HOUSTON-GALVESTON AREA COUNCIL

2020 WATER QUALITY MANAGEMENT PLAN UPDATE

Water Quality Planning for the Houston-Galveston Region

Houston-Galveston Area Council

Texas Commission on Environmental Quality

EPA United States Environmental Protection Agency

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

FINAL REPORT for CONTRACT NO. 582-20-10169

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WATER QUALITY MANAGEMENT PLAN UPDATE
Fiscal Year 2020

PREPARED IN COOPERATION WITH THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY AND U.S. 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 582-20-10169.

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ABBREVIATIONS LIST

BIG	Bacteria Implementation Group
CCN	Certificate of Convenience and Necessity
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DMR	Discharge Monitoring Report
EPA	United States Environmental Protection Agency
FOG	Fats/Oils/Grease
FY	Fiscal Year
GBEP	Galveston Bay Estuary Program
GIS	Geographic Information System
GPS	Global Positioning System
H-GAC	Houston-Galveston Area Council
HCPC	Harris County Pollution Control
MGD	Million gallons per day
MPN	Most Probable Number
MUD	Municipal Utility District
NCTCOG	North Central Texas Council of Governments
NRAC	Natural Resources Advisory Committee
NRCS	Natural Resources Conservation Service
OSSF	On-Site Sewage Facility
PCR	Primary Contact Recreation
PUC	Public Utility Commission of Texas
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QPR	Quarterly Progress Report
Region	Houston-Galveston region
SAB	Service Area Boundary
SEP	Supplemental Environmental Project
SSO	Sanitary Sewer Overflow
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TSWQS	*Texas Surface Water Quality Standards*
TWC	Texas Water Code
TWDB	Texas Water Development Board
USDA	United States Department of Agriculture
WCID	Water Control and Improvement District
WISE	Water Innovation Strategies of Excellence
WPP	Watershed Protection Plan
WQMP	Water Quality Management Plan
WWTF	Wastewater Treatment Facility

PHOTO: Tree-lined water feature, The Woodlands

INTRODUCTION

Within the Houston metropolitan region and surrounding counties, there are a variety of water quality issues, particularly those caused by elevated levels of bacteria. Contaminants from both point and nonpoint sources continue to impair the region's streams, rivers, lakes, and bays. To address water quality impairments and concerns and implement watershed-based plans, it is important to have current and accessible data, including geospatial data of regional wastewater infrastructure. Evaluating effluent discharge quality and quantity, as well as the frequency, amounts, and potential causes of unauthorized discharges, is also an important component of planning efforts to address water quality in the region.

The Houston-Galveston Area Council's (H-GAC) regional Water Quality Management Plan (WQMP) helps to address the water quality issues affecting the region by acquiring, compiling, and analyzing water and wastewater data and subsequently making this data accessible to various programs, projects, and stakeholder groups who use the data for planning purposes. The WQMP is updated annually, and these updates are used to guide planning and implementation measures to support current and future efforts and inform decision-makers in their evaluations.

The WQMP Update is a report from the Houston-Galveston Area Council on the Fiscal Year (FY) 2020 activities conducted under Contract 582-20-10169, with funding through a Clean Water Act (CWA) § 604(b) grant by the Texas Commission on Environmental Quality (TCEQ). This report will focus on the progress achieved in the primary task objectives set forth in the Project Scope of Work. These tasks are:

- Project Administration
- Quality Assurance
- Wastewater Data Update and Coordination – Geographic Information System (GIS)
- Support Watershed Planning
- On-Site Sewage Facility (OSSF) Planning, Support, and Outreach Activities
- WQMP Update (Final Report)

The H-GAC's WQMP Update Report will become part of the State's Water Quality Management Plan after completion of its public participation process, acceptance by the H-GAC's Board of Directors, and certification by the TCEQ.

PROJECT BACKGROUND & SIGNIFICANCE

WATER QUALITY MANAGEMENT PLAN BACKGROUND

The H-GAC is a voluntary association of local governments in the Houston-Galveston region (Region), an area that covers approximately 12,500 square miles and is home to more than 7 million people. H-GAC's service area encompasses 13 counties: Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, Walker, Waller, and Wharton (Map 1). H-GAC is the designated water quality planning agency for the Region and is responsible for the development of the regional WQMP.

The annual WQMP Updates are used to guide planning for implementation measures that control and/or prevent water quality problems. The purpose of this WQMP Update is to support current and future planning decisions concerning water quality efforts, wastewater infrastructure development, watershed management, and related issues on both a regional and state level.

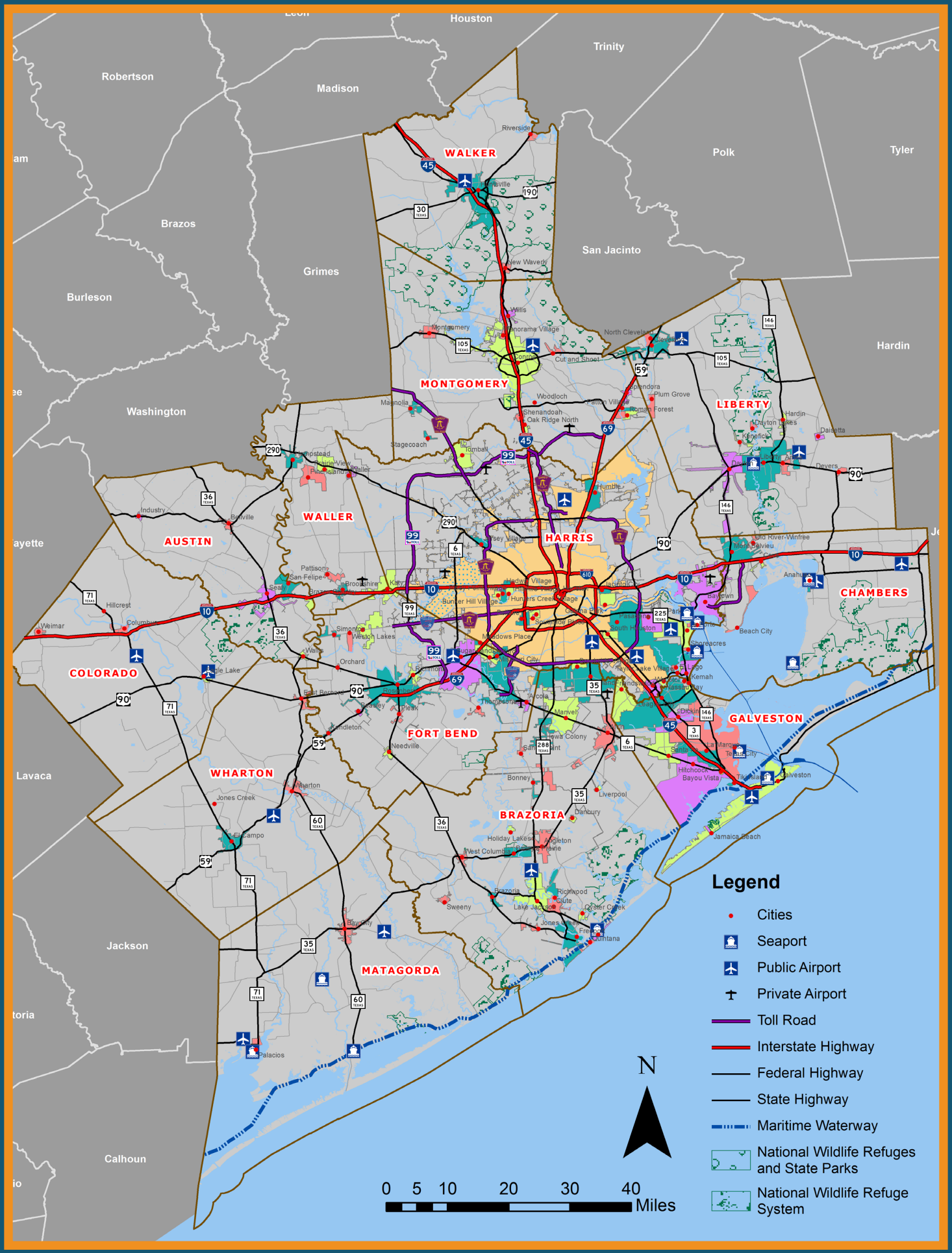
Development of the WQMP Update involves acquiring, compiling, and evaluating water and wastewater data, as well as a series of special studies and coordination activities, as requested by the State. The data and information compiled by H-GAC is combined with data from the TCEQ to form a series of integrated datasets to allow for meaningful evaluation of infrastructure and water quality decisions.

The Clean Water Act requires the WQMP to be updated as needed to fill information gaps and to revise earlier approved and certified plans. Any updates to the plan need include only the elements of the plan that are new or require modification. This update revises only the information specifically addressed in the included sections. Previously certified and approved WQMPs remain in effect.

The annual WQMP Update is reviewed by the Natural Resources Advisory Committee (NRAC), a policy and technical advisory committee that advises H-GAC's Board of Directors on issues related to natural resources. Its membership includes diverse representatives from local governments, natural resource management agencies, environmental organizations, and the private sector. An opportunity is provided to both the NRAC and the public to review and submit comments on the WQMP Update before the report is finalized. After review, comments are incorporated into the report to produce the final plan, which is submitted to H-GAC's Board of Directors. Once accepted by the Board, the report is submitted to the TCEQ for review and approval. H-GAC's WQMP Update will become part of the State WQMP after it is certified by the TCEQ.

Under previous WQMP projects, H-GAC sought to address aspects of the information and data needs related to water quality issues facing the Region. These projects typically have been a mix of both ongoing efforts and short-term special studies. Some of the project efforts have been continuous, such as wastewater data collection and maintenance. Other efforts have been stand-alone research relating to specific data needs or questions, such as GIS analyses for infrastructure consolidation, Phase II stormwater permit implementation, support for the Coastal Communities project, etc. This balance of continuous and stand-alone efforts allows for the long-term accumulation of data while retaining flexibility to address specific issues.

The ongoing efforts in the FY 20 WQMP project focused on updating and improving existing regional wastewater infrastructure databases (wastewater treatment facility outfalls and service area boundaries) and spatial datasets of OSSF locations, support of local watershed-based plans, and coordination and public outreach in support of a Supplemental Environmental Project (SEP) to repair or replace failing OSSFs within the Region.

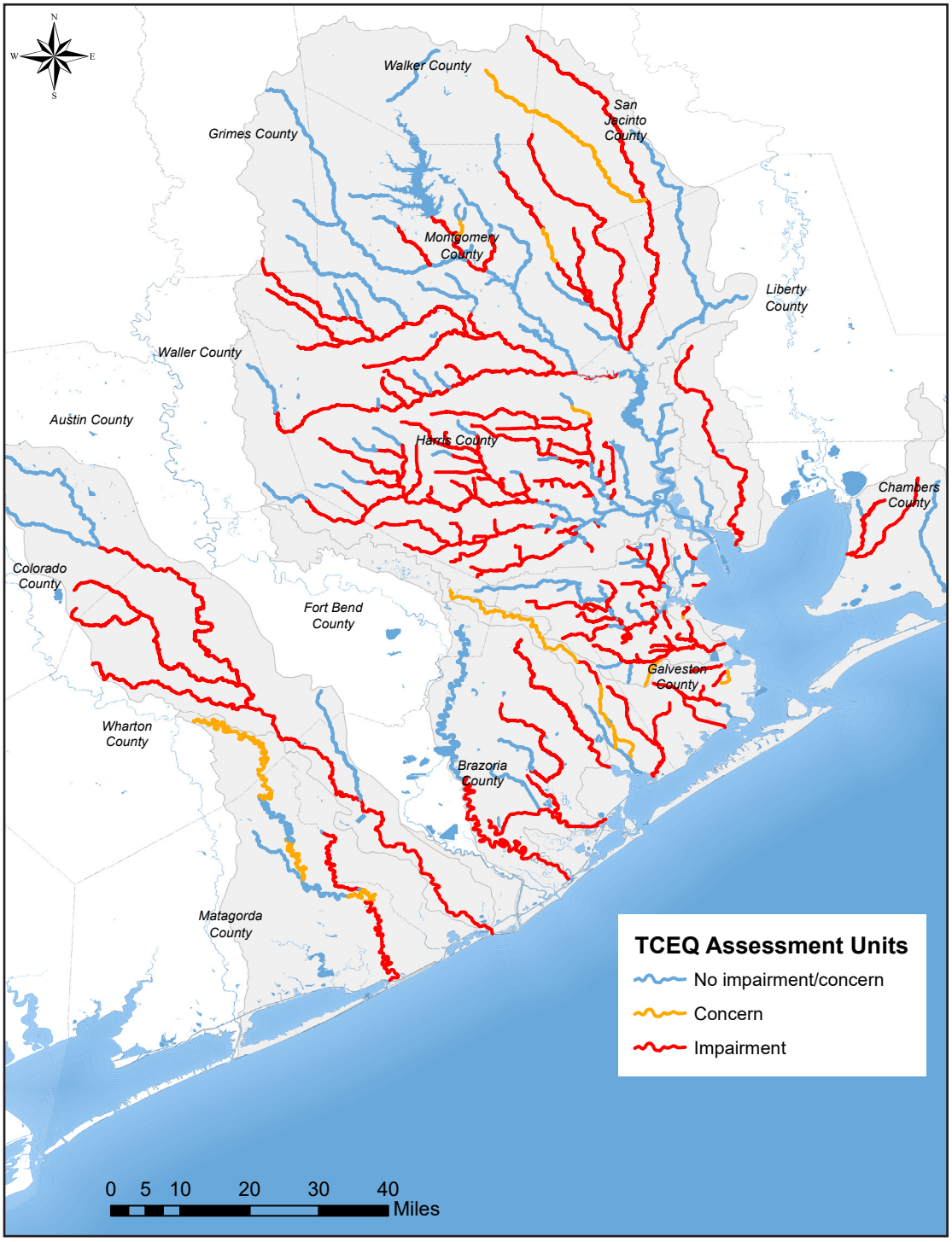


MAP 1: H-GAC Regional Map

SIGNIFICANCE

Already one of the largest metropolitan statistical areas in the United States, the Houston-Galveston Region continues to grow at a rapid pace, resulting in a proportional increase in population growth and land development. Development, and its accompanying utility infrastructure, continues into counties beyond the urban core. Existing water and wastewater infrastructure systems continue to age and face challenges related to drought and flooding events. With the Region expected to gain several million additional residents by 2040, these challenges will only be exacerbated.

Within the Region, there are a variety of water quality impairments and concerns. The majority of stream segments in the Region fail to meet the water quality standards as defined in the *Texas Surface Water Quality Standards* (TSWQS). Many of those water bodies are listed with impairments or concerns in the 2018 *Texas Integrated Report of Surface Water Quality*. Approximately 80 percent of the Region's streams are unable to meet one or more state water quality standards, with the most pervasive issue being elevated bacteria levels in exceedance of the primary contact recreation standard (Map 2).



MAP 2: Regional Bacteria Impairments and Concerns (from the 2018 Integrated Report)

42%

Percentage of stream miles in the Houston-Galveston Region that are impaired due to elevated levels of bacteria (2018 Texas Integrated Report)

The bacteria in the Region's lakes, creeks, streams, and bayous 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, such as discrete "end-of-pipe" discharges, or diffusely through nonpoint sources, carried by precipitation runoff flowing over the land. While some bacteria are naturally occurring, development brings additional bacterial sources and a greater potential impact to water bodies. Careful planning is necessary to address these additional sources.

PHOTO: Discharge pipe on Canal C-147 (City of Houston)

PHOTO: Saw-tooth weir, League City Wastewater Treatment Facility

In addition to the identified water quality issues, numerous developmental challenges exist in the Region as well. The wastewater infrastructure that serves the Region's increasing population has expanded and developed much like the Region itself. As the population has expanded and spread into less urban areas, there has been a proliferation of smaller-sized wastewater treatment facilities (WWTFs) and the creation of a diffuse network of infrastructure to provide utility service to this population. This is partially due to the area's flat topography, as larger centralized WWTFs would require a significant number of costly lift stations to consolidate flow. Due to the availability to fund infrastructure through political subdivisions like Municipal Utility Districts (MUDs) and other special districts, many areas of the Region have a wastewater treatment network that is relatively widespread and diffuse rather than limited by the bounds of a traditional, centralized model. Development through this model has created a patchwork of wastewater infrastructure, which offers both future challenges and opportunities for local decision-makers.

One objective of this WQMP is to collect and analyze data related to wastewater infrastructure in the Region. Wastewater infrastructure is a potential contributor of bacteria into area waterways through improperly treated effluent discharges, or through sanitary sewer overflows (SSOs) from the treatment facilities or throughout the collection systems. Self-reported data from WWTF Discharge Monitoring Reports (DMRs) and SSO violation reports can be analyzed to better evaluate the potential impacts these sources have on bacteria impairments throughout the Region. As the population continues to increase at a rapid pace and the infrastructure continues to age, the integrity of these treatment and collection systems may be harmed. It is important to continuously monitor these systems over time to ensure decision makers and water resource managers have the necessary information to implement best management practices, repairs, or system replacements in areas with the most need.

The population is expected to continue to rapidly grow in the coming decades, and the ability to make informed decisions regarding water quality and wastewater infrastructure development will be crucial in planning for the Region's future. The accumulation, maintenance, and analysis of regional wastewater and effluent quality data can help inform regional solutions to water quality issues.

PHOTOS: Sanitary Sewer Overflows

In areas that are not served by a sanitary sewer collection system, which includes a sizable portion of the Region, wastewater is treated through use of decentralized OSSFs (such as aerobic treatment units or conventional septic systems). These OSSFs collect, treat, and disperse wastewater generated by a home or business.

When properly designed, sited, and maintained, these systems are an effective form of wastewater treatment. However, if an OSSF fails, which can occur for numerous reasons (improper design, system overload, improper operation, mechanical failure, lack of proper maintenance, etc.), it can contribute to groundwater or surface water contamination. One of the objectives of the WQMP is to maintain a geospatial database of permitted OSSFs, and an estimation of locations of unpermitted OSSFs, which are typically those "grandfathered" systems that were installed prior to the State requirement that these systems be permitted.

PHOTO: Installation of a new aerobic On-Site Sewage Facility in Brookshire (Waller County)

From a regional perspective, the water quality and wastewater infrastructure decisions facing the Region are more effectively considered on a watershed basis, as contaminants do not adhere to political boundaries along waterways. This is particularly important for watersheds that serve as significant sources of drinking water, such as Lake Houston. H-GAC maintains a large store of relevant and accessible data to provide useful information, analysis, and viable recommendations. The data collection and analysis tasks completed under this WQMP Update project have significant value for a variety of efforts in the Region, such as the development of watershed protection plans (WPPs) or Total Maximum Daily Loads (TMDLs) to address known water quality issues in local waterways.

HOW DOES H-GAC UTILIZE THE DATA ACQUIRED THROUGH THE WATER QUALITY MANAGEMENT PLAN PROJECT?

Internal Data Collection and Regional Data Sharing

The wastewater permit data, service area boundaries, and OSSF location data acquired and/or collected under this WQMP Update project serve to augment existing data sets, 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, data were used by the Houston-area Bacteria Implementation Group (BIG) and Basins 11 and 13 TMDL efforts, the Galveston Bay Estuary Program (GBEP), the Clean Rivers Program, and others.

Regional Project Coordination

Maintaining and expanding data resources allows the H-GAC and TCEQ to better understand and facilitate regional coordination between parties involved in wastewater infrastructure decisions and general water quality/watershed protection efforts. Participation in regional groups and coordination efforts helps ensure decisions benefit from the resources compiled under the WQMP.

Source Water Protection

A large portion of the Region's population is served by treated surface water originating in local rivers and lakes. The infrastructure planning and watershed coordination activities of this WQMP Update project help foster a greater understanding of the relationship between water quality issues and steps to help protect drinking water sources.

Project Review

Data and analyses allow H-GAC staff to assist state and federal granting agencies in the review of regional grant applications. These reviews ensure potential projects concur with regional priorities and regional data projections.

Education and Outreach

Data gathered under this WQMP Update project have been used as a focal point or basis for several education efforts, including the OSSF location database and various facilitated meetings, such as the ongoing NRAC.

The Bacteria Implementation Group

Data gathered through the WQMP Update are used to inform numerous projects within the Region, including the Clean Rivers Program and numerous WPPs and TDMLs. One of the ways the Region is addressing bacteria issues is through projects such as the BIG. The BIG is a partnership between H-GAC, local governments, businesses, and community leaders who developed and implement a shared plan to reduce bacteria. The BIG Project area (MAP 3) is a combination of more than 100 TMDLs in adjacent watersheds.

One of the recommendations implemented through the BIG was an initiative to lower the standard bacteria permit limit to 63 MPN/100 mL (most probable number per 100 milliliters) for some wastewater permittees in the BIG project area. This regulatory initiative, and other non-regulatory activities, contribute to continued water quality improvement in the BIG area. Although overall bacteria levels for both the BIG area and the Region have shown a gradual improvement since 2006, bacteria geometric mean values for the Region continue to be significantly greater than the State standard for primary contact recreation (Figure 1).

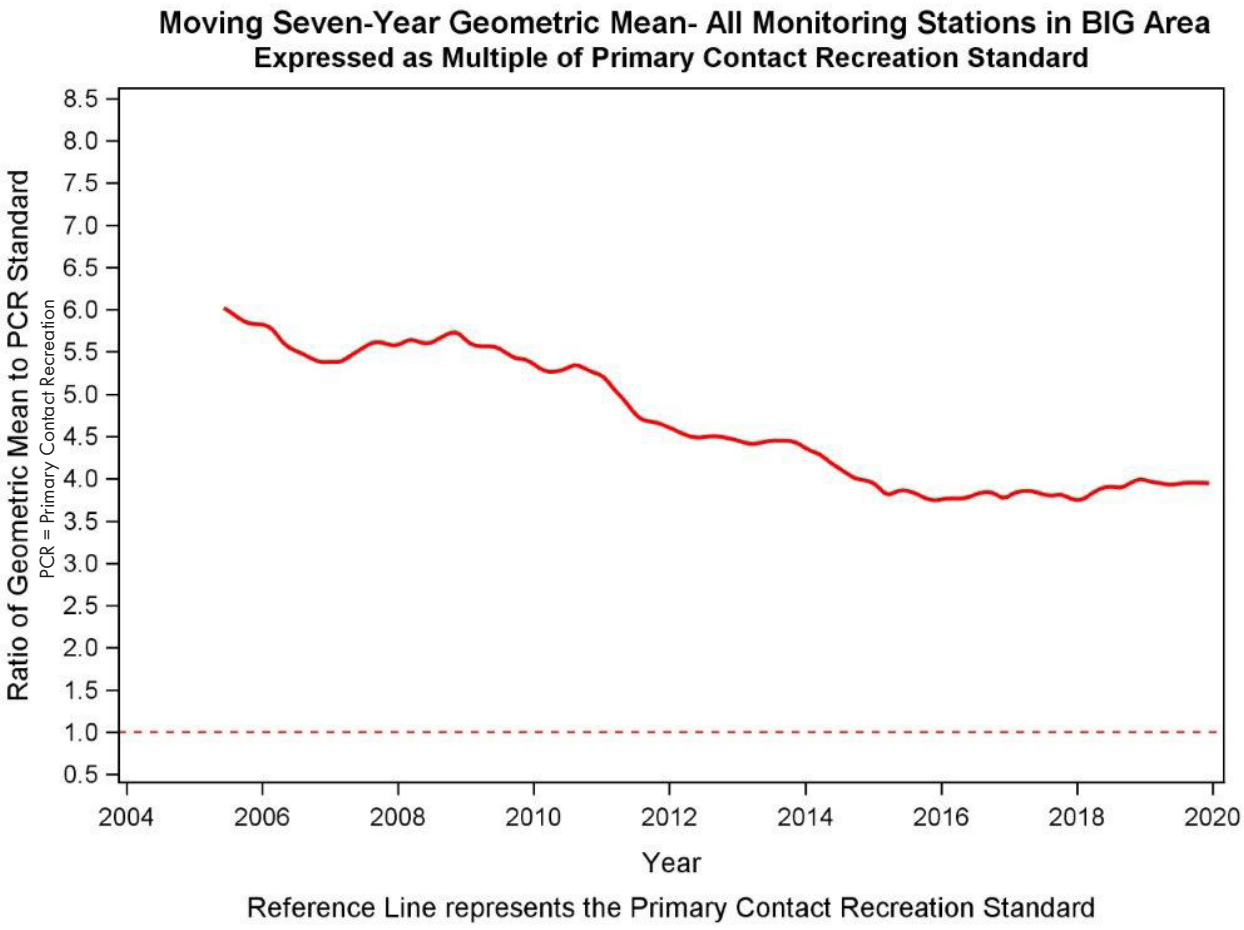


FIGURE 1: Moving Seven-Year Bacteria Geometric Mean Plot for the Region and BIG Area

MAP 3: Bacteria Implementation Group (BIG) Project Area

PHOTO: Tributary of San Bernard River

PROJECT OBJECTIVES

OVERVIEW OF PROJECT TASK OBJECTIVES

The WQMP Update is a report from H-GAC on the FY 2020 activities conducted under Contract 582-20-10169, with funding through a Clean Water Act § 604(b) grant by the U.S. EPA and administered through the TCEQ.

This report focuses on the progress achieved in the primary Task Objectives set forth in the Project Scope of Work. The report is organized as a series of Task Reports with each Task Objective discussed separately. These Task Objectives are:

- Task 1: Project Administration
- Task 2: Quality Assurance
- Task 3: Wastewater Data Update and Coordination – Geographic Information System (GIS)
- Task 4: Support Watershed Planning
- Task 5: On-Site Sewage Facility (OSSF) Planning, Support, and Outreach Activities
- Task 6: WQMP Update (Final Report)

Table 1 describes each objective as defined in the Contract Scope of Work.

Each of the primary project Task Objectives serves to maintain, expand, or implement H-GAC's store of water quality and wastewater infrastructure data, or provide related services to the Region. Each Task Objective is described in a separate section of the WQMP Update report, and includes methodologies, results and observations, and discussion (as appropriate). A series of interim deliverables were required for each project objective. This report provides a description of the methodologies used to complete these contractual deliverables. Some of the deliverables generated for this project are large electronic data sets unsuitable for full inclusion in a printed version of this Final Report. However, copies of the full electronic data are available, with representative portions of the data included in thisl report.

For some analyses presented in this report, such as the wastewater treatment facility outfalls, a 15-county area (to include Grimes and San Jacinto counties) is considered due to the location of watersheds of interest. These counties are included in the area monitored by H-GAC as part of its ambient surface water quality monitoring program, known at the Clean Rivers Program.

