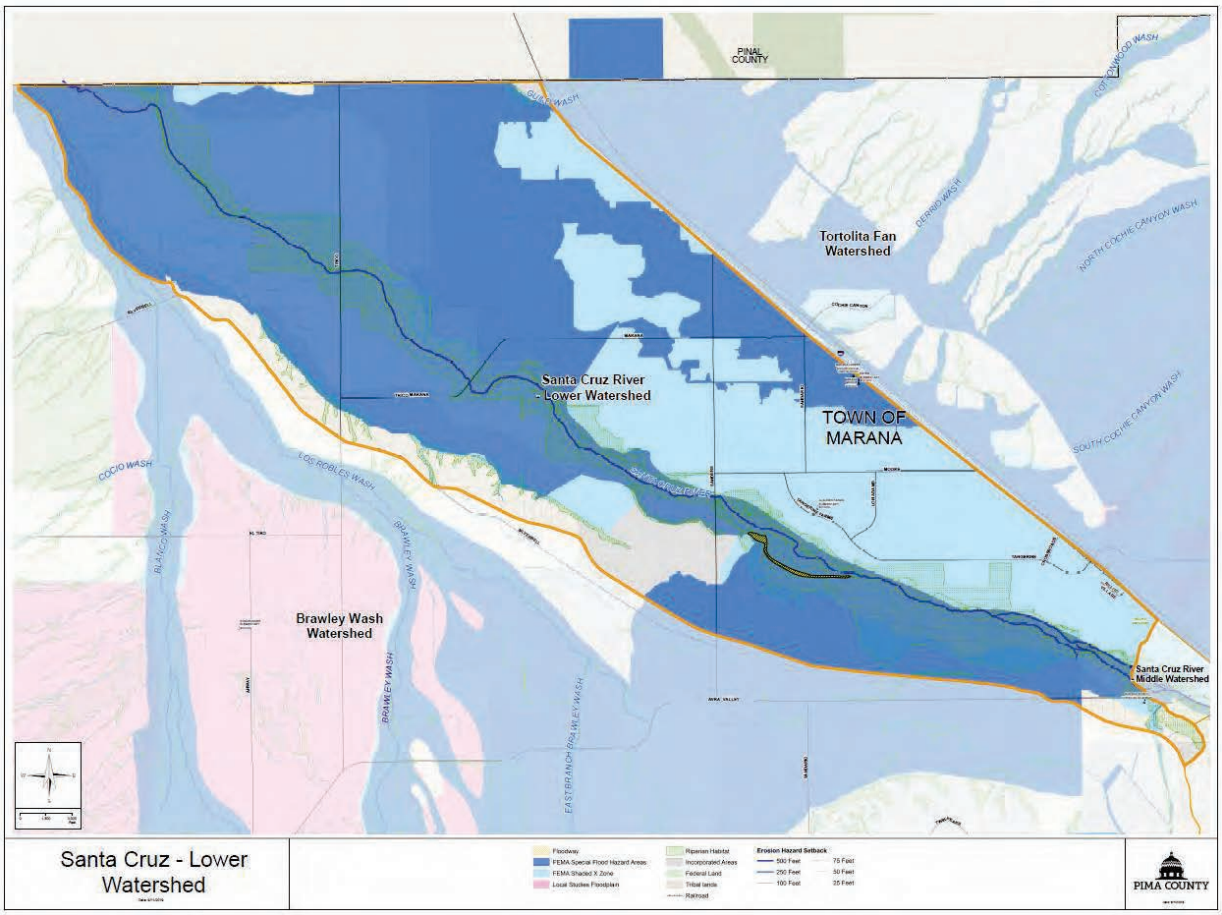
5.4.12 Santa Cruz River – Lower

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 128 - Lower Santa Cruz River Watershed Map

