Introduction

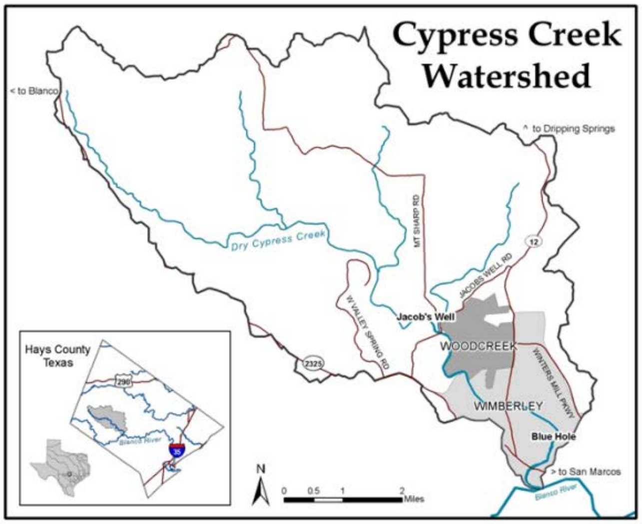

Figure 1. Cypress Creek Watershed

History of the Cypress Creek Project

The Cypress Creek Project was initiated when concerned landowners, non-governmental organizations (NGOs) and the Meadows Center for Water and the Environment (Meadows Center) applied for state and federal 319 funds to develop a preventative and community-driven watershed protection plan (WPP) for Cypress Creek (Figure 1). The goal was to keep Cypress Creek from being listed as impaired on the 303(d) list, as it had been in 2000 for inadequate dissolved oxygen (DO) (segment 1815). That year, the creek stopped flowing due to drought conditions, which negatively affected DO. When precipitation returned to average levels, the segment was delisted.

Beginning in 2008, the Meadows Center for Water and the Environment provided technical assistance and facilitation to a group of dedicated Cypress Creek stakeholders to create the WPP. The Stakeholder Committee and subject-specific subcommittees first identified significant information gaps needed to develop a comprehensive and effective WPP. This led to focused water quality monitoring, analysis, and collection of additional information and data to characterize the watershed. The resulting *2010 Cypress Creek Watershed Characterization Report* included water quality analyses, a comprehensive snapshot of the watershed, potential pollution sources, vulnerable areas, as well as target constituents.

The Stakeholder Committee then voted to adopt specific management measures that could be used to meet selected target water quality standards. The Stakeholder Committee also integrated an initial source water protection strategy with the goal to keep Cypress Creek flowing. Given that the quality of the water in the Creek is highly dependent on ensuring sufficient source groundwater flows, preservation of flows from Jacob's Well is a major component of this Watershed Protection Plan.

The resulting Cypress Creek Watershed Protection Plan presented here is meant to help guide decision makers and citizens to ***keep Cypress Creek clean, clear, and flowing*** for future generations. Additional resources, data and research are included in the Technical Reference Document that accompanies this plan. This plan satisfies the Environmental Protection Agency's nine elements required to be addressed in watershed plans. These elements, A-I, comprise the framework for the Watershed Protection Plan. More information about the Nine Elements can be found in the EPA's *Handbook for Developing Watershed Protection Plans to*

Restore and Protect Our Waters, as well as in The EPA National and EPA Region 6 Watershed Based Plan Guides (http://water.epa.gov/polwaste/nps/cwact.cfm, http://www.epa.gov/region6/water/ecopro/watershd/nonpoint/watershed-plan-review.pdf)

Significance of the Cypress Creek Watershed

Located in Hays County and the Hill Country of central Texas, the Cypress Creek watershed is a significant tributary to the Blanco River (Figure 1). It has rugged terrain, narrow canyons, and springs that dominate the landscape. The terrain also reflects the underlying karstic, faulted, and fractured limestone geology of central Texas that forms the basis of the regional aquifers. These aquifers are significant sources of surface water, providing much of the base flows to central Texas rivers. The groundwater is largely used for residential and commercial water supplies in the area. The regional climate is temperate, with hot dry summers and rainfall that ranges from infrequent and sparse to heavy downpours occasionally resulting in flash flooding. Cypress Creek is home to a diversity in species, including fishes, water fowl, reptiles and amphibians, mammals, and insects.

