FAILING SEPTIC SYSTEM INITIATIVE

Final Report

Houston-Galveston Area Council

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Failing Septic System Initiative

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FAILING SEPTIC SYSTEM INITIATIVE

EXECUTIVE SUMMARY

The Failing Septic System Initiative assesses localized human health and environmental water quality issues associated with bacterial contamination in the region's water bodies. It is the result of a partnership between the Houston-Galveston Area Council (H-GAC) and the Galveston Bay Estuary Program (GBEP), performed with support from Harris County Precinct 2.

Malfunctioning Individual On-Site Sewage Treatment Facilities (OSSFs) have the potential to create human health and water quality problems because they are prone to failure, releasing inadequately treated sewage and wastewater into surface and ground waters. Waterborne pathogens from raw or poorly treated sewage can cause illness such as gastrointestinal infections, infectious hepatitis, cholera, and typhoid fever. Although direct correlation has yet to be established between human illness in the region and the presence of pathogens from failing OSSFs, the potential to do so exists. H-GAC estimates 60,000 people in the region could be directly affected through exposure to waterborne pathogens and hundreds of thousands indirectly, through degraded water quality.

The Failing Septic System Initiative (FSSI) provides an assessment of bacterial contamination in a high interest community in Harris County Precinct 2 (HCPCT2), Westfield Estates (Community), and an adjacent portion of Halls Bayou. The four overriding objectives of this study are

- Quantification of bacterial contamination;
- Identification of the source of the contamination;
- Development of Correction Strategies to address the problem; and
- Raise awareness of the issue to assist in specific correction initiatives.

To achieve these objectives, grab samples were taken from standing water in ditches in front of homes in Westfield Estate, in Halls Bayou, and at the Sunbelt Freshwater Supply District (FWSD) wastewater treatment plant (WWTP) outfall. Sampling determined the presence of *Escherichia coli (E. coli)*, a predictive indicator for waterborne pathogens in fresh water. Four sampling events in both wet and dry weather occurred.

Bacterial Source Tracking (BST) using a Carbon Utilization Profile (CUP) with a locally generated reference library identified the source of 66% of the bacterial contamination. Bacteria from human sources (16%) were identified in water from several locations in the Community, along with canine (33%), chicken (17%), and undetermined sources (34%).

A companion study performed by Texas A & M University at Galveston (TAMUG) at six of the H-GAC sampling locations identified human adenovirus, a common influenza virus, in sample water using polymerase chain reactions.

Without epidemiological studies, it is not possible to quantify the number of residents at risk for illness in Westfield Estates. However, using EPA estimates for the entire country that approximately 5% of the population can become ill from exposure to waterborne pathogens, a possible 150 persons out of a population of 3,000 could be affected on a regular basis in the Community, as well as others who use Halls Bayou for contact recreation. The very young, the very old, or those with compromised immune systems would be the most effected. Additionally, results of the initiative can be used to:

- Educate elected officials about the magnitude of the problem;
- Encourage developers and homeowners to act responsibly in design, installation and maintenance of OSSFs;
- Support the need for funding to convert OSSFs to municipal sewer facilities;
- Establish the need to address bacterial contamination from non-human sources.

The Correction Strategy included in this report proposes formation of a stakeholder and/or partnership group to bring municipal sewer service to the community through new and creative funding along with an increased public awareness of the need for environmental stewardship. Other strategic elements include a strong public outreach program in English and Spanish and a Community education component coupled with a practical site-specific approach to implementing OSSF best management practices until the municipal sewer system is available. Best management practices (BMPs) include the need for regular maintenance and repair of existing systems, timely removal of septic system waste from storage tanks, modifications leading to more efficient and timely enforcement of permit design criteria for new and/or remodeling structures, improved drainage, and implementation of flood control plans. The significant contribution of non-human sources of bacterial contamination (dogs and chickens) should be included in the development of appropriate BMPs.

Funding provided by the Galveston Bay Estuary Program (GBEP) and the expertise and logistical support of Harris County Precinct 2 Commissioner Sylvia Garcia and her staff allowed H-GAC to establish sampling locations, gather data, develop strategy, and involves the community and stakeholders in developing solutions. The project serves as a model for developing and cementing the stakeholder cooperation needed to assess and implement a strategy to address the OSSF malfunction problems in the region's watersheds. It helps establish a foundation for continuing water quality monitoring, bacterial load estimation, bacterial source identification, risk assessment, and outreach programs in H-GAC's other twenty-five target OSSF at risk communities.

