Section 2

Watershed Characterization

Photo Credit: Kendall Guidroz

Section 2. Watershed Characterization

Watershed characterization considers the natural features of the land, the human elements that interact with them, and the relationship these factors have with water quality. This represents the first step in understanding the causes and sources of pollution in the watershed to identify effective means to address them. Evaluating all elements and factors that shape the connection between land and water is part of a watershed approach to improving water quality.

Geography

The watershed area of East Fork San Jacinto River includes portions of Harris, Montgomery, Liberty, San Jacinto and Walker counties (**Figure 2**). Small cities such as Cleveland, North Cleveland, Plum Grove, and Roman Forest intersect or are completely contained within the watershed area. Large cities intersecting the watershed area include Huntsville and Houston. This drainage area is connected to the Houston metropolitan area by the US Highway 59/Interstate 69 (IH 69) transportation corridor and runs parallel to Interstate 45 (IH 45).

Regional Context

East Fork San Jacinto River and its network of tributaries drain into the Lake Houston reservoir. Lake Houston's prominence as a drinking water source, recreational venue, and as an integral part of the complicated hydrology of the San Jacinto River Basin make the contributions from East Fork San Jacinto River and other tributaries especially important in a regional context.

Watershed Delineation

The East Fork San Jacinto River watershed was delineated using a combination of existing data, map review, and field observations. The primary watershed and subwatershed delineations were developed from National Hydrography Dataset Plus (NHD+) watershed layers, with minor adjustments to reflect conditions on the ground, segregate tributaries, and normalize subwatershed size. NHD+ data was compared with United States Geological Survey (USGS) Hydrologic Unit Code 12 and 10 data, and other local sources. Compared to aerials and known hydrologic boundaries, the NHD+ data was closest to expected actual drainage patterns in this system. Staff conducted map surveys using online mapping and limited field reconnaissance to confirm assumptions.

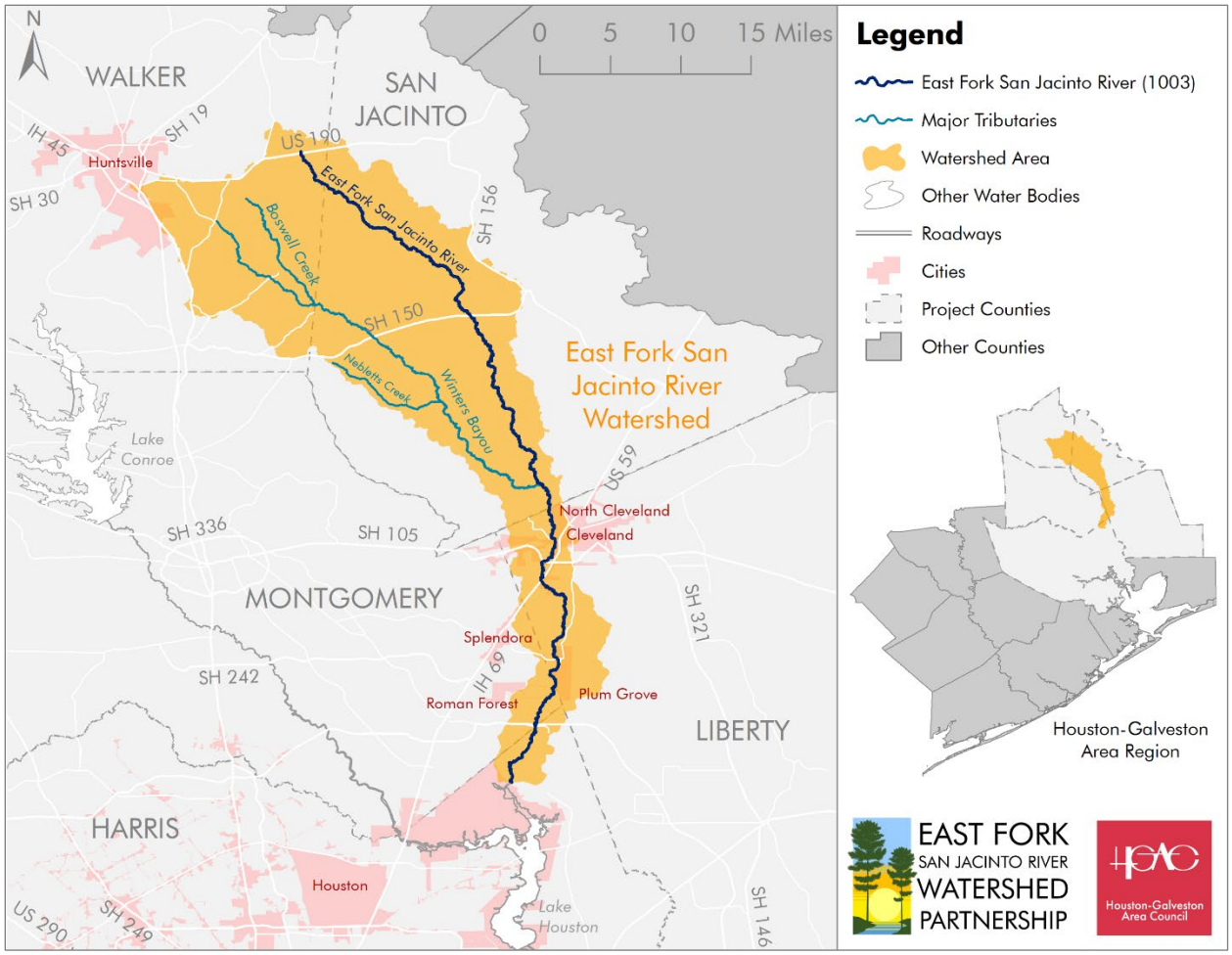

Figure 2. Regional context for the East Fork San Jacinto River watershed

Subwatersheds were further delineated from a selection of existing and continuing water quality monitoring stations to ensure the ability to evaluate these areas during the implementation of the WPP (**Figure 3**). Considerations for the selection of the stations were their ability to represent different areas of the watershed, the natural hydrologic elements of the watershed (e.g., major tributaries), appreciable areas of developmental or land cover type, and general comparability in size. The resulting subwatersheds balance these interests, with the highest priority given to representation by ongoing monitoring stations at their terminal ends.

