COLORADO'S FOUNTAIN CREEK

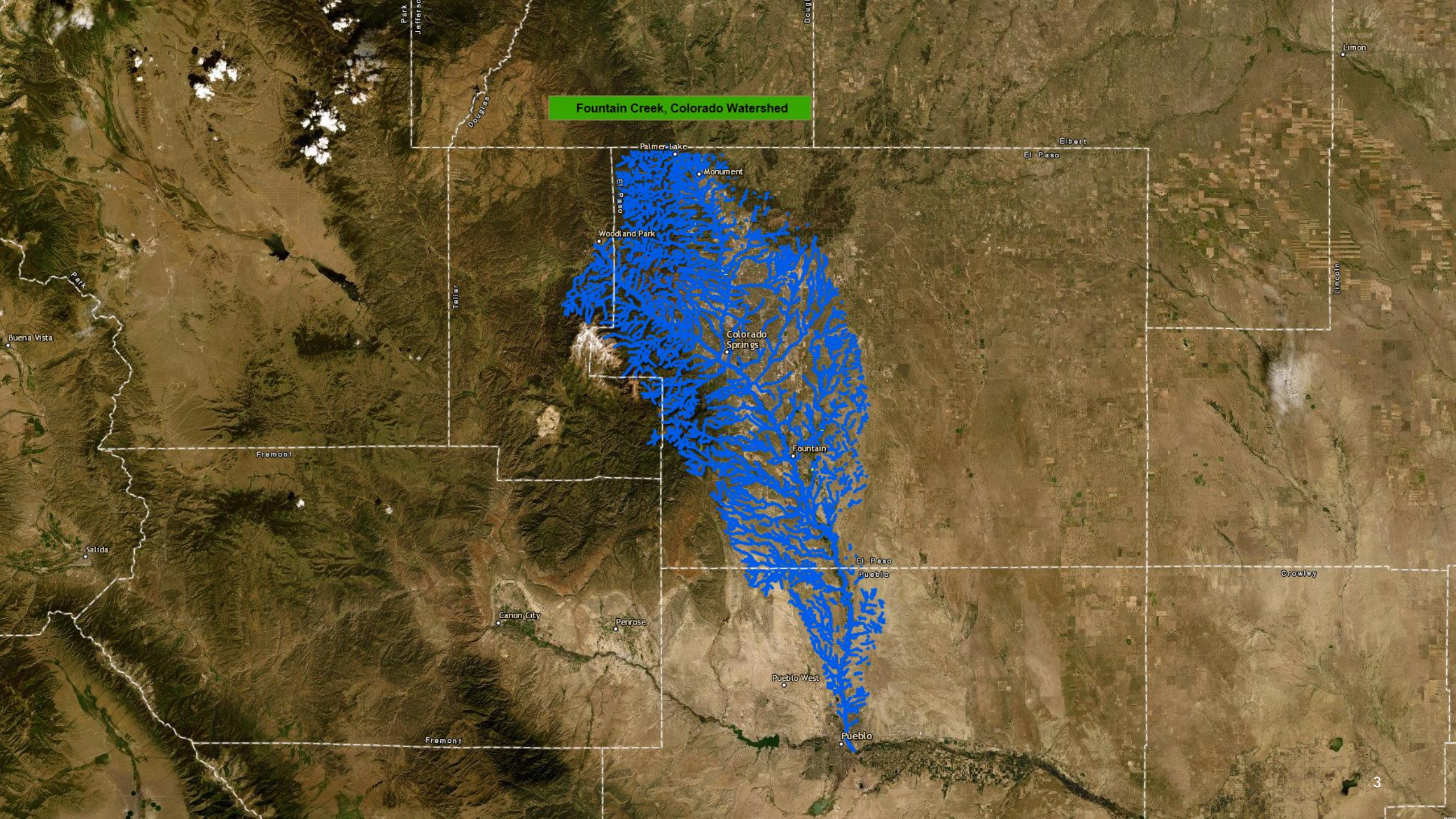
A WATERSHED IN TRANSITION

Prepared by
Shavano Intelligence Systems
Website: https://shavanointelligencesystems.com
Twitter: @ShavanoSystems

FOUNTAIN CREEK WATERSHED HYDROLOGY

Fountain Creek, an Arkansas River tributary, is located in and along the eastern slope of the front range section of the Southern Rocky Mountains in Eastern Colorado (see graph 3).

- The watershed encompasses approximately 930 square miles of parts of Teller, El Paso, and Pueblo Counties, includes metropolitan Colorado Springs and the northern half of the City of Pueblo.
  - The majority of western headwater streams flow through National Forest or Department of Defense owned property.
  - Eastern headwater streams primarily originate in the Black Forest highlands and generally flow to the southwest.
  - Ephemeral streams predominate to the east of Monument Creek and south of the city of Fountain.
- Natural stream flow has historically been dominated by spring snowmelt and summer monsoon generated thunderstorms. These events often result in high-flows that at times reach catastrophic flash flood levels. Lower to very low flows were once common during drier summer periods and winter months.


Fountain Creek, Colorado Watershed
Limon
Douglas
Palmer Lake
Monument
El Paso
Elbert
El Paso
Woodland Park
Teller
Park
Lincoln
Buena Vista
Colorado Springs
Fountain
Fremont
Salida
El Paso
Pueblo
Crowley
Canon City
Penrose
Pueblo West
Fremont
Pueblo