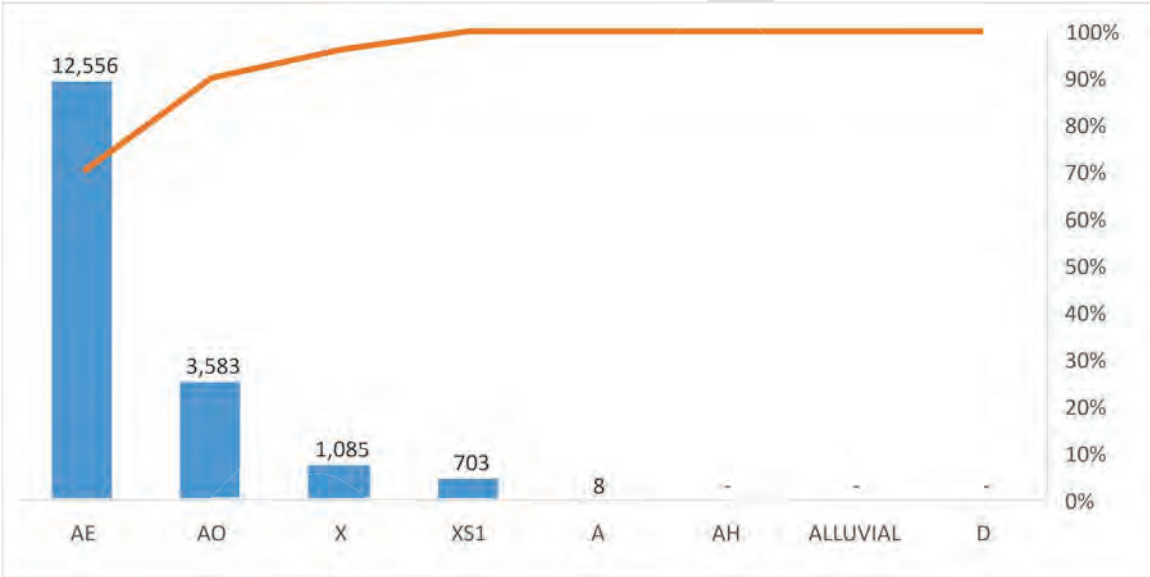


5.4.12.1 Flood Characteristics

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 129 - Lower Santa Cruz River Watershed Federal Floodplain Designations



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 39 - 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 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 40 - 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 41 - 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.

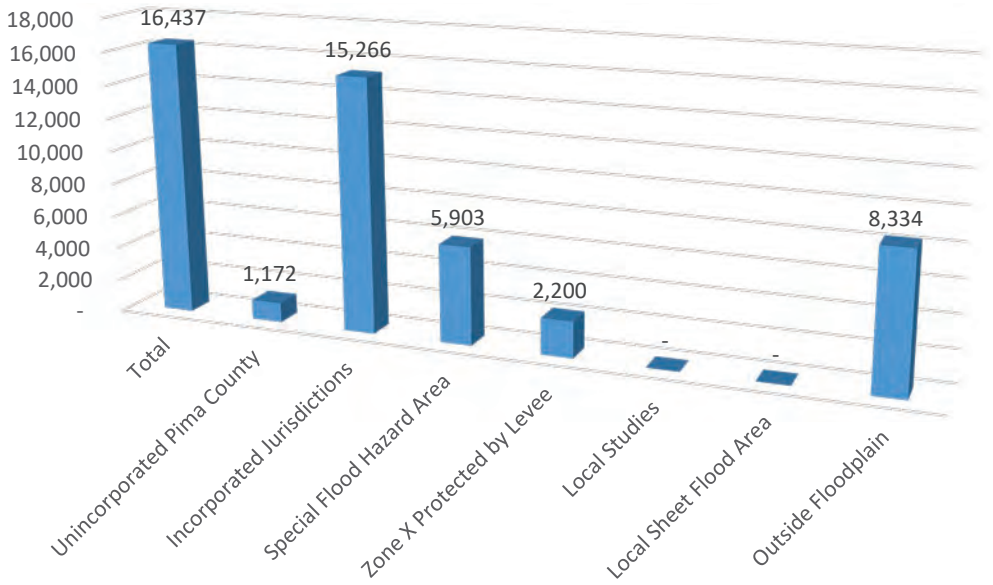
FEMA has mapped Special Flood Hazard Zones (SFHA) for the Santa Cruz River and overbank areas, the eastern Tortolita alluvial fans, and along the Union Pacific Railroad. In addition, the overbank areas of the Santa Cruz River include shaded Zone X areas of 1% annual chance flood average depths of less than 1 foot, and areas protected by a levee from the 1% annual chance flood.

5.4.12.2 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.