Stream Network and Drainage Area

The main channel of the East Fork San Jacinto River starts in the heavily forested areas of eastern Walker County. As it progresses south, the waterway grows in size. Once the main channel passes into more developed area south of SH 105, the waterway is a moderately sized creek in normal flow conditions. The stream network of the East Fork San Jacinto River watershed contains three primary tributaries (**Figure 4**). These are the unclassified

segments which are assessed by TCEQ and are the more prominent tributary systems in the watershed. They include:

- **Winters Bayou (1003A)** — Winters Bayou flows on the western side of the East Fork San Jacinto River watershed and is primarily characterized by more natural land types such as hay/pasture, varied types of forested land and wetlands.
- **Nebletts Creek (Segment 1003B)** — Nebletts Creek branches south of Winters Bayou just west of the bayou's confluence with East Fork San Jacinto River. It shares the same land cover types as Winters Bayou.
- **Boswell Creek (Segment 1003C)** — Boswell Creek branches north of Winters Bayou and is covered mainly in forested area.

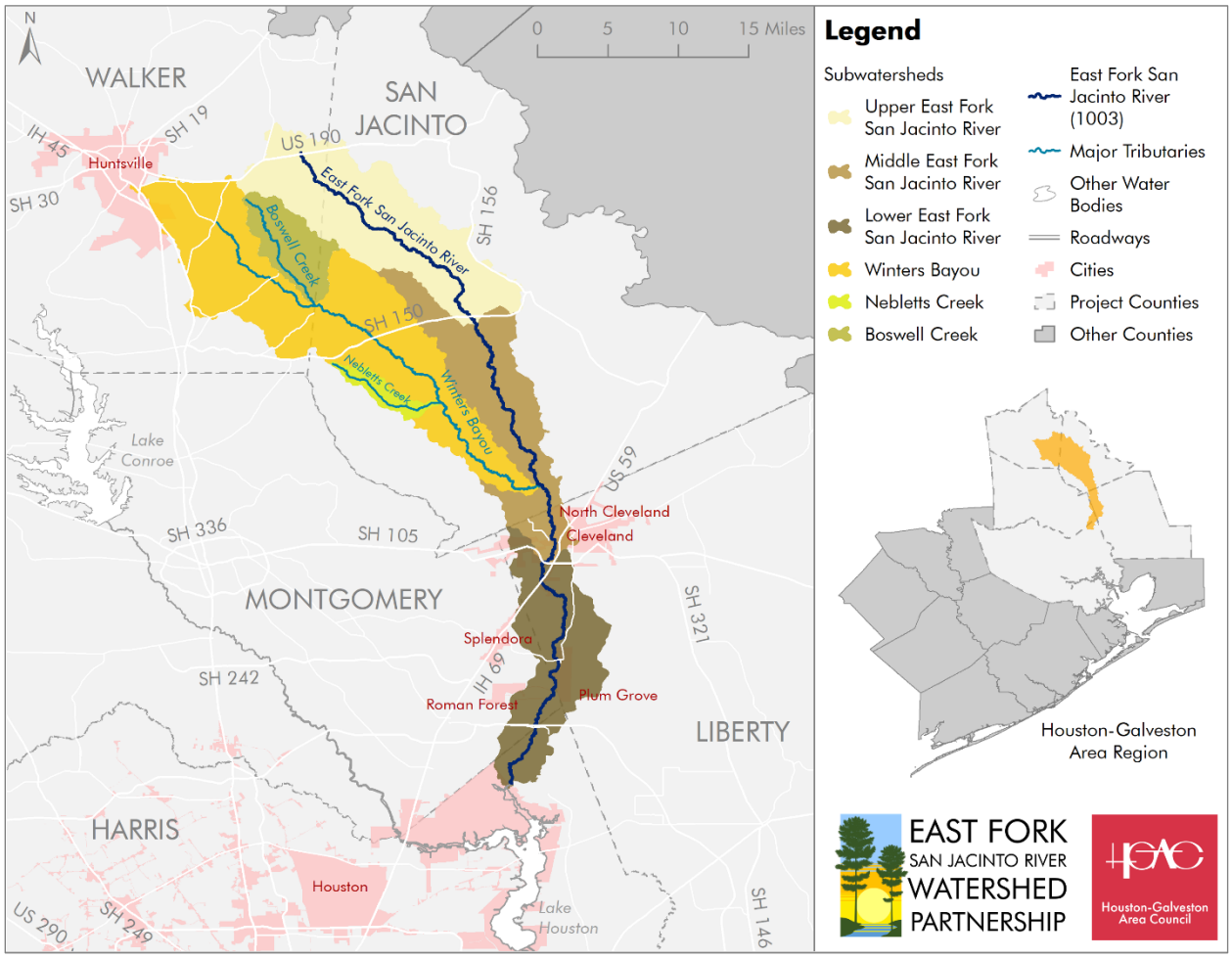

Figure 3. East Fork San Jacinto River subwatersheds

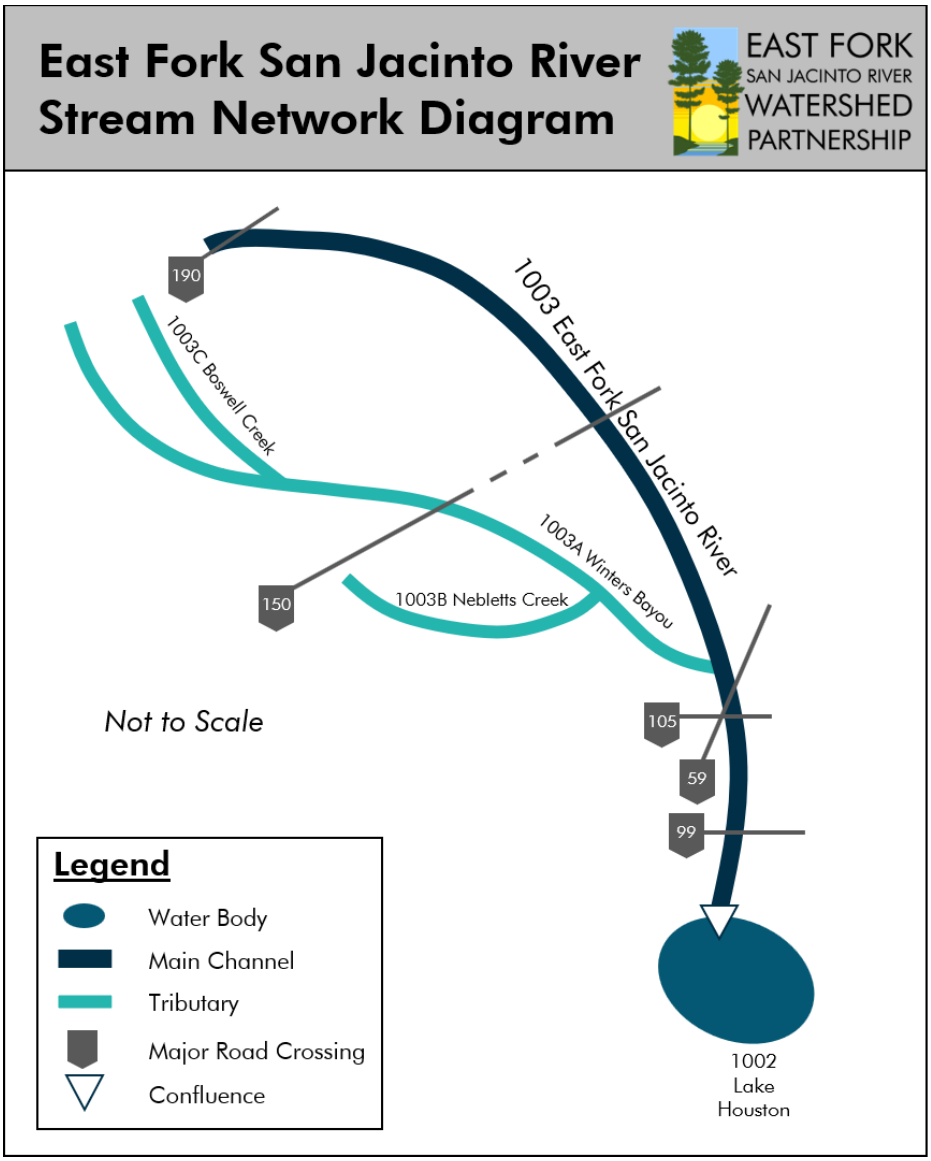

Figure 4. Stream network diagram

