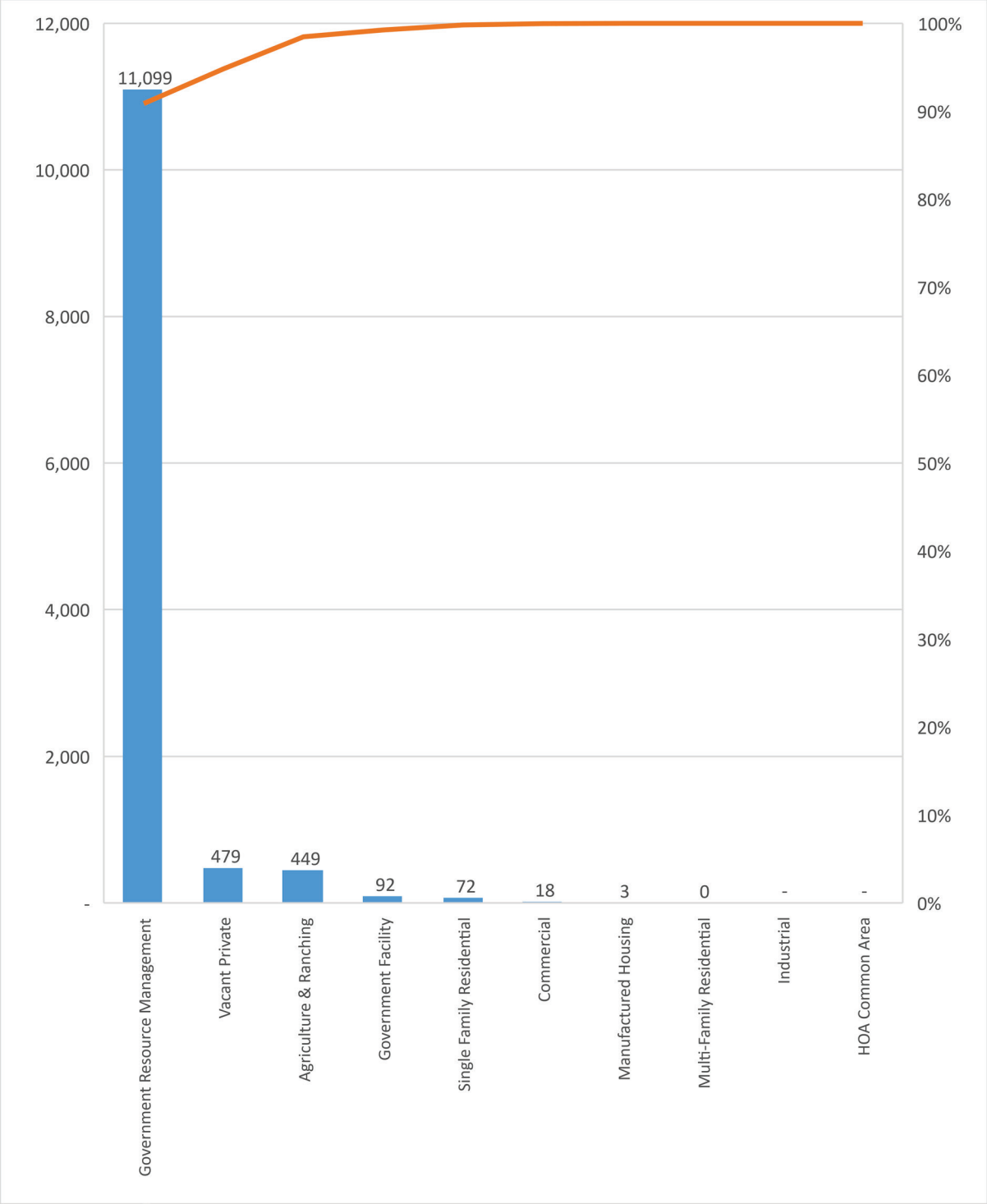


Figure 283 - Tenmile Wash Floodplain Land Use in Acres

While there are residential and commercial areas this watershed is predominately rural. Less than 10% is urban as shown on the land use chart above and map below.

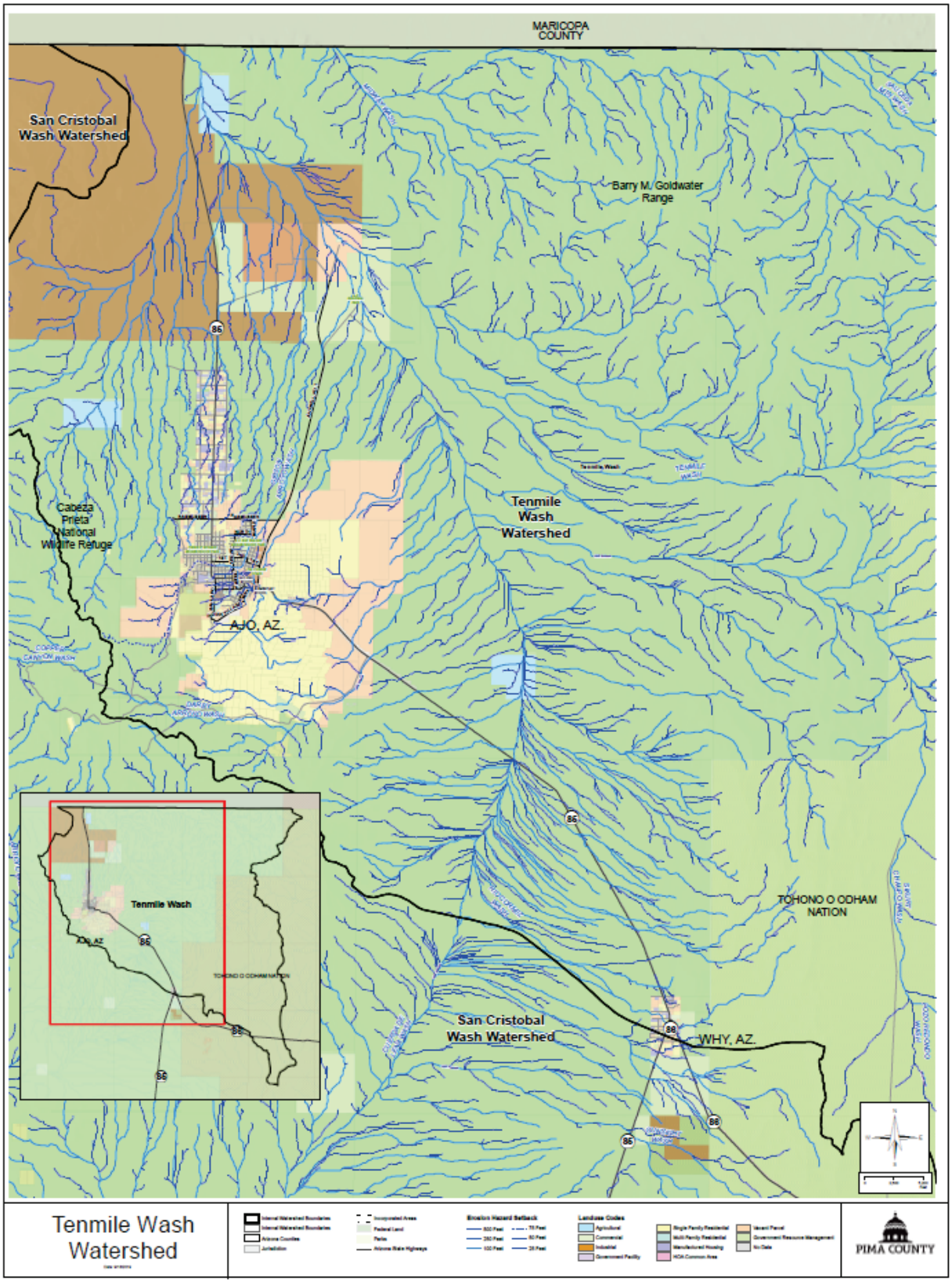


Figure 284 - Tenmile Wash Land Use Map

C.2.9.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 13,405 acres of Pima County Regulated Riparian Habitat in this watershed. Much more exists in a natural condition outside the unincorporated area where the District has not completed mapping. There are also 12,110 preserved acres in this watershed, including 157 in regulatory floodplain.

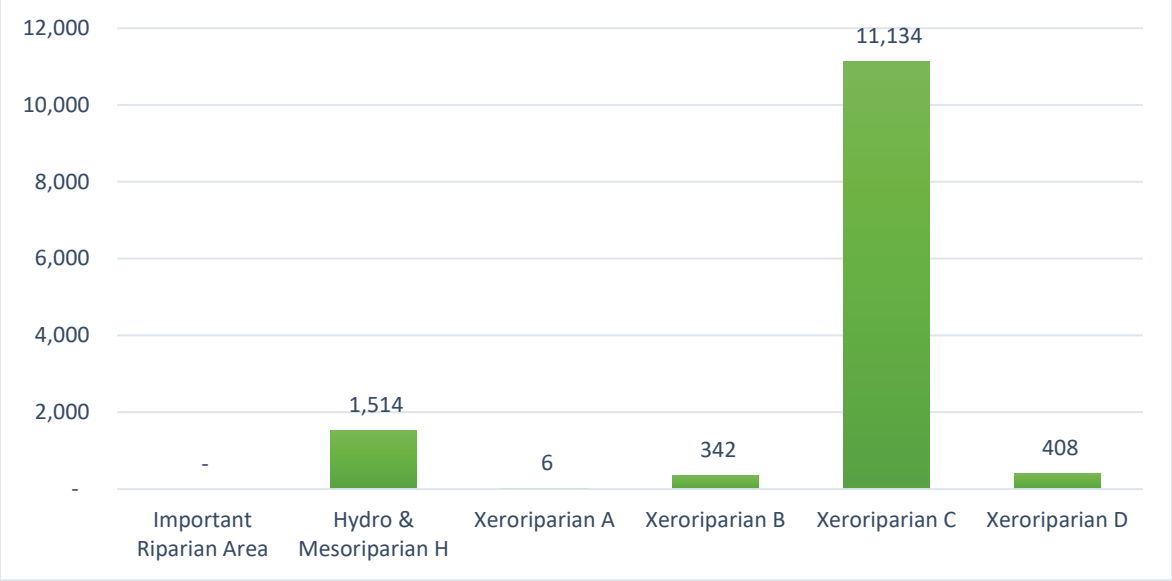


Figure 285 - Gibson Arroyo & Tenmile Wash Riparian Habitat in Acres

C.2.9.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

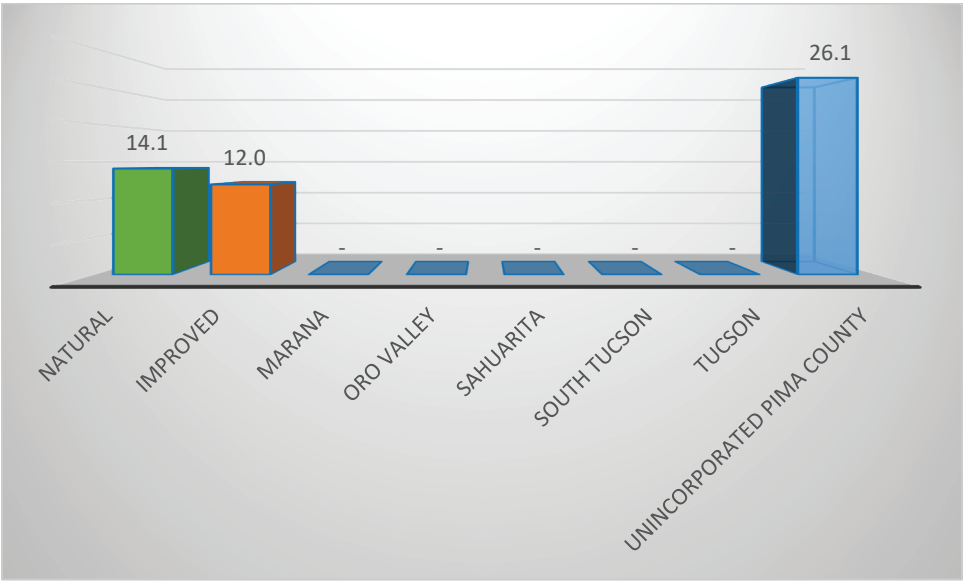


Figure 286 - Tenmile Wash Drainageway Acreage

As shown on the chart above, 100% of the drainage system managed by the District in this watershed is natural. In addition, there are 11,593 acres of preserved open space managed by multiple entities. In reality, as shown on the map almost the entire watershed is natural with the exception of the mine and towns of Ajo and Why, however much of the land is either part of the Tohono O'odham Nation, is managed by the Bureau of Land Management, or is a part of military reserves used largely for flight training. Each of these lands are in a largely natural condition but are not preserves.

During 2003, a significant flood event in the Town of Ajo led to completion of a regional detention basin, channel and bridge improvements to reduce risks for community residents and visitors within the urbanized area.

In July 2014, floods affected those living in the community of Why.

2014 Why Flood Damages

C.2.9.5 Needs

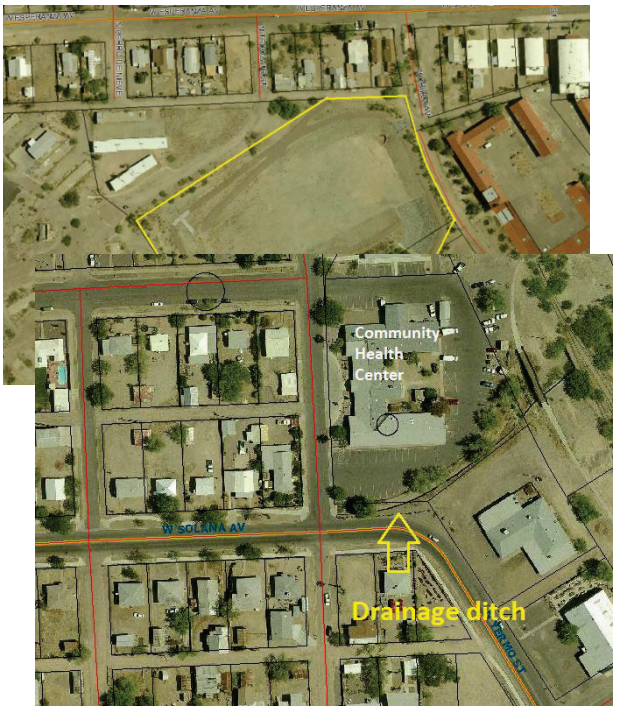
For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's *Flood Response Field Manual* (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow.

Frequently Flooded Structures and Properties Subject to Damage

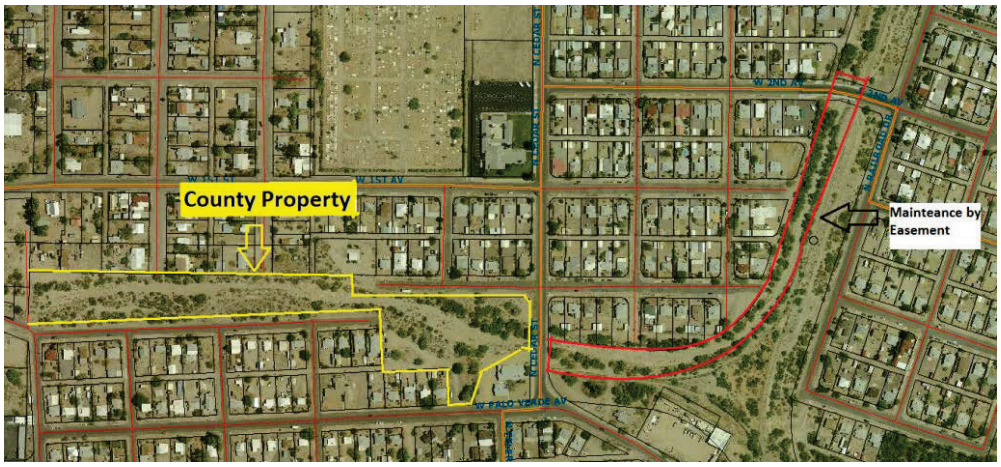
- A Gibson Arroyo West Rocalla culvert is under a house and outlets next to it.
- Gibson Arroyo floods West Morado Avenue.
- Gibson Arroyo floodwater backs up behind the West Morado Bridge and floods properties.

Infrastructure

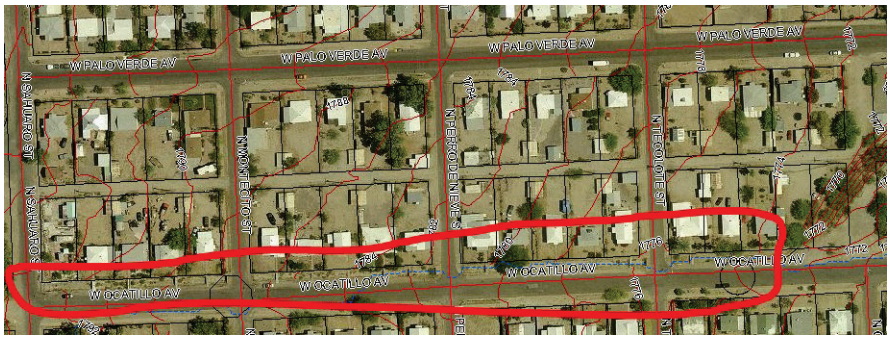
- Water may come up out of the storm drain on the south side of Esperanza Avenue, east of Montecito Street, due to head created by water backing up behind the headwall located at the southwest corner of Esperanza and Montecito.
- The Curly School Detention Basin near Esperanza Avenue and Orilla Avenue requires inspection of the spillways for debris blockage and slope erosion along the basin wall.
- The drainage ditch along the south side of the Ajo Community Health Center. Inspect for damage to or blockage of the drainage ditch south of the Community Health Center. County maintenance responsibilities stop at the north side of Solana Avenue. The culvert at Solana Ave. belongs to the Arizona Department of Transportation and the drainage upstream (south) of Solana is private.



- The County maintains the Gibson Arroyo upstream of 2nd Avenue to Cedar Street via a maintenance easement granted by Phelps Dodge. This area is subject to deposition. Bank erosion can occur in upstream and downstream of Cedar Street. Upstream of Cedar street there are no construction plans for the channel. Utilities crossing to the channel are shallow and in some locations exposed. The channel lacks capacity for moderate to strong storm events and widespread flooding is likely. Flood damage reports should address channel conditions.



- The County maintains that portion of the drainage ditch north of Ocatillo Avenue that lies within the road right-of way from Sahuaro Street east to a point approximately 170 feet east of Tecolote Street, at which point the channel leaves the road right-of-way. It is unknown if we maintain the footbridges across the channel. Flood damage reports should address the condition of the channel.



There were no CIP completed by the District in this watershed during the previous five years. Needed minor projects are dependent upon funding levels.

C.2.9.6 Floodplain Management

Issues identified include:

- Old and undersized infrastructure especially roadway culverts
- Presence/Program for Public Information
- Lack of residential permit requirement

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 1.2.d Update the Critical Basin map

- Identify undersized infrastructure
- Identify existing development at risk from flooding

Ref# 4.2.c Expand and update the District's flood threat recognition and integrate it with warning system

- Coordinate with other jurisdiction including the Tohono O'odham Nation on flood warning needs

Ref# 4.2.d Expand inundation mapping coverage for flood warning for use in flood warning system

- Create inundation mapping for Gibson Arroyo

Ref# 6.2.a Update outreach messages for new targets and audiences (e.g. critical facilities, private infrastructure, renters, riparian habitat and high stress index populations)

- Identify and conduct targeted outreach to areas which can get cut-off during flood events

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

Figure 287 - Tenmile Wash Action Plan Map

C.2.10 Tule Desert

The watershed extends from the Bates Mountains and Cipriano Hills within Organ Pipe Cactus National Monument westward past the Antelope Hills and Sierra Pinta to the Tule desert Playas including Dos Playas, Pinta Playa and Las Playas near the traditional O'odham community of Papago Well. Near 1000' above mean sea level, these are amongst the lowest elevations within the County. Within Pima County, it is comprised of 117,503 acres (183.6 square miles).