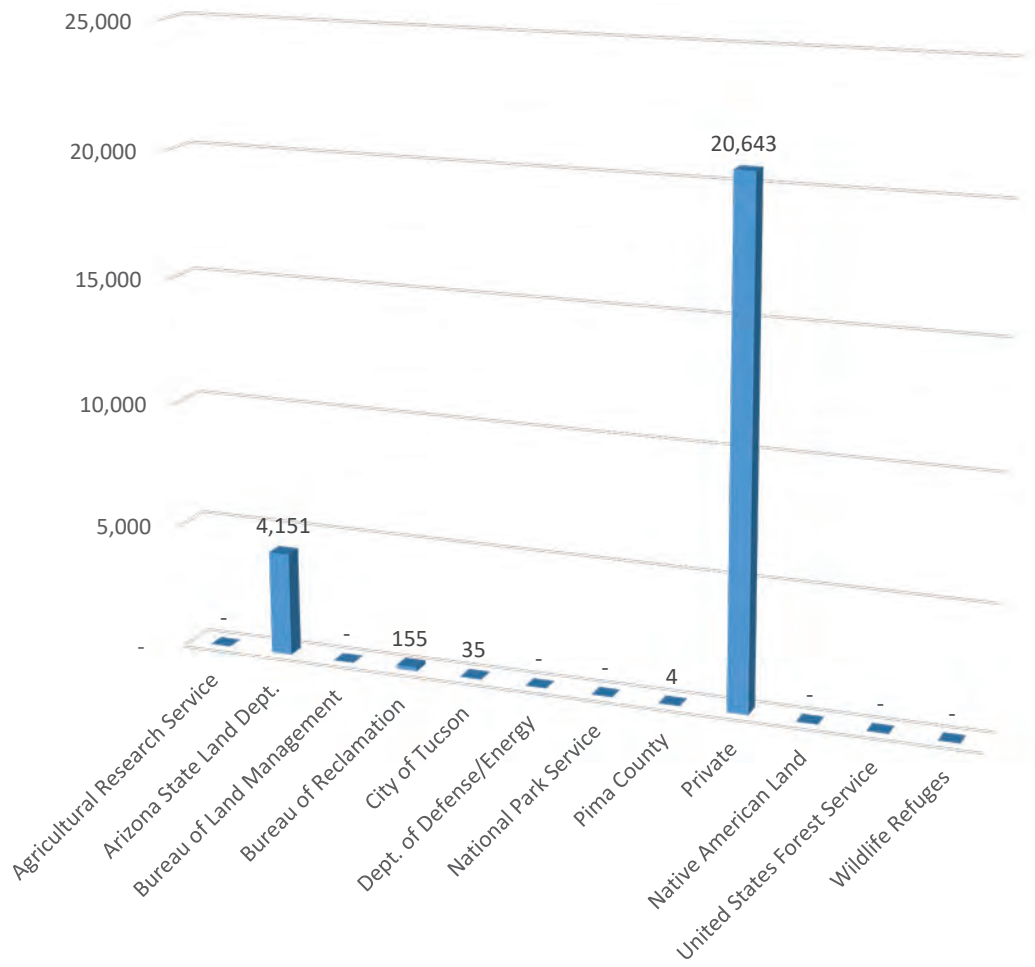
Figure 130 - Lower Santa Cruz River Watershed Population Distribution



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.