The full drainage area of the East Fork San Jacinto River watershed covers over 410 square miles (**Figure 5**). The drainage network includes both natural streams, modified waterways, and manmade drainage (channels and storm sewer systems) of varying size. Each of East Fork San Jacinto River's primary tributaries (Winters Bayou, Nebletts Creek, and Boswell Creek) are themselves networks of smaller tributaries and drainage conveyances.

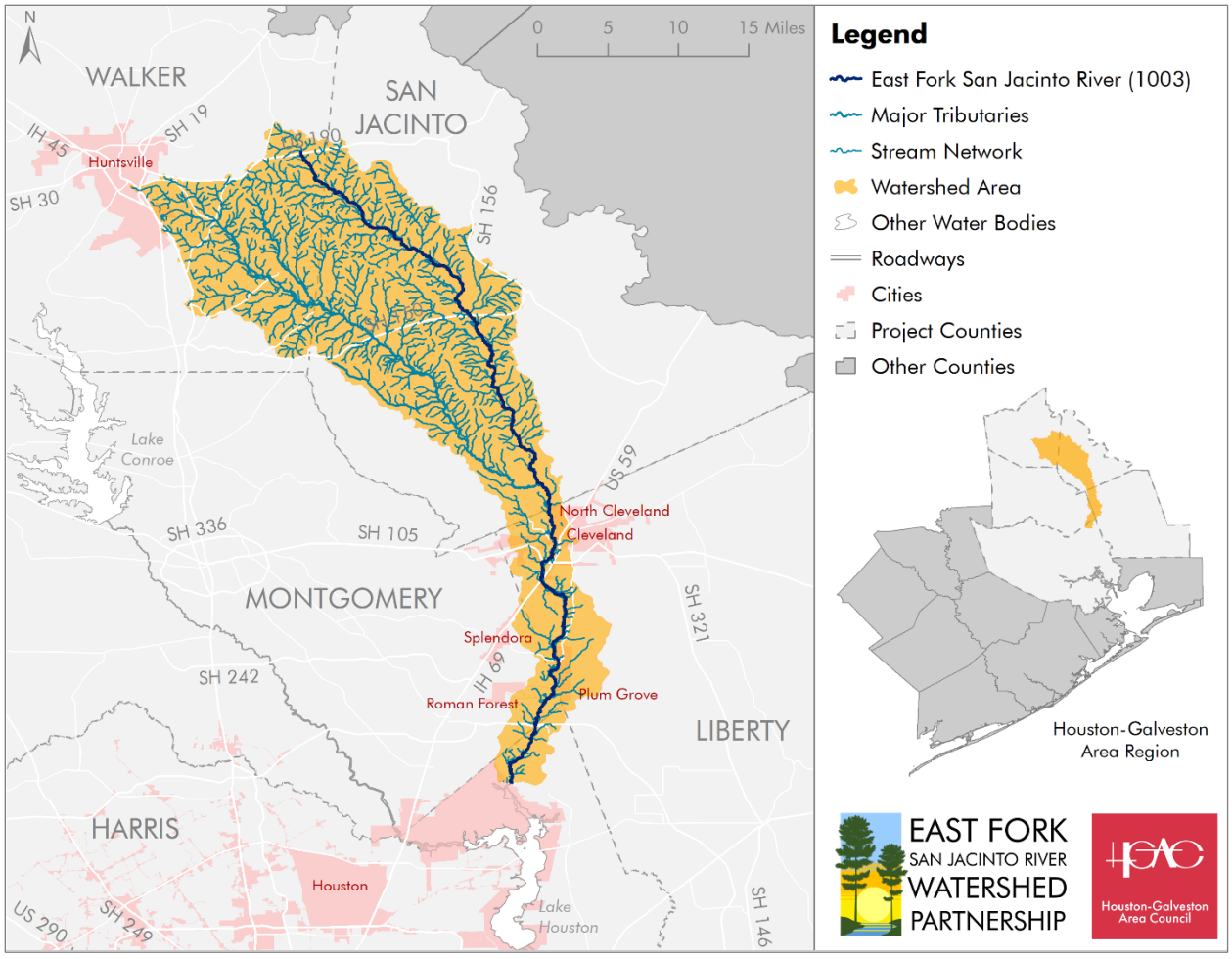

Figure 5. Hydrology in the East Fork San Jacinto River watershed

Political Geography

The watershed includes portions of Liberty County Commissioner Precincts 2 and 3, Harris County Commissioner Precinct 3, San Jacinto County Commissioner Precincts 1, 3 and 4, Montgomery County Commissioner Precinct 3, and Walker County Commissioner Precincts 2, 3 and 4. Representation at the national level includes United States House of Representatives Districts 2, 8, 17, and 36 (in addition to the United States Senate general representation). Representation at the state level includes Texas House of Representatives Districts 12,18, and 127; and Texas State Senate Districts 3, 4, and 5. In addition, the watershed overlaps the service area of a variety of other districts and authorities, including the San Jacinto River Authority, the Trinity River Authority, the Coastal Water Authority, the Harris County Flood Control District, and Harris County Flood Control District. Soil and Water Conservation Districts include those for Montgomery County, Harris County, Polk-San Jacinto County and Lower Trinity. Additionally, several other special purpose districts overlap with the watershed area.