FOUNTAIN CREEK WATERSHED
HUMAN ACTIVITIES

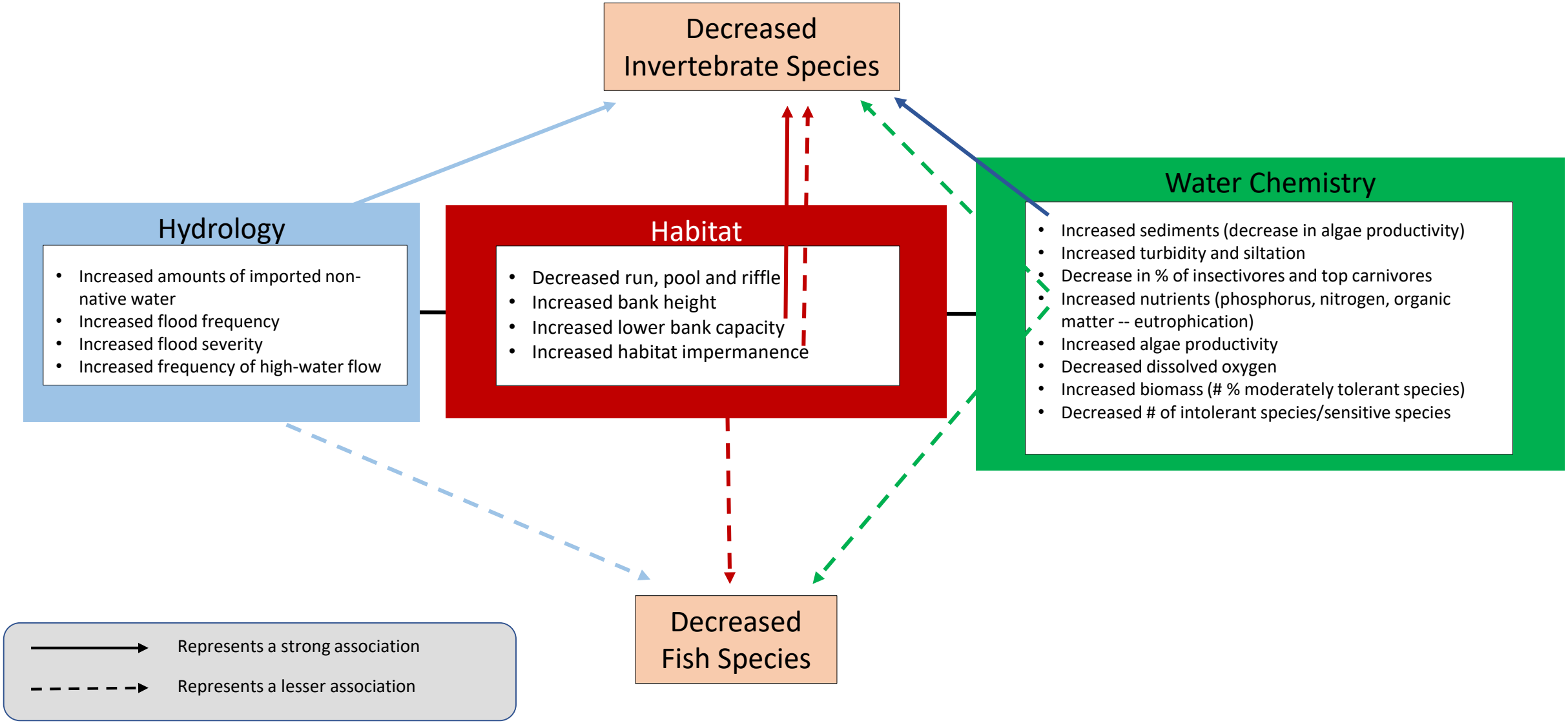
- Much of the Fountain Creek main stem, its principal tributary Monument Creek, and all the Fountain's eastern and southern tributary streams are privately owned. This makes the main stem and tributary streams subject to intensive – current and future – urban and suburban development, commercial sprawl, and industrial operations. In recent years, Fort Carson and, to a somewhat lesser extent, the Air Force Academy have increased the amount of impervious surfaces (roadways, parking lots, and structures) on their properties.
- Extensive reservoir construction and ground water withdrawals over the past 150 years (primarily for urban use, flood control, and agriculture) have decreased the Fountain Creek and its tributary stream natural base flows.
- Historic flash flooding along the Fountain Creek main stem and its tributaries remains constant and has often been severe. Catastrophic flooding has resulted in loss of life and extensive damage to property, highways, buildings, flood-control structures, stream banks, and stream-side vegetation.
- Flooding severity and occurrences have increased in recent years, likely due to the infusion of non-native water sources into the mid-lower Fountain main stem and the exponential increase of impervious surfaces across the Fountain Creek watershed.

FOUNTAIN CREEK WATERSHED
NON-NATIVE WATER SOURCE AFFECTS

Since the 1970's, imported non-native water from deep wells and the Colorado and Arkansas Rivers make up more than 80% of the middle and lower Fountain Creek main stem.