In conclusion, the Failing Septic System Initiative shows

- Bacterial contamination by the pathogen predictor of *Escherichia coli* is above State of Texas standard for contract recreation in all standing water in ditches in Westfield Estates and in Halls Bayou;
- Bacterial levels at half the sampled locations are in the range that has been demonstrated to pose a risk to human health (>100,000 MPN/100ml);
- Sources of bacterial contamination are from both human and non-human sources (dog, chicken, and unknown) with non-human category a greater contributor;
- The wastewater treatment plant located immediately upstream did not contribute significantly to bacterial contamination in Halls Bayou;
- Additional work is needed to quantify human illness through epidemiology studies, identify unknown bacteria sources with DNA testing, and apply data to Total Maximum Daily Load (TMDL) studies;
- Correction Strategies for a permanent infrastructure solution is expensive ($16.2 million) and will take a long time to develop;
- Correction Strategy interim solutions to the contamination problem (e.g. Best Management Practices) can be developed;
- Issues will best be addressed by a group of stakeholders and partnerships; and
- Sustained public outreach to the Community at large will be necessary.

1.0 INTRODUCTION

Individual On-Site Sewage Treatment Facilities (OSSFs) are prone to failure, releasing inadequately treated sewage and wastewater into surface and ground waters. Surveys conducted by the Environmental Protection Agency (EPA) estimate that as much as 17% of the stream pollution in some states is related to OSSF problems versus 13% associated with wastewater treatment plants, and 10% related to storm water pollution (EPA, 1998; U.S. Department of Commerce, 1996)

In 2005 the Houston-Galveston Area Council (H-GAC) estimated 12% (17,800) of OSSFs in the H-GAC region were chronically malfunctioning (H-GAC, 2005). Common reasons cited for OSSF failure include age and design of the system, soil type, small lot size, improper installation, or lack of proper operation and/or maintenance. Communities that lack access to reliable sanitary sewer services generally lack the tax base necessary to support needed services because of income levels and/or lack of economic development.

In 2004 Harris County Precinct 2 (HCPCT2) began a precinct-wide evaluation of unincorporated neighborhoods without access to public water and/or public sewer. Preliminary findings in the fall of 2005 indicated the neighborhood of Westfield Estates (Community), adjacent to Halls Bayou (Stream Segment 1006) in northern Harris County, had the highest need for public sewer services and greatest potential for its residents to be exposed to waterborne pathogens from human and non-human sources.

Developed in the 1940s, the Community is comprised primarily of single-family houses of less than 1000 square feet with a median lot size (7,065 square feet) large enough for conventional on-site sewer systems. It is located in Harris County Precinct 2 bounded by Halls Bayou on the east, Little York Road on the south, Aldine Westfield Road on the west and Hopper Road on the north (Figures 1 and 2).

Original homeowners were promised "City sewer" by the Community's developers. Although Houston grew up around it, Westfield Estates was never annexed, remaining part of unincorporated Harris County without municipal wastewater treatment service. Home values have risen rapidly in the last ten years from a value of $21.68 per square foot in 1994 to $58.59 per square foot in 2005. Today the community is comprised of 780 homes with a median market value of $43,000 (2005). The rise in home values has resulted in some gentrification as well as an opportunity for repair and reinvestment in the community. Listed by the state as a "Texas Landmark and Vanishing Community," Westfield Estates is not to be confused with a similarly named new project in Katy, Texas.

Over the years, the residential character of the Community has changed. Original lots in the Community, sized for proper OSSF functioning, have been subdivided. Small machine shops and automobile repair facilities dot the Community. Many lots contain multiple houses, trailers, and/or manufactured homes. Thus, in some cases, adequate area for a septic system no longer exists. In some cases sewage flows directly into county ditches in front of the properties and ultimately into Halls Bayou via the drainage system. In other cases, current OSSFs cannot manage the increased flow.

Many homes in Westfield Estates have deteriorated because of deferred maintenance leading to the presumption that the OSSFs have not been maintained either. Several locations in the Community exhibit characteristics of failing septic systems. Stagnant black-colored water is found in ditches during dry weather from which a strong "sewer" odor emanates. Residents voice concern about the raw sewage in their ditches. They hoped that somehow, after all these years, the problem will be corrected.