Physical and Natural Characteristics

The physical aspects of watershed areas can impact how natural processes and effects of human development affect water quality.

Topography

Elevation generally decreases from northwest to southeast, and from headwaters toward the drainage pathways. There is a 161-meter difference between the highest and lowest points[9] of the watershed.

Climate

The climate of the area is categorized as humid subtropical, indicating it has winters cold enough to generate occasional freezing conditions. Average annual precipitation between 2006 and 2020 measured at the National Oceanic and Atmospheric Association station in Cleveland, Texas measured at 52.88 inches with the most rainfall occurring in the summer and the least occurring in the winter[10]. However, drought events can have appreciable effect on the area, as evidenced in the 2011 drought. Throughout this period, water elevations fell to record levels in downstream areas like Lake Houston—the reservoir into which East Fork San Jacinto River drains. Even though the watershed is not directly adjacent to the coast, the area is still well within the range of hurricanes and other large storms coming in from the Gulf of Mexico.

Soils

Fine-loamy soils[11] are found throughout the East Fork San Jacinto River watershed (**Figure 6**). Soils in the northern portion of the watershed tend to be more loamy and are especially fine along riparian areas. Very fine sediments are common south of Winters Bayou and in the riparian areas of the main stem just north of SH 150. South of SH 150 near Nebletts Creek, a high prevalence of clayey soils are found. Coarse-loamy sediments are more common south of the San Jacinto-Liberty county line. Erosion of soils is prominent in the alluvial sediments along the waterways.

[9] Based on USGS Digital Elevation Model 10-meter resolution spatial data.
[10] Accessed 11/3/2023 at: https://www.ncei.noaa.gov/access/us-climate-normals/#dataset=normals-annualseasonal&timeframe=15&location=TX&station=US1TXLR0013
[11] A key to the soil types represented in the map can be found at the link provided in this note. Data provided by: Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Accessed on 11/3/2023 at: https://websoilsurvey.nrcs.usda.gov/. Soil survey dates and methods can differ from jurisdiction to jurisdiction and across time periods.

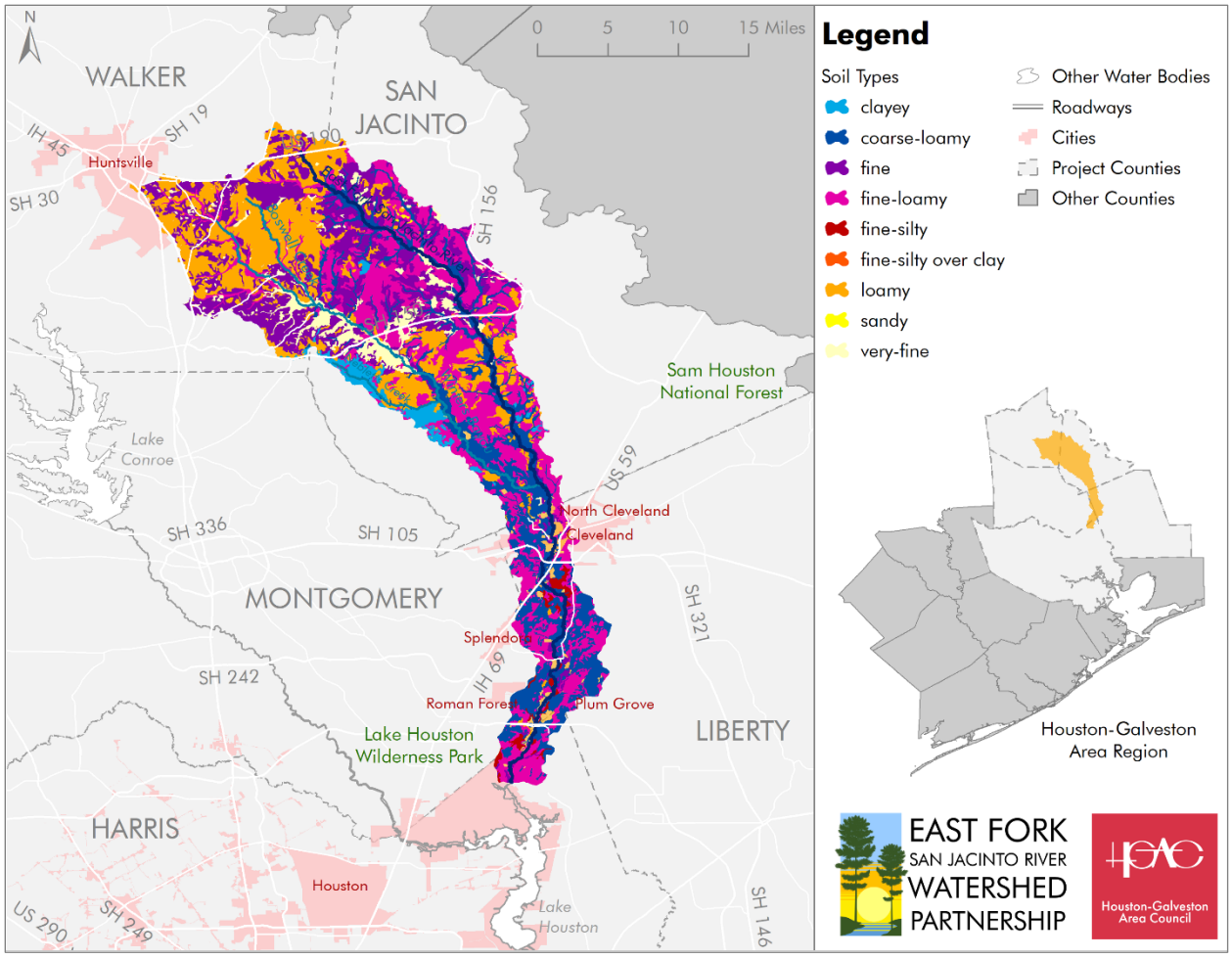

Figure 6. Soils in the East Fork San Jacinto River watershed

Habitat and Wildlife

The East Fork San Jacinto River watershed is fairly homogenous in that it only overlaps two designated ecoregions[12] (areas of similar climate, habitat, and landscape). The watershed is evenly split just north of the county line between San Jacinto and Liberty counties between the Southern Tertiary Uplands (EPA Level IV ecoregion 35e) in the north and the Flatwoods (EPA Level IV ecoregion 35f) in the south. Both of these designations fall under the broader South-Central Plains (EPA Level III ecoregion 35) designation.