TABLE 1: Project Task Objectives

#	Task Objective	Task Description
1	Project Administration	To effectively coordinate and monitor all technical and financial activities performed under this contract, prepare regular progress reports, and manage project files and data.
2	Quality Assurance	To update or develop Quality Assurance Project Plans (QAPPs) for acquired and geospatial data to ensure environmental data acquired is of known and acceptable quality.
3	Wastewater Data Update and Coordination - Geographic Information System (GIS) Update	To collect and integrate wastewater infrastructure and permit data to support planning for wastewater treatment facilities and water quality projects in H-GAC's region, and to support TCEQ in their WQMP Update process.
4	Support Watershed Planning	To support watershed planning in H-GAC's region, including the San Bernard River Watershed, and to support regional information sharing on water quality and related topics, such as urban forestry and Total Maximum Daily Load (TMDL) projects.
5	On-Site Sewage Facility (OSSF) Program Support - Planning, Support, and Outreach	To administer and coordinate H-GAC's On-Site Sewage Facility program activities. These activities include maintaining and continuing to develop H-GAC's existing spatial database of permitted OSSFs and projected unpermitted OSSF locations to support regional water quality and wastewater infrastructure projects, and coordination of H-GAC's Supplemental Environmental Project (SEP) to repair or replace failing OSSFs within the watershed, and H-GAC's outreach and education programs.
6	Water Quality Management Plan Update (Final Report)	To summarize all contract activities and findings that are relevant to the water quality goals of the region in a Draft WQMP Update. In accordance with Texas Water Code Section 26.037, H-GAC will provide a notice of participation to review the Draft WQMP Update. H-GAC will incorporate all comments received, including those by the Natural Resources Advisory Committee (NRAC), to prepare and provide to TCEQ a comprehensive final report on the water quality management planning activities. H-GAC will provide documentation that H-GAC's Board of Directors has accepted the completed WQMP Update.

TASK 1: PROJECT ADMINISTRATION

TASK DESCRIPTION
The goal of this Task is to effectively coordinate and monitor all technical and financial activities performed under the Water Quality Management Planning contract, Contract Number 582-20-10169, prepare regular progress reports, conduct quarterly conference calls, and manage project files and data.

SCOPE OF WORK

The following Subtasks are included in the Scope of Work under this project task:

- Subtask 1.1: Project Oversight
- Subtask 1.2: Quarterly Progress Reports
- Subtask 1.3: Reimbursement Forms
- Subtask 1.4: Contract Communication
- Subtask 1.5: Draft Project Summary
- Subtask 1.6: Final Project Summary

TASK OBJECTIVES

Project Oversight

As part of the *Project Oversight* for the WQMP Update project, H-GAC staff provides technical and fiscal oversight to ensure tasks and deliverables are acceptable and are completed as scheduled and within budget.

The contract has an effective period of September 1, 2019 to August 31, 2020 (FY 20), with a budget of $136,588.00. Newly included in the Scope of Work for the FY 20 contract was public outreach support for Total Maximum Daily Load projects in the Houston area. This work includes support activities for the BIG, Oyster Creek, and Chocolate Bayou TMDL projects. These activities are included in Subtask 4.4.

Quarterly Progress Reports

Following the end of each state fiscal quarter, H-GAC staff submit *Quarterly Progress Reports* (QPRs) to TCEQ. These reports contain a level of detail sufficient to document the activities that occurred under each Task during the quarter. The QPRs also contain a comprehensive tracking of deliverable status for the Project.

Reimbursement Forms

Reimbursement Forms are submitted at the end of each quarter for work performed to complete the Tasks of the contract Scope of Work.

Contract Communication

H-GAC staff maintain *Contract Communication* with TCEQ project management staff regarding the status and progress of the project. These activities include quarterly conference calls to discuss task status, financial status, specific deliverables, quality assurance project plan development and updates, and contract amendments.

Draft Project Summary

A *Draft Project Summary* summarizes activities completed under this Project. This report is due to TCEQ by the 15th of the month following the last quarter of the project. H-GAC will respond to and address any TCEQ comments.

Final Project Summary

The *Final Project Summary* summarizes activities completed under this Project. This report is due to TCEQ by the 30th day of the month following the last quarter of the project.

TASK 2: QUALITY ASSURANCE

TASK DESCRIPTION

The goal of this task is to update and develop Quality Assurance Project Plans (QAPPs) that are consistent with EPA requirements for QAPPs for acquired or geospatial data. QAPPs ensure environmental data that is acquired is of known and acceptable quality.

SCOPE OF WORK

The following Subtasks are included in the Scope of Work under this project task:

- Subtask 2.1: QAPP Planning Meeting
- Subtask 2.2: QAPP Annual Review Certification
- Subtask 2.3: QAPP Amendments

TASK OBJECTIVES

A QAPP is a formal document outlining the procedures a project will use to ensure that data collected and analyzed as part of the project are of known and adequate quality and meet specific project requirements. This task involves the maintenance and updating of QAPPs related to the acquisition of existing data and the preparation of geospatial data for this Project.

Historically, data have been collected and analyzed under two project-specific QAPPs: These were the *H-GAC Regional Water Quality Data Acquisition and Compilation QAPP* and the *H-GAC Regional Geospatial Data QAPP*. Beginning with the FY 20 Project year, these QAPPs were combined into one document. This document, the *H-GAC Water Quality Management Plan Data Acquisition and Geospatial Data Quality Assurance Project Plan*, was approved by TCEQ on December 10, 2019. Adherence to this QAPP ensures that all data are collected and analyzed in a manner appropriate for the data objectives of this project.

QAPP Planning Meeting

The *QAPP Planning Meeting* allows H-GAC and TCEQ project staff to determine the format and content of QAPPs for the project tasks. H-GAC and TCEQ staff formally discussed the QAPP for the WQMP Update Project as part of the project kickoff conversation on September 30, 2019. This meeting was held in Austin, TX, in conjunction with the TCEQ Non-Point Source Post Award Meeting. The outcome of the meeting was a confirmation of the elements covered by the project QAPPs and an agreement to combine the two project QAPPs to create a consolidated QAPP.

QAPP Annual Review Certification

Through the *QAPP Annual Review Certification* process, H-GAC submits documentation certifying its annual review of project QAPPs. QAPPs are reviewed annually to ensure policies and procedures are up-to-date. QAPPs for this project are effective for three years (spanning multiple project years) and must be reviewed and recertified annually as part of the Annual Review Certification. Because the previous QAPPs were revised and consolidated into one QAPP this project year, an annual review was not necessary. The next annual review certification will be due by December 10, 2020, which is one year from the effective date of the current QAPP.

QAPP Amendments

Any necessary changes to QAPPs are made through a *QAPP Amendment*. Amendments to the QAPP may be necessary to reflect changes in project management, tasks, schedules, objectives, or methods. QAPP amendments may be initiated to address deficiencies and non-conformances, improve operational efficiency, or accommodate unique or unanticipated circumstances.

As the QAPP for this year's project was completely revised with the creation of the consolidated QAPP, amendments to the QAPP were not needed for the current project year. If there are any changes next project year, the QAPP will be amended as part of the Annual Review Certification, to be completed by December 10, 2020.

WASTEWATER DATA UPDATE AND COORDINATION

PHOTO: Wastewater Infrastructure (League City)

TASK 3: WASTEWATER DATA UPDATE AND COORDINATION

TASK DESCRIPTION

The goal of this task is to collect and integrate wastewater infrastructure and permit data to support planning for wastewater treatment facilities and water quality projects in the Houston-Galveston region and to support TCEQ in their WQMP Update process.

SCOPE OF WORK

The following Subtasks are included in the Scope of Work under this project task:

- Subtask 3.1: Wastewater Infrastructure Geographic Information System (GIS) Data
- Subtask 3.2: Wastewater Discharge Monitoring Report (DMR) and Sanitary Sewer Overflow (SSO) Data Analysis
- Subtask 3.3: Clean Water State Revolving Fund (CWSRF) Application Review

TASK OBJECTIVES

WASTEWATER INFRASTRUCTURE GIS DATA OUTFALLS & SERVICE AREA BOUNDARIES

Wastewater Infrastructure Geographic Information System Data

For the Wastewater Infrastructure GIS Data task, H-GAC updates the service area boundaries and related permitted domestic wastewater outfalls for the Region's wastewater collection and treatment facilities and incorporates the information into GIS. The update, prepared annually, includes a map of the boundaries of the wastewater collection systems within the Region and the geographic location of wastewater treatment facility outfalls.

To update the WQMP, H-GAC utilizes a series of data sets related to the Texas Pollutant Discharge Elimination System (TPDES) permitted wastewater facilities in the region. These are the Service Area Boundary (SAB) data set, maintained in-house by H-GAC, and the Wastewater Outfalls data set, maintained by TCEQ. A primary task under this Project is to update and continue to integrate these data sources. To approach this task, H-GAC set out to address the following questions:

- Is there a corresponding service area boundary for every domestic outfall?
- What are the differences between the current and previous outfall locations for current domestic permits?
- Are there any data errors that need to be reported to TCEQ?

The SAB data set is a GIS layer maintained by H-GAC. This file contains a spatial representation of the service area boundaries of the permitted domestic wastewater dischargers in the region. Typically, these boundaries include municipalities, Municipal Utility Districts (MUDs), Water Control and Improvement Districts (WCIDs), other public districts, and private utilities that serve an area greater than a single facility. Industrial permittees are not included in the SAB data set as these dischargers typically only serve a single facility.

The wastewater outfall layer is maintained by TCEQ. This GIS layer identifies the location of TPDES-permitted wastewater treatment facility outfalls for the region. Each year, as part of the WQMP Update process, H-GAC requests an updated wastewater outfalls GIS data set from TCEQ. The data for this year's report were provided by TCEQ on 2/21/20.

H-GAC utilizes data from multiple sources (MUD records, EPA and TCEQ permit databases, etc.) to update the service area boundary and outfall layer data sets. In addition, H-GAC also utilized the Public Utility Commission of Texas' (PUC) Certificates of Convenience and Necessity (CCN) data set to match outfalls to service area boundaries. A CCN grants the holder the exclusive right to provide retail water and/or sewer utility service to a defined geographic area. If a CCN is issued, it may serve as a proxy for the service area boundary, as the CCN holder is required to provide continuous and adequate service within its CCN boundary.

METHODS

The acquisition and analysis of wastewater infrastructure data, including wastewater outfall locations, adhered to updated QAPPs and quality assurance/quality control (QA/QC) methods.

The Wastewater Outfalls data set is available for download from TCEQ's website at the following URL:

https://gis-tceq.opendata.arcgis.com/datasets/wastewater-outfalls

The data on TCEQ's website is updated quarterly. To assure that the data acquired for this project was the most accurate and up-to-date, TCEQ staff were contacted by email and a request was made for the most recent version of the data set. An updated Wastewater Outfall GIS layer was acquired from TCEQ on 2/21/20.

For this Project, H-GAC examined the domestic wastewater outfalls in the 15-county region. In the metadata for the GIS layer provided by TCEQ, the outfalls are classified with descriptors. The outfalls examined for this project include those categorized as "D" or "W" in the data dictionary. The "D" category represents domestic outfalls at <1 MGD (millions of gallons per day) domestic sewage. The "W" category includes wastewater outfalls ≥1 MGD domestic sewage or process water, including water treatment facility discharge. As the focus of this analysis is on domestic discharges, the "D" category was automatically included in H-GAC's evaluation. To determine which facilities in the "W" category were domestic and which were industrial, the permit numbers were queried using TCEQ's water quality permit registry, which is located at the following URL:

https://www6.tceq.texas.gov/wqpaq/index.cfm

Permits in the "W" category identified as Public Domestic Wastewater or Private Domestic Wastewater were included in the domestic wastewater outfall layer. Industrial discharges were excluded from analysis, as these are tied to a single location and not a service area.

The service area boundary GIS layer was compared to the previous year's data to determine if data have changed from year-to-year, and if so, to what extent. A manual review of the GIS outfall layer and service area boundaries was performed to identify outfalls without an associated service area boundary. To address small private systems without an associated service area boundary, and to help develop boundaries for these systems, the SAB data set was compared to other sources of boundary data, such as city boundaries and the CCNs available through the PUC. These city boundaries and CCNs can serve as proxies for the service area boundary until H-GAC staff can reach out to the individual entities for verification of their service areas. These proxy boundaries were added to the service area boundary GIS layer.

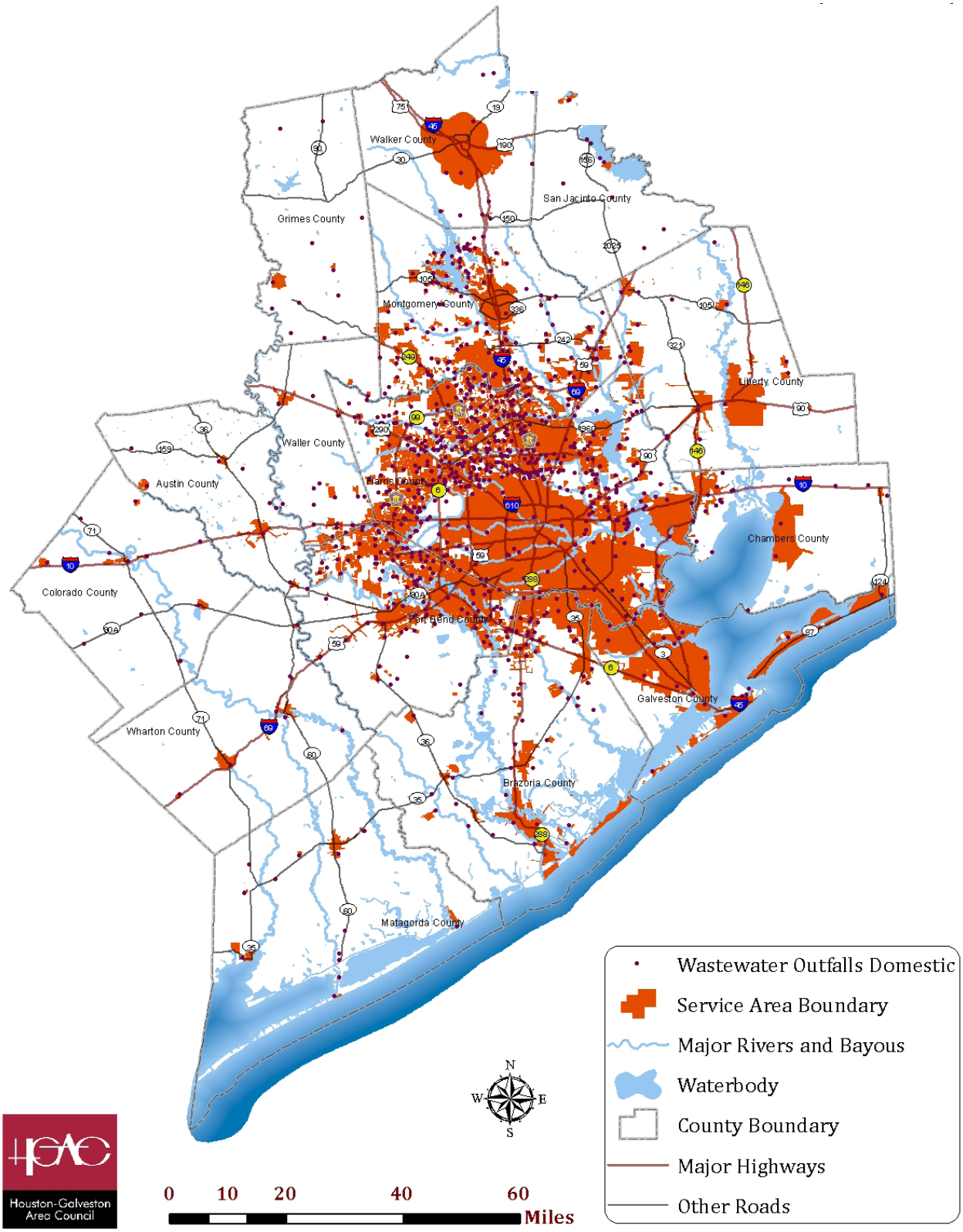
RESULTS AND OBSERVATIONS

The data comparison of year-to-year data showed the removal of 48 permits and the addition of 41 permits.

Map 4 shows the service area boundaries alongside the domestic outfalls. The new Outfalls and Service Area Boundaries GIS layers will be used to inform other programs and projects, such as the Clean Rivers Program, the BIG, and various TMDL and WPP projects.

Updated data sets were submitted to TCEQ in digital format with this report. Copies of these data sets are available upon request.

MAP 4: Domestic Wastewater Outfalls and Service Area Boundaries in the 15-County Region



Data Analysis

The Wastewater DMR Data Analysis for this project involves the acquisition and analysis of self-reported discharge monitoring data for regional permitted facilities. The WQMP Update specifically evaluates bacteria discharges, but other constituents may be evaluated if a waterbody-specific or facility-specific need is identified, or if requested by stakeholders. H-GAC also acquires and analyzes Sanitary Sewer Overflow data for the Region.

DISCHARGE MONITORING DATA ANALYSIS

As part of the analysis for the WQMP Update, H-GAC acquired self-reported DMR data for permitted facilities through TCEQ and EPA to evaluate bacteria permit limit exceedances for the period of 2012–2019.

As defined in the *Texas Surface Water Quality Standards*, the *E. coli* geometric mean criterion for primary contact recreation for ambient surface water is 126 most probable number (MPN) per 100 milliliters (mL), and 399 MPN/100 mL for single grab samples. For enterococci, which is the designated indicator organism for tidal segments, the criterion for the geometric mean is 35 MPN/100 mL, with a single sample criterion of 89 MPN/100 mL. TCEQ does not apply the single sample criterion for their assessment.

In most cases, these standards are generally applied as an effluent permit limit for WWTFs. In the Region, the majority of TPDES permits have effluent limitations set for *E. coli*. However, some permits have enterococci as the indicator organism. Select WWTFs may have more stringent bacteria permit limits depending on site-specific conditions or participation in TMDL projects like the BIG.

Effluent discharges from WWTFs are regulated by TCEQ, with water quality limits specified in each discharger's permit. These effluent discharge limits are monitored by WWTF personnel on a frequency dependent on facilitysize, location, wastewater type (domestic or industrial), and other factors. Results from field measurements (pH, dissolved oxygen, instantaneous flow, etc.) and laboratory analyses (biochemical oxygen demand, total suspended solids, ammonia, etc.) from these required monitoring events are submitted to the TCEQ monthly as a DMR. As with any self-reported data, there is an expectation that some degree of uncertainty or variation from conditions may occur. Additionally, samples are collected at the weir and not at the end of the outfall pipe, so results generated do not take into account potential bacterial regrowth in the outfall pipe. Even with these inherent uncertainties, DMRs are the most comprehensive data available for the broad regional evaluations conducted under the WQMP Update. Evaluating trends in permit exceedances for indicator bacteria is important in understanding the impact WWTFs may have on overall surface water quality.

The data created under this task continues to be widely used by local projects and entities. Water quality protection efforts, including the various watershed protection plans, TMDLs, and the Clean Rivers Program, use the data to guide and inform planning decisions.

METHODS

For this project, H-GAC staff evaluated the occurrence of self-reported bacteria violations through domestic WWTF DMRs in the region for the period of 2012–2019. Evaluations were based on the regulatory permit limits specific to each facility and consider the number of exceedances and bacteria loadings by year and by WWTF size. The data analyzed for this project are self-reported by WWTFs and samples are collected before the end of the outfall pipe, so results do not consider the effect of bacteria regrowth.

The number of permittees can change from year-to-year, and multi-year comparisons are based on the current wastewater outfall GIS layer. Therefore, slight variations may be present from the data presented in this report and previous or subsequent reports. The data presented in this report are accurate as of the date the data being analyzed were

acquired (March 2019), but previous or subsequent data could be slightly different based upon the number of outfalls present at the time of that data acquisition.

DMR data for this Project were acquired from TCEQ and EPA in March 2020. The wastewater outfall GIS layer was acquired from TCEQ on 2/21/20. The acquisition and analysis of wastewater infrastructure data adhered to updated QAPPs and QA/QC methods.

RESULTS AND OBSERVATIONS

Based on the GIS data acquired from TCEQ, there are 1,243 permitted outfalls in the TCEQ Outfall Layer, with the EPA Registry showing 1,231 outfalls. This discrepancy is most likely due to new permits approved by TCEQ but not yet entered into the EPA Registry. Of the permitted systems in the Registry, self-reported DMR data (of any type) were submitted for 1,001 outfalls, with bacteria data being submitted for 881 of the outfalls. Of the permittees submitting bacteria DMR data (either *E. coli* or enterococci), 792 are domestic WWTFs, and 89 are industrial facilities. Table 2 provides a summary of the WWTFs submitting DMR data in 2019. The remainder of the data analysis will focus on the DMR bacteria data, as impairments due to elevated bacteria are the most prevalent water quality issue within the region.

For many of the analyses in this report, WWTFs are evaluated on relative facility size, as categorized by daily flow in millions of gallons per day (MGD). Those facility size categories and the number of facilities per category are shown in Table 3. The total number of dischargers submitting bacteria DMR data shown in Table 2 (881 WWTFs) differs from that in Table 3 (896 WWTFs) due to a difference in the timeframe the data represent. The values shown in Table 2 are based on 2019 data only. The number of WWTFs by size shown in Table 3 are calculated using data from 2012–2019 so permit exceedance rates by year and facility size can be determined.

Within the Region, the largest number of WWTFs are in the <0.1 MGD category, with 31.9% of facilities, followed by those in the 0.1 – 0.5 MGD category at 25.1%. Combined, these two categories represent over half of the permitted domestic facilities submitting

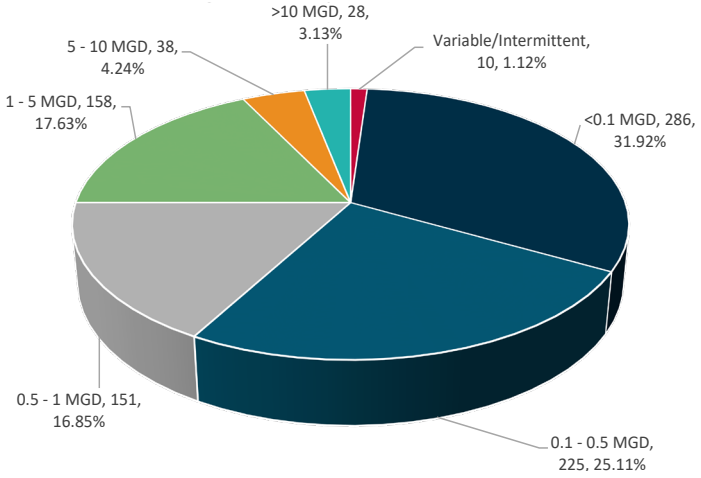
TABLE 2: DMR Data Submission Summary, 2019

WWTF Type	Permittees Submitting DMR Data (any type)	Permittees Submitting DMR Bacteria Data
Domestic	796	792
Industrial	205	89
TOTAL	1001	881

TABLE 3: Number of WWTFs Reporting Bacteria DMR Data by WWTF Relative Facility Size, 2012 - 2019

WWTF Facility Size by MGD	Number of Facilities, 2012 - 2019	Percentage of Facilities
Variable/Intermittent	10	1.1%
<0.1 MGD	286	31.9%
0.1 - 0.5 MGD	225	25.1%
0.5 - 1 MGD	151	16.8%
1 - 5 MGD	158	17.6%
5 - 10 MGD	38	4.2%
>10 MGD	28	3.1%
TOTAL	896	100.0%

FIGURE 2: Percentage of WWTFs by Facility Size (by Flow, in MGD), 2012 - 2019



bacteria data in the Region. Considering the growth patterns within the Region and the proliferation of MUDs and other special districts, it is expected that the number of these smaller facilities would be very high in the region.

WWTFs in the Variable/Intermittent category represent the smallest group, at 1.1% of all facilities. The Variable/Intermittent facilities are typically located at industrial facilities. In 2019, WWTFs within the Region self-reported a combined 8,336 bacteria geometric mean results and 8,670 bacteria single grab sample results. Of these reported results, 87 of the geometric mean results (1.0%) and 304 of the single grab sample results (3.5%) exceeded permit limits (Table 4). These records include only those outfalls with permit limits. Facilities that test and report data but do not have a permit limit are not included in these numbers.

TABLE 4: Bacteria DMR Data Reported and Permit Exceedance Rates, 2019

Bacteria Data Reported	Geometric Mean Results	Daily Maximum or Single Grab Sample Results
Total Results Reported	8,336	8,670
Total Exceeding Limit	87	304
Percent Exceedance	1.0%	3.5%

Geometric mean and single grab bacteria reporting and compliance data for 2019 were evaluated by relative facility size. Table 5 shows the number of geometric mean and single sample results reported, the number exceeding permit limits, and the percent exceedance for each of the WWTF relative facility size categories.

TABLE 5: Bacteria DMR Data Permit Exceedance Rates by Relative Facility Size, 2019

Relative Facility Size	Geometric Mean Results Reported	Geometric Mean Results Exceeding Permit Limit	Geometric Mean Percent Exceedance	Daily Maximum or Single Grab Results Reported	Single Grab Results Exceeding Permit Limit	Single Grab Results Percent Exceedance
Variable/Intermittent	105	8	7.6%	105	9	8.6%
< 0.1 MGD	1,446	20	1.4%	1,512	40	2.6%
0.1 – 0.5 MGD	2,474	27	1.1%	2,569	58	2.6%
0.5 – 1 MGD	1,771	9	0.5%	1,784	47	2.6%
1 – 5 MGD	1,875	16	0.8%	1,877	95	5.1%
5 – 10 MGD	456	4	0.9%	477	27	5.7%
> 10 MGD	321	3	0.9%	346	28	8.1%

WWTFs in the 0.1 - 0.5 MGD category have the largest number of samples reported (both geometric mean and single grab samples), with the smallest number being for facilities in the variable/intermittent category. The variable/intermittent category has the highest percent exceedance for both geometric mean and single grab samples. This is likely due to the smaller number of samples being collected and analyzed, since sampling is only conducted when these facilities discharge. WWTFs in the >10 MGD category had a higher single grab percent exceedance (8.1%) than other categories, most likely due to the higher

frequency of sampling conducted at these facilities. The geometric mean exceedance rate for the >10 MGD category remained low at 0.9%. Overall, rates of compliance were high.

Geometric mean and single grab bacteria sampling and compliance data were also evaluated by year. Table 6 shows the number of geometric mean and single grab sample results reported, the number exceeding permit limits, and the percent of samples exceeding permit limits for each year (2012 - 2019).

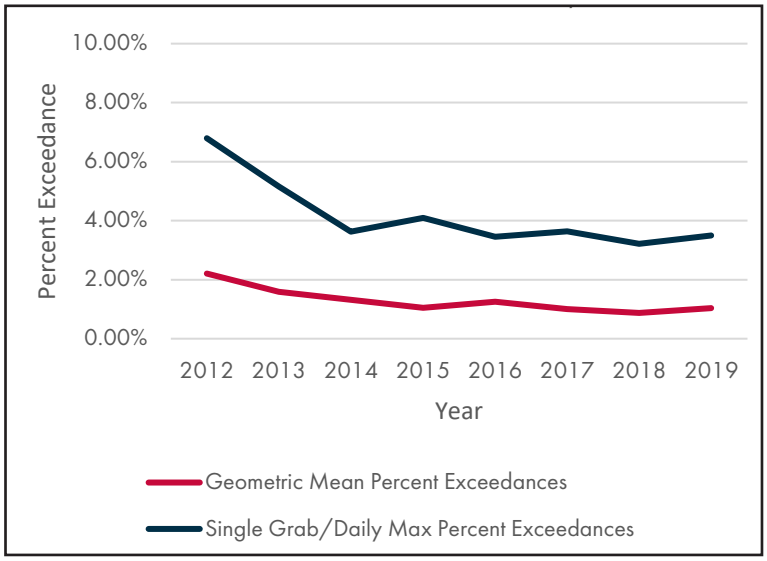
TABLE 6: Bacteria DMR Data Permit Exceedance Rates by Year, 2012 - 2019

Year	Total Geometric Mean Results Reported	Samples Exceeding Geometric Mean Permit Limit	Geometric Mean Percent Exceedances	Total Grab/Max Results Reported	Samples Exceeding Single Grab/Daily Max Permit Limit	Single Grab/ Daily Max Percent Exceedances
2012	3,748	83	2.2%	4,076	277	6.8%
2013	5,542	88	1.6%	6,002	310	5.2%
2014	6,651	88	1.3%	7,158	260	3.6%
2015	7,241	76	1.0%	7,867	322	4.1%
2016	7,536	95	1.3%	8,043	278	3.5%
2017	7,776	78	1.0%	8,262	301	3.6%
2018	7,871	69	0.9%	8,407	271	3.2%
2019	8,336	87	1.0%	8,670	304	3.5%

In general, results indicate a small number of bacteria permit exceedances are reported annually. For 2019, 87 of 8,336 geometric mean results, or 1.0%, were reported as exceedances. Of the 8,670 single grab samples reported, 304 results, or 3.5%, were reported as permit exceedances in the self-reported DMR data. Overall, permit compliance is high, with 99.0% of geometric mean results and 96.5% of single grab samples being within compliance with effluent permit limits.

