Section 5

Recommended Solutions

Photo Credit: Jessica Casillas

Section 5. Recommended Solutions

Sources of pollution in the Spring Creek watershed are widespread, diverse, and expected to increase in the future. Without intervention, water quality will likely continue to degrade. Identifying a path forward that details a comprehensive approach for addressing these water quality issues is a necessary step in linking stakeholder concerns to achievable results. While the situation is challenging, potential solutions[1] exist that can be implemented on a voluntary basis and in a cost-efficient manner.

This WPP is designed to establish a clear link between the causes and sources of contamination, and the solutions identified and scaled to address them. Section 3 quantified the sources that contribute to water quality impairments and Section 4 identified the *E. coli* reductions and DO improvements needed to meet the Partnership's water quality goals. This Section details the voluntary solutions identified and prioritized by the stakeholders and discusses the financial and technical resources needed to implement them. Section 6 links these activities to corresponding education and outreach elements, Section 7 details the timeline and milestones associated with implementation, and Section 8 provides a path forward to evaluate their success.

Identifying Solutions

As detailed in Section 1, the stakeholders established six guiding principles for the recommendations of the WPP. The stakeholders emphasized: 1) recognizing the uniqueness of the areas in the system; 2) making decisions locally; 3) using voluntary solutions; 4) utilizing proven strategies; 5) coordinating with flood mitigation, conservation, and other adjacent activities occurring in the watershed; and 6) incorporating a strong education and outreach campaign. This focus provided a framework for identifying a set of feasible solutions in line with community priorities. These considerations shaped the discussion of potential solutions and the ultimate selection processes.

Stakeholders reviewed a wide range of potential solutions, starting with those identified in existing projects[2] and ongoing local efforts[3]. The diversity of pollutant sources in the

[1] In WPPs, TMDL Implementation Plans (I-Plans), and other watershed restoration work, solutions are often referred to as best management practices (BMPs), implementation activities (IAs), or management measures. In this WPP these efforts are referred to generally as "solutions". The stakeholders preferred to put an emphasis on outreach that avoided jargon and technical terms.

[2] Including previous WPPs and TMDL I-Plans conducted in other watersheds, as well as the I-Plan for the Bacteria Implementation Group, under whose auspices the Spring Creek/Lake Houston TMDL project now rests.

[3] Including planned or potential activities of local government partners like the Harris County Precincts and Harris County Flood Control District; NGOs like the Bayou Land Conservancy; regional efforts like USACE studies; private developers, and others.

watershed required that stakeholders consider an equally wide range of potential solutions sufficient to address each source[4] in proportion to the prominence of the source. This palette of potential solutions served as a starting point for local customization and development of area-specific actions. Recommendations were discussed at multiple meetings of the Partnership. In the interim, the topic-specific Work Groups refined ideas and added expertise in the form of recommendations to the Partnership for further discussion. The discussions focused primarily solutions to reduce fecal waste loads, with the assumption that most of the fecal waste solutions proposed would also benefit DO and other water quality goals. However, the Partnership discussed some solutions specific to other concerns. After several rounds of discussion and one-on-one meetings with specific partners, the Partnership formed the set of recommended solutions described herein. Both ongoing projects and new efforts are reflected.

This list of solutions is built around the understanding that the WPP operates on a process of adaptive management that will add or remove solutions based on efficacy, funding levels, changing conditions, or opportunities.

Solution Prioritization

The prioritization of solutions was a primary discussion point for the stakeholders. Funding limitations were a key concern for some structural solutions. In general, the stakeholders favored enhancement or supplementation of existing efforts before the addition of new elements. High priority was placed on solutions that:

- Had potential funding sources;
- Served multiple benefits (*e.g.*, vegetative riparian buffers that reduce the transmission of *E. coli* and nutrients while also slowing storm flows and reducing hydrologic impacts of runoff);
- Were already proven programs with sustaining support from agencies or other organizations;
- Involved or emphasized voluntary conservation;
- Were related to or supplemental to flood mitigation efforts;
- Had a strong outreach and education component or tie-in; and
- Were focused on areas most adjacent to the water.

These priorities are reflected in both the set of recommended solutions, as well as the priorities for their implementation, as discussed later in this section.

[4] Deer, migratory birds, and other wildlife for which no feasible solutions existed were not considered under this process, based on stakeholder feedback or regulatory restriction

Recommended Solutions

In developing solutions, the stakeholders considered the purpose of the solution, the scope of its implementation, the responsible parties[5], the period in which it would be implemented[6], the contaminants addressed, its status as either an existing or new effort, the technical and financial resources needed for implementation, and its potential for reducing *E. coli*. The solutions will be implemented together, or in phases, such that they cumulatively address the *E. coli* reduction goals for each source. Estimated costs reflect the period through 2030. The solutions identified in this section are for direct structural or programmatic elements. Solutions related to education and outreach for each source category are highlighted in Section 6. While solutions are intended to be implemented in all appropriate subwatersheds, proportional to the load from the subwatersheds, specific focus areas are indicated for each source category. Focus areas identify the subwatersheds for which a set of solutions is most applicable. For all solutions the Partnership, as an ongoing point of coordination facilitated by H-GAC or a successor agency, is assumed to be a supporting party, though the level of support will differ based on the solution. Additional information on potential funding mechanisms is included as Appendix D.

Figure 1. Twilight in the Spring Creek watershed

[5] Throughout this section, references to categories (Counties, Districts) are made unless a specific party is named.

[6] The period represented for each solution is the timeframe within the initial 9-year implementation window between an assumed approval in 2021 and the target year of 2030. Many solutions will likely continue to be implemented as ongoing efforts or as needed to maintain water quality after that point.

Wastewater Treatment Facilities and Sanitary Sewer Overflows

WWTFs in the watershed are generally able to meet their bacteria limits, with few exceedances, but enhancements to structural and operational elements and a focus on addressing SSOs can reduce these sources of human fecal pathogens. Based on established jurisdictions for WWTF operation and SSOs, the responsibilities for these recommendations will largely fall to the local utilities and special districts, who provide the overwhelming amount of sanitary sewer service in the watershed. Many of these MUDs, utility districts, water control and improvement districts (WCIDs), private utilities, and other entities are actively engaged in these efforts and have had noteworthy success. Priority is placed on aging systems, smaller systems with less oversight, systems with chronic issues, economically disadvantaged areas, or facilities located in floodplains vulnerable to storm events.

Despite the relatively low daily load from WWTFs and SSOs, these sources are being considered a high priority because of their proximity to developed areas, and the relatively high risk of human waste. The primary focus of WWTF and SSO solutions are continuation and enhancement of utility operations. Supplemental support from the Partnership, or additional activities beyond normal operations emphasize information sharing, funding identification, and prioritization.

These recommendations are in supplement to the existing day-to-day operations of the WWTFs in the area. The following solutions were identified by the stakeholders for WWTFs and SSOs:

- WWTF 1 — Address problem plants and consider regionalization
- WWTF 2 — Recommend increased testing
- SSO 1 — Remediate Infrastructure
- SSO 2 — Consider additional preventative measures

Educational elements related to WWTFs and SSOs are expanded on in Section 6. Due to the variety of operations in the watershed, cost estimates for these solutions vary widely or are future costs that cannot be predicted. However, the primary focus of funding in this section is existing utility funding resources as augmented with support from the Partnership in identifying and pursuing additional funds. More information about funding sources is available in Appendix D.

WWTF 1 – Address Problem Plants; Consider Regionalization

Purpose: To increase oversight of facilities with discharge violations, and potentially consolidate operations where appropriate to increase economies of scale and phase out outdated treatment infrastructure.

Description: The Partnership will work with local authorized agents and interested utilities to promote remediation of plants or processes in which exceedances are occurring or likely to occur. This may happen through: routine or augmented investment by the utilities; support from the coordinating entity of the Partnership in identifying or pursuing additional funding resources; or action or recommendation from the counties regarding regionalizing problem, undersized, or aging plants and infrastructure. No specific problem facilities were identified in the watershed characterization, but as systems age, problem areas may arise.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Utilities; Cities; Counties	Ongoing-2030	Bacteria, Nutrients	Extends existing management; potential enhancement to existing operations

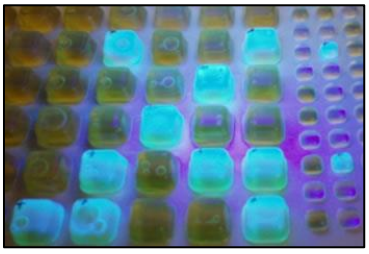
Technical and Financial Resources Needed	Estimated Costs and Funding
The technical resources needed to fulfill these recommendations are sufficient utility staff to address system elements, and Partnership support for funding identification. Financial resources needed for this recommendation are highly variable, but include utility staff time costs, and infrastructure costs as warranted.	Costs involved with WWTP rehabilitation or regionalization are highly variable and not estimated individually here. Funding sources potentially include tax or utility revenue, TWDB loans or grants or other applicable grant programs (USDA Rural Utilities Service, *etc.*).

Bacteria Reduction Capability

This activity directly reduces bacteria, nutrients, and additional concerns stemming from poorly treated effluent. Because there is not a significant pattern of exceedance existing already among watershed WWTFs, future reductions cannot be quantified as they will be dependent on the future state of infrastructure. The primary reduction potential for this task is as a preventative measure.

WWTF 2 – Recommend Increased Testing

Purpose: To increase oversight of plants with infrequent testing and enhance nutrients data through voluntary testing.