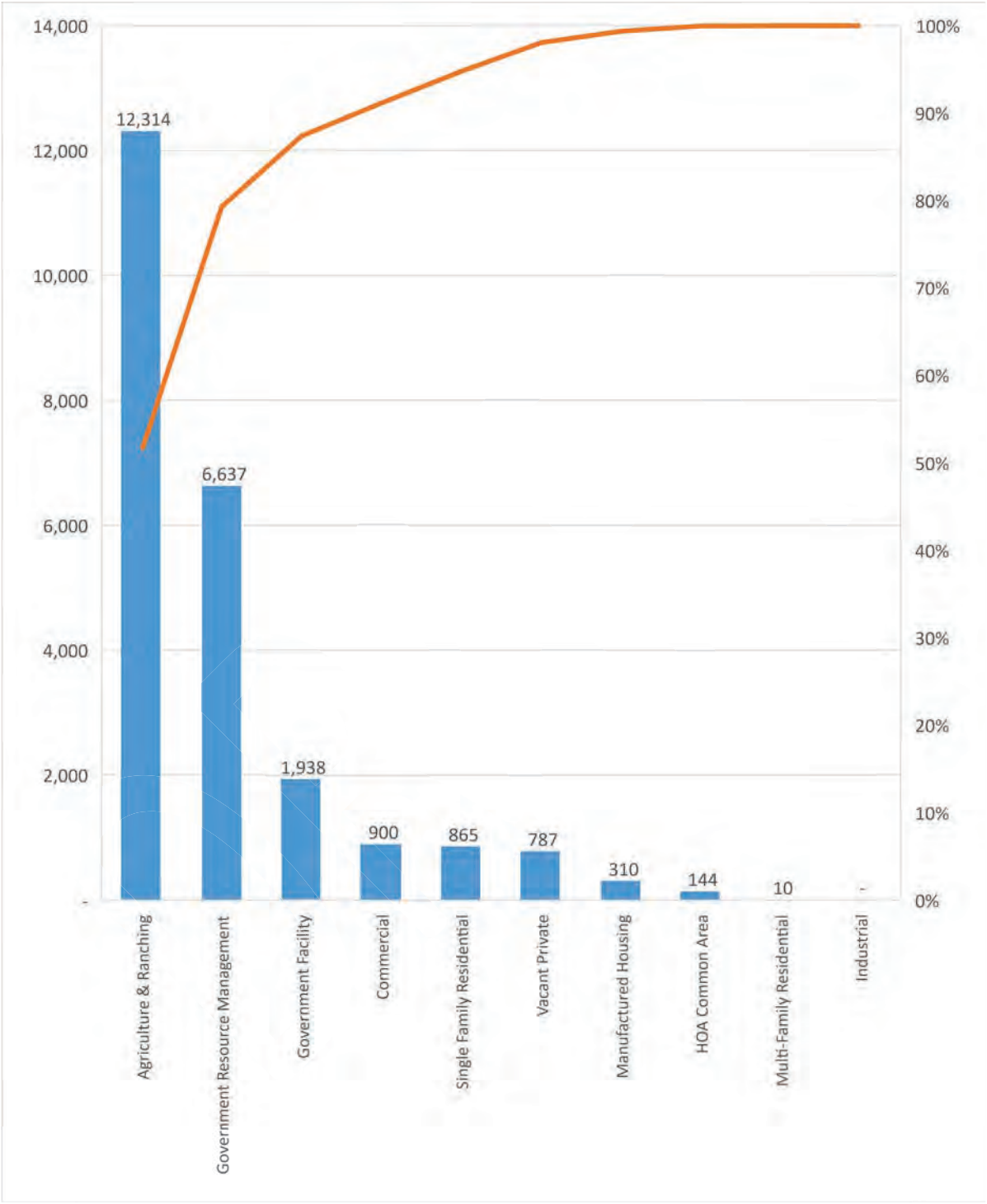
There are three distinct regions within the unincorporated area of this watershed. The largest consists of northernmost reaches of the Santa Cruz River that are largely not bank protected and surrounded by farmlands. South of the Town of Marana where the river meets West Avra Valley Road at Interstate 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 131 - Lower Santa Cruz River Watershed Ownership in Acres