Figure 1: Harris County Precinct 2 and Westfield Estates
(Source: Houston-Galveston Area Council)

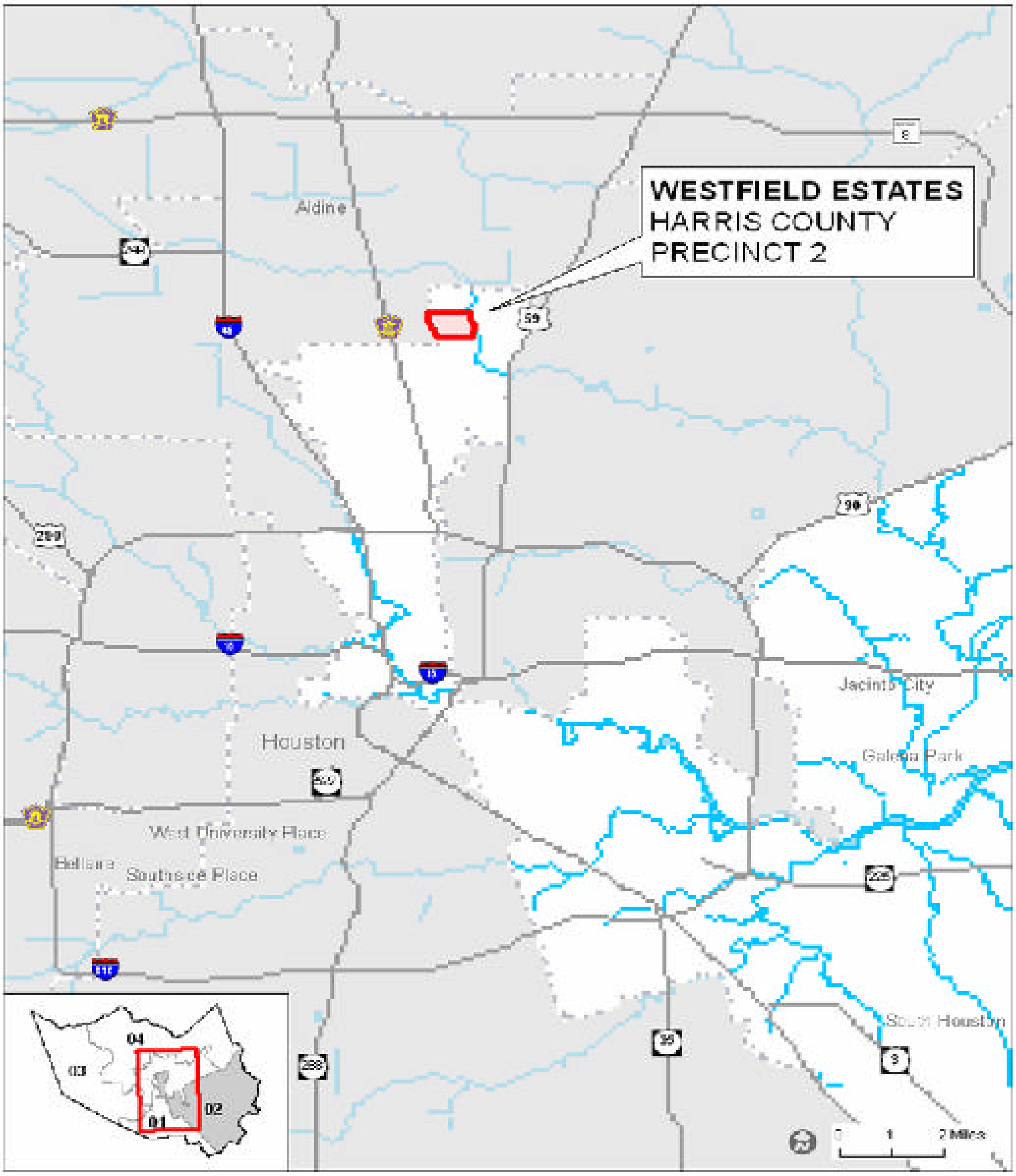


Figure 2: Westfield Estates and Halls Bayou

(Source: Houston-Galveston Area Council)

Halls Bayou, located within the Greens Bayou watershed, has a long history of flooding. It was channelized in the 1930s to alleviate problems, but flooding and erosion continue. Periodic flooding from Halls Bayou adds to potential human health concerns as well as water quality degradation. Most of the Community is within the Hundred Year Flood Plain. Westfield Estates residents were displaced by several feet of floodwater from Tropical Storm Allison in 2001. Many homeowners are still recovering from the effects of the flood with a few FEMA "blue tarps" still visible (Figure 3).