Description: The Partnership will recommend additional bacteria testing to local utilities that do not have daily testing requirements. The intent of the increased testing is to expand the ability to identify operations that would benefit from additional resources. Infrequent testing may mask issues, especially in smaller facilities with less consistent loading. The Partnership also recommends that utilities consider testing, as appropriate, for a wider suite of nutrients, to include total phosphorus and nitrogenous compounds. This data would help establish the potential impacts of effluent on nutrient loading to the waterway and potentially help prepare facilities for future permit changes, including future statewide additions of other nutrient criteria by TCEQ.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Utilities	Ongoing-2030	Bacteria, Nutrients	Extends existing functions

Technical and Financial Resources Needed	Estimated Costs and Funding
The technical resources needed to fulfill these recommendations are sufficient utility staff to handle increased testing. Financial resources needed for this recommendation are the incremental costs of sampling, dependent on the frequencies and constituents involved.	Testing costs are highly variable by the frequency of testing and costs specific to the individual entity involved. Funding sources are expected to be tax or utility revenues of the utility.

Bacteria Reduction Capability

This activity does not directly reduce bacteria; it provides information for decision-makers to address current or future operations to directly reduce pollutants.

SSO 1 – Remediate Infrastructure

Purpose: To physically remediate collection system SSOs through rehabilitation and preventative maintenance.

Description: Utilities will continue to identify and address areas in collection systems prone to SSOs and consider structural and operation changes that will reduce SSOs, including:

- prioritizing rehabilitation of problem elements/areas
- considering additional funding for rehabilitation where appropriate
- pursuing additional grant or loan funding to expand resources for rehabilitation

No specific problem areas were identified by stakeholders, but as systems age, problem areas may arise.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Utilities	Ongoing-2030	Bacteria, Nutrients	Enhance existing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources for remediating SSOs include sufficient staff capacity for investigating problem areas, and implementing capital projects or operational adjustments. For grant projects, staff grant administration capacity would be needed. Financial resources for remediating SSOs are typically borne by utilities directly, through rate revenue or *ad valorem* tax revenue. Potential supplemental funding sources include Texas Water Development Board (TWDB) Clean Water State Revolving Fund loans or grants, funding from resiliency-based funding sources from federal agencies as listed in Appendix D, and traditional commercial loan or bond opportunities. Costs are highly variable depending on the size, age, and type of infrastructure and the nature of the causative factor for SSO problem areas. Resources needed include maintaining adequate staff capacity, equipment to conduct inspections and supplement operations, and cost of rehabilitation and contractor services. Residents are responsible for maintenance and repair of their private line connections.	Estimated costs for addressing SSOs are highly variable depending on the extent of the issues, size of the system, and nature of the fix. Example costs from other regional WPPs include mid-sized cities who spend $1,000,000-$5,000,000/year on addressing aging collection system infrastructure. The distributed nature of service in the watershed means costs per utility are likely lower than this estimate, but in conglomerate amount to appreciable investment. Funding sources include tax or utility revenue and loans/grants from TWDB or other programs.

Bacteria Reduction Capability

This activity is expected to reduce SSO activity at chronic locations. Efficiency is variable depending on extent of the local problem and nature of implementation. The primary benefit is expected to be localized, but significant in those localities based on the relatively high risk of untreated sewage. While the total volume of SSO flow that will be reduced cannot be projected, the reduction efficiency is 100% for each gallon of effluent not released.

SSO 2 – Consider Additional Preventative Measures

Purpose: To enhance operations and infrastructure capacity to help prevent SSOs.

Description: Utilities will consider enhancing their operations and preparations for mitigating SSOs by implementing one or more of the following best practices (if not already in place):

- Evaluate and enhance lift station[7] backup capacity, including backup power or capacity for bypass pumping or other remediations in the event of power outages.
- Consider implementing grease trap inspections where not already required.
- Consider implementing or upgrading a proactive asset management program to evaluate and prioritize rehabilitation needs.
- Revise response procedures/standard operating procedures for identifying and mitigating SSOs in high rain events.
- Consider participation in TCEQ's Sanitary Sewer Overflow Initiative for problem systems.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Utilities	Ongoing-2030	Bacteria, Nutrients	Enhance existing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources for additional preventative measures include sufficient staff capacity to evaluate lift station capacity, implement capital projects, conduct grease trap inspections, oversee asset management efforts, review standard operating procedures for SSOs, and/or make recommendations on operational changes. Staff costs are variable dependent on the size and scope of the project and staff involvement. Financial resources for enhancing lift station capacity are borne by the utility. Additional financial resources include loan and grant programs.	Estimated costs are variable, depending on the type and scale of measures selected and implemented. Funding sources include government tax or utility revenue and loans/grants from TWDB or other grantors.

Bacteria Reduction Capability

This activity is expected to reduce SSO activity by ensuring lift station functionality in all conditions, and enhancing preventative measures. While the total volume of SSO flow that will be reduced cannot be projected, the reduction efficiency is 100% for each gallon of effluent not released.

[7] Lift stations are an essential part of collection systems in relatively flat regions, transferring waste between pipes at different elevations to maintain flow. However, during power outages or similar events, lift stations can cease to function and be prone to overflow without backup capacity. Utilities will evaluate and consider enhancing their backup capacity (generators, bypass pumps, etc.) for their lift stations to ensure continuity of operations during power outages or other events.

Onsite Sewage Facilities

Failing OSSFs are a priority source due to high risks to human health associated with untreated human waste, and their increasing share of total load by 2030. The general intent of the stakeholders was to prioritize failing systems that are unlikely to be addressed otherwise, to attempt to prevent future failures through education and outreach to the community and licensed professionals, and to direct intervention with a focus on economically disadvantaged households. These solutions are in addition to the existing requirements of watershed counties, including mandatory maintenance contracts for systems and other authorized agents, and the enforcement thereof. It should be recognized that county and authorized agent efforts are the primary foundation for all other efforts. The following supplementary solutions were identified by the stakeholders:

- OSSF 1 — Remediate failing OSSFs (repair, replace, pump, decommission)
- OSSF 2 — Improve and update spatial data to identify priority areas
- OSSF 3 — Convert OSSFs to sanitary sewer

The focus areas for this solution are all subwatersheds with existing sanitary sewer systems, with a focus on the Tomball area in subwatershed 5. Educational elements (e.g., homeowner workshops) are included in the discussion of education and outreach activities in Section 6.

Actual implementation will be opportunistic, and will seek to emphasize priorities noted in each OSSF solution. Proposed siting of OSSF projects within the watershed to be implemented by 2030 (**Table 1**) includes additional units to convert in order to cover downstream reduction loads from deer and the safety margin, as noted previously[8].

Table 1. Proposed siting for OSSF solutions to be implemented by 2030

Attainment Area	Units to Address, Total	Subwatershed	Units to Address, Subwatershed
Headwaters	545	1	92
		2	150
		3	56
		4	248
Downstream	2,786	5	821
		6	645
		7	489
		8	831

[8] The number of OSSFs designated to be addressed by subwatershed is based on each subwatershed's proportional contribution to the total OSSF load for its segment area. This proportion is applied to the reduction load for the segment area and divided by the load per BMP unit to produce the number of BMP units per subwatershed. As with other sources, the focus of implementation will continue to be on siting BMPs opportunistically to generate the greatest bacteria reduction for each segment area. Therefore, actual implementation in each subwatershed may differ from these targets based on opportunities and changing conditions in the watershed.

OSSF 1 – Remediate Failing OSSFs

Purpose: Reduce bacteria and nutrient contributions from failing OSSFs through physical remediation.

Description: H-GAC will work with watershed counties and OSSF owners to inspect and remediate failing systems through pumping, repair, replacement, or abandonment/conversion to sanitary sewer. H-GAC will use Supplemental Environmental Program (SEP)[9], CWA §319(h), or other grant funding to address priority systems. Authorized agents will work with homeowners to enforce existing requirements concerning OSSF function and inspection. In remediation efforts, priority will be given to failing systems near the waterways.

Responsible Parties	Period	Contaminant(s) Addressed	Status
H-GAC; Homeowners; Counties (enforcement); Utilities (for conversion projects)	Ongoing-2030	Bacteria, Nutrients	Expansion of existing efforts (e.g., H-GAC OSSF SEP, residential maintenance)

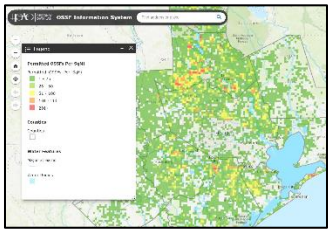
Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resource needs include data on OSSF locations from H-GAC's regional OSSF database, the counties, local utilities/special districts, who may also provide violation information as appropriate. Actual remediation conducted by H-GAC, the homeowner, or another party; enforcement and referrals will be provided by the other responsible parties. Inspection will be conducted as needed by authorized entities based on existing ordinance or other authority. Financial resources required include H-GAC staff time to manage remediation contracts, other parties' staff time in enforcement, and funding for the remediation. Staff time is variable and is not included in cost estimates. Homeowners are expected to provide most of the funding, with other sources supplementing routine maintenance and replacement costs.	Estimated costs are an average[10] of $5,500 per unit, with a total cost of $26,961,000 for 4,902 systems. Funding Sources include routine homeowner maintenance costs, as supplemented by H-GAC SEP and other grant programs (CWA §319(h), etc.).

Bacteria Reduction Capability

Remediating failing OSSFs is assumed to remove 100% of their daily load. Full implementation of this solution will meet the bacteria reduction goal for OSSFs by 2030.

[9] H-GAC's SEP is used to remediate, repair, pump, or decommission OSSFs for homeowners making less than 80% of the Area Median Income.

[10] Average cost numbers were based on a review of OSSF work completed under other projects and approved WPPs in the area, including pump outs, repairs, replacements, and related costs. The range of potential costs for all services mentioned runs from several hundred dollars for a pump out to over $10,000 for replacement of a new system in some areas.