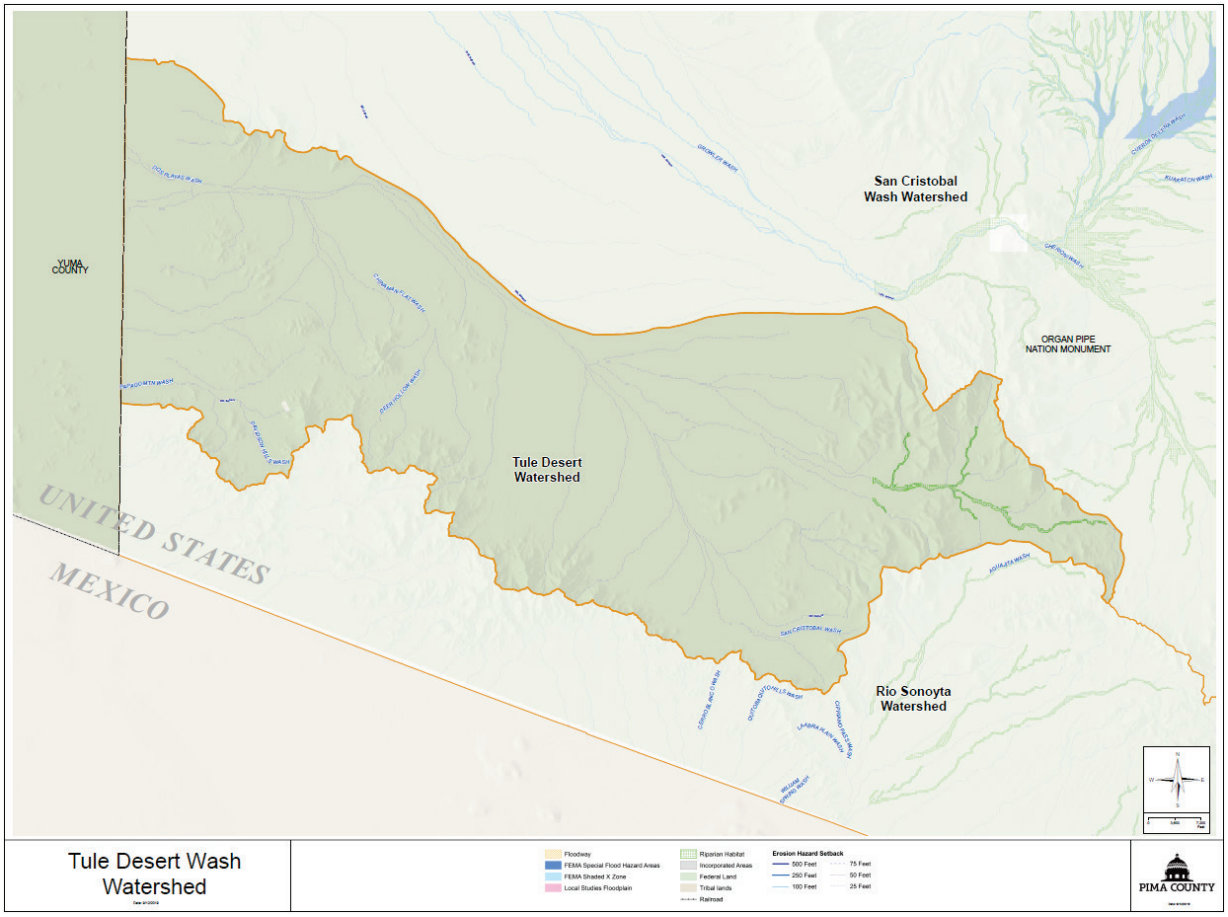


Figure 288 - Tule Desert Watershed Map

C.2.10.1 Flood Characteristics

This watershed is entirely within federal lands and therefore classified as Zone D indicating that it like tribal lands has not generally had flood risk mapping completed under the National Flood Insurance Program. No special studies are available within this watershed. There are no USGS or ALERT gages stations in this watershed.

C.2.10.2 Existing Development & Infrastructure Trends

The chart below shows population distribution between incorporated and unincorporated areas. The chart also shows the distribution of residents within known floodplains.

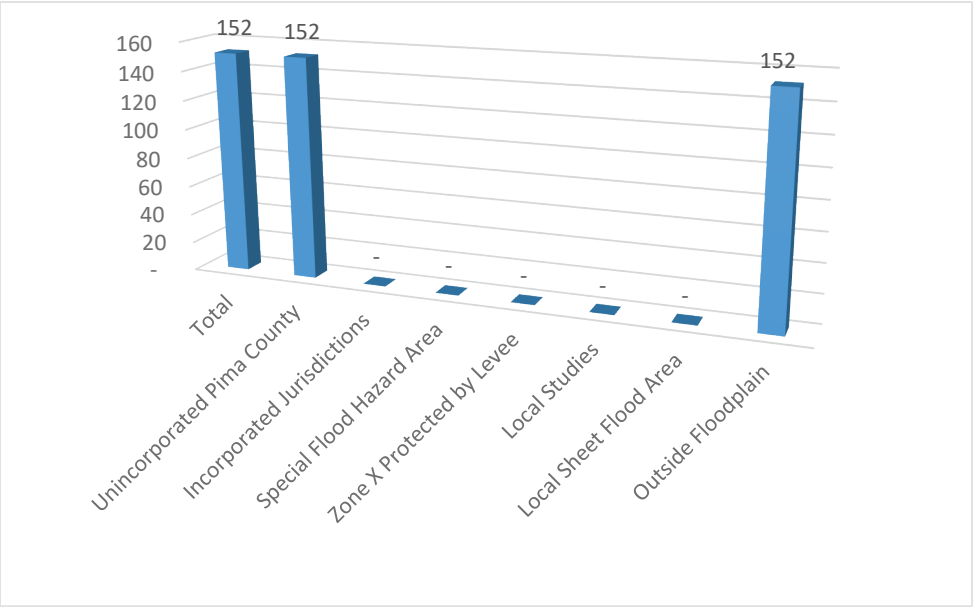


Figure 289 - Tule Desert Watershed Population Distribution

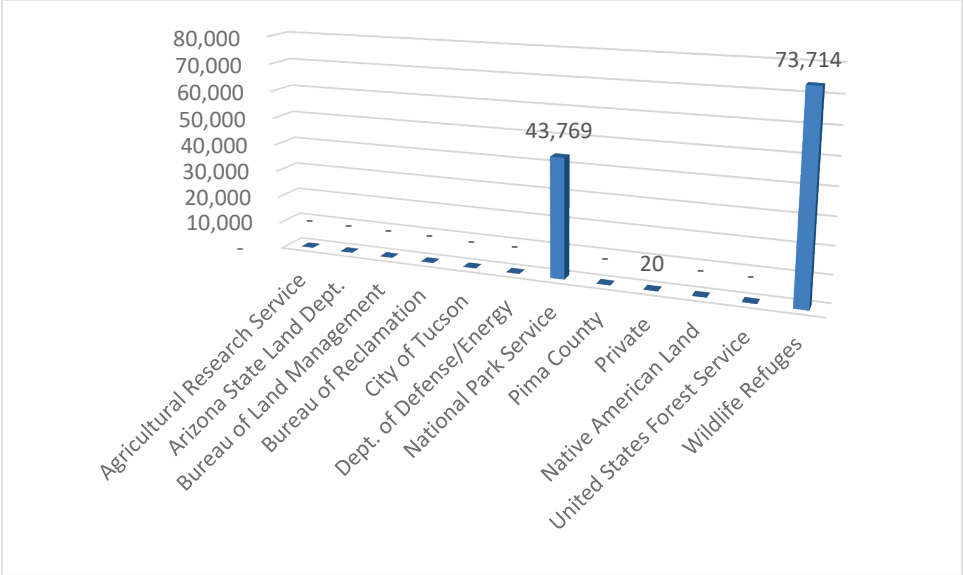


Figure 290 - Tule Desert Watershed Ownership in Acres

As shown above there is just 20 acres of private land in this watershed.

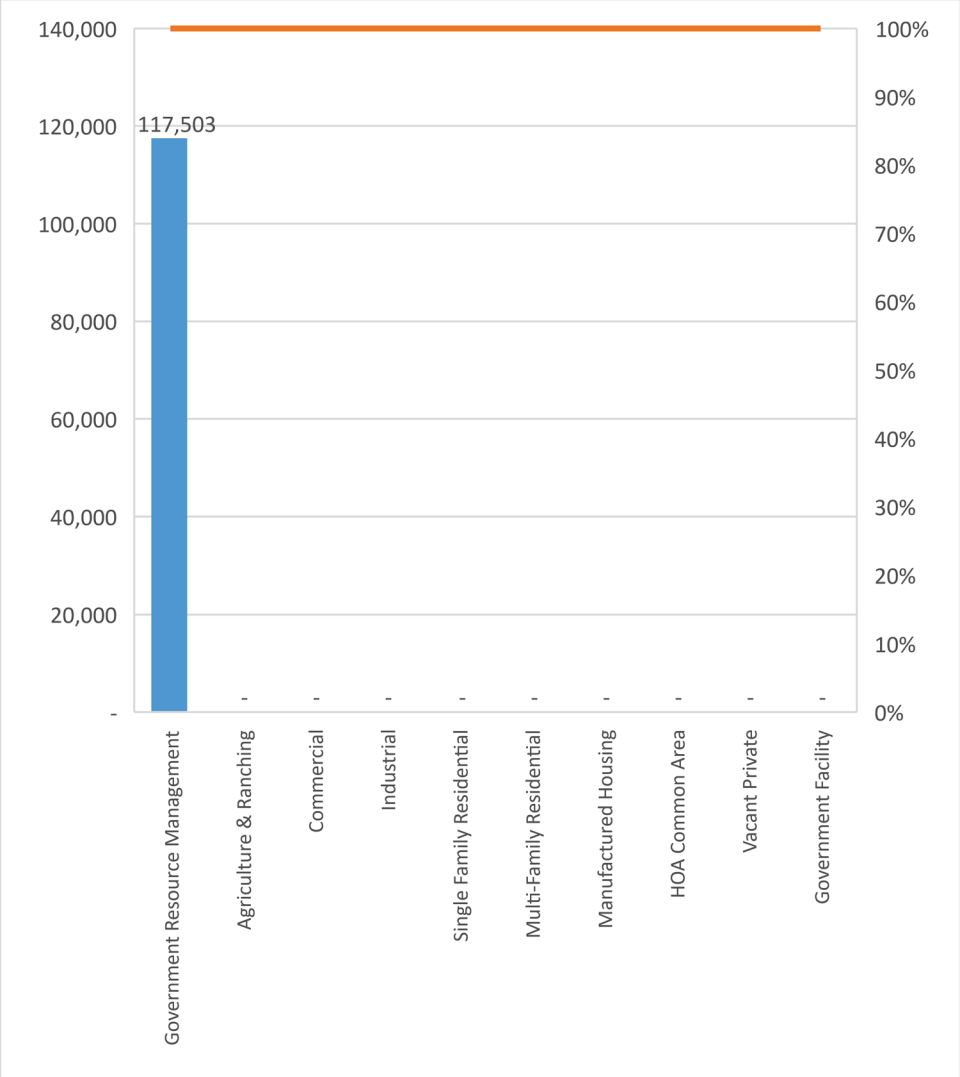


Figure 291 - Tule Desert Watershed Land Use

The Tule Desert watershed is entirely vacant per the assessor's land use code as it is within the Organ Pipe Cactus National Monument and Agua Prieta Wildlife Refuge.

C.2.10.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 386 acres of Pima County Regulated Riparian Habitat in this watershed. There are also 117,502 preserved acres in this watershed, including 438 in regulatory floodplain.

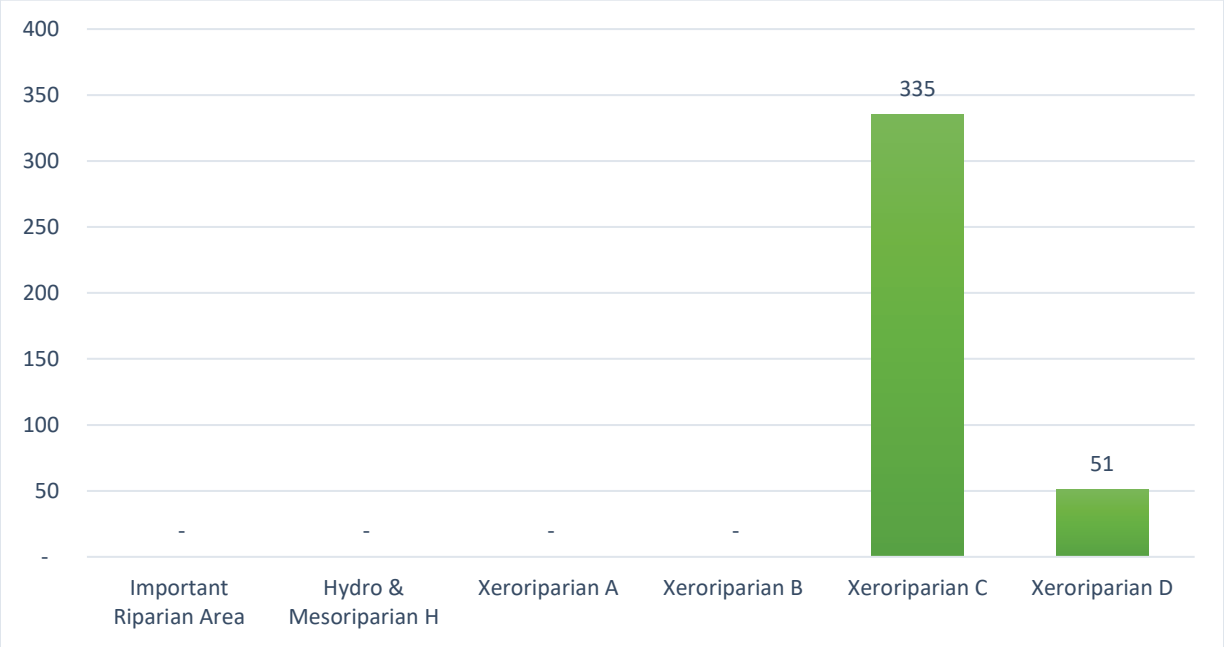


Figure 292 - Tule Desert Watershed Riparian Habitat in Acres

C.2.10.4 Historic Floodplain Management Approach

While there are no drainageways, or for that, matter paved roads, in this watershed the entire watershed is within Cabeza Prieta National Wildlife Refuge and Organ Pipe Cactus National Monument.

C.2.10.5 Needs

The District completed no projects during the prior five years, and none planned for the next five years. The 2019 *Flood Response Manual* identifies no specific items of concern in this watershed.

C.2.10.6 Floodplain Management

District staff identified no future needs as the watershed is entirely within federal preserve.

El Camino El Diablo Photo by AZNightstalker

Action Plan recommendations specific to this watershed in addition to those countywide actions identified in the Action Plan includes the following:

Ref# 4.2.c Expand and update the District's flood threat recognition and integrate it with warning system

- Coordinate with other jurisdiction including the Tohono O'odham Nation on flood warning needs

The Action Plan map below shows regulatory floodplains and riparian habitat, the publically maintained drainage system including open space and improved drainageways, existing and budgeted capital improvements, restoration sites, and gages that are part of the flood threat recognition and warning system operated by the District.

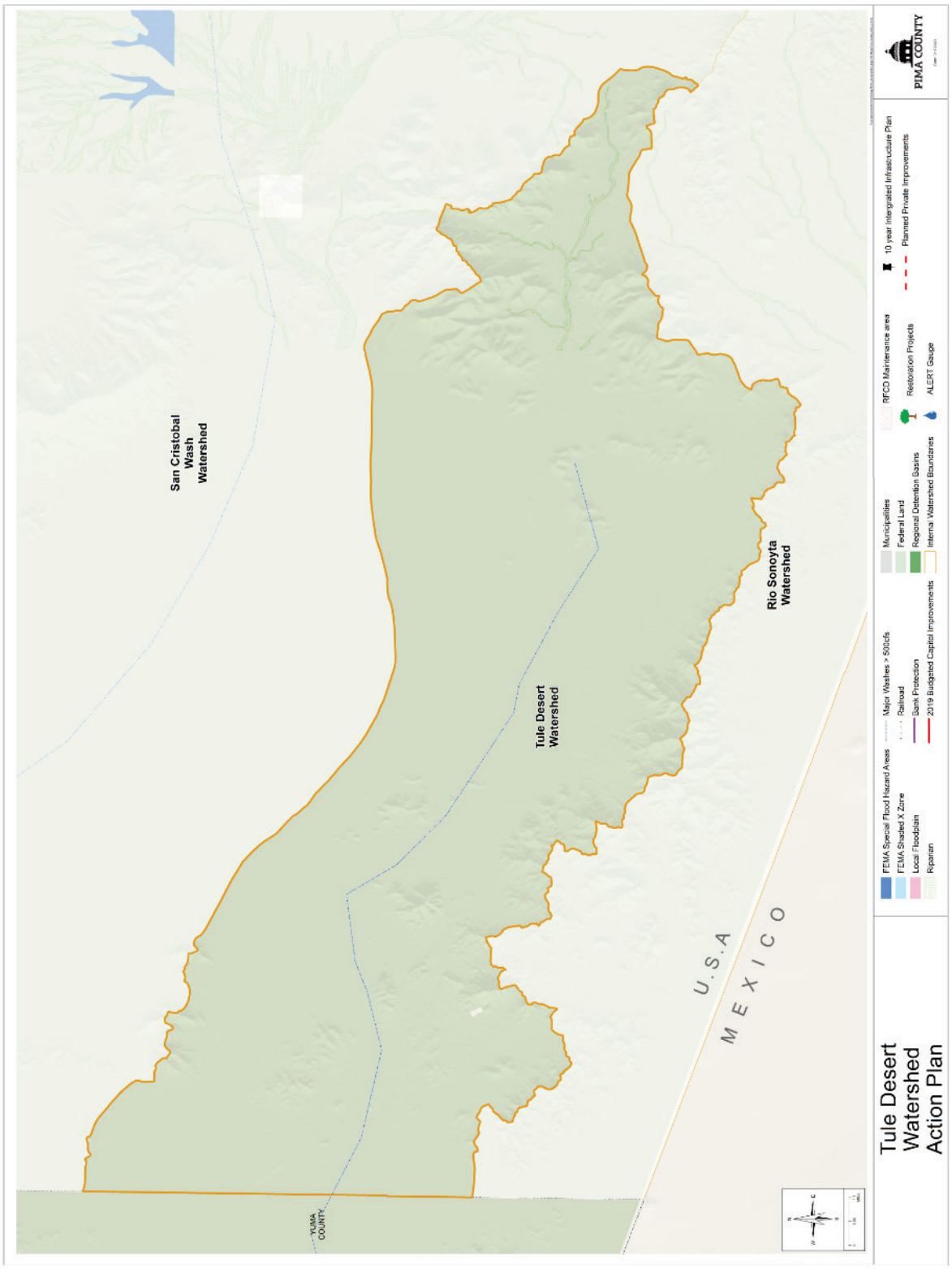


Figure 293 - Tule Desert Action Plan Map

Appendix D – Review of Current Activities

D.1 Public Information Activities (CRS Activity 300)

In order to inform the public about risk exposure and reduction the District provides floodplain mapping, protection assistance, and education. The 2017 score for this activity is 692 up 117 from the prior audit.

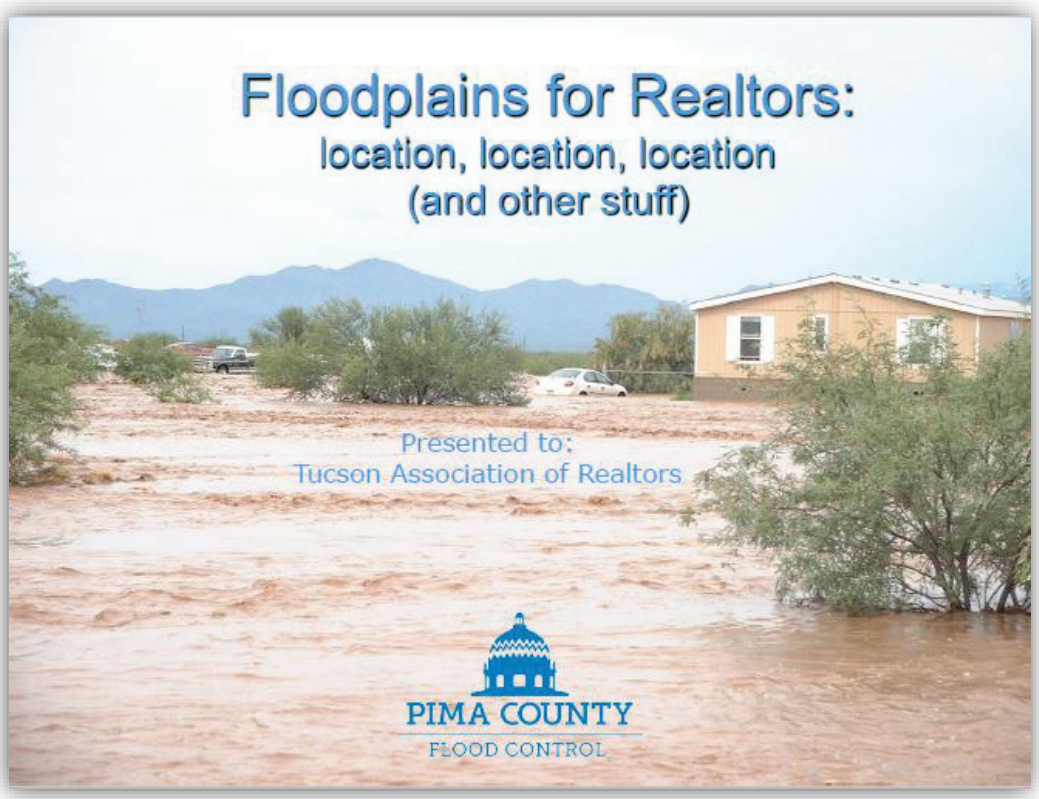


Figure 294 - Sample of Outreach Efforts

D.1.1 Elevation Certificates (CRS Activity 310)

An Elevation Certificate is a form created by the Federal Emergency Management Agency (FEMA) under the National Flood Insurance Program (NFIP) as a compliance and insurance tool within federally mapped floodplains. The certificates verify that structures are safely elevated above the expected 100-year flood level and that they meet other floodplain requirements. Insurance companies utilize the certificates to determine flood insurance premiums for homeowners within flood hazard zones.

