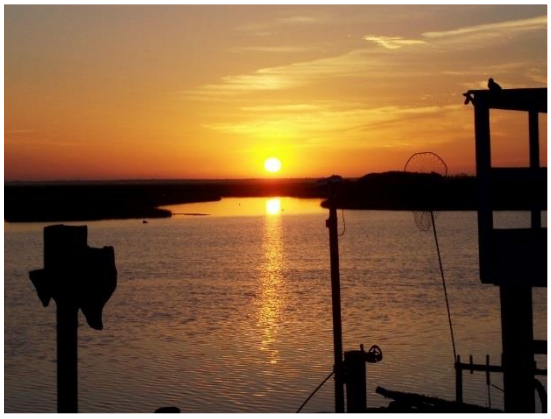
Water Quality Planning for the Houston-Galveston Region

Water Quality Management Plan Update, FY 2017

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Houston-Galveston Area Council

TCEQ

EPA United States Environmental Protection Agency

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Prepared by the Houston-Galveston Area Council, in coordination with the Texas Commission on Environmental Quality. This project was funded under a Clean Water Act Section 604(b) grant; TCEQ contract number 582-17-70167.

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Acronyms

ARRA	American Recovery and Reinvestment Act
BMP	Best Management Practice
CCP	Coastal Communities Program
CWSRF	Clean Water State Revolving Fund
DMR	Discharge Monitoring Report
EPA	United States Environmental Protection Agency
FOG	Fats, Oils, and Grease
GBEP	Galveston Bay Estuary Program
GIS	Geographic Information System(s)
H-GAC	Houston-Galveston Area Council
HHW	Household Hazardous Waste
MPN	Most Probable Number
MUD	Municipal Utility District
NPS	Nonpoint Source
OLD	Outfall Location Dataset
OSSF	On-Site Sewage Facility
PCB	Polychlorinated Biphenyl
PCR	Polymerase Chain Reaction
PER	Preliminary Environment Report
PID	Permit Information Database
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
SABD	Service Area Boundary Dataset
SAS	Statistical Analysis Software
SBWPP	San Bernard Watershed Protection Plan
SEP	Supplemental Environmental Project(s)
SRF	State Revolving Fund
SSO	Sanitary Sewer Overflow
TCEQ	Texas Commission on Environmental Quality
TEHA	Texas Environmental Health Association
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
WCID	Water Conservation and Improvement District
WQMP	Water Quality Management Plan
WPP	Watershed Protection Plan
WWTF	Wastewater Treatment Facility

Executive Summary

This report summarizes Contract 582-17-70167 (Project), a 604(b) project administered by the Texas Commission on Environmental Quality (TCEQ). The Project entailed a series of five (5) data collection, special study, and coordination activity objectives, listed as Objectives two through six below,[1] completed by the Houston-Galveston Area Council (H-GAC) in conjunction with the TCEQ. The purpose of these activities is to provide data and analysis regarding wastewater infrastructure, watershed planning, and sources of nonpoint source (NPS) pollution that impact water quality in the 13-county Houston-Galveston Region (Region) of the Upper Gulf Coast of Texas. This document[2] is a summary of the results of these efforts, and a discussion of future needs.

Objective 2 – Quality Assurance – This objective involved the maintenance of the project Quality Assurance Project Plans (QAPPs): the Regional Water Quality Data Acquisition and Compilation QAPP (Data QAPP) for the collection and assessment of the various data sources described under Objective 3; and the Regional Geospatial Data QAPP (Geospatial QAPP) for the collection and analysis of geospatial data as described in Objective 6 (Subtasks 6.1 and 6.2 related to OSSF database maintenance). The following tasks were completed:

- A **QAPP discussion** was held (as part of a general post-award meeting) on 9/16/2016 between H-GAC and TCEQ staff, along with continuing conversations throughout the Project term.
- A new version of the **Geospatial QAPP** was developed, approved, and disseminated.
- Annual Reviews of the **Data QAPP** were completed and submitted by H-GAC, and approved by TCEQ and EPA.

Objective 3 - Wastewater Data Update and Coordination – Objective 3 of this Project involved the acquisition and analysis of wastewater infrastructure and permit data, the review of Clean Water State Revolving Fund (CWSRF) applications for compliance with regional data and aims, and coordination of regional watershed management efforts. The following tasks were completed:

- Datasets containing spatial information related to **WWTF service area boundaries** and **permitted outfalls** were updated and amended to reflect changes and better reconcile with other related datasets (Task 3.1).
- **WWTF permit information** was updated through 4/28/17 using TCEQ online databases. A total of 1,216 permits were reviewed for outdated or erroneous data, and then compared against the service area boundaries and outfall location datasets. Staff

[1] These five water quality objectives are Objectives 2-6 of the Project. Objective 1 – Administration, and Objective 7 – Final Report are not discussed separately, but are referenced in relation to other Objectives.
[2] Due to size and length considerations, some documents or deliverables are provided in digital format, as noted in the Report.

reviewed updated TCEQ online databases to identify points of redundancy to address in future projects.

- H-GAC acquired and analyzed **discharge monitoring report (DMR)** and **sanitary sewer overflow (SSO)** data from regional permitted facilities for bacteria discharges and overflow frequency (Task 3.2). Violation rates for a total of 762 permittees with DMR *E.coli* limits were analyzed and the rate of SSO events, volumes, and causes were analyzed for reports submitted between 2011 and 2016. Based on the analyses performed, WWTF effluent discharges were not found to be a significant driver of regional bacteria impairments while SSOs pose a disproportionately higher risk to human health during recreation, and their episodic nature can make them an acute risk while they are ongoing. A detailed account of the results and findings from DMR and SSO analyses are included in the DMR and SSO Data Analyses Summary Report in Appendix B.
- H-GAC reviewed **four** applications to the **State Revolving Fund** (SRF), and provided formal comment to the TCEQ (Task 3.3).

Objective 4 - Support Watershed Planning– Objective 4 involved support of watershed planning in the San Bernard River watershed and general coordination and support for regional watershed and water quality efforts. The following tasks were completed:

- Continued **stakeholder coordination** for the San Bernard WPP project was facilitated by H-GAC. H-GAC staff gave their project updates at key partner meetings and through outreach at local events rather than a single stakeholder meeting. A primary effort of this year was coordination of revisions to the San Bernard WPP with TCEQ and EPA, resulting in a final revised submission for EPA consideration (Task 4.1).
- H-GAC provided general **watershed/water quality management coordination** through the staffing and facilitation of the Natural Resources Advisory Committee (NRAC), coordination of data and efforts with ongoing Total Maximum Daily Load (TMDL) and Watershed Protection Plan (WPP) projects, sending liaisons to a variety of local water quality and watershed organizations including the Galveston Bay Estuary Program's Water and Sediment Quality and Monitoring and Research subcommittees, and coordinating efforts between other H-GAC environmental efforts and this Project (Task 4.2). In conjunction with Task 3, H-GAC fulfilled several project data requests for regional stakeholders, including the Bayou Preservation Association, the Galveston Bay Foundation, and local governments.

Objective 5 – Coastal Nonpoint Source Program Coordination – For the fifth objective, H-GAC's primary areas of focus were representing small coastal communities in planning for nonpoint source reduction needs and providing direct support to participants. A program website was maintained to host model materials, funding resources, and other pertinent information. The following tasks were completed:

- H-GAC facilitated continued **program maintenance** for the Coastal Communities project through materials disseminated by email and/or its website. (Tasks 5.1).

- H-GAC maintained **a program website**[3] to host program resources, funding opportunities, and related information relevant to our program participants (Task 5.1).
- H-GAC **provided coordination and resource support services** to program participants and other small coastal communities through education and outreach to coastal residents at local events (Bay Day Festival, Nurture Nature Festival, World Oceans Day, Trash Bash – Bastrop Bayou) and through H-GAC led programs (in conjunction with Task 6, TSSWCB project 15-10, implementation of the Cedar Bayou WPP, and TCEQ umbrella contract 582-14-42709, implementation of the San Jacinto-Brazos and Brazos-Colorado Coastal Basin TMDLs) (Task 5.2).

Objective 6 - OSSF Database Update – In fulfillment of Objective 6, H-GAC updated and expanded an existing GIS database of regional on-site sewage facility (OSSF) locations and a spatial projection of likely locations for unpermitted systems[4]. The following tasks were completed:

- The **OSSF location database** was updated with new data received through 5/31/17 (Task 6.1). A total of 4,427 of new permitted systems were added to the database during this project period.
- **Unpermitted OSSF data** was analyzed and updated by H-GAC staff based on the most current versions of the OSSF datasets. (Task 6.2)
- H-GAC staff held a series of **OSSF Visual Inspection** trainings for residents and real estate inspectors (in conjunction with other projects).

Downstream of WWTF outfall at Canal C-147 in southeast Houston

[3] www.coastalcommunitiestx.com

[4] These data collection and analysis activities took place under the auspices of the H-GAC Regional Geospatial Data QAPP.

Introduction

This document is the culminating report for the fiscal year 2017 efforts conducted under 604(b)-funded Contract 582-17-70167 (Project) between the H-GAC and the TCEQ. The Project involved acquiring, compiling and evaluating water and wastewater data, and a series of special studies and coordination activities. The purpose of the Project is to support current and future planning decisions concerning water quality efforts, wastewater infrastructure development, watershed management, coastal nonpoint source management, and related issues on both a regional and state level.

The 13-county Houston-Galveston Area Region (Region) has a variety of water quality concerns and developmental challenges. The majority of our local water bodies are impaired under state water quality standards, and our developmental patterns have resulted in a relatively patchwork and diffuse network of wastewater infrastructure. With population expected to expand dramatically in the coming decades, the ability to make informed decisions regarding water quality and wastewater infrastructure development will be a key tool in planning for the Region's future. The background of this Project is discussed in the **Project Significance and Background** section. The efforts summarized in this document serve to advance these purposes through a series of specific studies and the maintenance of regional datasets for local use and in support of the state's Water Quality Management Plan.

This report will focus on the progress achieved in the five primary objectives[5] set forth in the Project:

- Quality Assurance
- Wastewater Data Update and Coordination
- Support Watershed Planning
- Coastal NPS Program Coordination
- OSSF Database Update

Each of these primary tasks serves to maintain, expand or implement the H-GAC's store of water quality and wastewater infrastructure data, or provide related services to the Region. Each objective is explained in greater depth later in the **Project Studies and Coordination Activities** section.

The Project required a series of interim deliverables related to these tasks. A description of the methodologies used to fulfill the deliverables is provided in the **Methods** section. Some of the deliverables are generated as large electronic datasets, unsuitable for full inclusion in a printed version of this final report[6]. However, representative pieces of each deliverable are included, and all Project outcomes are discussed in the **Results and Observations** section. The synthesis

[5] Objective 1 (Project Administration) and Objective 7 (Final Report) are not specifically reported on in this document, as they relate only to the maintenance of the contract and the development of this document.
[6] Copies of these electronic data are contained within the media that accompanies this report, and have been provided under separate cover.

of the information gathered and tasks implemented under this Project are discussed in the **Discussion** and **Summary** sections. Additional information and standalone reports completed for some deliverables are provided in the **Appendices.**

Photo of Rummel Creek located in west Houston

Project Significance and Background

Background

As the Houston region continues to grow, development and its accompanying infrastructure and pollution challenges continue to expand into counties beyond the urban core. At the same time, existing infrastructure has continued to age and has faced challenges related to drought and flooding events. With several million more residents expected by 2040, these challenges will only be exacerbated by future population growth.

The majority of the stream segments in the Houston area are listed on the State of Texas's list of impaired water bodies[7]. Approximately 80% of the Region's stream segments are unable to meet one or more state water quality standards. Bacteria impairment in excess of the contact recreation standard continues to be the most pervasive water quality issue in the Region. Other development related issues like low dissolved oxygen, PCBs, and dioxins are also present in some water bodies. Bacteria contributions into our lakes, creeks, streams, bayous, and bays come from a variety of sources including human waste, domestic animal waste, pet waste, and wildlife. These wastes may enter the water through point sources, i.e. discrete "end of pipe" discharges, or diffusely through nonpoint sources, carried in precipitation flowing over the land. While some bacteria are naturally occurring, careful planning is key to managing additional bacterial sources that will come with expanded development.

The wastewater infrastructure that serves the Region's increasing population has expanded and developed much like the Region itself. The availability to fund infrastructure through political subdivisions like Municipal Utility Districts (MUDs) and other special districts allowed for a wastewater treatment network that is relatively widespread and diffuse rather than limited by the bounds of a traditional, centralized model. The resulting patchwork of regional wastewater infrastructure development offers both future challenges and opportunities for local decision-makers. The accumulation, maintenance and application of wastewater and effluent quality data can help inform regional solutions to these challenges.

Under previous 604(b) projects, H-GAC has sought to address aspects of the information and data needs related to the water quality issues that face the Region. These projects have typically been a mix of ongoing efforts and short term special studies. Some of the project efforts have been continuous (wastewater data collection and maintenance, etc.) while others have been standalone research efforts relating to specific data needs or questions (GIS analyses for infrastructure consolidation, Phase II stormwater permit implementation, etc.). This balance allows the long term accumulation of data while retaining flexibility to address specific issues. The ongoing efforts in the FY17 Project focused on the acquisition and analysis of regional wastewater infrastructure data and spatial datasets of OSSF locations, management of

[7] The list of impaired water bodies is part of the State's Integrated Report of Surface Water Quality (for the Clean Water Act Sections 305[b] and 303[d]). The current (2014) report can be accessed online at https://www.tceq.texas.gov/waterquality/assessment/14twqi/14txir

nonpoint source support to small coastal communities, and coordination of local watershed protection planning. Short term/special study efforts include facilitating watershed planning efforts for the San Bernard River, a regional priority watershed.

Significance

From a regional perspective, the water quality and wastewater infrastructure decisions facing our local areas are more effectively considered on a watershed basis, as contaminants do not adhere to political boundaries along waterways. This is especially important for watersheds that serve as significant drinking water sources, like Lake Houston. In order to provide useful information and viable recommendations, a large store of relevant and accessible data is necessary.

The data collection and analysis tasks completed under this Project have significant value for a variety of efforts in the Region, benefitting local watershed protection planning, wastewater infrastructure planning, and program development.

