4. General Causes and Sources of Pollution

There are no major permitted point sources within the Cypress Creek watershed. Currently, treated wastewater is used to irrigate golf course turf grass and no direct negative water quality effects from these discharges have been identified with limited water quality sampling. All modeling activities assume that these discharges are operating in accordance with TCEQ permit requirements, but monitoring of these permitted sources is recommended.

Due to the karstic limestone and the interconnectivity between rainfall, surface waters, and groundwater, the watershed and the Upper and Middle Trinity Aquifers are vulnerable to nonpoint source pollutants. Such dispersed pollutants can be part of infiltration or surface water runoff from development, septic systems/on-site sewage systems, spray and subsurface effluent irrigation systems, spills or dumping of chemical pollutants, fertilizer applications and other agricultural activities, including animal waste. During implementation, stakeholders will identify best management practices to mitigate effects of pollutants regarding surface and groundwater interactions.

The primary water quality factors addressed in the Cypress Creek Watershed Protection Plan are non-point sources of pollution. The stakeholder committee also identified issues of local concern with respect to water quality which include: bacteria levels in the water, oil and grease, dissolved oxygen levels, impervious cover, and adequate base flows.

The 2010 Cypress Creek Watershed Characterization Report (Technical Reference Document) and supporting information were used as the baseline information for determining the causes and sources of pollution for nitrogen, Phosphorus, Suspended Solids, Dissolved Oxygen, *E. coli,* Oil and Grease, and Ammonia. It included a comprehensive snapshot of the watershed such as its vulnerable areas, water quality monitoring results, watershed delineation, land use analysis, target constituents Figure 14). Common pollutants are briefly described below, while comprehensive descriptions of these and other pollutants can be found in the 5.0 Nonpoint Source Pollution Section of the WCR (located in the Technical Reference Document).

Wildlife and Pets

White-Tailed deer are abundant throughout the Texas Hill Country and excessive numbers of deer contribute significantly to bacteria and nutrient loadings. Feral hogs are a rapidly growing problem as well and tend to deposit their waste near or into water bodies. Further their rooting behavior can cause extensive erosion and siltation in water.

When not properly disposed, pet waste can enter waterways, lower the quality of the water, and increase pathogen levels. Pet waste contains *E. coli*, bacteria and other parasites that can be harmful to humans and aquatic life. In addition, future development in the watershed will increase the opportunities for water quality impairments due to elevated pathogens, nutrients, sedimentation/siltation, organic enrichment, depressed oxygen levels, reduced aquifer recharge, habitat alterations, and biological impairments.

Septic Tanks

Homeowners are responsible for the maintenance of their on-site sewage facilities (OSSFs). Septic systems work well when functioning correctly and sited in the correct soil. However, soil type, age, design and maintenance issues can contribute to OSSF failure. Septic system failure can impact the quality of ground and surface water and often contribute bacteria, nutrients and oil and grease pollutants within the watershed and Cypress Creek. High concentrations of OSSFs can be found in subwatersheds 10, 42, 45 and 46 of which 10, 42 and 45 are also vulnerable tributaries (Group B). These subwatersheds are listed as priority subwatersheds by the stakeholders due to their possible contribution to nonpoint source pollution. Medium concentrations of OSSFs can be found in subwatersheds 20, 21, 27, 39, and 40 of which 21 and 27 are considered vulnerable tributary (Group C).

According to a study conducted by the Texas On-Site Wastewater Treatment Council (Reed et al., 2001), septic systems built after 1987 have an estimated failure rate of 12%. Because of missing data and the uncertainty regarding failure rates for septic systems of any age, and considering the Steering Committee's input, OSSF calculations used in pollutant load modeling assume a failure rate of 12% for all systems regardless of year built. The estimated number of OSSF's in the watershed is 1452 Figure 13. below shows known OSSFs within the watershed. We anticipate doing a study of the OSSF potential failure rate (with improved data) during the first three years of implementation.