The NFIP requires FEMA Elevation Certificates for structures within federally mapped floodplains. The District also requires their use in locally mapped floodplains. The Ordinance requires Elevation Certificates required for compliance purposes to be completed by an Arizona registered land surveyor or Arizona registered civil engineer.

D.1.2 Map Information Service (CRS Activity 320)

As the official repository for FEMA Flood Insurance Rate Maps (FIRMs), the District provides the map information service required for participation in the NFIP. The District provides an additional service of providing maps showing all known flood hazards for individual parcels, obtained by the public on-line at: http://pcmaps1.pima.gov/mapps/rfcd/parcelsearch/. Certified Floodplain Managers, Hydrologists, Engineers and Planners are available to assist the public on a walk-in or scheduled basis to provide comprehensive flood hazard information and related design guidelines. The public information counter is open from 8:00 a.m. to 4:30 p.m. weekdays. Property owners, buyers, lenders, architects, engineers, builders and their representatives may obtain detailed flood elevation information including Elevation Certificates, local and federal flood maps, guidance and assistance.

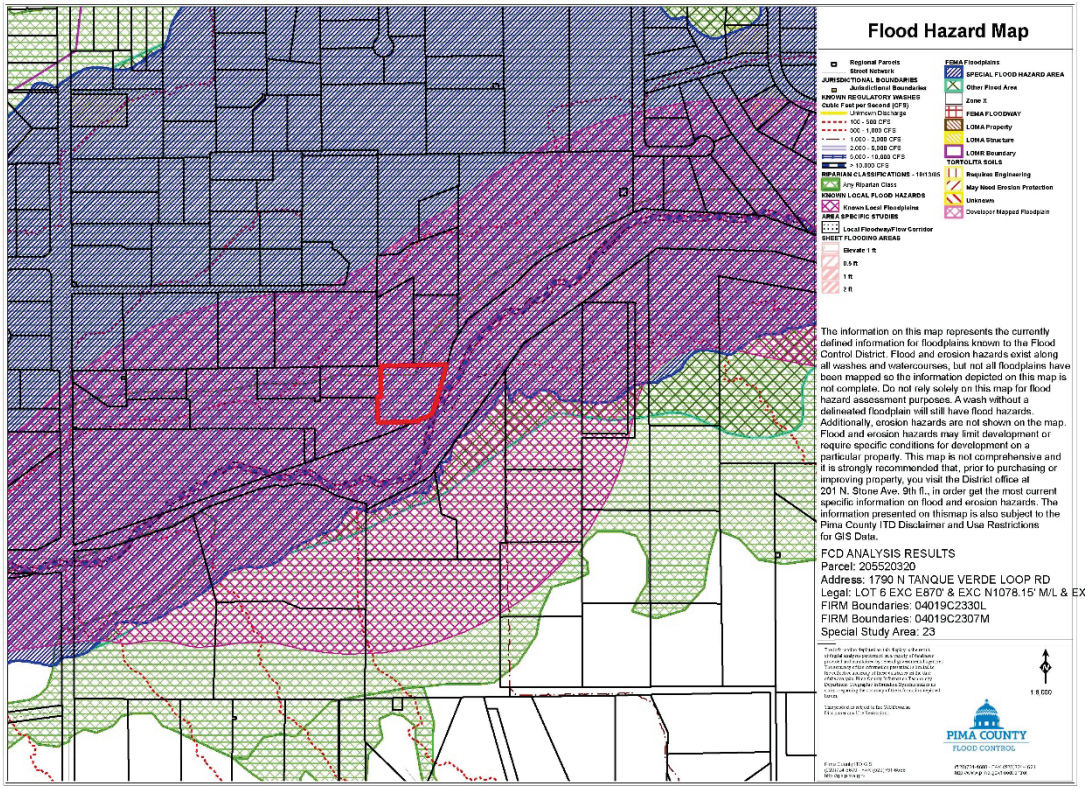


Figure 295 - Sample Flood Hazard Map

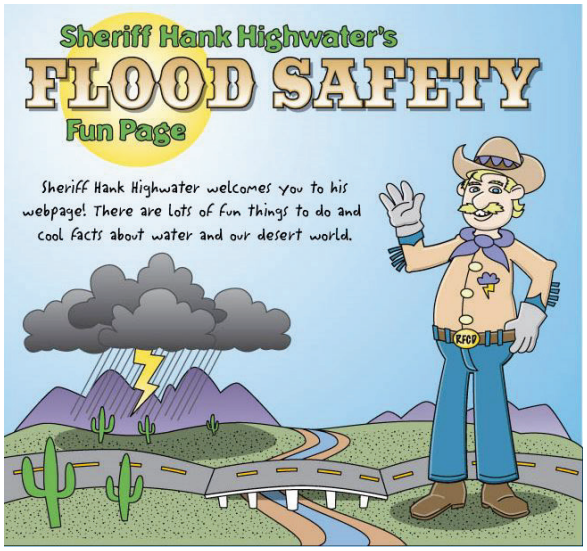
D.1.3 Program for Public Information (CRS Activity 330)

In order to promote risk reduction and the purchase of flood insurance the District engages in extensive outreach and educational activities. These range from signage to advanced technical workshops, including activities targeted to specific audiences such as property owners and floodplain residents, realtors, drivers, surveyors, engineers and children to name a few.

Prior to 2015, as promoted by the NFIP CRS 2007 Manual, the District conducted three major types of outreach in addition to the Map Information Service. This included direct mailings to floodplain and Repetitive Loss Property owners and residents, including annual informational brochures and floodplain status information. This activity fell under the CRS heading of Outreach to Floodplain Residents and included over 12,000 properties annually. Additionally, the District provides a monsoon themed insert in water bills. It reaches over 250,000 customers of Tucson's major water provider and provides flood safety, road closure and other flood preparedness information. The main message of the insert is do not drive through flooded roadways. Other outreach efforts include posters on buses and other general information placed in public places, as well as radio and TV ads. This activity falls under the CRS heading of Outreach to the Community. The District reaches additional targeted audiences by cooperating with various stakeholders such as schools, the Sheriff's Department, Pima County Office of Emergency Management, libraries, Tucson Association of Realtors and other professional groups to conduct special events, including Earth Day, various street and school fairs, and professional development seminars.

Typical Event Booth

These programs have been in place since the prior five-year planning period, in which time technological, social and environmental changes have occurred. In order to reevaluate the effectiveness of these programs and to comply with the FEMA CRS 2017 Manual, the District created a Program for Public Information. A stakeholder committee participated in creating the plan by identifying service gaps. They also recommended specific messages for identified audiences.



Sample Hank Highwater School Outreach

D.1.4 Hazard Disclosure (CRS Activity 340)

In Arizona, realtors and sellers are required to disclose when flood insurance is required for a federally backed mortgage prior to closing. The flood hazard information shown on a property information form completed by real estate agents and provided to buyers through a widely used Multiple Listing Service is not always accurate. As part of the Program for Public Information described above and included in Appendix A for reference (excluding appendices) the District has targeted real estate agents for further

outreach regarding disclosures and the availability of local hazard information including locally mapped floodplains, erosion hazard areas, and Regulated Riparian Habitat. As previously noted, the District mails annual notices to all property owners within unincorporated Pima County impacted by known flood hazards.

Figure 296 - Annual Disclosure and Brochure Cover Page

The brochure contains a map of roads impacted by floods and other useful information for floodprone property owners. The District, with its partners, conducts additional outreach relating to travel hazards that are not specific to individual property.

D.1.5 Flood Protection Information (CRS Activity 350)

The Pima County public library system consists of multiple branches throughout incorporated and unincorporated areas. The card catalogue is web based to make it easier to find a full suite of materials required by FEMA and many locally pertinent publications, including historical accounts of flooding and flood farming practices, land use and environmental change, desert and riverine ecology, modern water harvesting, low impact development, green infrastructure, flood protection practices and much more.

The District also maintains an extensive website with advanced mapping and flood threat recognition information. This includes a link where a visitor may download or print a Flood Hazard Map. This map depicts hazards identified by FEMA and locally, along with Regulated Riparian Habitat. The map includes a section with information on regulations, permitting, dumping, and the availability of insurance and the beneficial functions of floodplains.

The website also includes an interactive map to find historic, real-time rainfall, and stream flow data for more than 100 gage sites maintained by the District and other agencies. Known as the Automated Local Evaluation in Real Time (ALERT) system the District has recently upgraded its ALERT system software and improved the public interface for displaying real, or near real-time hydro-meteorological data for Southeastern Arizona. Precipitation, stream flow and other weather related information produced by gages maintained by the District and other agencies is now just a few clicks away. More information on ALERT is in Section 5.4.

D.1.6 Flood Protection Assistance (CRS Activity 360)

When addressing a flood concern, the District has used various combinations of regulatory, CIP, and open space options to protect properties. When the public submits a complaint or permit, District staff provides technical assistance. This includes determining design adequacy and identifying alternatives. The District has also adopted a series of Technical Policies and Procedures designed to assist the public. These provide guidance on items such as minimum foundation requirements for structures built in floodprone areas, locally appropriate scour calculation methodologies for underground utilities, wet flood proofing, fence and wall design and much more. District staff meets with clients at the customer service counter and conducts site visits as needed. Should the assistance require either maintenance of a public drainage facility, enforcement of a regulation, construction of flood or erosion control improvements, or environmental restoration the District will engage its infrastructure and resources management staff and partners as needed. Whether the result is a public or private flood control project District staff remain involved throughout design and maintenance to ensure functionality.

Samples of Damaged Homes Where the District Provided Assistance

D.1.7 Flood Insurance Promotion (CRS Activity 370)

The District promotes the purchase of flood insurance as part of annual outreach projects to floodplain residents, at special events, and as part of post flood investigations. The District maps local floodplains

and erosion hazard areas and encourages property owners to obtain flood insurance in these areas. The outreach notifies floodplain property owners of the insurance requirement for federally backed mortgages and the availability of low cost polices outside of FEMA Special Flood Hazard Areas. During 2016, our Program for Public Information Committee identified the need to further target residents of locally mapped floodprone areas, particularly renters, regarding the availability of insurance.

D.2 Mapping and Regulations (CRS Activity 400)

This Section describes our mapping program, ordinance and supporting policies and procedures. The 2017 score for this activity is 2,021 up 414 from the prior audit.

D.2.1 Floodplain Mapping (CRS Activity 410)

The District conducts river and basin management plans and other flood and erosion studies to identify present and future flood control needs and to implement related land use planning activities on major watercourses and tributary watersheds. The basin management plans and studies allow the District to move away from reactive spot improvements toward larger-scale long-range improvements. When the District first joined the CRS, the Floodplain Management Plan Synopsis described updating the plan one watershed at a time via basin management studies. This effort continues and this Watershed Management Plan compiles these studies into one document for the first time.

Below is a list of local studies conducted during the previous five years. These used the latest hydraulic and hydrologic modeling techniques, weather records, and topographic conditions to provide updated floodplains, depths and discharges.

- Sabino Vista
- Tucson Mountains Unnamed Wash #10
- Caliente Hills
- Airport Wash
- Pima Wash
- Catalina Mountains Unnamed Wash #4
- Indian Hills Wash
- Red Butte/ Saginaw Hill
- Upper Santa Cruz River RiskMAP
- North Ranch

The map below is the most recent CRS Cycle verification submittal. The watershed maps in Step 5 include all studies.

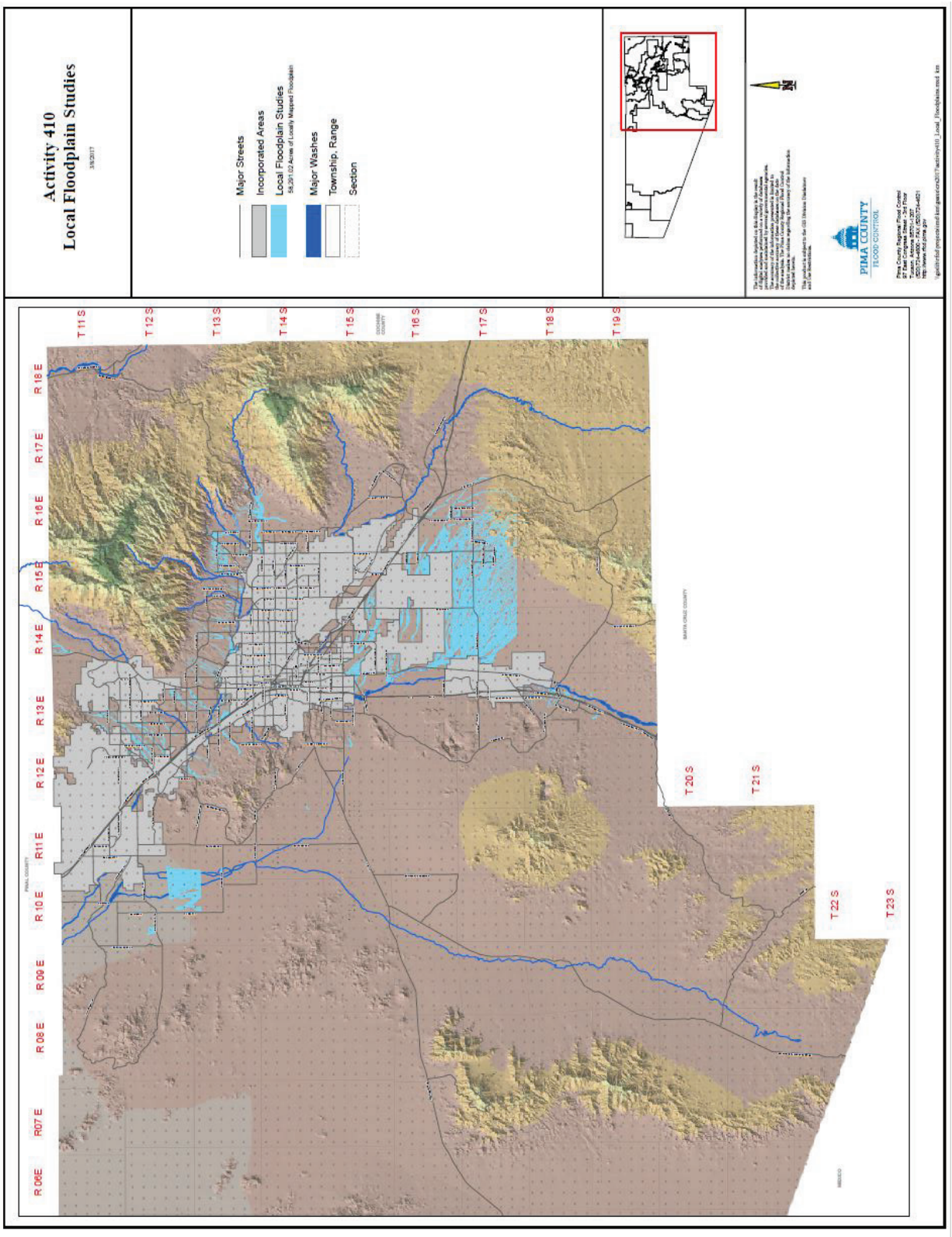


Figure 297 - CRS Cycle Verification Map of Local Floodplain Studies

D.2.2 Open Space (CRS Activity 420)

Pima County has been proactive in recognizing the role of open space in flood risk reduction and the other beneficial functions of floodplains, such as groundwater recharge, riparian habitat preservation and as a recreational amenity. Open space is protected via regulatory processes and by land acquisition. The Sonoran Desert Conservation Plan (SDCP) is Pima County's plan for balancing the conservation and protection of our cultural and natural resource heritage with our efforts to maintain an economically vigorous and fiscally responsible community. The Pima County Board of Supervisors approved the SDCP in 1999.

Broadly, the SDCP considered the following elements: critical habitats and biological corridors, riparian areas, mountain parks, historical and cultural preservation, and ranch conservation. All five elements, along with fiscal analysis, were critical in forming a viable land management plan for Pima County.

The SDCP identified the types of development that improved the tax base, and the relationship of these with the sewer service area. Excesses of land needed for urban development exist within the County as shown by build-out analyses. Furthermore, certain types of development are costly to the tax base and are contrary community values identified through over 600 public meetings. Over 200 technical reports documented these values, using the combined talents of over 150 contributing scientists.

In 2001, the Pima County Board of Supervisors updated the Pima County Comprehensive Land Use Plan, integrating the land-use policies and principles of conservation developed in the SDCP, including the Conservation Lands System (CLS). The CLS identifies lands necessary to achieve SDCP biological goals, while delineating areas suitable for development. The CLS covers approximately 2 million acres in eastern Pima County. The CLS was renamed the Maeveen Marie Behan Conservation Lands System in 2009 in memory of Dr. Behan's work on the SDCP and development of the CLS.

Since 2001, the SDCP has guided where public money is spent to conserve important natural areas, providing the basis for how cultural and historic resources are protected, and serving to help insure that our western lifestyle, heritage, and traditions continues. The SDCP set the stage for later efforts such as the City-County Water Study and re-investment in the County's sewage treatment facilities. It also

created a new standard for public transparency and involvement. The Multi Species Conservation Plan (MSCP) is the part of the SDCP that deals with compliance with the Endangered Species Act. Significant property acquisitions have greatly contributed to the success of this plan along with complementary regulatory and voluntary components. Although out of date, Figure 19 depicts how this works as a regional approach.

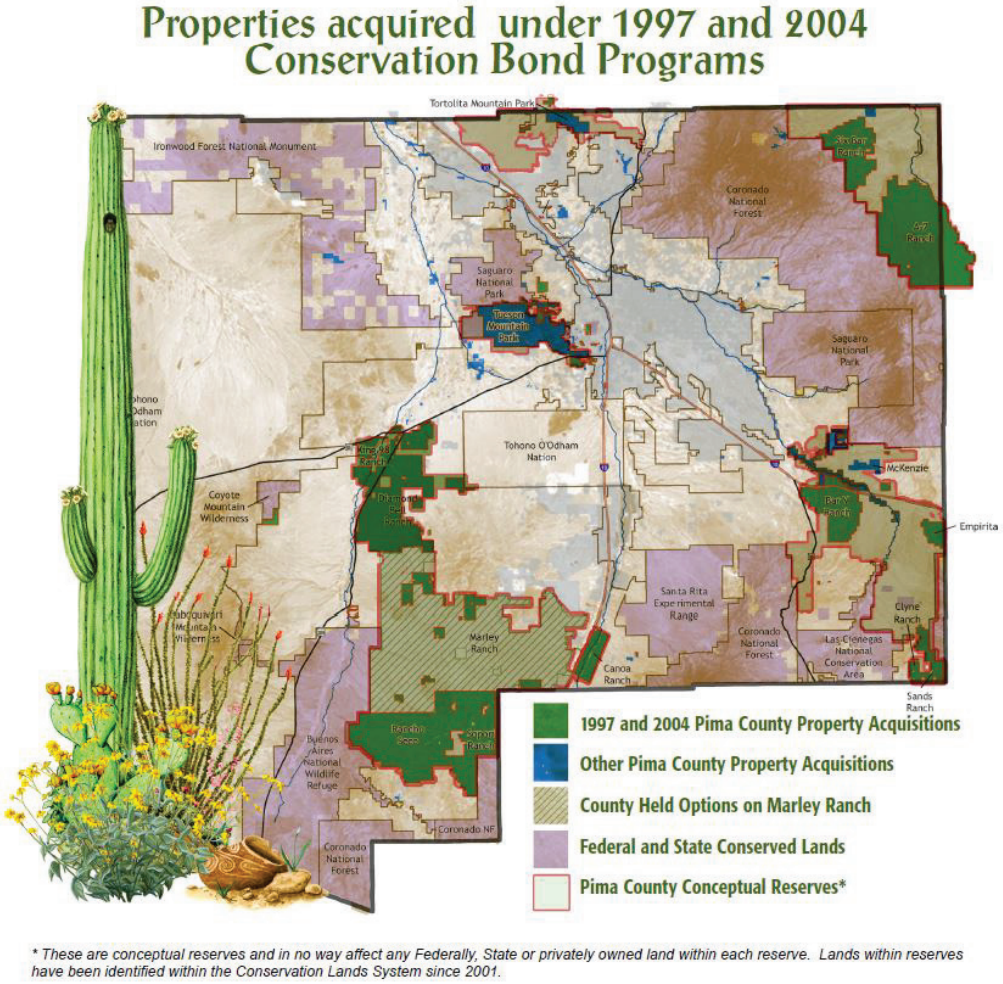


Figure 298 - Open Space Acquisition Map

In 2013, FEMA approved the SDCP as our NFIP CRS compliant Natural Floodplain Functions Plan. Components of the plan include Pima County Regulated Riparian Habitat and Important Riparian Areas designated under the SDCP and Pima County Conservation Lands System. These resources guide and inform staff recommendations for entitlements such as rezoning requests to the Board of Supervisors. The County has adopted avoidance regulations for Pima County Regulated Riparian Habitat throughout the Ordinance and Zoning Code as well as through the adoption of mitigation guidelines. Mitigation standards require replacement of habitat in like kind and the standards apply to both public and private projects. The descriptions and illustrations below describe the classifications of regulated habitat.

Hydroriparian habitat is generally associated with perennial watercourses, and may contain plant species such as cottonwood and willow. This is the rarest type of riparian habitat in Pima County and is vital to the many wildlife species that require this habitat for at least some portion of their life cycle.

Mesoriparian habitat is associated with areas of shallow groundwater and/or intermittent stream flow. Mesquite bosques are characteristic of this habitat type.