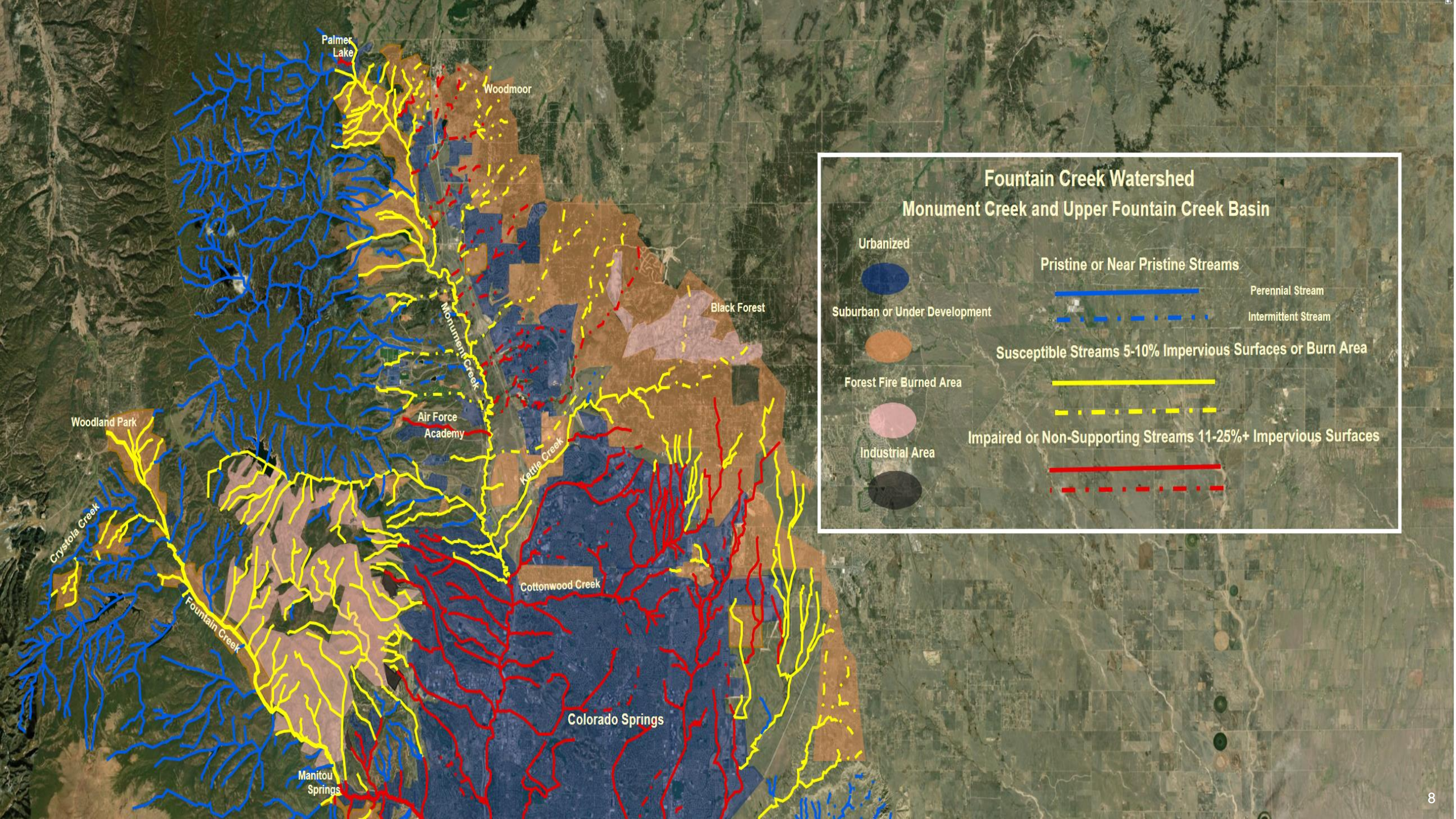
- This water is brought by pipeline and used by Colorado Springs for municipal and industrial purposes.
- It enters Fountain Creek at the city's primary sewage treatment facilities.
- Its infusion into Fountain Creek results in year-round high flows causing radical change to stream morphology, increased flood threats and severity, and negatively impacts the Fountain Creek's natural high to extremely low flow riparian environment (see graphic 6).
- Environmental impacts of these non-native waters into the Fountain Creek watershed have shown consistently elevated phosphorous levels particularly south of the Colorado Springs metro area sewage treatment plants.
- The cities of Colorado Springs and Pueblo, the State of Colorado, and the Federal Government are spending millions of dollars to construct flood mitigation projects and greenways to help control this infusion of non-native water into the middle and lower Fountain Creek.

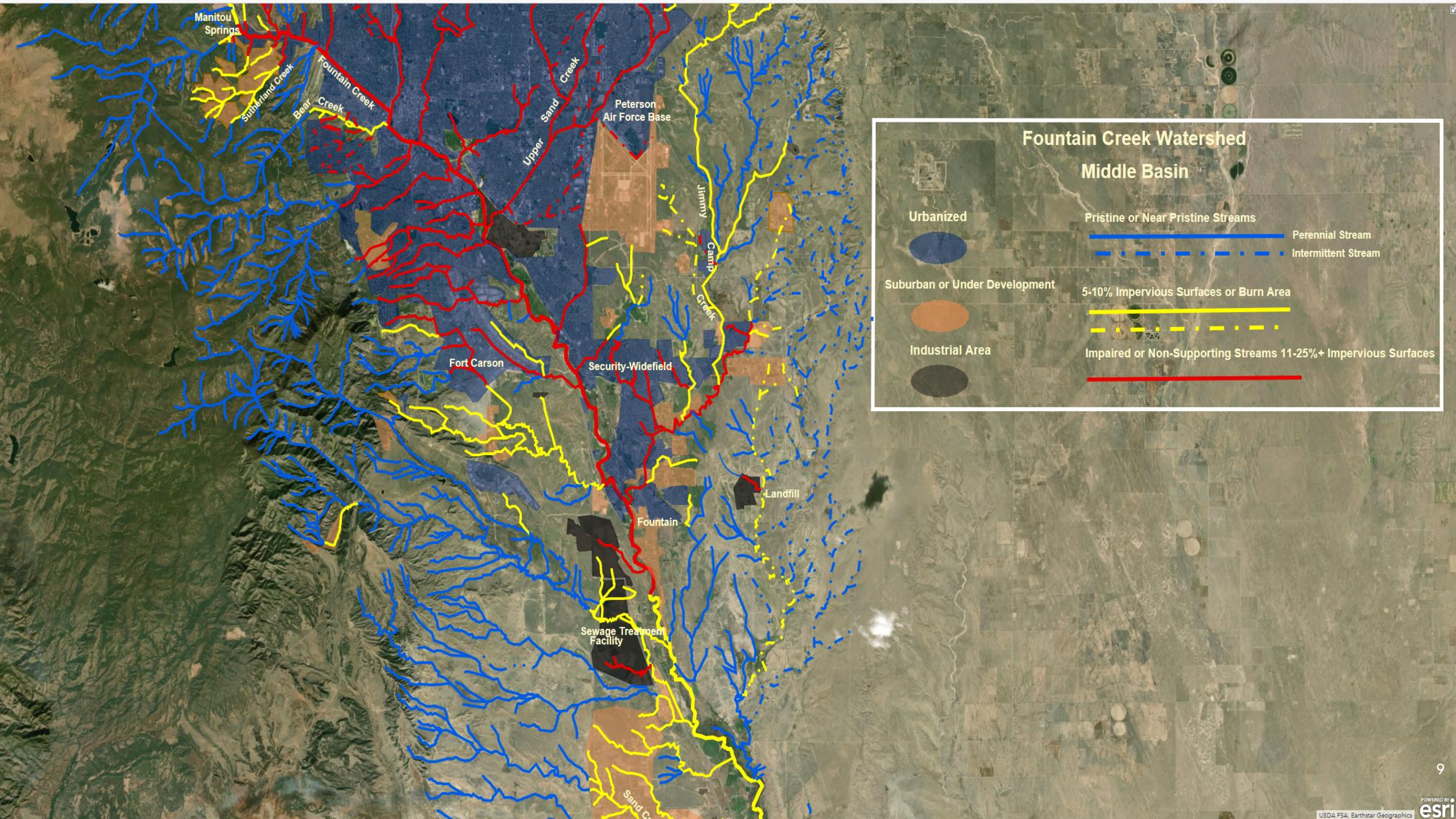
Middle and Lower Fountain Creek Environmental Variables Associated with Urbanization and Non-Native Water Source Infusion