OSSF 2 – Improve Spatial Data			
Purpose: Inform decisions about prioritizing OSSF remediation.			
Description: H-GAC will work with watershed counties and other local partners to continue to collect spatial data on OSSF locations as part of H-GAC's existing OSSF spatial database[11]. The partners will update and improve designations for priority remediation areas based on the data and other factors (*e.g.*, growth, developmental trends). 			
Responsible Parties	**Period**	**Contaminant(s) Addressed**	**Status**
H-GAC; Counties; Special Districts; Utilities	Ongoing-2030	Bacteria, Nutrients	Expansion of existing efforts (*e.g.*, H-GAC OSSF database)
Technical and Financial Resources Needed			**Estimated Costs and Funding**
Technical resources include existing staff capacity at H-GAC and partner agencies. H-GAC currently maintains the database as part of a CWA Section 604(b) grant project with TCEQ. No additional technical resources are needed for this aspect of the task. Financial resources needed include staff time from local partners to continue to submit and review OSSF data, and to coordinate with H-GAC on maintaining and updating priority areas for H-GAC SEP and other funding in the watershed. Specific focus will be given to economically disadvantaged households and OSSFs in riparian or flood-prone areas.			Estimated costs include existing funding of staff time which is variable depending on workload for this element. Funding sources are the ongoing H-GAC CWA §604(b) grant and local partner staff time.
Bacteria Reduction Capability			
This solution does not directly reduce fecal waste pollution but is designed to better inform other solutions (OSSF 1 and OSSF 3; OSSF homeowner workshops) to enhance their effectiveness.			

[11] Available for review online at: http://datalab.h-gac.com/ossf/

OSSF 3 – Convert to Sanitary Sewer

Purpose: Convert old and/or failing OSSFs to sanitary sewer service where available and appropriate.

Description: Local partners, in coordinating with funding sources like H-GAC's SEP for OSSF remediation, will focus on identifying and pursuing opportunities to convert OSSFs within service area boundaries to sanitary sewer service. Cities will consider promoting or requiring conversion of areas within existing or annexed boundaries. Priority should be given to failing systems, and this recommendation only applies where sanitary service is available/feasible.

Responsible Parties	Period	Contaminant(s) Addressed	Status
H-GAC; Counties; Special Districts; Utilities; Homeowners	Ongoing-2030	Bacteria, Nutrients	Expansion of existing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources include available staff at local governments, H-GAC, and watershed counties to promote and/or process conversion projects. Homeowners or funders will need to have, or contract for, personnel skilled in this specific type of construction. Financial resources include the cost to permit the service connection, construct the service line, and pump/decommission the OSSF. It's expected that a good number of conversions may result in abandoned OSSFs as development of master-planned communities displaces existing residences.	Estimated costs of converting a residence to sewer service are $3,000-$5,000. No specific number of OSSFs is slated for this specific action (see OSSF 2). Funding sources include expected routine costs from homeowner, as supplemented by H-GAC SEP or CWA §319(h) grant funding.

Bacteria Reduction Capability

This solution is expected to provide 100% removal rate by actively converting systems to alternate service.

Stormwater

Stormwater runoff from populated areas with large amounts of impervious cover can contribute pollutants from a variety of sources that often reach waterways through storm sewers without filtration. While urban stormwater is not an original source, but a conveyance for sources, several solutions exist to mitigate its impacts.

The primary means for addressing these sources in most of the urban areas of the watershed are the Municipal Separate Storm Sewer System (MS4) permits through TCEQ's General Permit (TXR040000). The permits require stormwater utilities to address sources of pollutants they may discharge to impaired waterways[12]. The recommendations of this WPP are not designed to supplant the existing efforts of the MS4s in the watershed. They are intended to supplement those activities, which form the basis of stormwater quality management in the area[13]. MS4 activities are likely to have the most impact on bacteria and nutrient levels in the downstream area. In addition to MS4 permit activities, the stakeholders recommended the following solutions:

- Urban Stormwater 1 — Install stormwater inlet markers
- Urban Stormwater 2 — Investigate drainage channels for illicit discharges
- Urban Stormwater 3 — Promote and implement riparian buffers
- Urban Stormwater 4 — Promote low impact development

Points of focus of this category include education and outreach activities, as reflected in Section 6. Implementation will target the urbanized portions of the downstream attainment area. These recommendations are in addition to the general recommendation by the stakeholders that infrastructure should be properly maintained. For both Urban Stormwater 2 and Urban Stormwater 3, the Partnership recommends that the investigation program and inlet installation program both include reporting of damaged infrastructure as a standard operating procedure. This will help ensure utilities or other property owners are aware of infrastructure problems and can work effectively to address them, which produces both water quality and flood mitigation benefits to the community. It should be noted that targeted monitoring that is complementary to Urban Stormwater 1 is a recommendation for the broader Bacteria Implementation Group[14] (BIG) area, and

[12] More information on the permits can be found at: https://www.tceq.texas.gov/permitting/stormwater

[13] No funding other than that from the MS4 permittees themselves is expected to be applied to activities specific to their permit activities. Any mention of funding sources in the solutions identified for this subsection is intended in reference to activities above and beyond permit requirements.

[14] The BIG is an ongoing TMDL effort addressing fecal indicator bacteria for a number of segments in the H-GAC region, including Spring Creek. The WPP provides a more specific focus on Spring Creek, considers additional pollutants and stakeholder concerns, and makes watershed-specific recommendations, but is working in conjunction with the broader BIG effort to reduce fecal contamination in local waterways. Learn more at: https://www.h-gac.com/bacteria-implementation-group

active projects are currently underway which may serve as valuable models for this watershed. All efforts under this category will be coordinated to the greatest extent possible with efforts occurring as part of the BIG.

Development of new features in existing rights of way has to be balanced against other uses for our urban corridors, including flood mitigation. Siting of riparian buffers should take this into account. Limitations on vegetation or other measures in drainage easements, or access requirements for maintenance may limit buffers in some areas, or require they be further from the channel.

Figure 2. Volunteers installing storm drain markers in the Village of Grogan's Mill

Urban Stormwater 1 – Install Stormwater Inlet Markers

Purpose: To increase public visibility of stormwater drains as vectors for pollution.

Description: This solution involves installation of stormwater inlet markers, where appropriate for local governments, special districts, homeowners associations (HOAs), and neighborhoods. Local organizations (e.g., The Woodlands Township Environmental Services Department, Harris County's Stormwater Inlet Marking program[15]) have existing programs for this purpose. This solution reflects partners intent to continue or expand programs. Inlet markers will be installed based on the requirements of the specific jurisdictions. The intent is to utilize this as a project to engage local volunteers in coordination with outreach efforts.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Harris County; Local Governments; Special Districts; HOAs; Local Volunteers	Ongoing with focus on 2021-2025	Bacteria, Nutrients, Sediment, Trash	New or expanded effort

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources include staff capacity to train volunteers and manage installation programs. This capacity already exists in the watershed. Financial resources include costs of staff time in installation or managing volunteers, and the costs of the inlet markers. Potential sources include existing programs (The Woodlands Township, Harris County), local government/organization funding, CWA §319(h) grant funding, neighborhood HOA funding, or private foundation funding.	Estimated costs include the markers themselves (average of $5 or less when bought in bulk), and time in installation (which will vary dependent on whether staff or volunteers are involved). Total costs depend on the extent of the implementation. Funding sources include existing programs (The Woodlands Township and Harris County provide marking kits upon registration), utility revenues, or non-governmental organization (NGO) partner funds.

Bacteria Reduction Capability

This activity is expected to have an indirect impact on bacteria, nutrients, sediment, and trash by providing structural outreach to residents. No specific reduction efficiency is assumed.

[15] Harris County maintains a Stormwater Inlet Marking program. More details can be found at: https://www.cleanwaterways.org/swim/

Urban Stormwater 2 – Investigate Drainage Channels

Purpose: To identify and reduce illicit discharges in drainage areas with high bacterial loads.

Description: This solution involves targeted reconnaissance of waterway and drainage channels by H-GAC or partner agency staff on foot to identify broken infrastructure, illicit discharges, or other pollutant sources. Illicit discharge detection is a minimum control measure for MS4 permits, but targeted reconnaissance based on "hotspots" and coordination of follow-up to anything found would be efforts above and beyond permit requirements. The models for this recommendation are similar to TCEQ/Galveston Bay Estuary Program (GBEP) projects[16] identifying high bacteria load streams in the Houston urban area. This effort can be paired with monitoring activities. Areas along the I-45 corridor would be opportune sites.

Responsible Parties	Period	Contaminant(s) Addressed	Status
H-GAC; MS4s; Counties; TCEQ	Ongoing with focus on 2021-2025	Bacteria, Nutrients, Sediment, Trash	New or expanded effort

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources include staff capacity in investigation of water and drainage channels. Enforcement data and knowledge from the counties and other jurisdictions would aid in choosing sites and channels. Financial resources include costs of staff time and travel expenses. Staff time would likely be only an incremental addition above a base cost for watershed facilitation in implementation by H-GAC or another lead agency (Section 6).	Estimated costs include hourly costs of $40-50 for staff time and overhead. Total costs depend on scale of effort. A $20,000 project could fund 200-300 hours of field investigation and follow-up. Funding sources include grants (CWA §319(h), GBEP, etc.), collaborations with MS4s, or existing partner resources.

Bacteria Reduction Capability

This activity is expected to have an indirect impact on bacteria, nutrients, sediment, and trash by identifying potential sources, which would then be referred to responsible enforcement jurisdictions.