Compared to previous years, the bacteria DMR permit exceedance rates appear to be decreasing, particularly in regards to the single grab/daily maximum samples (Figure 3). Further evaluation is necessary to determine if this decrease is statistically significant, and if so, if there has been a change in conditions (such as operational changes, TMDL implementation, etc.) that may be resulting in this observation.

FIGURE 3: Bacteria DMR Data Permit Exceedance Rates by Year, 2012 - 2019

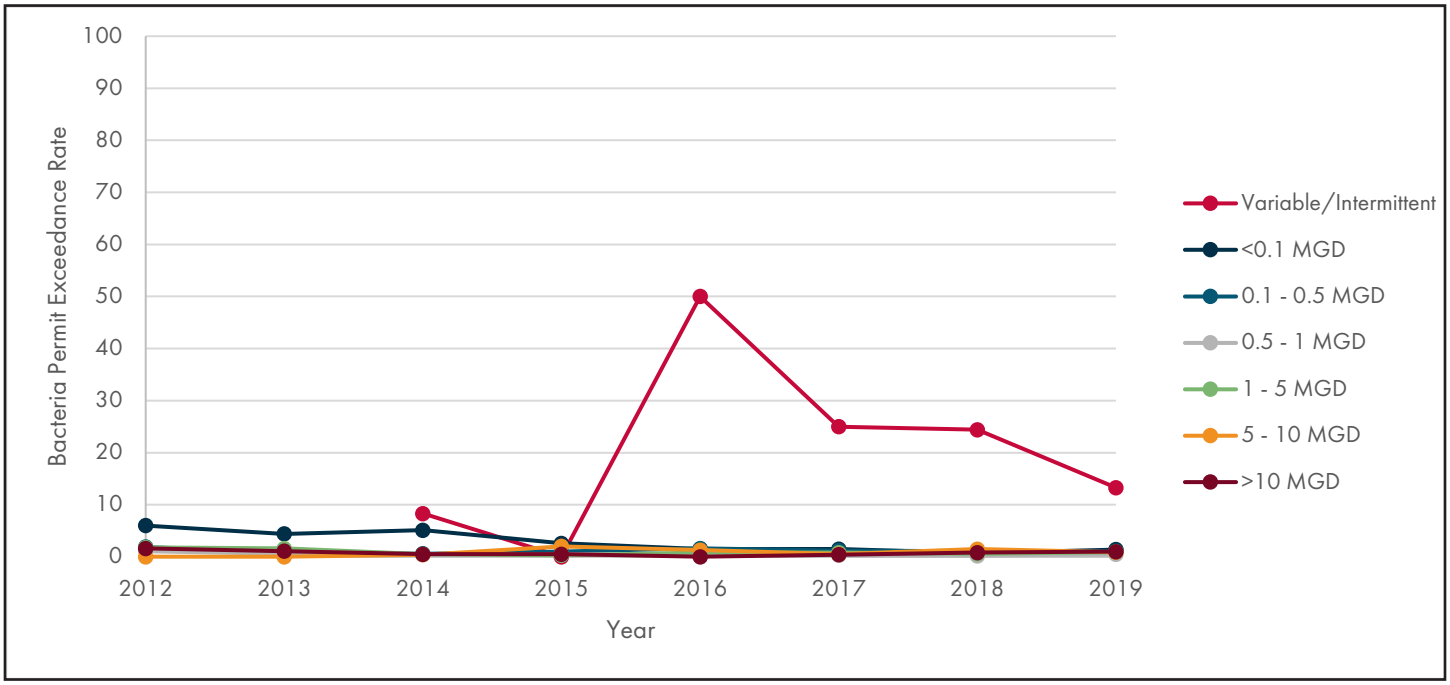


Bacteria DMR permit exceedance data were also analyzed by year and relative facility size. Table 7 and Figure 4 show the bacteria permit limit exceedance rates for each facility size category for geometric mean samples for the period of 2012–2019.

TABLE 7: Bacteria DMR Data Geometric Mean Permit Exceedance Rates by Relative Facility Size and Year, 2012 - 2019

Relative Facility Size	2012	2013	2014	2015	2016	2017	2018	2019
Variable/Intermittent	-	-	8.3%	0.0%	50.0%	25.0%	24.4%	13.3%
<0.1 MGD	6.0%	4.4%	5.1%	2.6%	1.5%	1.5%	0.7%	1.4%
0.1 - 0.5 MGD	1.9%	0.9%	0.6%	1.0%	1.6%	1.2%	1.1%	1.1%
0.5 - 1 MGD	1.1%	0.6%	0.4%	0.5%	0.4%	0.3%	0.2%	0.5%
1 - 5 MGD	1.8%	1.6%	0.5%	0.3%	0.8%	0.8%	0.6%	0.9%
5 - 10 MGD	0.0%	0.0%	0.4%	2.0%	1.3%	0.5%	1.5%	0.9%
>10 MGD	1.6%	1.1%	0.5%	0.5%	0.0%	0.4%	0.8%	1.0%

FIGURE 4: Bacteria DMR Data Geometric Mean Permit Exceedance Rates by Relative Facility Size and Year, 2012 - 2019



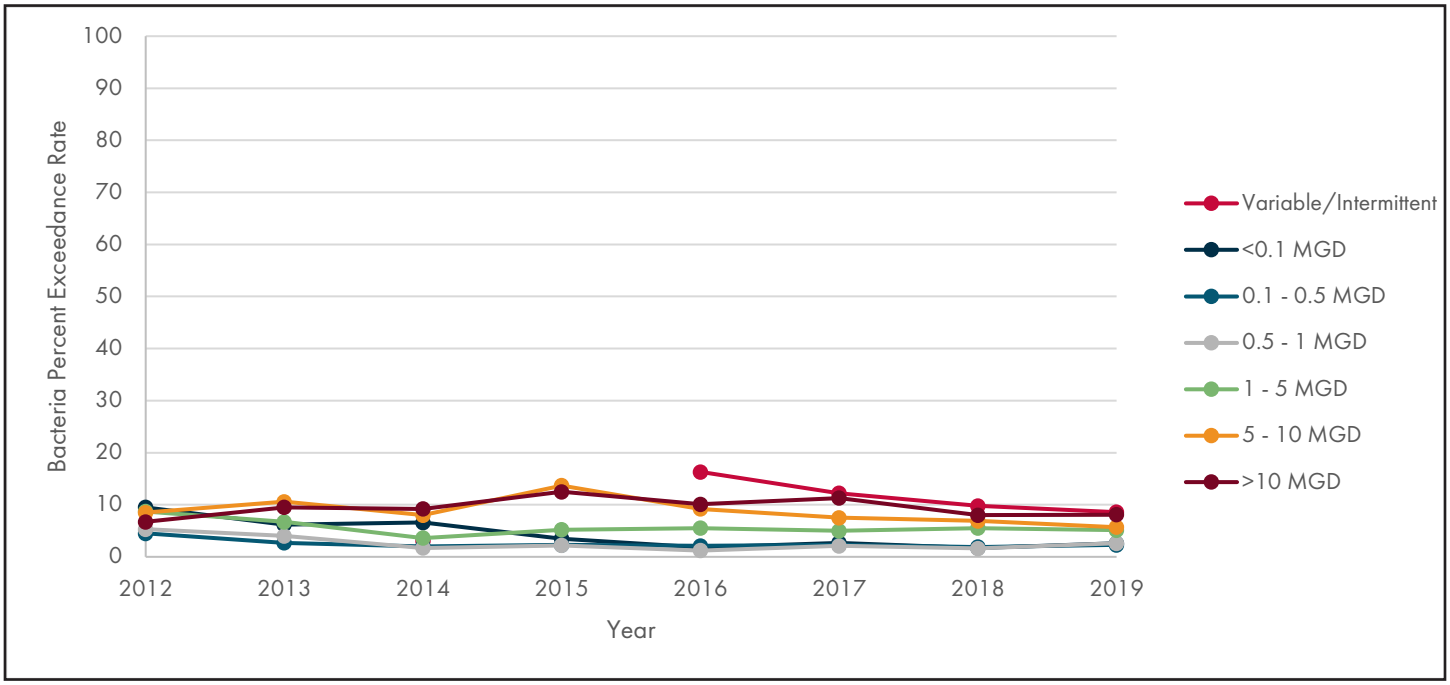
The highest rate of bacteria permit exceedances for geometric mean data are observed with WWTFs in the variable/intermittent discharge category. These facilities are typically small and discharge infrequently and at a smaller volume than most facilities. Generally, permit exceedances for geometric mean permit limits are low (below 1.5%), with the exception of the variable/intermittent dischargers.

Table 8 and Figure 5 show the bacteria permit limit exceedance rates for single grab samples by relative facility size for the period of 2012–2019.

TABLE 8: Bacteria DMR Data Single Grab Sample Permit Exceedance Rates by Relative Facility Size and Year, 2012 - 2019

Relative Facility Size	2012	2013	2014	2015	2016	2017	2018	2019
Variable/Intermittent	-	-	3.1%	-	16.31%	12.2%	9.8%	8.6%
<0.1 MGD	9.5%	6.2%	6.6%	3.5%	1.8%	2.7%	1.7%	2.6%
0.1 - 0.5 MGD	4.5%	2.7%	2.0%	2.3%	2.1%	2.3%	1.9%	2.3%
0.5 - 1 MGD	5.3%	4.0%	1.7%	2.2%	1.2%	2.1%	1.61%	2.6%
1 - 5 MGD	8.7%	6.7%	3.6%	5.2%	5.5%	5.0%	5.5%	5.1%
5 - 10 MGD	8.5%	10.6%	8.0%	13.7%	9.2%	7.5%	6.9%	5.7%
>10 MGD	6.7%	9.5%	9.2%	12.5%	10.1%	11.3%	8.0%	8.1%

FIGURE 5: Bacteria DMR Data Single Grab Sample Permit Exceedance Rates by Relative Facility Size and Year, 2012 - 2019



Higher permit exceedance rates are observed with the single grab samples as compared to the geometric mean results. However, this is to be expected. For smaller facilities, permitted dischargers may only have to sample once per quarter or once per month. For larger facilities with higher flow volumes, sampling frequency may increase to weekly or daily. There can be multiple single grab results for each facility each month, but there will only be one geometric mean result reported for the month.

Overall, bacteria permit limit exceedance rates are low and WWTFs in the region are usually within permit compliance. However, it is important to remember that these DMR data are self-reported and therefore have some inherent uncertainty. In many cases, these samples are collected at the same time each day, which may bias the results if sample collection is postponed until conditions are ideal. Wastewater treatment facility compliance inspection data from Harris County Pollution Control (HCPC) are acquired for the BIG project and show higher rates of permit exceedances than are observed in the self-reported data. This is likely due to the more random nature of compliance inspection monitoring (i.e., it is not biased to certain flow conditions, chlorine residual levels, etc.). The HCPC compliance data are acquired under the BIG and not under this project's QAPP. Therefore, those results are not reported as part of the WQMP Update. However, this data, combined with the data generated under this WQMP project, are an important cornerstone for the analyses that inform activities of the BIG. The BIG addresses bacterial impairments within a sizable portion of the Region (see Map 3 in "Significance" section).

In addition to the analysis of the exceedance rates for the geometric means previously discussed, the geometric mean of the reported geometric mean and single grab *E. coli* sample results were calculated. This analysis calculated the geometric mean for all results reported each year for each relative facility size category. Results of these analyses are presented in Table 9 (for geometric mean samples) and Table 10 (for single grab samples).

TABLE 9: Geometric Mean (in MPN/100 mL) of E. coli DMR Geometric Mean Results by Relative Facility Size and Year, 2012 - 2019

Relative Facility Size	2012	2013	2014	2015	2016	2017	2018	2019
Variable/Intermittent	8.8	148	165	201	199	124	83	56
< 0.1 MGD	3.1	2.6	2.7	2.3	2.3	2.1	2.1	2.3
0.1-0.5 MGD	2.3	2.0	1.9	2.0	2.0	2.0	2.0	2.0
0.5-1 MGD	2.1	1.8	1.7	1.6	1.8	1.8	1.8	1.8
1-5 MGD	3.4	2.7	2.4	2.3	2.3	2.3	2.5	2.4
5-10 MGD	2.6	2.3	2.0	2.2	2.1	2.0	2.0	1.7
> 10 MGD	2.4	2.5	2.5	2.4	2.0	2.3	2.3	2.2

TABLE 10: Geometric Mean (in MPN/100 mL) of E. coli DMR Single Grab Sample Results by Relative Facility Size and Year, 2012 - 2019

Relative Facility Size	2012	2013	2014	2015	2016	2017	2018	2019
Variable/Intermittent	8.8	177	235	341	284	191	124	82
< 0.1 MGD	5.4	3.9	3.8	3.2	2.9	2.8	2.6	3.0
0.1-0.5 MGD	3.5	2.6	2.5	2.5	2.4	2.5	2.4	2.4
0.5-1 MGD	4.7	3.2	2.8	2.9	3.0	3.2	3.1	2.9
1-5 MGD	13	8.1	6.8	7.3	8.0	7.7	9.0	7.9
5-10 MGD	8.0	12	14	17	16	14	11	8.5
> 10 MGD	14	22	23	36	20	17	17	18

The geometric mean calculation normalizes the range of values being averaged and shows the typical value or central tendency of the data set, so that outliers (such as an atypical elevated single grab value) do not overly influence the results, as would be the case if an arithmetic mean were utilized. While this data does not allow us to draw conclusions about any single facility, it is useful to look at the data in aggregate. As these data show, the highest geometric means are observed for the Variable/Intermittent discharge category. For 2019, the geometric mean of the reported DMR *E. coli* geometric mean data was 56 MPN/100 mL, with geometric means ranging from 8.8 — 201 MPN/100 mL for the period of 2012 — 2019. For the single grab sample data, the geometric mean for all *E. coli* samples for 2019 was 82 MPN/100 mL, with a range of 8.8 — 341 MPN/100 mL for the period of 2012 — 2019. Several of the calculated geometric means, for both the geometric mean results as well as the single grab results, exceeded the state water quality standard of 126 MPN/100 mL.

For other size categories, the geometric means of the DMR *E. coli* geometric mean data was low, with results typically below 3.0 MPN/100 mL. Results were typically low for the geometric means of the DMR single grab samples as well, with slightly higher results for the 1 — 5 MGD, 5 — 10 MGD, and >10 MGD relative facility size categories. However, even the highest of these results (36 MPN/100 mL for the >10 MGD category in 2015) is substantially lower than the water quality standard of 126 MPN/100 mL for *E. coli*. These size categories, because of their increased daily flows, analyze samples at a greater frequency than smaller facilities. For the single grab samples, facilities in the 0.1 — 0.5 MGD size category have the lowest geometric mean at 2.4 MPN/100 mL for 2019 and a range of 2.4 — 3.5 MPN/100 mL for the period of 2012 — 2019. Smaller facilities such as these will have few samples collected each month compared to larger facilities.

PHOTO: Anahuac Wastewater Treatment Facility

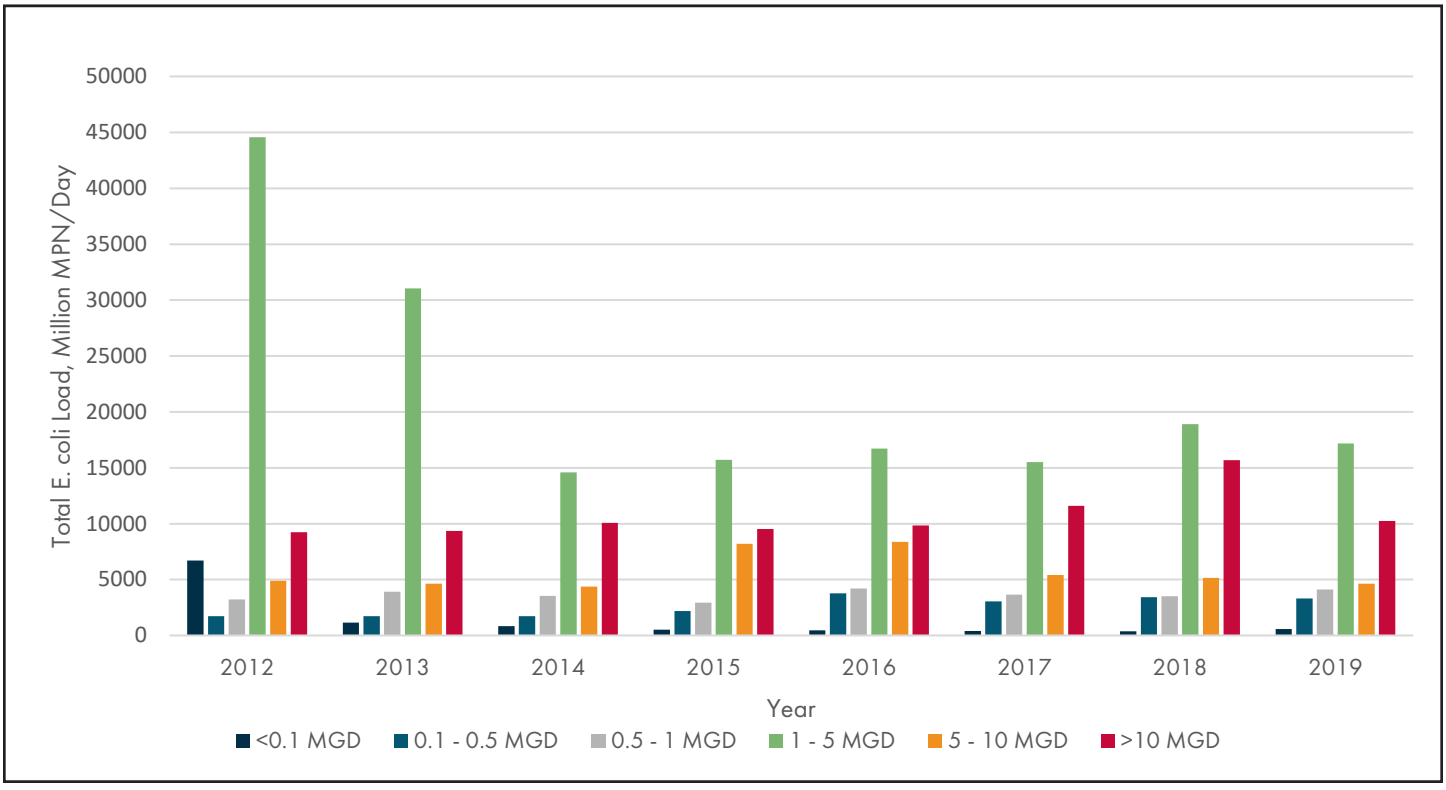
The estimated *E. coli* daily loads (in Millions MPN per day) from domestic WWTFs are shown in Table 11 and Figure 6. Results are shown by year and relative facility size, and are based on WWTF effluent discharge rates and average *E. coli* geometric mean concentrations reported by facility size.

TABLE 11: Estimated E. coli Load (in Million MPN/Day) from Domestic WWTFs by Relative Facility Size and Year, 2012 - 2019

Relative Facility Size	2012	2013	2014	2015	2016	2017	2018	2019
<0.1 MGD	6,713.8	1,160.1	839.9	518.4	467	401.3	380.6	578.9
0.1 - 0.5 MGD	1,726.1	1,727.4	1,733.1	2,197.2	3,767.5	3063	3,435.9	3,329.6
0.5 - 1 MGD	3,242.6	3,930	3,535.4	2,936.9	4,210.2	3,660.7	3,519.9	4,131.7
1 - 5 MGD	44,557.7	31,053.9	14,579.6	15,710.8	16,722.9	15,505.7	18,914.7	17,167.3
5 - 10 MGD	4,887.1	4,646.5	4,373.1	8,202.5	8,380.5	5,414.5	5,168.8	4,631.9
>10 MGD	9,242.1	9,353.1	10,071.9	9,523.9	9,843.8	11,588.1	15,691.8	10,243.8

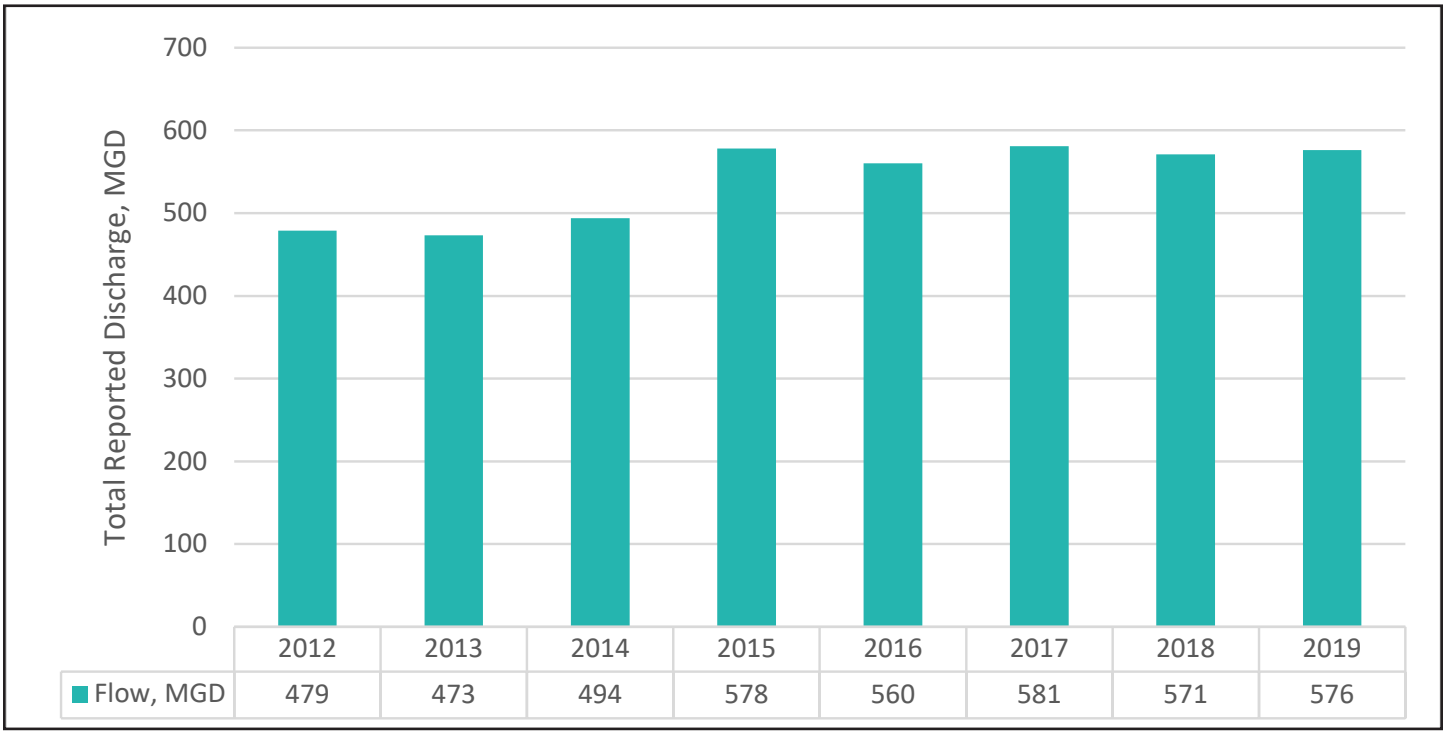
For the period of 2012 — 2018, WWTFs in the 1 — 5 MGD size category contributed the most bacteria loading. In 2019, the estimated bacteria loading for this facility size category was 17,167.3 Million MPN per Day. With the exception of 2012, WWTFs in the <0.1 MGD size category contributed the least amount of bacteria loading. Although this category represents the largest number of facilities (286 WWTFs, or 31.9% of the total number of facilities), the relatively low flow rates for this category helps minimize the amount of bacteria loading entering local waterways.

FIGURE 6: Estimated E. coli Load (in Million MPN/Day) from Domestic WWTFs by Relative Facility Size and Year, 2012 - 2019



The total discharge from domestic WWTFs for each year was calculated based upon the reported average daily discharges as reported in the DMRs. These results, reported in MGD, are shown in Figure 7.