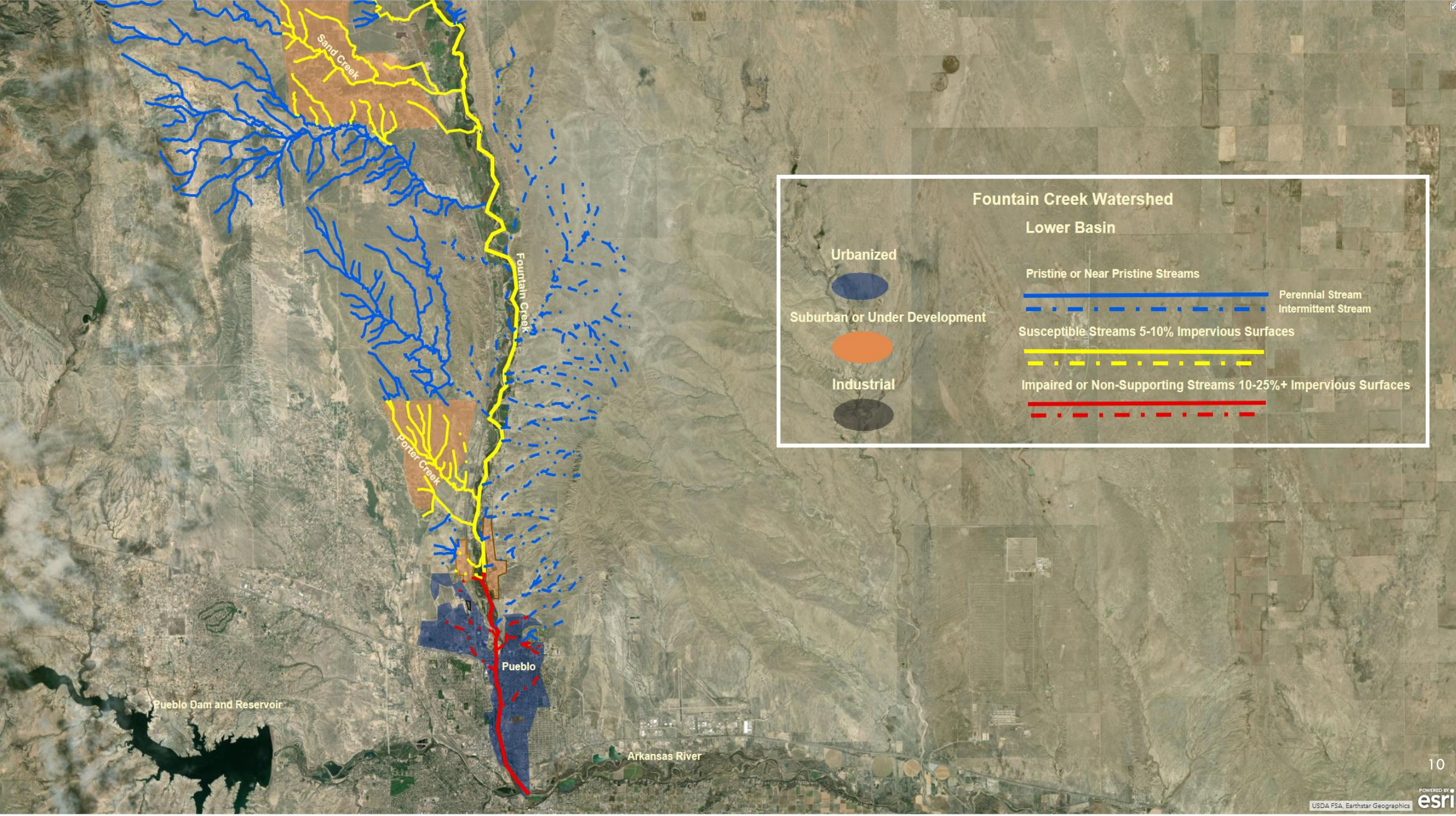


FOUNTAIN CREEK WATERSHED
SUB-WATERSHED IMPACTS

- Fountain Creek headwater streams, particularly from eastern Teller County to west of Manitou Springs, are showing increased sedimentation, reduced water quality, bank erosion, and reduced biodiversity. This is likely due to a significant increase in impervious surfaces and lingering effects from the Waldo Canyon and to a somewhat lesser extent the Black Forest fires.
    - The 2012 Waldo Canyon and 2013 Black Forest fires have resulted in near-catastrophic flash flooding in areas downstream from the burned areas (see graphic 8). This has required expensive flood control projects to protect metropolitan Colorado Springs and to divert excessive sediment deposition from roadways, commercial and residential buildings, and scenic areas such as the Garden of the Gods.
- Upper Monument Creek and the non-National Forest tributary basins of Fountain Creek show increased stream flow rates, pervasive stream undercutting, and persistent bank erosion (see graphic 8). This is likely due to the rapid increase of impervious surfaces.
- Recent increases of suburban development along the northeastern half of the Fountain's upper tributaries are causing increased sedimentation and reduced water quality downstream (see graphic 8). This has negatively impacted several once near-pristine sub-watershed streams.
- Several sand and gravel quarries, numerous abandoned gold and coal mines, and an abandoned limestone mine are located within or west of Colorado Springs (see graphics 8-9). These quarries and mines contribute to overall watershed pollution and can leach heavy metals in sub-watershed streams. The Fountain City landfill is also a primary point pollution area of concern.