The significance of the efforts undertaken in this Project is demonstrated by the variety of capacities in which the outcomes are used:

- **Internal data acquisition/collection and regional data sharing** – The wastewater permit data, service area boundaries, and OSSF location data acquired/collected under this Project serve to augment existing datasets, inform project decisions on related efforts, and expand internal abilities of both the H-GAC and TCEQ to incorporate and produce future data and analyses. For example, this year's data was used by the Houston-area Bacteria Implementation Group (BIG) and Basins 11 and 13 TMDL efforts; the West Fork Watershed WPP; the San Bernard WPP; the Cedar Bayou WPP; the West Fork Greenprint project by the Trust for Public Land; the Clean Rivers Program; the BIG's Top Five Most and Top Five Least Impaired Water Bodies project; and in the planning activities of a variety of local governments and organizations.
- **Regional project coordination** – Maintaining and expanding regional data resources allow the H-GAC and TCEQ to better understand and facilitate regional efforts between parties involved in wastewater infrastructure decisions, and general water quality/watershed protection efforts (WPP and TMDL efforts, etc.). Participation in regional groups and efforts helps ensure decisions benefit from project resources and expands the reach of the project's aims through partner efforts.
- **Source water protection** – A large portion of the Region's population is served by treated surface water that originates in our local rivers and lakes. The infrastructure planning and watershed coordination activities of this Project fostered greater understanding of the issues facing surface water drinking sources.
- **Project review** – Data and analyses allow H-GAC Project staff to assist state and federal granting agencies in review of regional grant applications. These reviews ensure that potential projects concur with regional priorities and regional data projections.

- **Education and outreach** – Data gathered under this project has been used as a focal point or basis for several educational efforts, including the OSSF location database, and various facilitated meetings like the ongoing Natural Resources Advisory Committee.
- **Coastal NPS program development**– The continuation of the Coastal Communities Program focuses on supporting efforts by the participating communities and other small coastal communities to access resources and support to reduce point source and NPS issues.

Stakeholder discussions at a San Bernard WPP meeting

Project Studies and Coordination Activities

This section details the background, process, and outcomes for the five Objectives that represent the component efforts of this year's Project studies and coordination activities *(Objectives 1 and 7 of the Project are administrative tasks and WQMP Update requirements, and therefore are not reported on this document).*

Objective 2: Quality Assurance

This objective includes tasks related to maintenance and update of two existing Quality Assurance Project Plans (QAPPs): the Regional Water Quality Data Acquisition and Compilation QAPP (Data QAPP) for acquisition and assessment of TPDES permit data and related information as part of Objective 3; the Regional Geospatial Data QAPP (Geospatial QAPP) for the collection and analysis of geospatial data as described in Objectives 4 and 6.

The purpose of this objective is to ensure all data are collected and analyzed in a manner appropriate for the data objectives of the Project.

Task 2.1 – QAPP Planning Meeting

H-GAC Project staff and TCEQ formally discussed the QAPP needs for the project as part of a project kickoff conversation on 9/16/2016 after the initiation of the contract. The outcome of the meeting was a confirmation of the elements covered by each QAPP and a briefing for TCEQ staff on the project background. Informal discussions regarding the maintenance and update of the QAPPs occurred continuously throughout the project term, including the annual certification for both QAPPs.

Task 2.2 – QAPP Annual Review Certification

An annual review certification for the Data QAPP was approved by TCEQ on 3/30/2017. The annual certification for the Geospatial QAPP was approved by TCEQ on 8/8/2017. Other updates and revisions to the existing QAPPs were made as part of Task 2.3.

Task 2.3 – QAPP Amendments

H-GAC amended the Data and Geospatial QAPPs for content and for annual certification. The revised versions were submitted and approved by TCEQ. A new version of the Data QAPP was developed, approved, and implemented on 4/3/17. A new version of the Geospatial QAPP was developed, approved, and implemented on 8/7/17.

Objective 3: Wastewater Data Update and Coordination Geographic Information System (GIS)

This objective includes tasks related to wastewater infrastructure data acquisition, dataset updates, and SRF project proposal reviews.

H-GAC maintains a series of datasets related to TPDES-permitted wastewater infrastructure facilities in the region. They are the **Service Area Boundaries Dataset (SABD)**, and the **Outfall Locations Database (OLD)**. A primary task under this Project is to update and continue to integrate these data sources.

Task 3.1 – GIS Data

The SABD is the spatial representation of the wastewater dischargers' service area boundaries. Typically, this boundary data includes municipalities, public districts (MUDs, WCIDs, etc) and private utilities. The OLD is a companion dataset to the SABD, and identifies the location of wastewater treatment facility (WWTF) outfalls for the Region. H-GAC GIS staff uses data from MUD records and EPA and TCEQ permit databases to update the SABD and OLD datasets.

The data was checked for consistency across all outfalls of a single permit, and for consistency across all permits. It should be noted that while the SABD are integrated for those WWTFs that have boundaries, a 1:1 ratio is not possible as boundaries do not exist for the majority of industrial permits (which may serve a single parcel, and do not have traditional boundaries, but do have outfall locations).

The updated versions of the SABD and OLD are included in digital format on the media accompanying this report. The OLD update generated a total of 9 new permits through April 2017.

Additionally, staff conducted an integration review after incorporating the most recent version of EPA and TCEQ data during this project period. As part of the review process, project staff compared the existing dataset with the most current EPA and TCEQ datasets to identify and resolve any discrepancies. Based on the review, H-GAC generated a list of discrepancies for TCEQ's review. The primary source of discrepancies was duplicate records in TCEQ's data or typos in permit numbers (6 records); or errors in region assignments (17 records).

Task 3.2 – Wastewater Data Analyses

In addition to the SABD and OLD, H-GAC also acquired DMR data for regional permitted facilities to evaluate bacteria permit limit exceedances between the period of 2012 to 2016. SSO data was also acquired and analyzed for the region to evaluate areas with high or frequent SSO activity between 2011 and 2016. The DMR and SSO data was acquired through TCEQ and EPA and analyses for this task included:

- An evaluation of SSO events and estimated volume by cause for the region.

- Assessment of the frequency of DMR bacteria violations by WWTF plant size.
- Development of an SSO density map for the region by watershed.
- Development of a DMR bacteria violation density map by watershed.

The analyses and maps generated for this task are included in digital format on the media accompanying this report. A summary and discussion of analyses results is included as a separate report in Appendix B.

Task 3.3 - State Revolving Fund

In conjunction with H-GAC's role as a regional planning group and the council of governments for the Houston-Galveston area of the Upper Gulf Coast, staff regularly provides comment on grant proposals of varying types. These reviews help to assure that regional goals were represented in project funding decisions at a variety of governmental levels.

H-GAC reviews the grant applications and associated engineering documentation (PER, Environmental Review, population projections) for concurrence with regional planning goals. Specifically, staff looked for:

- Population projections that matched TWDB, H-GAC or other relevant forecasts
- Consideration of alternatives that may impact water quality considerations
- Concurrence with regional priorities and goals (water quality impacts, etc.)

As part of this Project, H-GAC staff used data gathered under this and previous projects to provide comment on **four (4)** State Revolving Fund (SRF) projects for the TCEQ. The outcomes of the reviews are shown in Table 1 below.

Table 1 – FY2017 CWSRF Projects Reviewed by H-GAC

Granting Agency	Project ID#	Requesting Entity	Project Summary	Findings	Notes
TWDB CWSRF	73736	City of Anahuac	Collection system and WWTF Improvements	Support, with comments	Sent letter of support.
TWDB CWSRF	73742	City of Houston	Rehabilitation of existing sewer infrastructure	Support, with comments	Sent letter of support.
TWDB CWSRF	73740	City of Montgomery	Expansion and rerouting of lift stations	Support	Sent letter of support.
TWDB CWSRF	73764	San Jacinto River Authority – Woodlands Division	Improvements to the Woodlands wastewater system	Support, with comments	Sent letter of support.

Objective 4 - Support Watershed Planning

Objective 4 provides targeted support for ongoing source water and watershed planning in priority watersheds of the region. The efforts under this objective include continued stakeholder group maintenance for the San Bernard River Watershed and its WPP (Task 4.1) and general coordination with other regional water quality efforts (Task 4.2).

4.1 – San Bernard River WPP Coordination

H-GAC has established a WPP effort in the San Bernard River Watershed through previous ARRA/319(h) grants from the TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB). During this project, staff worked with TCEQ to revise the WPP and to maintain an active and engaged stakeholder base. Due to ongoing WPP revisions and review, H-GAC staff gave their project update through presentations at key partner meetings, a watershed stakeholder meeting, and through outreach at local events. Additionally, H-GAC coordinated efforts and communication with stakeholders engaged in reopening the mouth of the San Bernard River (a priority concern for the project stakeholders). Speaking engagements, events, and efforts related to this subtask are summarized in Table 2.

The San Bernard WPP was given final EPA approval in July of 2017. Subsequent project terms will support implementation of the approved WPP.

Table 2 – San Bernard River Stakeholder Events

Date	Event	Participation
Various	NRAC	H-GAC gave intermittent brief updates to the NRAC on the WPP progress at quarterly meetings.
Various	WPP revisions	H-GAC revised the WPP in response to TCEQ and EPA rounds of comments.
Various	GBEP	H-GAC provided San Bernard updates as part of project updates at the GBEP Water and Sediment Quality subcommittee meetings.
11/30/2016	Watershed Stakeholders Meeting	H-GAC met with local stakeholders to discuss the San Bernard project status, WPP revisions, and other local projects.
6/10/2017	World Oceans Day	H-GAC maintained a booth at the nature-oriented festival representing H-GAC water quality projects, including the SBWPP.
7/11/2017	Texas Watershed Steward Workshop	H-GAC staff provided updates on the SBWPP at this Texas A&M AgriLife Extension Service led event. Event was held at the Brazoria County Fairgrounds within the San Bernard watershed area.

Date	Event	Participation
7/26/2017	Texas Watershed Coordinator Roundtable	H-GAC staff presented information about the SBWPP at this Texas Water Resources Institute and Texas A&M Institute of Renewable Natural Resources led event in College Station.

Task 4.2 - Coordination

As an extension of H-GAC's role as a coordinator of regional planning efforts in a variety of fields, project staff members develop and maintain relationships with other local and state governments, community groups, and other organizations involved in efforts related to the aims of this Project.

Staff members facilitate the H-GAC's Natural Resources Advisory Committee, which provides policy recommendations for the H-GAC's Board of Directors, and serves as a regional roundtable for coordinating environmental efforts. The NRAC provides an efficient communication network and point of contact for H-GAC staff with other local and regional water quality decision makers. Four (4) meetings were held during the Project term. Topics discussed at these meetings included an update on the San Jacinto Waste Pits and PCB/Dioxin contamination, a summary of the Galveston Bay Report Card, and an overview on urban pollinators (November 2016); urban forestry efforts in the region (February 2017); Low Impact Development (LID) and examples of innovative water quality and stormwater improvement projects (May 2017); and on-site sewage facility (OSSF) impacts to water quality and current management practices (August 2017). Legislative updates were provided to NRAC members on a regular basis throughout the legislative session and initiation of a new Innovation in Water Quality Award program is currently under development by the NRAC. This award program will recognize projects and programs in the region that help improve water quality conditions through innovative water infrastructure projects and improvements. The first award ceremony will take place during the FY2018 project term.

Project staff members also routinely attend meetings of, or otherwise support, a variety of other organizations involved in water quality efforts. This project term, staff helped coordinate activities with a wide variety of organizations. An example of these groups that staff worked with this year includes:

- Coordination with the Clean Rivers Program on the development of the Basin Highlights Report.
- Promotion of OSSF data collection efforts relating to Objective 6, and other water quality efforts through presence and speaking engagements with a variety of conferences including the Texas Environmental Health Association Sam Houston Chapter annual meeting, Montgomery County's OSSF workshop, Texas Watershed Stewards trainings, the Texas Watershed Coordinators Roundtable, and other watershed coordinator meetings at the local and regional level.

- The Galveston Bay Estuary Program – Water and Sediment subcommittee membership and leadership (Justin Bower is vice-chair of the Committee); Monitoring and Research subcommittee membership (Jean Wright), and attendance at other subcommittee and Council meetings.
- A variety of interactions with state and local policy and regulatory efforts (including coordination with ongoing TMDL, WPP, and other efforts). Some projects of specific note are:
    - Bacteria Implementation Group (BIG), East and West Forks of the San Jacinto River, San Jacinto-Brazos Coastal Basin, Brazos-Colorado Coastal Basin, and Upper Oyster Creek TMDL Implementation Plans
    - West Fork Watersheds, Cedar Bayou, Bastrop Bayou, and San Bernard River Watershed Protection Plans
    - BIG's Top Five Most and Top Five Least Impaired Water Bodies Project

In addition to facilitating regional communication, coordination, and cooperation on water quality efforts through staff presence and participation, H-GAC also uses the data generated under this project to support various internal and external project needs. External requests for project data were fulfilled for the Bayou Preservation Association, the Galveston Bay Foundation, and other local governments.

Objective 5 – Coastal NPS Development

Under the FY2012 604(b) project, H-GAC initiated a Coastal Communities Program to evaluate the needs of these communities, the nexus of those needs with NPS contributions, and potential services that would serve elements of the communities' needs while alleviating NPS pollution. During this Project term, H-GAC maintained the program, but focused specifically on participating in outreach events and disseminating information about available resources, workshops and trainings, funding opportunities, and educational tools coastal communities can utilize to learn more about current water quality conditions and methods that help reduce NPS pollution.

Task 5.1 – Coastal NPS Program Maintenance

The primary focus of this year's Program effort was to make program resources and services available to the participating communities. The following services or products were delivered to the participants:

- A **program website** (www.coastalcommunitiestx.com) was maintained for disseminating information to participants. The website hosts model programmatic resources, information on funding resources (RESTORE Act, etc.), and information on events of interest. Figure 1 is a screenshot of the website landing page.
- H-GAC staff **maintained communication** with participating coastal communities through outreach events, meetings, and training opportunities held in coordination with other coastal project efforts. Table 3 summarizes all communications with coastal communities during this Project term.