Hays County is projected to grow by approximately 300% in the coming years. This is an important consideration for all future natural resources management, particularly water. Cypress Creek's natural beauty is a major factor for the economy and population growth in the area. Weighing the needs of the community - to ensure sufficient quantity and quality for daily consumptive use and for the aesthetic, economic, and ecological value – is and will continue to be a challenge to community leaders in the future.

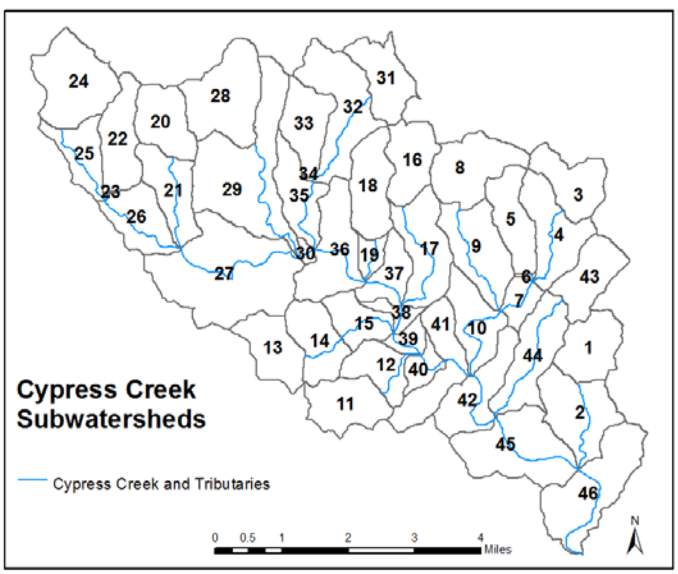

Figure 2. Cypress Creek Subwatersheds

Why the Community Wanted a Watershed Plan

Overall, water quality in Cypress Creek is meeting standards set by the Texas Commission on Environmental Quality. However, the Creek has shown signs of water quality degradation in the recent past and data have revealed that there is a potential for degradation in the future if nothing is done now. Data reveal both spatial and temporal trends that may be due to climate variability, nonpoint source pollution, and changes in land use and/or management at the sub watershed level (Figure 2).

Water quality in streams can directly affect water quality in the aquifer because of rapid recharge through karst features, such as fractures and sinkholes in streambeds. The reverse is also true where springs contribute to river flows. 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. Stakeholders and the Meadows Center used current conditions and information about groundwater recharge to determine potentially vulnerable tributaries (Figure 3).

Due to the karstic limestone and the interconnectivity between rainfall, surface waters (creeks) and groundwater, the watershed and the Upper and Middle Trinity Aquifers are vulnerable to nonpoint source pollutants (Figure 3). Such dispersed pollutants can be part of infiltration or surface water runoff from development, animal waste, septic systems, spills or dumping of chemical pollutants, and fertilizer applications. In addition, future development in the watershed will increase the opportunities for water quality impairments due to elevated pathogens, nutrients, sedimentation or siltation, organic enrichment, depressed oxygen levels, reduced aquifer recharge, habitat alterations, and biological impairments.