Palmer Lake
Woodmoor
Black Forest
Monument Creek
Air Force Academy
Woodland Park
Kettle Creek
Crystola Creek
Fountain Creek
Cottonwood Creek
Colorado Springs
Manitou Springs
Fountain Creek Watershed
Monument Creek and Upper Fountain Creek Basin
Urbanized
Suburban or Under Development
Forest Fire Burned Area
Industrial Area
Pristine or Near Pristine Streams
Perennial Stream
Intermittent Stream
Susceptible Streams 5-10% Impervious Surfaces or Burn Area
Impaired or Non-Supporting Streams 11-25%+ Impervious Surfaces


Manitou Springs
Fountain Creek
Sutherland Creek
Bear Creek
Upper Sand Creek
Peterson Air Force Base
Jimmy Camp Creek
Fort Carson
Security-Widefield
Landfill
Fountain
Sewage Treatment Facility
Fountain Creek Watershed
Middle Basin
Urbanized
Suburban or Under Development
Industrial Area
Pristine or Near Pristine Streams
Perennial Stream
Intermittent Stream
5-10% Impervious Surfaces or Burn Area
Impaired or Non-Supporting Streams 11-25%+ Impervious Surfaces
USDA FSA, Earthstar Geographics
esri


Fountain Creek Watershed
Lower Basin
Urbanized
Suburban or Under Development
Industrial
Pristine or Near Pristine Streams
Perennial Stream
Intermittent Stream
Susceptible Streams 5-10% Impervious Surfaces
Impaired or Non-Supporting Streams 10-25%+ Impervious Surfaces
Sand Creek
Fountain Creek
Porter Creek
Pueblo
Pueblo Dam and Reservoir
Arkansas River
USDA FSA, Earthstar Geographics
esri

FOUNTAIN CREEK WATERSHED
SUMMARY OF TRIBUTARY STREAMS

The following headwater streams are most at risk from existing and new development, point pollution, and impervious surface runoff (see appendixes A and B for representative examples):

- Cottonwood Creek (Colorado Springs, El Paso County) – urbanization, sedimentation, elevated nitrogen, and near complete development of its tributaries (see graphic 8).
- Upper Sand Creek (Colorado Springs, El Paso County) – urbanization, high potential for toxic pollutants, sedimentation, and near complete development of its tributaries (see graphic 9).
- Kettle Creek (Colorado Springs, El Paso County) – urban development and extensive suburban development, runoff impact from the Black Forest fire (see graphic 8).
- Crystola Creek (Teller County) – several new dispersed suburban developments along its tributary streams and main channel (see graphic 8).
- Sutherland Creek (Manitou Springs, El Paso County) – a large new suburban development along all tributary and main stem streams (see graphic 9).

FOUNTAIN CREEK WATERSHED
SUMMARY OF TRIBUTARY STREAMS (CONTINUED)

- Jimmy Camp Creek (El Paso County, Colorado Springs, City of Fountain) – several new suburban developments along the upper tributary streams and from the Security-Widefield urban area (see graphic 9).
- Sand Creek (lower) (El Paso County) – extensive new subdivision under construction across Sand Creek and along its two adjacent stream drainages (see graphic 10).
- Porter Creek (Pueblo County) – a new subdivision under construction along the creek mid basin (see graphic 10).
- Palmer Lake Area (Town of Palmer Lake, El Paso County) – extensive urbanization around the lake and along nearby streams, extensive impervious surface runoff (see graphic 8).
- Bear Creek (El Paso County, west central Colorado Springs) – excellent stream buffers exist in this natural preserved area. However, extensive urbanization of the Bear Creek lower course sub-watersheds makes it highly susceptible to sedimentation, chemical pollution, and other negative environmental impacts (see graphics 9).
- Monument Creek (El Paso County, Colorado Springs) – western headwaters essentially pristine while eastern, mostly intermittent streams, are becoming impacted by dense to moderately dense suburban development, mid and lower basin significantly impacted by Black Forest and Waldo Canyon fires (see graphic 8).

FOUNTAIN CREEK WATERSHED
COTTONWOOD CREEK TRIBUTARY

Cottonwood Creek flows southwest across northern Colorado Springs, originating in the Black Forest (see graphic 8).

- Nearly all upper tributaries and the main stem are under intense residential and commercial development. Tributary streams are assessed as impaired or non-supporting while only a few Black Forest upper watershed tributaries can be assessed as susceptible from impervious surface impacts.
- The stream does have a narrow riparian greenway that originates at the Colorado Springs eastern city boundary and extends to the confluence with Fountain Creek.
- The creek has concrete and rip rap flood control structures along its course. It also has higher levels of nitrates, phosphorous and other contaminants likely from a greater concentration of impervious surfaces than other lesser developed streams. Bank undercutting, pervasive erosion, and high-sediment loads are also present, particularly during high water periods.
- Tributary streams have limited to no riparian buffers, are often channelized, have numerous concrete flood control features, and appear to have been artificially straightened to facilitate suburban development (see appendix A).
- Recommendations: Establish wetlands and expand the greenway riparian buffer. Develop new riparian buffers on tributary streams. Return and preserve main stem and tributary stream sinuous bends and meanders, where possible, to reduce sediment erosion, bank cutting, and flooding.