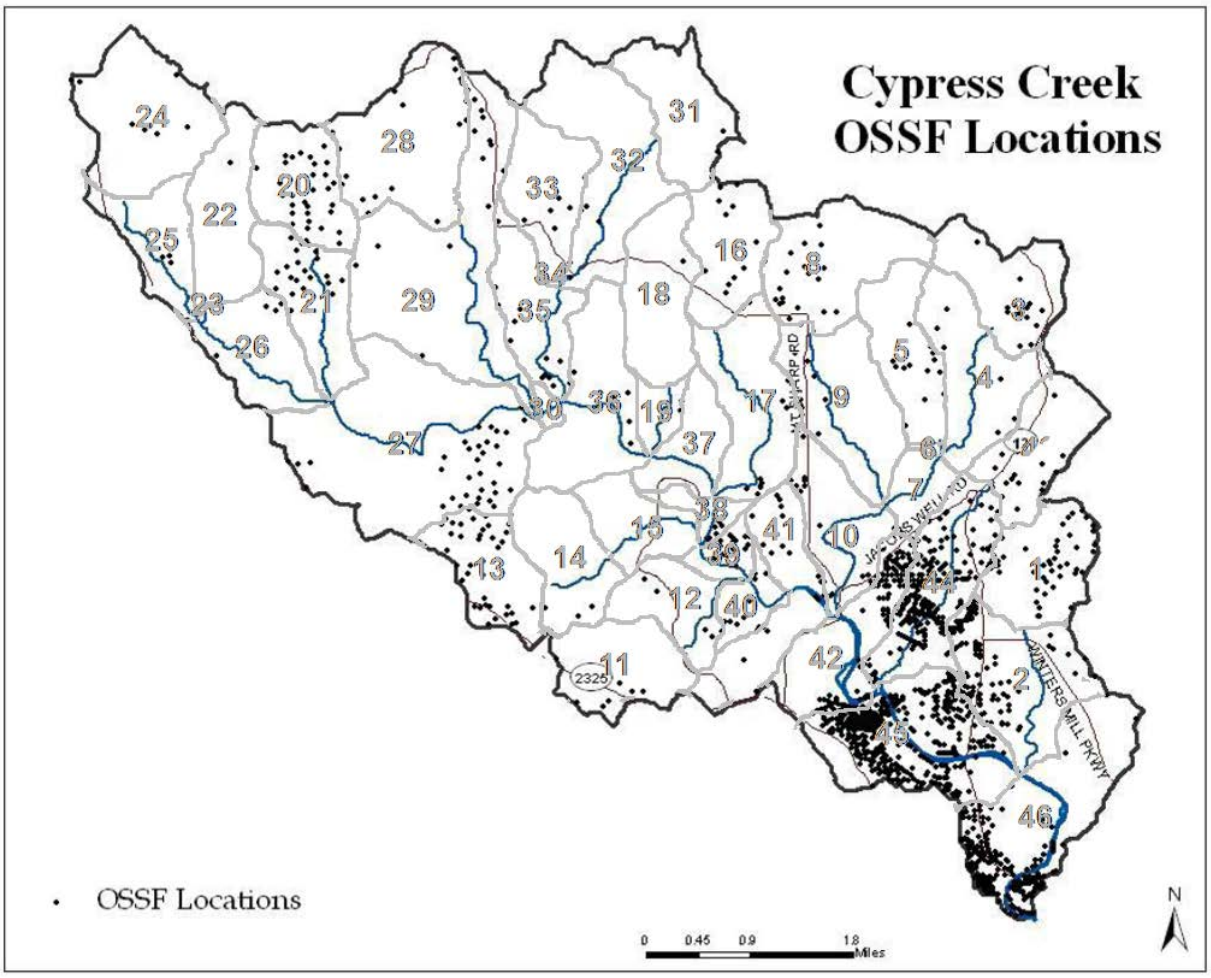

Figure 13. OSSF locations

Municipal Wastewater

Municipal wastewater management is a potentially significant source of pollution in the watershed. There are two wastewater treatment plants (WWTP) that serve the watershed. The Village of Wimberley and Guadalupe-Blanco River Authority have a permit for the Blue Hole Wastewater Treatment Facility in Wimberley. The plant is authorized to dispose of effluent at a maximum volume of 0.050 MGD by land application on 19 acres of land that is not available to the public. Application rates are not to exceed 2.96 acre-feet per year per irrigated acre.

The other WWTP is located in the City of Woodcreek. Aqua Wastewater Management, Inc. (AquaTexas) services a large number of households and businesses in the area. This WWTP is located outside of Cypress Creek watershed boundaries and the treated waste is pumped back into the watershed for dispersal. The plant is authorized to dispose of the treated wastewater at a maximum volume of 0.375 MGD by land applying on 175 acres of land. This acreage is the

Woodcreek Quick Sand golf course. Application rates cannot exceed 2.4 acre-feet per year per acre irrigated. No discharge of pollutants in to water is allowed by this permit.

Further testing of vulnerable areas near the golf course would be beneficial to definitively affirm that there is no negative impact from effluent runoff (Table 8).