Priority subwatersheds were identified by modeled increases in nitrogen, *E. coli*, and TSS, as well as high densities of OSSFs and observed low flow conditions that could contribute to reduced DO Further, stakeholders used current conditions and information about groundwater recharge to determine potentially vulnerable tributaries. Each of these parameters or issues is described in detail in the document below. See Table 1 below, which identifies subwatersheds (either with instream concentrations or overland loadings) that have high observed/modeled levels for Nitrogen, TSS, *E. coli*, DO, high concentrations or clusters of OSSFs or are noted as vulnerable tributaries. The table also includes known baseline conditions for TSS and Nitrogen. (Please refer to Table 12 for information about parameter targets). These subwatersheds are designated as priority watersheds and most include current or potential future exceedances for multiple parameters. For example, Subwatershed 2 is expected to have instream levels of

TSS and nitrogen that exceed stakeholder targets, *E. coli* levels above stakeholder targets and is designated as a vulnerable tributary. Subwatershed 1 does not contain a reach of the creek or tributary but modeling results indicate that the land use activities within its boundaries yield high loadings for nitrogen and *E. coli* that are eventually carried to the creek by stormwater runoff.

Table 1. Stakeholder Identified Priority Subwatersheds by Parameter or Concern and Baseline Concentrations (in 2000)

	Reach within Priority Subwatershed	TSS* Base Line Concentrations (mg/L)	Nitrogen Base Line Concentrations (mg/L)	OSSF Density	*E. coli* (#/100 mL)	Vulnerable Tributary	DO Below 6.0 mg/L
Priority Subwatershed Reaches	2	137.08	1.66	-	X	X	-
	4	99.0	1.63	-	-	X	-
	6	-	-	-	-	X	-
	7	-	1.64	-	-	X	-
	9	95.38	1.27**	-	-	X	-
	10	-	-	X	-	X	-
	12	-	-	-	X	X	-
	14	72.79	-	-	-	X	-
	15	-	-	-	X	X	-
	21	-	-	-	-	X	-
	27	91.48	1.19**	-	X	-	-
	29	85.37	1.19**	-	-	X	-
	30	-	-	-	-	-	-
	32	100.10	1.86	-	-	-	-
	35	-	1.66	-	-	-	-
	36	102.42	1.39**	-	X	-	-
	41	91.52	-	-	X	-	X
	42	92.91	-	X	X	-	X
	44	84.91	1.1**	-	X	X	-
	45	93.21	1.36**	X	X	-	X
	46	102.76	1.42**	X	X	-	X
Subwatersheds with high potential load contributions	1	-	X	-	X	-	-
	8	X	-	-	-	-	-
	13	-	-	-	X	-	-
	24	X	X	-	-	-	-
	28	X	X	-	-	-	-

**At low flow conditions all reaches will exceed target loads for TSS.*

*** These subwatersheds do not show exceedances for Nitrogen but may in the future and have been identified as secondary priorities.*