FOUNTAIN CREEK WATERSHED
UPPER SAND CREEK TRIBUTARY

Sand Creek originates in the Black Forest region of El Paso County and flows through eastern Colorado Springs before reaching Fountain Creek (see graphic 9).

- Sand Creek and its tributaries flow through a rapidly developing urbanized corridor that includes Peterson Air Force Base and the Colorado Springs Municipal Airport. A large sand and gravel quarry is also located at the confluence of Sand Creek and the Fountain.
- Polyfluoroalkyl substances (PFAS), a firefighting foam used at Peterson Air Force Base, has been detected in drinking water at the base and the city of Fountain. Sand Creek would be the most likely candidate to carry PFAS into the Fountain Creek watershed.
- Sand Creek has been plagued with major flash flood events. The City of Colorado Springs has completed a series of rock flood control structures, detention basins, and stream bank restoration projects to protect urban areas, reduce downstream sedimentation, and slow flood waters. Little has been done to protect riparian buffers or to enhance or return natural stream sinuous bends.
- Extensive new subdivisions and commercial development in the Black Forest tributary creeks and along the eastern Sand Creek tributaries and main stem will result in increased flooding from impervious surfaces.
- Recommendations: Increase efforts to return natural vegetation to the stream bank. Use existing flood control structures to improve stream quality by reducing sedimentation and bank cutting. Avoid or reduce large-scale subdivision development in the far northern tributaries. Regularly monitor and report on any PFAS or other point pollutant infiltration into the Upper Sand Creek watershed.

FOUNTAIN CREEK WATERSHED
KETTLE CREEK TRIBUTARY

Kettle Creek originates in the Black Forest region of El Paso County with upstream tributaries ephemeral and mid to lower courses perennial (see graphic 8).

- Upper reaches are impacted by the Black Forest fire burn area. The fire has greatly increased sediment erosion, bank cutting, and toxic pollutants downstream.
- Extensive dispersed subdivisions, outbuildings, and roads are located across the entire upper tributary streams resulting in a moderate level of impervious surfaces and increased toxic pollutants, nitrogen, and phosphorous into the stream basin.
- The lower stream course is more densely developed with several major high-impact subdivisions completed or under construction.
- An excellent forested riparian buffer is present throughout the majority of Kettle Creek's main stem. This buffer reduces and absorbs many pollutants, provides shade for fish, aquatic insects, and wildlife. In contrast, Kettle Creek's tributary streams are being negatively impacted by suburban home construction and have significantly less to no riparian buffer protection.
- Recommendations: The existing forest riparian buffer should be maintained and enlarged along the main stem and expanded into the tributary streams. Subdivision home densities should be reduced, more storm water retention ponds should be constructed, and natural stream meanders should be retained to help slow runoff, protect property from flooding, enhance stream bio-diversity, and reduce impacts from impervious surfaces.

FOUNTAIN CREEK WATERSHED
CRYSTOLA AND SUTHERLAND CREEK TRIBUTARIES

Crystola Creek (see graphic 8) and Sutherland Creek (see graphic 9) are key headwater streams for the upper Fountain Creek watershed. Crystola is in eastern Teller County and Sutherland is south of Manitou Springs.

- Both creeks are increasingly threatened by moderate to large-scale subdivision developments along their lower and middle courses.
- The southern Crystola and Sutherland Creek tributary streams are most affected by urban development. These subdivisions have only minimal to no stream buffers. Sutherland Creek is more urbanized while Crystola is, at this time, showing more dispersed residential development.
- Development on both creeks have increased the amount of impervious surfaces resulting in sedimentation, bank cutting, erosion, and greater point pollution. Continued housing construction will negatively impact invertebrate populations and fish spawning habitats in these once pristine creeks.
- Recommendations: Closely monitor these subdivision creeks for point pollution, siltation, nitrogen, phosphorous and other contaminants. Maintain or enhance stream buffers along developed sections of Crystola and Sutherland Creeks and all their tributaries. Construct storm water retention ponds, preserve meanders and riffle habitats to reduce erosion, bank cutting, and surface pollutants.

FOUNTAIN CREEK WATERSHED
JIMMY CAMP CREEK TRIBUTARY

Jimmy Camp Creek is located in El Paso County, east of Peterson Air Force Base, and flows through a rapidly developing area that was once agricultural and grassland (see graphic 9).

- The northern headwater streams are facing intense development pressures, while the southern section of Jimmy Camp Creek flows through highly urbanized Security-Widefield and the City of Fountain.
- This creek is subject to extreme high and low flows. Flash flooding is common but is not generally as severe as Cottonwood Creek or Upper Sand Creek.
- Less developed areas of the Jimmy Camp Creek sub-watershed remain pristine or near pristine, but post 2006 developments along the creek show increased sedimentation, bank cutting, and erosion. This is likely caused by an increase of dispersed suburban developments and significantly greater impervious surfaces.
- Recommendations: Limit dense development in the middle stream tributaries, enhance and preserve sinuous stream bends, perform stream bank stabilization, and expand grassland vegetation stream buffers where new subdivision development activity is either planned or underway.

FOUNTAIN CREEK WATERSHED
LOWER SAND AND PORTER CREEK TRIBUTARIES

Lower Sand Creek is in extreme southern El Paso County, and Porter Creek is in northern Pueblo County (see graphic 10).

- Both creeks flow from pristine to near pristine headwater tributaries but lower creek reaches are experiencing extensive development pressures with increased impervious surfaces either completed, underway, or planned.
- Both Sand and Porter Creeks have a history of flooding. Damage to stream banks, agricultural areas, structures, roads, and railways are a common occurrence.
- The housing developments under construction along both watersheds will increase down stream flooding, bank cutting, and sedimentation into the lower Fountain Creek basin. Fountain Creek is already impacted by continuous high-water flows from Colorado Springs non-native imported water sources.
- Recommendations: Begin bank stabilization operations and establish robust prairie riparian buffers along the developing sections of these creeks. Preserve sinuous bends, and accelerate plans to divert and slow storm water from the residential areas so that it doesn't exacerbate flash flood conditions along the creeks and into the Fountain Creek.