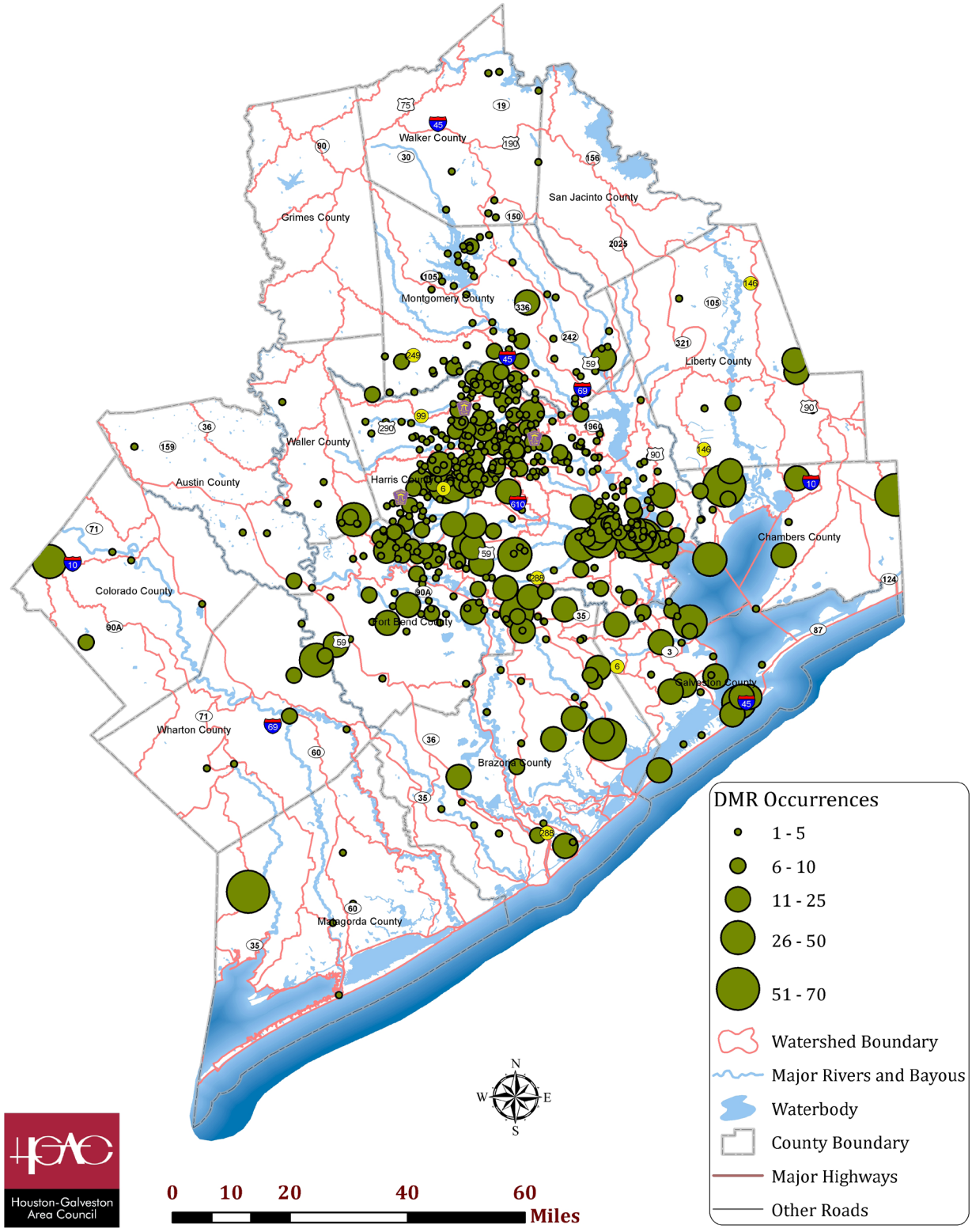
FIGURE 7: Total Discharge from Domestic WWTFs by Year, MGD



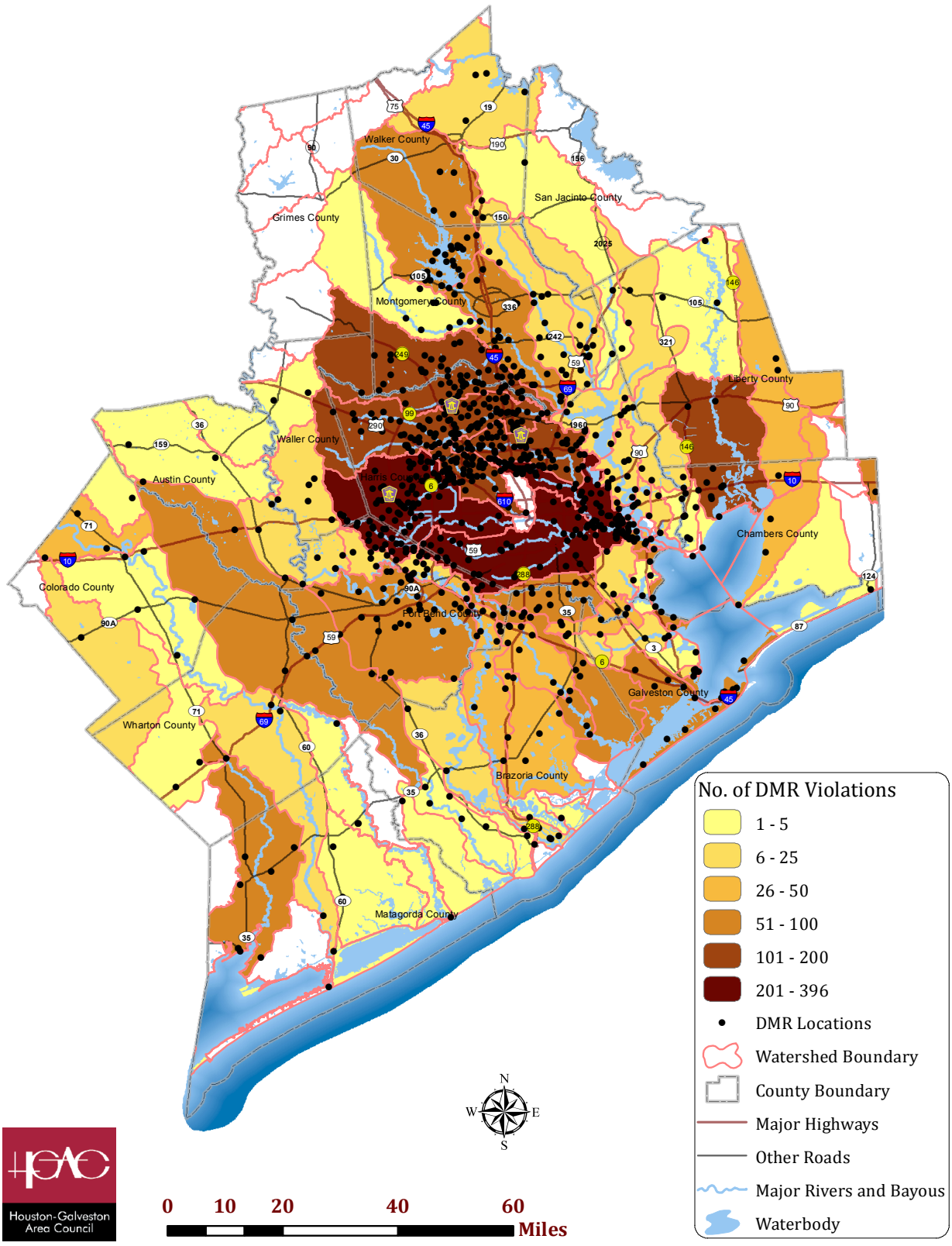
Maps 5—8 illustrate the frequency of DMR bacteria violations and the density of those violations by watershed. Maps 5 and 6 show this data for the period of 2010 — 2019. Maps 7 and 8 show this data for 2019. These maps illustrate areas in the region that have the highest rate of permit exceedances based 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.

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.

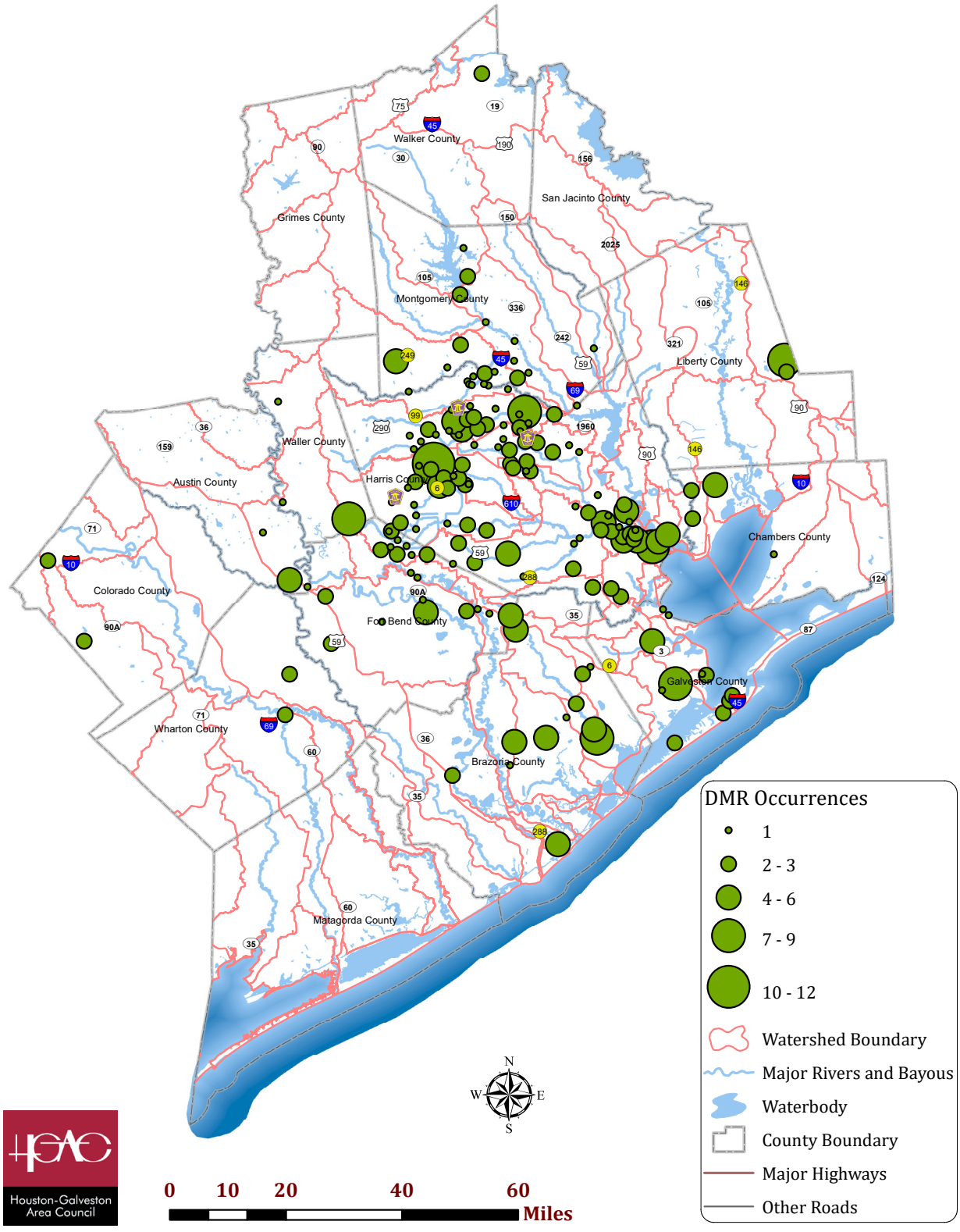
MAP 5: DMR Bacteria Violation Occurrences, 2010-2019



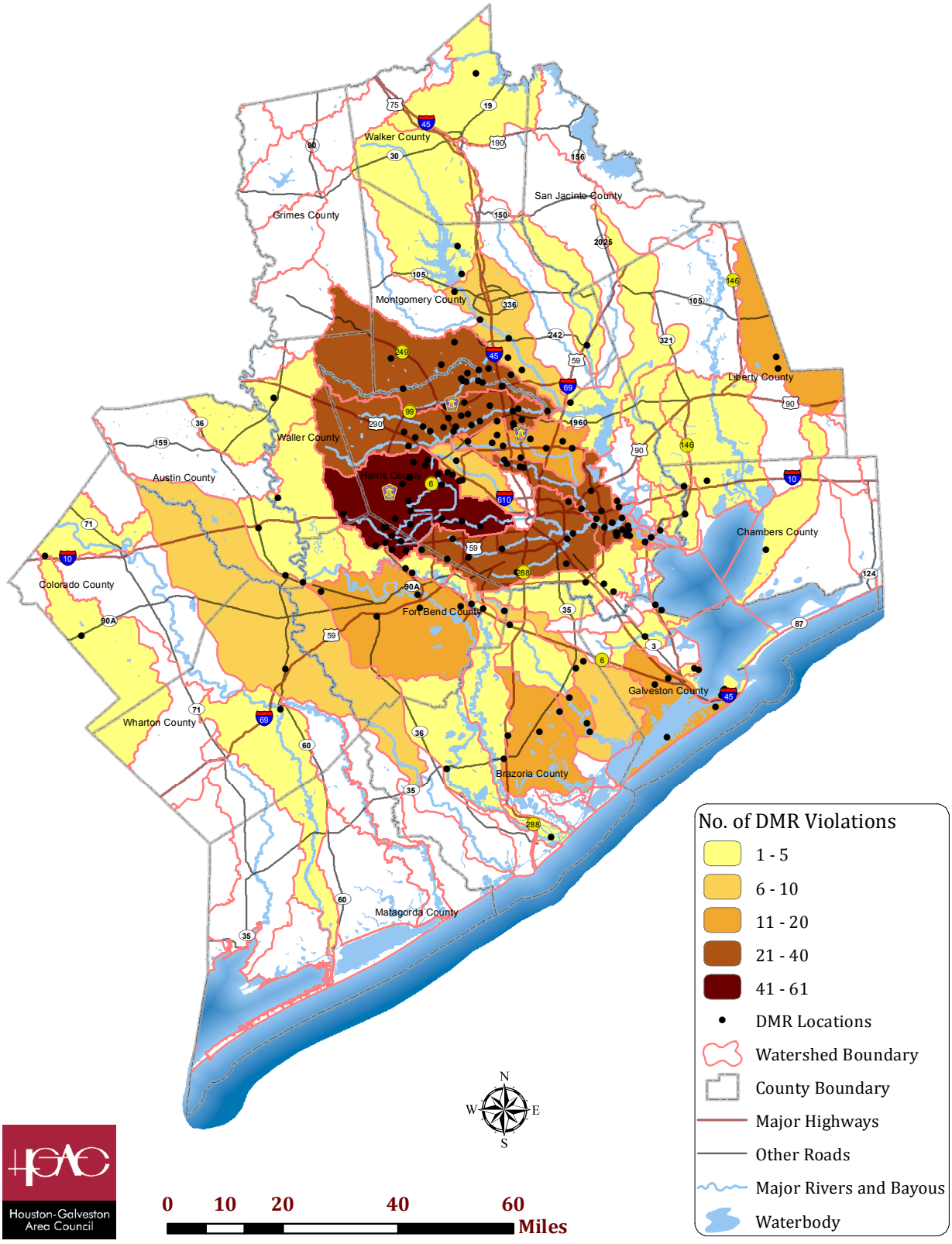
MAP 6: DMR Bacteria Violation Density by Watershed, 2010-2019



MAP 7: DMR Bacteria Violation Occurrences, 2019



MAP 8: DMR Bacteria Violation Density by Watershed, 2019



SANITARY SEWER OVERFLOW DATA ANALYSIS

Sanitary Sewer Overflow Data Analysis

A Sanitary Sewer Overflow, or SSO, is defined as any type of unauthorized discharge of untreated or partially treated wastewater from a collection system or its components (e.g., manholes, lift stations, cleanouts, etc.) before reaching a treatment facility. Issues such as blockages, significant inflow/infiltration (INI), poor operation and maintenance, or inadequate capacity to collect, store, or treat the wastewater can result in SSOs.

Unlike treated WWTF effluent, SSOs represent a high, if episodic, risk because they can have bacterial concentrations several orders of magnitude higher than treated sewage. Untreated sewage can contain large volumes of raw fecal matter, making areas with sizable and/or chronic SSO issues a significant human health risk under certain conditions.

SSOs are self-reported to the TCEQ, with each event 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. A subscriber system is a sewer system that conveys flow to a wastewater treatment facility that is owned by a separate entity. The term is not intended to indicate individual private laterals, such as a homeowner's connection to a sewer system.

As specified in 30 TAC § 327.32(c), permitted facilities are required to report SSOs to TCEQ within 24-hours of becoming aware of the event, and provide a written notification within 5 days. A monthly summary is also required. Exceptions are made for accidental discharges of less than1000 gallons, which only have to be reported monthly provided they are controlled or removed before entering a water way or adversely affecting a source of public or private drinking water. Information reported must include, at a minimum, the location, volume, and content of the discharge, a description of the discharge and its cause, dates and times of the discharge, and steps taken to reduce, eliminate, and prevent recurrence of the discharge.

PHOTO: Sanitary Sewer Overflow

It should be noted that SSO volumes are estimates and are based on visual observations or estimated calculations that can be subjective based on the individual reporting the event.

METHODS

This study considered TCEQ SSO violation data from 2012 through 2019. Analysis included an overview of the total number of permittees reporting SSOs by year, the cause of SSOs, and the estimated overflow volume by cause. SSO volumes are self-reported estimates based on visual observations or estimated calculations. Therefore, the values reported 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, self-reported 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 facilities, 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.

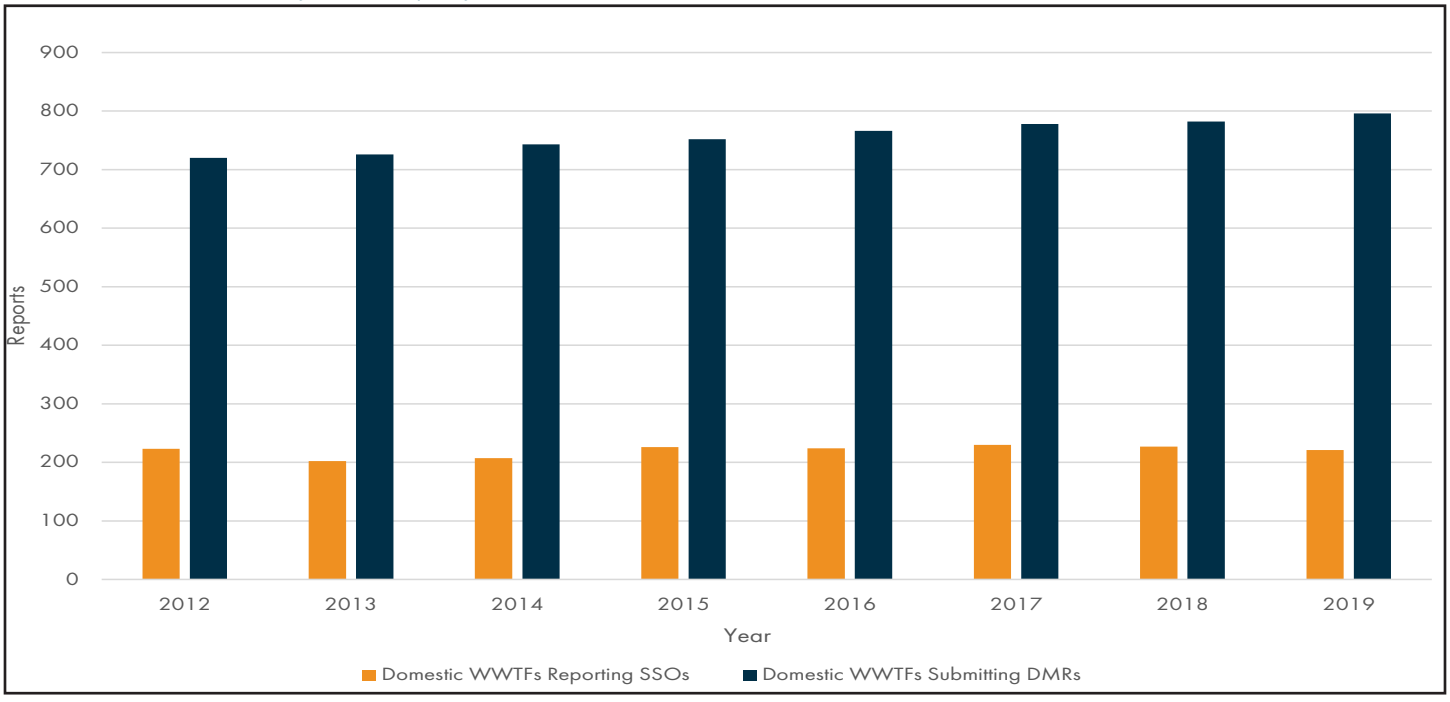
RESULTS AND OBSERVATIONS

For the SSO analyses, H-GAC first evaluated the number of permittees submitting SSO violation reports by year compared to the number of permittees in the region submitting DMR data. Based on these data, SSO violations are being reported by approximately 25 — 30 percent of the domestic WWTFs within the region. The number of domestic WWTFs submitting DMRs and reporting SSOs are presented in Table 12 and Figure 8.

TABLE 12: Domestic WWTFs Submitting DMRs and Reporting SSOs Each Year, 2012 - 2019

Year	Domestic WWTFs Reporting SSOs	Domestic WWTFs Submitting DMRs
2012	223	720
2013	202	726
2014	207	743
2015	226	752
2016	224	766
2017	230	778
2018	227	782
2019	221	796

FIGURE 8: Domestic WWTFs Submitting DMRs and Reporting SSOs Each Year, 2012 - 2019



The total number of SSO violations and the estimated overflow volumes reported by year were also calculated. These values are shown in Table 13. Figures 9 and 10 show a graphical representation of the number of reported SSOs and the volume of SSOs by year.

During the period of 2012 – 2019, the greatest number of SSOs were reported in 2017. During that year, 2,170 events were reported, with an estimated volume of 18,086,000 gallons being discharged. With Hurricane Harvey making landfall in the Houston region during 2017, a higher number of SSOs for that year is expected. Considering the inundation caused by Harvey, it would be reasonably expected that 2017 would also have the highest volume of SSO discharge. However, because numerous wastewater treatment facilities were underwater during and immediately after the storm, it is not possible to make an estimate of the amount of unpermitted discharge, and many may have been underreported or not reported at all. Based on reported values, the highest estimated volume of discharge occurred in 2018, with an estimated 27,648,000 gallons discharged over 1,584 events.

TABLE 13: Reported SSOs and Estimated Discharge Volume by Year, 2012 - 2019

Year	Number of SSOs Reported	Estimated Volume (Thousand Gallons)
2012	1,195	4,399
2013	1,239	2,810
2014	1,364	4,474
2015	1,562	9,154
2016	1,925	19,107
2017	2,170	18,086
2018	1,584	27,648
2019	1,249	22,860

FIGURE 9: Reported SSOs by Year, 2012 - 2019

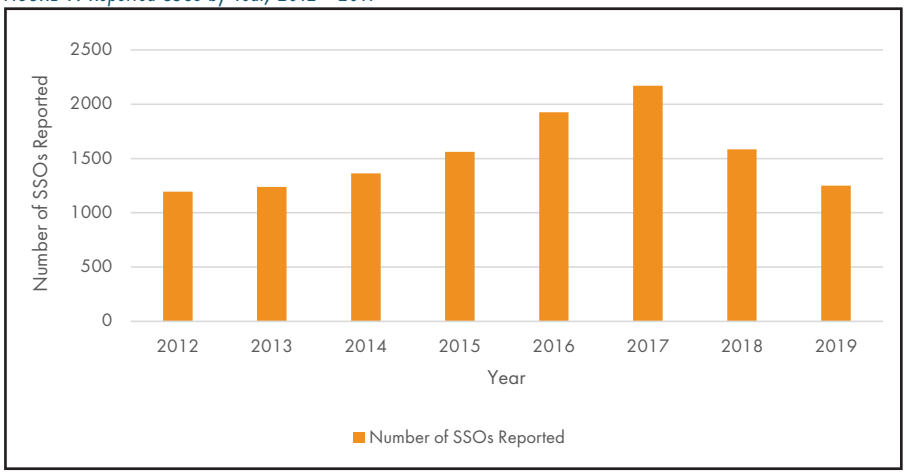
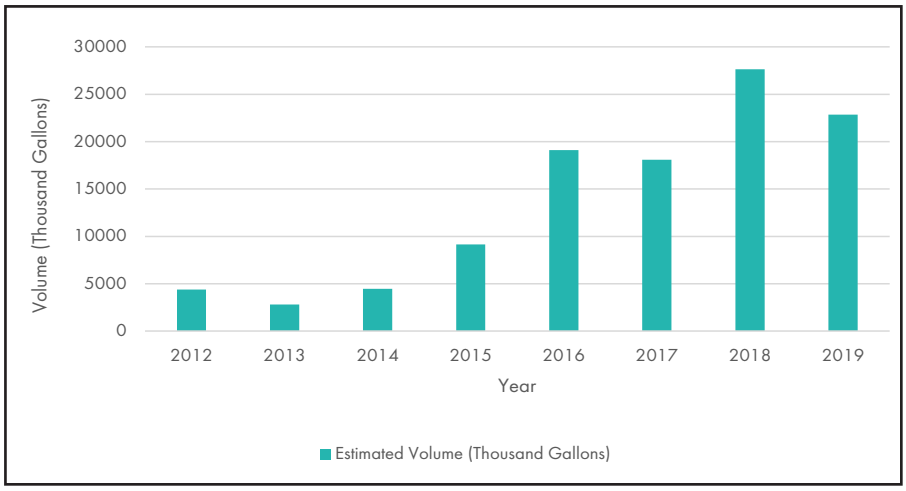


FIGURE 10: Estimated Volume of SSOs by Year, 2012 - 2019



To evaluate if some permitted dischargers may be experiencing chronic SSO issues, the number of permittees submitting SSO reports over multiple years was calculated. The results of this analysis are shown in Table 14.

Some permittees report SSOs more frequently or consistently, with 5.24% of permittees reporting SSOs every year for the previous 9 years. In contrast, 41.85% of permittees have not reported an SSO event between 2011 and 2019.

TABLE 14: Frequency of Reported SSOs, 2011 - 2019

Number of Years SSO Events Were Reported	Number of Permittees Submitting SSO Reports Over Multiple Years	Percentage of Permittees
None Reported	375	41.85%
1 year	142	15.85%
2 years	85	9.49%
3 years	55	6.14%
4 years	56	6.25%
5 years	38	4.24%
6 years	35	3.91%
7 years	40	4.46%
8 years	23	2.57%
9 years	47	5.24%
TOTAL	**896**	**100.00%**

In order to determine the primary causes of SSO events, the potential causes were separated into 4 general categories to reflect the breakdown of SSO causes in the TCEQ SSO database. The causes included in each category are listed in Table 15. It should be noted, however, that categorization depends on the accuracy of the data reported by the permittees. It should also be noted that while a single cause is typically listed on the SSO report, many SSOs are caused by a combination of factors. For example, fats/oils/grease (FOG) collecting in lift station pumps can cause overflows in high rain events when excess water is in the system. The event may be listed as lift station failure, but FOG and inflow and infiltration (INI) of stormwater were also causative elements. Table 16 shows the number of SSOs by general cause category as reported each year from 2011 — 2019. The most common cause for reported SSOs each year is blockages (all types).

TABLE 15: General Categories of SSO Causes

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

TABLE 16: General Causes of SSOs by Year, 2011 - 2019

Year	Blockage (All Types)	Infrastructure/WWTF	Other	Rain/INI	TOTAL
2011	1,528	260	31	20	1,839
2012	754	266	24	151	1,195
2013	886	240	24	87	1,239
2014	1,005	216	35	105	1,364
2015	1,058	215	20	266	1,562
2016	1,117	220	161	422	1,925
2017	1,557	223	218	172	2,170
2018	1,019	305	78	182	1,584
2019	785	222	34	208	1,249

Figure 11 shows the percentage of reported SSOs for each general cause category for 2019. At 63% of all SSOs, blockage (all types) was the most common listed reason for reported SSO events. Figure 12 shows the number of SSO events by category each year from 2011 — 2019.