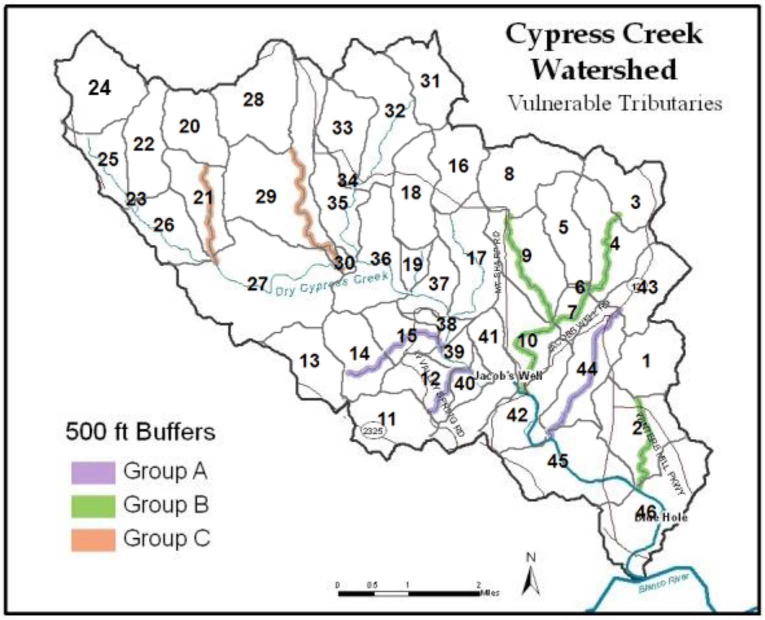

Figure 3. Vulnerable Tributaries Groups A, B, and C

Using Science to Find Answers - Causes and Sources of Pollution

To help understand the physical context and factors that may be influencing water quality in the creek, the Meadows Center created load duration curves for the primary pollutants of concern in the area, including: nitrogen, phosphorus, *E. coli*, suspended sediments and dissolved oxygen. These load duration curves were used to identify daily mean loading for the above parameters, which do not currently have set state or federal standards. Modeled water yields and event mean concentrations were used to calculate pollutant loads and identify potential sources of nonpoint source pollution for existing and future conditions at the watershed and subwatershed level (Figure 4).

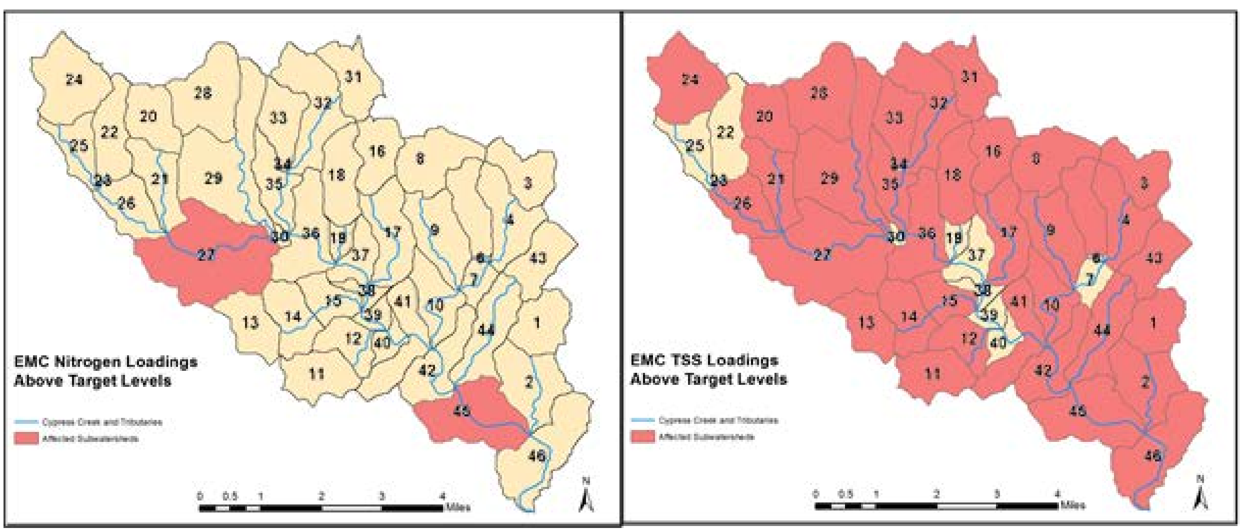

Figure 4. Example Model Output - Subwatersheds with Nitrogen and TSS Loadings Above Target Levels

The Stakeholder Committee and experts agreed that meeting State water quality standards would be insufficient to maintain the desired health and historical nature of the creek as a spring-fed stream. As a result, the stakeholders identified acceptable water quality and flow parameters based on historical information. A detailed description of water quality parameters, primary sources, and the potential causes are outlined in Table 2 below.