This landscape hosts a diverse array of animal and plant species. Moderate winter temperatures and the location of the watershed in the Central Flyway for migratory birds support a dense and varied community of bird species year-round. Local bird species include wading birds (e.g., great blue heron, white ibis), a wide variety of passerine species, and several raptors (e.g., red-tailed hawk, bald eagle, barred owl). Typical mammal

[12] Based on EPA Level III (broad) and Level IV (more specific) Ecoregion data accessed on 11/3/2023 at: https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states

species include white-tailed deer, Virginia opossum, raccoons, coyotes, eastern grey squirrels, striped skunks, nine-banded armadillos, and numerous species of rodents and bats. The watershed is also home to many common reptiles and amphibians, including *Nerodia* water snakes, red-eared slider turtles, and bullfrogs.

Of particular concern to the watershed are some of its invasive species. In addition to exotic plants (*e.g.*, Chinese tallow) and various invasive animals, feral hogs (*Sus scrofa*) are a growing issue for the Houston region and are present in the East Fork San Jacinto River watershed. Feral hogs threaten native wildlife species through direct competition for food and destruction of habitat. Large feral hog populations can cause damage on agricultural lands and are also a nuisance for suburban and exurban residential areas. Hogs tend to congregate in and around water bodies, causing damage to the riparian corridor and depositing fecal waste directly into the water body.

Land Cover and Development

The mixture of natural landscapes in the East Fork San Jacinto River watershed determines the density and transmission of pollutant sources, and considerations for implementing solutions.

Land Cover

In general, the watershed transitions gradually from undeveloped areas north of SH 105, to growing suburban/commercial areas in the southernmost portion of the watershed (**Figure 7**). Land cover in the watershed area is characterized by heavily wooded areas, especially in the portions of the watershed spanning Walker and San Jacinto counties. These areas are part of the Sam Houston National Forest. Pasture and woody wetlands are also common in these areas. The southern part of the watershed is more developed, especially in Liberty and Harris counties. Development is expected to expand as growing populations push north from the Houston area along the US Highway 59/IH 69 transportation corridor.

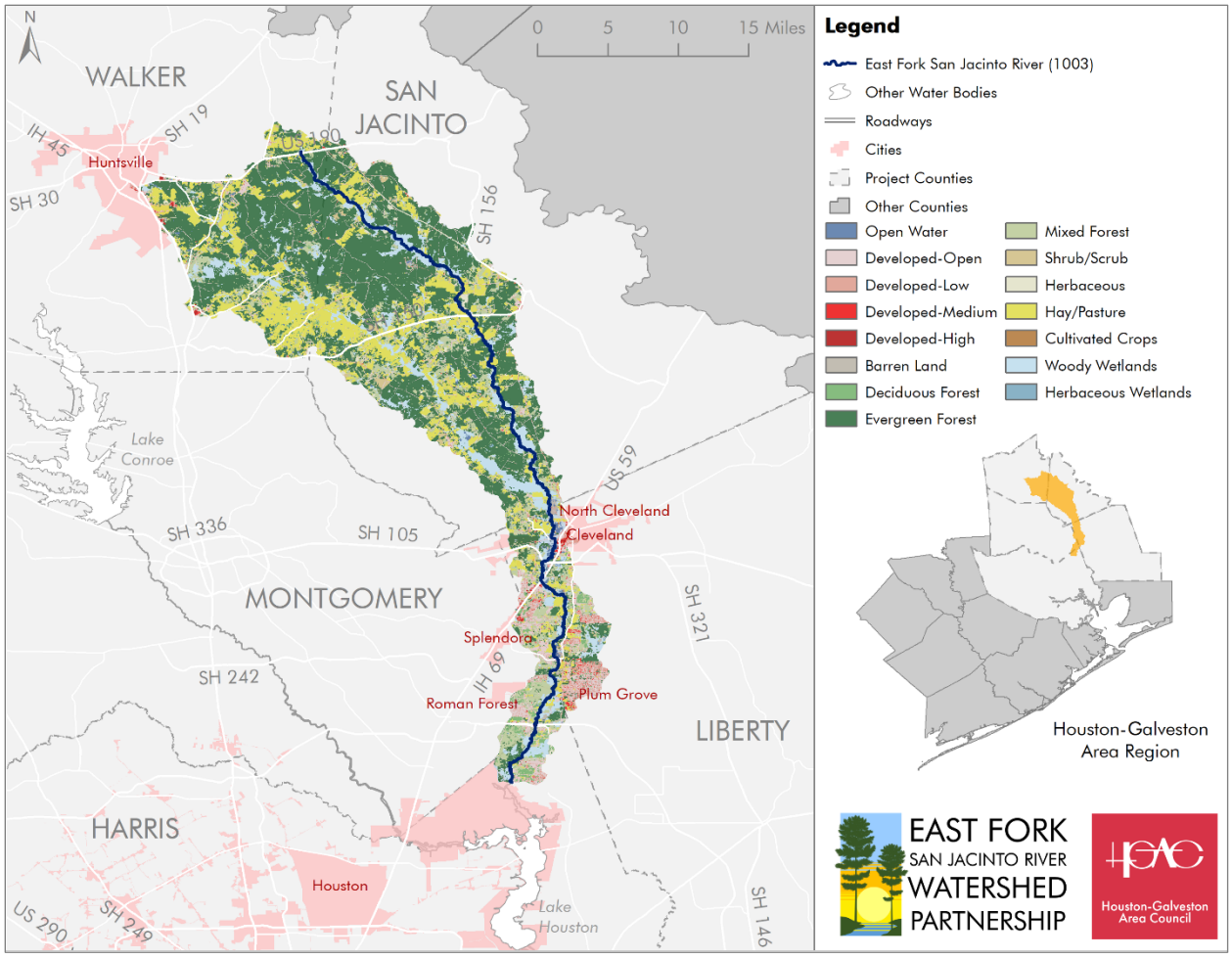

Figure 7. Land cover in the East Fork San Jacinto River watershed

Natural land uses make up the vast majority (~70%) of the total area of the watershed followed by agricultural uses (~19%). The approximate 11% of remaining area consists of developed areas (**Table 2**)[13]. The mix of land cover and uses in different areas of the watershed emphasizes the WPP focus on selecting locally-appropriate measures to address local challenges, identifying multiple areas in the watershed at which to monitor progress, and the need to coordinate with a broad array of partners throughout the watershed area.