FOUNTAIN CREEK WATERSHED
PALMER LAKE

Palmer lake is the primary source of the Fountain Creek and is located in extreme north El Paso County. The upper reaches of Monument Creek flow through the town of Palmer Lake (see graphic 8).

- Headwater streams for the lake originate in town-controlled forest or the Pike National Forest lands northwest and west of the lake. These streams are pristine to near pristine but become impaired by impervious surface development as they flow through the town of Palmer Lake.
- Adequate stream buffers exist along Monument Creek, but two of the headwater streams flowing into Palmer Lake have only minimal to no stream buffers in place.
- Palmer Lake only has a narrow riparian buffer around the lake.

Recommendations:

- Expand the riparian forest buffer around Palmer Lake and ensure all streams flowing into or out of Palmer Lake have enhanced stream riparian buffers.
- Retain and improve upon the Monument Creek stream riparian buffer that flows through Palmer Lake and into El Paso County.
- Limit home construction development along the low forested ridge located within the town's corporate limit, east of Palmer Lake.

FOUNTAIN CREEK WATERSHED
BEAR CREEK TRIBUTARY

Bear Creek flows northeasterly from National Forest lands through Bear Creek Canyon and then southeasterly into a densely urbanized section of west-central Colorado Springs (see graphic 9).

- The Creek is one of the least developed of all the Fountain Creek urban tributaries since most of its course flows through Federal or County owned lands.
- The Creek's main stem presents an excellent model for current and future best stream management practices with significant vegetation buffers in place, protections from impervious surfaces, extensive natural stream meanders, riffle and pool habitats, and high numbers of aquatic species (see appendix B).
- While the Bear Creek main stem has been well protected from development, the creek's urbanized sub-watershed streams have not received the same level of protections or watershed management.
- Recommendations: Expand riparian buffers along the Bear Creek urbanized tributary streams. Failure to provide enhanced protections such as bank stabilization, storm water catchment areas, and enhanced riparian buffers will negatively impact the future long-term viability of the Bear Creek sub-watershed.

FOUNTAIN CREEK WATERSHED
MONUMENT CREEK

Monument Creek originates in the Pike National Forest then turns south paralleling Interstate Highway 25 until it joins with the Fountain Creek in west Colorado Springs (see graphic 8).

- It is the primary tributary for the Fountain Creek and has been under intense development through the conversion of once pristine grass and forest lands into suburban homes, commercial businesses, and expansive office complexes.
- Sections of Monument Creek have been channelized to protect urban areas, businesses, and highways and its lower main stem and tributaries have been impacted by widespread flooding, stream erosion, and deposition from the Waldo Canyon and Black Forest Fires.
- The lower watershed Colorado Springs residential areas of Rockrimmon and Cragmor contain several abandoned shallow and deep coal mines that may leach heavy metals and other contaminants into the watershed.
- The creek is showing increased levels of phosphorous and nitrogen contaminants, particularly in areas associated with suburban housing construction and development.
- Once prolific aquatic species are declining commensurate with the exponential suburban and urban expansion, especially in the upper non-National Forest areas.

FOUNTAIN CREEK WATERSHED
MONUMENT CREEK (CONTINUED)

- The creek's only remaining pristine tributary streams lie within the Pike National Forest but even these streams begin to degrade as they approach confluence with Monument Creek.

Recommendations:

- Preserve and expand the remaining privately owned grass and forest mid-basin Monument Creek riparian buffer before it is completely lost to suburban and commercial developments.
- To protect the higher-quality western headwater streams, solicit Air Force Academy assistance to limit or restrict new developments along the streams and creeks that flow through its campus.
- Flood control projects should also address bank rehabilitation and wetlands preservation and creation, particularly between Palmer Lake and the Colorado Springs city limit.
- The lower urbanized section of Monument Creek and its tributaries should be routinely monitored for heavy metals, point pollutants, nitrogen, and phosphorus.
- Sinuous stream bends and meanders should be retained or reestablished to reduce flash flooding and limit bank erosion.

FOUNTAIN CREEK WATERSHED
GENERAL RECOMMENDATIONS

While federal, state, county, and city governments have restored and preserved sections of the Fountain Creek watershed, additional restoration and protections are needed, particularly along the rapidly developing headwater streams.

- Tributary stream buffers should be expanded, sinuous bends retained or returned, expansion of wetlands, and restoration of stream banks should become the norm.
- Stream straightening, channelization, and flash flood concrete diversion ponds should become a last choice flood control option.
- Acquisition efforts to preserve critical watershed habitats should be accelerated to protect these riparian areas from encroaching urbanization.
- The presence of non-native water source infusion into the watershed should be studied to assess for any long term environmental impacts.
- Suburban developments should have more open natural spaces between homes, dedicated stream bank riparian buffers, and established storm water sediment retention and diversion ponds to protect both perennial and ephemeral streams.

FOUNTAIN CREEK WATERSHED
GENERAL RECOMMENDATIONS (CONTINUED)

- Headwater streams near subdivisions and commercial areas should be closely monitored to determine increased presence of sedimentation, stream bank erosion, nitrogen, phosphorous, or other pollutants.
- Industrial areas and abandoned mine site monitoring should occur frequently to assess industry-point pollutants, the presence of heavy metals, and the potential return of toxic PFAS contamination into the aquifer and watershed.
- Expand upon the current Fountain Creek public affairs campaign by including all sub-watershed streams to better inform businesses, residents, and visitors as to the benefits of maintaining a healthy Fountain Creek watershed ecosystem.
- State and county highways should be signed to indicate to residents and visitors they are entering the Fountain Creek watershed and its key tributary streams.