Table 2. Sources and Causes of Negative Impacts on Water Quality Parameters Identified by Stakeholder Committee

Parameter	Primary Sources (land use)	Causes
Nitrogen* 1.65 mg/L (Stakeholder target)	Residential and Undeveloped	Residential and Commercial application of Fertilizer. OSSFs, animal waste, overland flow, impervious cover, atmospheric deposition and low flows.
Total Suspended Solids* 4.0 – 5.0 mg/L	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 in the wet portion of Cypress Creek.
E. coli	Residential and Commercial	Septic tanks (OSSFs), pets, and wildlife. Low flows in the creek lead to high concentrations.
Dissolved Oxygen	Residential and Commercial	Low base flows limit aeration of water downstream of ground/source waters.
Oil and Grease	Residential	Residential wastewater (kitchen and bathroom).
Impervious Cover increases	Residential, Commercial and Transportation	Increased urbanization.
Preferred Base Flows	Residential and Commercial	Groundwater pumping, uncoordinated drought management, insufficient knowledge of local aquifer supplying baseflow to Cypress Creek, insufficient protection for karst aquifer system, insufficient statutes and management of groundwater to maintain surface water flows, inefficient water use, increased impervious cover, decreased recharge, lack of stormwater management for recharge, climate variability (drought).

**** Red Rows Indicates Parameters Exceed Target Levels at low flows (2.5 cfs)***

Surface Water Strategies Chosen by the Community to Improve Water Quality

The Stakeholder Committee selected a suite of best management practices (BMP) to mitigate identified and potential water quality impairments in the watershed. The BMPs were prioritized for immediate implementation and as future options in an adaptive management suite. When possible, BMPs are targeted for priority subwatersheds. However, many of the selected BMPs will not be implemented until several years into future as pollutant loads increase with development.

The Cypress Creek Watershed Protection Plan is adaptive in nature and, as a result, it includes detailed practices and management approaches to address water quality the first three years, with the intention that the community will reevaluate specific watershed needs thereafter. The Stakeholder Committee agreed that the first three years implementing the plan should focus on stormwater assessment, employing demonstration BMPs, retrofitting and maintaining existing and recently built BMPs, and coordinating existing community efforts in order to address threats to water quality, including nitrogen and TSS from urbanization in the watershed. The Stakeholder Committee's goal is to keep the creek "clean, clear and flowing," but more specifically to prevent reductions in DO, and prevent TSS, Nitrogen and bacteria from exceeding set target levels and protect flow.

As a result of the six years it took to construct this plan, the City of Wimberley, City of Woodcreek and Hays County have each pledged to implement BMPs pending finalizing formal financial agreements during the Interim period.

Groundwater Strategies Chosen by the Community to Improve Water Quality

Efforts to maintain good water quality conditions are constrained by the reliance on adequate baseflows from Cypress Creek's artesian headwaters, Jacob's Well. Community expectations of maintaining a clean, clear, and flowing stream will succeed with this integrated management plan incorporating groundwater and surface water components, spanning agency jurisdictions, and with a comprehensive approach for maintaining balance between natural resource management and economic development. The Cypress Creek Stakeholder Committee identified several critical components for their ground/source water protection strategy. Preliminary goals listed below, have the primary purpose of preserving flows:

1. Maintain headwaters and flow regime at or above 6 cfs.
2. Launch a coordinated water conservation campaign between water suppliers and cities to effectively reduce demand for groundwater during drought stages 2 and 3.
3. Determine strategies for water suppliers to implement tiered pricing and market-based conservation efforts that will sufficiently incentivize demand reduction.
4. Establish science process, proposals, and estimated budget needed for determining recharge and artesian area affecting the springs of the Wimberley Valley.

The Importance of an Informed Community

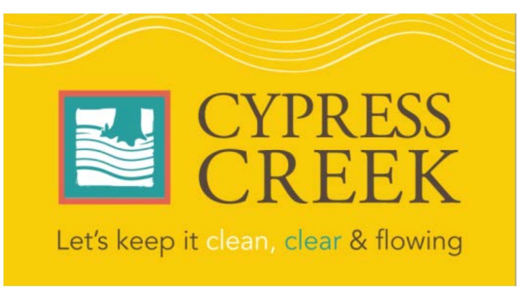

Figure 5. Cypress Creek Project Branding

Local residents and communities play a critical role in the success of natural resource conservation and watershed management initiatives through their meaningful participation and actions. Throughout the six year plan development, the Stakeholder Committee was dedicated to ensuring that the community at large was kept informed of the process and had the opportunity to participate. This was done through outreach campaigns such as Cypress Creek

Project week, surveys, brand and slogans, permanent watershed signs, public informational meetings, notifications of Stakeholder Committee meetings, newsletters, and open public comment periods to review documents (Figure 5).