In 1996 the Texas Commission on Environmental Quality (TCEQ), then called the Texas Natural Resources Conservation Commission, was instrumental in the formation of Sunbelt Fresh Water Supply District – Oakwilde (FWSD), which provides water and/or wastewater service to a number of discontiguous communities in Harris County, including parts Westfield Estates and the surrounding area. The FWSD completed installation of potable waterlines to most of the Community through a Community Development Grant from Harris County in 2006. The FWSD has limited legal authority to raise capital for the municipal sewer project needed for Westfield Estates and cannot require residents to connect to the system when completed.

Figure 3: Flooding in Westfield Estates from Halls Bayou during Tropical Storm Allison

(Source: Photo Courtesy of Houston Chronicle)

Westfield Estates has a higher proportion of minorities, disabled, under-educated, foreign-born, non-English-speaking, lower income population and a higher than average family size than Houston as a whole, Texas, or the U.S. Census data show 22% of the population in Westfield Estates lives below the poverty level, 43% are disabled, 67% have not graduated from high school, 75% are non-white, 37% are foreign born, and only about half speak English at home (Table 1). This area's demographic profile is strikingly different when compared to those for Houston, the State of Texas, and the U.S. (Table 2).

The Failing Septic System Initiative obtained samples from standing water in ditches in front of residences in the Westfield Estates Community, in Halls Bayou, and at the FWSD wastewater treatment plant (WWTP) outfall immediately upstream from the Community. Analysis for a variety of bacteria associated with human sewage indicated the presence of *Escherichia coli (E. coli*), a predictive indicator for waterborne freshwater pathogens.

Determination of sources of fecal bacterial pollution in water bodies has recently advanced with the development of Bacterial Source Tracking (BST) methodologies. BST may use one of several methods to differentiate between potential sources of fecal contamination grouped into three major sources: human, livestock, or wildlife. In more urban watersheds, a fourth category of pets or dogs may be added.

Table 1: Westfield Estates Demographics - 2000 U.S. Census

Category	Population 1*	Population 2**	Population Total	Percent of Total (%) ***
2000 Census Tract	221900	221900		
2000 Census Block	2	3		
Total Population	1181	1763	2944	
65 or older	69	133	202	7%
White	386	324	710	24%
African American	25	49	74	3%
Hispanic	765	1390	2155	73%
Other	5	0	5	0%
Average Family Size	3.7	3.65	3.68	
High School or higher diploma	255	245	500	33%
Disability	628	648	1276	43%
Foreign Born	327	765	1092	37%
Residence – owner occupied Median Value	36600	40100	38350	
Language other than English at home	547	1109	1656	56%
In labor force	441	545	986	48%
Household income (Median)	26739	27039	26889	
Families Below Poverty Level	213	445	658	22%

* 2000 Census Tract 221900 Block 2: ** 2000 Census Tract 221900, Block 3
******* Percent exceeds 100 percent because population may appear in more than one category

Table 2: Westfield Estates Comparative Demographics - U.S. Census 2000

Demographic	Westfield Estates	Houston	Texas	U.S.
65 or older	7%	8%	10%	12%
White	24%	31%	52%	69%
African American	3%	24%	11%	12%
Hispanic	73%	38%	32%	13%
Other	5%	7%	4%	6%
Average Family Size (Number of persons)	3.68	2.67	2.45	2.33
High School or higher diploma	33%	43%	71%	78%
Disability	43%	33%	30%	32%
Foreign Born	37%	27%	14%	11%
Residence – owner occupied Median Value ($)	38,350	78,100	51,600	70,600
Language other than English at home	56%	38%	29%	17%
In labor force (18 or older)	48%	48%	57%	61%
Household income (Median) ($)	26,889	36,501	31,039	33,125
Families Below Poverty Level	22%	19%	17%	14%

Each source produces unique, identifiable strains of fecal bacteria because intestinal environments and selective pressures to which the bacteria are subjected differ from source to source (EPA, Water Technology – BST, 2002).

A Risk Assessment based on data generated in the study illustrates the nature of possible health effects associated malfunctioning OSSFs and other non-human sources of bacterial pollution in the Community and after exposure to water bodies in the target area. The Risk Assessment is useful to

- Educate the public, elected officials and the judiciary to the magnitude of the problem;
- Encourage developers and homeowners to act responsibly in installation and maintenance of OSSF;
- Determine if OSSFs contribute to decreased water quality along Halls Bayou, Harris County Precinct 2, in the Galveston Bay Estuary Program region;
- Support the need for funding to connect current OSSF-served residences to municipal sewer service; and,
- Develop plans to minimize contamination from non-human sources such as domestic pets.