FIGURE 11: Percentage of Reported SSOs by General Cause, 2019

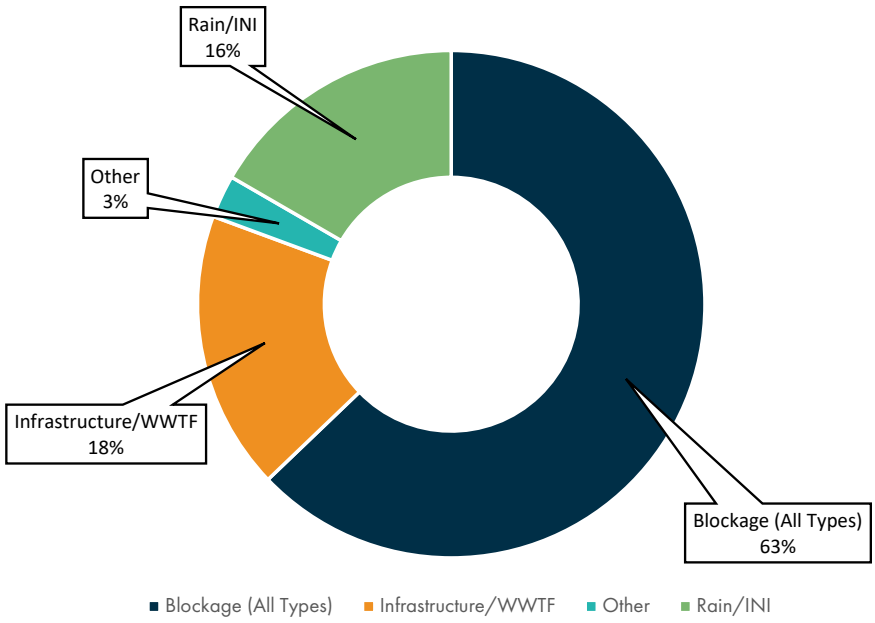


FIGURE 12: Number of Reported SSOs by General Cause, 2011 - 2019

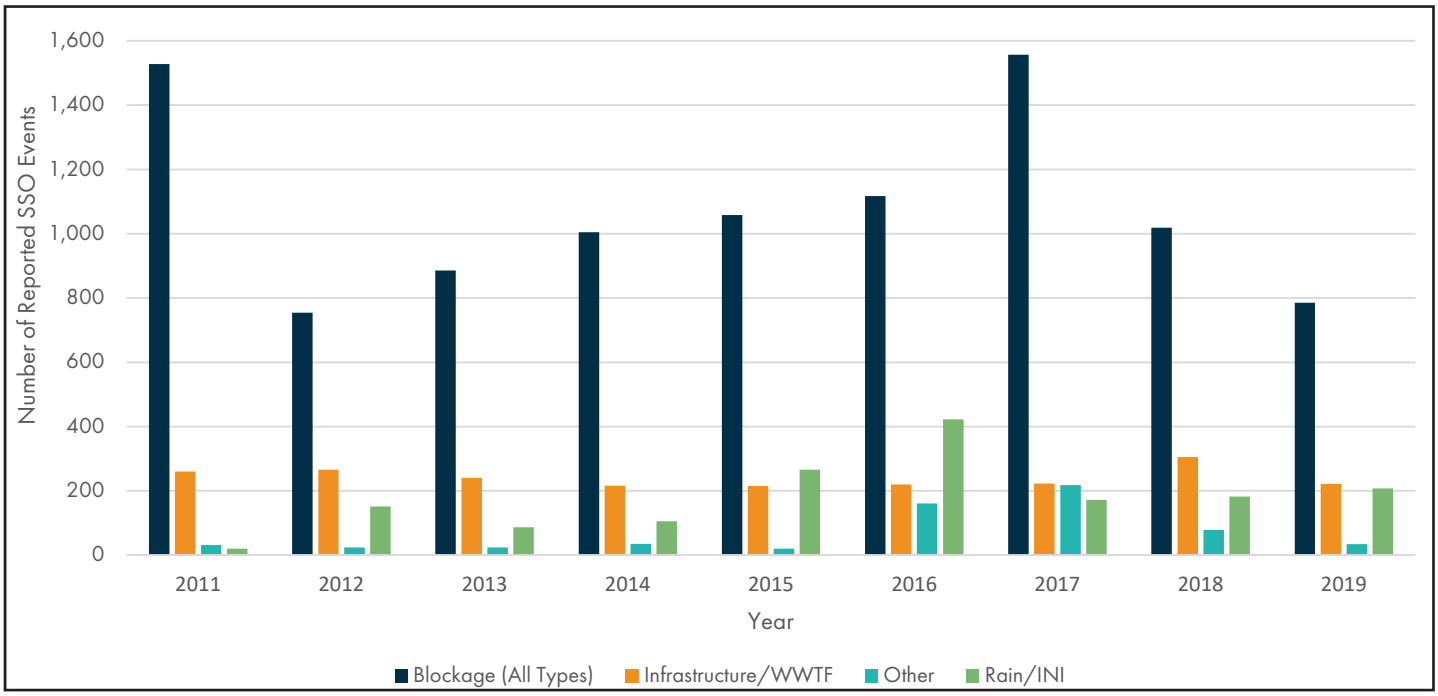


Table 17 provides a more detailed breakdown of the causes of reported SSOs, the number of events for each cause type, and the estimated volume of discharge due to each cause for 2019. Figure 13 shows the number of events per reported cause for 2019. Figure 14 shows the estimated volume discharged for each cause for 2019.

TABLE 17: Summary of SSO Causes

Reported Cause	Number of Events	Estimated Volume (1000 Gallons)
Blockage Due To Roots/ Rags/ Debris	85	1,025.2
Blockage in Collection System Due To Fats/Oils/ Grease	511	355.5
Blockage in Collection System-Other Cause	189	354.9
Collection System Structural Failure	74	848.9
Human Error	6	32.3
Lift Station Failure	92	1,496.8
Power Failure	6	5.3
Rain / Inflow / Infiltration	208	17,878.3
Unknown Cause	28	221.7
WWTF Operation or Equipment Malfunction	50	641.4
TOTALS	**1,249**	**22,860.3**

FIGURE 13: Causes of Reported SSOs Ranked by Number Per Cause, 2019

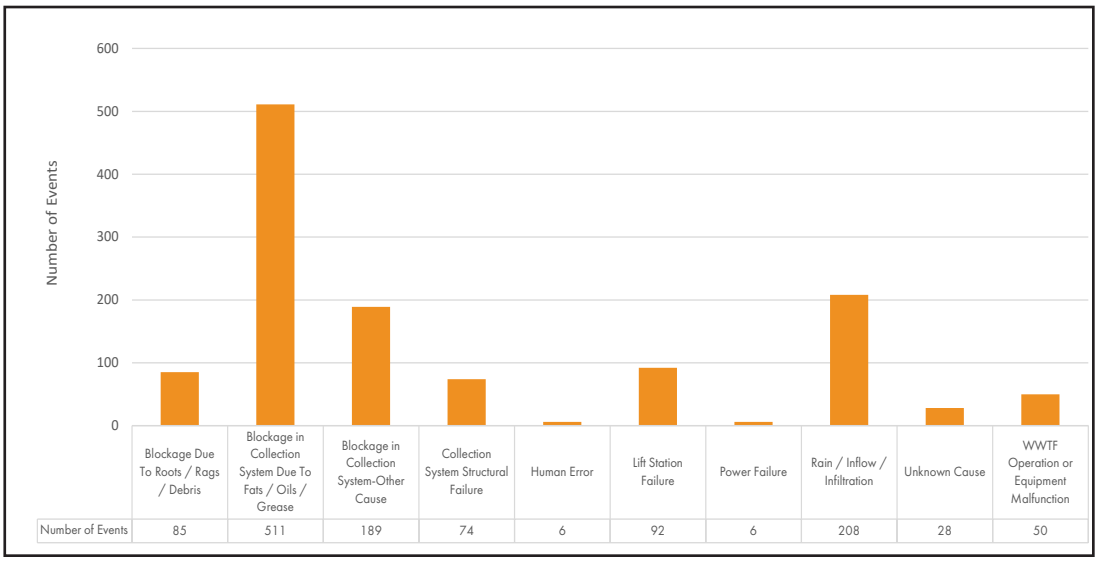
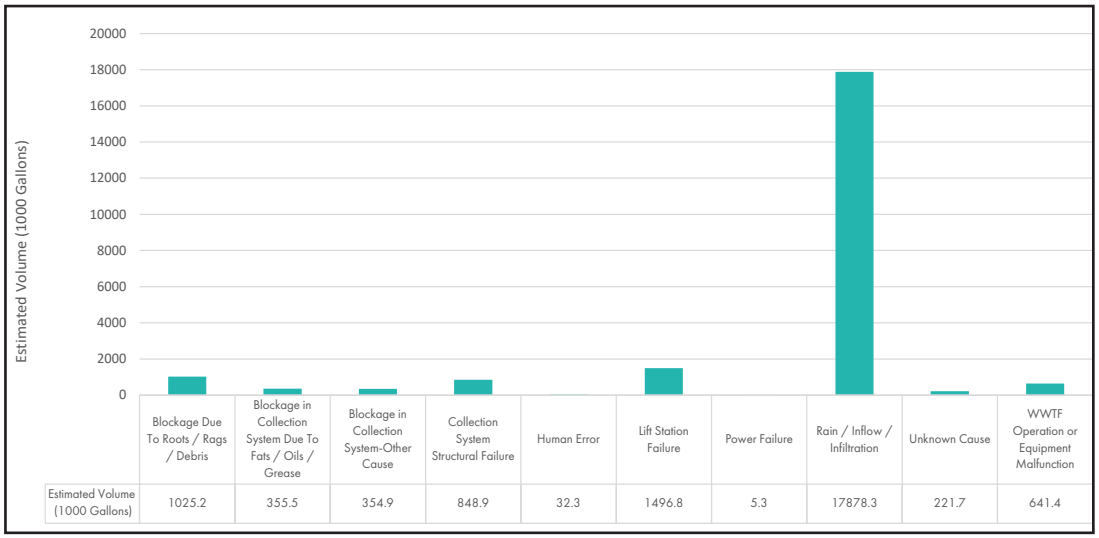


FIGURE 14: Causes of Reported SSOs Ranked by Discharge Volume, 2019

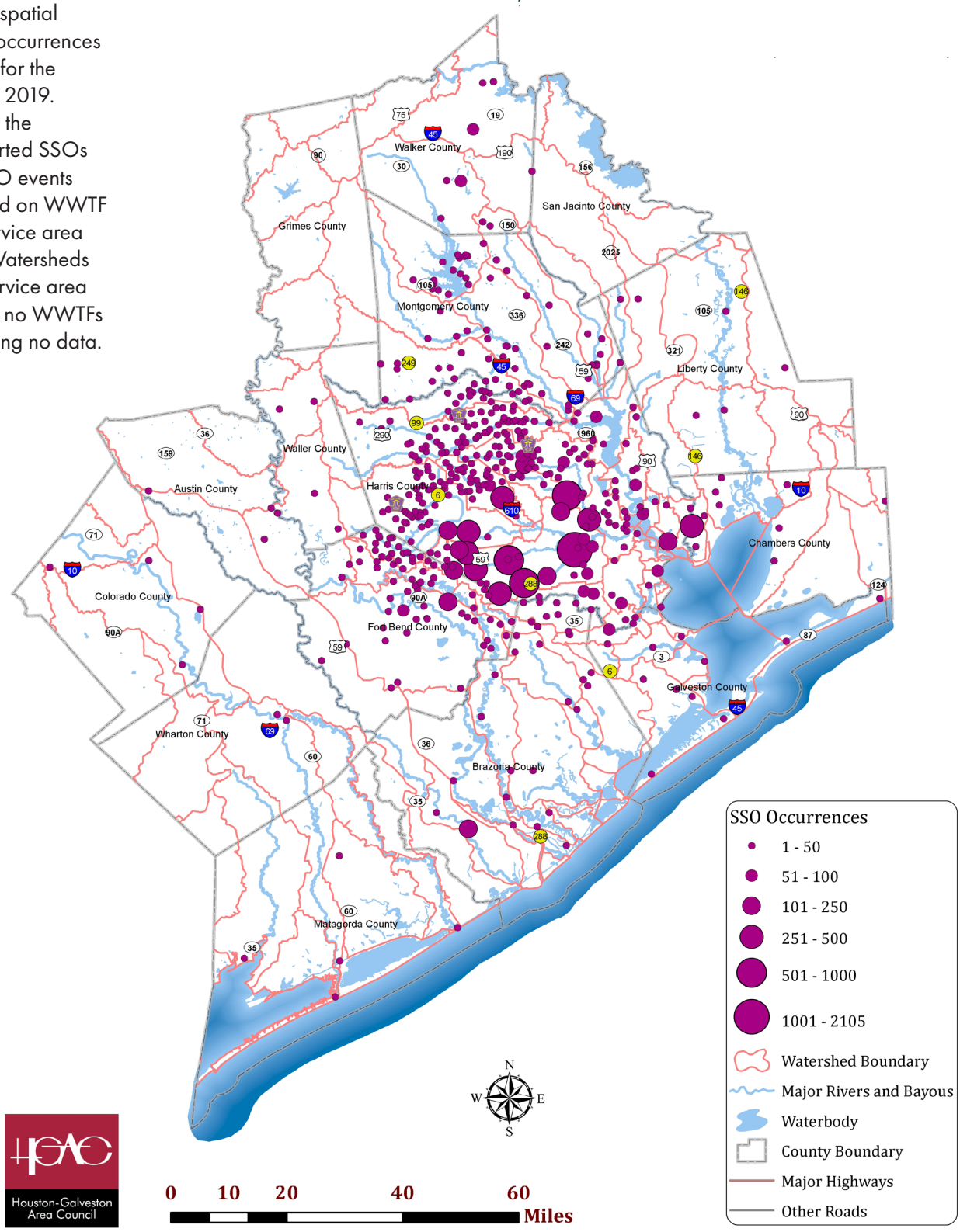


Looking at more specific causes than just the general categories, blockage in the collection system due to FOG was the leading cause (40.9% of reported SSOs) for SSOs reported in 2019. Again, it must be noted that with self-reported SSO data, the cause of the SSO may be listed as a single cause when in actuality multiple causes may have been contributing factors.

The largest volume of discharges from SSOs for 2019 was due to rainfall and inflow/infiltration, with an estimated volume of 17,878,300 gallons.

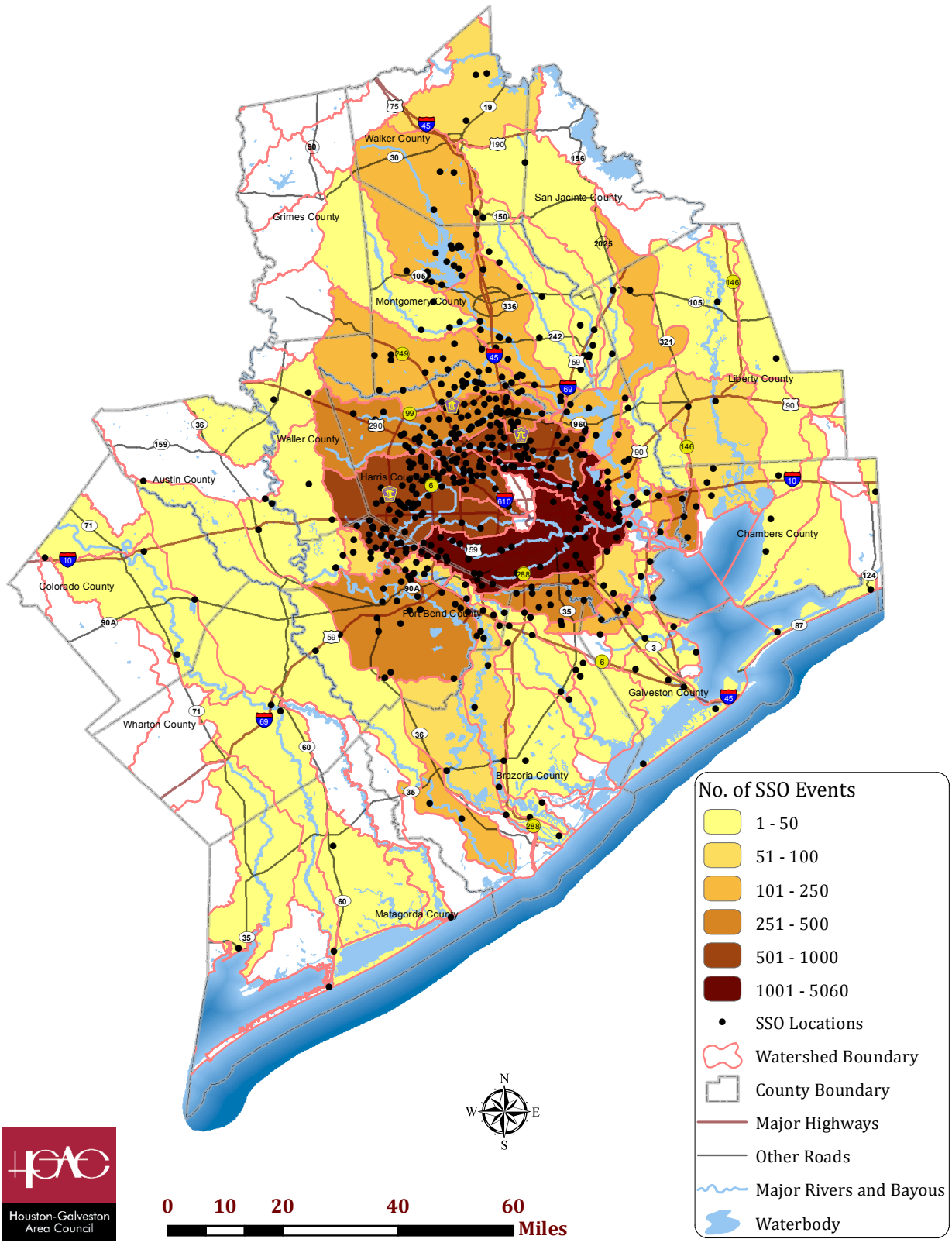
Map 9 shows the spatial representation of occurrences of reported SSOs for the period of 2010 — 2019. Map 10 illustrates the frequency of reported SSOs by watershed. SSO events are mapped based on WWTF addresses and service area boundary data. Watersheds with insufficient service area boundary data or no WWTFs are shown as having no data.

MAP 9: SSO Occurrences, 2010 - 2019



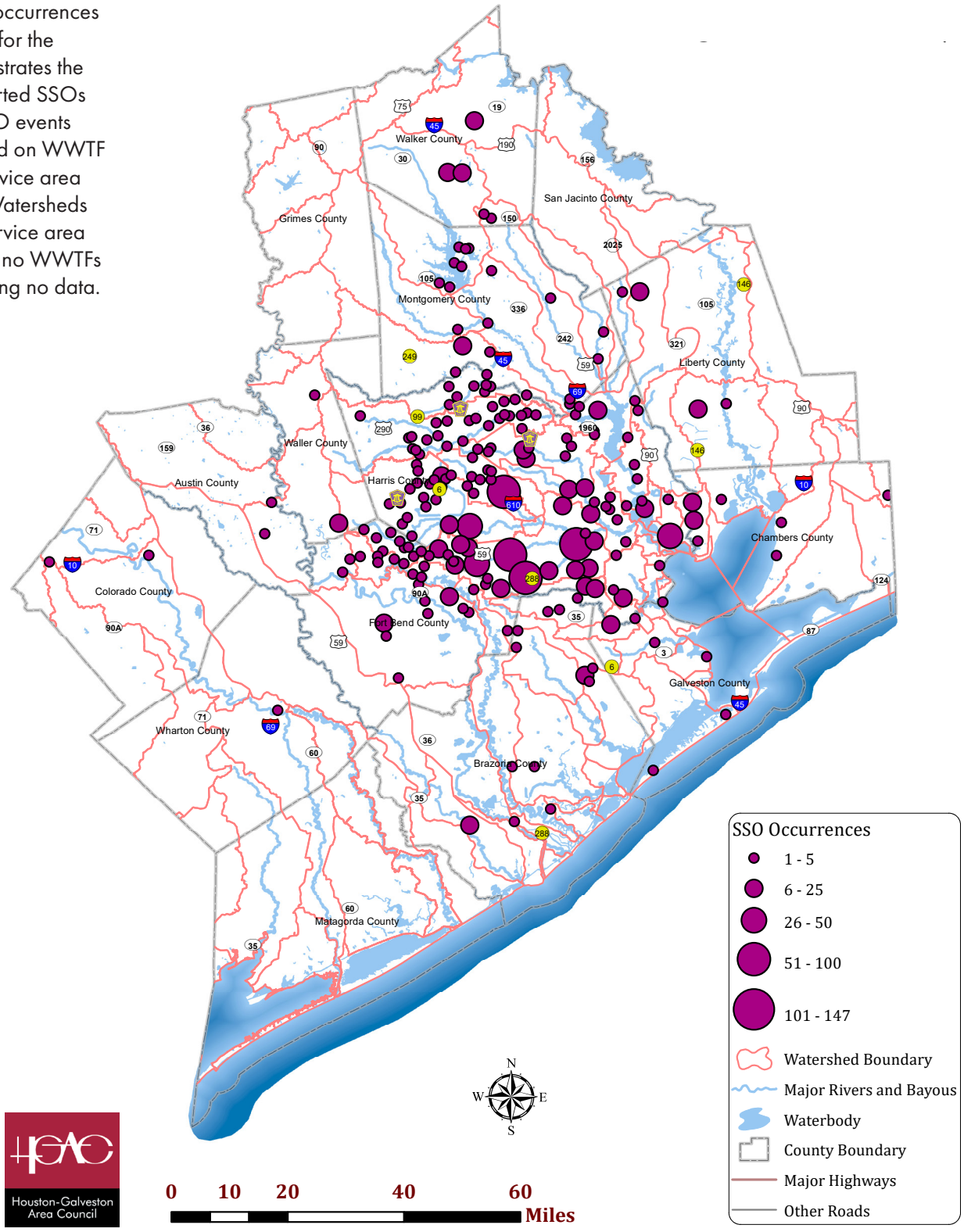
Houston-Galveston Area Council

MAP 10: SSO Frequency by Watershed, 2010 - 2019

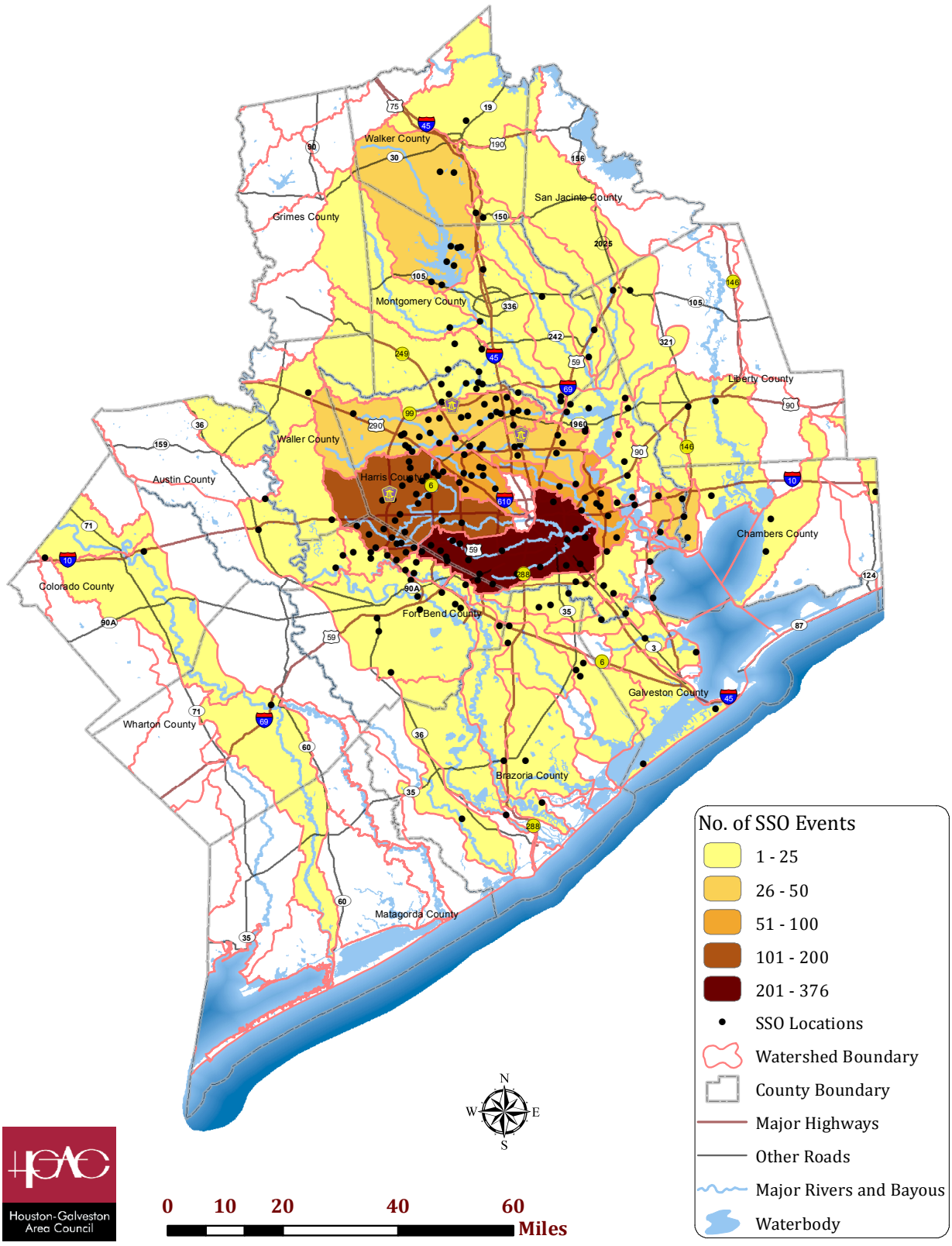


Map 11 shows the spatial representation of occurrences of reported SSOs for the 2019. Map 12 illustrates the frequency of reported SSOs by watershed. SSO events are mapped based on WWTF addresses and service area boundary data. Watersheds with insufficient service area boundary data or no WWTFs are shown as having no data.

MAP 11: SSO Occurrences, 2019



MAP 12: SSO Frequency by Watershed, 2019



Based on the locations of reported SSOs, the more populated urban and suburban watersheds throughout the region are experiencing higher rates of SSO events compared to 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 facilities 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 putting added strain on the collection systems overall, including contributing FOG to the collection system, resulting in a greater frequency of blockages. Also, the amount of impervious cover in urban areas may make SSOs more visibly identifiable, as rural systems may have long runs of pipe between connections or running though undeveloped areas where they may go unseen.

PHOTO: Sanitary Sewer Overflow

CLEAN WATER STATE REVOLVING FUND APPLICATION REVIEW

Clean Water State Revolving Fund Application Review

In conjunction with H-GAC's role as a regional planning group and the local council of governments for the Houston-Galveston area of the Upper Gulf Coast, staff regularly provides comments on grant proposals of varying types. For the WQMP Update, H-GAC reviews proposals for projects under the Texas Water Development Board's (TWDB) Clean Water State Revolving Fund (CWSRF) program. These reviews help ensure regional goals are represented in project funding decisions at a variety of governmental levels.

METHODS

Entities with wastewater treatment facility and transport infrastructure make loan applications to TWDB to assist in the cost of improvements. These applications are reviewed by TCEQ. H GAC also completes a review as requested by TCEQ to determine if the applicant has conformed to the regional water quality management plan. H-GAC reviews the grant application and associated engineering documentation (such as the Preliminary Engineering Report, Environmental Review, population projections, etc.) for concurrence with broad regional planning priorities and goals (such as improving water quality, protecting waterways, reducing bacteria or nutrient loading, etc.).

During this review process, H-GAC staff looked for:

- Population projections that matched TWDB, H-GAC, or other relevant forecasts;
- Alternatives that may impact water quality considerations; and
- 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 review and provide comments on one CWSRF project application during the FY 20 WQMP Update period.

RESULTS AND OBSERVATIONS

There were three projects reviewed during the project period. The outcomes of those reviews are shown in Table 18. The CWSRF projects reviewed during this year were all consistent with regional goals of the WQMP.

TABLE 18: Clean Water State Revolving Fund Application Review

Project ID	Requesting Entity	Project Summary	Findings
73832	Harris County Municipal Utility District (MUD) No. 148	This project involves the expansion of the existing wastewater treatment facility for Harris County MUD No. 148 to meet future demands. The District plans to expand the existing 0.55 MGD treatment facility to 0.95 MGD, modifying the existing lift station, and adding new structures to meet the permitted demand in the District.	The goals of the project are consistent with regional goals as defined in the WQMP.
73766	Sienna Plantation	This project is a continuation of the City of Missouri City Steep Bank Flat Bank WWTF and lift station construction project reviewed in 2018. This phase of the project involves the completion of diversion of flow from the Sienna Plantation MUD No 1 WWTF to Steep Bank Flat Bank WWTF and the decommissioning of the Sienna Plantation MUD No 1 WWTF.	The goals of the project are consistent with regional goals as defined in the WQMP.
73887	City of Pearland	This project involves the expansion of the John Hargrove Water Reclamation Facility's treatment capacity to address current and future needs. This regionalization project involves the consolidation of flow and decommissioning of the Longwood Water Reclamation Facility and the Southdown Wastewater Treatment Facility.	The goals of the project are consistent with regional goals as defined in the WQMP.