[13] Data for this analysis represents 15-class data produced by H-GAC in 2020.

Table 2. Land cover as a percentage of watershed area

Land Cover Category	Percentage of Watershed Area
Open Water	0.83%
Developed - Open Space	7.24%
Developed - Low Intensity	3.00%
Developed - Medium Intensity	0.57%
Developed - High Intensity	0.15%
Barren Lands	0.42%
Deciduous Forest	1.27%
Evergreen Forest	43.54%
Mixed Forest	11.32%
Shrub/Scrub	0.62%
Herbaceous	0.92%
Hay/Pasture	18.64%
Cultivated Crops	0.02%
Woody Wetlands	11.41%
Emergent Herbaceous Wetlands	0.05%

Agriculture

Summary assessments below were derived from the United States Department of Agriculture (USDA) 2017 Census of Agriculture State and County profiles for Texas[14].

- **Harris County** – Harris County saw a 14% decrease in the number of farms, and an 8% decrease in the amount of land under production since 2012. Market value of sold products dropped by 22% in the same period. Most farms in the county are under 180 acres (92%) and many are under 50 acres (80%). However, there are several operations of 1,000 acres or larger. Current production value is heavily weighted toward crops (73%) as opposed to livestock (27%), but this is not reflected by total acreage for each type, with pastureland making up 62% of the total farmland, and cropland (24%) and other uses being smaller shares, proportionally. Only 5% of farmland is irrigated, and while agriculture is in overall decline in the county, over a third of the 3,106 producers are new and beginning. These numbers apply to the whole of the county and are not representative of the very small portion of Harris County overlapped by the watershed. Rather, this information is listed to provide context.

[14] Accessed on 11/3/2023 at: https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Texas/

- **Liberty County** – Liberty County saw a 5% increase in the number of farms, but a 12% decrease in the amount of land under production since 2012. Market value of sold products decreased in this period by 14%. Like Harris County, most farms in Liberty County are under 180 acres (84%). Farmed land area is similarly weighted toward pastureland (47%), with cropland being a smaller share (27%). The share of sales for each type show that cropland represents 40% of sales value, and livestock makes up the remaining 60%. Only 2% of farmland is irrigated.

- **Montgomery County** – Montgomery County saw a 1% increase in the number of farms, but a 7% decrease in the amount of land under production since 2012. Market value of sold products increased by 8% in the same period. Most farms in the county are under 180 acres (90%) and many are under 50 acres (69%) Current production value is largely weighted (74%) toward livestock. Cattle are the predominant livestock product by value. Most farmers (66%) are new or beginning with a majority (63%) between the ages of 35 and 64.

- **San Jacinto County** – San Jacinto County saw a 1% decrease in the number of farms, and a 25% decrease in the amount of land under production since 2012. Market value of sold products decreased in this period by 16%. Most farms in Waller County are under 180 acres (89%). Farmed land area is weighted toward pastureland (53%), with almost equal shares of cropland and woodland (20% and 24% respectively). Crops represented 35% of sales and livestock made up the remaining 65%. Only 1% of farmland is irrigated.

- **Walker County** – Walker County saw an 8% decrease in the number of farms, and a 19% decrease in the amount of land under production since 2012. Market value of sold products decreased in this period by 2%. Like the rest of the project counties, most farms in Waller County are under 180 acres (86%). Farmed land area is mostly pastureland (55%), with woodland being the next largest category (27%). Crops yielded 57%of sales and livestock generated 43%.

Recreation

East Fork San Jacinto River is a popular destination for a variety of recreational activities Many of the prominent parks and natural areas[15] are adjacent to the creek system and are points of access for recreation (**Figure 8**).

[15] This map is not exhaustive of all parks in the watershed.

Among the most significant natural areas in the watershed is the Sam Houston National Forest[16]. The forest covers 163,037 acres across Montgomery, San Jacinto, and Walker counties. This area is not contiguous and is mixed in with privately owned farms and timberland. The forest is home to the 128 mile Lone Star hiking trail. Another prominent park overlapped by the watershed is Lake Houston Wilderness Park[17]. This park covers nearly 5,000 acres near New Caney, Texas. Over 20 miles of trails traverse the park. Both of these areas offer recreation opportunities such as camping, canoeing, fishing, and hunting.