[16] The Top 5/Least 5 project, among others, was a GBEP and H-GAC partnership project to detect potential sources of contamination in highly contaminated waterways, and those close to meeting the standard. The project was successful in identifying sources for several waterways in excess of MS4 permit requirements in the area, through targeted monitoring and reconnaissance.

Urban Stormwater 3 – Promote and Implement Riparian Buffers

Purpose: To reduce sheet flow pollution by maintaining or restoring riparian buffers where appropriate.

Description: While much of the flow from urban areas enters waterways through MS4s, sheet flow from areas adjacent to the waterways can bring pollutants into the waterway over impervious surfaces. Maintaining a vegetated buffer (forest, native plantings, *etc.*) along waterways can slow storm flows, decrease erosion, filter pollutants, lower temperatures, increase DO, and provide other ecosystem services. When maintained in areas appropriate to drainage needs, riparian buffers are a natural, lower cost infrastructure solution. Implementation can take place on public or private land and use a mix of vegetative approaches. Urban forests and tree canopy within the watershed area can also help mitigate impacts of development. This solution is to maintain or restore areas of vegetative buffer in riparian areas and expand tree canopy in urban areas.

Responsible Parties	Period	Contaminant(s) Addressed	Status
MS4s; Local Governments; Special Districts; Texas A&M Forest Service (forestry technical support); NGOs; Landowners	Ongoing-2030	Bacteria, Nutrients, Sediment, Trash	Expansion of ongoing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources include staff capacity or partner support in design and installation of vegetative barriers (for restoration) or legal support for conservation easements or similar maintenance projects[17]. NGOs like Trees for Houston, American Forests, and Bayou Land Conservancy may be able to offer technical advice on riparian easement management. Financial resources vary depending on the size and type of project, but should consider ownership/acquisition costs, maintenance costs, and restoration costs. Funding sources are dependent in part on the applicant and property type. While this strategy will be implemented across the watershed, stakeholders are supportive of prioritizing the downstream attainment area.	Estimated costs vary greatly depending on the size and type of project. Funding sources include CWA §319(h) grants, NGO/endowment funding, TPWD grants, private land investment, or local government/MS4 funding.

Bacteria Reduction Capability

This activity is expected to have an indirect impact on bacteria, nutrients, sediment, and trash by providing filtration to sheet flow in stormwater runoff events. Filtration capacity is dependent on site-specific factors.

[17] Restoration or expansion of forested areas in and adjacent to riparian zones in urban areas should consider specific practices and resources available from the Texas Forest Service, available at: https://tfsweb.tamu.edu/LandownerAssistance

Urban Stormwater 4 – Promote Low Impact Development

Purpose: To reduce pollutants in stormwater flows through infrastructure that mimics or improves on natural hydrology.

Description: This solution involves promoting and implementing low impact development (LID) design and green infrastructure to filter, slow, and increase infiltration of stormwater runoff. H-GAC and local partners will promote LID through providing model materials on our website, coordinating with local and regional LID projects, and including LID as part of broader discussions of MS4 permits and new development. Local partners may elect to use LID practices in new institutional development (government buildings, parks, *etc.*) Focus areas for this solution are the denser portions of the downstream especially in areas of new development.

Responsible Parties	Period	Contaminant(s) Addressed	Status
H-GAC; MS4s; Counties; Local Governments; Special Districts	Ongoing with focus on 2021-2025	Bacteria, Nutrients, Sediment, Trash	New or expanded effort

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources include staff capacity to facilitate discussions for promotion and staff capacity among local partners to implement LID projects. Financial resources of promotion include costs of staff time in developing and disseminating LID materials and coordinating discussion. Financial costs of implementing include the engineering, staff, and structural costs of each project which will vary widely by type and scale.	Cost estimates for promotion are included in the general duties of a watershed coordinator, and do not represent appreciable additional costs. Costs for implementation are dependent on the projects undertaken by local partners. Funding sources include local government revenues with potential grant supplement (CWA §319(h), *etc.*)

Bacteria Reduction Capability

This activity is expected to have a direct impact on bacteria, nutrients, sediment, and trash by providing structural barriers. However, reduction capacity is dependent on the practices used. No reduction is assumed specifically for this activity in the WPP.

Pet Waste

Waste from both pet and feral dogs is a substantial source of bacteria and nutrients in the Spring Creek watershed, especially in the more densely developed areas. The general focus of the recommended solutions is to enhance existing pet waste reduction efforts, install new structural elements, and promote spay/neuter programs to reduce unwanted populations. The implementation of these tasks is designed to focus on making pet waste reduction easy and visible to dog owners, especially in public places. In light of this, stakeholders recommended the following solutions:

- Pet Waste 1 — Install pet waste stations in local areas
- Pet Waste 2 — Add dog parks or dog areas in public places
- Pet Waste 3 — Hold spay/neuter clinics to reduce feral populations
- Pet Waste 4 — Increase enforcement of pet waste rules and ordinances

The focus of implementation for these solutions will be on public areas with high traffic from pet owners, including parks, trails, and large multi-family complexes. The priority areas are the urban centers and regional park areas, especially the developed portions of the downstream attainment areas adjacent to waterways. The recommendations are in supplement to existing pet ordinance enforcement by local governments and existing structural elements (pet waste stations, *etc.*). Grouping multiple stations at single locations increases ease of use and visibility.

Pet Waste 1 – Install Pet Waste Stations

Purpose: To reduce pet waste in runoff by encouraging pet owners to pick up after pets in public areas.

Description: Pet waste stations are a widely used, proven technology for reducing pet waste in public areas where dog owners bring their pets. The stations are cost-effective, with low maintenance aside from refilling bags as needed. This solution would install 40 or more pet waste stations in the watershed, which would be installed and continually maintained by the entity receiving them. The pet waste stations would be targeted for high traffic public areas in the watershed, such as the Spring Creek Greenway, , other neighborhood and county parks, other recreational areas, and new development. Temporary stations at large events are another potential supplement to this effort.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Counties; Local Governments; HOAs; Apartment Complexes	Focus on 2021-2025 for installation; 2025-2030 for ongoing use	Bacteria, Nutrients	Expand on existing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources required are limited to adequate staffing commitment to install and maintain the sites, functions within the scope of the partners' existing capabilities. Financial resources are needed for the purchase of the stations and initial materials (identified sources include existing funding from local partners, CWA §319(h) grants - wholly or in cost-share with partners, and private sector donations through H-GAC); installation and ongoing maintenance (staff time, provided by the receiving partner); and bag refills (provided by the receiving partner, or as appropriate under future grants). Alternative funding sources for initial materials include partnerships with local industry/commercial entities or park volunteer groups. The Partnership will explore with H-GAC the potential to participate in H-GACBuy[18] cooperative purchasing	Estimated costs for 40 pet stations include installation costs of $200 per station, $50 in bags, $200 in labor and materials (total $18,000). Maintenance is estimated at $300/year per station ($168,000 for 14-year period). The total cost is $186,000. Costs for mobile stations at events are variable. Funding sources include local government tax or utility revenues, or grants from CWA §319(h) or other sources.

Bacteria Reduction Capability

The number of dogs impacted by this solution will vary based on the location. An average of 50 dogs a day per station served was chosen based on stakeholder description of high-traffic area parks. Assuming half of the dog's daily waste is served, full implementation of this solution would yield 2,000 dogs, or 1,000 representative units, addressed. This would represent a daily bacteria reduction of 2.5E+12 in riparian areas (300-foot buffer), and 6.25E+11 in areas outside the buffer based on SELECT assumptions.

[18] More detail about H-GAC's cooperative purchasing program can be found online at: https://www.hgacbuy.org/

Pet Waste 2 – Expand Dog Parks

Purpose: To provide additional areas for dog owners to bring dogs, to sequester waste and increase the likelihood of owners picking up waste.

Description: This solution would entail partners developing dog park/areas at their properties or developing new specific dog parks. Dog park areas already exist in the watershed (e.g., Cattail Dog Park, Tamarac Park, Rob Fleming Dog Park, Springwoods Village Dog Park). Heavily used recreation areas and other parks adjacent to waterways are prime locations for dog parks or off-leash areas with waste stations. Newly developing private communities with strong amenity focuses are also potential opportunities for expanded parks. Priority areas are based on highest potential use/traffic and population served.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Counties; Local Governments; HOAs; Developers; Special Districts	One new park, 2021-2025; another park, 2025-2030	Bacteria, Nutrients	New and expanded effort

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources needed are sufficient staff capacity for park owners to evaluate potential expansion of dog areas, manage capital projects, and/or seek funding. Financial resource needs reflect the stages for which technical resources are needed. Identified sources of funding include internal revenue of the partners, grants from governmental sources and private endowments, and partnerships with private industry/organizations. Dog park costs are highly variable based on location and composition, and whether new land is acquired, or dog facilities are developed in existing parkland.	Cost estimates for new park acquisition in area plans range from $500,000 to $1,000,000+, whereas development of new facilities in existing parks range from $50,000 to $300,000. Funding sources include municipal revenues, CWA §319(h) grant funding, TPWD park grant funding, or foundation grants.

Bacteria Reduction Capability

This solution indirectly reduces waste, by sequestering it where it can be more easily addressed by owners and park staff. The number of dogs served is based on the number and scale of parks/park areas added. An assumption of 50% reduction of daily load per dog visiting the park is used based on stakeholder input.