Table 8. Reclaimed Water Quality Standards

For a 30 day average, per TCEQ (1997), Type I reclaimed water shall have a quality of:	
BOD5 or CBOD5	5 mg/l
Turbidity	3 NTU
Fecal coliform or *E. coli*	20 cfu/100 ml*
Fecal coliform or *E. coli*	75 cfu/100 ml**
Enterococci	4 cfu/100 ml*
Enterococci	9 cfu/100 ml**

**30 day geometric mean*
*** maximum single grab sample*

Agriculture

Agriculture is not a large source of pollution in the Cypress Creek Watershed. The thin, rocky soil makes it difficult to grow row, forage or other types of crops. In addition, there are no concentrated animal feeding operations in the watershed. Bacteria can enter waterways from waste excreted by livestock and was considered in pollutant loadings and best management practices.

Ground/Source Water

Water quality in streams can directly affect water quality in the aquifer because of rapid recharge through fractures and sinkholes in streambeds. The reverse is also true where springs contribute to river flows. In addition, the health of the creek is highly dependent on maintaining adequate spring flows, making recharge and groundwater management in the larger region critical to maintaining a healthy system in Cypress Creek.

Support for including the ground/source water strategy to protect Cypress Creek is found in research from State of Texas agencies. Texas Parks and Wildlife has designated Cypress Creek as an Ecologically Significant Stream Segment (ESSS) for its Hydrological function (Edwards Aquifer Recharge Zone) as well as high water quality, exceptional aquatic habitat and high

aesthetic value (TPWD, 2013). The Bureau of Economic Geology at UT Austin identified in a 2005 study on ground and surface water interactions in Texas that increasing groundwater development can change streams from gaining to losing status and contaminated groundwater can impact surface water bodies (Tinker et al., 2005). Another Bureau of Economic Geology in 2009 highlights that polluted stormflows can minimize the amount of bacteria removed during the recharge process (Chaudhary et al., 2009).

Summary of Water Quality Sources and Potential Causes

In 2013, The Meadows Center conducted extensive modeling to identify the most likely causes and sources of pollution in the watershed. More detailed modeling results can be found in the *Water Quality* section below (Page 54).

Table 9 summarizes the parameters above water quality targets for N and TSS levels and parameters of concern, as well as their sources and causes. Targets were adopted and updated to account for the naturally occurring conditions in the creek. The tributary categories and subwatershed numbers in Figure 14 and Figure 15 correspond with those in Table 9 below.

The primary causes of increased nitrogen concentration levels in the watershed are due to residential and commercial application of fertilizers and from on-site septic facilities (OSSFs), septic maintenance, animal waste, and low flows in the creek, among other (see Table 9).

Total suspended solids levels spike when human activities have disturbed natural processes on otherwise undeveloped land and are exacerbated by storm events. Top soils in the watershed are relatively shallow which limit vegetative ground cover. Low flows in the creek also lead to higher TSS concentrations.

E. coli bacteria are present naturally, but are also attributed to septic tanks (OSSFs), pet waste, and other feces present naturally by wildlife. Low flows in the creek also lead to higher concentrations of *E. coli*.

Table 9. Water quality parameters, primary sources, and their potential causes

Parameters Exceeding Target Levels.			
	Number of Subwatersheds Affected	**Primary Sources (land use) Identified with EMCs**	**Primary Causes**
Nitrogen 1.65 mg/L (Stakeholder target)	5 (Subwatershed #2, 4, 7, 32, 35)	Residential and Undeveloped	Residential and Commercial application of Fertilizer. OSSFs, animal waste, overland flow, impervious cover, atmospheric deposition and low flows.
Parameters of Concern			
Total Suspended Solids 4.0 – 5.0 mg/L	34	Residential and Undeveloped	Anthropogenic activities where land cover is disturbed, impervious cover and natural processes on undeveloped land. Soil across much of the watershed is shallow which limits ground cover. Low base flows.
E. coli 126/100mL	Group A Group B Subwatersheds	Residential and Commercial	Septic tanks (OSSFs), pets, and wildlife. Low flows in the creek lead to high concentrations.
Dissolved Oxygen 24-hr mean values above 6.0 mg/L Grab sample values above 4.0 mg/L	Group A Group B Subwatersheds	Residential and Commercial	Low base flows limit aeration of water downstream of ground/source waters.
Oil and Grease	Group A Group B Subwatersheds	Residential	Residential wastewater (kitchen and bathroom),
Impervious Cover increases	Basinwide	Residential, Commercial and Transportation	Increased urbanization
Preferred Base Flows	Cypress Creek Headwaters to confluence with the Blanco River	Residential and Commercial	Most people living in the Cypress Creek rely on well water from the same aquifer that feeds the creek.

The stakeholders identified vulnerable tributaries within the watershed (see Figure 14). Because they are vulnerable, they are also included in Table 1 as stakeholder identified priority reaches. The tributaries are broken up into groups with similar characteristics including Group A (subwatersheds 12, 14, 15 and 44), Group B (subwatersheds 2, 4, 6, 7, 9 and 10), and Group C (subwatersheds 21 and 29).