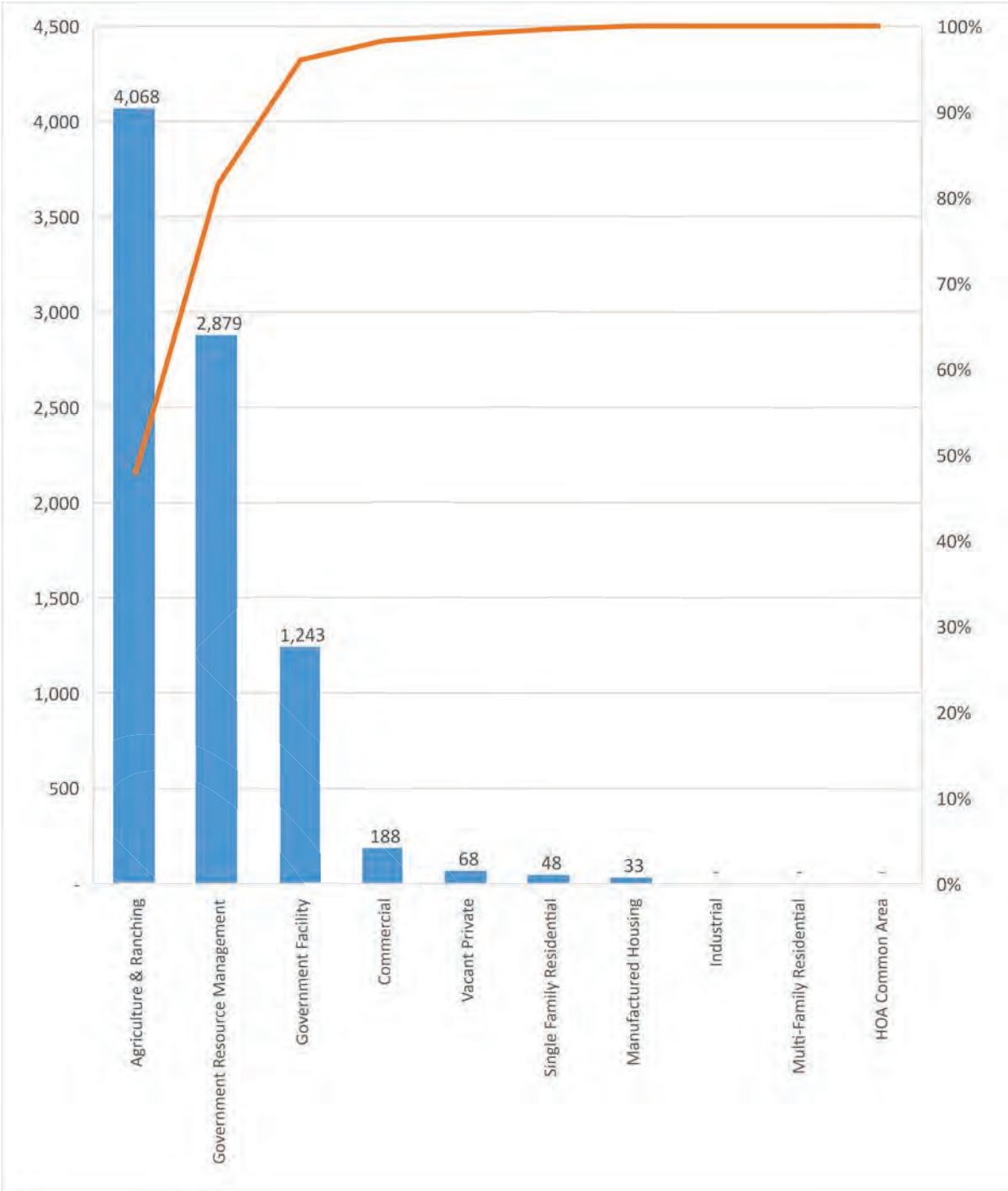
There are 20,643 acres of private land, which is 82%, and 4,151 acres of State Trust land, which is 16%. In sum, developable area makes up 98% of the watershed.

Figure 132 - 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.