Pet Waste 3 – Promote Spay and Neuter Events			
Purpose: To reduce feral dog populations through reproductive controls.			
Description: Spay and neuter programs are an effective means of curbing feral and unwanted pet populations[19]. The Partnership will work with a spay and neuter provider to hold local spay and neuter events or promote local services to pet owners through local governments, special districts, NGOs and HOAs. Potential models include existing spay and neuter programs at Harris County and NGOs like Friends For Life[20].			
Responsible Parties	**Period**	**Contaminant(s) Addressed**	**Status**
Service provider (such as SPCA or similar); Local Partners	2021-2030, every 5 years (2)	Bacteria, Nutrients	New effort
Technical and Financial Resources Needed			**Estimated Costs and Funding**
Technical expertise would be provided by the existing spay/neuter program staff. Similarly, outreach materials already exist for these programs. H-GAC and partners will adapt materials as needed. Various providers have had mobile programs in the area. Financial resources needed include funding for the events from a combination of local government funds, other grant funding, or funding from private endowments, in addition to any contributions received from other interested partners. Funding for the spay/neuter of residential pets would be provided by the residents, or to some degree by the spay/neuter program itself based on its internal funding sources.			Costs estimates for Spay/Neuter education events are $5,000 per event, ($15,000 total) and spay/neuter costs for owners are $40-$150 per animal[21]. Funding sources include pet owners, local partner or non-profit funding, and grants.
Bacteria Reduction Capability			
This solution's efficiency will vary based on the number of dogs addressed. A single female dog can have up to three litters a year or an average litter size of seven puppies, yielding up to thousands of dogs in five years or less[22]. Even with a low feral survival rate, this is an appreciable, if not directly quantifiable, reduction. The reduction of each average litter represents a 1.75E+10 daily source load reduction[23].			

[19] Harris County has an existing Trap, Neuter, Release program for community (feral) cats. More details are available at: https://www.countypets.com/Pet-Resources/Community-Cat-Program

[20] More information on a model program by this NGO to curb pet populations in underserved communities can be found at: https://friends4life.org/programs-and-events/fix-houston/

[21] Based on cost estimates provided by the Houston Humane Society, available online at: https://www.houstonhumane.org/clinic/spay-neuter

[22] https://dogpages.net/health/how-many-puppies-do-dogs-have

[23] The reduction represents a total potential source load reduction and does not consider spatial location.

Pet Waste 4 – Consider Increased Enforcement			
Purpose: To reduce pet waste through enforcement of existing or new ordinances or other restriction.			
Description: Requirements to pick up pet waste vary throughout the watershed in both public and private areas. The focus of this solution is to provide model ordinances and outreach materials, as well as direct engagement, for entities considering increasing their enforcement. Specific attention will be given to apartment complexes and high traffic public areas, especially those adjacent to waterways.			
Responsible Parties	**Period**	**Contaminant(s) Addressed**	**Status**
Local Governments; Special Districts; HOAs; Apartment Complexes	Ongoing-2030	Bacteria, Nutrients	New effort
Technical and Financial Resources Needed			**Estimated Costs and Funding**
Limited technical resources are required for this solution. Model materials already exist and can be adapted as needed. Financial resources needed for the solution are primarily an issue for increased enforcement costs if active enforcement is conducted. Otherwise, costs are limited to staff time in developing and seeking approval for additional restrictions. A primary focus for this watershed is large apartment complexes. Existing models for multifamily property enforcement exist in the watershed.			Cost estimates for developing new ordinances or outreach materials will vary by scope and type. However, H-GAC maintains model materials on its website[24] as do partners like Harris County. Costs for increased enforcement will vary based on the entity involved and scope of enforcement. Funding sources for developing new enforcement or materials are expected to come primarily from the enforcing entity's existing revenue streams. Model materials already developed do not require additional funding.
Bacteria Reduction Capability			
This solution is not a direct intervention, but a reinforcement or expansion of restrictions that serve to prevent wastes.			

Dogs are a substantial portion of the modeled source load for Spring Creek. While they are concentrated most densely in the downstream area, they are present in good numbers throughout the watershed, and will be addressed by the preceding recommendations wherever opportunities lie. The Partnership's goal is to address dog waste proportional to the number of dogs in any subwatershed, but special attention will be given to riparian areas and high-use public facilities. Discussions during this WPP indicated there are a good number of public and private parks adjacent to the creek and its tributaries that would be good candidates for pet waste stations (including

[24] http://www.h-gac.com/pet-waste-pollutes/default.aspx

enhancement of existing stations), enforcement, or spay and neuter events (**Table 2**)[25]. Proposed siting of pet waste projects within the watershed to be implemented by 2030 includes additional units to convert in order to cover headwaters reduction loads from deer and the safety margin, as noted previously. The Partnership recommends the expansion of these elements to any appropriate areas where opportunities exist, including smaller HOA and private parks.

Table 2. Proposed siting for pet waste solutions to be implemented by 2030

Attainment Area	Units to Address, Total	Subwatershed	Units to Address, Subwatershed
Headwaters	7,049	1	1,767
		2	1,900
		3	476
		4	2,905
Downstream	21,718	5	4,519
		6	4,709
		7	6,074
		8	6,416

[25] The number of dogs designated to be addressed by subwatershed is based on each subwatershed's proportional contribution to the total pet waste load for its segment area. This proportion is applied to the reduction load for the segment area and divided by the load per BMP unit to produce the number of BMP units per subwatershed. As with other sources, the focus of implementation will continue to be on siting BMPs opportunistically to generate the greatest bacteria reduction for each segment area. Therefore, actual implementation in each subwatershed may differ from these targets based on opportunities and changing conditions in the watershed.

Agriculture

Agriculture maintains a small, declining presence in the watershed. Legacy agricultural areas in the headwaters attainment area maintain populations of livestock in addition to row crops. While modern agricultural practices are often efficient in reducing bacteria and nutrient transmission to waterways, loads from cattle, horses, sheep, and goats are still present in the watershed. Fertilizers are also a potential source of nutrient pollution, and pesticides and herbicides can impact macrobenthic communities and aquatic vegetation. The solutions identified by the Partnership focus on addressing wastes from livestock by expanding and supporting existing, successful programs by TSSWCB, USDA NRCS, and Texas A&M University AgriLife Extension (AgriLife Extension) and Research (AgriLife Research) in coordination with local producers and conservation efforts on agricultural lands by the Bayou Land Conservancy and other NGOs. The intent of these solutions is to provide financial assistance or technical resources for local producers to make voluntary improvements to their property and operations. These improvements are designed to be beneficial to the producer and to water quality. These recommendations recognize the benefits that well-run agricultural lands provide.

The solutions selected by the stakeholders include promoting and implementing voluntary, site-specific management plans for individual farms. The efforts will focus on implementing multiple BMPs where appropriate. The focus areas for the solutions below are subwatersheds 1 and 2.

- Agricultural Operations 1 — Develop land management plans including TSSWCB WQMPs and NRCS Conservation Plans
- Agricultural Operations 2 — Implement other land management techniques through financial assistance and technical programs
- Agricultural Operations 3 — Implement horse manure composting program

Agricultural Operations 1 – WQMPs and Conservation Plans

Purpose: Provide technical and financial assistance to agricultural producers to plan and implement land management practices that benefit water quality.

Description: Both the USDA NRCS and TSSWCB offer agricultural producers technical and financial assistance for "on-the-ground" implementation. To receive financial assistance from TSSWCB, the landowner must develop a WQMP with the local SWCD that is customized to fit the needs of their operation. The USDA NRCS offers options for development and implementation of both individual practices and whole farm conservation plans. Priority for WQMPs and other projects will be given to management practices which most effectively control bacteria contributions to the waterways, with a focus on areas adjacent to riparian corridors. Based on site-specific characteristics, plans will include one or more of the TSSWCB's approved practices[26] including but not limited to filter strips, riparian buffers, prescribed grazing, and providing alternative shade and water. More information on the practices is included in Appendix C. Similarly, the USDA NRCS offers conservation planning services through its Conservation Technical Assistance (CTA) program[27] and financial assistance through its Environmental Quality Incentive Program (EQIP) and related programs. These services assist landowners to conserve resources and protect water quality by providing NRCS expertise and financial assistance. In addition to WQMPs and Conservation Plans, NRCS offers a broad range of other land and habitat management programs[28].

Responsible Parties	Period	Contaminant(s) Addressed	Status
TSSWCB; SWCDs; USDA NRCS; Agricultural Producers/Landowners	Ongoing-2030	Bacteria, Nutrients, Sediments, Pesticides	Ongoing and expanded effort

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources required by this solution are the expertise of TSSWCB and USDA NRCS staff involved with their respective programs, and the local knowledge of the agricultural producers. Additional WQMP technician(s) may be needed to assist in plan development depending on demand. H-GAC and other partners will assist in promoting WQMPs to landowners. Financial resources required for this solution vary based on the type and scope of plan implemented. Costs for implementing WQMPs are borne in part by the landowner, and in part by TSSWCB, with up to $15,000 in financial assistance available for qualified WQMPs. Sources of funding for these costs include agricultural producer contributions and TSSWCB allocated funds. Resources for NRCS conservation plans and financial assistance programs include NRCS staff time and related costs, funding from EQIP and other programs, and contribution from the landowner. The funding for these costs is expected to come directly from the respective parties. WQMPs or other plans addressing an average of 50 livestock units will need to be implemented (**Error! Reference source not found.**).	Estimated costs for WQMPs include up to $15,000 per WQMP in financial incentives125, with the landowner share of costs being variable. NRCS Conservation Plan costs are estimated at $2,000-$3,000 in NRCS staff time , with landowner costs being variable. Funding sources include existing programs (TSSWCB, USDA NRCS) and landowner funding.

Bacteria Reduction Capability

This solution's bacteria reduction capacity assumes a direct reduction of bacteria loading from lands covered by a WQMP/*etc.* The specific mix of efforts under a given project may affect the overall efficiency, in conjunction with the nature and location of the property.