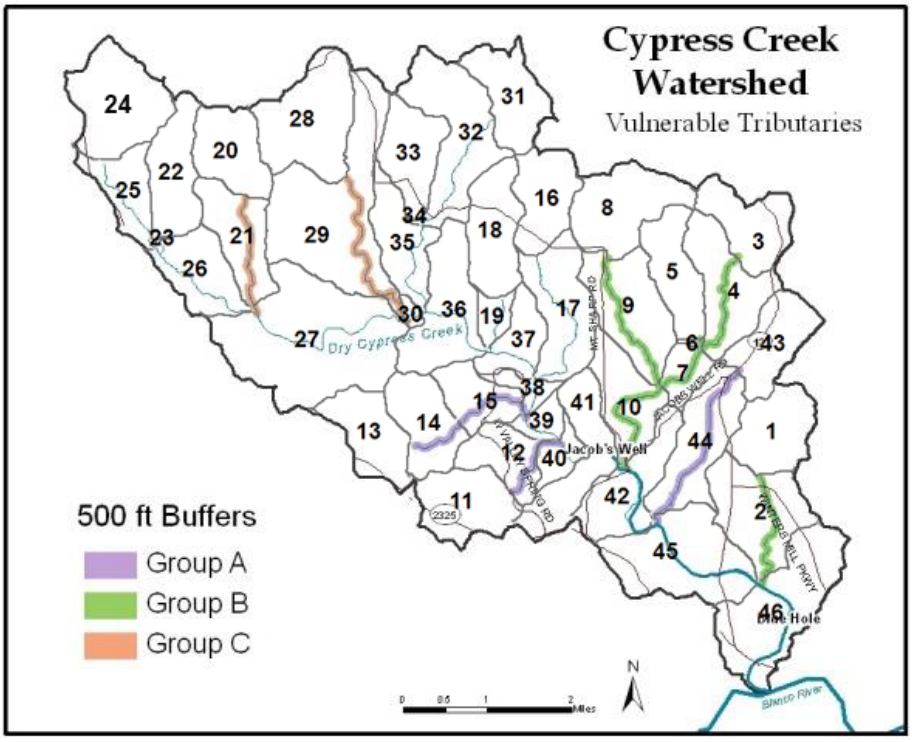

Figure 14. Vulnerable Tributaries Prioritized for BMPs.

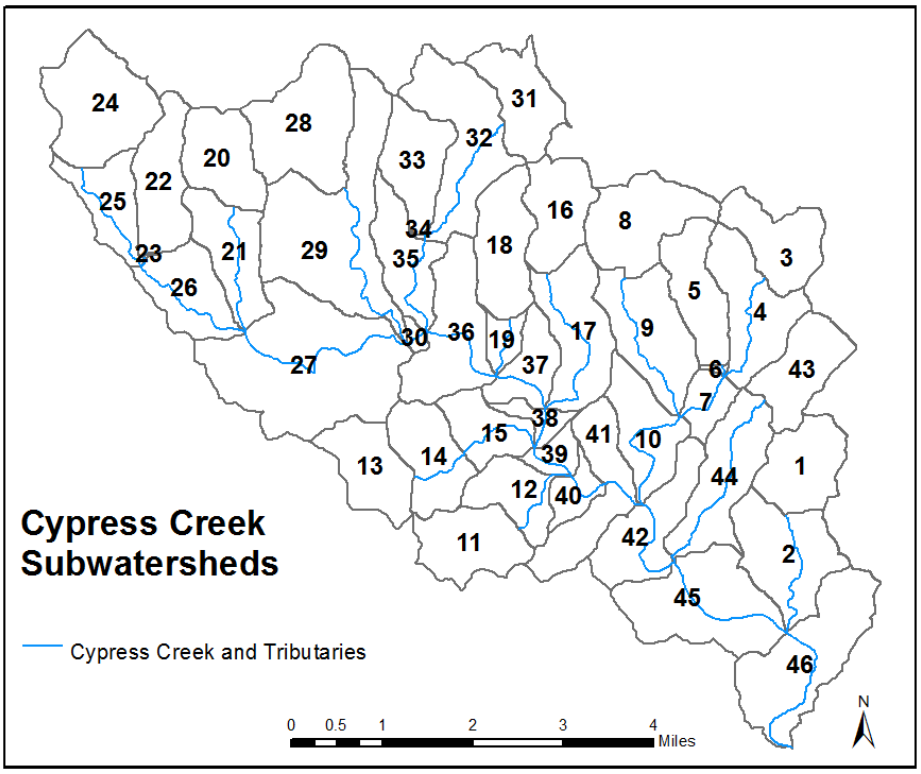

Figure 15. Subwatershed Delineation Map