For future involvement and buy-in during the implementation of the Cypress Creek Watershed Protection Plan, the Stakeholder Committee created and *Education and Outreach Plan*. This plan defined the Cypress Creek community's education and outreach goals and objectives for the Watershed Protection Plan: to increase public awareness, increase community engagement and educate and support decision makers. Four target audiences were identified, including the community at large, homeowners/landowners, business owners and government/education.

Ensuring the Plan is Working

The Cypress Creek Watershed Protection Plan prescribes BMPs and other actions to attain, maintain and ultimately improve water quality in the creek and its tributaries. The implementation of management measures throughout the watershed over time will result in pollutant loading reductions, while established pollutant targets will serve as benchmarks of progress and indicators for future adaptive management activities. Tracking the effectiveness of these management measures will ensure that water quality goals are being achieved.

Components of the stakeholder approved monitoring plan include the coordination of all existing monitoring efforts, increased surface water quality monitoring, groundwater monitoring, the continuation of US Geological Survey gage collection of stream flow and water quality parameters, as well as the implementation of monitoring of:

- water quality related to stormflow, baseflow and rain events,
- biological and environmental components (including dissolved oxygen),
- demonstration best management practices,
- implemented and existing BMPS, and
- bacterial source tracking.

As the watershed continues to urbanize, water modeling results will be used as a guide for detecting early signs of potential pollution concerns. Routine water quality monitoring data will be disseminated to the Stakeholder Committee and will help to identify any new concerns. If target levels are exceeded regularly, the Stakeholder Committee will utilize adaptive management to address new concerns.

Indicators of Success

Measureable milestones adopted by the Stakeholder Committee include number of BMPs implemented and pollutant load reductions (e.g. 5% reduction of TSS) or areas of coverage (e.g. 5,000 feet of permeable sidewalk constructed). If the identified milestones are not achieved in year 3, 6, or 10 of implementation, the appropriate adaptive management activities will be initiated, tested and adjusted as needed. Table 3 summarizes the BMP milestones for the first three years of implementation. Table 21 provides additional information including subwatershed location for implementation. Milestones are presented in Table 25 in Chapter 11 of this document.

Table 3. Summary of Implementation Year 3 Milestones

Management Measure	Milestone Years 1-3 of Implementation	Milestones	Priority Watershed *
Comprehensive Stormwater Assessment	1 Assessment	Completion of Stormwater Assessment, including selection of BMPs and locations for implementation based on findings	12, 14, 15, 39, 40, 41, 44, (Basinwide)
Riparian Buffers	1 Managed buffer area Identified	Identify and prioritize locations for implementation, commitments for streamside natural buffer management	41, 45, 42
Rainwater Harvesting Strategies	1 Demonstration Area	Establishment demonstration area, and can include adoption of use in all new development	41, 46, 2, 44
Gabions (Rock Berms)	1 Berms Demonstration Areas	Establishment of demonstration areas throughout the basin and use in all new development in urban public spaces; added to existing codes where appropriate	41, and TBD
Biofiltration/rain garden	1 Demonstration Areas	Establishment of demonstration areas, and can include use in all new development in public spaces or added to existing codes as water quality protection measure	41, 46, 10, 44, 2, and TBD
Existing BMP Maintenance	6 Inspections and Maintenance When Needed	Establishment of program to maintain existing BMPs for proper function	41, 46, and TBD
"Entering Watershed" Signs on Roadway	3 Signs	Installation of 3 "Entering Watershed" Signs on Roadway to increase community awareness	TBD