[26] For more information, see: http://www.tsswcb.texas.gov/en/wqmp
[27] For more information, see: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/
[28] For more information, see: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/

Agricultural Operations 2 – Maintain or Restore Riparian Buffers

Purpose: To reduce transmission of pollutants by slowing and filtering runoff from agricultural areas.

Description: Vegetative buffers (including filter strips and riparian forests) in areas adjacent to waterways are an effective means of reducing the transmission in runoff of wastes, organic materials, and nutrients from agricultural operations. This solution would seek to promote and implement voluntary landowner and public entity land management to increase the existing healthy riparian buffers of the watershed.

In addition to WQMPs and conservation plans, potential methods of implementation include the utilization of conservation easements held by land trusts, voluntary individual landowner implementation, or participation in a USDA NRCS Farm Bill program (e.g., EQIP or similar). Priorities for this solution are maintaining and expanding buffers in the headwaters attainment area.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Landowners/producers (on a voluntary basis); NGOs; Agricultural Agencies	Ongoing-2030	Bacteria, Nutrients, Organic Wastes, Pesticides	Expanded existing effort

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resource needs include staff capacity at support agencies to provide technical services and knowledge to landowners. Funding resources for this solution are projected to be a mix of landowner costs (including opportunity costs of acreage removed from production and actual costs of installation and/or maintenance); funding under applicable financial incentive programs (WQMP; USDA NRCS Farm Bill programs); and existing staff capacity among support agencies in staff time and travel costs. If used in conjunction with conservation easements, legal and staff costs include establishing and maintaining the easement, potentially through conservation NGOs.	Cost estimates are variable with type and extent of buffer. Costs may be limited to simply not mowing an area (opportunity cost of productive acreage) to restoration/plantings. Funding sources include established programs and property owner contributions.

Bacteria Reduction Capability

Efficiency will vary based on the extent and size of the barrier and its composition. Reduction estimates for fecal bacteria range from 50%[29] to 95%[30].

[29] Rifai, H. 2006. Study on the Effectiveness of BMPs to Control Bacteria Loads. Prepared by University of Houston for TCEQ as Final Quarterly Report No. 1.

[30] Larsen, R.E., R.J. Miner, J.C. Buckhouse and J.A. Moore. 1994. Water Quality Benefits of Having Cattle Manure Deposited Away from Streams. *Biosource Technology* Vol. 48 pp 113-118.

Agricultural Operations 3 – Implement Horse Manure Composting Program

Purpose: To reduce transmission of wastes from non-agricultural horses through collection and composting of wastes.

Description: Recreational horse (*i.e.*, horses not attached to an agricultural operation) ownership is prevalent in the watershed, with several stabling operations in the watershed.

Horse manure is well suited for composting[31] under correct conditions. The Partnership will work with local government, stabling operations, and commercial partners to implement a horse manure composting program to reduce manure piles at existing operations and potentially produce a viable commodity[32] or resource to defray program costs. This will involve a mix of centralized, collected compost and composting sites at individual operations. This solution is focused on stabling operations throughout the watershed.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Horse Owners; Stabling Operations; Commercial Facilities	Ongoing-2030	Bacteria, Nutrients	New effort

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical expertise required includes staff capacity of local partners to develop and maintain a composting program and logistics and assist sites with developing composting infrastructure and operations. Potential technical support could be obtained from AgriLife Extension or other partner programs. Financial resources needed will depend on the nature of the final program elements. Estimates for built facilities for a single site vary widely from hundreds of dollars for simple pile systems[33] to tens of thousands for more complicated building structures. Funding for individual site systems may be available from agricultural agencies. A commercial venture with a private or NGO partner may not require additional funding if it utilizes existing capacity.	Costs estimates assume existing staff capacity (at $40-$50 total hourly cost per employee) and resources (vehicles). Funding sources include local government revenue and manure compost sales.

Bacteria Reduction Capability

Efficiency will vary based on the extent of operations. Removal of unmanaged manure is assumed at 100% reduction. Effectiveness may benefit from voluntary audits of facilities to identify priority operations.

[31] For more, see: https://agrilifeextension.tamu.edu/library/ranching/composting-horse-manure/

[32] A variety of estimates on the marketability of composted manure exist. An example is the discussion of value and logistics found in industry publication Stable Management at: https://stablemanagement.com/articles/making-money-on-manure#:~:text=Automated%20Composting&text=This%20greatly%20reduces%20the%20labor,time%20with%20Moon%20as%20needed

[33] An example of a low cost aerobic pile system for a single site can be found here: https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/low_cost_equine_manure_composting_16_01.pdf

Feral Hogs, Deer and Other Wildlife

Feral hogs are a potential source of bacteria in watersheds, especially those with large rural areas. Within this general category of wildlife and non-domestic animals, feral hogs are the primary focus of this WPP because of their relatively high bacteria concentration, the other damages they create, and the availability of feasible solutions to address them[34]. Other animals included in this WPP's estimates of loading for deer and other wildlife[35] sources are not intended to be addressed specifically by this WPP, primarily for lack of effective solutions and stakeholder preference in addressing other sources.

There are ongoing discussions at the state and national level about alternative means (chemical controls, etc.) to address feral hogs. The recommendations of this WPP focus on solutions within the scope of local implementation, and already known to be best practices. The focus of implementation for the feral hog solution will be in agricultural and open space areas in which feral hog damage is a potent incentive for landowner participation. Reduction from feral hogs is expected to derive directly from landowner efforts, as supported by partner agencies through information and technical services, although the Partnership recommends that local and state governments consider active involvement in feral hog reduction efforts.

While the WPP does not specifically seek to address deer and other wildlife, the stakeholders considered the benefit of providing alternative habitat away from riparian areas to reduce population densities and time spent near waterways. The wildlife solution presented here represents that indirect focus.

The focus for these solutions is watershed-wide, with special attention paid to localized hog problems, or conservation opportunities may exist in the watershed. To one degree or another, hog, deer, and other wildlife populations are found throughout the project area. For feral hogs, deer, and other wildlife, stakeholders recommended the following solutions:

- Feral Hogs 1 — Remove feral hogs
- Wildlife 1 — Conserve or restore upland habitat
- Wildlife 2 – Manage feeding

The Partnership's approach to the feral hog, deer and other wildlife source category includes a strong corresponding focus on education and outreach recommendations, as detailed in Section 6.

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[34] Contributions from deer were also modeled, but the Partnership does not recommend direct solutions for deer due to a lack of feasible solutions or means to achieve them.
[35] Included in the safety margin.

Feral Hogs 1 – Remove Feral Hogs

Purpose: To encourage landowners and local governments to directly reduce feral hog populations through trapping and hunting.

Description: This solution seeks to reduce feral hog populations in the watershed through active hunting and trapping. The primary focus of this effort is on voluntary efforts from individual landowners, but the Partnership recommends abatement activities on behalf of local governments, as appropriate.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Landowners; Local Governments; Special Districts; Agricultural Agencies (technical support)	Ongoing-2030	Bacteria, Nutrients	Expansion of existing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources needed for this solution are advice and support for landowners engaged in feral hog abatement, and technical knowledge on behalf of the landowners themselves. The primary agency providing technical support on feral hog issues is AgriLife Extension. Financial resources of this project include the staff time and related costs of the partner agencies, and the cost of implementing solutions borne primarily by the landowners on a voluntary basis. No grant funds have been identified to supplement these contributions. Potential other resources include leasing property to hog hunting at a potential net gain of costs.	To reduce an estimated 1,694 hogs, 339 traps would be needed (assuming each trap serves to reduce five hogs). With an average cost of $1,000 for a medium sized trap, this would represent an annual cost of $339,000[36], not inclusive of staff/landowner time. Funding sources include local government and property owners. No specific grant resources were identified for this solution.

Bacteria Reduction Capability

This solution nominally reduces feral hog waste by a maximum daily *E. coil* load of 4.45E+9 for each hog reduced, representing a 100% efficiency. However, this may not account for the volatility of hog population dynamics in which lost members may be replaced through reproduction in excess of population maintenance and does not consider SELECT spatial discounting of source load contributions.

[36] The solution covers a range of practices from hunting to trapping. Assumptions of trap usefulness and costs are based on stakeholder feedback on success rates, and review of varying trap options and pricing. Costs vary from single animal small box traps at $400 to automated drop corral traps at $4000-$5000. Costs do not include time, feed, and other elements. The estimate given should be considered conservative due to the capability of feral hog populations to breed rapidly up to (or beyond) the carrying capacity of the areas they inhabit. Rates of removal below 75% are not likely to have a net reduction of feral hog populations.

Wildlife 1 – Conserve or Restore Upland Habitat

Purpose: To encourage landowners, NGOs, and local governments to conserve and restore upland habitat to relieve wildlife pressures on riparian areas.

Description: This solution seeks to encourage voluntary conservation and restoration of upland habitat away from riparian areas. This solution is intended to coordinate directly with the conservation and land management solutions found later in this section, and will be based on the same approaches, partners, and technical/financial needs.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Landowners; NGOs; Local Governments; Agricultural Agencies (technical support); Developers	Ongoing-2030	Bacteria, Nutrients, Sediment, Flooding	Expansion of existing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
The primary technical resources needed for this solution are staff capacity for pursuing and implementing voluntary conservation projects or ecosystem restoration. Potential technical resources include existing NGOs in the watershed (*e.g.*, Bayou Land Conservancy), agricultural agencies, and local governmental staff (*e.g.*, county precincts already involved in habitat conservation in parks and public areas like Harris County Precinct 4). Financial resources needed are dependent on the scale. Costs may be limited to opportunity costs of unrealized development potential (conservation) or costs associated with physical remediation of property (restoration). Existing efforts in the watershed provide a basis for estimating costs of restoration activities specific to the western watershed land cover types. New development is an opportunity to increase set asides.	Cost estimates vary based on scale and type of conservation or restoration and area. Funding sources include agricultural agencies (*e.g.*, USDA NRCS Farm Bill programs), other grants, and local governmental or NGO funding (including private donation and in-kind donation of land value from property owners).