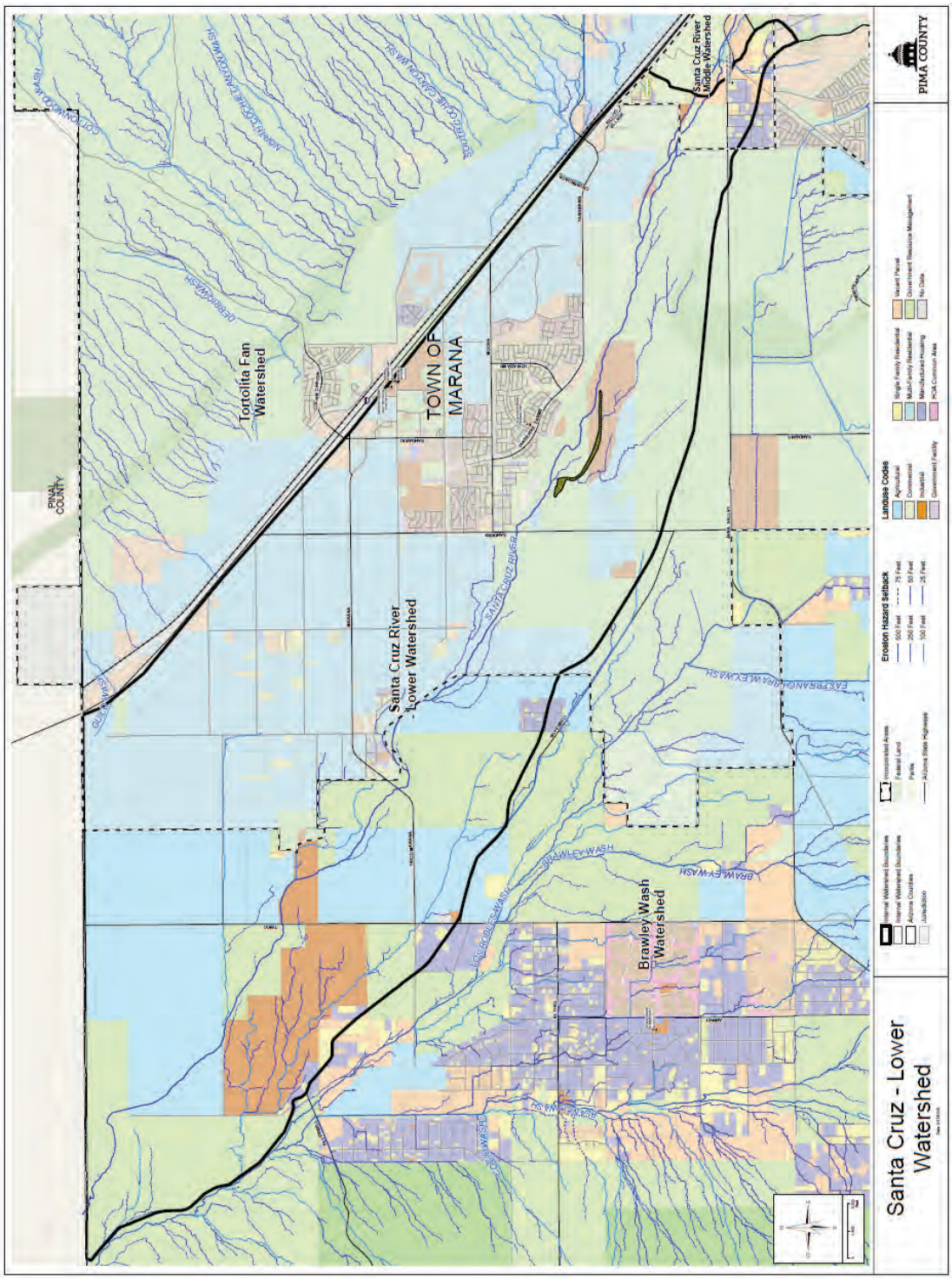
Figure 133 - Lower Santa Cruz River Floodplain Land Use



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 134 - Lower Santa Cruz River Land Use