Management Measure	Milestone Years 1-3 of Implementation	Milestones	Priority Watershed *
Watershed Coordinator	1 Coordinator	1 employee to implement BMPs for water quality reduction and community awareness	Watershed Wide
Enhanced Water Quality and Groundwater Modeling (CC-DSS)	1 Session	1 session in enhanced Water Quality and Groundwater Modeling (CC-DSS) to improve water quality decision making as the scenario changes	Watershed Wide

**Additional management measures may be implemented that are not mentioned in this table, or may be implemented in additional subwatersheds.*

Table 4 below shows the Stakeholder Committee's prioritization of accepted management measures (in addition to best management practices listed above in Table 3). These measures were ranked on importance and urgency as well cost, load reduction, and ease of implementation. Measures were also assigned to subwatersheds with highest modeled instream concentrations and land based loadings of pollutants and constituents of concern. It is important to note that there were several additional factors that guided the overall implementation strategy, including support committed by watershed partners for implementation activities, identification and approval of partner owned land for BMP and demonstration BMP implementation, availability of publicly accessible spaces for demonstration BMPs and engineering constraints. For example, rain and biofiltration gardens were selected for implementation in Subwatershed 41 because of the expected TSS exceedances (high TSS loadings), as well as the availability of a publically accessible space that would be suitable for a demonstration garden. The Stakeholder Committee will routinely review monitoring data to identify if milestones are being met and BMPs are working effectively.

If monitoring shows that the BMPs are not effective or unforeseen changes in the watershed occur, the Stakeholder Committee can potentially use one, several, or a combination of several approved BMPs from their BMP "Adaptive Management Toolbox" to address water quality (Table 4). Additional information including potential subwatershed locations, load reductions as well as associated milestones can be found in Table 26. The Stakeholder Committee will submit an adaptive management review after the first three years of implementation and in subsequent years as needed. During this time, efforts will be undertaken to increase the capacity of the existing model to determine pollution loading and mitigation efforts on a more localized scale. Additionally, each city will undergo an efficacy assessment of current and potential future ordinances that will improve our understanding of where and when to place appropriate BMPs.

Table 4. Adaptive Management Toolbox

Highest Prioritization	Second Highest Prioritization	Medium Prioritization	Low Prioritization
Water Conservation Pricing Strategies	Urban Wildlife Management – Deer	Rainwater Harvesting Strategies	Rock Weirs/Cross-vanes
Water Conservation Program for Water Providers or Municipalities	Riparian Buffers	Cypress Creek Land Trust	Vegetative Filter Strips
Groundwater Management strategies assessment and research	Water-intensive Turf Grass Ordinances and/or Ban	Nutrient & Fertilizer Management	Livestock Water Quality Management Plan
Groundwater Protection Strategy	Groundcover Establishment – Agricultural	Habitat Conservation Areas – Urban	Rain/soil moisture sensors
	Parking Lot Pervious Design Strategies	Rock Berms/Gabions	Wastewater Solutions
	Xeriscaping/Nativescaping	Biofiltration/Rain Garden	Septic replacement program
	Engineered Swales	Tree Protection	
	Conservation Easements	Groundcover Establishment – Urban	
	Karst Feature Protection Measures	Porous/Pervious Pedestrian Walkways	
	Comprehensive Stormwater Assessment	Alternative Brush Control -- Prescribed burns	
	Purchase of Development Rights	Grazing Management Strategies	
	Landscape Mulching	Landowner Incentive Program	
		Pet Waste Ordinance & Stations	

The Cypress Creek Stakeholder Committee will continue to meet on a regular basis to discuss progress on implementation, outreach efforts, identification of additional financial assistance, and adaptive management modifications to the plan as needed. The Stakeholder Committee is dedicated to vision initially set to preserve the natural beauty and excellent water quality of Cypress Creek for current and future generations.

Let's keep it clean, clear, and flowing!