Bacteria Reduction Capability

This solution is not intended to directly impact sources, but is expected to generally reduce feral hog, deer, and other wildlife time in riparian areas by providing alternative range. Due to the wide variety of species this may impact, and the potential variety of lands involved, no specific reduction potential can be generated. However, this solution is modeled after existing agricultural best practices designed to reduce cattle time adjacent to streams by providing alternative water/shade. It will contribute to the general reduction of these sources.

Wildlife 2 – Manage Feeding

Purpose: To encourage landowners to mitigate wildlife concentrations near riparian buffers and avoid attracting invasive species.

Description: This solution seeks to encourage voluntary implementation of exclusionary devices around deer feeders to deter invasive species such as feral hogs[37]. These measures are especially recommended near riparian areas to avoid concentrating invasive species populations and their waste near waterways. The primary focus of this effort is on voluntary efforts from individual landowners across the watershed.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Landowners; Agricultural Agencies (technical support)	Ongoing-2030	Bacteria, Nutrients	New effort

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources needed for this solution are advice and support for landowners, and participation from the landowners themselves. The primary agency providing technical support on wildlife and feral hog issues is AgriLife Extension. Financial resources of this project include the staff time and related costs of the partner agencies, and the cost of implementing solutions borne by the landowners on a voluntary basis. No grant funds have been identified to supplement these contributions.	Costs for 100 feet of 28" fencing vary between $250-S300 depending on materials, and do not include landowner time. Funding for these measures would come from property owners. No specific grant resources were identified for this solution.

Bacteria Reduction Capability

This solution is not intended to directly impact sources, but is expected to generally reduce feral hog, and other wildlife time in riparian areas by discouraging the formation of resident populations of invasive species. Due to the wide variety of species this may impact, and the potential variety of lands involved, no specific reduction potential can be generated.

[37] For more information, see: https://wildpigs.nri.tamu.edu/media/1153/l-5533-using-fences-to-exclude-feral-hogs-from-wildlife-feeding-stations.pdf

Other Concerns

In addition to the practices recommended for specific sources in the preceding pages, the Partnership recommends several solutions to other local concerns. The recommendations fall into three primary categories:

- Conservation and Land Management
  - Conservation and Land Management 1 — Riparian buffers
  - Conservation and Land Management 2 — Voluntary conservation
  - Conservation and Land Management 3 — Increase Tree Canopy
- Trash/Illegal Dumping
  - Illegal Dumping 1 — Report Chronic Dump Sites and Consider Increased Enforcement
- Flooding
  - Flooding 1 — Coordinate with Ongoing Flood Mitigation Efforts

Conservation and land management activities relate to conserving or developing natural barriers to pollutants entering the water body. These solutions are approached on a voluntary basis. Prioritization is placed on areas adjacent to riparian corridors in the watershed, but may include open space areas in the watershed in general. Areas appropriate for restoration activities in more developed areas may also be targeted for conservation activities (*e.g.*, increasing tree canopy, restoring riparian vegetation). Conservation practices recommended by this WPP are wholly limited to voluntary landowner decisions supported by resources from local government, landowners, and conservation NGOs (*e.g.*, Bayou Land Conservancy), and the Partnership. This WPP makes no recommendations concerning recreational trails or development; its sole focus in this category is improving water quality by maintaining or restoring ecosystem services from conserved land. A variety of successful, model conservation activities exist in the watershed.

Trash and illegal dumping are a visible impact on local waterways and were a secondary focus of the Partnership. The WPP's role in trash reduction is primarily in support of the efforts of other agencies or efforts (*e.g.*, local MS4s as part of Texas Pollutant Discharge Elimination System (TPDES) permit activities). Illegal dumping is the primary focus for the Partnership under this category.

Flooding is another concern for the Spring Creek community. The focus of this WPP will be to coordinate with and support the advancement of flood mitigation activities, with an eye toward advocating for inclusion of water quality features.

These recommendations are supplementary to ongoing efforts by the area's local governments, organizations, and MS4s relating to these issues.

Conservation and Land Management 1 – Riparian Buffers

Purpose: To reduce transmission of bacteria, nutrients, trash, and sediment to waterways by maintaining or implementing vegetated buffers in riparian corridors.

Description: This solution is supplementary to Urban Stormwater 3 – Promote and Implement Urban Riparian Buffers and Agricultural Operations 2 – Maintain and Restore Riparian Buffers, with a focus on non-agricultural areas.

This solution would engage local landowners and local governments to install and/or maintain vegetative buffers along waterways and drainage channels (as appropriate based on drainage needs). Implementation will differ widely in type and scale. Support for these efforts will be provided for residents by the same agencies and partners indicated in the urban and agricultural versions of this solution. This solution focuses specifically on current and new developments and the headwaters area.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Landowners; NGOs; Counties; Local Governments; Special Districts; Agricultural Agencies	Ongoing, with focus on 2021-2025 to prevent degradation	Bacteria, Nutrients, Sediment, Flooding	Expansion of existing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources needed for this solution include the existing programmatic resources and staff expertise of the partners identified above, which are considered sufficient to meet this need. Financial resources needed for this solution include the staff resources and landowner contributions previously detailed for the other versions of this solution. Other costs include opportunity costs related to lost property value.	Cost estimates are variable depending on type, size, and location of buffer. Savings in maintenance (mowing, *etc.*) may counter some potential costs. H-GAC offers a riparian buffer planning tool for landowners to estimate potential costs[38]. Funding sources include local government revenues (public buffers), landowner funding, or NGO/local partner funding.

Bacteria Reduction Capability

This solution's efficiency will vary greatly based on the type, and extent of riparian buffer and local area. Nutrient/sediment removal may be a greater benefit than bacteria removal based on existing literature. However, some literature values indicate fecal bacteria removal rates more than 80-90%[39].

[38] Available at: http://www.h-gac.com/riparian-buffer-tool/default.aspx
[39] See references under Agricultural Operations 2

Conservation and Land Management 2 – Voluntary Conservation

Purpose: To reduce transmission of bacteria, nutrients, trash, and sediment to waterways through voluntary land conservation.

Description: This solution is intended to represent the range of efforts and need for increased voluntary conservation projects as a mitigating factor for changing land use. This solution has three primary facets:

- Individual conservation — voluntary efforts by local landowners (including commercial properties) to manage property to maintain natural value, alone or with other entities
- Organizational projects — projects by the local governments, special districts, and NGOs in the watershed to implement voluntary conservation projects
- Developer-driven projects — projects or supplemental elements in new development that maintain or restore natural function or mitigate impacts.

The primary focus of this solution is the headwaters area, especially in riparian corridors and projects like the Spring Creek Greenway.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Landowners; NGOs; Counties; Local Governments; Special Districts; Agricultural Agencies	Ongoing-2030	Bacteria, Nutrients, Sediment, Flooding	Expansion of existing efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources needed for this solution include the existing programmatic resources and staff expertise of the partners identified above, which are considered sufficient to meet this need. Financial resources needed for this solution include the staff resources or individual landowner resources to develop and maintain conservation easements or conservation lands, including staff time, easement or land acquisition costs, and ongoing maintenance funding.	Cost estimates are variable depending on type, size, and location of properties. Tax savings may offset potential lost land value in easements. Funding sources include existing project funding[40], new grant sources; developer funding or in-kind value for land set-asides or remediation, and additional investment by public and private partners.

Bacteria Reduction Capability

This solution's efficiency will vary greatly based on the type, and extent of conserved lands. No specific reduction efficiency is assumed. Reduction is based on the difference between transmission rates of developed land uses and natural land uses. The value of the land conserved and the potential alternative use for the land (suburban development, *etc.*) determine the difference in potential transmission.

[40] Projects of note in the watershed include the Spring Creek Greenway project; existing conservation efforts by prominent NGOs (Bayou Land Conservancy), and current partnership opportunities being sought with USDA NRCS and other federal funding sources.

Conservation and Land Management 3 – Increase Tree Canopy

Purpose: To reduce transmission of bacteria, nutrients, trash, and sediment to waterways by increasing trees in the watershed.

Description: Trees and tree canopy provide a highly beneficial set of ecosystem services, including increased flood retention and interception by canopy, improvements to air and water quality, decreased heat impacts to waterways, decreased erosion, *etc*. There are a variety of efforts underway in the region to increase the use of trees as natural infrastructure for water quantity and quality.

Stakeholders coordinated with Texas A&M Forest Service and other forestry programs to identify adjacent efforts and practices that would address fecal waste and other concerns. Based on preliminary i-Tree Hydro modeling by Texas A&M Forest Service[41], increasing the number of trees and canopy in the watershed would have appreciable impact on stormwater and associated pollutants, especially in developed portions of the downstream area.