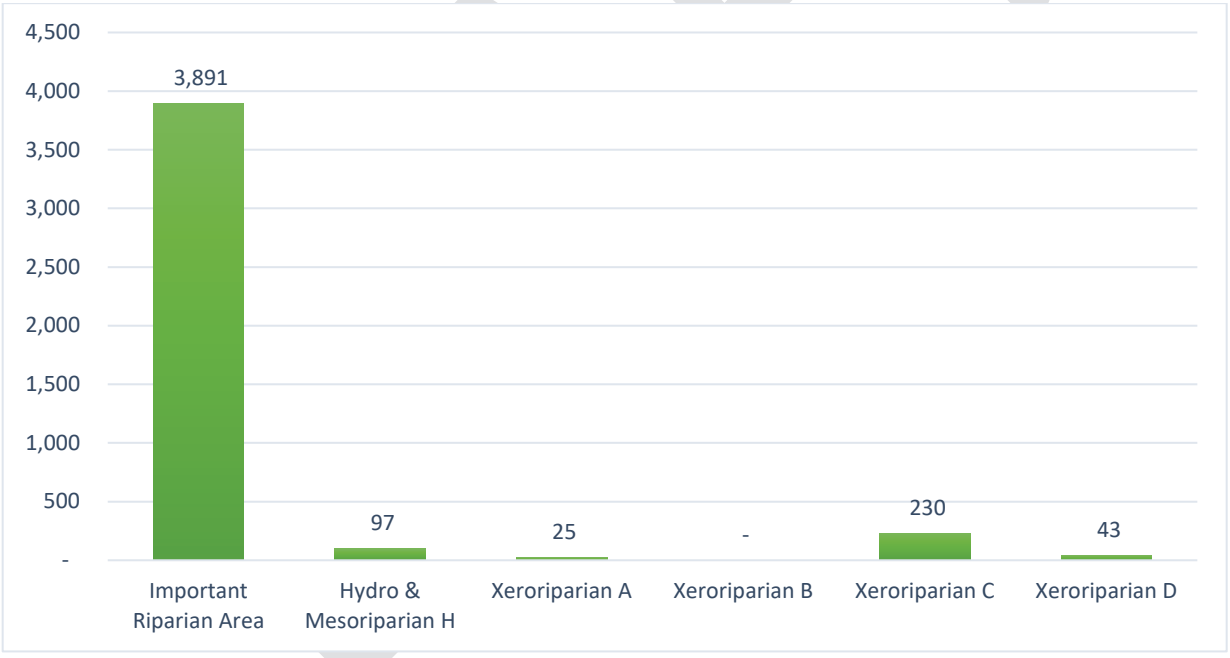


5.4.12.3 Riparian Habitat and Natural Areas

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 135 - Lower Santa Cruz River Watershed Riparian Habitat in Acres

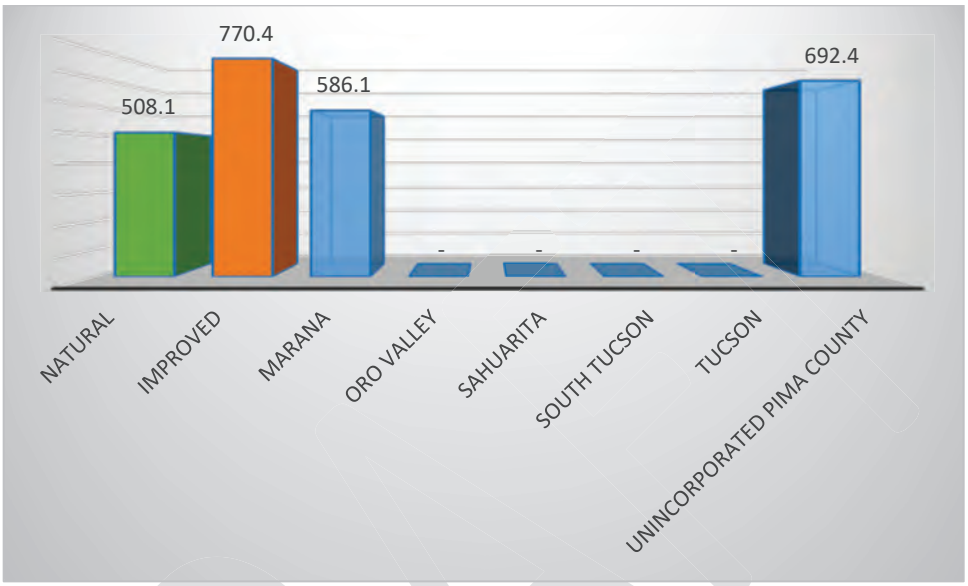


Perennial reclaimed water flow supports wetland and nitrogen-tolerant plans as well as mature trees. This relationship has been the focus of the Sonoran Institute's Living River Project in which the District participates.

5.4.12.4 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 136 - 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.

5.4.12.5 Needs – Capital Improvement

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.

Data Gathering Needs

- No site-specific issues identified.

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 (T11S R10E Sec. 24) <GIS Point ID: SCL-FSP-001>. (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. (T11S R10E Sec. 24) <GIS Point ID SCL-INF-001>

Safety Concerns

- No site-specific issues identified.

The District has not planned major new CIP at this time. Maintenance of existing infrastructure including sediment and vegetation management remains a priority.

5.4.12.6 Floodplain Management

Future needs identified by District staff include:

- Effluent
- Bank protection toe erosion
- River Management Plan for Pinal County Line to Grant Road