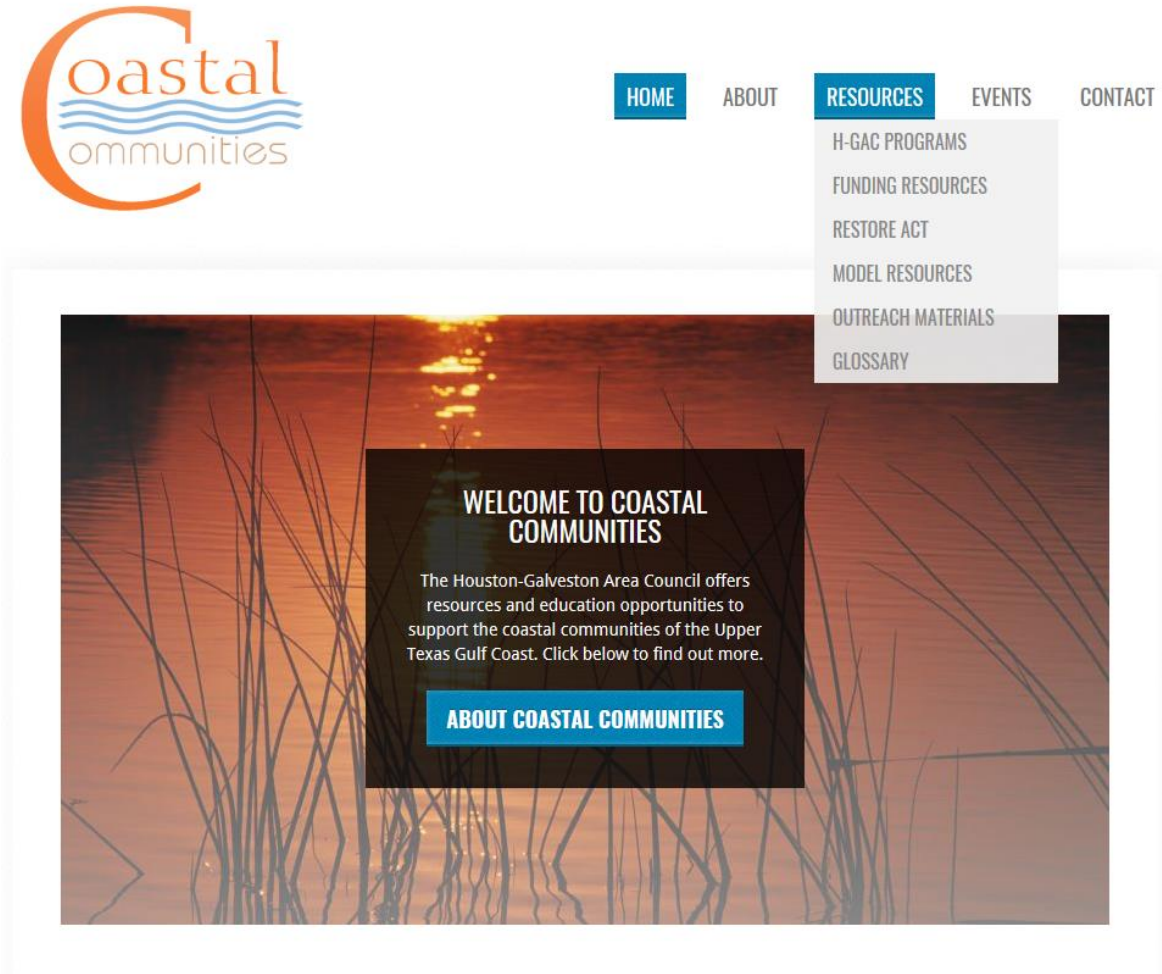

Figure 1 – Screenshot of Coastal Communities Program Website

Table 3 – Summary of communications with Coastal Communities

Date	Event/Communication	Location	Participation
12/6/2016	Public Meeting for San Jacinto-Brazos Coastal Basin (Basin 11) Bacteria Reduction Project	Brazoria County Public Library-Alvin Branch	H-GAC staff presented information about bacteria levels in Basin 11 and discussed development of a plan to address these issues.
4/8/2017	Nurture Nature Festival	Baytown Nature Center	H-GAC maintained a booth with educational materials for coastal communities. A total of 5,200 attendees participated in the event.
5/13/2017	Bay Day Festival	Kemah Boardwalk	H-GAC maintained a booth with educational materials for coastal communities. A total of 6,000 attendees participated in the event.
6/8/2017	World Oceans Day	Stewart Beach, Galveston Island	H-GAC maintained a booth with educational materials for coastal communities. A total of 125 attendees participated in the event.
7/6/2017	Coastal Communities E-Blast	Email communication	H-GAC staff sent out a Coastal Communities E-blast that included a link to the updated program website.
7/21/2017	OSSF Homeowner Visual Inspection Course	Texas A&M AgriLife Extension Service – Brazoria County	H-GAC staff presented information to homeowners about how to properly inspect and maintain OSSFs.
8/1/2017	Public Meeting for Brazos-Colorado Coastal Basin (Basin 13) Bacteria Reduction Project	West Columbia Civic Center	H-GAC staff presented information about bacteria levels in Basin 13 and discussed development of a plan to address these issues.
8/10/2017	Public Meeting for San Jacinto-Brazos Coastal Basin (Basin 11) Bacteria Reduction Project	Brazoria County Public Library-Alvin Branch	H-GAC staff presented information about bacteria levels in Basin 11 and discussed development of a plan to address these issues.

Task 5.2 – Coordination and Resource Support

H-GAC provided educational materials and promotional items to coastal partners, including GBEP, upon request during this Project term. Figure 2 illustrates examples of outreach materials and educational games that H-GAC maintains and provides to coastal communities upon request. While no individual communities took advantage of other H-GAC services during this project year, H-GAC continued to maintain relationships and investigate potential opportunities.

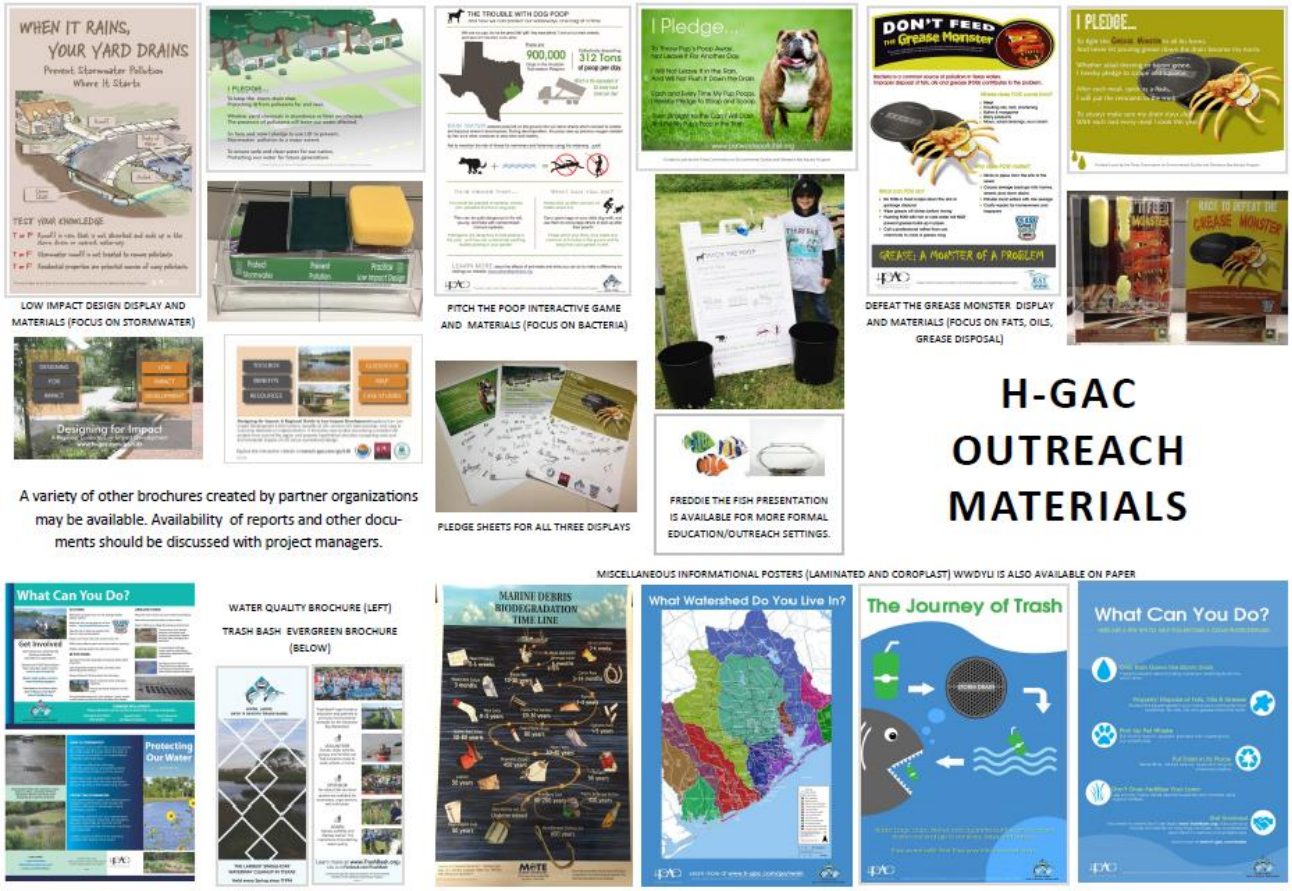

Figure 2 – Available Educational Outreach Materials H-GAC Maintains

Objective 6 – OSSF Database Update

On-Site Sewage Facilities (OSSFs), or septic systems, are a widespread wastewater treatment technology in the Region, especially in the developing counties on the Region's borders. OSSFs are relied upon for the treatment and disposal of wastewater in areas not conducive to sanitary service, but can be appreciable sources of contamination. Annually, thousands of additional OSSFs are designed, sited, and installed within the Region, especially in the rapidly developing

unincorporated areas of northern Harris and Montgomery Counties, as well as the rural counties that reside along the Region's outer boundary. While new systems are subject to permit requirements, systems installed before 1989 may be grandfathered and specific locations may be unknown. The H-GAC estimates that there are over 300,000 OSSFs within the region with only approximately one third of them being permitted systems installed after 1989.

Authority over managing OSSF permitting is designated to Authorized Agents (counties, municipalities and other responsible entities), who have traditionally kept this data in a variety of formats. To ensure a regional, uniform set of data for use by Authorized Agents and water quality planning efforts, H-GAC developed a comprehensive inventory of permitted system locations and likely unpermitted system locations under previous grant contracts[8]. During the 2017 Project, new data from the Authorized Agents and old data not previously converted were added to the OSSF permit database.

Task 6.1 – Permitted OSSF Update

The intent of the existing OSSF database is to provide a comprehensive, spatially-explicit inventory for all permitted OSSF locations throughout the region. No such inventory existed prior to the initiation of H-GAC's initial database development. The initial work had collected existing location data for permitted OSSFs and developed a program under which participating Authorized Agents would submit new system data on a regular basis, including spatial locations using GPS units provided by H-GAC[9]. This regularly updated data is available to the public though the OSSF Mapping Tool (Figure 3) found on H-GAC's website.

H-GAC added new records to the OSSF Permits Database in FY2017, and removed outdated or bad data. An additional 4,427 OSSFs were added to the database during this update covering the period through May of 2017. Table 4 summarizes the permitted OSSF data for the region based on the FY2017 update. The updated OSSF database and maps illustrating the location of new permitted systems and the density of OSSFs by county are included in the digital media attached to this report.

Our partners have been very responsive with data submittals, partly in thanks to periodic efforts (monthly emails and/or calls as necessary) to remind them to submit data. Records submitted by Brazoria County, Chambers County, Fort Bend County, Galveston County, Liberty County, Montgomery County, Waller County, and Wharton County contained latitude and longitude coordinates of the location of the system's septic or trash tank, allowing very precise siting. Permit Records received by the remaining Authorized Agents were geo-referenced, or identified on a map, by the permit address. Project staff worked directly with several Authorized Agents to improve their data quality and submissions. However, for the most part data transmittal was efficient.

[8] The effort was initiated in an ARRA grant (Federal ID #96690301), and continued in previous years' 604(b) projects.

[9] Further information about the development of the database, the methodologies employed, and previous efforts can be found in the FY2012-FY2016 604(b) Final Reports and the Geospatial QAPP.

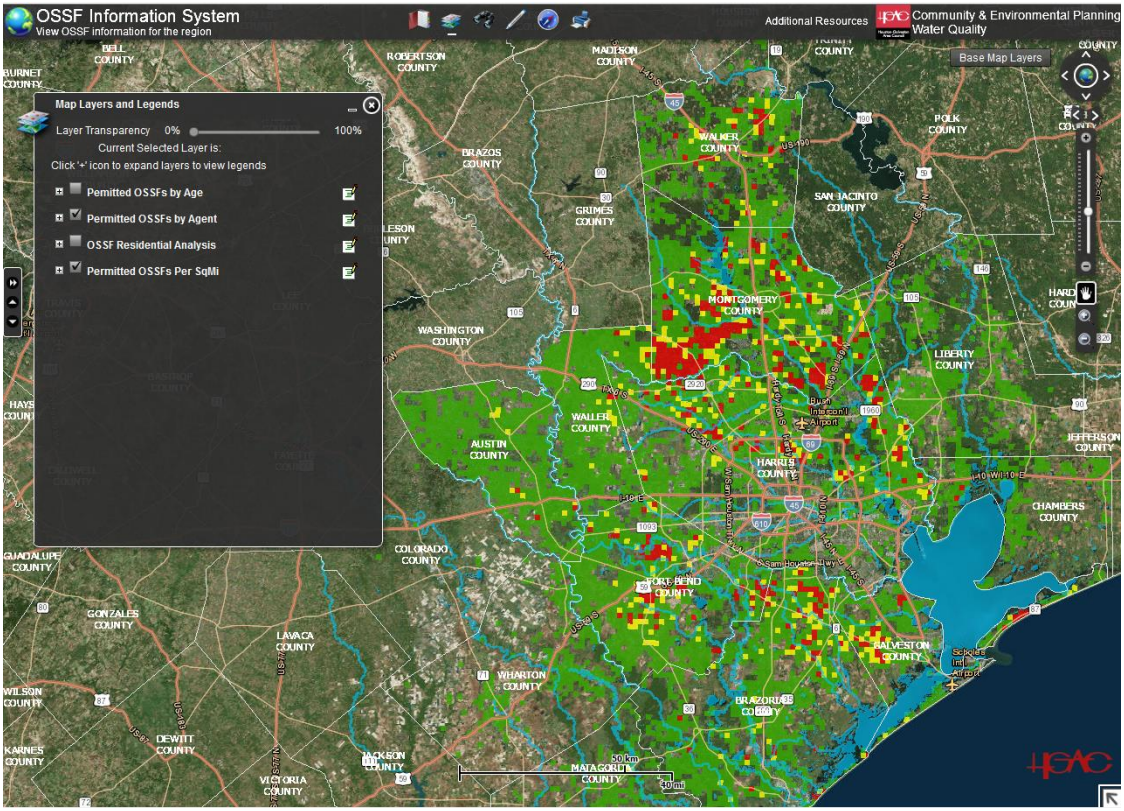

Figure 3 – Screenshot of H-GAC's OSSF Mapping Tool Website

Table 4 – Summary of permitted OSSFs by County

County	Number[1] of OSSFs	2017[1] Update	System Type			
			Conventional	Aerobic Treatment	Other	Unknown
Austin	3,290	116	203	-	184	2,903
Brazoria	12,126	517	-	1,726	63	10,337
Chambers	1,060	153	1	494	5	560
Colorado	712	117	312	217	171	12
Fort Bend	10,807	342	33	1,296	-	9,478
Galveston	5,569	593	141	1,535	63	3,830
Harris	17,502	494	-	17,502	-	-
Liberty	985	16	1	365	11	608
Matagorda	1,257	55	-	228	74	955
Montgomery	28,550	927	5,209	19,493	442	3,406
Walker[2]	6,056	49	-	-	-	-
Waller	3,789	200	102	718	20	2,949
Wharton	723	81	-	503	105	115