This solution will include Partnership support for existing forestry efforts by watershed counties, the Bayou Land Conservancy, and agricultural/silvicultural agencies; and seek to supplement them with additional support in identifying funding, promoting urban forestry to local partners, and partnering on tree planting events where appropriate. A key focus will be coordinating with new development to promote increased tree canopy where appropriate.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Landowners; NGOs; Counties; Local Governments; Special Districts; Agricultural Agencies; Developers	Ongoing, with focus on 2021-2025 to prevent degradation	Bacteria, Nutrients, Sediment, Flooding	Expansion of existing efforts

Continued on Next Page

[41] Texas A&M Forest Service project liaison Mac Martin worked with H-GAC project staff to provide modeling information on the impact of increased tree canopy and numbers in various areas of the watershed. The purpose of this modeling effort was to provide their technical support in identifying priorities and potential impacts of tree plantings as a land management best practice. The modeling was done with i-Tree, wholly by Texas A&M staff and therefore was not covered under this project's QAPP. The data from this model is not being used to develop reduction goals or removal assumptions as it was not quality assured by this project. However, i-Tree is an established forestry modeling package, and the results are valuable information for potential implementation of this solution.

Conservation and Land Management 3 – Increase Tree Canopy, Continued	
Technical and Financial Resources Needed	**Estimated Costs and Funding**
Technical resources needed for this solution include the existing programmatic resources and staff expertise of the partners identified above. Additional i-Tree modeling may be used to further refine benefits of tree canopy increases at varying locations or percentage increases in canopy. The Partnership will rely on Texas A&M Forest Service, local NGOs, USDA NRCS, and other subject experts for identifying opportunities and potential funding sources. The Partnership will seek to coordinate with existing large-scale planting programs and flood mitigation efforts, including those of the Harris County Precinct 4 to take advantage of existing organizational capacity. Financial resources needed for this solution include the staff resources to manage tree plantings or restoration projects, and the physical costs of the materials for these efforts.	Cost estimates are variable depending on the type and size of forestry practice implemented. Tree costs vary greatly by size, with stock material and labor for a single planting of a 5-gallon tree potentially costing $100 for a small-scale effort, with a large economy of scale for greater efforts that involve cost saving measures like volunteers and corporate donations. Funding resources include a wide variety of grant resources including existing operating resources of flood control entities, forestry agencies, and other technical experts. Potential funding sources should consider the related flood mitigation impacts and associated funding sources that may be available.
Bacteria Reduction Capability	
This solution's efficiency will vary greatly based on the type, and extent of tree planting or restoration practice, its proximity to the riparian areas of the watershed, and the nature of the surrounding land use. Nutrient/sediment removal may be a greater benefit than bacteria removal based on existing literature regarding riparian buffers and tree benefits in general. However, as nonpoint sources are a leading cause of *E. coli* loads in the watershed, and tree benefits include stormwater flow reductions, additional trees should provide a benefit.	

The watershed has extensive existing conservation activity, with the Bayou Land Conservancy maintaining large preserves in the downstream area, local governments like Harris County who have done extensive work on public lands adjacent to the riparian, and a network of other NGOs and local partners. Ongoing efforts by these and other partners form the backbone of conservation efforts in the watershed and are an important aspect of water quality and flood mitigation efforts.

Developers in the watershed stand to play a large role in the future use of natural systems for water quality and flood mitigation. Specific focuses of these voluntary conservation measures include developing wetland areas in wet or dry detention facilities or including wetland plantings in floodplain mitigation ponds along the corridor. Wetland areas in detention or mitigation facilities can add water quality improvement using existing infrastructure. In large master-planned communities, the ability or desire to use

floodplain mitigation ponds as wetland structures would add appreciable water quality benefit without requiring additional land. The Partnership recommends continued exploration with public and private partners into opportunities to expand required elements with voluntary, incremental improvements that benefit water quality. These recommendations are also relevant for the Urban Stormwater 4 – Promote Low Impact Development recommendation to the extent existing facilities in developed areas can add natural elements.

Illegal Dumping 1 – Report Chronic Dump Sites and Consider Increased Enforcement			
Purpose: To reduce trash in waterways at chronic dump sites by encouraging reporting and increased enforcement.			
Description: This solution is intended to augment existing county and local efforts to reduce illegal dumping in the following ways: • Encouraging reporting (see Section 6 for outreach elements) • Coordinating between the Partnership and local enforcement to ensure reporting for sites • Consider using cameras to identify dumpers[42] The solution targets the downstream area, where problem areas were identified by the stakeholders. The primary focus of this solution is chronic dump sites, with emphasis on those adjacent to or near waterways. 			
Responsible Parties	**Period**	**Contaminant(s) Addressed**	**Status**
Counties; Local Governments; H-GAC; Landowners	Ongoing-2030	Trash	New and expanded efforts
Technical and Financial Resources Needed			**Estimated Costs and Funding**
Technical resources needed for this solution are local enforcement capacity, especially through the counties, to respond to reports and enforce violations. Enforcement capacity already exists in the watershed. Technical resources for potential camera-based enforcement would require staff capacity to install, operate and maintain the cameras. The camera systems are relatively simple to install and operate and are assumed to be within existing staffing capacity. Financial resources needed for this solution include staff time for local enforcement (variable) and costs of camera technology, which may be eligible for existing solid waste grant programs through H-GAC and other sources.			Cost estimates include the incremental costs to local enforcement, which will be dependent on extent of use; Prior camera programs have spent approximately $500- $1,000 a unit for high end equipment and maintenance. Funding sources include local government revenues and solid waste grant programs.
Bacteria Reduction Capability			
This solution is not expected to directly address bacteria, although it may be an ancillary benefit.			

[42] While not currently funded, H-GAC and other local partners have successfully utilized camera systems for illegal dumping curtailment in the past. The relatively low cost of camera systems provides an efficient way to monitor problem areas.

Flooding 1 – Coordinate with Ongoing Flood Mitigation Efforts

Purpose: To promote water quality elements in flood mitigation projects and share resources among adjacent efforts.

Description: Flooding is a common issue in the Spring Creek Watershed. In addition to area-wide studies by the USACE and Harris County Flood Control District[43], there are several flood mitigation projects underway such as the Harris County Flood Control District's 2018 Bond Program projects[44].

This solution focuses on areas where flood planning and projects are active and seeks to coordinate WPP efforts with flood mitigation efforts, including the promotion of water quality elements or considerations in these projects. The Partnership will seek to coordinate with new development on water quality features for drainage and detention, as appropriate.

Responsible Parties	Period	Contaminant(s) Addressed	Status
Harris County Flood Control District; Special Districts; Local Governments; Counties; NGOs	Ongoing-2030	Bacteria, Nutrients, Sediment, Flooding	Current and expanded efforts

Technical and Financial Resources Needed	Estimated Costs and Funding
Technical resources needed for this solution are primarily found on the flood mitigation entities' side, with the primary WPP role being to coordinate water quality efforts with their work. Continued facilitation of the Partnership would help provide those technical skills, but local technical partners like the Harris County Flood Control District are already actively engaged in these projects. Other potential points of coordination include the Regional Flood Mitigation Committee[45], and the newly formed San Jacinto River Regional Flood Planning Group. Financial resources needed for the Partnership's role are primarily staff time for coordination.	Costs estimates are limited to staff time, scaled as necessary to coordinate effectively with the intended efforts. This is conservatively estimated at approximately 10-20 staff hours per year. Funding sources include new grants for WPP implementation (CWA §319(h), etc.) or local partner contributions.

Bacteria Reduction Capability

This solution is expected to directly and indirectly address fecal waste and other water quality concerns, although it may be a wholly ancillary benefit. Rates of reduction from detention facilities and other flood mitigation projects will vary widely based on the project type. However, several studies[46] have shown appreciable impacts of wet bottom detention and other mitigation practices that incorporate natural infrastructure of natural elements on nutrients and, to a lesser degree, *E. coli*.

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[43] Including the San Jacinto Regional Watershed Master Drainage Plan. More information on these efforts can be found at: https://sanjacstudy.org

[44] The updated status of projects under the 2018 Bond Program can be found at: https://www.harriscountyfemt.org/cb

[45] http://www.h-gac.com/board-of-directors/advisory-committees/regional-flood-management-committee/default.aspx

[46] Including studies from North Carolina (http://lshs.tamu.edu/docs/lshs/end-notes/indicator%20bacteria%20removal%20in%20stormwater%20bmps%20in%20charlotte,%20nc-3678140698/indicator%20bacteria%20removal%20in%20stormwater%20bmps%20in%20charlotte,%20nc.pdf), and Virginia (Clary, J., R. Pitt, and B. Steets, eds. 2014. *Pathogens in Urban Stormwater Systems*. Reston, VA: ASCE. 289 pp.), among others.

H-GAC and other local partners have an active role in both water quality and flood mitigation programs and will continue to seek opportunities to represent water quality concerns in efforts to curb flooding. The Partnership will specifically seek to identify funding opportunities under several of the large disaster mitigation resources available currently and for the short term, including:

- Community Development Block Grants (mitigation funding opportunities related to 2015, 2016, and Hurricane Harvey competitions),
- Texas Water Development Board Flood Infrastructure Fund, and
- Various Federal Emergency Management Agency (FEMA) disaster mitigation programs.

Solutions Summary

The recommended solutions presented in this section are intended to meet the *E. coli* reduction goals defined in Section 4 and to also reduce nutrient sources, or to address other local water quality concerns not specifically related to the primary pollutants. The solutions represent a variety of options for each primary source, that will be scaled to address the number of representative units identified for each source, in each attainment area.

These recommendations were developed and vetted by a diverse stakeholder group as part of a locally led decision-making process. However, the WPP recognizes that additional efforts are ongoing in the watershed that will be complementary to the recommended solutions. These recommendations are not intended to be exclusive of other potential stakeholder projects and efforts that serve the same goals. They represent areas of overlapping concern and agreement among the various interests of the Partnership. It is expected that the toolbox of solutions will change over time as part of local priorities and the adaptive management process.

Further efforts to engage and educate the public are reflected in Section 6, and specifics about the timelines and logistics of implementation are discussed in Section 7.