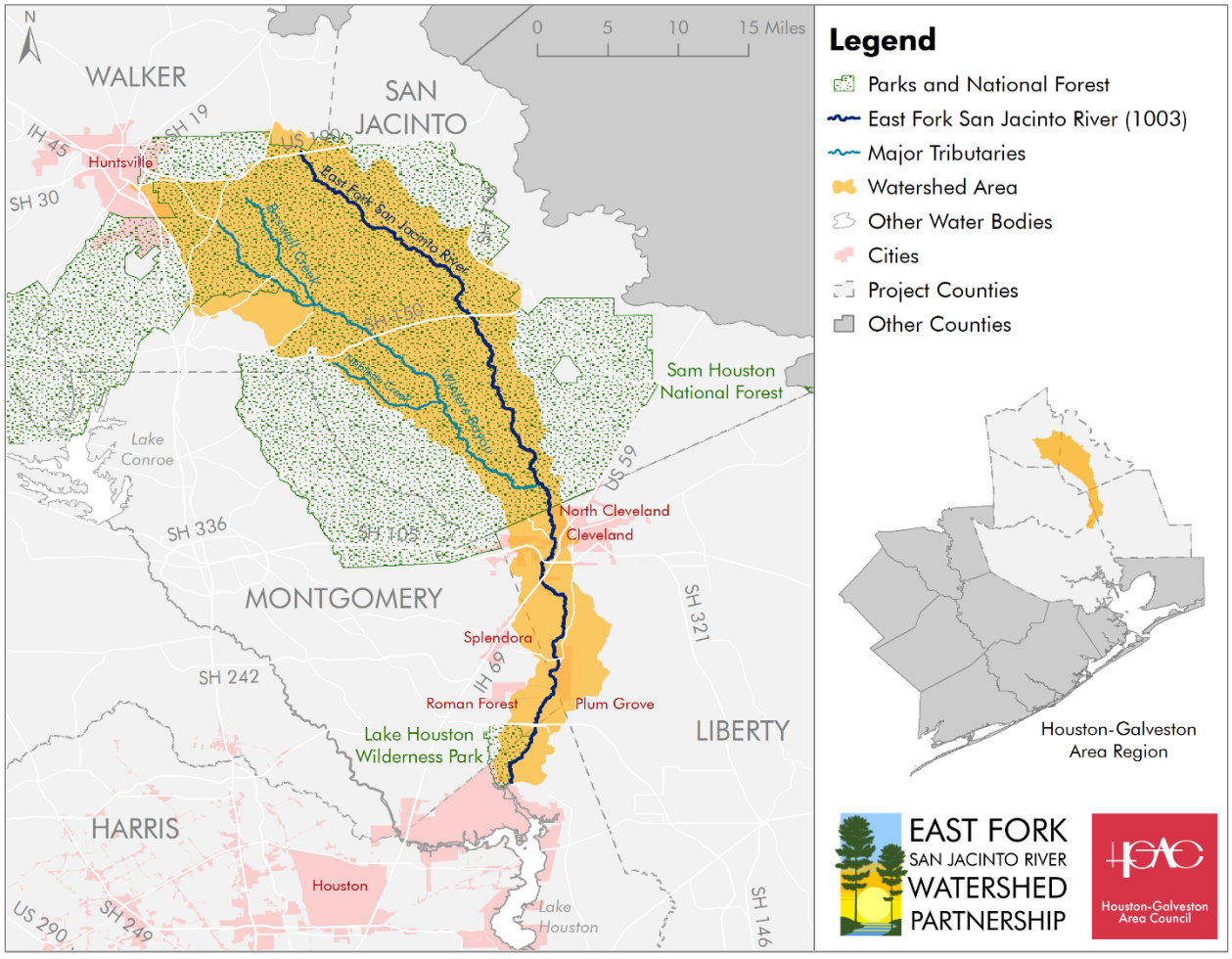

Figure 8. Parks and natural areas in the East Fork San Jacinto River watershed

Water Quality

For the State of Texas' routine water quality assessments of its water bodies, water quality parameters are strictly defined and tied to the uses we derive from a waterway (**Table 3**).

[16] For more information, see: https://www.fs.usda.gov/detail/texas/about-forest/districts/?cid=fswdev3_008443

[17] For more information, see: https://www.houstontx.gov/parks/lakehoustonpark.html

However, water quality for local stakeholders includes other factors specific to the values their community places on their local waterway, and they may have concerns not reflected in ambient water quality monitoring that range from other contaminants like trash to more qualitative concepts such as sense of place and aesthetic quality. This WPP recognizes that the defined water quality parameters discussed herein should be considered alongside other stakeholder concerns and valuations.

Water Quality Standards

For the lakes, creeks, streams, rivers, bays and bayous of Texas, water quality is evaluated based on SWQSs. Under the delegated authority of the CWA, TCEQ develops the SWQSs and is responsible for ensuring they are met. The intent of the standards is to establish explicit goals and limits to ensure Texas' surface waters continue to support recreation, drinking water supply, aquatic communities, and other established uses.

Table 3. Designated uses for water bodies

	The **aquatic life use** designation reflects the ability of the waterways to support aquatic ecosystems and habitat. Compliance with this use is determined by the availability of DO and an assessment of the diversity and health of existing ecological communities (fish, macrobenthics, and their habitat). High levels of chlorophyll-*a*, and elevated levels of nutrients, can indicate potential issues related to low DO.
	The **contact recreation use** designations indicate the waterway is used for recreational activities, such as swimming, that involve a greater chance of ingesting water. The basis of the SWQS for contact recreation standards is to protect public health. Ubiquitous fecal indicator bacteria organisms (*E. coli* and Enterococcus) are used as indicators of the potential contamination level from fecal pathogens. In freshwater systems like the East Fork San Jacinto River watershed, elevated levels of *E. coli* are a sign the waterway does not meet the SWQSs.
	The **public water supply use** designation indicates a waterway is used for public water supply. The assessment of compliance for this use is a measure of the suitability of the waterway to serve as a current or future drinking water source. A variety of criteria are used to evaluate this use, including temperature, total dissolved solids, DO, pH range, fecal indicator bacteria, chlorine, and sulfates levels.
	The **general use** designation reflects the overall health of the waterway as measured by criteria for temperature, pH, chloride, sulfate, and other parameters.

The vast network of surface water bodies is divided into segments, which are cohesive groupings of waterways and associated tributaries. The primary classified segment in the East Fork San Jacinto River watershed is Segment 1003 (East Fork San Jacinto River). Major tributaries or waterways of interest within these classified segments are delineated as

subordinate unclassified segments. Unclassified segments in this watershed include 1003A (Winters Bayou), 1003B (Nebletts Creek), and1003C (Boswell Creek). Other contributing waterways and drainage networks also contribute to the system but are either not designated as unclassified segments by TCEQ or are not actively assessed.

Surface water segments are further divided into assessment units (AUs), the fundamental targets for assessments that determine whether a water body is in compliance with applicable standards. AUs are designated as the segment number followed by the AU number (*e.g.*, 1003_01 for East Fork San Jacinto River, AU 1). AUs in the East Fork San Jacinto River system (**Table 4**; **Figure 9**) include:

Table 4. East Fork San Jacinto River segments and assessment units

Segment	Assessment Units
East Fork San Jacinto River - 1003	01, 02, and 03
Winters Bayou - 1003A	01
Nebletts Creek - 1003B	01
Boswell Creek - 1003C	01

Assessments are made based on data collected under the state's Clean Rivers Program (CRP) and other quality-assured data. TCEQ conducts assessments every two years for the state's water bodies, reviewing the previous seven years of data against the designated uses for the waterways. The results are included as part of TCEQ's 2022 Texas Integrated Report of Surface Water Quality (2022 Texas Integrated Report). The results of the assessments of the East Fork San Jacinto River AUs only reflect ambient surface water quality, not the quality of tap water provided by utilities in the watershed, which is not the focus of this WPP.

State of the Water

The water quality of the East Fork San Jacinto River system is affected by numerous factors, including human activities, natural processes, availability of rainfall, and releases and natural seepage from impoundments to which it is connected. Based on assessment of water quality data[18], many of the AUs in the watershed have existing water quality challenges. As development continues over the coming decades, additional sources of contamination may exacerbate these issues if no mitigating action is taken.