[1]This table does not include OSSF data for permits submitted by special districts

[2]Walker county OSSF data submissions do not include information about system type

Task 6.2 – Unpermitted OSSF Update

The OSSF inventory data developed by H-GAC under Task 6.1 dealt with permitted OSSFs. For most Authorized Agents, systems began to be permitted after 1989. OSSFs installed prior to this date were not required to have a permit and in most cases are not actively tracked unless violation data exists for that site. While many of these systems are well maintained, aging systems in general pose a greater threat of failure and contamination of surface water sources. These systems also potentially represent an appreciable portion of the systems in service. H-GAC devised and tested a methodology to use existing data to identify by process of deduction, likely locations for unpermitted systems (see the corresponding section under "Methods"). During this Project year, the identification methodology was re-run to update the analysis. The updated Unpermitted OSSF map is included in the digital media attached to this report.

In addition to these contract deliverables, H-GAC promoted our OSSF data resources at a variety of meetings and through speaking engagements (see Task 5.1). Project staff held OSSF presentations and visual inspection/management trainings in Harris, Montgomery, and Brazoria County, and maintained an online OSSF data website and data tool[10]. Training courses provide information to real estate inspectors and homeowners about how to properly inspect and maintain OSSF/septic systems on private property. Trainings targeted areas with high numbers of permitted and potentially unpermitted OSSFs identified through H-GAC's OSSF database, as well as watersheds with active WPP or TMDL efforts. Table 5 lists OSSF trainings and presentations H-GAC held during this project period.

Table 5 – FY2017 OSSF Presentations and Trainings

Date	Event/Communication	Location	Participation
6/22/17	Montgomery County OSSF Symposium	San Jacinto River Authority – Lake Conroe	H-GAC staff presented information about OSSF programs, trainings, and tools.
7/8/2017	OSSF Homeowner Visual Inspection Course	Crosby Public Library	H-GAC staff presented information to homeowners about how to properly inspect and maintain OSSFs.
7/21/2017	OSSF Homeowner Visual Inspection Course	Texas A&M AgriLife Extension Service – Brazoria County	H-GAC staff presented information to homeowners about how to properly inspect and maintain OSSFs.

[10] Accessible at http://www.h-gac.com/community/water/ossf.aspx

H-GAC has created, in conjunction with several other projects, a Supplemental Environmental Project (SEP) through TCEQ to remediate septic systems in the priority watersheds of the 13-county region. Throughout FY2017, H-GAC staff promoted the SEP to permit holders through one on one contacts and events. Two contributions totaling $160,000 were made during this project period.

Methods

The following is a brief summary of the methods employed by Project staff, and their strategy and approach to each of the primary Objectives. The methods used, objective goals, and results for each are described in more detail in their respective sections in the Project Objectives section.

Objective 2: Quality Assurance

The general strategy employed by H-GAC was to first confirm that the new Project year tasks were covered under the existing QAPPs, and to implement the existing QAPPS. Annual Certification for the Data and Geospatial QAPPs were completed as required, and new QAPPs were developed and implemented.

H-GAC utilized its existing QA/QC methods developed with TCEQ and other agencies over the course of many years of related projects, in application to the FY2017 Project.

Objective 3: Wastewater Data Update and Coordination

The acquisition and analysis of wastewater infrastructure data adhered to updated QAPPs and QC methods for FY2017. This included the acquisition and analysis of WWTF outfall locations, service area boundaries, DMRs, and SSO violation reports.

For the SRF coordination aspects of the Objective, Project staff maintained a manifest in which to log SRF and other project reviews, and in which transition time was monitored internally.

Objective 4: Support Watershed Planning

To foster the San Bernard WPP group, H-GAC maintained an active presence in the watershed and contact with key stakeholders through general outreach and participation in meetings and events. The WPP was revised over several rounds based on TCEQ and EPA comments. H-GAC staff also facilitated the H-GAC's Natural Resources Advisory Committee through quarterly meetings held during the project term.

Objective 5: Coastal NPS Program Coordination

The methods employed in the maintenance of the Coastal Communities Program focused on providing information and services to support the needs of the participant (and other) small coastal communities and representing them in broader regional efforts. In addition to maintaining the Coastal Communities website, communication with coastal communities was

frequent and in coordination with other coastal project efforts through meetings, workshops and trainings, outreach events, and informational newsletters.

Objective 6: OSSF Database Update

The methods employed in the update of the OSSF database and unpermitted OSSF analysis are described in further detail in the FY2017 Geospatial QAPP. Generally, H-GAC maintained regular contact with submitting Authorized Agents, to ensure regular data submissions. H-GAC's methods for the unpermitted analysis were the same as previous project years, in which unpermitted locations were deduced through a comparison of known parcels, known OSSFs, and known sanitary sewer systems. Parcels outside service areas, with occupied structures, that did not have a permitted OSSF were assumed to have an unpermitted OSSF.

Methods Summary

In general, the methodical approach of the Project team for all tasks was to assess available data/resources, make a preliminary plan toward the task objective, periodically review the progress and plan, and make adjustments as necessary.

For those objectives dealing with public interaction, staff utilized existing communication networks and meetings to maximize the number of people reached, and incorporated feedback into revised versions of deliverables.

As much of the data and analysis developed under this Project will likely serve other water quality and watershed efforts, H-GAC coordinated with internal and external project managers to assure that the format and approach to these efforts would provide meaningful products.

To the greatest degree possible, Project staff attempted to streamline and make uniform the methods and processes involved in the various Tasks to increase efficiency in future Project years.

Results and Observations

This year's project was successful in building on progress made in last fiscal year's project, and providing a solid base for a number of regional efforts. The following observations will inform the approach to future iterations of this Project.

Objective 2, QAPP - The extent of QAPP coverage and the proactive approach to planning for annual certification and other QAPP changes were generally successful. The development of a new Data and Geospatial QAPP will provide a basis for next year's data work.

Objective 3, WWTF Data – The acquisition of wastewater infrastructure data from TCEQ databases significantly streamlined the WWTF data update Task compared to methods used in previous project years. This streamlining of data acquisition allowed for staff to expand data updates and analysis to include the evaluation of DMRs and SSOs. The data created in this task

continues to be widely used by local projects and entities. Water quality protection efforts including the various WPPs, TMDLs, and the Clean Rivers Program use the data to characterize the location and potential impact of sanitary sewers systems, and local decision-makers use the data to guide planning decisions.

Objective 4, Support Watershed Planning – The NRAC and H-GAC participation in other projects continues to be a valued part of this contract. The density of project work in the Houston area requires a good deal of coordination, communication, and cooperation. NRAC has continued to be well attended, and the legislative review and development of a Water Quality Award program are favorably received by the participants. H-GAC staff members were able to complete ongoing revisions to the San Bernard WPP and make contacts with key partners throughout, including a full stakeholder meeting during WPP revisions.

Objective 5, Coastal NPS Program Coordination – Active participation by the majority of project participants continued to be minimal, as primary needs were for large infrastructure financing or engineering work beyond the scope of this project. H-GAC continued to support participants through communication and dissemination of information related to available resources, educational materials, and upcoming events and workshops.

Subsequent project terms following FY2017 will no longer support the Coastal NPS Program because a separate TCEQ 319 grant contract will cover these efforts. The Coastal NPS program through 319 funds will focus on coastal communities that lack the financial and staff capacity to develop, launch, and implement public outreach campaigns. The targeted communities are Bailey's Prairie, Bonney, Danbury, Anahuac, Oak Island (census-designated place), and Rosharon (census-designated place). These communities are either within the Double Bayou or Bastrop Bayou watersheds, both of which are covered by a US EPA-accepted WPP to reduce nonpoint source pollution, and do not have MS4 permits. This project seeks to bridge the gap between the needs identified by coastal communities through 604b funded efforts and the measures identified in the WPPs.

Objective 6, OSSF Database Update – The OSSF data has already been used for a variety of watershed protection efforts and other local planning projects. With the population expansion of the coming decades, and aging infrastructure, additional information about unpermitted system locations will be vital to utility planning. Future work should consider ways in which to account for OSSF abandonment in expanding sanitary sewer areas, which cannot be easily captured currently.

In general, H-GAC project staff members are confident in the results of this year's Project. H-GAC feels that the deliverables meet the needs of the current Project, and will provide a solid foundation for future work. Results and observations specific to each task and objective of this Project are described in detail in their corresponding subsection of the **Project Objectives** section of this document. Future needs identified during this year's Project are established in the **Discussion** section of this document.

Discussion

This section will detail the areas of need identified for inclusion in future projects, including any recommended solutions.

Service Area Boundaries
Additional scrutiny to service area boundaries to fill data gaps from private utilities is recommended for future SABD updates under this project. With a more comprehensive SABD, SSO and DMR data analyses would also greatly improve.

Expand Project Coordination
As H-GAC continues to expand its range of planning projects aimed at supporting water quality (ex. urban forestry efforts in the region), coordination with a wider range of projects through this contract is recommended.

OSSF Database Update
Future project periods will focus on identifying permitted systems that are no longer active due to conversions to sanitary sewer or other factors. Additionally, the Trinity River Authority will be added to the list of Authorized Agents submitting OSSF data to H-GAC.

OSSF Trainings
Steady interest and participation in H-GAC's visual OSSF inspection course for real estate inspectors and homeowners has indicated that this is a valued educational program, and should be continued.

SEP for OSSFs
Significant contributions into H-GAC's supplemental environmental program (SEP) for OSSFs during this project term have initiated potential partnerships with regional entities to implement OSSF improvement projects. Contributions into the SEP are expected to continue. With this increased traction, the support of administration and coordination of the SEP through this project would be a valuable addition to Objective 6 Tasks.

Summary

This year's Project was successful in acquiring and analyzing WWTF infrastructure data for the Region, for the benefit of both local and state purposes. H-GAC continues to provide its unique regional perspective to the review of SRF projects.

H-GAC continues to develop and foster relationships with interested parties in the Region's watersheds, and coordinate regional water quality activities. We have been leaders in previous TMDL and WPP efforts, and the coordination activities of this Project mesh well with our overall approach of outreach, targeted studies and implementation activities. By having multiple water quality projects within the same organization, we are able to achieve a good vertical integration between base data sources, internal analysis, planning efforts (WPPs, TMDLs, etc.), and external coordination.

The Coastal Communities Program has continued to be a source of information for participant communities, but has not attracted as many specific community projects as anticipated. The transition of project funding for the Coastal Communities Program to 319 grant support will shift efforts to focus more on a specific subset of coastal communities, potentially generating a greater level of interest by participants.

The OSSF inventory development continued during this fiscal year. This deliverable remains one of our most well-received efforts among internal and external clients.

This report, the accumulated datasets, the GIS analyses, and other deliverables of this Project are attached in electronic format on accompanying media. Where allowable and appropriate, data from this Project will be used to support other related efforts and/or made available (upon TCEQ approval) on H-GAC's website at http://www.h-gac.com/community/water/quality. This Final Report document, when approved, will be made available at this location.

Appendices

Appendix A – Summary of Materials included on Media

The following materials are included on the media attached with this Report:

1) Service area boundaries layer (GIS format) – Task 3.1
2) Outfall locations and recommended changes to TCEQ outfall layer (GIS format) – Task 3.1
3) Map of FY2017 service area boundaries and outfall locations (PDF format) – Task 3.1
4) WWTF permit review (3 excel spreadsheets) – Task 3.1
5) DMR and SSO data analysis output (Word document) – Task 3.1
6) SSO events by volume and cause graphic (GIF image) – Task 3.1
7) SSO events and rainfall graphic (GIF image) – Task 3.1
8) DMR permit exceedances layer (GIS format) – Task 3.2
9) SSO event violations layer (GIS format) – Task 3.2
10) DMR permit violation density map (PDF format) – Task 3.2
11) SSO event density map (PDF format) – Task 3.2
12) Permitted OSSF update (GIS and PDF format) – Task 6.1
13) Potential unpermitted OSSF map (PDF format) – Task 6.2
14) Change in permitted OSSFs map (PDF format) – Task 6.2
15) Density map of total permitted OSSFs by county (PDF format) – Task 6.2
16) Density map of FY2017 permitted OSSF update by county (PDF format) – Task 6.2
17) Final FY2017 WQMP Update, digital version – Task 7.2

Appendix B –DMR and SSO Data Analyses Summary Report

Summary Report Regional DMR and SSO Data Analyses, FY 2017

Funding for this project was provided by the Environmental Protection Agency through a Clean Water Act 604(b) grant to the Houston-Galveston Area Council, administered by the Texas Commission on Environmental Quality.

Introduction

Escherichia coli (*E. coli)* is an indicator bacterium commonly found in the gut of warm-blooded animals. High concentrations of *E.coli* in area waterways may indicate the potential presence of untreated or improperly treated fecal waste. *E. coli* from human waste has a significantly greater pathogenic potential compared to *E. coli* strains from other sources[11] that can cause gastrointestinal illness in persons who come into direct contact with contaminated waters.