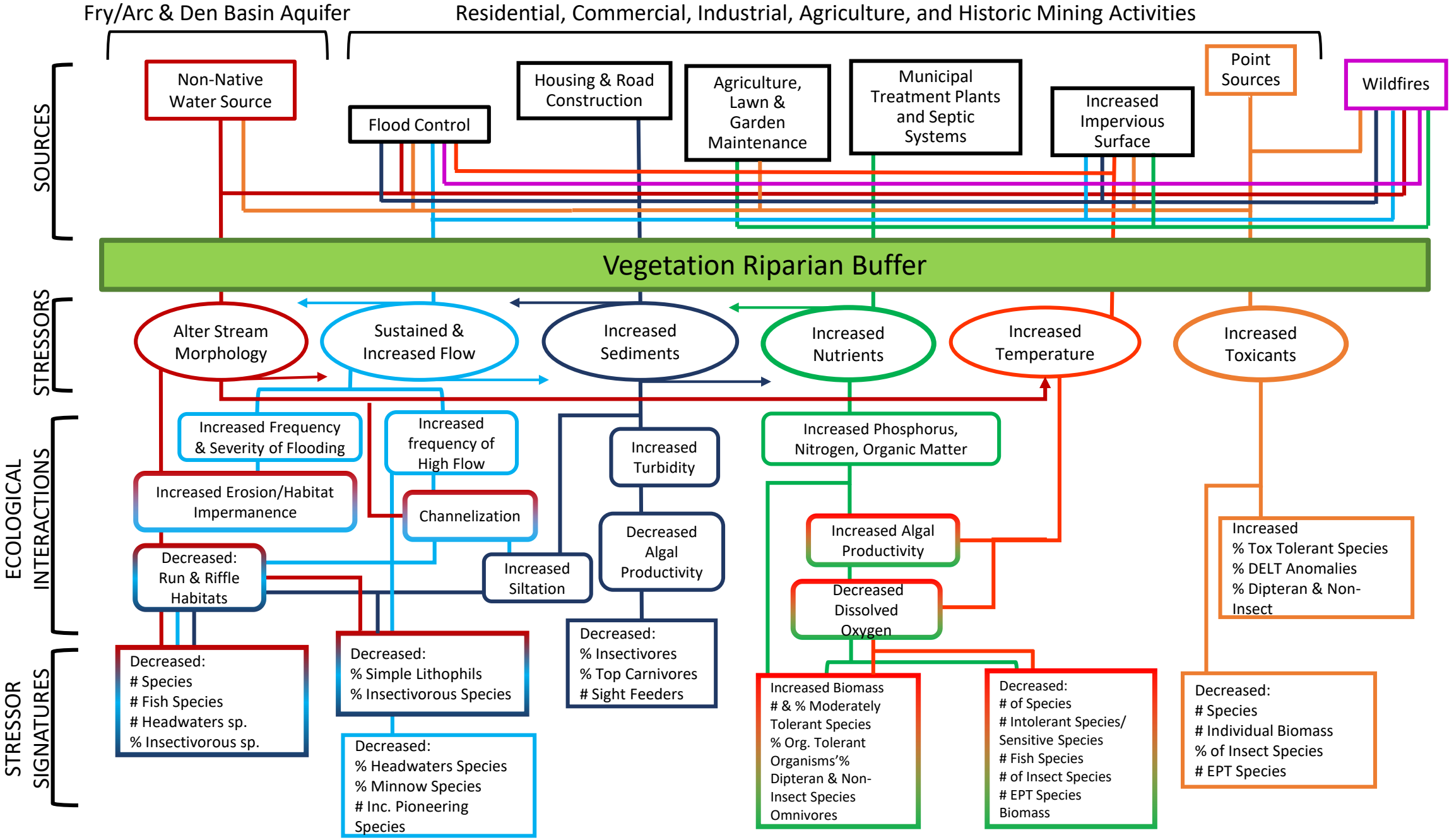
F0UNTAIN CREEK WATERSHED
TIPPING THE BALANCE

The Fountain Creek watershed is a rare mountain highlands to upland prairie river system. It is under extreme transitional stress from nearly two centuries of:

- Encroaching urban and suburban development.
- Increased presence of impervious surfaces.
- Human caused pollution.
- Intense flood control management.
- Uncontrolled mining and quarry operations.
- Harmful ranching and farming practices.
- Infusion of non-native waters for urban purposes.
- Climate change exacerbated wild fires.
- Habitat destruction, fragmentation, and degradation.

(See graphic 26)

Fountain Creek Watershed Conceptual Model of Exposure of Fish and Macroinvertebrates



FOUNTAIN CREEK
A WATERSHED IN TRANSITION

- The Fountain Creek and its tributaries have long been considered more of a nuisance due to its erratic and often extreme flood prone behaviors than as an asset to the communities through which it flows.
- In recent years state and local governments, civic, private, and non-government organizations have joined together to begin a process of restoring and preserving portions of the Fountain Creek and to a lesser degree its tributary creeks and streams. These efforts should be commended, continued, and expanded. Shavano Intelligence Systems hopes this Fountain Creek whole of watershed assessment assists with this endeavor.
- The assessment was designed to provide the reader with an enhanced understanding of conditions found across the Fountain Creek watershed. It uses geospatial tools and analytic models to graphically display this information. The recommendations provided are not prescriptive or directive though they do align with standard watershed best management practices.
- Shavano Intelligence Systems is interested in responding to comments or questions about this assessment and you can reach us at info@shavanointelligencesystem.com or please follow us on Twitter at @ShavanoSystems.


Cottonwood Creek Tributary
At Risk Stream Representative Example
No Riparian Buffer
High Impervious Surfaces
High Density Residential Areas
Channelized Stream Banks
Flood Control Structures
Natural Meanders Removed
Appendix A
Esri, HERE, Garmin, iPC | Microsoft
POWERED BY esri


Bear Creek
Ideal Urban Stream Representative Example
Impervious Surfaces
Shaded Natural Stream Banks
Protected and Managed Stream Channel
Forested Riparian Buffer
Stream Meanders Retained
Run and Riffle Aquatic Habitat

Appendix B