WATERSHED PLANNING SUPPORT

PHOTO: Hermann Park

TASK 4: SUPPORT WATERSHED PLANNING

TASK DESCRIPTION
The goal of this Task is to support watershed planning in the Houston-Galveston Region and to support regional information sharing on water quality and related topics.

SCOPE OF WORK

The following Subtasks are included in the Scope of Work under this project task:

- Subtask 4.1: San Bernard River Watershed Coordination
- Subtask 4.2: General Water Quality Coordination
- Subtask 4.3: Urban Forestry Support and Coordination
- Subtask 4.4: Public Support for TMDL Projects in the Houston Area, including the BIG, Upper Oyster Creek, and Chocolate Bayou

TASK OBJECTIVES

San Bernard River Watershed Coordination

H-GAC facilitates ongoing San Bernard River Watershed Coordination for stakeholders in the watershed. This includes meetings with the Friends of the River San Bernard stakeholder group, maintaining communication with stakeholders, and assisting stakeholders in coordinating their implementation activities as outlined in the EPA-accepted San Bernard River WPP.

During the FY 20 project year, H-GAC staff:

- coordinated with the Friends of the River San Bernard to develop a watershed-scale mapping project (Map 13);
- coordinated with Texas Stream Team volunteers regarding the volunteer water quality monitoring activities that occur within the watershed;
- explored opportunities to tie water quality planning in the San Bernard River watershed with ongoing resilience planning efforts.

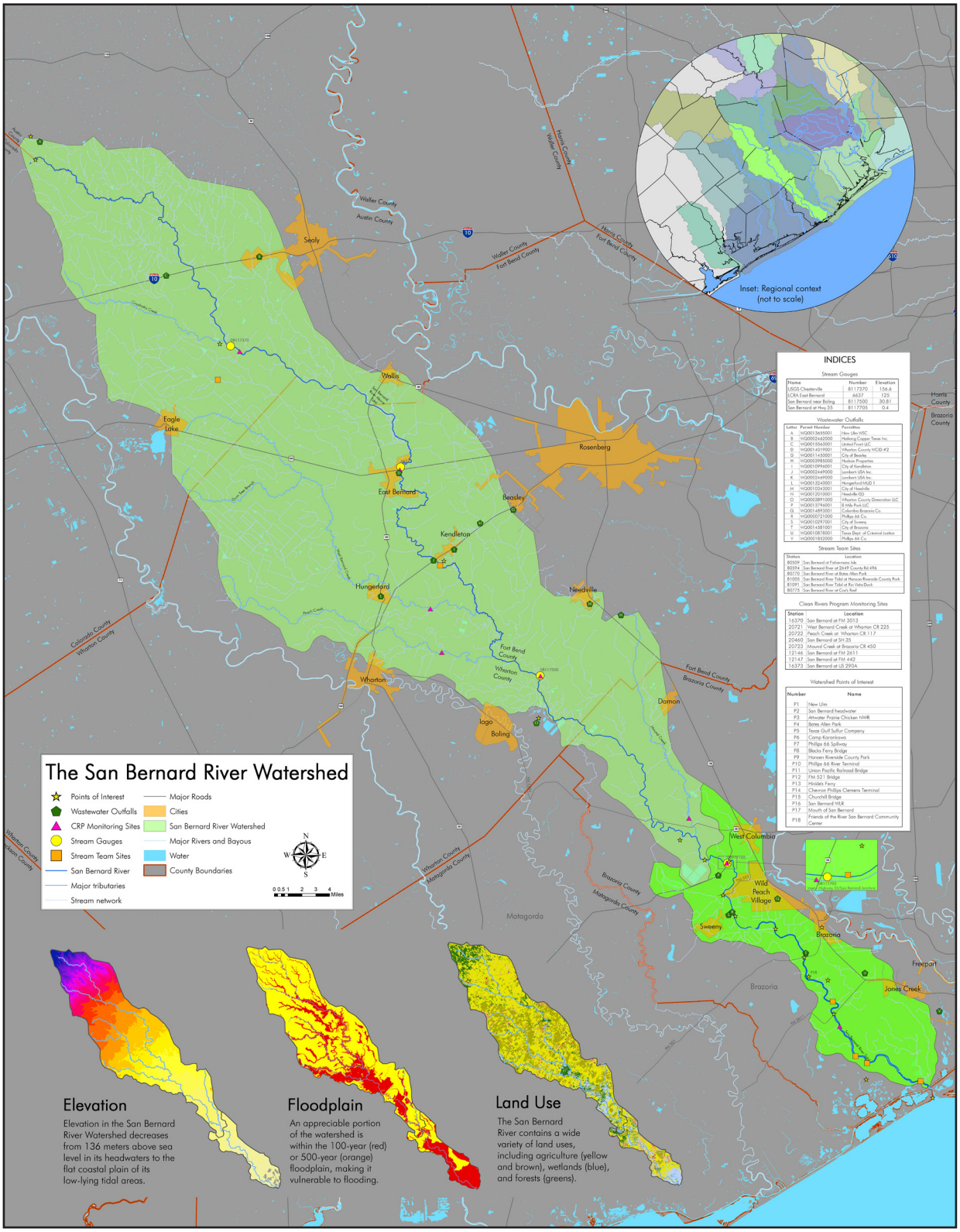
Unfortunately, most meetings and outreach events, generally scheduled for the Spring or Summer, had to be canceled due to social distancing requirements related to COVID-19.

General Water Quality Coordination

As an extension of H-GAC's role as a coordinator of regional planning efforts, H-GAC 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. Activities under this subtask include water quality planning activities that are not currently funded under other contracts. This includes participation in stakeholder activities and information-sharing events related to both TMDLs and WPPs that are not currently funded. Through this task, H-GAC provides staff for the quarterly NRAC meeting to address regional watershed management and related natural resource issues. H-GAC also coordinates with state and federal water programs, such as the Galveston Bay Estuary Program (GBEP), and local governments, targeting prevention of duplication of efforts and promoting watershed management.

Staff members facilitate meetings of the NRAC, a committee which provides policy recommendations for 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

MAP 13: San Bernard River Watershed



decision makers.

Beginning in the FY 19 project year and continuing in this project year, NRAC implemented an annual awards program to recognize projects and programs in the region that help improve water quality conditions through innovative water infrastructure projects and improvements. This program, the Water Innovation Strategies of Excellence (WISE) Awards, honors projects in four categories. These categories are:

- Built Project (Less than $500,000)
- Built Project (More than $500,000)
- Planning and Policy
- Education and Public Awareness

The WISE Awards recently completed review of its second year of applications. Due to timing issues relating to the novel coronavirus, multiple extensions for applicants and judges were provided. However, judges completed their scoring recommendations in May 2020. Pending final discussion and review, recommendations on winners will be presented during the August 2020 meeting of the NRAC. Pending conditions associated with COVID-19, an awards ceremony will be held later this year.

Compared to FY 19, the WISE Awards saw a 45% reduction in total applicants. However, this reduction is consistent with other H-GAC award programs, such as the Our Great Region Awards and Parks and Natural Areas Awards, which each demonstrated a second year drop, despite a broader outreach/engagement strategy for publicizing the awards. For the 2021 cycle, tentatively scheduled for release in January 2021, staff will work more closely with Bacteria Implementation Group and NRAC members to help promote submissions.

Four NRAC meetings were held during the Project term. Topics discussed at these meetings are presented in Table 19.

TABLE 19: Natural Resources Advisory Committee Meetings, FY 20

Date	Topics Discussed
11/07/2019	• Appointment of new members • Parks & Natural Areas Subcommittee Report • WISE Awards Subcommittee Report • Environmental Program Highlights • Galveston Bay Watershed Trash Action Plan • Planning for 2020
02-06-2020	• Appointment of new members • Parks & Natural Areas Subcommittee Report • WISE Awards Subcommittee Report • Regional Flood Management Committee Highlights • Solid Waste Management Committee Highlights • Environmental Program Highlights
05-07-2020	• Parks & Natural Areas Subcommittee Report • WISE Awards Subcommittee Report • Regional Flood Management Committee Highlights • Solid Waste Management Committee Highlights • Environmental Program Highlights • "Know Your Watershed" presentation
08-06-2020	• Parks & Natural Areas Subcommittee Report • WISE Awards Subcommittee Report • Regional Flood Management Committee Highlights • Solid Waste Management Committee Highlights • Environmental Program Highlights • Presentation of Draft Water Quality Management Plan

H-GAC staff routinely attend meetings of, or otherwise support, numerous other organizations involved in water quality efforts throughout the region. Due to the density of work in the Houston-Galveston Region, coordination and communication is essential. During the current project term, staff helped coordinate activities on several projects with a variety of internal programs and outside organizations. Examples of the groups and projects staff worked with this year include:

- GBEP subcommittee memberships (Water and Sediment, Monitoring and Research) and leadership (Water and Sediment – Vice Chair);
- Coordination with the Clean Rivers Program on the development of the Basin Highlights Report;
- Promotion of OSSF projects, including presenting at the Harris County Onsite Wastewater Seminar;
- Attendance and presentations at city council meetings throughout the Region;
- A variety of interactions with state and local policy and regulatory efforts (including coordination with ongoing TMDL, WPP, and other efforts). Noteworthy watershed-based projects include:
    - Bacteria Implementation Group
    - San Jacinto-Brazos Coastal Basin TMDL
    - Brazos-Colorado Coastal Basin TMDL
    - Upper Oyster Creek TMDL
    - East Fork San Jacinto River TMDL
    - West Fork San Jacinto River WPP
    - Big Creek TMDL
    - Cedar Bayou WPP
    - Bastrop Bayou WPP
    - San Bernard River WPP
    - Cypress Creek WPP
    - Spring Creek WPP

In addition to facilitating regional communication, coordination, and cooperation on water quality efforts through staff presence and participation, H-GAC uses the data generated under the Project to support various internal and external project needs.

Urban Forestry Support and Coordination

Through the Urban Forestry Support and Coordination subtask, H-GAC supports regional efforts to coordinate water quality and forestry efforts, with a focus on riparian and urban areas. H-GAC supports the Texas Forest Service and other forestry agents in facilitating events and efforts in the H-GAC region, including participation in the Houston Area Urban Forestry Council, participation on the planning team for the Texas Forests and Drinking Water Partnership, and support in providing data resources and information on funding resources to local forestry partners.

Support for Urban Forestry issues has become a major focus for H-GAC in recent years. As part of these activities, H-GAC staff works regularly with various entities, such as Houston Wilderness, The Nature Conservancy, and Trees for Houston, to provide data for urban forest research projects.

PHOTO: Terry Hershey Park

Major urban forestry milestones for FY 20 include:

Committee Memberships

- Served on the Board of the Houston Area Urban Forestry Council to represent watershed projects and water quality efforts in the area, and helping to develop a regional forestry coordination group;
- Served on the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) State Technical Advisory Committee group for urban areas, representing forestry;
- Served on the Coordinating Committee for the statewide Forests and Drinking Water Partnership.

Presentations

- Represented the region at the NYC Natural Areas Conservancy Urban Forest conference in New York City, NY, and presented on Houston area urban forestry coordination efforts;
- Presented on forests and water resources at several conferences including the Houston Areas Urban Trees conference on 11/15/19, the GBEP Symposium on 1/22/20, and as part of several other local events and meetings.

Project Planning

- Represented H-GAC and partner water quality efforts in discussions with various forestry stakeholders throughout the period, including Texas A&M Forest Service, Texas A&M AgriLife, and City of Houston Source Water Protection;

- Worked with Texas A&M Forest Service and several national non-governmental organizations on a Forests and Drinking Water Partnership effort for the state/Houston region, planning to implement later in FY 20 as a continuation of prior efforts;

- Worked with Texas A&M Forest Service to develop a leadership training course for natural resource managers in the Houston area, to implement in late 2020;

- Worked with local partners (USDA NRCS, US Forest Service, Texas A&M Forest Service) on identifying potential reforestation and riparian buffer projects in priority watersheds;

- Worked with the City of Houston to identify funding sources and project scoping for a conservation master plan targeting forested natural areas in public lands;

- Assisted local member governments in funding identification and pursuit, including Harris County Precinct 1, City of Houston, and others;

- Represented or coordinated forestry efforts for inclusion in several water quality and water conservation planning projects, including:
    - Cypress Creek WPP
    - Spring Creek WPP
    - West Fork San Jacinto River WPP
    - Big Creek TMDL

- Assisted local entities with data requests or project development related to urban forestry, including:
    - The Nature Conservancy
    - City of Houston Source Water
    - Texas A&M Forest Service
    - Houston Wilderness
    - City of Houston Parks Department
    - Harris County Precinct 1
    - H-GAC Transportation EcoLogical
    - Various individuals

Outreach

- Represented forestry efforts and practices at local events throughout the year, in addition to other water resources projects.

Publications

- Co-authored two journal articles in partnership with the City of Houston and the NYC Natural Area Conservancy published by the journal Cites and the Environment:

    - Bower, Justin; Burkes, Jeremy; and Ondracek, Kelli (2020) "Assessing Houston's Forested Habitat," Cities and the Environment (CATE): Vol. 13: Iss. 1, Article 3. Available at: https://digitalcommons.lmu.edu/cate/vol13/iss1/3

    - Bower, Justin; Burkes, Jeremy; and Ondracek, Kelli (2020) "Planning for Climate Change Through Riparian Restoration in Houston, Texas," Cities and the Environment (CATE): Vol. 13: Iss. 1, Article 9. Available at: https://digitalcommons.lmu.edu/cate/vol13/iss1/9

Public Support for TMDL Projects in the Houston Area

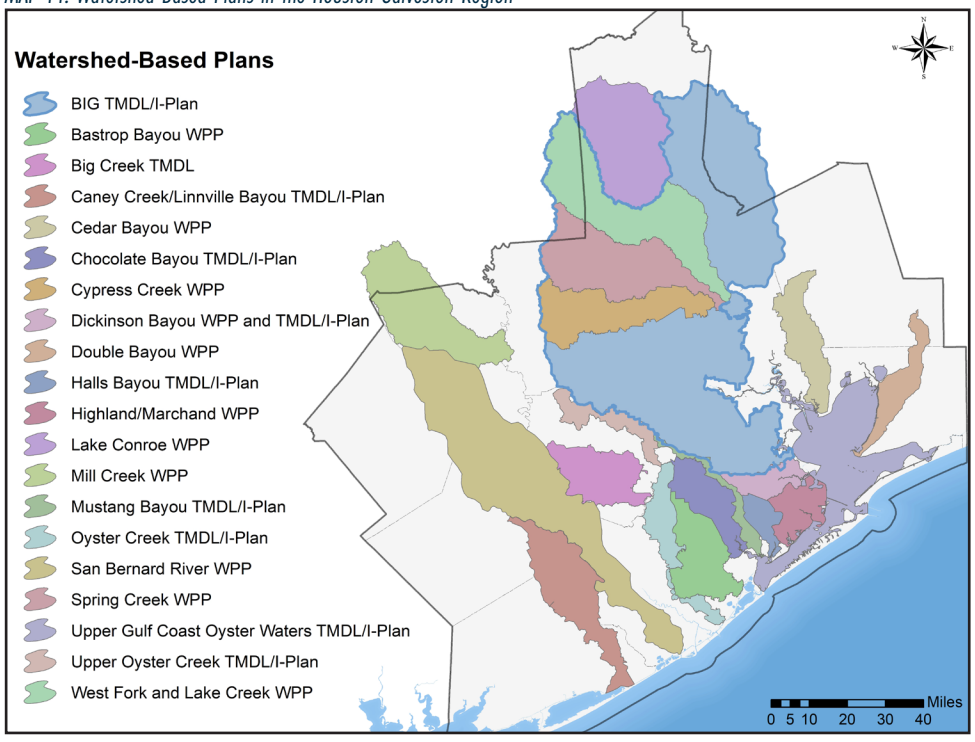
For this subtask, H-GAC provided support for public outreach activities for completed TMDL projects and other TMDL projects being developed in the region. Projects included under this subtask include the BIG, Upper Oyster Creek, and Chocolate Bayou (see Map 14). Please note that the BIG TMDL project area overlaps with several of the WPP projects. To see the full extent of the BIG project area, refer to Map 3 on page 21.

The support activities performed under this task included all activities necessary to plan and conduct project meetings. Public meetings related to TMDL projects in the region are listed in Table 20. Due to COVID-19, many of the meetings in the Spring/Summer were held by conference call or webinar in order to maintain social distancing.

TABLE 20: TMDL Project Meetings, FY 20

Date	Meeting
10/02/2019	BIG Coordination and Policy Meeting
10/29/2019	BIG Fall Meeting
12/10/2019	Oyster Creek Coordination Committee
12/10/2019	Caney Creek Coordination Committee
01/16/2020	BIG Coordination and Policy Meeting
01/30/2020	Chocolate Bayou Watershed Public Meeting
03/17/2020	Caney Creek Coordination Committee
03/23/2020	BIG Coordination and Policy Meeting
05/28/2020	BIG Coordination and Policy Meeting
06/02/2020	BIG Spring Meeting
06/25/2020	Caney Creek Coordination Committee
06/30/2020	Oyster Creek Coordination Committee
07/20/2020	BIG WWTF and SSO Work Group
07/23/2020	BIG Stormwater and Construction Work Group
07/23/2020	Upper Oyster Creek TMDL
07/28/2020	BIG Agriculture Work Group
07/29/2020	BIG OSSF Workgroup

MAP 14: Watershed-Based Plans in the Houston-Galveston Region



ON-SITE SEWAGE FACILITY PROGRAM SUPPORT

PHOTO: Installation of new aerobic On-Site Sewage Facility

TASK 5: ON-SITE SEWAGE FACILITY PROGRAM SUPPORT

TASK DESCRIPTION

The goal of this task is to coordinate H-GAC's various On-Site Sewage Facility program activities. These activities include maintaining and continuing to develop H-GAC's existing spatial database of permitted OSSFs and projected/estimated unpermitted OSSF locations to support regional water quality and wastewater infrastructure projects, administration of H-GAC's Supplemental Environmental Project (SEP) to identify failing OSSFs eligible for repair and replacement within the watershed, and outreach and education programs.

SCOPE OF WORK

The following Subtasks are included in the Scope of Work under this project task:

- Subtask 5.1: Permitted OSSF Update
- Subtask 5.2: Unpermitted OSSF Update
- Subtask 5.3: Coordination and Outreach to Authorized Agents
- Subtask 5.4: Supplemental Environmental Program Administration and Coordination
- Subtask 5.5: OSSF Outreach and Education

TASK OBJECTIVES

Decentralized On-Site Sewage Facilities are a widespread wastewater treatment technology in the Region. OSSFs are relied on for the treatment and disposal of wastewater in areas not conducive to centralized sanitary sewer service. Although they produce treated effluent of a high grade when functioning properly, OSSFs can be appreciable sources of bacterial contamination if they are not properly maintained and functioning. Annually, thousands of OSSFs are designed, sited, permitted, and installed within the Region, especially in the rapidly developing unincorporated areas of northern Harris and Montgomery counties, as well as the rural counties along the Region's outer boundary. While new systems are subject to permit requirements as specified in Title 30 Texas Administrative Code Chapter 285 (30 TAC §285), many systems installed before 1989 did not require a permit. Specific locations of these unpermitted systems may be unknown.

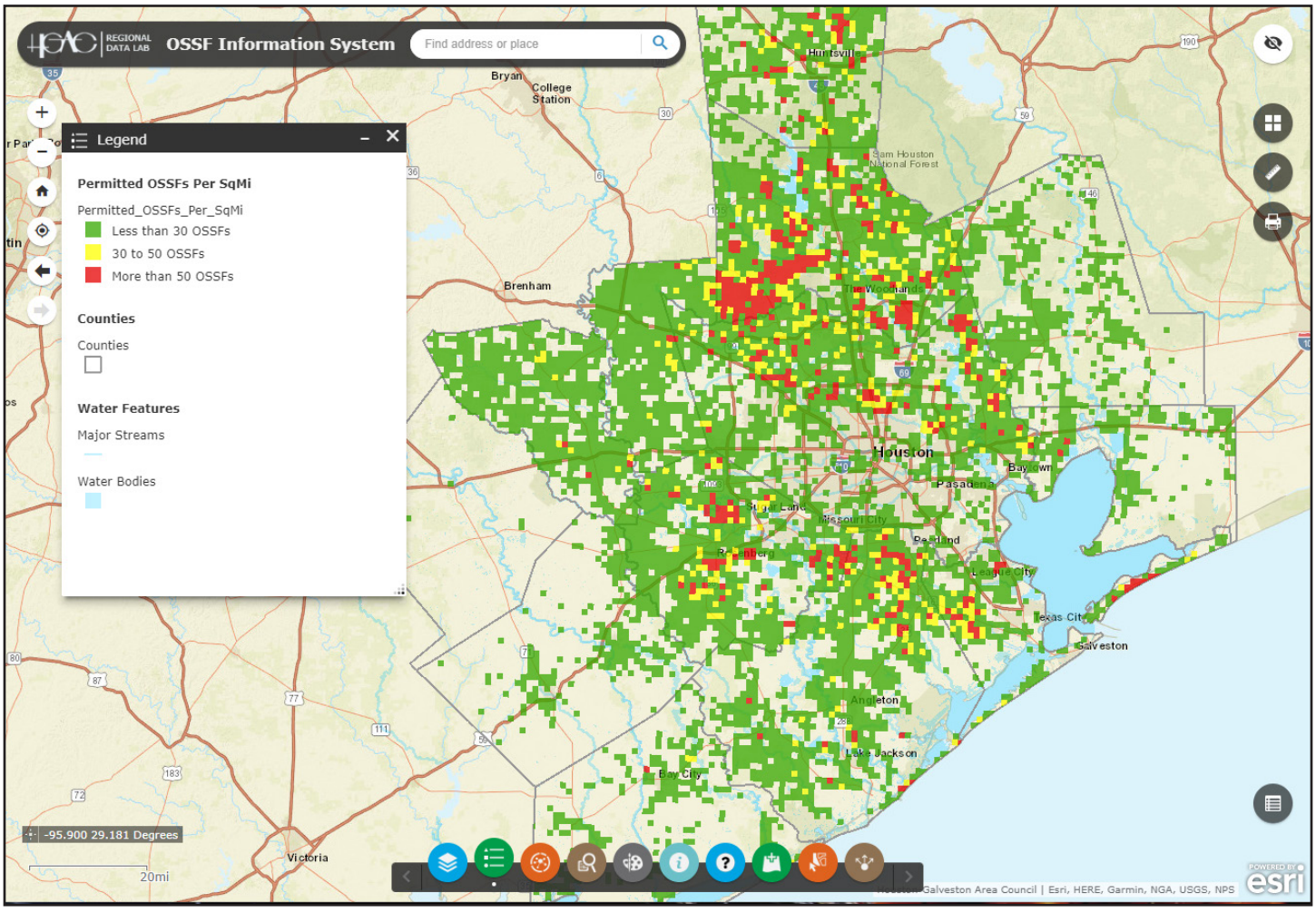
TCEQ has authority over the regulation and permitting of OSSFs in Texas. In many cases, that authority is delegated by TCEQ to Authorized Agents (counties, municipalities, river authorities, and other responsible entities). As there is no centralized repository for OSSF permitting data, the Authorized Agents have traditionally maintained these 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. During the FY 20 Project, new data provided by the Authorized Agents were added to the OSSF permit database.

PERMITTED ON-SITE SEWAGE FACILITY UPDATE

Permitted OSSF Update

For the Permitted OSSF Update, H-GAC staff continued to update the OSSF location database with data from Authorized Agents, including permitted OSSF locations and related permit data as appropriate. The intent of the 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 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 Global Positioning System (GPS) units provided by H-GAC. This information is updated regularly and is available to the public through the OSSF Information System (Figure 15) found on H-GAC's website at the following URL: https://datalab.h-gac.com/OSSF/. This interactive OSSF mapping tool allows the user to view the locations of permitted OSSFs by age, Authorized Agent or permitting authority, number of permits per square mile, and likely locations for old or unpermitted OSSFs.

FIGURE 15: H-GAC's OSSF Information System



METHODS

Authorized Agents typically submit data to H-GAC in electronic format. Several of the Authorized Agents (including Brazoria, Chambers, Galveston, Montgomery, and Waller counties) submit data to H-GAC monthly. Other Authorized Agents submit data as requested. H-GAC's partners have been responsive with data submittals. Records submitted by Brazoria, Chambers, Fort Bend, Galveston, Liberty, Montgomery, Waller, and Wharton counties contained latitude and longitude coordinates of the location of the system, 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. Updated data was not provided by Austin, Colorado, and Matagorda counties. Those entities will be contacted in an effort to receive data for future updates.

Data received by Authorized Agents are reviewed by H-GAC staff and reformatted as necessary for inclusion into the geospatial database. The methods employed in the update of the OSSF database are described in further detail in the *H-GAC Water Quality Management Plan Data Acquisition and Geospatial Data Quality Assurance Project Plan*. As data was received, existing records were examined. Any data errors (incorrect GPS coordinates, typographical errors, etc.) were corrected, while duplicate records were removed.

This update, which includes data from the period of the last update (June 2019) through December 31, 2019, brings the database current through the end of calendar year 2019.

RESULTS AND OBSERVATIONS

As of December 31, 2019, there are a total of 106,460 permitted OSSFs in the database.

Table 21 shows a breakdown of the number of permitted systems by county.

Map 15 shows the permitted systems in the region.

Map 16 shows the concentrations of permitted OSSFs by county.

Table 22 documents data processing notes related to the most recent update. This includes information such as the number of records received, any issues with that data, and how discrepancies (duplications, incorrect GPS data, etc.) were handled in order to process and incorporate that data into H-GAC's OSSF database.