Currently, nearly half of the stream miles in the 13-county H-GAC region (Region 12) have bacteria levels higher than the state standard for contact recreation. Although overall bacteria levels have shown a gradual improvement over time since 2005, current bacteria geometric mean values for the region continue to be significantly greater than the state standard for primary contact recreation (Figure 1).

Figure 1. Moving seven-year bacteria geometric mean plot for Region 12

[11] While the project considers many sources of fecal bacteria, recent research has indicated that human waste has a significantly higher risk of causing sickness in humans as compared to animal sources. Additional information about this research can be reviewed at http://oaktrust.library.tamu.edu/handle/1969.1/158640?show=full. (Gitter, 2017).

Wastewater infrastructure is a potential contributor of bacteria into area waterways through improperly treated Wastewater Treatment Facility (WWTF) effluent discharges or through the occurrence of sanitary sewer overflows (SSOs) from the plants or throughout the collection systems. Data from WWTF Discharge Monitoring Reports (DMR) and SSO violation reports can be analyzed to better evaluate the potential impact these sources have on bacteria impairments throughout the region. As the population continues to increase at a rapid pace concurrently with aging infrastructure, the integrity of these treatment and collection systems may be adversely impacted. It is important to continuously monitor these systems over time to ensure decision makers and water resource managers implement best management practices, repairs, or system replacements in areas that need it most.

This report summarizes regional DMR and SSO violation data acquired through the TCEQ for the period covering 2011/2012 through 2016. Spatial analysis of violations was also conducted using current WWTF outfall locations and service area boundaries in the region (Figure 2).

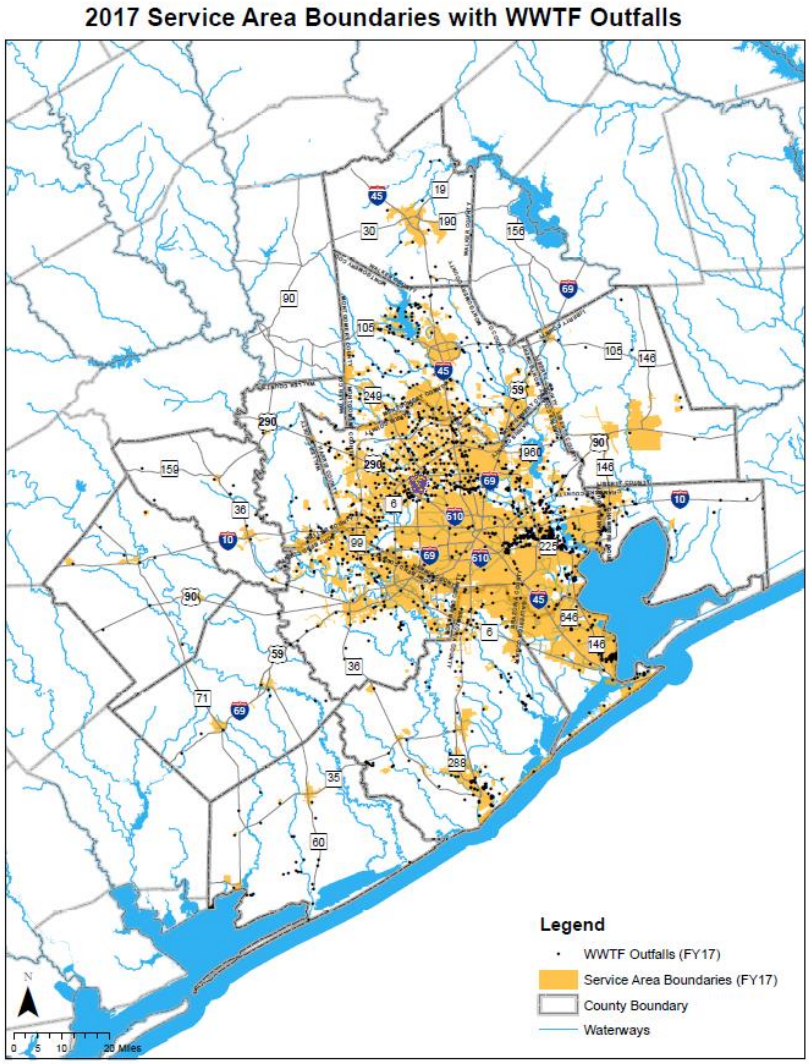

Figure 2. Map of current outfall locations and service area boundaries for WWTFs in the region.

Discharge Monitoring Report (DMR) Data

Discharges from WWTFs are regulated by water quality permits from the TCEQ which require stringent limits for effluent quality. Discharges are monitored on a regular basis by WWTF personnel with a frequency dependent on plant size, location, wastewater type, and other factors. Data from these required sampling events is submitted to (and compiled by) the TCEQ as DMRs. As with any self-reported data, there is an expectation that some degree of uncertainty or variation from conditions may occur, but DMRs are the most comprehensive data available for evaluating WWTFs in the region.

Bacteria Permit Limits

The water quality standard for ambient conditions is 126 most probable number (MPN) per 100mL of water (for the geomean of samples), and 399 MPN/100mL (for single grab samples). These standards are generally applied as a water quality permit limit for WWTFs as well[12]. Evaluating trends in permit exceedances for indicator bacteria is important in understanding the impact WWTFs may have on overall surface water quality.

DMR Bacteria Violation Data Analyses

For this project, staff evaluated the occurrence of *E.coli* violations reported through WWTF DMRs in the region for the last five years (2012-2016). Evaluations were based on the regulatory permit limits specific to each plant and consider the number of exceedances and bacteria loadings by year and by plant size. Spatial analysis of the frequency of DMR bacteria violations by watershed was also conducted. Each DMR bacteria violation reported was mapped based on the WWTF outfall location linked to the water quality permit number included on the DMR report.

DMR Analysis Results

Table 1 provides a summary of the total number of WWTFs in the region with *E.coli* permit limits that are required to submit DMRs to TCEQ. The majority of plants with *E.coli* limits in the region are domestic WWTFs with only five percent of plants treating industrial wastewater. Table 2 summarizes the actual *E.coli* permit limits for each plant. These limits were used to evaluate the number of exceedances by year and plant size.

Table 1. Summary of WWTFs submitting DMR *E.coli* data in the H-GAC region (2012-2016)

Parameter	Number	Percent
WWTFs Submitting DMR *E.coli* Data	762	100%
Domestic WWTFs	721	95%
Industrial WWTFs	41	5%

[12] Select plants have more stringent limits depending on site-specific conditions, or participation in TMDL projects like the Houston-area Bacteria Implementation Group (BIG). For all analyses, the actual limit for each plant was used in comparison with its plant-specific results. The range of limits applied to the average and maximum conditions ranges from 63 to 399 cfu/100ml.

Table 2. Summary of current *E.coli* permit limits by WWTF type

WWTF Type	Geometric Mean Limit	Daily Maximum / Grab Limit	Number of Permits
Domestic	-	394	1
Domestic	63	197	79
Domestic	63	200	365
Domestic	126	200	5
Domestic	126	394	28
Domestic	126	399	243
Industrial	-	126	1
Industrial	63	-	1
Industrial	63	197	5
Industrial	63	199	1
Industrial	63	200	2
Industrial	126	200	1
Industrial	126	394	7
Industrial	126	399	23

Tables 3 and 4 include the percentage of DMRs submitted with bacteria permit limit exceedances by plant size and year. In general, the results indicate that a very small number of bacteria permit exceedances were reported between 2012 and 2016 (333 out of 15,283 records). A greater rate of exceedances are reported with daily maximum and grab sample limits, indicating there is likely some variability in conditions, as would be expected.

Table 3. Percent of DMR bacteria geometric mean exceedances by plant size and year

Plant Size (Millions of Gallons per Day)	2012	2013	2014	2015	2016
<0.1 MGD	5.6%	4.4%	5.1%	2.3%	1.6%
0.1-0.5 MGD	1.8%	1.0%	0.5%	1.1%	1.8%
0.5-1 MGD	1.3%	0.7%	0.3%	0.3%	0.3%
1-5 MGD	1.9%	1.5%	0.5%	0.3%	0.3%
5-10 MGD	1.1%	0%	0%	0.3%	1.3%
>10 MGD	0.8%	0.6%	1.1%	2.6%	0%
Variable/Intermittent Discharge	0%	0%	18.8%	25.0%	18.2%

Table 4. Percent of DMR bacteria daily maximum or grab sample exceedances by plant size and year

Plant Size (Millions of Gallons per Day)	2012	2013	2014	2015	2016
<0.1 MGD	9.7%	6.4%	6.5%	3.1%	2.1%
0.1-0.5 MGD	4.4%	2.9%	1.9%	2.3%	2.2%
0.5-1 MGD	5.2%	4.0%	1.6%	2.3%	0.9%
1-5 MGD	8.7%	5.9%	3.5%	5.0%	4.9%
5-10 MGD	14.8%	13.8%	7.7%	12.3%	9.5%
>10 MGD	11.9%	14.3%	14.2%	21.4%	14.6%
Variable/Intermittent Discharge	0%	0%	18.8%	18.8%	18.2%

Table 5 summarizes the total number of WWTFs by plant size, and lists the percentage of plants with 25 percent or more of DMRs submitted between 2012 and 2016 with bacteria permit limit exceedances. In general, larger plant sizes are reporting exceedances for daily maximum or grab sample limits more frequently than smaller plants. It should be noted that geometric mean concentrations reported on DMRs consider daily maximum and grab sample concentrations in their calculations. Therefore, the low percentage of geometric mean exceedances reported by larger plants (0%) implies that the daily maximums are likely not significantly higher than the designated permit limits overall.

Table 6 shows the average *E.coli* geometric mean concentrations reported between 2012 and 2016 by plant size. This data indicates that DMR *E.coli* concentrations reported by small plants is significantly higher than other plant sizes. However, the overall average *E.coli* geometric mean concentrations reported by all plant sizes remain considerably lower than the designated permit limit requirements.

Figure 3 estimates the total *E.coli* loadings from 2012 to 2016 based on WWTF effluent discharge rates and average *E.coli* geometric mean concentrations reported by plant size. Due to significantly greater discharge volumes, larger plants contribute the greatest bacteria loads to area waterways overall.

Table 5. Permittees with 25% or more excursions above bacteria permit limits by plant size (2012-2016)

Plant Size (Millions of Gallons / Day)	Total Number of Plants	Percentage of Plants w/ 25% or more Exceedances	
		Geomean	Daily Max / Grab
<0.1 MGD	302	14.2%	17.9%
0.1-0.5 MGD	197	5.6%	7.6%
0.5-1 MGD	140	0%	5%
1-5 MGD	176	2.3%	21.6%
5-10 MGD	27	0%	44.4%
>10 MGD	17	0%	100%
Variable/Intermittent Discharge	3	100%	66.7%

Table 6. Average *E.coli* geometric mean values reported by plant size (2012-2016)

Plant Size (Millions of Gallons / Day)	Average *E.coli* Geomean (MPN/100mL)
<0.1 MGD	34.36
0.1-0.5 MGD	12.77
0.5-1 MGD	6.89
1-5 MGD	12.09
5-10 MGD	4.86
>10 MGD	15.40

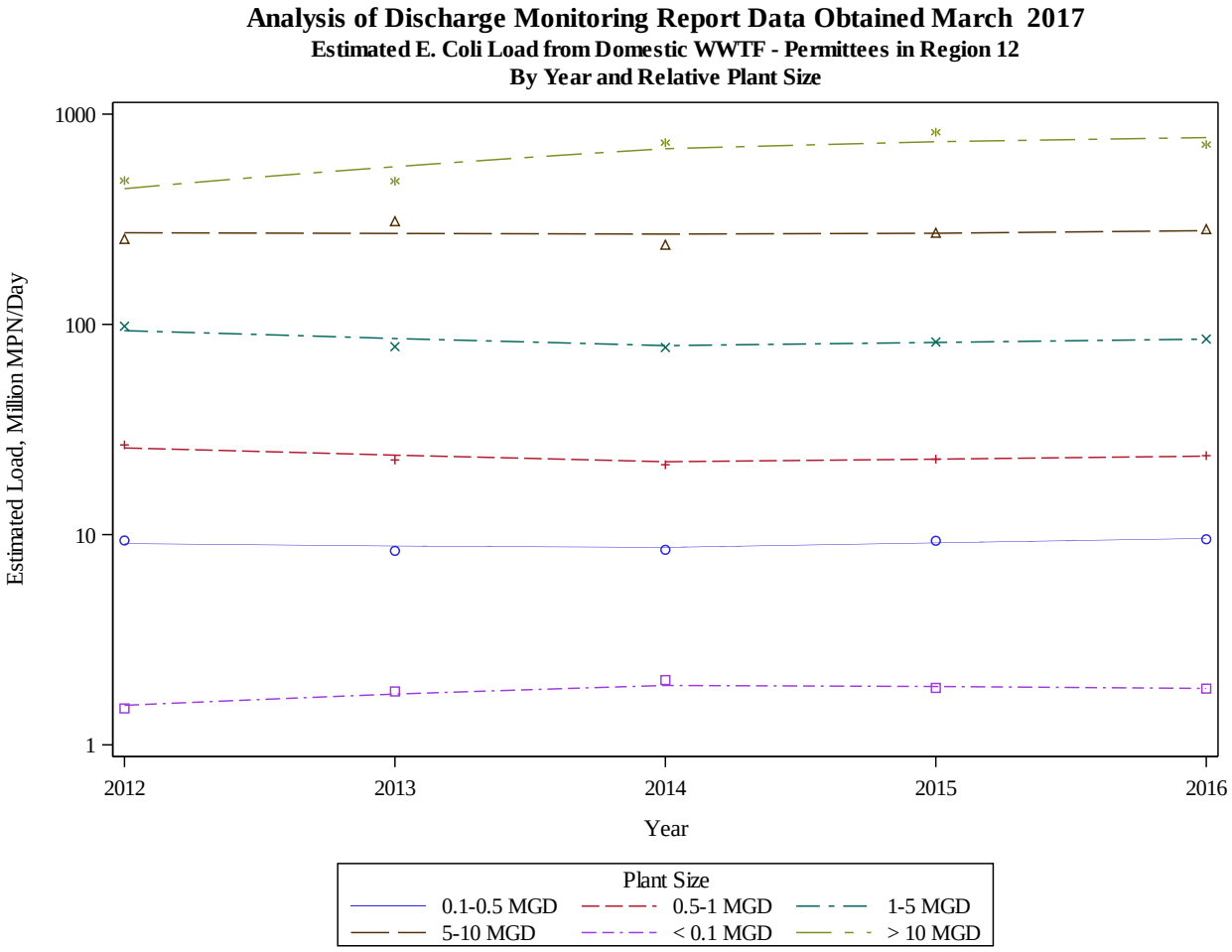

Figure 3. Estimated *E.coli* loadings per year in regional waterways based on domestic WWTF plant size

Figure 4 is a map illustrating the frequency of DMR bacteria violations between 2012 and 2016 by watershed. This map illustrates areas in the region that have the highest rate of permit exceedances

based on the reported DMR data acquired from TCEQ. It is evident that the more populated urban and suburban areas present in the region experience the greatest number of bacteria violations compared to more rural watersheds along the region's perimeter. It should be noted that spatial analysis of DMR exceedances are based on the location of WWTF outfalls. Watersheds with no outfalls located within their boundary are shown as having no data.