Xeroriparian habitat is typically associated with ephemeral streams (those that flow only in response to rainfall). The plant species present are similar to those found in upland areas but plant densities tend to be greater due to the relative abundance of water. There are four classes of Xeroriparian habitat based upon species, density and size, they are:

Xeroriparian Class A

Xeroriparian Class B

Xeroriparian Class C

Xeroriparian Class D

D.2.3 Higher Regulatory Standards (CRS Activity 430)

The Ordinance regulates activities and developments in the regulatory floodplain in unincorporated Pima County. The Ordinance contains the following chapters:

Chapter 16.04 - General Provisions
Chapter 16.08 - Definitions
Chapter 16.12 - Exemptions and Nonconforming Uses
Chapter 16.16 - Floodplain Maps and Boundaries
Chapter 16.20 - Use Permits—General Provisions
Chapter 16.24 - Floodway Requirements
Chapter 16.26 - Floodway Fringe Area Requirements
Chapter 16.28 - Erosion Hazard Areas and Building Setbacks
Chapter 16.30 - Watercourse and Riparian Habitat Protection and Mitigation Requirements
Chapter 16.34 - Manufactured Homes and Manufactured Home Parks and Subdivisions
Chapter 16.36 - Subdivisions and Development
Chapter 16.38 - Maintenance of Private Drainage Improvements
Chapter 16.42 - Sediment and Erosion Control
Chapter 16.44 - Vehicular Access
Chapter 16.48 - Runoff Detention Systems
Chapter 16.52 - Sand, Gravel and Other Excavation Operations
Chapter 16.54 - Administration, Compliance
Chapter 16.56 - Appeals and Variances
Chapter 16.60 - Amendments
Chapter 16.64 - Violation—Penalty

Administering the Ordinance accomplishes two goals:

1. Meeting FEMA Flood Insurance Study (FIS) and NFIP requirements, governing activities in federally mapped flood hazard area.
2. Addresses local flood hazard issues by regulating activities in locally designated regulatory flood and erosion hazard areas. Provisions of the Ordinance are more restrictive than the minimum required by the NFIP.

Floodplain Use Permit Program

A Floodplain Use Permit (FPUP) is required prior to development in a regulatory flood or erosion hazard area. As defined by the Ordinance, "Development" is "any manmade change to improved or unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, fencing, excavating or drilling or storage of equipment or materials." The Ordinance further states that, "…[no person shall be exempt] from obtaining a floodplain use permit …for any use which diverts, retards or obstructs the flow of water and creates a danger or hazard to life or property in the affected area."

The most restricted area is the floodway, an area necessary to allow for the passage of the base flood. In these areas, there are prohibitions on structures and most other developments. Allowable floodway uses include agricultural, recreational, and accessory residential uses, as well as sand and gravel excavations subject to the conditions stated in the Ordinance. Annual renewal of FPUPs for sand and gravel excavation is required.

The Ordinance allow most uses in the floodway fringe (the portion of the regulatory floodplain outside of the floodway), including the placement of buildings, provided they adhere to minimum design and construction standards. The Ordinance prohibits structures designed for human habitation where the product of the flow depth times the square of the flow velocity (dv^2) exceeds the value of 18 for more than 30 minutes or the depth of the surrounding base flood exceeds three feet. In addition, the lowest floor of habitable structures must be at least one foot above the water surface elevation of the base flood. Other regulations govern the design of the foundation, the amount and type of any fill used, measures for protecting the fill, anchoring structures to prevent flotation, elevating service facilities such as electrical and heating equipment, and aligning structures relative to the direction of flow.

Unless approved bank stabilization is constructed, the Ordinance also requires buildings to be set back from watercourses in order to allow for lateral channel migration. The setback marks the edge of the erosion hazard measured from the top edge of the highest channel bank or the edge of the floodplain, whichever is closer to the channel centerline. The setback distance of varies with the discharge of the watercourse as dictated by the Ordinance unless an alternative erosion hazard area is established through a site-specific engineering analysis. Revisions adopted during the last decade include requirements for riparian habitats and critical facilities.

Appeals, Variances and Enforcement

In 2014, the Board adopted FPMO revisions including procedures governing fines for non-compliance, appeal and hearing procedures. The Ordinance specifies activity and development types allowed in flood and erosion hazard areas and provides a mechanism for appealing any interpretation of the Ordinance, and a process for obtaining a variance from the Ordinance. During this reporting period, the hearing process for enforcement was in development and no variances requested nor fines leveed. In 2014, the Board adopted Ordinance 2014-FC1, which proscribes enforcement procedures related to non-compliance, including fines, appeals and hearing procedures related to violations of the Ordinance.

Please refer to the above-references ordinances for more detailed information, copies of which are available on the District website.

Other Regulatory Activities

In addition to issuing FPUPs, District staff provides information to the public about permissible activities in flood hazard areas, provides information about the flood hazard status of specific properties, and provides flood protection assistance as needed. Requests for information can be made via letter, fax or on a walk-in basis. The public information counter is open weekdays from 8:00 a.m. to 4:30 p.m.

Staff also investigates drainage complaints filed by the public. The District notifies the property owner and requests corrective action when it is determined that a violation of the Ordinance exists. When not corrected to the District's satisfaction, staff issues a violation notice, and may refer the case to the Pima County Attorney's Office. Staff often provides technical support to the attorney working on the case and may testify on behalf of the District.

The table below provides data on floodplain management services provided by the District over the past five years.

Table 72 - Floodplain Management Services

	2015	2016	2017	2018	2019 through August
FPUPs (Received/Issued)	538/352	686/498	758/554	805/865	534/461
Complaints Received	397	488	510	641	186
Counter Service	1,913	2,319	2,312	2,400	1,673

D.2.4 Flood Data Maintenance (CRS Activity 440)

In addition to identifying locally regulated floodplains, FEMA FIRMs need periodic revision due to the availability of better data, improved modeling techniques, new development, construction of structural flood control projects, or natural changes in floodplain conditions. Changes to the effective FIRMs include Physical Map Revisions, whereby FEMA republishes the entire FIRM panels and Letters of Map Revision (LOMRs), whereby FEMA modifies a portion of a FIRM panel.

Changes can also be requested on a parcel basis if a parcel or structure is incorrectly included in an SFHA (i.e., if a small topographic high point did not show up), and the structure or parcel is actually elevated above the 100-year water surface elevation. In this case, FEMA issues a Letter of Map Amendment (LOMA), which eliminates the flood insurance requirements but does not modify the floodplain boundary shown on the FIRM.

The District typically funds the cost of LOMRs associated with public projects. The private sector is responsible for completing the necessary paperwork to obtain LOMRs and LOMAs for private improvement projects. The District performs complementary reviews of LOMR and LOMA applications prior to submittal. See Appendix B for a listing of LOMR and LOMA activity within unincorporated Pima County over the past five fiscal years.

The question of who should file for lands held in Trust by the Department of the Interior for Native American governments has arisen in recent years but is unresolved.

D.2.5 Stormwater Management (CRS Activity 450)

The District has developed this Comprehensive Program Report in part to satisfy watershed-planning requirements of the CRS. It incorporates by reference the critical and balanced basin designation contained in our Retention/Detention Manual. This designation identifies basins in which drainage infrastructure is inadequate and therefore flow reduction is required on a project-by-project basis. The City of Tucson adopted these standards, promoting a holistic approach to watershed management.

D.2.6 Conclusion

The current standards in the Pima County plans and regulations reviewed in Section 3.1 include preventative activities summarized above. These include Pima Prospers the Comprehensive Plan, Building Code, Zoning Ordinance, and stormwater management regulations and District staff is involved in review and implementation of each of these regulations. While current policy enforcement activities partially address future flood losses, the planning Committee identified additional activities to strengthen these efforts and further reduce risk, even as those risks increase due to climate change, development trends and behavior.

D.3 Flood Damage Reduction (CRS Activity 500)

This section describes our damage reduction activities including Floodplain Management Planning, Acquisition and Relocation, Flood Protection, and Drainage System Maintenance. The 2017 score for this activity is 689 up 247 from the prior audit.

Constructed channels require maintenance including sediment removal

D.3.1 Floodplain Management Planning (CRS Activity 510)

The first Floodplain Management Plan approved when Pima County joined the CRS indicated that the district would update the plan as basin studies are completed. The District has since completed numerous basin studies but did not update the plan. The County has received FMP credit under the CRS for the Multi-Jurisdictional Hazard Mitigation Plan in recent cycles. The District is also participating in updating the HMP and is incorporating it herein by reference.

D.3.2 Acquisition and Relocation (CRS Activity 520)

Bond monies authorized by Pima County voters and annual allocations from the District's tax levy are used to fund the Floodprone Land Acquisition Program (FLAP) that began in 1984. FLAP is an effective nonstructural floodplain management tool that provides a number of community benefits. Some of these include removing residences and structures from vulnerable areas, preserving natural floodplain characteristics and attenuation of downstream flood peaks, providing recreational opportunities, maintaining open space, and protecting groundwater quality and riparian habitat resources. The District purchases property through FLAP solely on a voluntary basis without utilizing its land condemnation authority. The District has acquired Floodprone parcels along the Cañada Del Oro Wash, in Avra Valley, along the Black and Brawley Washes, and along the Santa Cruz River. The table below provides an overview of FLAP acquisition acreage and costs by fiscal year.

Table 73 - Floodprone Land Acquisition Program Summary

Fiscal Year	Land Purchased in Acres	Total Cost
FY 2014/15	246.92	$271,000
FY 2015/16	101.69	$172,180
FY 2016/17	313.06	$625,500
FY2017/18	411.36	$765,448
FY2018/19	525.01	$850,750
5 Year Total	1,598.01	$2,684,878

The District anticipates that funding for this program will continue.

The map below shows the distribution of acquired land as of 2017 in red and floodplains in blue.

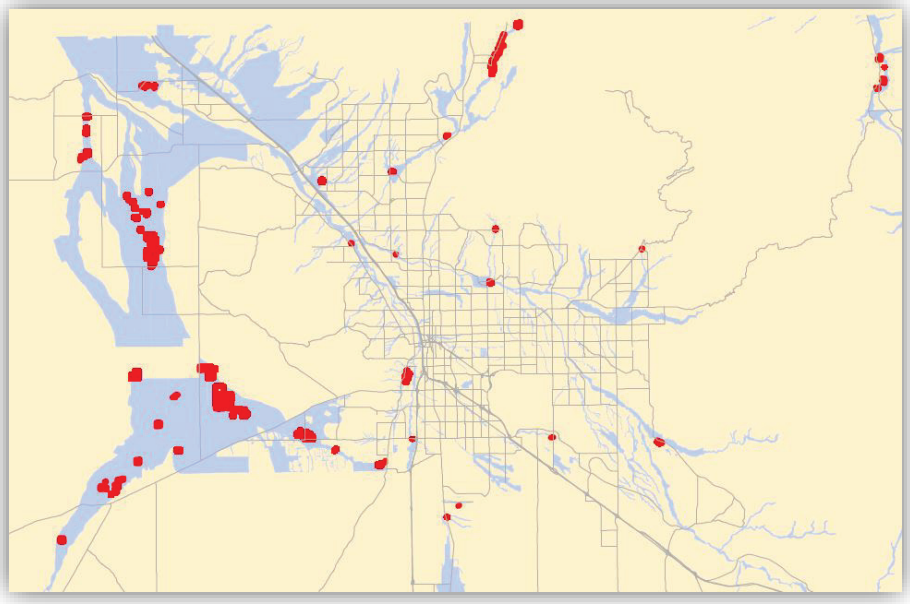
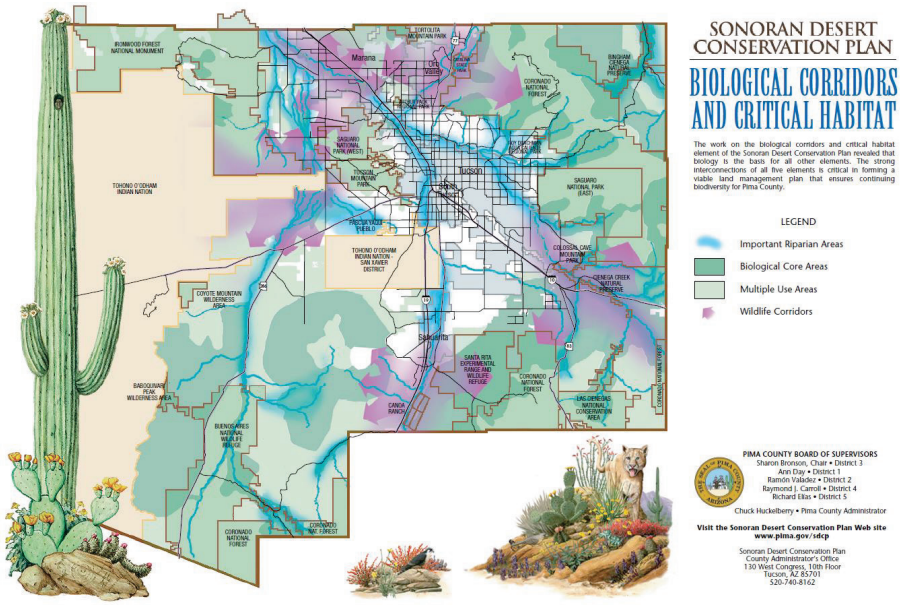


Figure 299 - FLAP Acquisitions

Seen below in context of preserves and regulatory context of the Sonoran desert Conservation Plan including Pima County Regulated Riparian Habitat and Maeveen Behan Conservation Lands System the true regional benefit becomes apparent.

Figure 300 - Maeveen Marie Behan Conservation Lands System



D.3.3 Flood Protection (CRS Activity 530)

The District's Capital Improvement Plan seeks to reduce future flood damage by utilizing bank stabilization, regional detention, engineered channels and floodprone land acquisition to address regional flood and erosion issues throughout incorporated and unincorporated Pima County. Due to the erosive nature of many regional watercourses, the District historically expended the bulk of CIP funds on bank protection. However, both structural and non-structural components of the plan contribute to the overall success.

The District constructs bank stabilization along major watercourses within Pima County where flood and erosion hazards threaten public and private development or infrastructure. Bank stabilization projects along major watercourses typically employ soil cement, which is a mixture of cement and local soil materials. Soil cement is a cost-effective flood and erosion control solution that has many of the strength characteristics of concrete. It also retains much of the appearance and textural quality of a natural riverbank that occurs in an arid landscape. Bank protection projects often include linear parks that provide a safe and attractive place for recreation. CIP expenditures during this program period reflect the high degree of public support for these projects.

Another structural flood control strategy used by the District is the construction of detention basins. Detention basins are facilities that allow for the temporary storage and measured release or metering out of floodwaters. Control of flows exiting a detention basin during a storm event significantly

decrease downstream flood peaks, and thereby minimize the potential for inundation in downstream areas. In most cases, basins serve multiple purposes including buffering, recreation and habitat.

The District's CIP for FY 2011 to FY 2016 included projects addressing flood and erosion control along the Santa Cruz River and Rillito Creek. The program also included urban infrastructure improvements to control drainage and repetitive flooding, channel improvements, linear parks, habitat restoration and substantial floodprone land acquisition.

While countywide flood control property tax projects, the citizenry is so supportive of flood control efforts that Pima County voters have approved bonds to provide for additional improvements. Below are descriptions of the projects completed within the last five years. Step 8.1 contains a list of CIP planned for the next five years.

Funding

The revenue from the District's tax levy provides the largest share funding for CIP projects. At the start of the reporting period, revenues from the District's property tax levy accounted for 91.8% of CIP funding. By the end, almost 98% of CIP funding came from the tax. Other sources of revenue include voter approved General Obligation Bonds and state grants. Federal matching funds of about $2 million from the Army Corps remained for completion of the Arroyo Chico project; however, the district received no new federal funds.

In 2004, voters for approved significant funds for five urban drainage projects and FLAP funds for open space acquisition. The District completed forty-six projects during the reporting period using revenue derived primarily from the property tax.

From the beginning of the reporting period in FY 2011/12 to the end in FY 2015/16, property tax revenue decreased for two years and then increased for two, ending at $21,462,804 annually. This is lower than the previous five-year period average.

Typical bank protection

Figure 21 on the following page shows the locations of projects in the list below, which the District completed during the current reporting period.

1. Arroyo Chico Final Phase – High School Wash Box Culvert Storm Drain;
2. Catalina Estate Drainage Way Improvements;
3. CDO River Park Thornydale to Magee;
4. City of South Tucson Urban Drainage;
5. City of South Tucson Urban Drainage;
6. Dakota Wash Erosion Control;
7. Green Valley Drainageway #6;
8. Green Valley Erosion Control;
9. Julian Wash Kolb Rd Pathway Underpass;
10. Los Reales Wash at SCR Channel Extension;
11. Lower Santa Cruz Levee Bank Repair;
12. Lower SCR Levee at Tangerine Rd;
13. Mission View Wash;
14. Pantano Wash Speedway to Tanque Verde;
15. Pantano Wash Watershed Study;
16. Paseo de Las Iglesias;
17. Pasqua Yaqui Tribe Black Wash Urban Drainage Improvements;
18. Rillito Riverpark Repaving between La Cholla Boulevard and Campbell Avenue;
19. Santa Cruz to Julian Connection;
20. SCR Continental Ranch Remediation;
21. SCR Grant Camino del Cerro River Park Drainage Improvements;
22. SCR Paseo de Las Iglesias Restoration;
23. SCR Watershed Study; and
24. Tucson Mall Linear Park.

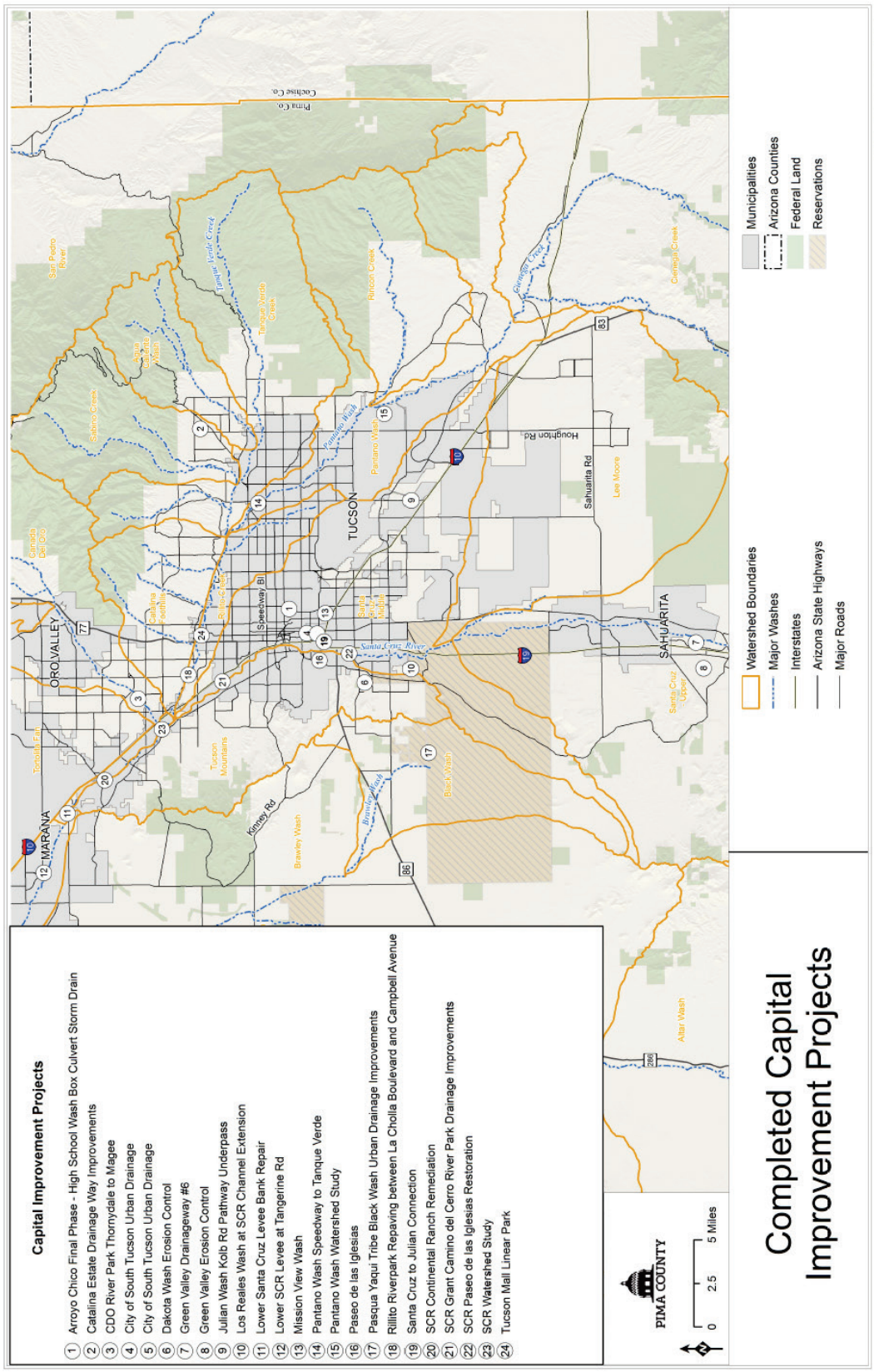


Figure 301 - Completed Capital Improvements Projects

The following table shows project expenses by year.