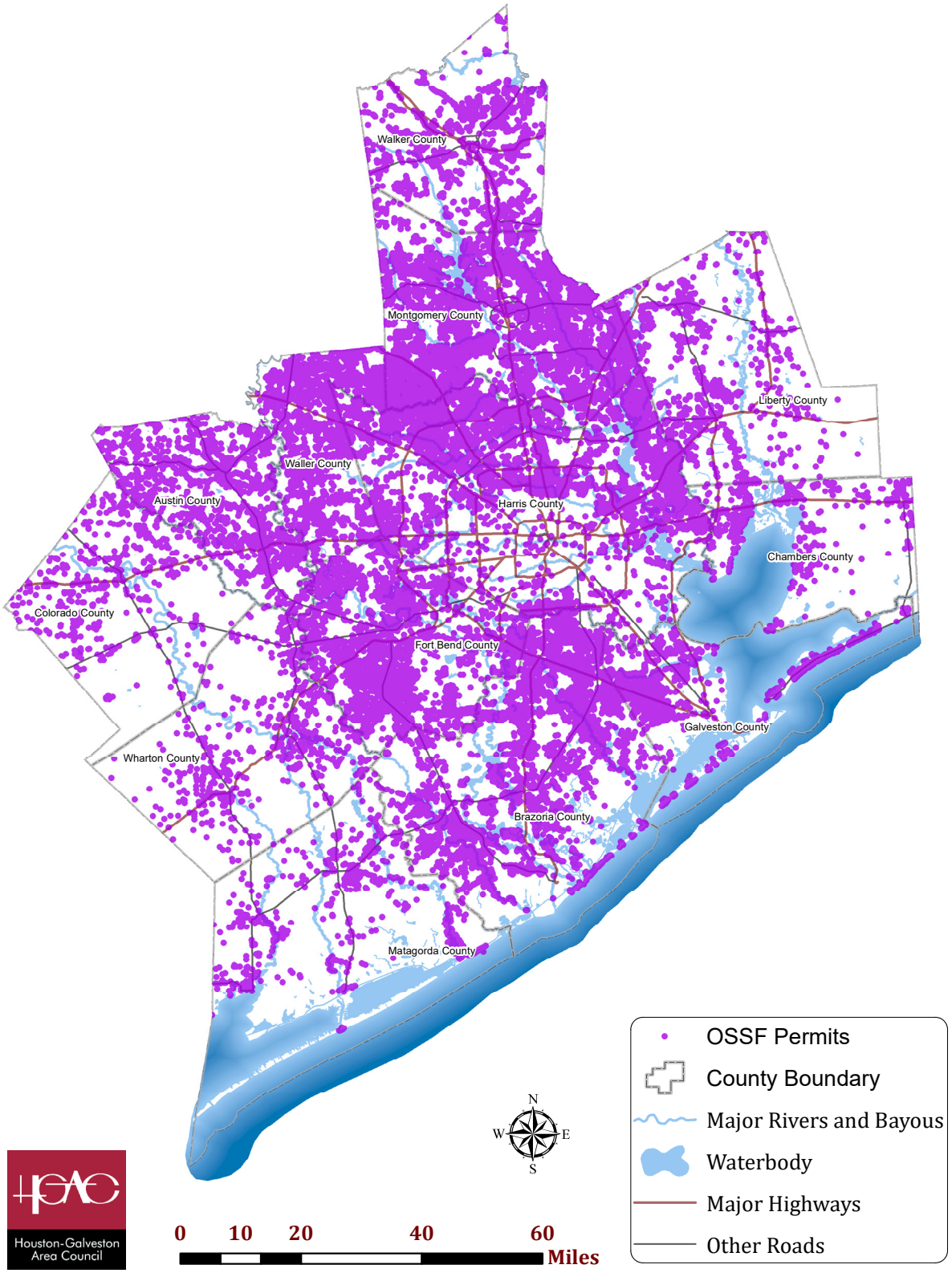
A QA/QC review of existing data identified several instances of duplicates within the data (based on permit ID number). Once identified, these duplicate records were removed or consolidated as appropriate. In the case of Harris County, all data within the GIS layer were removed and replaced with an updated comprehensive dataset provided by the Harris County Engineering Department.

In the past, H-GAC's analysis included the number of systems by type (conventional, aerobic, other, or unknown). Based on some data discrepancies and the fact that not all Authorized Agents submit this detail, that analysis has been excluded from the FY 20 WQMP Update. However, this is an area of particular interest to H-GAC staff and could be beneficial to the development of WPP and TMDL implementation plans. This is an area that will be explored further once H-GAC can acquire additional data and verify the data records for accuracy.

TABLE 21: Permitted OSSFs by County

County	Permitted Systems
Austin	3,175
Brazoria	14,644
Chambers	1,159
Colorado	595
Fort Bend	13,095
Galveston	6,060
Harris	22,595
Liberty	990
Matagorda	1,405
Montgomery	31,559
Walker	6,041
Waller	4,057
Wharton	1,085
TOTAL	**106,460**

MAP 15: Permitted OSSFs in the Houston-Galveston Region



MAP 16: Concentrations of Permitted OSSFs by County

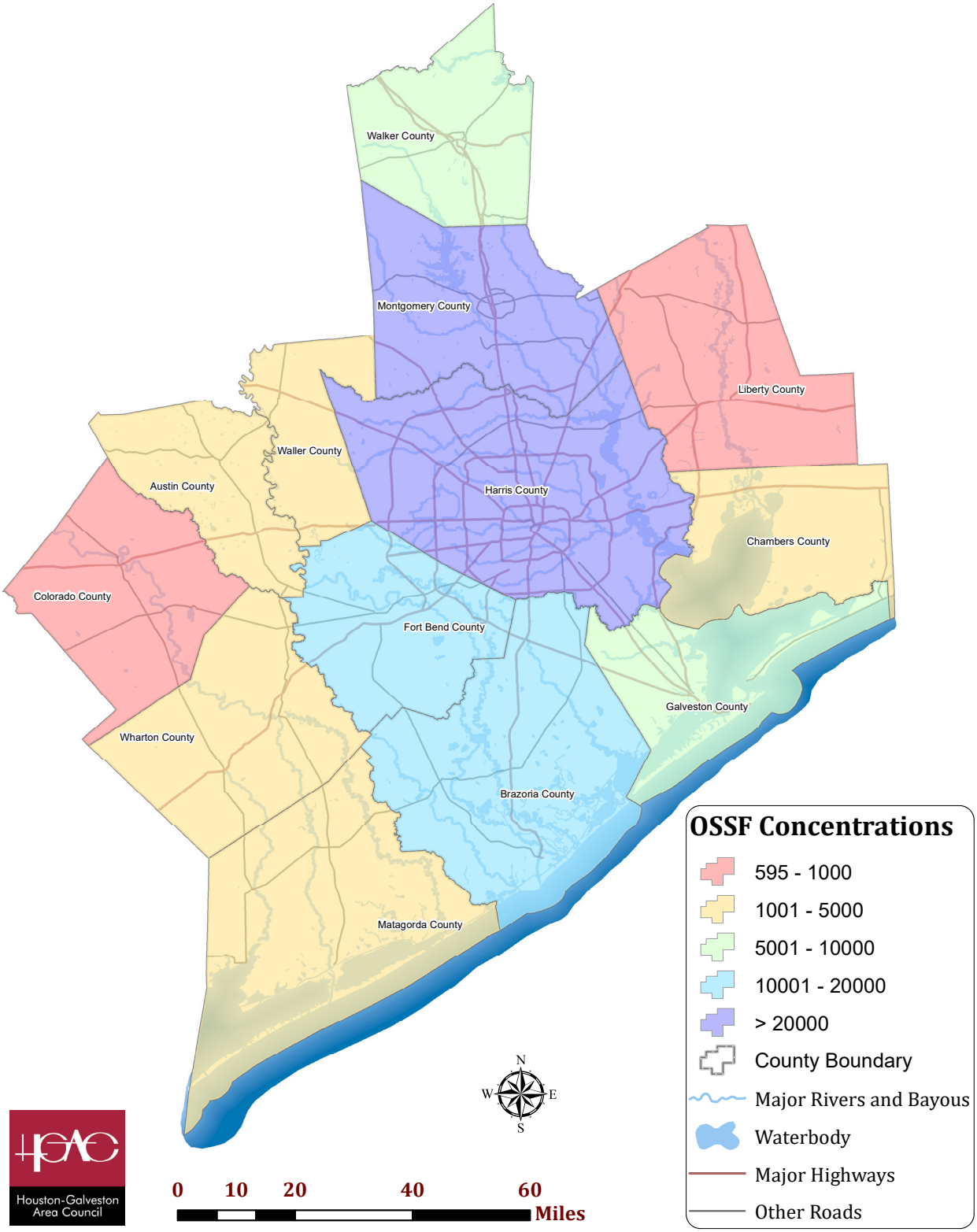


TABLE 22: OSSF Database Update Notes

County or Authorized Agent	Update Notes
Austin	No permit data submitted during the update period. Duplicate data points removed.
Brazoria	The 2020 updates contain 2019 data from July 2019 – December 2019. Total records entered into database is 419. Moved 5 features to different GPS points as they were displayed as out of Brazoria County. Used StarMap coordinates of address points.
Chambers	The 2020 updates contain data from May 2019 – December 2019. Total of 211 records entered into the database. Three records had incorrect GPS coordinates and were replaced with StarMap coordinates based off their address points.
Colorado	No permit data submitted during the update period. Duplicate data points removed.
Fort Bend	The 2020 updates contain data from January 2013 – December 2019. Fort Bend County supplied us with a dataset including permits from January 2013 to February 2020. For consistency purposes, only data up until December 2019 was incorporated. A total of 2,624 records were entered into the database. Of those records, GPS coordinates for 105 permits lie outside of Fort Bend County and were removed from the database. These will need to be geocoded and incorporated into the database at a later date.
Galveston	The 2020 updates contain data from June 2019 – December 2019. A total of 228 records entered in database. Five records lie outside of Galveston County. Four records were corrected with revised GPS coordinates. The last record was found to lie outside of the county boundary and GPS coordinates were not changed.
Harris	Harris County provided a dataset for all OSSFs (aerobic and conventional). The dataset was received too late to include in the 2019 update so it was included in the 2020 update. A review for duplications identified duplicates within H-GAC's existing records. All Harris County data records were removed and replaced with the updated dataset. An Identify and Delete tool was used to remove duplicates in the 2019 and 2020 data. After appending the data, a total of 21,503 records are in the database for Harris County. Because the dataset provided covered multiple years and some records did not provide a permit date, H-GAC was unable to determine what systems are considered new permits.
Liberty	No update notes.
Matagorda	No permit data submitted during the update period. Duplicate data points removed.
Montgomery	The 2020 updates contain data from July 2019 & October -December 2019; missing August and September 2019 data. That data has been requested from the Authorized Agent. A total of 567 records were entered into the database. Three records lie outside of Montgomery County, but there are no addresses to correct them to. They will be left in the database.
San Jacinto River Authority	SJRA provided a large dataset in early 2020 which included 2,232 new record entries.
Walker	No update notes.
Waller	The 2020 updates contain data from July 2019 – December 2019. A total of 141 records entered into database. One record had incorrect GPS coordinates and was replaced with StarMap coordinates based off its address point.
Wharton	Wharton County has supplied H-GAC with a dataset covering the period of February 2014 to Jan 2020. However, for consistency with the 2020 database update, only incorporated data up to December 31, 2019. The dataset contained 441 records with GPS locations and 362 records without locational data. Those without locational data will need to be geocoded at a later date.

UNPERMITTED ON-SITE SEWAGE FACILITY UPDATE

Unpermitted OSSF Update

For the Unpermitted OSSF Update, H-GAC staff evaluated and estimated the probable locations of unpermitted systems, which were typically installed prior to the requirement that OSSFs be permitted. This analysis is performed using polygons representing parcel and census block data.

The OSSF inventory data developed by H-GAC deals specifically with permitted OSSFs. For most Authorized Agents, systems began to be permitted after 1989. OSSFs installed prior to this date were not necessarily required to have a permit (depending on county). These systems are considered to be grandfathered and, in most cases, are not actively tracked unless violation data exist for that site. While many of these systems are well-maintained, aging systems in general pose a greater threat of failure and contamination of groundwater and surface water sources. Many of these older systems may be of a type that is not appropriately suited for the soil type. These unpermitted systems represent an appreciable portion of the systems in service. The OSSF data have already been used for a variety of watershed protection efforts and other local planning projects. With the projected population expansion and aging infrastructure, additional information about unpermitted system locations will be vital to utility planning.

METHODS

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 polygons (known parcels/census blocks), known locations of OSSFs, and known sanitary sewer systems service boundary data. Parcels with occupied structures that are located outside of established service areas and do not have a permitted OSSF were assumed to have an unpermitted OSSF. The detailed methodology employed in the unpermitted OSSF analysis is described in the *H-GAC Water Quality Management Plan Data Acquisition and Geospatial Data Quality Assurance Project Plan.*

The Unpermitted OSSF analysis was originally designed to identify the locations of unpermitted OSSFs by tax parcel polygon or census block data. H-GAC has a comprehensive parcel database for a majority of the 13 counties in the H-GAC region. Tax appraisal parcels allow for numeric estimations of unpermitted OSSFs with some limitations. For example, the centroid of the parcel is usually identified as the location of the OSSF. As properties vary in size and shape, the centroid in many cases is not adjacent to the actual system. It is also assumed that there is a 1:1 ratio of OSSFs to parcels. This potentially underestimates the number of OSSFs, as there is typically only one OSSF per parcel for a single-family residency use, but there likely could be more than one system per parcel under certain uses (such as a mobile home community).

For the counties for which H-GAC does not have digitized tax parcels available (Austin, Chambers, Matagorda, Walker, and Wharton), census blocks were used to complete the analysis. However, use of the census blocks is not ideal. Using this methodology, areas containing unpermitted OSSFs could be established, but it is difficult to ascertain a numeric estimation or the exact physical location of systems. A 1:1 ratio is also used for the census blocks to provide a conservative estimate, but it is almost a certainty that there will be multiple households per census block, so the number of OSSFs will be underestimated using census block data.

While parcel and census block data have been extremely useful in identifying potential locations of unpermitted OSSFs, H-GAC will attempt to refine the process in future project years by utilizing the 911 address data set. The QAPP has been revised to allow use of the 911 address points, and H-GAC staff are currently developing the methodology to begin using these data to develop a more accurate and detailed estimation and location of unpermitted systems in future project years.

RESULTS AND OBSERVATIONS

Based upon H-GAC's analysis, there are a combined 199,192 polygons (parcels and census blocks). Assuming a 1:1 ratio of OSSFs to polygons and recognizing there are inherent issues with this method that likely underestimates the number of OSSFs, H-GAC conservatively estimates that there are approximately 200,000 unpermitted systems within the region.

Unpermitted OSSF data is summarized below. Table 23 shows the number and type of polygons without permitted OSSFs by county. Table 24 shows the number of permitted and estimated unpermitted OSSFs by county and the estimated total number of OSSFs in the region. Locations of areas containing unpermitted OSSFs within the region are shown in Map 17.

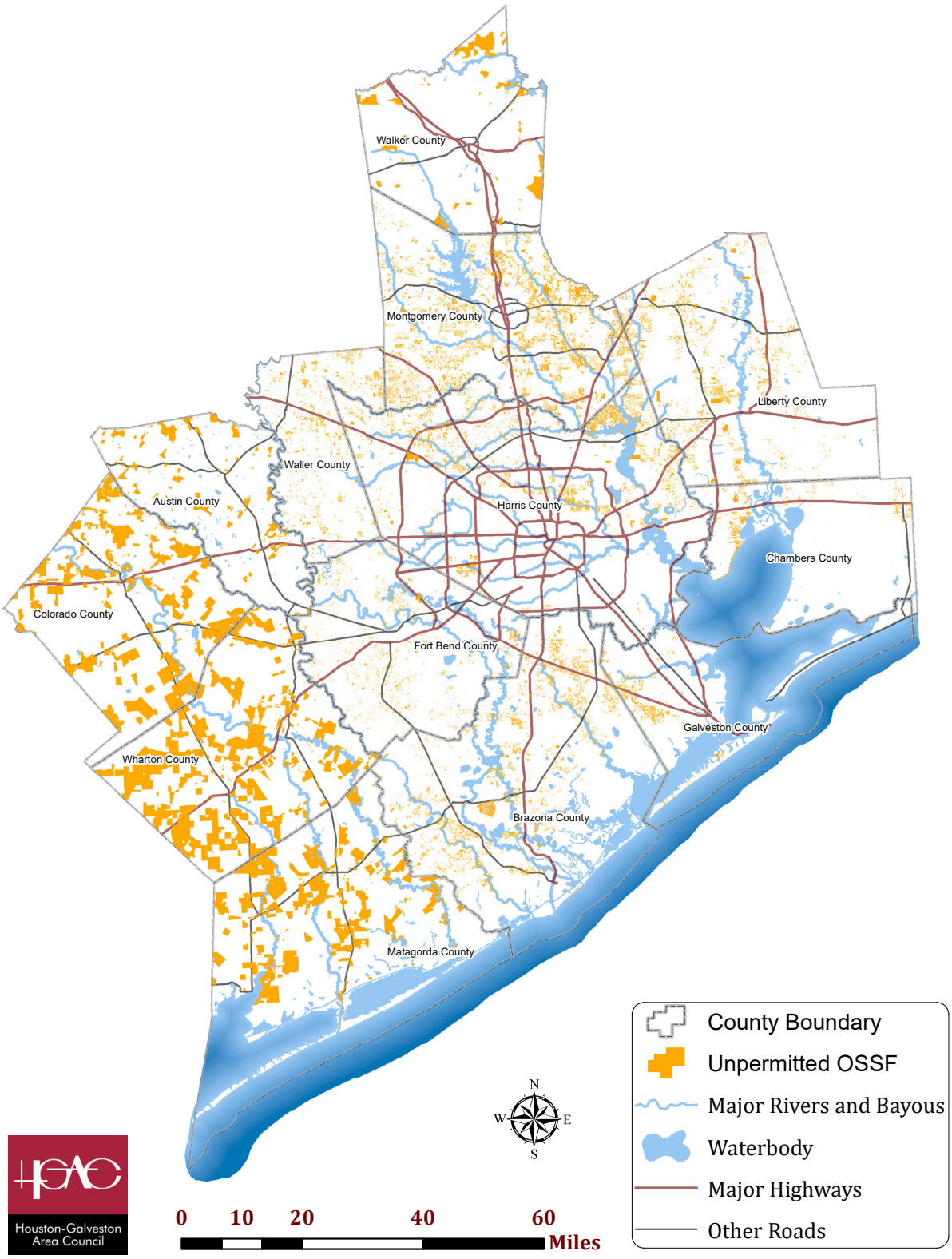
TABLE 23: Number of Polygons Witthout Permitted OSSFs by County

County	Polygon Source	Polygon Count
Austin	Census Block	209
Brazoria	Parcel	33,662
Chambers	Parcel	5,481
Colorado	Census Block	475
Fort Bend	Parcel	9,493
Galveston	Parcel	5,773
Harris	Parcel	76,214
Liberty	Parcel	11,093
Matagorda	Census Block	419
Montgomery	Parcel	44,461
Walker	Census Block	179
Waller	Parcel	11,154
Wharton	Census Block	579
TOTAL		**199,192**

TABLE 24: Summary of Permitted and Unpermitted OSSFs by County

County	Permitted Systems	Unpermitted Systems	TOTAL
Austin	3,175	209	3,384
Brazoria	14,644	33,662	48,306
Chambers	1,159	5,481	6,640
Colorado	595	475	1,070
Fort Bend	13,095	9,493	22,588
Galveston	6,060	5,773	11,833
Harris	22,595	76,214	98,809
Liberty	990	11,093	12,083
Matagorda	1,405	419	1,824
Montgomery	31,559	44,461	76,020
Walker	6,041	179	6,220
Waller	4,057	11,154	15,211
Wharton	1,085	579	1,664
TOTAL	**106,460**	**199,192**	**305,652**

MAP 17: Unpermitted OSSFs in the Houston-Galveston Region



COORDINATION AND OUTREACH TO AUTHORIZED AGENTS

Coordination and Outreach to Authorized Agents

H-GAC staff works in coordination with Authorized Agents and their Designated Representatives to receive OSSF permit data submissions for inclusion into the regional OSSF database. For counties in the Coastal Zone (Brazoria, Chambers, Galveston, Harris, and Matagorda), H-GAC facilitates data gathering and sharing with Texas A&M AgriLife Extension, who are currently developing a Coastal Zone OSSF database for TCEQ.

Several counties did not submit data for inclusion in this year's OSSF database update, with some not having submitted data in several years. Staff changes at both H-GAC and some of the Authorized Agents have led to the need to meet with those entities' Designated Representatives and reestablish some of the working relationships that have existed in the past. While staff have had discussions with several of the Designated Representatives, further meetings are necessary to resume receiving data from the other permitting authorities.

In June 2020, H-GAC staff reached out to the Designated Representatives for both San Jacinto County and Grimes County. Although both of these counties are outside H-GAC's 13-County area, H-GAC does conduct water quality monitoring in those counties. Additionally, H-GAC is the lead agency on watershed-based plans being developed for water bodies in those counties. Information on OSSF location and density is very important for TMDL implementation or making recommendations in watershed protection plans.

During the project year, H-GAC presented on OSSF topics at four meetings. These meetings are detailed in Table 25.

The Authorized Agents were a driving force in the success of H-GAC's Homeowner Wastewater Assistance SEP program, as several of the Authorized Agents routinely refer applicants to H-GAC's program to repair and replace failing OSSFs. Many of the systems installed or repaired through the project were the direct result of those referrals.

TABLE 25: OSSF Program Coordination and Outreach Meetings, FY 20

Date	Meeting	Location	Presentation Title
9/10/2019	Clean Rivers Program Regional Monitoring Workgroup	Houston, TX	Homeowner Wastewater Assistance Program
10/15/2019	Texas Environmental Health Association 64th Annual Education Conference	Austin, TX	A Supplemental Environmental Project to Repair or Replace Failing On-Site Sewage Facilities in the Houston-Galveston Region
7/29/2020	Bacteria Implementation Group (BIG) OSSF Workgroup	Houston, TX (Webinar)	OSSF Update for the BIG
8/5/2020	10th Annual Harris County On-Site Wastewater Seminar	Houston, TX (Webinar)	Working Together to Protect Our Waterways: Addressing Nonpoint Source Pollution Through Watershed-Based Plans

SUPPLEMENTAL ENVIRONMENTAL PROJECT ADMINISTRATION AND COORDINATION

SEP Administration and Coordination

H-GAC is the Third-Party Administrator for a Supplemental Environmental Project through the TCEQ (Agreement No. 2012-15). H-GAC's Homeowner Wastewater Assistance Program funds the repair or replacement of malfunctioning or failing OSSFs for homeowners who meet certain income requirements. Funding from this project may also be used to provide extension of first-time sewer service, pump-out service, and water conservation equipment. Homeowners are not charged for any portion of the cost of the work performed.

Funding for the SEP program is provided through voluntary contributions by respondents in a TCEQ enforcement action. These respondents negotiate an agreement to perform a TCEQ-approved SEP to offset a portion of the assessed administrative penalty. In addition to the funding through TCEQ, the Harris County District Attorney's Office also provides funding through their enforcement actions. Homeowners under enforcement for violation of TCEQ rules set forth in 30 TAC § 285 are not eligible for assistance under the TCEQ SEP. However, the additional funding from the Harris County District Attorney's Office does not have that same requirement. Additionally, since Harris County is concerned about water quality on a regional level, their funding is not limited to Harris County and can be used to address OSSF issues throughout the region. Funding has also been supplied by DOW and Olin Corporation for projects in Brazoria County. Examples of program signage acknowledging SEP funding sources are shown in Figures 16 and 17.

Coordination of H-GAC's Homeowner Wastewater Assistance Program occurs through the WQMP project. The WQMP contract does not fund any OSSF repair and replacement projects, as that funding strictly comes from one or more of the SEP funding sources. However, the WQMP supports the SEP program as a component of the water quality planning process, particularly the outreach and education component of the SEP. Through the SEP, H-GAC can identify failing OSSFs, either through homeowner self-disclosure or reported through referrals from Authorized Agents or OSSF professionals. This is an important planning tool used by H-GAC in addressing OSSFs as a major contributor to bacterial impairments in the region. By identifying these systems and then targeting them for repair, replacement, or decommissioning through the SEP, H-GAC can actively contribute to the remediation of these failing systems.

H-GAC's efforts largely target priority watersheds (such as those monitored by the Clean Rivers Program or subject to a WPP or TMDL) to identify areas with failing OSSFs and evaluate best management practices to address the issue. Efforts are coordinated with the appropriate H-GAC staff for each watershed project, as well as the local permitting and enforcement agencies.

FIGURE 16: TCEQ-Funded SEP Program Signage

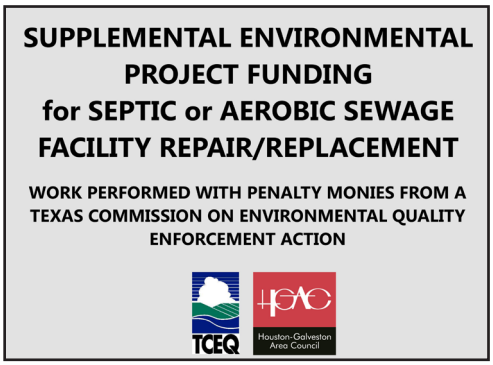


FIGURE 17: Harris County District Attorney's Office-Funded SEP Program Signage

SEP activities supported by the WQMP include coordinating with elected government officials and enforcement agencies to promote the program and presenting at numerous meetings to inform homeowners and OSSF professionals about the program and the qualifications that applicants must meet to qualify.

SEP OSSF Replacement Project

As of 7/1/20, the SEP program has funded the replacement of 23 failed OSSFs and the repair of 14 malfunctioning OSSFs (Table 26). In addition to those systems that have been repaired or replaced, H-GAC has over 38 homeowners on a waiting list. H-GAC has received $342,975 in contributions through TCEQ and the Harris County District Attorney's Office to fund the SEP program and has spent $293,550 on OSSF remediation by repairing and replacing failing systems (Table 27).

Map 18 shows the spatial distribution of projects throughout the basin (by funding source).