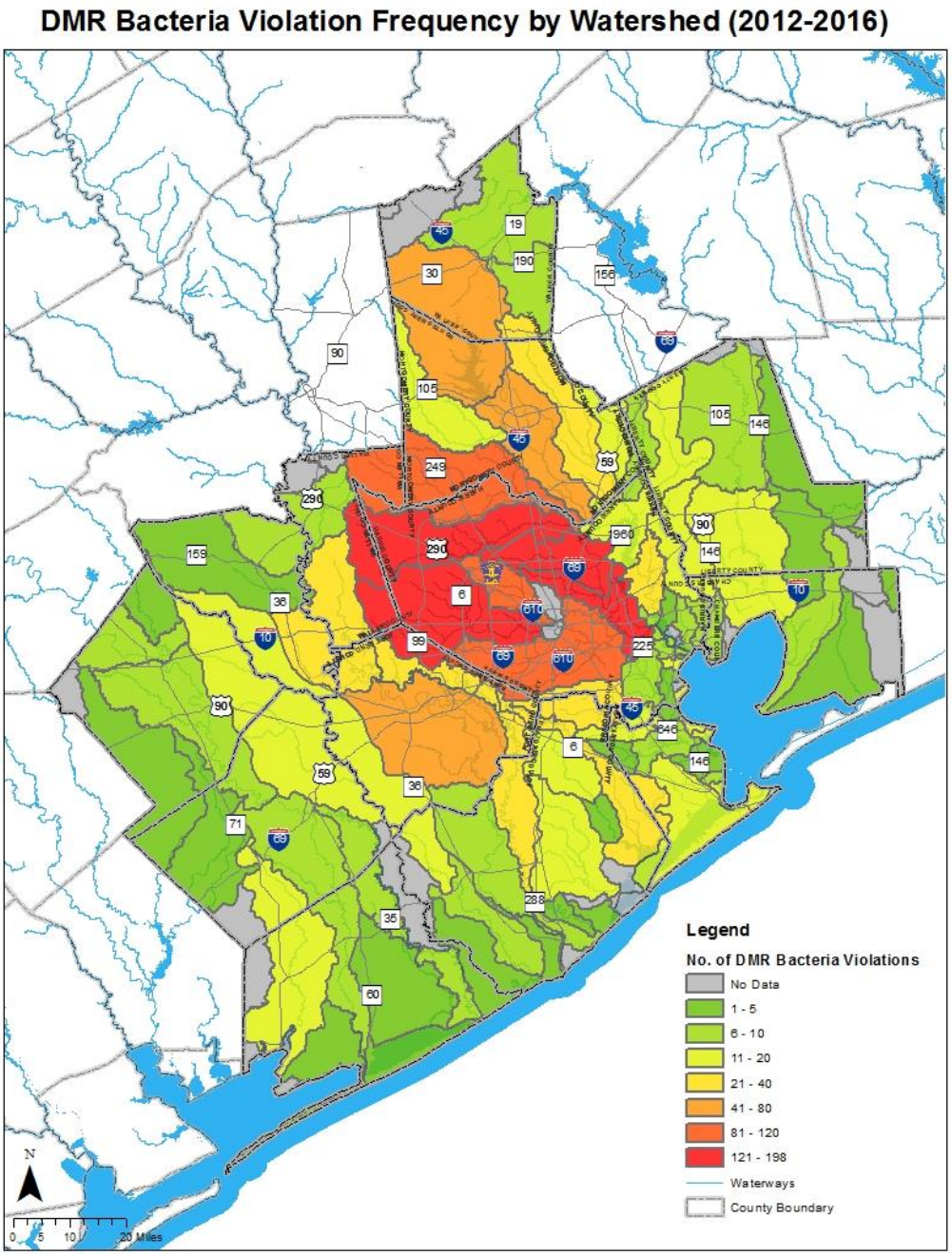

Figure 4. Frequency of DMR bacteria permit violations by watershed reported between 2012 and 2016

DMR Analysis Discussion

Based on the analysis of DMR bacteria violations by plant size, plants with the lowest discharge rates (<0.1 MGD) are reporting violations with the highest bacteria concentrations overall. This would likely include package plants and WWTFs in smaller communities that are generally operated manually by few personnel. In general, plants of this size are older and may lack the funding necessary to upgrade and improve treatment efficiency leading to the potential of increased water quality permit violations. However, due to the low discharge rate, overall bacteria loading to regional waterways originating from smaller plants is insignificant and would likely only cause localized, acute bacteria problems under certain conditions. Larger WWTFs are contributing a significantly greater daily volume of effluent and therefore have a higher potential of impacting bacteria levels on a regional scale if significant violations occur on a regular basis.

Even so, only approximately 333 out of the 15,283 DMR records submitted between 2012 and 2016 reported bacteria permit limit exceedances. This equates to approximately 97.8 percent of effluents meeting permit requirements and discharging water with bacteria concentrations likely below the 126 MPN/100 mL primary contact recreation standard. This may indicate that most discharges are actually contributing clean effluent with the potential to dilute natural bacteria concentrations in receiving waters.

The DMR bacteria violation frequency map illustrates that the more populated urban and suburban areas in the region are experiencing the highest rate of bacteria violations. However, it should be noted that the density of WWTF outfalls in urban and suburban centers are much greater than the less populated watersheds in the region, therefore it would be expected that the number of DMR bacteria violations would also be higher.

While WWTFs may show appreciable bacteria contributions under certain conditions, the DMR analysis indicates that they are not likely a significant driver of regional bacteria impairments due to the comparatively few exceedances and the relatively small volumes of effluent overall. Nonetheless, due to the potential impact poor effluent quality can have, especially in larger plants, continued monitoring and maintenance of treatment systems remains an essential component of proper water quality management.

Sanitary Sewer Overflow (SSO) Data

Current TCEQ regulations define an SSO as any type of unauthorized discharge of untreated or partially treated wastewater from a collection system or its components (e.g., manholes, lift stations, or cleanouts) before reaching a treatment facility. Unlike treated WWTF effluent, SSOs represent a high, if episodic risk, because they can have concentrations of bacteria several orders of magnitude higher than treated effluent. Untreated sewage can contain large volumes of raw fecal matter, making areas with sizeable and/or chronic SSO issues a significant human health risk under certain conditions.

SSO Reporting

SSOs are reported to the TCEQ and each event is linked to the water quality permit number for the facility or subscriber reporting the violation. A permitted facility may be a municipality, municipal water district, private individual, or company. Subscribers of permitted facilities include any municipality, business, or organization acting as a waste contributor or customer of a permitted facility.

There is no current minimum reportable volume enforced through state or federal regulations, so permitted facilities are required to report all SSOs regardless of volume within 24-hours of becoming aware of the event. Events that have the potential of adversely affecting public or private drinking water sources, or discharges with a volume of 100,000 gallons or more, require public notification within 24-hours via media outlets.

SSO Violation Data Analyses

This study considered five to six years of TCEQ SSO violation data for 2011/2012 through 2016. Analyses included an overview of the total number of permittees reporting SSOs by year, the cause of SSOs, and the estimated overflow volume by cause. It should be noted that SSO volumes are an estimate and are based on visual observations or estimated calculations that can be subjective based on the individual reporting the event. Additionally, it is possible that SSOs go undetected in certain conditions and are therefore not documented or reported to the TCEQ. However, SSO violation reports are the most comprehensive source of data that can be used to evaluate SSO events and their potential impact to regional water quality.

The frequency of SSO violations by watershed was also evaluated and mapped for this project. Violations were mapped based on the service area boundary linked to each WWTF reporting the event. Service area boundary data was acquired through municipality, private utility, and public municipal utility district (MUD) records. Service area boundaries are updated on an annual basis to reflect things like collection system expansions and other changes or updates. However, spatial analysis of SSOs is limited due to unavailable or unusable service area boundary information. Private utilities in smaller communities for example, may not maintain usable records of their service area boundaries while service area boundaries do not exist for most package plants, industrial WWTFs, and other subscribers.

Additionally, due to inconsistent reporting of SSO event addresses and location data, frequency maps were generated using the address of the WWTF itself rather than the location of the SSO event. Therefore, watersheds with insufficient service area boundary data or no WWTF located within its boundaries may be mapped as having no data even if SSO events were common in those areas.

SSO Analysis Results

Figure 5 summarizes the total number of permittees submitting SSO violation reports by year compared to the total number of permittees in the region. Table 7 lists the total number of violations and estimated overflow volumes reported by year from 2011 to 2016. Table 8 summarizes the frequency at which permittees were reporting SSO events between 2011 and 2016.

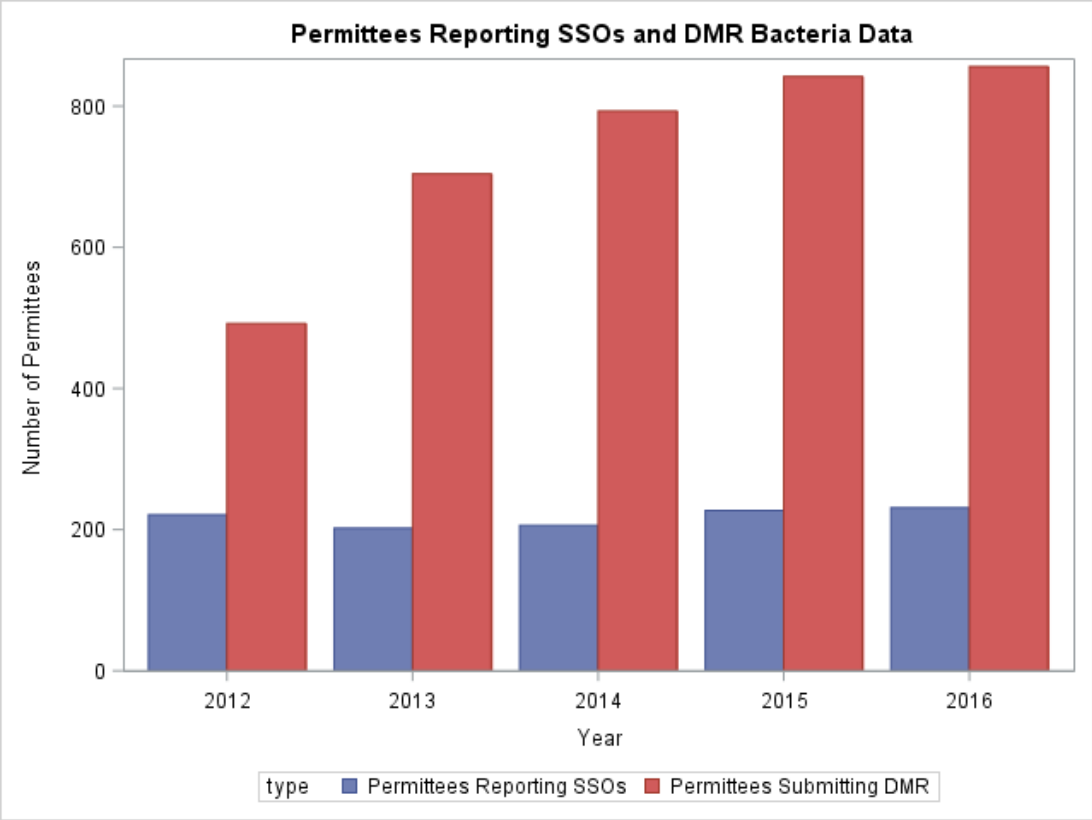

Figure 5. Total number of permittees reporting SSO violations by year from 2012 to 2016

Table 7. Total number of SSO violations and estimated volume reported by year from 2011 to 2016

Year	Number of SSOs Reported	Estimated Volume (Thousand Gallons)
2011	1,869	1,857
2012	1,274	6,988
2013	1,331	3,803
2014	1,403	6,373
2015	2,278	27,359
2016	2,066	20,650

Table 8. Frequency of SSO events reported by permittees in the region between 2011 and 2016

Number of Permittees Submitting SSO Reports	Number of Years SSO Events were Reported between 2011-2016
406	0 years
146	1 year
87	2 years
65	3 years
54	4 years
41	5 years
63	6 years

A significant increase in the occurrence and volume of SSOs is evident in 2015 and 2016 (Table 7) although there is not much change seen in the total number of permittees submitting these reports (Figure 5). This could be an indication that some permittees are experiencing chronic SSO issues in localized areas under certain conditions. Table 8 supports this idea by showing that some permittees are reporting SSO events more frequently. For example, over the six-year period between 2011 and 2016, a total of 63 permittees (roughly 7%) are consistently reporting SSO events on an annual basis.

In 2015 and 2016, significantly higher precipitation rates and flooding may be the cause for the increased number of SSO events. Figure 6 supports this notion showing that rain or inflow/infiltration (INI) was reported as the second leading cause for SSOs in 2015 and 2016. In contrast, blockages were more commonly reported during dry conditions like in 2011 when the region was experiencing a significant drought.