Table 74 - Capital Improvement Project Expenditures

Number	Name	2012	2013	2014	2015	2016	Total by Project
CFC.4FPDLI	FC - SCR Paseo de Las Iglesias Restoration USACOE	$1,263,649	$1,279,879	$ 490,058	$ (3)	$ (15,124)	$ 3,018,459
CFC.4FTVCS	FC - TV Creek Sabino Canyon to Craycroft USACOE		$ 172,787	$ 113,693	$ 4,487	$ -	$ 290,967
CFC.5AIRPO	FC - Airport Wash - Economic Development Zone		$ 46	$ 425,560	$ 306,025	$ 229,406	$ 961,037
CFC.5CDOLL	FC - CDO Pathway La Cholla to La Canada		$ 498,354	$ 936,504	$ 162,097	$ 825,568	$ 2,422,523
CFC.5CDOPK	FC - CDO River Park Thornydale to Magee	$ 162,485	$ 501,398				$ 663,883
CFC.5CDOTY	FC - CDO Linear Park - Thornydale Rd to I-10		$ 180,948	$ 418,974	$ 917,932	$ 520,734	$ 2,038,588
CFC.5CRLFR	FC - SCR Continental Ranch Remediation	$ 1	$ 356,513				$ 356,514
CFC.5FLPRA	FC - Floodprone & Riparian Land Acq	$ 92,268	$ 420,403	$ 301,959	$ -	$ (2)	$ 814,628
CFC.5JUCON	FC - Santa Cruz to Julian Connection		$ 150,597	$ 25,000			$ 175,597
CFC.5JWKRP	FC - Julian Wash Kolb Rd Pathway Underpass	$ 39,565	$ 560,431				$ 599,996
CFC.5LOSRW	FC - Los Reales Wash at SCR Channel Extension		$ 52,600				$ 52,600
CFC.5PWSTV	FC - Pantano Wash Speedway to Tanque Verde	$2,785,724	$ 691,798	$ 93,484			$ 3,571,006
CFC.5PWWSS	FC - Pantano Wash Watershed Study	$ 105,192	$ 27,081				$ 132,273
CFC.5RILPV	FC - Rillito Riverpark Repaving La Cholla Blvd-Campbell Ave			$ 710,324			$ 710,324
CFC.5SCRBR	FC - Lower Santa Cruz Levee Bank Repair				$ 335,000		$ 335,000
CFC.5SCRGF	FC - SCR Grant Cmno del Cerro River Park Drainage Imprvmt	$ 602,861	$1,223,348	$ 317,123	$ -	$ (2)	$ 2,143,330
CFC.5SCRLT	FC - Lower SCR Levee at Tangerine Rd	$ 61,820					$ 61,820
CFC.5SCWSS	FC - SCR Watershed Study	$ 133,448	$ 110,982	$ 38,292			$ 282,722
CFC.5SERAJ	FC - SCR Flood Control Erosion Control & Linear Pk Ajo to 29	$ 17,759	$ 163,501	$ 6,406,829	$6,032,759	$1,638,968	$ 14,259,816
CFC.5TMALL	FC - Tucson Mall Linear Park		$ 17,461				$ 17,461
CFC.5UDPYT	FC - Pasqua Yaqui Tribe Black Wash Urban Drainage Imprvmt		$ 1,363	$ (484)	$ 445,411		$ 446,290
CFC.5UDSTU	FC - City of South Tucson Urban Drainage	$ 3,267					$ 3,267
Total by Year		$5,268,039	$6,409,490	$10,277,316	$8,203,708	$3,199,548	$ 33,358,101

The District typically constricts projects in phases due to the complexity, cost and the mix of funding sources. For example, the Arroyo Chico Flood Control Project was a $31.6 million project with the USACOE, to relieve flooding along Arroyo Chico and tributary washes in central and downtown areas within the City of Tucson. The project was two phase: Phase I included the construction of the Randolph South Detention Basin, which was completed in 1997 at a construction cost of $7 million; and Phase II includes construction of four detention basins along the Arroyo Chico upstream of Park Avenue and a new storm drain system for High School Wash. The District completed construction during the reporting period, in spring 2015.

CIP Project Highlights

The following sections describe the projects completed during the reporting period. Large, on-going projects not completed prior to June 30, 2016 are also included. Figure 23 shows the location of each project. The individual watershed maps series contained in Appendix C Projects also depicted existing and budgeted capitol projects.

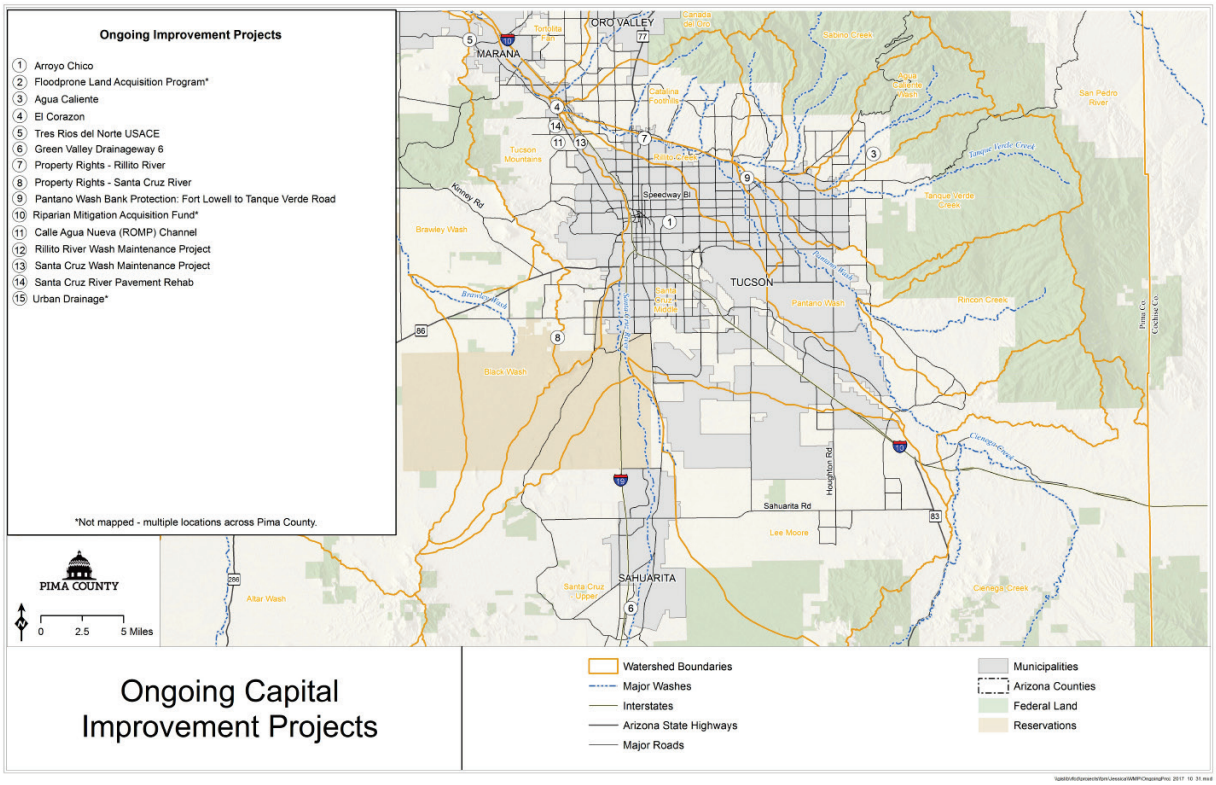
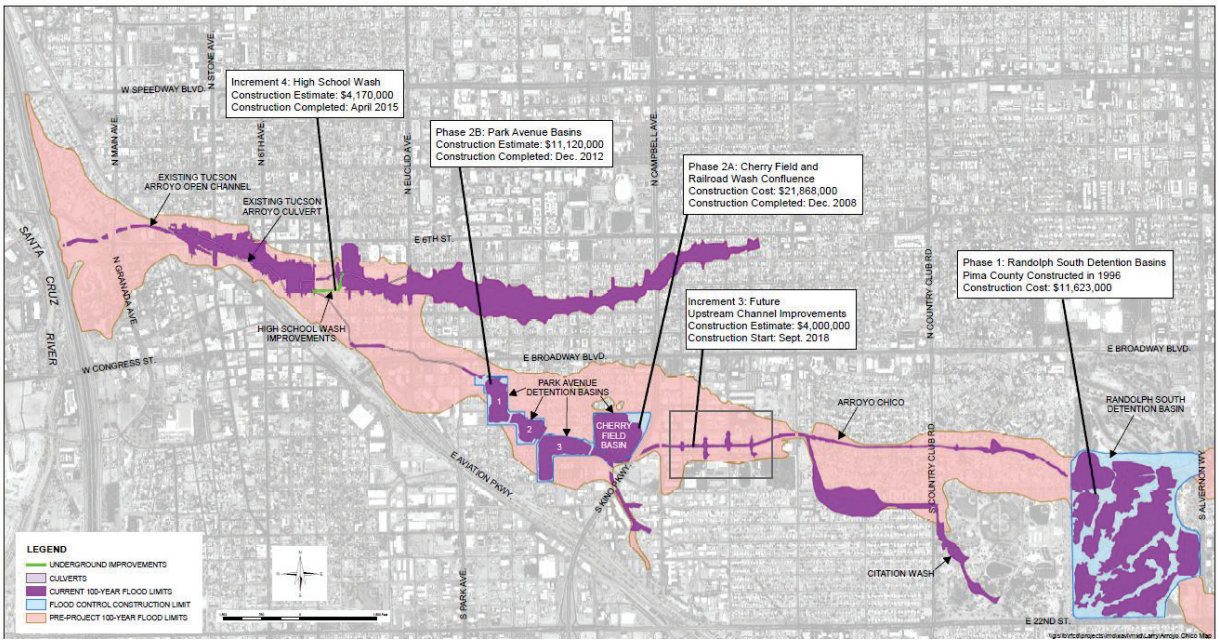


Figure 302 - Ongoing and Planned Capital Improvements Projects

Arroyo Chico Final Phase – High School Wash Box Culvert Storm Drain

The District and the City of Tucson, in cooperation with the USACE, have jointly undertaken a multi-phase flood control, environmental restoration and recreation project called the Tucson Drainage Area/Arroyo Chico Multi-Use Project. The phases of the project are Phase 1, Randolph South Detention Basins, completed in April 1996 by the District and the City of Tucson. Phase 2A, Cherry Field Detention Basin, completed in December 2008 by the USACE. Phase 2B, Park Avenue Detention Basin Complex, completed by the USACE in December 2012. Increment 4, High School Wash Storm Drain) started construction on June 2, 2014 and was completed in 2015.

Figure 303 - Arroyo Chico Phasing Plan



The High School Wash large box culvert is part of the contracted Phase 2B improvements. Using federal funds authorized on June 24, 2013, construction began on June 2, 2014 and completed in March 2015. At the request of the City of Tucson, the Board authorized an additional $1,500,000 for the District to construct drainage improvements in the form of enlarging a section of the main storm drain to handle additional flood flows and the addition of catch basins to remove street runoff, thereby reducing downstream flooding. The total cost of this additional work was $1,921,165.

The High School Wash box culvert storm drain consists of a 776 linear foot box culvert (12 ft. x 8 ft. and 10 ft. x 8 ft.) that connects with the existing 1930s vintage (10 ft. x 7.5 ft.) concrete box culvert located under Tucson High School. With the recently completed City of Tucson/Regional Transportation Authority (RTA) 8th Street Drainage Improvements that ended at 4th Avenue, the new storm drain efficiently moves storm flow from the inlet at Euclid east of Tucson High School into the new 8th Street storm drain system and ultimately into the Santa Cruz River. The project will significantly reduce

flooding around Tucson High School and the 4th Avenue business district. The estimated cost for construction of this increment was $4.2 million. The District completed this project in spring 2015.

Cañada Del Oro River Park – Thornydale to Magee

Cañada Del Oro Wash is now bank protected from the Union Pacific Railroad on the south bank and from just west of Thornydale on the north bank to the Omni Tucson National Golf Resort. The project provided a river linear park between Thornydale Road and Magee Road plus a paved bike path connection to the Rillito River Park via Thornydale Road. It includes a paved pathway on both sides of the river, landscaping, irrigation, and six pedestrian bridges. There are also underpass ramps at Thornydale and Ina Road, a parking node at Magee Road with ramadas and a restroom, a parking easement at Thornydale, as well as a reclaimed water irrigation system.

Bank protection under construction

Lower Santa Cruz River Levee at Tangerine Road

The District completed improvements to the Lower Santa Cruz River Levee at Tangerine Road for $61,820. Constant low flows had degraded the flowline along a section of the Santa Cruz River to within a couple of feet of the existing toe of the bank protection. This project included relocation of the thalweg by replacing material against the existing bank that had been lost during previous large storm events. The design included placing riprap groynes to direct low flows away from the bank and create a thalweg that does not run adjacent to the toe of bank and to help re-establish protective vegetation along the bank. The District awarded the contract for project on March 5, 2012. Construction started immediately and completed by April 10, 2012. The District completed this project within schedule and for roughly 15% of the estimated cost. This is because the estimate was for extending the toe down depth. Switching to groynes saves cost and had the added benefit that a Section 404 permit would not be required.

Groynes placed to shift the low flow channel and allow vegetation to grow

Pantano Wash Phase 2 – Speedway to Tanque Verde Road

Construction of bank protection along Pantano Wash started November 2011 and completed in February 2013. The project included the construction of 4,300 linear feet of new soil cement bank

protection and paved river park pathways, landscaping, irrigation, and new underpasses at Tanque Verde Road and on the west bank at Speedway Boulevard. The project is located on the Pantano Wash between Speedway Boulevard and Tanque Verde Road.

Paseo de Las Iglesias

Phase 1 of the Paseo de las Iglesias project, located along the Santa Cruz River from Ajo Way to Silverlake Road, and funded by the 2004 Bond Election. Construction began in November 2013 and included extensive removal of buried and exposed debris and clearing of invasive species prior to the beginning of bank protection construction, completed in 2017. Work was also performed to clean and bank protect Julian Wash, expand Mission View Wash and begin construction of gabion terraces and culverts on a minor tributary south of Mission View Wash. Grading was performed on the top of banks to begin construction of the parking areas and restroom as well as staking for pathway and landscape irrigation lines. The artists selected to create public art for the project made site visits and began construction of their pieces for the site. The District coordinated multiple onsite tours for groups such as Pima County, the U.S. Army Corps of Engineers (USACE), Arizona Department of Transportation, Tucson Electric Power, University of Arizona, and the Arizona Riparian Council Conference.

Santa Cruz River – Grant to Camino Del Cerro

With the bank protection completed primarily before this reporting period, the Board authorized additional work, including installation of pedestrian bridges pictured here and paved pathway on the east bank.

This is another example of the District's flood safety projects providing multiple benefits including flood control, recreation, open space, riparian habitat corridors and neighborhood stabilization.

Pantano Wash Fort Lowell Road to Tanque Verde Road Flood Control Improvements

In February 2018, the District along with its design consultant Psomas and contractor Borderlands completed the Pantano Wash Bank Protection and River Park project. The contractor completed the project under budget, saving the District $400,000. The Pantano Wash Bank Protection and River Park Project, located along the Pantano Wash between Ft. Lowell Park and Tanque Verde Road provided:

- Construted bank protection along the banks of the Pantano Wash to protect from flooding and erosion hazards,
- Stabilized the channel bed,
- Provided River Park and passive recreational improvements that completed the Loop (a 131-mile urban paved pathway alternative transportation and recreational system along the major watercourses at connect and encompasses the Tucson metropolitan area).
- Protected riparian habitat within the existing flood prone lands,
- Developed a new restoration area which utilized storm water harvesting in a formerly degraded depression,
- Utilized storm water harvesting basins throughout the project,
- Reused onsite inert debris to create lizard habitat,
- Reused onsite inert debris and rejected cobble material for slope erosion protection,
- Provided public art, sitting areas and interpretive signage.

Sunrise at the new pedestrian bridge over Rose Hill Wash, showcasing its river inspired public art.

The project that closed the final gap in the Chuck Huckelberry Loop received a "Project of the Year" honor from the Southern Arizona Branch of the American Public Works Association. Funding for the $8.2 million project came from the Pima County Regional Flood Control District tax levy, a secondary property tax.

The completed and current CIP is shown on each watershed map in Step 5 and on the project webpage.

D.3.4 Drainage System Maintenance (CRS Activity 540)

Maintenance of improvements and open space is a significant component of the District budget and activity. FEMA defines the Drainage System as improved or natural drainages that require maintenance in order to prevent property damages. County wide there is 25,562 acres in this drainage system. This includes portions of the system located within incorporated areas that the District maintains. These are largely located along the major river corridors.

Infrastructure Division staff routinely conducts field inspections of the District's drainage structures for all major watercourses and regional detention/retention basins. As part of this program, District staff compiled a resource base of all construction plans for bank protection, levees, grade control structures

and detention/retention basins. In order to monitor potential structural failure inspection staff created a cross-referenced filing system for inspection documentation including digital photographs.

The Chief Engineer approved a series of technical policies during the program period that establish infrastructure inspection and maintenance procedures. Infrastructure Management staff inspects, maintains and repairs watercourses and associated improvements that are owned or operated by Pima County or the District per these procedures. Tasks include repairing constructed improvements, removing sediment buildup, clearing vegetation and other debris, maintaining drainageway access roads, and grading channels to provide positive drainage. District Water Resources Division staff complements these drainageway inspections by monitoring natural areas. District Floodplain Management Division staff is also involved when investigating drainage complaints.

When internal resources are not available, contractors may be used. Additionally, through Inter-Governmental Agreements, the District maintains major watercourses, bank stabilization and other improvements within the City of Tucson, and the towns of Oro Valley and Marana. When conducting maintenance work, the District obtains appropriate permits from the USACE and notifies the U.S. Fish and Wildlife Service.

With sediment management becoming an ever-larger portion of District activity in major and minor watercourses, the following excerpt from the 2017/2018 District Annual Report emphasized this role.

Alamo Wash Sediment Removal

In April 2018, the District began removal of approximately 5,000 cubic yards of sediment in the Alamo Wash where it meets Rillito Creek just east of Swan Road. The project seeks to prepare the confluence ahead of the Monsoon, which brings more than half of the Tucson area's annual rainfall. A buildup of sand at that spot has lowered the capacity of the wash to handle storm runoff.

Contractors preserve stands of desirable vegetation while removing invasive species and other plant life that could contribute to flooding or hamper Flood Control's response. County-contracted herpetologists scoured the area and relocated dozens of lizards and other reptiles prior to commencement of work.

D.4 Flood Warning and Response (CRS Activity 600)

The 2017 score for this activity is 3,492 up 45 from the prior audit.

D.4.1 Flood Threat Recognition and Early Warning Dissemination

The District has advanced an Automated Local Evaluation in Real Time (ALERT) system that is the linchpin in the District's Flood Threat Recognition (CRS Activity 611) and Early Warning Dissemination (CRS Activity 611). The District's *Flood Response Field Manual* describes response procedures and needs in detail. Staff substantially updated it in November 2016, with interjurisdictional coordination described in the Pima County Hazard Mitigation Plan and Emergency Response and Recovery Plans, Dam O&M Plans.

Road Closure Due to Flooding

As one of our most used services, the District's ALERT Flood Threat Recognition System has been providing precipitation and stream flow data from a series of gages located throughout Pima County since 1981. The ALERT system is part of a three-way agreement with the National Weather Service, the Arizona Department of Water Resources (ADWR) and the District. The ALERT system initially provided advanced warning of potential flood flows on the Upper Cañada Del Oro watershed from a breach of the

Golder Dam. Federal and state financial assistance combined with funding from the District has allowed us to expand the ALERT system.