TABLE 26: SEP OSSF Replacements and Repairs by County, 2018 - 2020

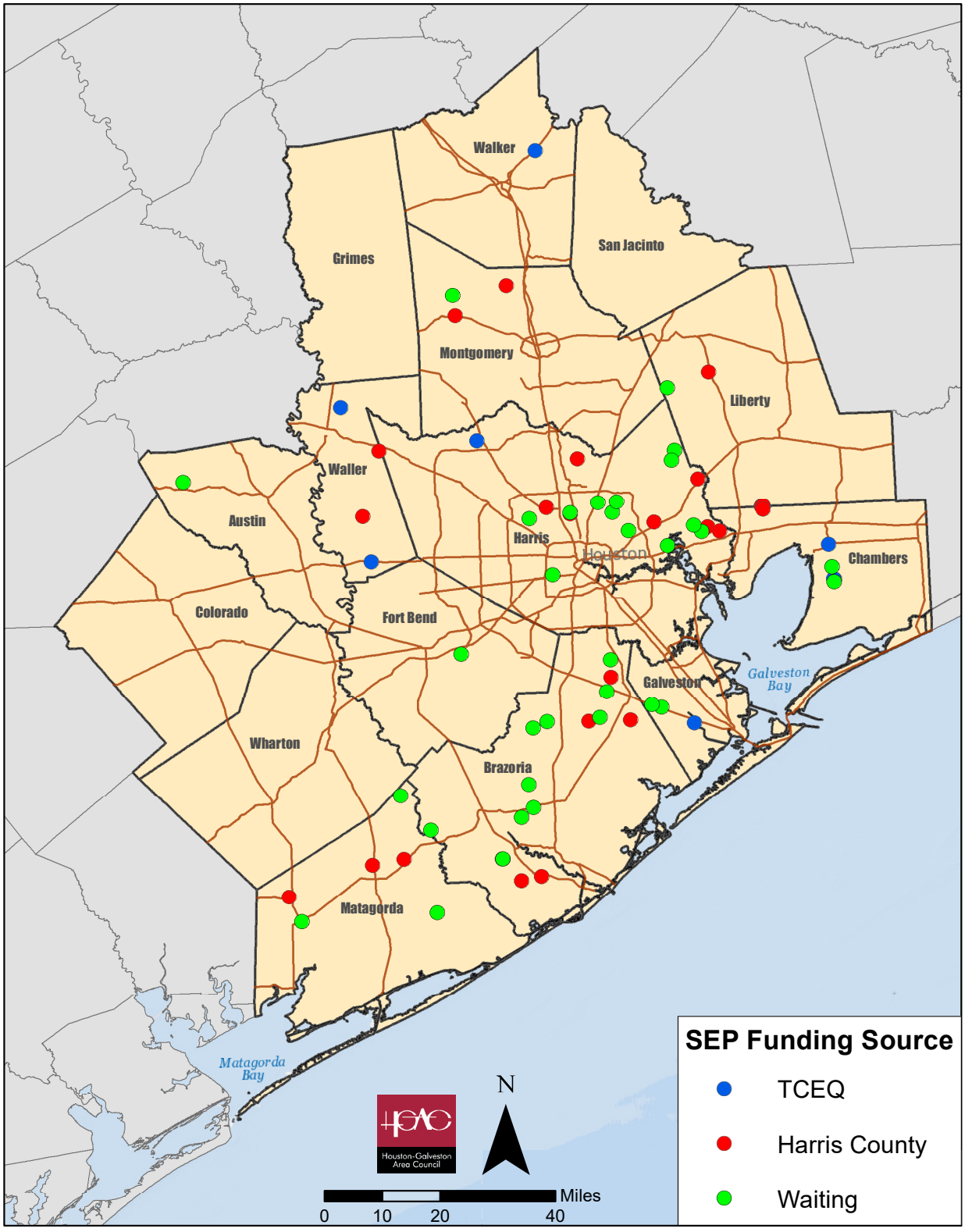
County	Replacement	Repair	Waiting
Austin	-	-	2
Brazoria	3	3	11
Chambers	4	-	3
Fort Bend	-	-	1
Galveston	2	-	2
Harris	5	3	12
Liberty	-	4	1
Matagorda	2	1	4
Montgomery	2	2	2
Walker	-	1	-
Waller	5	-	-
TOTAL	**23**	**14**	**38**

TABLE 27: SEP Expenditures, 2018 - 2020

Funding	TCEQ	Harris County	TOTALS
Received	$86,025	$256,950	$342,975
Expenses	$73,875	$219,675	$293,550
Remaining	**$12,150**	**$37,275**	**$49,425**

PHOTO: SEP OSSF Replacement Project in the Double Bayou Watershed

MAP 18 SEP OSSF Replacement and Repair Projects, 2018 - 2020



Bailey's Prairie Pump Out Program

Arranged through the Coastal Communities Program and funded through the Homeowner Wastewater Assistance Program SEP, H-GAC initiated an OSSF pump out program in Bailey's Prairie. After participating in an On-Site Sewage Facility Homeowner Education course, eligible homeowners received a free pump out of their aerobic or conventional septic system. Through this program, H-GAC pumped the systems for 7 homeowners in the Bailey's Prairie community.

PHOTO: OSSF Pump Out in Bailey's Prairie

OSSF Outreach and Education

Through H-GAC's OSSF Outreach and Education programs, staff conduct or facilitate educational training courses on basic OSSF maintenance and fundamentals of operation. These training courses are offered to homeowners, real estate inspectors and other interested parties as requested.

Homeowner outreach conducted through the SEP is an important component of numerous watershed-based projects. H-GAC uses this program as a vehicle by which homeowners can be educated about the proper operation and maintenance of their systems. Homeowner education courses conducted or scheduled during the FY 20 project year are documented in Table 28.

Two homeowner education courses were held during this project period. The flyer for one of those programs is shown in Figure 18. H-GAC staff has been in discussion with the North Central Texas Council of Governments (NCTCOG) to hold a Visual OSSF Inspection Course for Real Estate Inspectors at their location, but due to COVID-19, this training has been postponed indefinitely. Once social distancing requirements are lifted, this course will be rescheduled.

FIGURE 18: OSSF Homeowner Education Course Flyer

TABLE 28: OSSF Education Courses, FY 20

Date	Meeting/Entity	Location	Title	# Participants
10/5/2019	Bailey's Prairie	Angleton, TX	On-Site Sewage Facility Homeowner's Education Course	11
10/12/2019	Brazosport College	Lake Jackson, TX	On-Site Sewage Facility Homeowner's Education Course	6

DISCUSSION

Through the WQMP Update Project, H-GAC continues to maintain and update its current database of OSSF locations and related data. The intent of the existing OSSF database is to provide a comprehensive, spatially explicit inventory for all permitted OSSF locations throughout the Region. H-GAC's database of permitted OSSFs is a valuable resource that provides useful data to numerous watershed-based projects.

Following the FY 20 WQMP Update, which brings the data current through 12/31/19, there are now 106,460 permitted OSSFs within H-GAC's OSSF database.

Under this task, H-GAC works to estimate the number and location of unpermitted OSSFs within the region. Through the use of parcel and census block data, H-GAC has estimated that there are approximately 200,000 unpermitted OSSFs within the region.

H-GAC actively works with several of the Authorized Agents to acquire OSSF permit data to update H-GAC's OSSF spatial database. H-GAC is updating the list of Designated Representatives to reestablish some relationships, as staff changes have occurred at both H-GAC and some of Authorized Agents. These relationships are important not only for the sharing of OSSF permit data and the update of the OSSF geospatial database, but also because the Authorized Agents have been the leading source of referrals of homeowners to H-GAC's SEP.

Since 2018, H-GAC has funded the replacement of 23 failed OSSFs and the repair of 14 malfunctioning OSSFs through its Homeowner Wastewater Assistance Program. This work has been conducted in multiple counties within the region. As of 7/1/20, the SEP has spent approximately $300,000 for OSSF remediation activities for qualifying homeowners. A need has been demonstrated by this program, as there are numerous applicants on a waiting list until additional funding is available.

Outreach and Education is an important component of H-GAC's OSSF program. H-GAC staff regularly present on OSSFs and the SEP program at various public meetings, workshops, and seminars. Historically, H-GAC has offered homeowner OSSF training courses through various watershed-based projects. The primary goal of these programs is to educate homeowners on the proper operation and maintenance of their OSSFs to reduce failure rates and improve water quality.

H-GAC's OSSF program activities remain an important part of the WQMP Update. Not only does the data generated through this program inform planning and decision-making for watershed-based plans such as WPPs and TMDLs, but through the SEP, H-GAC can directly address sources of bacteria and positively affect water quality through the repair and replacement of failing OSSFs.

TASK 6: WATER QUALITY MANAGEMENT PLAN UPDATE

TASK DESCRIPTION

The goal of this task is to provide the TCEQ with a comprehensive report on the water quality management planning activities conducted under this contract and to provide documentation that the Houston-Galveston Area Council's Board of Directors has accepted the completed FY 20 *Water Quality Management Plan Update.*

SCOPE OF WORK

The following Subtasks are included in the Scope of Work under this project task:

- Subtask 6.1: Draft WQMP Update Report
- Subtask 6.2: Final WQMP Update Report

TASK OBJECTIVES

Draft WQMP Update

For the Draft WQMP Update Report, H-GAC summarizes all contract activities and findings relevant to the water quality goals of the Region. Additionally, H-GAC will provide a public notice of participation to review the Draft WQMP Update Report in accordance with Texas Water Code (TWC) Section 26.037. Submittal of the Draft WQMP Update to the Natural Resources Advisory Committee begins the public comment period. The report will also be posted on H-GAC's website to allow other interested parties the opportunity to comment and provide input into the WQMP Update.

Based upon the Scope of Work, the contents of the report include the information shown in Table 29. References to the location of the information in the report are included.

TABLE 29: WQMP Report Required Content and Location

Required Content	Content Location
Title	Title Page
Table of Contents	Table of Contents List of Tables List of Maps List of Figures List of Photos
Contract Background	Project Background and Significance
Study Area	Project Background and Significance
Summary of all Task Reports	Individual project task sections
Amount of funding and amount spent	Project Administration task section
Discussion, including deliverables not completed, lessons learned, and recommendations	Individual project task sections Summary
Water Quality results achieved	Project Background and Significance Wastewater Data Update and Coordination task section Summary
Appendices (if necessary)	Appendices A, B, and C

Final WQMP Update

After comments on the Draft WQMP Update Report are received from NRAC and other interested parties, H-GAC will incorporate the comments received to prepare a Final WQMP Update Report. Comments received will be addressed and incorporated into the document as appropriate. A table documenting comments received and H-GAC's written response to those comments will be incorporated into the Final WQMP Report as an Appendix (Appendix C). The Final WQMP Update Report will be submitted to H-GAC's Board of Directors for acceptance. Once accepted by the Board, the Update will be certified by TCEQ for inclusion in the State's Water Quality Management Plan.

The timeframe presented in Table 30 was established to meet the requirements of TWC Section 26.037 related to the public comment period for the report.

TABLE 30: WQMP Report Review, Acceptance, and Submittal Timeframe

Task	Due Date
WQMP Update Draft Report and Project Data Deliverables due to TCEQ	7/1/2020
Thirty-Day Public Comment Period Opens	7/1/2020
Send Draft WQMP Update Report electronically to NRAC members for review	7/1/2020
Upload Draft WQMP Update Report to H-GAC's website	7/1/2020
Public Comment Period closes	7/31/2020
Revise Draft WQMP Update Report to address public comments	7/31/20 - 8/5/2020
Management Review (if needed/requested)	7/31/20 - 8/5/2020
Present Final WQMP Update Report to NRAC for recommendation to Board of Directors	8/6/2020
H-GAC Board of Directors Meeting	8/18/2020
Upload Final WQMP Report to H-GAC's website	8/31/2020
Submit Final WQMP Update Report and documentation of public comment period to TCEQ	8/31/2020

SUMMARY

The FY 20 Water Quality Management Plan Update Report summarizes the activities conducted under Contract 582-20-10169 from the Texas Commission on Environmental Quality (TCEQ).

This year's project was successful in acquiring and analyzing the wastewater treatment facility infrastructure data for the Region. Both the wastewater permitted discharger GIS layer and the Service Area Boundary GIS layer were updated as part of this work, expanding the data repository that H-GAC maintains. This data is used throughout multiple H-GAC programs, such as the Clean Rivers Program, as well as watershed-based plans, such as WPPs and TMDLs.

A primary component of the WQMP Update involves the acquisition and analysis of self-reported Discharge Monitoring Report data. These data are important for evaluating potential sources of bacteria in area waterways. Analysis of WWTF effluent monitoring data provides a means by which decision makers and water resource managers can evaluate the role wastewater infrastructure plays in regional water quality issues. The analysis provided in this report shows wastewater treatment facilities are typically operating within compliance of their effluent discharge permit limits for bacteria. However, considering the volume of discharge and the potential for high bacteria loading in the case of a system malfunction, it is prudent to continue to monitor the DMR data closely. The DMR data acquired through this project are important for other watershed-based projects within the region, most notably the Bacteria Implementation Group. Through addressing issues such as wastewater treatment facility discharge permit limits, the BIG has been very successful in reducing bacteria loading in the region's water bodies.

As part of the FY 20 WQMP Update, H-GAC also analyzed self-reported Sanitary Sewer Overflow data for the Region. SSO data are of great interest due to the potential for acute loading of extremely elevated levels of human fecal bacteria. H-GAC analyzed the frequency, volume, and root causes of SSOs.

H-GAC continues to develop and foster relationships with interested parties in the region's watersheds and coordinate regional water quality activities. H-GAC has been a leader in TMDL and WPP efforts, and the coordination activities of the WQMP Update Project mesh well with the overall approach of outreach, targeted studies, and implementation activities. By having multiple water quality projects concurrently within the same organization, H-GAC is able to achieve vertical integration between base data sources, internal analysis, watershed planning efforts, and external coordination.

The OSSF Database development which started in previous projects continued during this year and will be an ongoing effort that will be continuously updated. This project deliverable remains useful in H-GAC's various watershed planning efforts. H-GAC acquires OSSF permit data from Authorized Agents throughout the Region and consolidates that data into a regional database. An estimation of unpermitted OSSFs is also performed through this project. The number, location, and density of these OSSFs are important considerations in the development of watershed-based plans. This information is also useful in targeting OSSF homeowner education and outreach programs or OSSF repair and replacement.

H-GAC is the Third Party Administrator for a Supplemental Environmental Project to repair or replace malfunctioning or failed OSSFs for qualifying homeowners within the region. Through this SEP, H-GAC addressed numerous failing systems. Although the WQMP Contract does not fund any OSSF repair or replacement, many of the coordination, outreach, and education activities are conducted through this project.

The accumulated data sets, the GIS analyses, and other deliverables generated through this project have been submitted electronically to TCEQ. Where allowable and appropriate, data from this Project will be used to support other related efforts.

This report, once accepted by the H-GAC Board of Directors and certified by TCEQ, will be incorporated into the State's Water Quality Management Plan.

ADDITIONAL RESOURCES

The following resources are provided for additional information on topics discussed in this report:

H-GAC

Water Quality Management Planning
http://www.h-gac.com/community/water/quality/default.aspx

On-Site Sewage Facilities (OSSF)
http://www.h-gac.com/community/water/ossf.aspx

OSSF Information System
https://datalab.h-gac.com/OSSF/

Clean Rivers Program
http://www.h-gac.com/community/water/rivers/default.aspx

Clean Rivers Program 2020 Basin Highlights Report
https://datalab.h-gac.com/BHR2020

Water Resources Information Map (WRIM)
http://h-gac.com/go/wrim

Natural Resources Advisory Committee (NRAC)
http://www.h-gac.com/board-of-directors/advisory-committees/natural-resources-advisory-committee/default.aspx

Clean Waters Initiative Workshops
http://www.h-gac.com/community/water/cwi/default.aspx

Bacteria Implementation Group (BIG)
http://www.h-gac.com/community/water/tmdl/big/default.aspx

Watershed Protection Plans
http://www.h-gac.com/community/water/watershed_protection/default.aspx

Total Maximum Daily Loads (TMDL) and Implementation Plans
http://www.h-gac.com/community/water/tmdl/default.aspx

Coastal Communities
http://www.coastalcommunitiestx.com/

TCEQ

Texas Surface Water Quality Standards
https://www.tceq.texas.gov/waterquality/standards

Texas Integrated Report of Surface Water Quality
https://www.tceq.texas.gov/waterquality/assessment

Texas Clean Rivers Program
https://www.tceq.texas.gov/waterquality/clean-rivers/index.html

Surface Water Quality Segments Viewer
https://www.tceq.texas.gov/gis/segments-viewer

Surface Water Quality Web Reporting Tool
https://www80.tceq.texas.gov/SwqmisPublic/index.htm

State Water Quality Management Plan
https://www.tceq.texas.gov/permitting/wqmp

Total Maximum Daily Load Program
https://www.tceq.texas.gov/waterquality/tmdl/index.html

Nonpoint Source Program
https://www.tceq.texas.gov/waterquality/nonpoint-source/index

Wastewater and Stormwater Permitting
https://www.tceq.texas.gov/permitting/wastewater

TCEQ GIS Data
https://www.tceq.texas.gov/gis/download-tceq-gis-data

Supplemental Environmental Projects
https://www.tceq.texas.gov/compliance/enforcement/sep

On-Site Sewage Facilities Rules and Regulations
https://www.tceq.texas.gov/permitting/ossf/ossfregulators.html

Galveston Bay Estuary Program
https://gbep.texas.gov/

TWDB

Clean Water State Revolving Fund (CWSRF) Loan Program
http://www.twdb.texas.gov/financial/programs/CWSRF/index.asp

APPENDICES

LIST OF APPENDICES

Appendix A – Task 3 Wastewater Data Update and Coordination Data Deliverables
Appendix B – Task 5 OSSF Database Update Data Deliverables
Appendix C – Task 6 WQMP Update / Final Report Documentation and Comments

APPENDIX A - Task 3: Wastewater Data Update and Coordination Data Deliverables

The following Contract Deliverables were submitted electronically with this report:

GIS LAYERS

- Wastewater Outfalls GIS Layer
- Service Area Boundaries GIS Layer

MAPS

- SAB_2020_Outfalls
- SAB_2020
- DMR_Frequency_2010_2019
- DMR_Frequency_2019
- DMR_Occurrences_2010_2019
- DMR_Occurrences_2019
- SSO_Frequency_2010_2019
- SSO_Frequency_2019
- SSO_Occurrences_2010_2019
- SSO_Occurrences_2019

APPENDIX B - Task 5: OSSF Database Update Data Deliverable

The following Contract Deliverables were submitted electronically with this report:

GIS LAYERS

- Permitted OSSF Database
- Unpermitted OSSF Analysis

MAPS

- 2020_Regional_OSSFs_Map
- 2020_Regional_OSSFConcentration_Map
- 2020_Regional_Unpermit_OSSFs_Map
- SEP OSSF_Repair_with_TCEQ

APPENDIX C - Task 6: WQMP Update / Final Report Documentation and Comments

The following Contract Deliverables were submitted electronically with this report:

- Documentation of Public Participation
- Comments received on the 2020 Water Quality Management Plan Update Report
- Response to comments on the 2020 Water Quality Management Plan Update Report

Documentation of Participation in the WQMP Update

- To ensure the public has an opportunity to participate in the WQMP Update and provide comments on the report, a 30-day public comment period was available. This comment period opened on 7/1/20.

- The Draft WQMP Update Report was sent electronically to members of the Natural Resources Advisory Committee (NRAC) for review and comment on 7/1/20.

- The Draft WQMP Update Report document was posted on H-GAC's website for public review and comment.

- The Public Comment period closed on 7/31/20.

- The Draft WQMP Update Report was updated to address public comments and comments from the NRAC.

- The Final WQMP Update Report, incorporating comments submitted by the public and NRAC, was presented to the NRAC on 8/6/20 as part of a public meeting.

- The Final WQMP Update Report was submitted to the H-GAC Board of Directors for acceptance on 8/18/20.

- The Final WQMP Update Report was submitted to TCEQ for certification on 8/31/20.

Public Comments on WQMP Update

Please note that references to specific page numbers below refer to the page number of the Draft report. Due to edits made to the text, some of these page numbers may have changed slightly in the Final Report.

From	Page #	Comment	Response
Andrea Tantillo Senior Communications Specialist H-GAC (Internal Review)	Table of Contents	Add the Table of Contents to the Bookmarks in the PDF file.	Will add bookmarks to PDF document.
	Acronyms	TCEQ ultimate checklist recommends "Abbreviations List" instead of using the word "acronym"	Renamed to "Abbreviations List"
	Introduction	Introduce acronyms for H-GAC, WQMP, CWA, TCEQ, and TSWQS in this section.	Completed
	Background	Add "Region" to list of abbreviations and maintain consistency with use.	Document reviewed and edited for consistency
	General	Consistency with language (WQMP, WQMP Update, WQMP Update Report, Final Report)	Document reviewed and edited for consistency

From	Page #	Comment	Response
Brian Butscher City of Sugarland	44	Says "report all SSOs regardless of volume within with 24 hours". Please see Texas Administrative Code 30TAC 327.32(c). This allows for a monthly submission if under 1000 gallons	This error has been corrected in the Final version of the report.

From	Page #	Comment	Response
Jerry Caraviotis Water Specialist Harris County Pollution Control	N/A	On behalf of Harris County Pollution Control, please know our team has reviewed your 2020 Draft Water Quality Management Plan. We have found it to be very complete, and upon our review do not have any comments to offer. Thank you so much for including us in your process.	Thank you and everyone at Harris County Pollution Control who reviewed the Draft Water Quality Management Plan Update. Your input into the update process is very important to us.

From	Page #	Comment	Response
Richard Chapin, P.G. Senior Project Manager City of Houston	N/A	I don't have any comments, questions, or suggested changes.	Thank you for reading and reviewing the Draft Water Quality Management Plan.

From	Page #	Comment	Response
Tom Douglas Natural Resources Advisory Committee Private Citizen	9	Add FOG (Fats/Oils/Grease) to the list of acronyms and abbreviations. Use the expression "Fats/Oils/Grease" consistently throughout the document.	FOG added to list of acronyms. Document reviewed and edited for consistency.
	14	The upper part of Little Cypress Creek is not shown – it is all the way out by Hockley, near Warren Ranch Road. See the map on page 1-2 of the September 2009 Technical Support Document for the Lake Houston Watershed TMDL.*	An error has been identified in the TCEQ GIS layer. The segment/AU description is incorrect, and has changed since the 2008 GIS layer used to generate the maps for the Lake Houston TMDL were generated. TCEQ is aware of the issue and is making the correction. However, because of the QA process necessary to change/revise GIS layers, this change will probably not be effective until the 2022 assessment.
	20	On the Y-axis of the graph in Figure 1, it would be preferable to spell out the words "Primary Contact Recreation". If you use the acronym PCR, consider adding that term to the list of acronyms and abbreviations on page 9. The trouble with that solution would be that "PCR" is commonly used to signify Polymerase Chain Reaction, which is frequently used in connection with water quality.	Added a note as an overlay on the graph that PCR = Primary Contact Recreation, and included in the list of acronyms. In order to redo the graph, the statistical analysis would have to be rerun using SAS. Under normal conditions this would be easy to accomplish, but working remotely over VPN due to COVID-19 complicates the process considerably.
	30	In line 1, insert the word "of" between the words "analysis" and "self-reported".	Corrected
	44	Paragraph 3: The BIG Implementation Plan defines a subscriber system as follows: "A subscriber system is a sewer system that conveys flow to a wastewater treatment facility that is owned by a separate entity. The term is not intended to indicate individual private laterals, such as a homeowner's connection to a sewer system." Since both of these documents originate with the H-GAC, consider using the same definition.	The text has been changed to reflect the language used in the BIG I-Plan.
	46	The highest number of SSOs is reported for the year 2017, which is attributed to Hurricane Harvey. At first look, it seems odd that 2017 would not also have the highest volume of SSOs. If this were due to some systems not reporting SSOs because they went completely underwater, so that no estimate of volume could be made, consider offering this as a probable explanation.	This very likely possibility was addressed in the report.
	47	Consider adding a row to the bottom of Table 14, with "Total" in column 1 and "896" in column 2. Also in column 2, consider adding the percentage value, in parentheses, for each row. This would make it easier for the reader to refer back and forth between the table and the text, and to see that the percentage values do add up to 100%.	Added an extra column to list Percentage of Permittees. Included row for total.
	49	To match usage elsewhere, consider adding "Oils/" to the entry in column 1 of row 3 in Table 17, so that it reads "Fats/Oils/Grease". Also, use this expression consistently, such as in the captions to Figures 13 and 14.	Added to Table 17, and changed captions for consistency.
	49	Stating either in Table 17 or in the text that the total number of events (the denominator used to calculate percentages for 2019) is 1,249 would save the reader from having to look back two pages to find that number at the bottom of Table 16.	Added a totals row to table

From	Page #	Comment	Response
Tom Douglas Natural Resources Advisory Committee Private Citizen	49	Table 17: In the number for the volume of SSOs due to Rain/Inflow/Infiltration, the comma should be shifted one place to the right, to read "17,878.3".	Typographical error corrected
	49	Figure 14: If the label for "Estimated Volume (1000 Gallons)" were moved down to a position below the row of numbers at the bottom of the graph, then it would be possible to stretch out the X-axis enough so that the categories in Figure 14 would lie directly below the corresponding categories in Figure 13. This would also allow for the font size in Figure 14 to be made as large as the font size in Figure 13. To make the style of the two tables match, a similar change could be made in Figure 13. Alternatively, a simpler solution would be to delete these two labels, since the meaning of the bars in each graph is already clear from the labels for the Y-axes, and only one color is used in each graph.	The label could not be removed from the Data Table in Excel, but I was able to reformat it so that it takes up less space. I also adjusted the image size of the charts to make them line up better.
	53	Map 12: A red line, signifying a watershed boundary, crosses the San Bernard River near Highway 35. The entire watershed for the San Bernard actually extends much farther inland, up to a point north of Interstate 10. Is the intent to demarcate a division between two San Bernard subwatersheds? If so, this might be worth a note. The same division of the San Marcos watershed also appears in other maps, such as Map 10, but it is particularly evident here.	According to Jessica Casillas, who prepared the maps, we have it delineated using Clean Rivers Program watersheds and further by USGS watersheds, which is why it appears as a subwatershed. East Matagorda Bay is a subwatershed of the San Bernard River watershed.
	54	On line 6, I recommend using the expression "fats/oils/grease", to match usage elsewhere. (The initial use of the term occurs on page 47.)	Changed to "FOG"
	59	Table 19: Are the listings for NRAC meetings on 11-07-2019 and 11-07-2020 a duplication? The first Thursday of November in 2020 will fall on November 5, and that date would be beyond the timeframe of this Update.	The meeting date of 11-07-2020 was a typo. The correct date was 05-07-2020. This typographical error has been corrected.
	62	Wording for the bullet point: "Represented or coordinated forestry efforts for inclusion in several water quality and water conservation planning projects resources projects" is hard to follow.	Corrected language and removed duplicate word
	63	Map 14: Add a comment that the BIG project area (Map 3 on page 21) overlaps with several of the WPP project areas. Otherwise, it would appear that the BIG project area is smaller than it actually is.	This comment was added to paragraph 1 under the Public Support section.
	65	Last paragraph: Insert "of" to read: "regulation and permitting of OSSFs".	Added
	66	Line 7: Replace "though" with "through", to read: "available to the public through the OSSF Information System".	Typographical error corrected
	70	Table 22: For Waller County, revise wording to read: "One record had incorrect GPS coordinates and was replaced with StarMap coordinates..."	Typographical error corrected
	70	Table 22: The Update Notes for Wharton County refer to Waller County.	Corrected

From	Page #	Comment	Response
Tom Douglas Natural Resources Advisory Committee Private Citizen	71	Lines 5 and 6 of the last paragraph: Insert the customary hyphen into "H-GAC".	Corrected hyphenation
	72	Line 2: Revise "Assuming a 1:1 ratio of OSSFs to polygon ..." to use the plural "polygons".	Corrected
	77	When I quickly checked the number of projects waiting in Austin County, Brazoria County, and Chambers County, the number of points shown on Map 18 did not agree with the number given for that county in Table 26. Is this due to using different data, or possibly just to map symbols that are too close together to be discriminated?	In this case, the map symbols are too close to be discriminated. For example, there are 4 projects in the same neighborhood in Dayton, including two that are located directly across the street from each other. The same situation exists in Double Bayou, where next door neighbors were both recipients of OSSF replacements. The only way we would be able to differentiate these would be to have a separate map for each county.
	80	Line 4 of the next to last paragraph: Insert the customary hyphen into "H-GAC".	Corrected hyphenation
	81	Line 4 of the first paragraph: Insert the customary hyphen into "H-GAC".	Corrected hyphenation
	83	Line 4 of paragraph 4: Consider revising to say "acute loading of extremely elevated levels of human fecal bacteria". The reason for this suggestion is that fecal bacteria from human sources pose the greatest threat to public health.	Incorporated suggested language.
	85	Is there a reason why most of Little Cypress Creek (1009E) does not show up on the TCEQ Surface Water Quality (Segments) Viewer? Its headwaters are near Warren Ranch Road in Hockley. See the map on page 1-2 of the September 2009 Technical Support Document for the Lake Houston Watershed TMDL.*	This portion of the segment does not show up in the TCEQ Surface Water Quality Viewer due to an error in the TCEQ GIS layer segment description. This is a change that H-GAC cannot make, but we have informed TCEQ of the error.
	87	Correct spelling of the word "Occurrences" in 4 of the bullet points.	Spelling error has been corrected
		The word "occurrences" is spelled correctly in the titles of Map 5 (p. 40), Map 7 (p. 42), Map 9 (p. 50), and Map 11 (p.52), but it is spelled incorrectly down in the box that explains the symbols for each of them.	All maps were regenerated with the misspelling corrected.

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