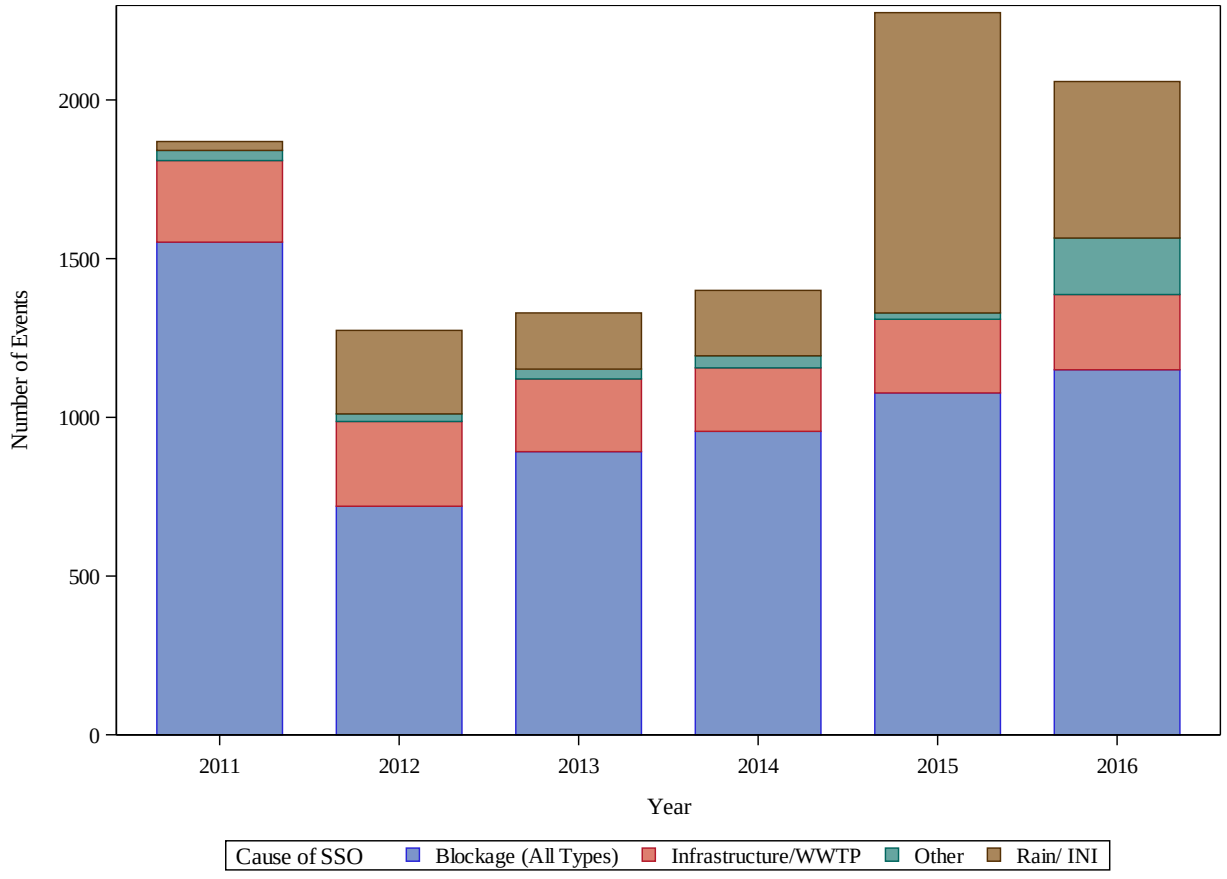

Figure 6. Cause of reported SSOs in the region by year

SSO causes were separated into 4 general categories to reflect the breakdown in the SSO database. The causes included in each category are listed in Table 9. It should be noted, however, that this categorization depends on the accuracy of the data reported by the utilities. Additionally, while a single cause is typically listed on the SSO report, many SSOs are caused by a combination of factors[13].

Table 9. Categories of SSO causes

SSO Cause	Inclusions
Blockage (All Types)	Blockage due to roots/rags/debris, fats/oils/grease, or other
Infrastructure/WWTP	Collection system structural failure, lift station failure, or WWTP operation or equipment malfunction
Other	Human error, power failure, unknown cause
Rain/INI	Rainfall, inflow, infiltration

Although the cause of SSOs is important, the volume reported for each SSO is also a significant factor that should be taken into consideration. Although most SSOs are caused by some type of collection system blockage, the overall SSO volume resulting from these events is relatively small compared to the overflow volumes from an event caused by significant rainfall or inflow/infiltration causes.

In 2016 for example, the total number of SSO events caused by blockages equaled 1,150 with a total overflow volume of approximately 814.5 thousand gallons. In comparison, the total number of SSO events reported in 2016 caused by significant rainfall or inflow/infiltration was only 493 while the total overflow volume for these events was approximately 14,489.6 thousand gallons. Refer to figures 7 through 12 for more information about the SSO volumes reported by cause between 2011 and 2016.

[13] e.g., fats oils and grease collecting in lift station motors can cause overflows in high rain events when excess water is in a system. The event may be listed as lift station failure, but FOG and inflow and infiltration of rainwater were also causative elements.

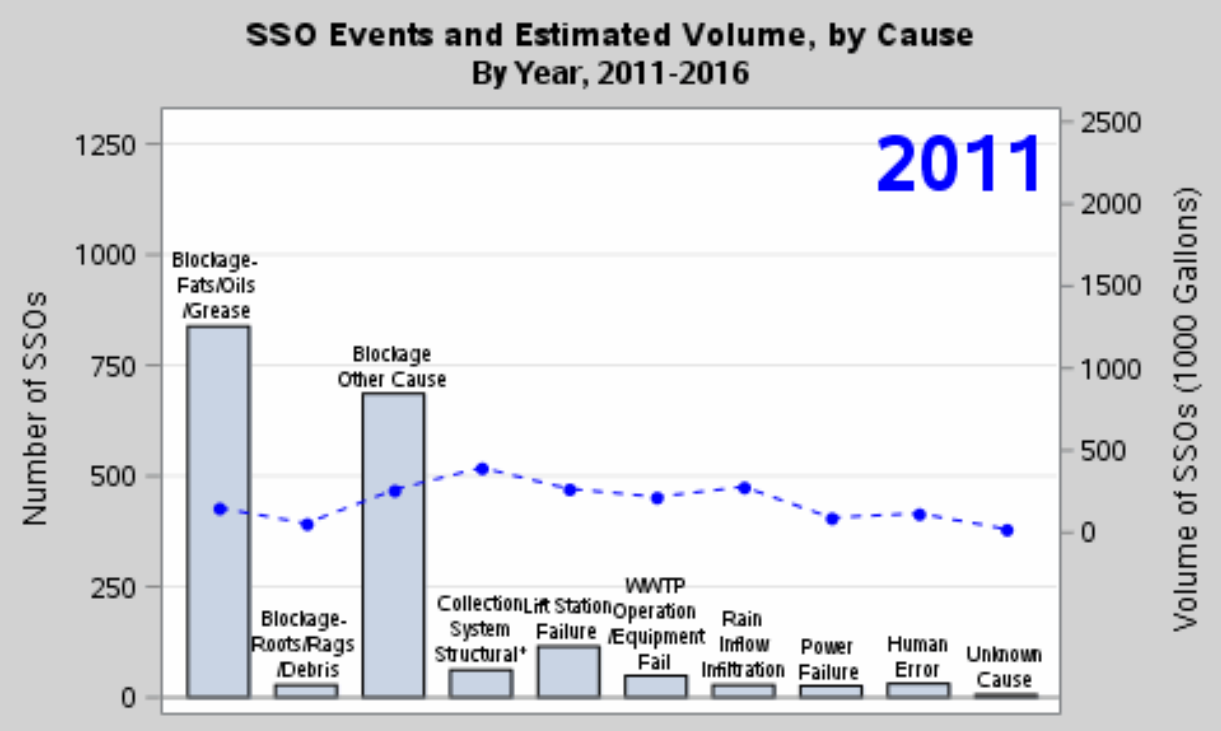

Figure 7. Number of SSO events and estimated volumes reported in 2011 by cause.

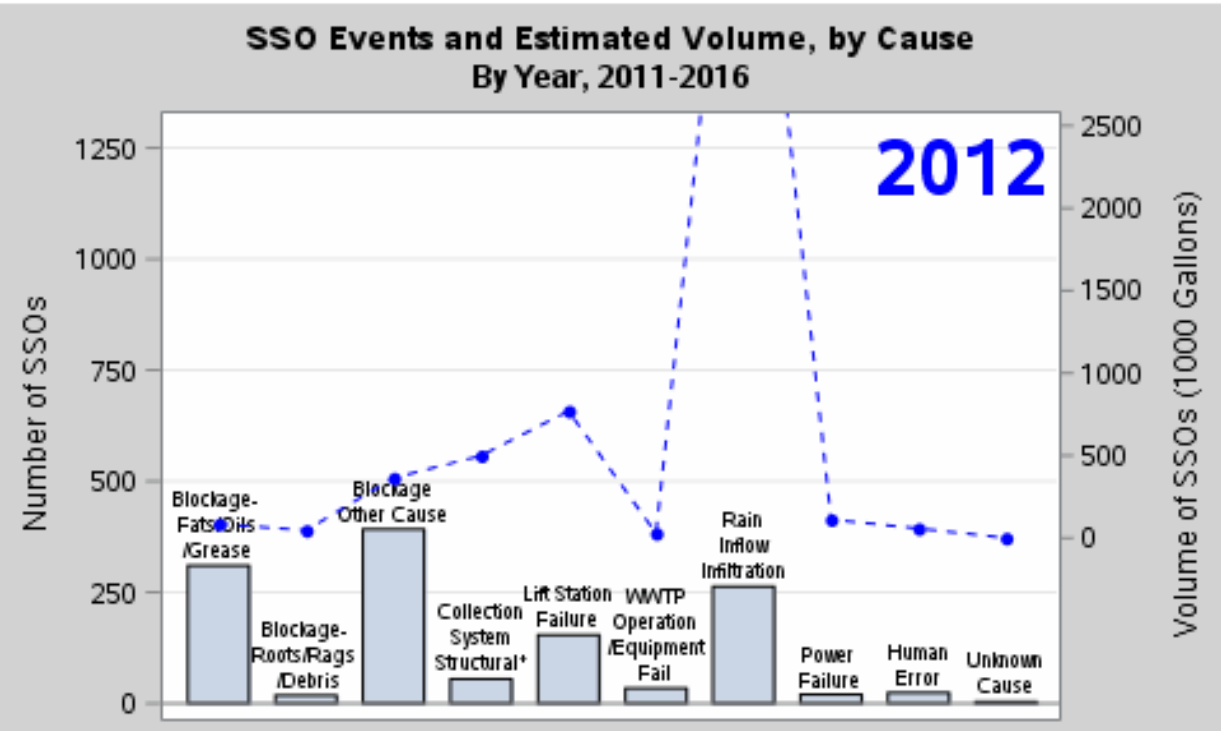

Figure 8. Number of SSO events and estimated volumes reported in 2012 by cause.

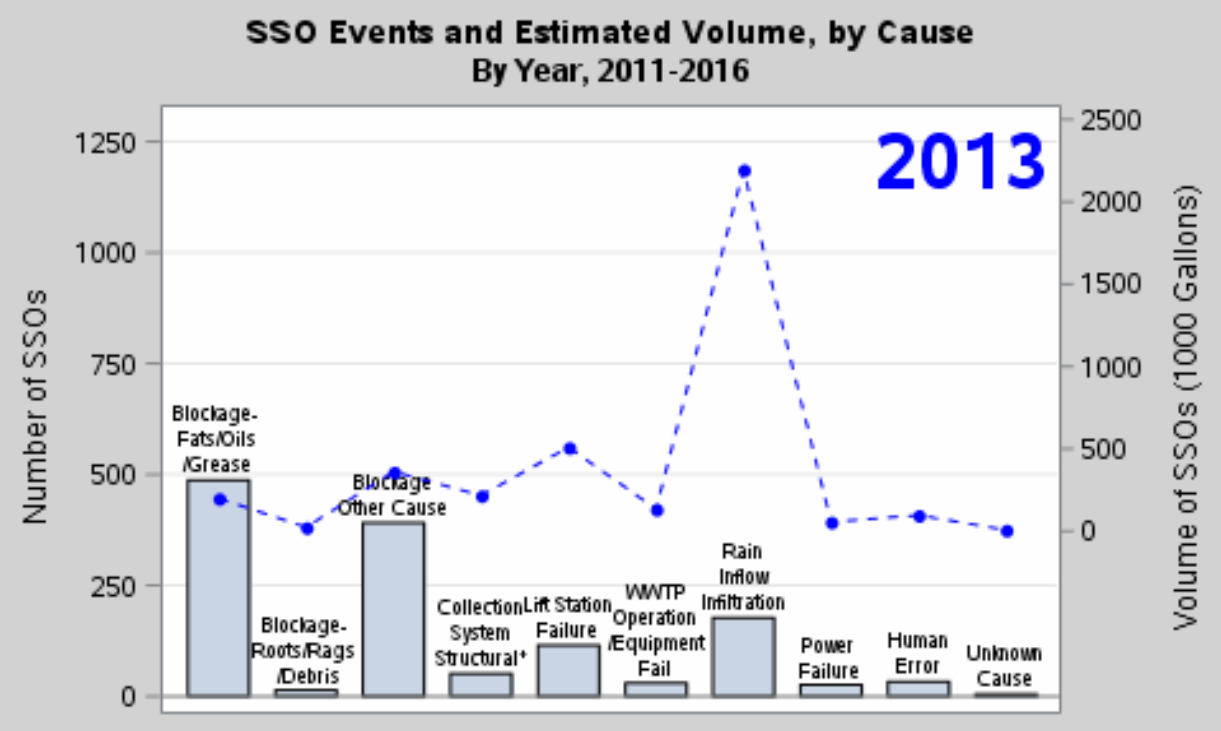

Figure 9. Number of SSO events and estimated volumes reported in 2013 by cause.