The system of gages now covers most of the large watersheds in eastern Pima County and currently includes 94 precipitation gages, 36 stream gages, and 5 weather sites. The precipitation gages relay rainfall amounts and intensities, stream gages measure the depth of flow in streams, and weather stations provide precipitation information plus wind speed, temperature, relative humidity and barometric pressure. This network of automated gages transmits data in real time to the District, NWS, and the ADWR office in Phoenix. The NWS uses this data to produce flash flood watches and warnings and ground-truth radar estimates of precipitation. District personnel utilize the information to assist emergency response agencies including the Pima County Department of Transportation's Maintenance Operations staff and the Office of Emergency Management during storm events. The public and responders may view data generated by these sites at:

https://alertmap.rfcd.pima.gov/gmap/gmap.html

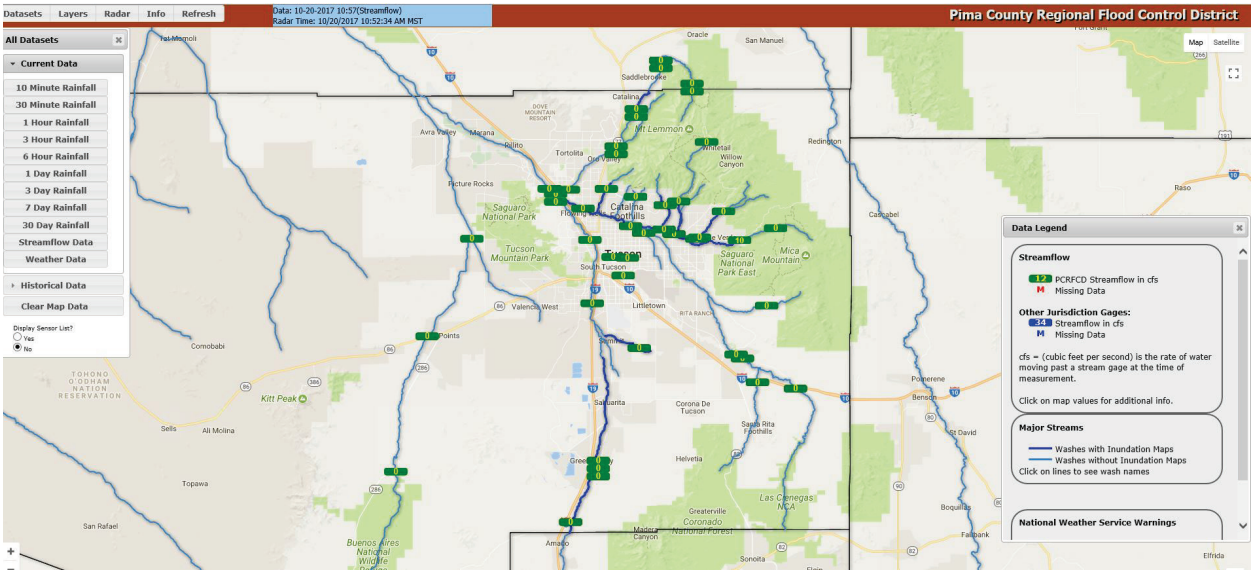


Figure 304 - Screen Capture of ALERT Webpage

The rapid development of floods in many watersheds poses a significant challenge to adequate flood warning and as such, calibration of travel times as become a priority for the District in recent years. The table on the next page provides a summary of critical discharges and early warning criteria for known locations**.** The *Flood Response Field Manual* provides full operational details.

Table 75 - Early Warning Discharges

Flood Threshold Known to be Less Than 100 Year Flood			
Watercourse	Flood Level Threshold	100 Year	Critical Areas
Tanque Verde Creek	7,000 cfs (6.6 ft at 2093)	16,000 cfs 13.0 ft at 2093	South Bank – Tanque Verde Loop Rd to Houghton Rd
Tanque Verde Creek	8,000 cfs (7.0 ft at 2093)	16,000 cfs 13.0 ft at 2093	49ers Subdivision (North bank, west of Wentworth)
Tanque Verde Creek	11,000 cfs (4.2 ft at 2093)	16,000 cfs 13.0 ft at 2093	Woodland Rd Area (North bank near Tanque Verde Rd Bridge)
Tanque Verde Creek			
Cañada Del Oro Wash	2,000-2,500 cfs (7.1-7.6 ft at 1079/1083)	17,500 cfs (7.25 at 1103*)	West Bank – just south of Meadowcrest alignment
Cañada Del Oro Wash	2,000 cfs (7.1 ft at 1079/1083)	17,500 cfs (7.25 at 1103*)	West Bank – just north of Hauser Street alignment
Cañada Del Oro Wash	875-1,500 cfs (5.2-6.4 ft at 1079/1083)	17,500 cfs (7.25 at 1103*)	West Bank – just south of Golder Ranch Rd Bridge
Cañada Del Oro Wash	1,500-2,000 cfs (6.4-7.1 ft at 1079/1083)	17,500 cfs (7.25 at 1103*)	West Bank – just north of Rollins Rd
Rincon Creek	1,000 cfs (5.5 ft at 4113)	16,000 cfs (12.5 ft at 4113)	Ranchos Pequenos Subdivision

The improved website is more user friendly, presents our ALERT data more reliably and offers much more information to assist local communities, public safety agencies, researchers and the public about current weather conditions. The website provides real-time data from the streamflow and weather-monitoring stations run by the District and partner agencies, including National Weather Service, U.S.

Geological Survey, Arizona Game and Fish, and Pinal, Cochise and Santa Cruz Counties. The list of available cooperator sites continues to expand and will be added as they become available.

The map display is built on a Google Maps structure which provides an easy to navigate, up-to-date map that can be viewed in either street- or terrain-view, and can display satellite imagery. Additionally, current radar images, both static and animations, can be displayed on the map along with National Weather Service storm warnings which appear on the map as a box outlining the affected area(s). At this time, flow depths and inundation areas including flood prediction are not available on a countywide basis.

During the previous five years, numerous rainfall events resulted in road closures and roadway damage. This required close communication with the Pima County Office of Emergency Management, the Pima County Department of Transportation, and the NWS.

The ALERT system also guides emergency response by identifying where people, infrastructure and critical facilities may be in danger from the rising floodwaters. In addition to triggering warning and notifying responders, the District responds directly by dispersing staff to flooded locations to inspect infrastructure and respond to complaints or other calls for assistance.

The District *Flood Response Field Manual* (Administrative Procedure 202) guides staff conducting Flood Response Operations and includes forms for gathering information, handouts relating to flood recovery, cameras and checklists of places and criteria for record keeping. A levee and dam specific plan (CRS Activity 620/630) is contained in the "O & M Report". The Pima County Recorder's office has the O & M plan recorded in Docket 13162 at Page 701. A list of levees and dams maintained by the District is also included in the Flood Response Plan for reference by staff conducting flood investigations.

Since residents may not be familiar with which roads are impassible during flooding, the Program for Pubic

Information committee has emphasized the need to increase outreach relating to road closures. The maps attached to our annual floodprone property owner mailing now include frequently flooded roads for route planning purposes. Figure 26 below shows this information.

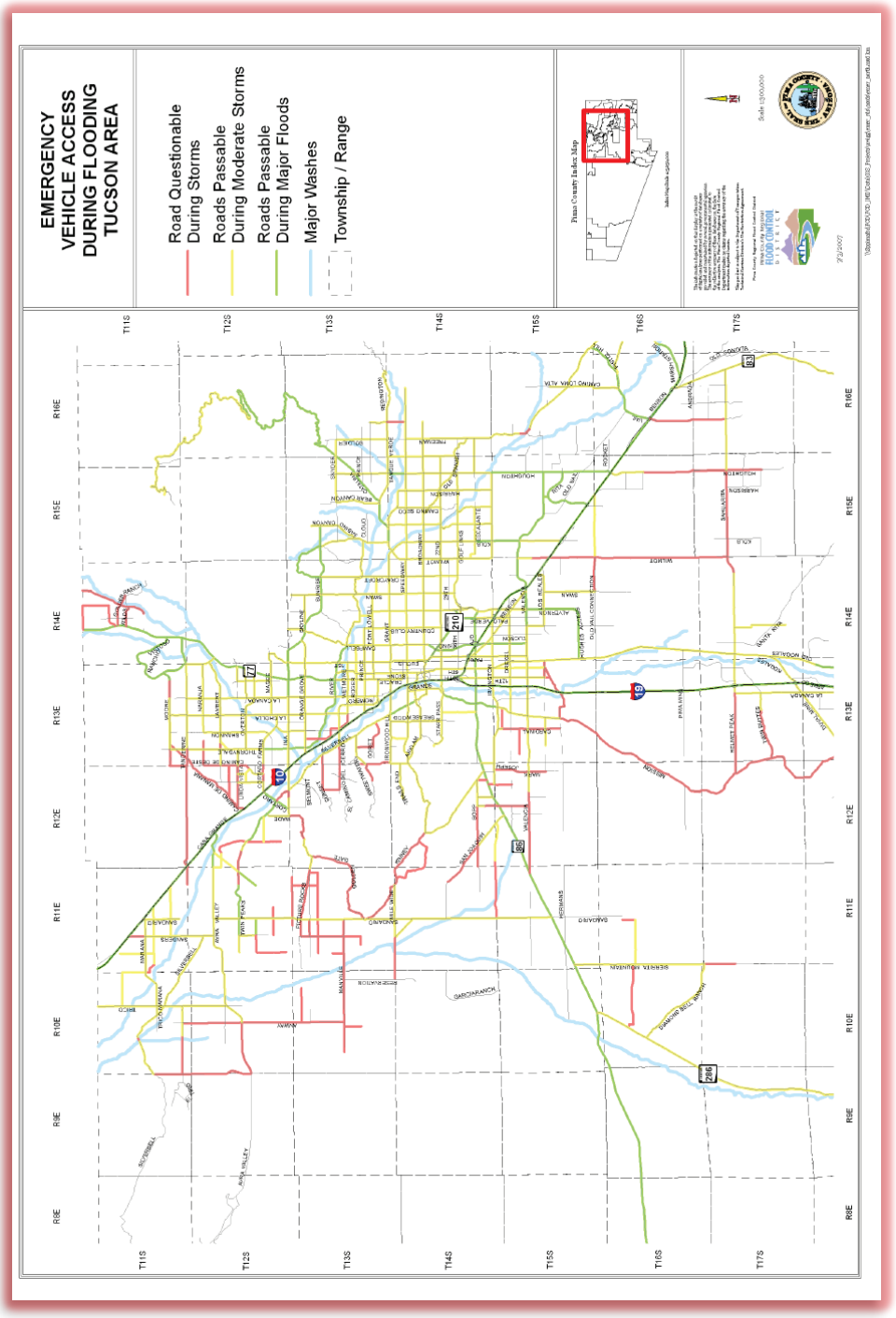


Figure 305 - Map of Frequently Flooded Roads

The County maintains a road closure website and hotline, issues press releases and includes maps for frequently flooded roads in direct mailers to the community. The ALERT page allows residents; drivers and responders to determine when they should avoid certain wash crossings.

D.4.1.1 Rain Gage Volunteer Program

Since 1977, the District has operated a system of volunteer weather watchers, known as rain gage volunteers. The District provides participants in the program with a standardized rain gage and data sheets to record daily rainfall information. Participants may also provide information about the duration and amount of each storm. Volunteers submit the data to the District every two months, at which time they are compiled and recorded. Since July 2006, the network has averaged approximately 60 volunteers distributed across the entire metropolitan and outlying areas.

D.4.1.2 Flood Preparedness

The District, in cooperation with the USACOE, Arizona Department of Water Resources, and other state and local agencies continues working to develop the communication aspect of a statewide flood warning system. District staff participates in the Multi-Agency Task Force committee, which provides communication activities between jurisdictions and coordinate development and updating of the HMP and Emergency Response and Recovery Plan.

D.4.2 Levees (Activity 620)

Section 5.3 reports the estimated population, number and value of buildings and critical facilities located behind levees. In 2019 for the first time the District expanded direct mailing outreach to these residents. This outreach included information on risks, availability of insurance, flood preparation and warning dissemination. This was a target audience identified in the 2019 PPI and appropriate because of the implementation of MyAlerts.com for direct warning notification. The District provided this notification to 2,192 properties, including to those in incorporated areas of Marana and Tucson, as well as unincorporated areas.

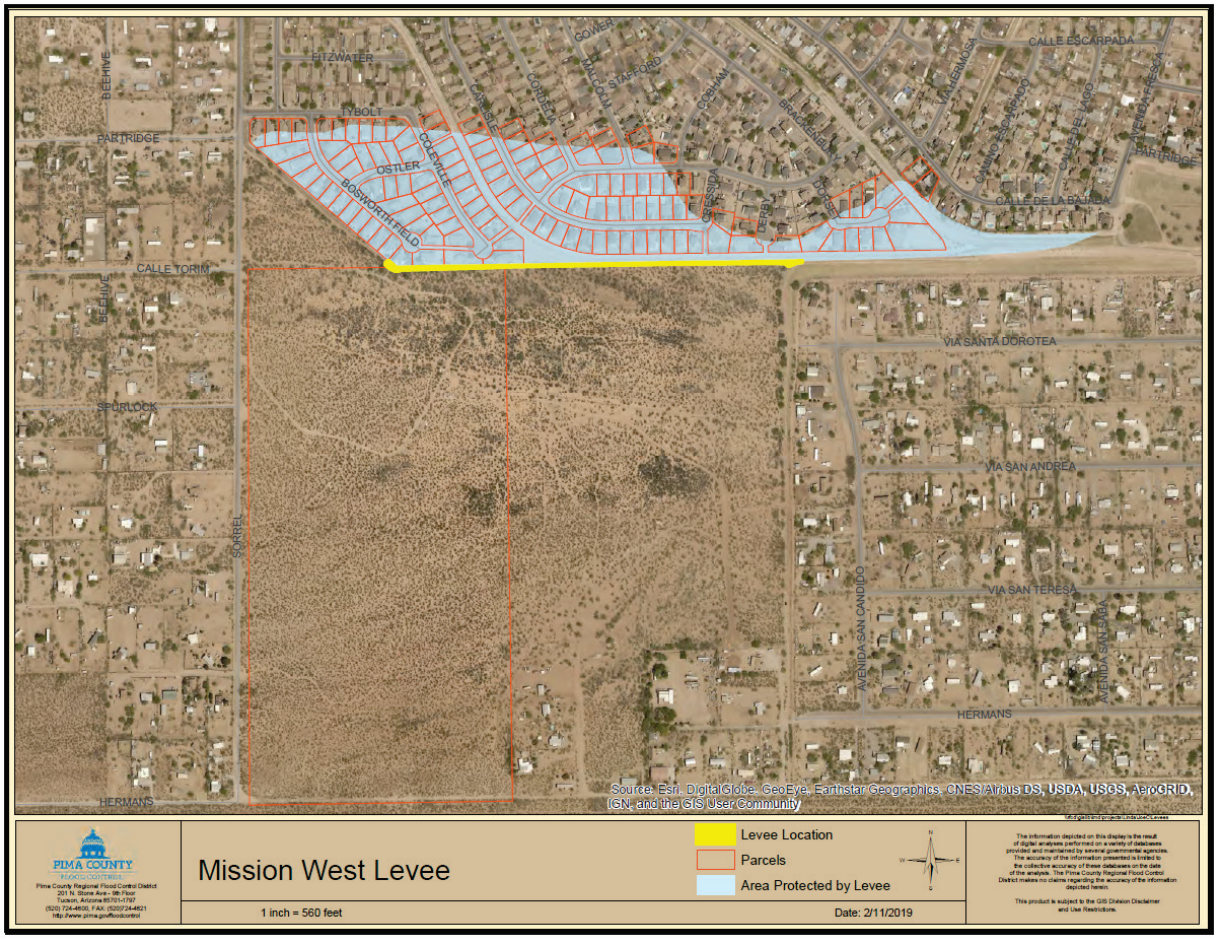


Figure 306 - Sample Levee Outreach Map

D.4.3 Dams (Activity 630)

The table below shows dams licensed by the Arizona Department of Water Resources.

Table 76 - Licensed Dams

National ID	State ID	Dam Name	Hazard Level	Owner
AZ00217	10.14	Murphy Reservoir	high hazard	Tucson Water
AZ00026	10.13	Kennedy Park	high hazard	PC
AZ00080	10.07	Leach Flood #1	high hazard	Phelps Dodge
AZ00210	10.16	Clearwell Reservoir	high hazard	Tucson Water
AZ00307	10.2	Park Avenue (aka Arroyo Chico)	high hazard	COT
AZ00265	10.18	The Lake	low	State
AZ00264	10.17	Twin Tanks	low	State
AZ00209	10.15	Green Valley WWTP	low	PC
AZ00132	10.08	Lower Rose Canyon	low	NPS
AZ00131	10.12	Arivaca	significant	AZGFD
AZ00273	10.19	Avra Valley WWTP	very low	PC

Appendix E - Planning Committee Meeting Minutes

December 6, 2018

Attendees:

Arlan Colton, University of Arizona Planning Program
Brian Jones, PCRFCD
Brian Powell, Natural Resources Parks and Recreation Department
Carolyn Campbell, Coalition for Sonoran Desert Protection
Catlow Shipek, Watershed Management Group
Chris Gurton, Country Financial
Christina McVie, Tucson Audubon Society
Clair Zucker, University of Arizona Water Resources Research Center
Craig Civaler, Community Water Coalition
Diana Durazo, Pima County Administration
Eric Holler, Community Water Coalition
Eric Shepp, Pima County Regional Flood Control District
Evan Canfield, PCRFCD
Griselda Maya-Flores, PCOEM
Ian Sharp, Farmers Investment Company
Ivy Schwartz, Tucson Mountain Association
Jason Ground, Pima County Communications
Jeff Guthrie, Pima County Office of Emergency Management
Jonathan Horst, Tucson Audubon Society
Joseph Cuffari, PCRFCD
Lola Graeme, Catalina Foothills Association
Matt McGlone, PCOEM
Nicole Fyffe, Pima County Administrator's Office
Sandra Espinoza, PCOEM
Shawn Cote, Southern Arizona Homebuilders Association
Steve Dolan, Tucson Mountain Association
Shane Clark, Pima County Office of Emergency Management
Terri Tillman, Pima County Development Services Department
Tim Campbell, Farmers Investment Company

1) Welcome & Introductions – Eric Shepp, Floodplain Administrator

   Mr. Shepp provided a history of the County's involvement with CRS.

2) FMP Project Overview Powerpoint – Greg Saxe, CRS Coordinator

   Mr. Saxe provided a project overview focusing on the role of the Planning Committee, schedule and intent to seek Board adoption of the final plan. Requested names of additional stakeholders and location for informational meetings.

3) Election of Chair, Adoption of Roberts Rules and Consensus Decision Making

   The Committee agreed to have the CRS Coordinator Chair the meetings in order to keep them on-track, and agreed to consensus decision-making.

4) Meeting Schedule

Members expressed concern that the schedule was ambitious and acknowledged that involvement was not just for the creation process but also implementation period. The District agreed that the schedule may be ambitious, but that it has hazard and exposure information already for Committee consideration. The organization and delivery of this information to the Committee for review will be key in meeting timeframes while ensuring feedback is substantive. Committee members are asked to invite the District to provide informational meeting for their respective groups. A sample watershed hazard assessment shall be prepared for the Catalina Foothills for presentation at the Catalina Foothills Association meeting in January, 2019. This example will be made available to the Committee via the website for input on information included and act as a format template, prior to completing the assessments for the remaining watersheds.

5) Questions

a) OEM suggests inclusion of Nogales Wash and dam Emergency Action Plans (EAP). (Jeff)

Watersheds upstream of and impacting Pima County are included in floodplain studies for modelling and mapping purposes and other issues may be identified through this process. Emergency Action Plans will be referenced including inundation areas and warning systems.

b) How will jurisdictions be involved? (Arlan)

Jurisdictions will participate as stakeholders and outreach will occur specifically to them, in addition to providing updates to the Flood Control District Advisory Committee.

c) Will the plan be submitted to FEMA?

Yes, as part of the National Flood Insurance Program (NFIP) Community Rating System (CRS). This will include courtesy submittals to the Insurance Services Organization/Verisk Analytics (ISO) Technical Reviewers for guidance at major project milestones and for rating purposes after approval by the Board. FEMA then provides a letter to the County Administrator indicating our score and associated discount rates.

d) What other plans will be incorporated? Include Pima Association of Governments 2045 Road Plan and tie to the County Comprehensive Plan. DSD to provide contacts.

As part of step 2, “Involve the public” the District is requesting that Committee Members provide the names of plans to include and interested stakeholders to be contacted individually. Pima Prospers and transportation plans are appropriate. The Flood and Drainage Element of Pima Prospers is significant, along with the Conservation Lands System, Water and Economic Development elements. A bibliography and list of studies by watershed will be posted to the project webpage and included in the draft plan.

Later, as part of step 4, “Assess the hazard” and step 5, “Assess the problem”, the Committee will be asked to identify available information on flood hazards specifically related to the constituency represented, along with any data that demonstrates gaps in floodplain management activities. Organizational mission and goal statements will be useful in step 6, “Set goals” and specific project needs in step 7, “Review possible activities”.

e) Additional recommended stakeholders: PAG, PCDOT, Taylor Lane Neighborhood, Tribes, Oro Valley (Chloe Olivares), School Districts, *Green Valley Coordinating Council, Western Pima County Council (Ajo), Southeast Community Council, Altar Valley Conservation Alliance, NRCS, ADOT, Pima County Community Development (Daniel Tylutki), Pima County Housing (Marcos Ismael), School Superintendent’s Office (Matt Stamp), Sonoran Institute, Bureau of Reclamation*. (Those italicized provided in follow up emails to date)

   During the next several months the District will conduct direct outreach to additional stakeholders and written records of input shall be kept and summarized for the Committees consideration in step 6, “Set goals” and step 7, “Review of possible activities”.

f) Recommendation from OEM to use Nextdoor Neighbor App to advertise and solicit input.

   The District will coordinate with OEM and Communications, as well as Program for Public Information (PPI) partners and stakeholders to identify effective use of social and electronic media and implement those programs as part of this planning process.

Adjournment

April 15, 2019

Members in Attendance:

Allyson Solomon, Metropolitan Pima Alliance
Arlan Colton, University of Arizona Planning Program
Carolyn Campbell, Coalition for Sonoran Desert Protection
Catlow Shipek, Watershed Management Group
Chris Gurton, Country Financial
Christina McVie, Tucson Audubon Society
Craig Civaler, Community Water Coalition
Eric Shepp, Pima County Regional Flood Control District
Griselda Moya-Flores, Pima County Office of Emergency Management
Ian Sharp, Farmers Investment Company
Ivy Schwartz, Tucson Mountain Association
Jason Ground, Pima County Communications
Nicole Fyffe, Pima County Administrator's Office
Sandra Espinoza, Pima County Office of Emergency Management
Shane Clark, Pima County Office of Emergency Management
Steve Dolan, Tucson Mountain Association

Others in Attendance:

Brian Jones, PCRFCD
Ann Moynihan, PCRFCD
Joseph Cuffari, PCRFCD

April 15, 2019

1) Welcome & Introductions – Chairman Saxe welcomed the Committee, thanked them for attending and the group introduced themselves.