[18] For more information on detailed water quality assessments and modeling, refer to Section 3 of this document. For in-depth information on water quality trends in the watersheds, please refer to the *Water Quality Data Analysis Summary Report* available on the website for this WPP project at: https://eastforkpartnership.weebly.com/uploads/1/3/0/7/130710643/30143_3.2_acquired_data_analysis_report_final.pdf

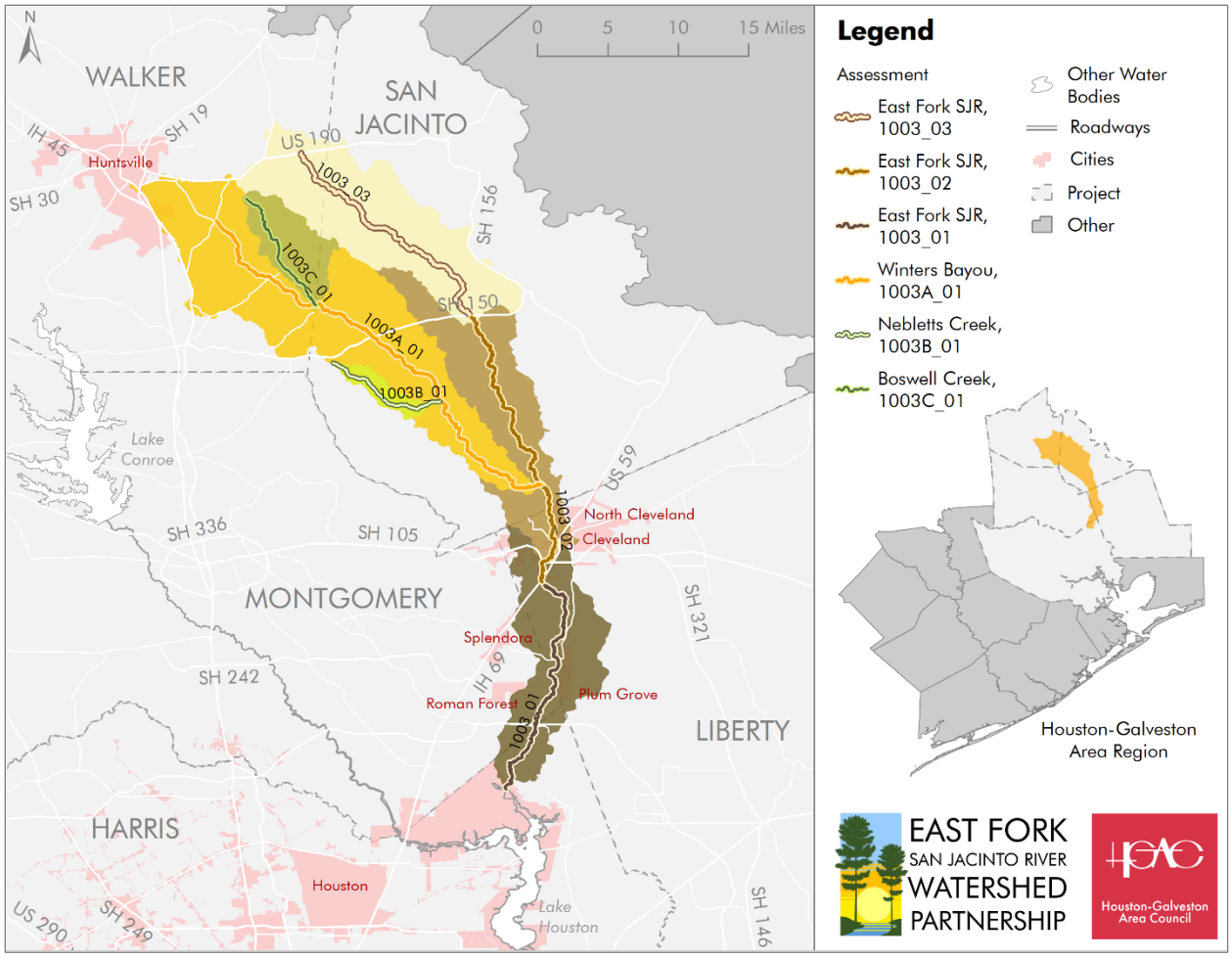

Figure 9. Segments and AUs in the East Fork San Jacinto River watershed

Impairments and Concerns

When a water body is unable to meet one or more of the SWQSs, it has an **impairment** for that standard. When an impairment may be imminent, or when substandard water quality conditions exist for a parameter that does not have an established numeric standard, the water body may be listed as having a **concern**. For example, water bodies are protected from excessive nutrient levels using screening levels. When concentrations of certain nutrients are above these screening levels, the water quality is characterized as a concern. Water quality in East Fork San Jacinto River and its tributaries is typical of challenges seen in other freshwater creeks and bayous in the area[19].

[19] References to assessments and water quality status refer, unless otherwise noted, to the 2022 Texas Integrated Report of Surface Water Quality, the most current report available at the time of publication.

According to recent versions of the Texas Integrated Report, current assessed water quality issues in East Fork San Jacinto River and its assessed tributaries include elevated levels of *E. coli* (**Table 5**). The contact recreation impairment exists across many of the watershed's AUs and is the primary focus of this WPP.

Table 5. Impairments and concerns in the East Fork San Jacinto River watershed, 2018-2022

Report Year	Assessment Units Impaired for *E. coli*	Assessment Units with Concerns for *E. coli*
2018	1003_01, 1003_02, 1003_03	1003A_01
2020	1003_01, 1003_02, 1003_03	1003A_01
2022	1003_01, 1003_02, 1003_03, 1003A_01	1003C_01

Other Concerns

While the primary focus of this WPP is to address water quality impairments and concerns, all water bodies have a range of issues that impact human and wildlife uses. The WPP model is inclusive of other stakeholder concerns as part of a broader effort to improve the waterway. During the development of this WPP, stakeholders identified several other issues as being secondary priorities for implementation activities.

Trash

Illegal dumping and ambient trash from stormwater are not reported by the stakeholders to be a widespread issue in the watershed, but implementation measures related to trash management are incorporated in this WPP as a precaution.

Flooding

While flood management is outside the scope of this WPP, changes to flow regimes or increased flooding can alter the impact of pollutant sources. These concerns are being included in this WPP based on their potential water quality impact, and the need to coordinate these efforts with the many flood mitigation projects underway or planned for the system.

Conservation of Natural Areas/Function

Using natural infrastructure to improve water quality, flood mitigation, maintain rural character, and protect natural landscapes and habitat was a standing concern among the stakeholders.