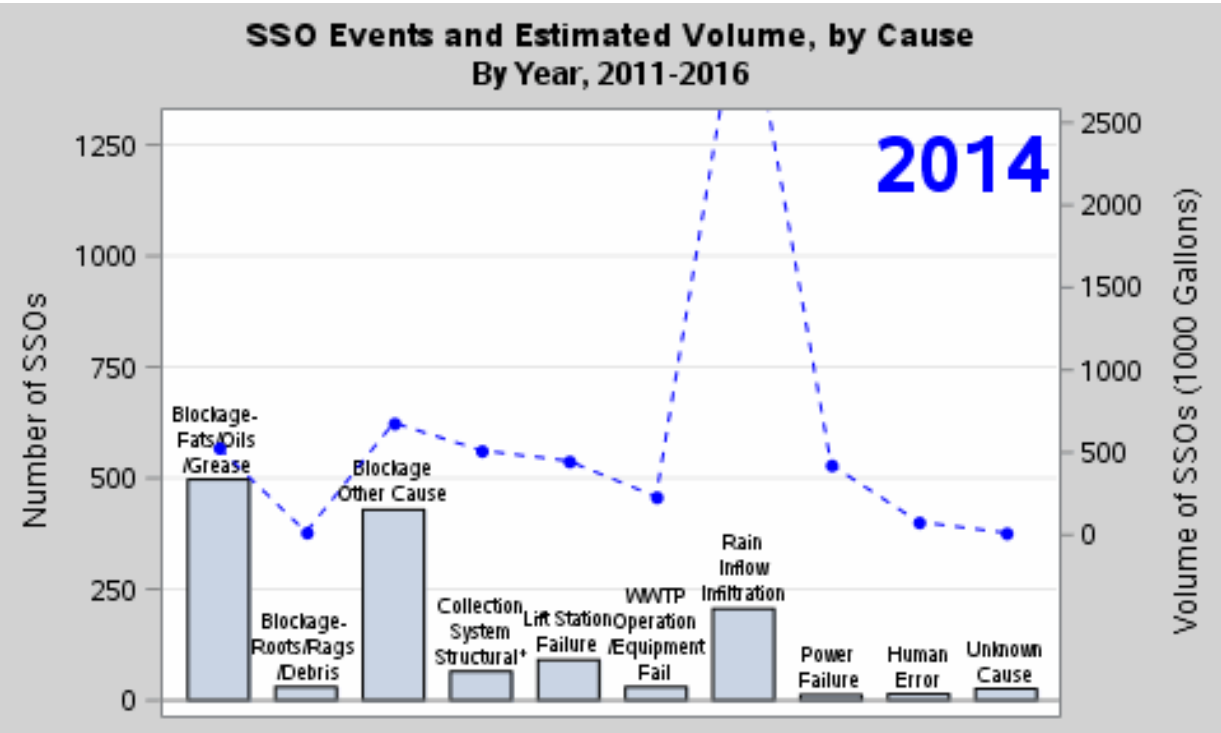

Figure 10. Number of SSO events and estimated volumes reported in 2014 by cause.

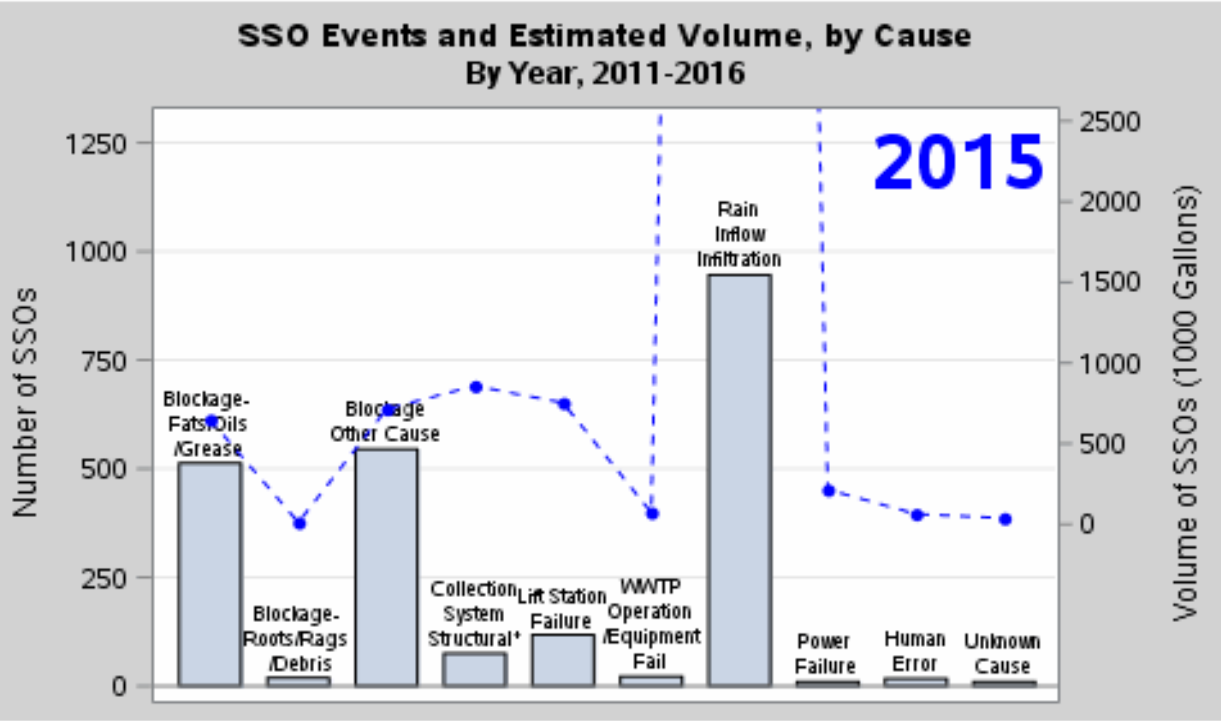

Figure 11. Number of SSO events and estimated volumes reported in 2015 by cause.

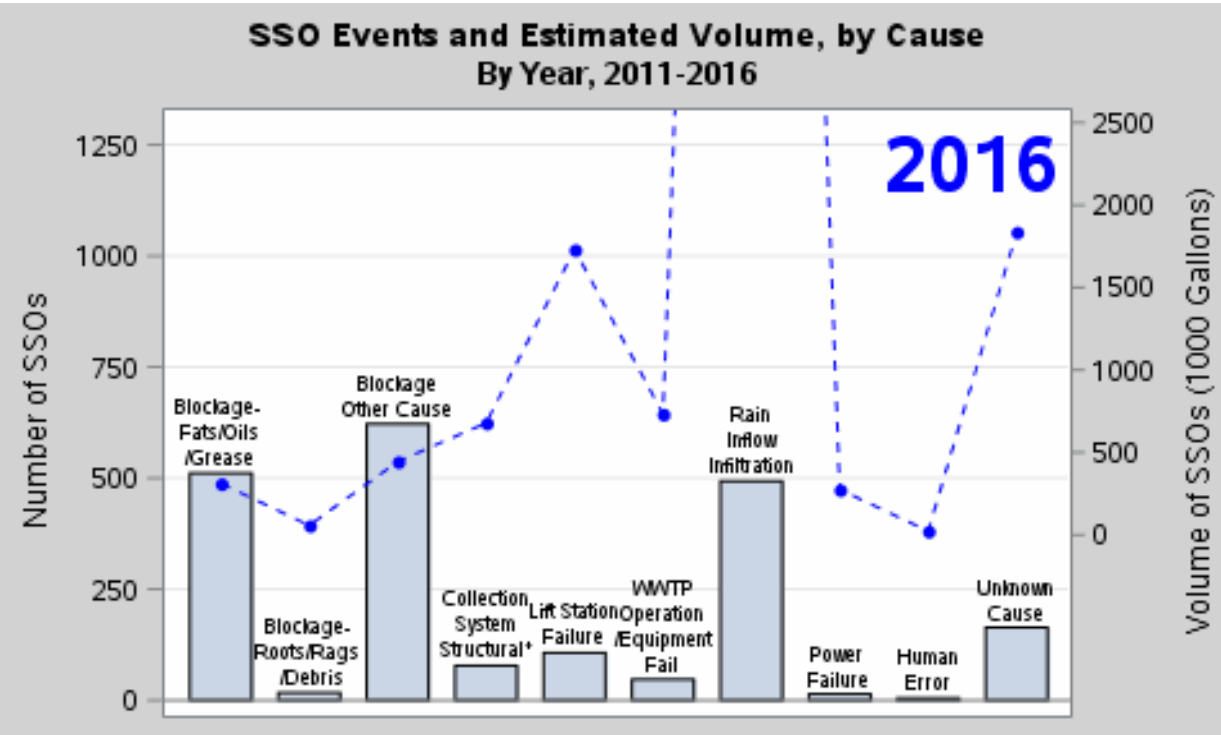

Figure 12. Number of SSO events and estimated volumes reported in 2016 by cause.

Figure 13 is a map illustrating the frequency of SSO violations reported in the region between 2012 and 2016 by watershed area. As mentioned previously, SSO events were mapped based on WWTF addresses and service area boundary data. Watersheds with insufficient service area boundary data or no WWTF located within its boundaries are shown as having no data.

Based on this analysis, the more populated urban and suburban watersheds throughout the region are experiencing the highest rate of SSO violation events compared the more rural, smaller communities along the outer perimeter of the region. However, it should be noted that some rural communities with small WWTFs and package plants may be underrepresented due to staff and resource limitations resulting in a greater likelihood of SSOs going undetected. Regardless, it is expected that developed areas experience more frequent SSO events due to larger populations and more impervious cover putting added strain on the collection systems overall.

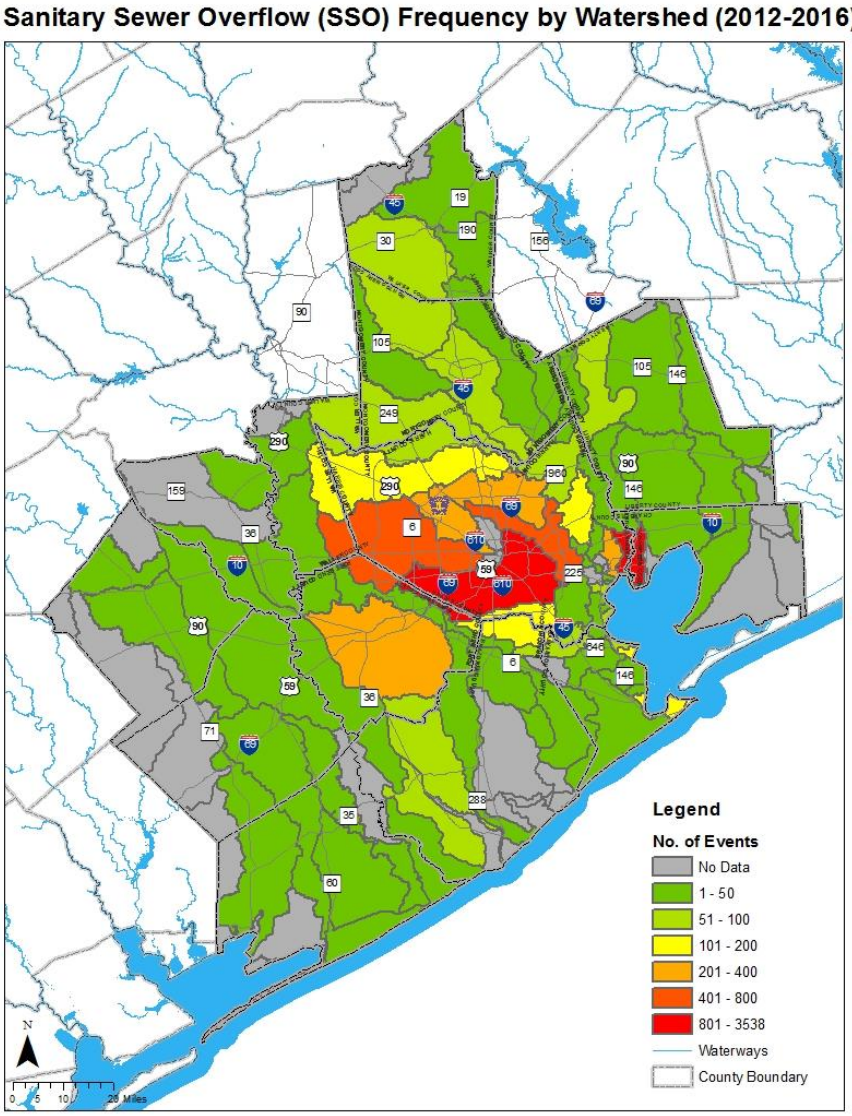

Figure 13. Frequency of SSO events by watershed reported between 2012 and 2016

SSO Analysis Discussion

Based on the SSO violation report analyses, the number of SSO events is largely dependent on certain social or climatic conditions. Areas with higher population rates tend to show a significant increase in SSO events likely related to the more frequent occurrence of blockages from fats, oils, and grease. Additionally, highly populated areas generally have more complex sewer systems and require more miles of pipeline to service the populations within their boundaries. With larger, more complex systems, the likelihood of SSOs is also greatly increased. This is especially true during extreme weather conditions such as droughts or heavy rain events. As infrastructure continues to age, such factors may exacerbate the rate of SSO events over time. Active maintenance of collection systems is important in managing SSOs, especially during extreme climatic conditions.

Although SSOs contribute a far greater concentration of bacteria into area waterways, their relatively minor volumes negate them to some degree as a primary source during average conditions. Their concentrations of untreated human waste pose a disproportionately high risk to human health during recreation, and their episodic nature can make them an acute risk while they are ongoing. However, given their pathogenic potential, inherently close proximity to urban populations, and the principle of focusing on those sources within our control, best management practices that reduce the number and volume of SSOs should remain as a priority in the region.

Conclusion

Bacteria impairments continue to be the leading water quality issue throughout the region. High bacteria concentrations in area waterways have the potential to cause gastrointestinal illness to those who come into direct contact with contaminated waters. Analysis of WWTF DMRs and SSO violation reports provides a means by which decision makers and water resource managers can evaluate the role wastewater infrastructure plays in regional water quality issues.

Based on the analysis of bacteria permit limit exceedances reported through WWTF DMRs between 2012 and 2016, WWTF effluent discharges are not likely a significant driver of regional bacteria impairments due to the comparatively few exceedances and the relatively small volumes of effluent discharges overall. Analysis of SSO violations indicates that although the bacteria concentrations contributed into area waterways from each event are significant, the intermittent and irregular nature of SSOs in conjunction with relatively minor overflow volumes overall does not make them a primary driver of bacteria impairments in the region. However, given their pathogenic potential, inherently close proximity to urban and suburban populations, and the principle of focusing on those sources within our control, best management practices that reduce the number and volume of SSOs should remain as a priority in the region. Additionally, although SSO reports provide information about surface overflows, leaking pipelines and illicit discharges are more difficult to track and may be significant contributors of bacteria to area waterways. Additional targeted bacteria monitoring projects are recommended to improve the identification of such bacteria sources.

Due to aging infrastructure and continued population growth in the region, the integrity of treatment and collection systems may be adversely impacted leading to an increase in WWTF bacteria permit exceedances, SSO events, and leaking pipelines. It is important to continuously monitor these systems over time to ensure best management practices, repairs, or system replacements are implemented in areas that need it most. Active maintenance of collection and treatment systems becomes increasingly important in extreme weather conditions such as during a drought or following a flood event.