2) Project Schedule – The CRS Coordinator provided a progress report and shifting target dates using the project PowerPoint presentation updated for this meeting. It is available on the project webpage at www.pima.gov/fmp.

3) Presentation of Flood Hazards
   a) General Overview of Hazards – Staff provided a description of the hazards included and asked members to identify gaps and fill them with any available hazard information prior to the next meeting.
   b) Map Displays by Watershed – Sample maps characterizing the scope of completeness and accuracy issues were described along with demonstrating how to access the full map sets on-line. Paper copies were also distributed.

4) Discussion and Recommendations for Additional Hazard Identification
   a) Staff provided examples of needed studies, asked members to determine if the scope was appropriate and whether or not they are aware of additional hazard data which should be included prior to conducting the problem/exposure assessment.

5) Hazard Exposure Introduction
   a) Using the PowerPoint presentation as a discussion guide staff presented the information to be included in the problem exposure assessment including as population, building counts, critical facilities, zoning and land use. Members were asked to determine of the scope of queries were appropriate and if any particular cohorts should be evaluated.

6) Questions
   a) The Watershed Management Group representative Catlow Shipek asked: What was the original basis of the Erosion Hazard Setbacks and are they sufficient?
   b) Coalition for Sonoran Desert Protection (CSDP) and Audubon representative Chris McVie noted that drones may be useful for inventorying braided washes.
   c) CSDP representative Carolyn Campbell asked what happens when an EHS determination is submitted by a private party.
   d) Community Water Coalition representative Craig Civalier asked if other jurisdiction are using the same EHS methods.
   e) McVie - What frequency event is associated with the discharge rates used in calculating EHS?
   f) McVie - How can we look at climate change?
   g) Civalier - How can we evaluate floodplain storage capacity?
   h) OEM comment (Griselda) The definition of Critical facility depends upon the community (e.g the only gas station).
   i) Colton – What social equity factors are to be considered? Contact Daniel Tyluki to initiate conversation and find stakeholders.
   j) Colton- Zoning not good, use something else for future growth such as Municipal General and County Comprehensive Plan designations, and the Imagine Greater Tucson

Preferred Growth Scenario. Recommends a sub-team to make determination as to what is and is not committed and how future growth should be depicted.

k) McVie – Don't forget maintenance needs.
l) OEM – Need to do press for floodplain resident mailer
m) OEM – Recommends using NextDoor Neighbor geocodes for social media outreach. District staff to participate in social media training at OEM and to utilize the County Communications Office.
n) WMG/OEM need simplified action specific outreach for stakeholders to leverage participation of their constituents and to define what feedback is needed and how it should be provided.
o) WMG "Give people something to react to". Schedule meetings to focus on specific watersheds, especially in economically diverse areas.
p) OEM – Coordinate survey tools and project outreach with Monsoon Awareness Week.
q) WMG – Christmas Wash Watershed drains to Rillito, not MSCR.

7) Adjournment

Action Items:

1. Prepare simple stakeholder input form for use at front counter and for distribution to public spaces such as libraries.
2. Schedule working sessions on individual watersheds.
3. Schedule next Planning Committee meeting for June. Focus will be on presenting problem and exposure assessments for each watershed.
4. Correct Rillito watershed boundary.
5. Mail project notification and survey to all residents and businesses in the floodplain.
6. Conduct problem/hazard assessment and prepare detailed maps for public meetings on individual watersheds.

FMP Project Update and Hazard Assessment Information Recommendations

Community Engagement:

Since the first Committee meeting held December 6, 2018, District staff has participated in the following informational and special meetings with stakeholders as follows:

- Pima Association of Governments Environmental Planning Advisory Committee – Dec 7, 2108 Informational Announcement.
- Catalina Foothills Association – January 29, 2019
- Community Water Coalition Lower Santa Cruz River Recharge and Oxbow Restoration Sites Tour – February 11, 1019
- Tucson Estates Property Owners Association Informational Meeting – February 27, 2019
- Tucson Mountain Association Board - March 26, 2019

Hazard Assessment:

Using best available data, the District has created maps depicting known flood hazards for each of the watersheds to be included in the plan. These maps will be presented in the April 15, 2019 meeting at the District offices and are available for stakeholder review in advance of the meeting on the project website at www.pima.gov/fmp.

In addition to shaded relief, jurisdictional and watershed boundaries the hazard maps show the following hazard information:

- Watercourses: The line-type, as shown in the legend, indicates the associated default Erosion Hazard Setback which is determined by the watercourses base flood peak discharge rate.
- Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas, including floodplains and floodways in blue.
- Pima County Local Study Floodplains in pink.
- Pima County Regulated Riparian Habitat in green.

The District requests that stakeholders review these maps in advance of the meeting with emphasis on areas with which you are concerned and or have specific knowledge. The goal is to share with the District and other stakeholders any comments or concerns regarding the existing information, provide additional relevant information regarding hazards which should be considered, and recommend future hazard assessment projects that can be incorporated into the overall plan recommendations.

July 22, 2019

Members in Attendance:

Arlan Colton, University of Arizona Planning Program
Carolyn Campbell, Coalition for Sonoran Desert Protection
Catlow Shipek, Watershed Management Group
Chris Bertrand, San Xavier District of the Tohono O'odham Nation
Chris Gurton, Country Financial
Christina McVie, Tucson Audubon Society
Eric Holler, Community Water Coalition
Eric Shepp, Pima County Regional Flood Control District
Griselda Moya-Flores, Pima County Office of Emergency Management
Ian Sharp, Farmers Investment Company
Jason Ground, Pima County Communications
John Blaskett, San Xavier District of the Tohono O'odham Nation
Jonathan Horst, Tucson Audubon Society
Julia Fonseca, Pima County Office of Sustainability
Matt McGlone, Pima County Office of Emergency Management
Nicole Fyffe, Pima County Administrator's Office
Steve Dolan, Tucson Mountain Association
Terri Tillman, Pima County Development Services Department

Others in Attendance:

Ann Moynihan, PCRFCD Civil Engineering Manager
Brian Jones, PCRFCD Floodplain Management Division Manager
Evan Canfield, PCRFCD Civil Engineering Manager
Joseph Cuffari, PCRFCD Program for Public Information Coordinator
Greg Saxe, PCRFCD CRS Coordinator

July 22, 2019

1) Welcome & Introductions

   The Community Rating System Coordinator (Coordinator) welcomed the group and the members introduced themselves as new participants had come.

2) Project Schedule Review

   a) Results if Step 1-3 (Committee, neighborhood meetings, stakeholder interviews, survey)

      As listed in the update new members had been added, numerous individual meetings held with stakeholders agencies, neighboring communities, businesses and neighborhood associations, and the survey had been distributed to all floodplain residents in unincorporated Pima County. Staff also described the intent to report the survey results during step 6, goal setting.

   b) Summary of additional hazards identified by stakeholders in Step 4 (debris flows, fire vulnerability, habitat with no underlying floodplain)

3) Presentation of Problem Assessment

   a) Problems identified in working sessions (developments designed under outdated standards and modelling and pre-firm structures, dips, scour critical bridges, critical facilities, erosion on private property)

      Staff described the use of a spreadsheet as recommended by the CRS Manual to track, compile and aggregate input.

   b) Regional Problem Summary (Fact Sheet)

      Staff described the contents of fact sheets and their intention as teasers for the more detailed analysis to be provided prior to the next meeting. Discussion included describing the reliability and potential of available data.

   c) Watershed Specific Problem Summary (Fact Sheets)

      Staff described the more detailed contents of the watershed specific fact sheets and the level of detail to be provided in the draft plan appendices devoted to problem assessment of each watershed.

   d) Detailed Problem Assessment (Draft Plan Availability)

      The Coordinator proposed that distributing the draft problem assessments for each watershed in Pima County is the most effective way to prepare for step 6, set goals and step 7, review possible activities. The Coordinator then asked the Committee for any additional assessment needs. Members recommended including:

- *Number of buildings vs number of buildings with flood insurance Coverage*
- *Building type by flood zone*
- *Income per capita by watershed*
- *Separating permitted structures vs non-permitted for standardization and comparability of counts*
- *Separating rentals from owner occupied*
- *Inclusion of damage assessments for critical facilities*
- *Calling out data limitation caveats and flushing them out within reason*
- *Pima County Stress index by floodplain in each watershed*
- *Referencing the Pima County Community Development and Neighborhood Conservation Department 5 Year Housing Study*
- *Establish outreach project to promote technical assistance to those in need.*
- *Assessment of lot split areas in addition to Pima Prospers Growth Areas and Infill Incentive Districts*
- *Revisiting the definition of critical facilities inventoried*

Staff responded in the affirmative and also described that at least some of these are components of the Program for Public Information target areas and Flood Insurance Coverage Assessment. Staff announced that this information will be a component of the draft chapters of the plan to be released to the Committee prior to the next meeting. The committee recommended that these be as separate documents under each watershed tab on the webpage for convenience and furthermore that the Table of Contents be distributed to help the committee understand the content. Staff agreed and further described how the chapters reflect the CRS planning steps and that the draft would include everything up to Step 6 goal setting and Step 7 review of activities. The Coordinator asked of there were any objections to proceeding in this manner. There were none.

4) Next Steps

i) Staff will distribute the draft plan table of contents and ALERT link to the Committee and they are attached hereto.
ii) District Geographic Information System staff to conduct detailed queries including all jurisdictions.
iii) Coordinator to draft watershed problem assessment chapters incorporating this data and ancillary plans by others and then make draft up through Step/Chapter 5 available on the project webpage.
iv) Schedule next meeting for mid-September after draft problem assessment chapters for each watershed are available.

5) Questions

    i) How do we get ahead of development?
    ii) How do we include reasonably foreseeable actions?
    iii) How do we identify vulnerable populations?
    iv) Can we establish data sharing agreements for flood studies and claims data?
    v) How can we evaluate and encourage future floodplain acquisition?

6) Adjournment

November 4, 2019

Members in Attendance:

Carolyn Campbell, Coalition for Sonoran Desert Protection
Christina McVie, Tucson Audubon Society
Diana Durazo, County Administrator's Office
Eric Holler, Community Water Coalition
Eric Shepp, Pima County Regional Flood Control District
Jonathan Horst, Tucson Audubon Society
Matt McGlone, Pima County Office of Emergency Management
Nicole Fyffe, Pima County Administrator's Office
Steve Dolan, Tucson Mountain Association
Jeanette DeRenne, Pima Association of Governments
Luke Cole, Sonoran Institute
Jennifer Varin, Coronado National Forest

Others in Attendance:

Ann Moynihan, PCRFCD Civil Engineering Manager
Brian Jones, PCRFCD Floodplain Management Division Manager
Evan Canfield, PCRFCD Civil Engineering Manager
Joseph Cuffari, PCRFCD Program for Public Information Coordinator
Greg Saxe, PCRFCD CRS Coordinator

1) Welcome & Introductions

The Community Rating System Coordinator (Coordinator) welcomed the group and the members introduced themselves as new participants had come.

2) Project Schedule Review

The CRS Coordinator presented an updated project powerpoint which had been used for the Arizona Public Works Association and Arizona Planning Association informational talks. Topics included project schedule, the hazards identified, problems by watershed and remaining steps.

3) Presentation of Problem Assessment (Exposure)

a) Building density in floodplains heat maps

Paper maps for each watershed showing the building density within floodplains as a color ramp "heat map" were presented and are available on the project webpage along with the hazard maps and draft plan.

b) Hazard and Problem Assessments – regional and by watershed

The CRS Coordinator demonstrated how to access the contents of the project webpage including the draft plan as searchable pdf, as well as watershed specific hazard and problem assessment.

c) Summary list of problems identified in Step 5

See problem list below, please submit any comments via email to the CRS Coordinator.

d) DRAFT Plan Availability

*A complete searchable PDF is available on the project webpage at: www.pima.gov/fmp. The watershed specific hazard and problem assessments have been separated for ease of access under each watershed tab. These chapters are more accessible due to their significantly shorter length and are complemented by full scale maps of hazards and building density in floodplains, and exposure fact sheets. Assessment of countywide hazard exposure is contained in the master document. This is the **first draft** and contains sample goals, a detailed report on current activities, and a sample action plan. After the next three meetings, a complete plan, including goals and action plan proposed by the committee will be made available to the general public and the Board for their consideration and approval.*

e) Goals from the Floodplain Management Ordinance

The approved goals contained in the Floodplain Management Ordinance were reviewed as food for thought, and to help describe the difference between regulatory and the floodplain management planning goals the Committee will be asked to identify in the next meeting.

4) Next Steps

a) Review DRAFT problem list for errors and omissions

See attached problem list, please submit any comments via email to the CRS Coordinator.

b) Review Ordinance Goals & identify additional possible floodplain management planning goals.

Please see the attached goals excerpted from the City of Tucson, Maricopa County and Ft. Worth Texas Floodplain Management Plans, in addition to those from the ordinance contained herein.

5) Schedule next 2 meetings for Goal Setting and Review of Activities to address listed problems.

   Please respond to this email with your availability for the proposed dates noted below.

6) Adjournment

Notes:

Step 5 Goals
Monday November 25, 1:30 - 3:30; or
Tuesday Dec 3 9 -11 or 1:30 - 3:30

Step 6 Activity Review
Monday December 16, 1:30-3:30; or
Thursday December 19 9-11 or 1:30-3:30

Step 7 Action Plan
Monday January 13, 1:30-3:30; or
Thursday January 16 9-11 or 1:30-3:30

Problem List

Hazard Assessment (What are the hazards?)
Information Gaps:

Geomorphologic Environment

- Erosion Hazard Areas – head-cutting, bank failure, channel migration
- Active Alluvial fans – distributary and uncertain flow paths
- Canyon wash floodways
- Riverine overbank flooding – Missing data or approximate Zone A only
- Sheet flooding – Approximate mapping could be better defined
- Subsidence

Changing Conditions

- Climate Change – Increasing frequency and severity of rain events
- Outdated and unidentified flood and hazard areas
- Inadequate or exposed infrastructure

Problem Assessment (Who is exposed to these hazards?)

Population Exposure

- Critical facilities in the floodplain
- Large floodplain population particularly in low income areas with low mobility and resources
- Frequency of flood damage claims outside mapped floodplains
- Road design – prevalence of dips, flow capture, private unmaintained and dirt roads
- Inadequate or exposed infrastructure and utilities

Existing Development and Trends

- Existing development that does not meet current standards (old and undersized infrastructure)
- Frequency of grandfathered and entitled rights
- Cumulative improvements
- Lot splitting
- Infill and redevelopment
- Encroachment and channelization
- Major multi-jurisdictional developments (Gravel pits, I11, Rosemont, Sahuarita Farms, Effluent)

Natural Floodplain Function

- Geologic floodplain development along major rivers
- Loss of natural tributary connectivity

- Groundwater depletion
- Encroachments
- Loss of energy dissipation and flow attenuation

Maintenance

- Inadequate maintenance of private drainageways
- Major river conveyance - aggradation, vegetation, and debris

Emergency Response

- Inadequacy of inter-agency 2-way reporting during events for road closures and situation assessment
- Lack of public tool for real time reporting of maintenance needs and problem areas
- Need for advance warning for road closures and flooding
- Invasive species fire nexus
- Swift water rescue frequency

Unauthorized Uses

- Homeless camps
- Off road vehicles
- Grazing
- Utilities
- Incremental Encroachments & Habitat Destruction

Awareness

- Lack of familiarity with District activities including technical assistance and emergency warning
- Lack of familiarity with floodplain environmental services and function
- Lack of awareness about ALERT and My Alerts
- Lack of knowledge about alternate routes
- Lack of renters getting flood insurance for their belongings

What's Next?: Step 6 Goal Setting

The product of the previous steps is a list of problems. This includes those identified by staff at the end of each watershed problem assessment appendice and those identified by the Committee to date. The draft contains a seed list, and the complete list will be distributed prior to the Committee meeting. The following policy goals and objectives are from the Floodplain Management Ordinance as reported each year in the District Annual Report and will be used as starting point for Committee discussion in the next meeting.

1) Minimize flood and erosion damages;

2) Meet or exceed state and federal requirements relating to floodplain management thereby enabling Pima County residents to purchase low-cost flood insurance, receive disaster relief (should the need arise), and seek residential and commercial real estate loans;

3) Establish minimum flood protection elevations and damage prevention requirements for structures and other types of development that may be vulnerable to flood and erosion damage;

4) Regulate encroachment and building development located within areas subject to flooding, erosion, or located within riparian habitat areas, and ensure that the flood-carrying capacity within the altered and/or relocated portion of any watercourse is maintained;

5) Encourage the most effective expenditures of public money for flood control projects;

6) Minimize the need for rescue and relief efforts associated with flooding and erosion, which are generally undertaken at the expense of the general public;

7) Minimize damage to utilities and public facilities such as water and gas mains, electricity, telephone and sewer lines, and streets and bridges located in regulatory floodplain and erosion hazard areas;

8) Help maintain a stable tax base by providing protection of regulatory floodplain and erosion hazard areas;

9) Inform the public where property lies within a regulatory floodplain, riparian habitat area or erosion hazard area;

10) Ensure that those who occupy areas within regulatory floodplain and erosion hazard areas assume the responsibility for their actions within those areas;

11) Protect, preserve and enhance groundwater recharge; and

12) Encourage the preservation of natural washes, riparian habitat, and preserve the riverine environment.

FMP Project Update and Hazard Assessment (Step 4) Results

Since the second Committee meeting held April 15, 2019, District staff has hosted work sessions as recommended by the Committee. These sessions provided interested members with access to senior District staff and the full suite of Geographic Information System (GIS) data available. This process helped identify site specific hazards and problems to be assessed in Step 5. In total four sessions were held. Participants included:

- Audubon Society
- Community Water Coalition
- Country Financial
- Coalition for Sonoran Desert Protection
- Pima County Administration
- Pima County Development Services Department
- Pima County Office of Emergency Management
- San Xavier District of the Tohono O'odham Nation
- Tucson Mountain Association
- Pima County Transportation Department
- University of Arizona – Planning Program
- Watershed Management Group

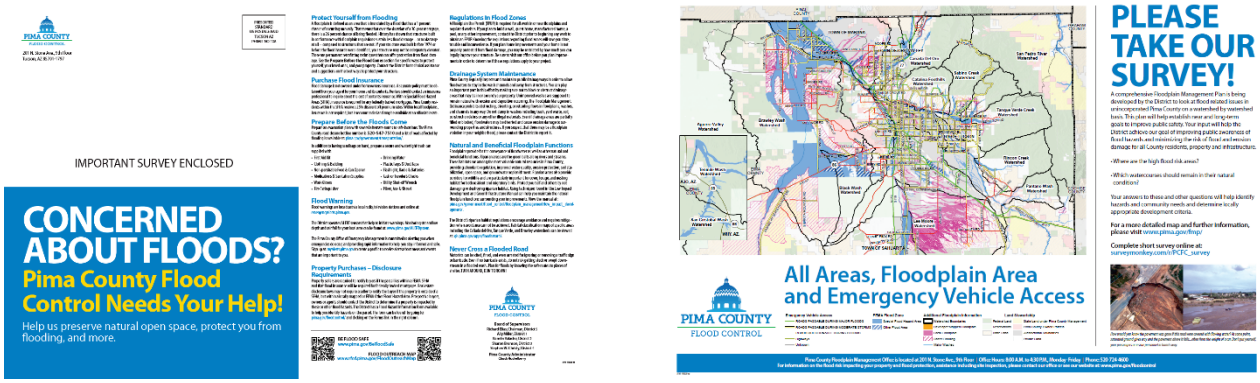
Hazard assessment maps and associated studies are available on the project webpage.

Staff has also conducted one-on-one interviews with partner agencies and neighboring communities including:

- Cadden Property Management/SAHBA
- Coronado National Forest
- National Weather Service
- Pima Association of Governments
- Sonoran Institute
- Tohono O'odham Nation
- Town of Oro Valley
- United States Fish and Wildlife Service

Additional interviews are planned. Lastly the District mailed a brochure to all floodplain residents in unincorporated Pima County informing them of the planning process and encouraging them to fill out the survey available on-line at:

https://www.surveymonkey.com/r/PCFC_survey



Results will be repoted in step 7, review of activities.

Step 5 Problem Assessment

Using best available data, the District has conducted GIS queries for each of the watersheds to be included in the plan. Staff has prepared fact sheets for the county as a whole, and each watershed that are available on the project website at www.pima.gov/fmp and are attached. Based in part on the committee's reaction to this information, greater detail will be provided in the draft plan.

While we look forward to Step 6, setting goals, and Step 7 review of possible activities, as well as drafting an action plan in step 8, the best way to present the problem assessment information for Committee and public review will be as a draft plan on the project webpage. It will contain drafts of all Steps up through Step 5.

In addition to the hazard maps the fact sheets provide the following problem indicators:

- Floodplain population
- Buildings in the floodplain
- Insurance claims paid
- Distribution of insurance claims
- Critical facilities in the floodplain

The District requests that the Committee review these fact sheets to become familiar with the basic exposure problem so that when greater detail is provided it can be digested and appropriate activities considered in the next step. It may also inspire questions and guide further assessment that is needed.

PIMA COUNTY
FLOOD CONTROL

Floodplain Management Plan

Flood Hazard Problem Assessment

The Pima County Regional Flood Control District (District) has prepared this assessment as part of Steps 4 & 5 of the Floodplain Management Plan process for the Planning Committee (Committee) and public, neighboring communities and partner agencies. The District strives to use forward-looking floodplain management planning practices to minimize the risk of flood and erosion damage for all county residents, property and infrastructure. These efforts include identifying high flood risk areas, preserving natural watercourses, constructing flood control facilities, establishing locally appropriate development standards, distributing public information, providing early warning, and responding to flood emergencies. This assessment will help the Committee identify the activities that will be most effective in each of the watersheds in unincorporated Pima County, as part of identifying goals in Step 6 and reviewing possible activities in Step 7.

Flood Hazards in Pima County

This chart includes acreage of Federal Emergency Management Agency (FEMA) Special Flood Hazard Area wherein flood insurance is required for insured mortgages. It also includes locally regulated, Local Study floodplains and Sheet Flood areas mapped by the District and included in the District's Geographic Information System. This fact sheet introduces readers to flood problems. The draft Plan will contain greater detail. Focused fact sheets are also available for each watershed.

For More Information
www.pima.gov/fmp/ * greg.saxe@pima.gov * 520-724-4633
201 N. Stone Avenue, 9th Floor, Tucson Arizona 85701

November 25, 2019

Attendees:

Arlan Colton, University of Arizona Planning Program
Carolyn Campbell, Coalition for Sonoran Desert Protection
Chris Burtrand, San Xavier District of the Tohono O'Odham Nation
Chris Gurton, Country Financial
Christina McVie, Tucson Audubon Society
Eric Holler, Community Water Coalition
Eric Shepp, Pima County Regional Flood Control District Floodplain Administrator
Greg Saxe, Pima County Community Rating System Coordinator
Griselda Moya-Flores, Pima County Office of Emergency Management
Jennifer Varin, United States Forest Service
John Baskett, San Xavier District of the Tohono O'Odham Nation
Jonathan Horst, Tucson Audubon Society
Mead Meir, Pima Association of Governments/Regional Transportation Association
Nicole Fyffe, Pima County Administrator's Office
Steve Dolan, Tucson Mountain Association
Terri Tillman, Pima County Development Services Department

Staff:

Brian Jones, Floodplain Management Division Manager
Ann Moynihan, Civil Engineering Manager

November 25, 2019

1) Welcome & Introductions

The Community Rating System Coordinator (Coordinator) welcomed the group and the members introduced themselves.

2) Project Schedule Review

The Coordinator noted being at Step 6 Goal Setting that the subsequent Steps 7 Review of Activities, and Step 8 Draft an Action Plan represented the hardest part of the Committees job. He also noted that while completing the draft plan represents 80% of their work, it would then be promoted publically prior to Board review. None-the-less we are targeting early 2020 for Board consideration. Followed by Steps 9 Implementation and Step 10 annual updates!

3) Problem List Approval

Members were given the opportunity to revisit the problem list and reached consensus that it was complete pending distribution of the revisions discussed. (See Attached)

4) Review Goals

Members discussed the existing District goals in relation to those of the organizations and areas they represent. This included the Development Services Department, former County Planning Director whom shepherded "Pima Prospers", the most recent revision of the County Comprehensive Plan; and the Coalition for Sonoran Desert Protection whom are the primary private stewards of the Sonoran Desert Conservation Plan noted below, as well as the Community Water Coalition.

Members proposed and no objections were heard, with some caveats to making the language more assertive including: replacement of "minimize" with something more definitive wherever it occurs (Goals 1, 4, & 5); changing the word "encourage" in Goals 3 to "ensure"; and removing the word "encourage" from Goal 6. Members also agreed to add two new goals for purposes of the Floodplain Management Plan. One addressing floodplain management services resilience in the face of climate change and another inter-governmental collaboration. In addition, Goals 1 and 5 were combined, and clarified. Thus the numbering changed. The caveats included statutory and financial limitations. (See Attached)

5) Goal Setting and Prioritization Exercise

Members were asked to place colored stickers corresponding to their priority goals in flood problem hot spot locations throughout the set of watershed maps arrayed around the Public Works Building hearing room. This venue had been scheduled versus the District conference room to facilitate greater access to the maps by the participants. The complete set of 28 watershed maps were available including one set depicting density of structures versus aggregated floodplains and ownership, and another complete set of the hazard maps with more detailed floodplain and riparian habitat zones. Results will be tallied and reported at the next meeting. This tally and the proposed goals will then form the basis for our review of current and future activities from which staff will draft the proposed action plan. A sample action plan is contained on page 483 in the draft available on the project webpage and a draft action plan will be distributed with the next agenda.

6) Next Steps

The Coordinator will distribute the proposed goals and final problem list (attached) for approval at the next meeting. Staff shall prepare a review of current and proposed activities to address each goal and problem for presentation at the next meeting (Step 7). The detailed review of current activities, which will be summarized for this effort, is contained in the draft plan (please see Chapter 7). A draft action plan will be distributed with the agenda.

Members were encouraged to review the draft, in particular new elements including the survey results, review of activities and draft action plan, as they should be familiar with the hazard and problem assessment after the workshops conducted over the previous months and documents available on the project webpage.

A meeting invitation will be distributed after Thanksgiving as the Committee recommended scheduling the meeting at a location potentially more accessible to private sector participants.

7) Adjournment

Notes:

Where have we been?: Final Problem List

Unique Local Hazards

- Erosion
- Alluvial fans
- Distributary and uncertain flow paths
- Canyon wash floodways
- Sheet flooding
- Missing, outdated information and approximate mapping
- Subsidence and changes in topography
- Upper watershed land management

Future Environmental Conditions

- Changing weather
- Unknown hazards
- Vegetation changes
- Climate change including extreme events and extended dry periods
- Post catastrophic fire impacts

Population Exposure to Hazards

- Critical facilities and utilities in the floodplain
- Floodplain populations especially those with low mobility and resources
- All-weather and emergency vehicle access
- Underinsured and uninsured

Existing and Future Development

- Existing development that does not meet current standards(old and undersized infrastructure)
- Historic entitlements not based on current hazard information
- Increasing runoff volume due to cumulative improvements
- Loss of natural floodplain function
- Lot splitting and wildcat developments
- Infill and redevelopment
- Encroachment and channelization
- Regional scale projects
- Flow diversions
- Groundwater depletion
- Riparian habitat disturbance
- Loss of tributary connectivity
- Water quality and spread of contamination

Maintenance Needs

- Private infrastructure
- Public infrastructure
- Conveyance capacity
- Illegal dumping activities
- Invasive species

Emergency Response

- Inter-agency 2-way reporting during events for road closures and situation assessment
- Public tools for near real time reporting
- All-weather access for responders
- Advanced warning for road closures and flooding
- Publication of alternate routes
- Fire nexus
- Swift water rescues

Unauthorized Uses

- Homeless camps
- Off-road vehicles
- Grazing
- Utilities
- Encroachments
- Riparian habitat destruction
- Flow diversions

Awareness

- District services
- Pima County services
- Best practices
- Flood hazards in the desert
- Interjurisdictional collaboration opportunities

Proposed Floodplain Management Plan Goals:

1. Prevent flood and erosion damages including ensuring the operability of critical facilities during flood events;

2. Ensure that those who occupy areas within regulatory floodplain and erosion hazard areas assume the responsibility for their actions within those areas;

3. Ensure the most effective expenditures of public money for flood control projects;

4. Reduce the need for rescue and relief efforts;

5. Protect, preserve and restore natural washes and riparian habitat;

6. Protect, preserve and enhance groundwater recharge;

7. Ensure flexibility for adaptive floodplain management for changing climate circumstances; and

8. Offer inter-jurisdictional floodplain management services.

December 16, 2019

Invitees:

Arlan Colton, University of Arizona Planning Program
Carolyn Campbell, Coalition for Sonoran Desert Protection
Christina McVie, Tucson Audubon Society
Eric Holler, Community Water Coalition
Eric Shepp, Pima County Regional Flood Control District
Greg Saxe, Community Rating System Coordinator
Jeanette DeRenne, Pima Association of Governments
Mead Meir, Pima Association of Governments
Melanie Mizzell, Community Water Coalition
Matt McGlone, Pima County Office of Emergency Management
Nicole Fyffe, Pima County Administrator's Office
Shawn Cote, Southern Arizona Homebuilders Association
Steve Dolan, Tucson Mountain Association
Valerie Verrochi, Proforma

Staff:

Ann Moynihan, Civil Engineering Manager
Brian Jones, Floodplain Management Division Manager
Evan Canfield, Basin Studies Division Manager

December 16, 2019

1) Welcome & Introductions

   Participants were welcomed and invited to introduce themselves.

2) Project Schedule Review

   The CRS Coordinator reviewed progress to date and what is ahead, including creating the action plan, draft completion, public outreach and the Committee's role in implementation.

3) Problem List Approval ***(final approved list attached)***

   Participants moved water rights to "Existing and Future Development", moved water quality to "Population Exposure to Hazards", added "Increase regional cooperation", and added an item for recreational opportunities under "Awareness" and were approved.

4) Goals Approval ***(final approved goals attached)***

   The tally of results from the prioritization exercise based on the draft goals conducted in the last meeting was presented to facilitate finalization. The language of goal 2, 5, 6, and 8 were amended as shown in track changes below and were approved.

5) Next Steps:

   a) Activity Review Introduction

      The CRS Coordinator reviewed the activities from the CRS Manual and indicated that the approved goals and problem list would form the basis of a draft action plan. The Committee recommend that staff prepare a presentation of the current and historic District activities to complement the narrative contained in the draft plan available on the project webpage.

   b) Presentation of Action Plan Format

      The CRS Coordinator reviewed the sample action plan from the manual and how the problems and goals identified by the Committee through the process would be included for consideration at the January meeting.

6) Adjournment

Reminder, the next meeting is scheduled for 1:30-3:30 January 16, 2020. The location is yet to be determined and will be provided with the Agenda sometime after Christmas.

Notes:

Opportunities for Improvement (aka Problem List)

Unique Local Hazards

- Erosion
- Debris flows and sedimentation
- Alluvial fans
- Distributary and uncertain flow paths
- Canyon wash floodways
- Sheet flooding
- Missing, outdated information and approximate mapping
- Subsidence and changes in topography
- Upper watershed land management

Future Environmental Conditions

- Changing weather
- Unknown hazards
- Vegetation changes
- Climate change including extreme events and extended dry periods
- Post catastrophic fire impacts

Population Exposure to Hazards

- Critical facilities and utilities in the floodplain (potential loss of service)
- Floodplain populations especially those with low mobility and resources
- All-weather and emergency vehicle access
- Ponded water and virus vectors (mold, mosquitos, etc.)
- Underinsured and uninsured
- Water quality and spread of contamination

Existing and Future Development

- Existing development that does not meet current standards(old and undersized infrastructure)
- Historic entitlements not based on current hazard information
- Increasing runoff volume due to cumulative improvements
- Loss of natural floodplain function
- Lot splitting and wildcat developments
- Infill and redevelopment
- Encroachment and channelization
- Regional scale projects
- Flow diversions
- Groundwater depletion
- Riparian habitat disturbance
- Loss of natural tributary connectivity

- Water rights, recharge projects, and managed surface flows

Maintenance Needs

- Private infrastructure
- Public infrastructure
- Conveyance capacity
- Illegal dumping activities
- Trash accumulation
- Invasive species

Emergency Response

- Inter-agency 2-way reporting during events for road closures and situation assessment
- Public tools for near real time reporting
- All-weather access for responders
- Advanced warning for road closures and flooding
- Publication of alternate routes
- Fire nexus
- Swift water rescues

Emergency Management

- Real time status update of conditions as they evolve during a flooding event
- Tools for near real time reporting of potential risks to specific communities during a flooding event
- Advance warning of potential road closures that would impact egress/ingress and therefore impede evacuation ability

Unauthorized Uses

- Homeless camps
- Off-road vehicles
- Grazing
- Utilities
- Encroachments
- Riparian habitat destruction
- Flow diversions

Awareness

- District services
- Pima County services
- Best practices
- Flood hazards in the desert
- Interjurisdictional collaboration opportunities
- Inter-departmental/integrated planning needs
- Increase recreation opportunities

Proposed Floodplain Management Plan Goals:

9. Prevent flood and erosion damages including ensuring the operability of critical facilities during flood events;

10. Ensure that those who occupy areas within regulatory floodplain and erosion hazard areas are aware of the consequences of their actions within those areas;

11. Ensure the most effective expenditures of public money for flood control projects;

12. Reduce the need for rescue and relief efforts;

13. Identify, protect, and preserve watercourses and the natural floodplain function and riparian habitat associated with them, and restore and enhance them where they have been degraded;

14. Protect, preserve and enhance water resources;

15. Ensure flexibility for adaptive floodplain management for changing climate circumstances; and

16. Increase regional cooperation and offer inter-jurisdictional floodplain management services.

January 16, 2020

Attendees:

Arlan Colton, University of Arizona Planning Program
Brian Jones, PCRFCD Floodplain Management Division Manager
Chris Bertrand, San Xavier District of the Tohono O'odham Nation
Eric Shepp, Pima County Regional Flood Control District
Evan Canfield, Basin Studies Division Manager
Greg Saxe, CRS Coordinator
Griselda Moya-Flores, Pima County Office of Emergency Management
Griselda-Maya Flores, Pima County Office of Emergency Management
John Baskett, San Xavier District of the Tohono O'odham Nation
Joseph Cuffari, PCRFCD Outreach Program Manager
Marisa Rice, PCRFCD Open Space Program Manager
Matt McGlone, Pima County Office of Emergency Management
Steve Dolan, Tucson Mountain Association
Terri Tillman, Pima County Development Services Department

January 16, 2020

1) Welcome

The CRS Coordinator reviewed progress to date and the pending public process leading to Board approval.

2) Activity Review staff presentation

The CRS Coordinator presented a review of current and proposed activities to address the needs and goals identified in previous steps. This review included the 6 activity types identified in the CRS manual and was cross referenced to goals and needs. District program managers and representatives of other County Department also contributed to this review.

The Committee members then discussed the 26 current and 32 new actions included on the draft Action Plan distributed in the meeting and attached hereto. Members suggested some clarifications that will be incorporated into the final draft along with any additional comments recieved. At the next meeting the Committee will be asked to approve the final Action Plan.

Please submit comments to Greg Saxe on the attached draft Action Plan by January 31.

3) Next Steps/Meeting:

a) Action Plan finalization

After the January 31, 2020 deadline to submit written comments on the draft Action Plan, flood control program managers will provide detailed action descriptions for each action.

b) Publication of DRAFT Plan

Staff will complete and publish the draft Floodplain Management Plan.

c) Public Meetings/Hearings

In between the next "Step 8" Committee meeting and Board of Supervisors Hearing, public meetings will be scheduled at the Library, Flood Control District Advisory Committee, as well as Planning and Zoning Commission for the public including stakeholders to comment on the Plan. Committee members welcome to attend.

At the next Committee meeting members will be asked to approve the final Action Plan which will be distributed with the meeting agenda after the January deadline. Members will also be asked how they wish to be involved in implementation including updates.

Please look for the next meeting invite and plan to participate in this important step.

4) Adjournment

February 12, 2020

Attendees:

Brian Jones, Pima County Regional Flood Control District
Brian Powell, Natural Resources Parks and Recreation Department
Chris Bertrand, San Xavier District of the Tohono O'Odham Nation
Chris Gurton, Country Financial
Christina McVie, Tucson Audubon Society
Eric Holler, Community Water Coalition
Eric Shepp, Pima County Regional Flood Control District
Evan Canfield, Pima County Regional Flood Control District
Greg Saxe, Pima County Regional Flood Control District
Griselda Moya-Flores, Pima County Office of Emergency Management
Jeanette DeRenne, Pima Association of Governments
John Baskett, San Xavier District of the Tohono O'Odham Nation
Matt McGlone, Pima County Office of Emergency Management
Mead Meir, Pima Association of Governments
Melanie Mizell, Community Water Coalition
Nicole Fyffe, Pima County Administrator's Office
Steve Dolan, Tucson Mountain Association

February 12, 2020

1) Welcome & Thank You

   The Community Rating System (CRS) Coordinator and Chairman thanked the Committee for their involvement and contributions.

2) Action Plan Review
   The CRS Coordinator led a review of the recommended Action Plan line by line, including watershed specific actions identified by staff and from workshop and public meeting feedback tracked throughout the process. Members requested additional actions, added watersheds in which actions should apply, modified language, increased cost estimates and identified partners. ***The Committee approved the Action Plan with identified changes, and set a deadline of Wednesday February 26 for any additional input from members****.*

3) Final Steps:
   a) Publication of DRAFT Plan

   Staff shall complete the draft plan for public review, publish it to the project webpage and make hard copy available at meeting locations by March 3. Final revision will then be made prior to submittal for the Board agenda.

   b) Public Meetings/Hearings
      i) February 26 Planning and Zoning Commission Information Session
      ii) March 3 Downtown Library Open House
      iii) April 7 or May 5 Board of Supervisors Hearing

   Additional meetings have been scheduled with the SAHBA Technical Committee and Flood Control District Advisory Committee. Our goal is to be ready for the April 7 BOS hearing.

   c) Committee Participation in Implementation

   The CRS Coordinator invited members to participate in implementation and updating the plan after approval as required by CRS guidelines.

4) Congratulations, Celebration Planning & Adjournment

5) Members expressed a desire to have a celebration after approval by the Board. Look for an announcement.

Time and Location 1:30-3:30 February 12, 2020 201 N Stone, PWB9 Conf A/B.

Appendix F - Bibliography

Brown, D.E., C.H. Lowe, and C.P. Pase, 1979, A digitized classification system for the biotic communities of North America, with community (series) and association examples for the Southwest. J. Ariz. Nev. Acad. Sci. 14 (Suppl. 1): 1-16.

For a complete list of basin studies published by the District organized by watershed, please see the project webpage at: www.pima.gov/fmp

Harris Environmental Group, URS Corporation, and R.B. Duncan & Associates, 2001, SDCP Riparian Vegetation Mapping and Classification Final Report. Prepared for Pima County.

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Pima County, Sonoran Desert Conservation Plan. http://www.pima.gov/cmo/sdcp/intro.html

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Appendix G - Approval Resolution

RESOLUTION NO. 2020-FC1

A RESOLUTION OF THE PIMA COUNTY FLOOD CONTROL DISTRICT BOARD OF DIRECTORS APPROVING A FLOODPLAIN MANAGEMENT PLAN AS PART OF THE NATIONAL FLOOD INSURANCE PROGRAM'S COMMUNITY RATING SYSTEM

The Board of Directors of the Pima County Flood Control District finds:

1. Pima County has experienced severe flood disaster events causing significant damage to public and private property, including homes and businesses, resulting in a need for insurance coverage for those who may be exposed to flood risks.

2. Relief from the economic hardships of flood damage is available in the form of federally subsidized flood insurance as authorized by the National Flood Insurance Act of 1968 and its subsequent amendments.

3. The National Flood Insurance Program (NFIP) is a federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding.

4. The Pima County Regional Flood Control District (District) participates in the NFIP's Community Rating System (CRS) which provides a framework necessary for a community's actions and efforts in meeting the three goals of: (1) reduction of flood losses; (2) facilitation of accurate insurance ratings; and (3) promotion of awareness of flood insurance.

5. As part of the CRS, communities are encouraged to exceed minimum standards and in doing so qualify for a reduction in flood insurance premiums for policy holders. Based on the District's floodplain management efforts, residents in unincorporated Pima County currently enjoy a premium discount of up to 25%.

6. The Floodplain Management Plan (FMP) was a committee driven planning process that included stakeholder involvement, hazard assessment, and identification of mitigation activities important to flood safety and the protection the natural beneficial functions of floodplains.

7. The District desires to further exceed the minimum NFIP standards through the implementation of the FMP.

8. A component of the FMP incorporates the previously approved Program for Public Information, Repetitive Loss Area Analysis, Flood Insurance Coverage Assessment and a Coverage Improvement Plan that requires promoting of the purchase of or an increase in coverage of flood insurance.

9. Pima Prospers Flood Control and Drainage Element Goal 2 Implementation Measure D is "Create and adopt a Watershed Management Plan which identifies the watersheds impacting Pima County, their drainage characteristics, regulatory and infrastructure needs."

10. The Board adopted Resolution No. 2018-FC6 that approved the initiation of the process to develop this Floodplain Management Plan.

NOW, THEREFORE, BE IT RESOLVED, that the District's Board of Directors hereby:

1. Approves the Floodplain Management Plan recommended by the Planning Committee; and

2. Directs the District to engage the Planning Committee consisting of staff and stakeholders per NFIP guidelines during implementation;

3. Authorizes District staff to do all things necessary to implement the Plan.

Passed and adopted, this 7th day of April, 2020.

Chairman, Board of Directors

APR 07 2020

ATTEST:

Clerk of the Board

APPROVED AS TO FORM:

Kell Olson, Deputy County Attorney