The Failing Septic System Initiative is a partnership between the Houston-Galveston Area Council (H-GAC), and the Galveston Bay Estuary Program (GBEP). Bacterial data was collected and analyzed by Hygeia Laboratories, Missouri City, Texas according to H-GAC and TCEQ policy under an approved Quality Assurance Project Plan.

2.0 INITIATIVE METHODOLOGY

The purpose of the Failing Septic System Initiative is to support an overall assessment of the Westfield Estates community and adjacent portion of the Halls Bayou watershed for bacterial non-point source pollution. Three overriding objectives of this study are quantification of bacterial contamination, source identification of the bacterial contamination, and development of strategies to address the problem of failing septic systems and non-human bacterial sources. Methodology is divided into three categories:

- Data collection, analysis, and source identification;
- Risk Assessment and Correction Strategy; and,
- Public outreach.

Data collection and analysis included water quality monitoring for *E. coli*, Enterococcus, Fecal coliform and Fecal streptococcus; bacterial source identification via CUP with comparison to a limited bacterial reference library; field reconnaissance; and analysis of geographic information databases. A companion study was performed by Texas A & M University at Galveston (TAMUG) for human adenovirus with water samples taken from six study sites in the FSSI study.

The Risk Assessment and Correction Strategy were developed after analyzing violation datasets, examining bacterial levels in surface water, statistical analysis of source identification data, and discussions with key stakeholders.

Public outreach and Community involvement included hosting public meetings, presentations, conducting interviews, disseminating brochures on proper maintenance of on-site sewer systems in English and Spanish, and developing an On-Site Sewer System Facility CD with considerations, solutions, and resource material.

2.1 Data Collection and Analysis

Systematic monitoring is defined as sampling conducted for a short duration to screen waters that would (1) not normally be included in the routine monitoring program, (2) monitor at sites to check the water quality situation, and (3) investigate areas of potential human health and environmental concern with regard to possible bacterial contamination from a malfunctioning OSSF and other non-human sources.

Water quality monitoring and field reconnaissance played critical roles in determining and identifying bacterial loading "hotspots," developing an understanding of baseline water quality, examining Community conditions, and identifying sources of human and non-human sources of bacterial contamination. Sampling and monitoring were divided into dry weather and wet weather events with three distinct efforts: field reconnaissance, water quality monitoring for bacterial contamination, and sample collection for the reference library.

H-GAC developed a written Quality Assurance Project Plan (QAPP) to guide data collection and management activities associated with this project. The QAPP was amended (Amendment 1) to include limited bacterial source tracking using a Carbon Utilization Profile (CUP). A CUP reference library included human, canine, and avian (chicken) sources developed from local sources of fecal material. The QAPP with Amendment was submitted to GBEP and the Texas Commission on Environmental Quality (TCEQ), approved, and made available on the H-GAC website www.h-gac.com. A copy of both is included in Appendix A Quality Assurance Program Plan and Amendments following this document. All samples were collected in accordance with the QAPP.

2.1.1 Field Reconnaissance

H-GAC conducted a field reconnaissance effort to supplement bacterial water quality monitoring data and to increase understanding of bacterial non-point source pollution in Westfield Estates and adjacent portions of Halls Bayou. Field reconnaissance included walking the Community, photographing, and recording observations of potential malfunctioning OSSFs or other sources contributing to bacterial non-point source pollution. These observations led to collecting additional water samples at areas of interest, most notably at the FWSD plant and additional sites in Halls Bayou, which were used to guide future sampling efforts and development of the Correction Strategy. Methods and additional information regarding the field reconnaissance effort are included in Appendix B Field Reconnaissance.

2.1.2 Geographic Datasets

H-GAC compiled and reviewed a suite of geographic datasets including high-resolution aerial photography, land cover, hydrology, topography, wastewater treatment plant outfalls and service area boundaries, population density, household locations, precipitation, and OSSF violations identified by Harris County. Analyzing the geographic datasets allowed H-GAC to develop a conceptual model of community watershed dynamics.

Understanding of Community "watershed" dynamics and bacterial contamination were enhanced substantially using Graphical Information System (GIS) analysis. GIS imagery went beyond simply mapping the area. High-resolution aerial photography was used to assess community land use, identify outfalls from wastewater treatment plants, locate septic system violations, and determine the density of on-site septic systems. GIS and geospatial analysis were keys to the success of this project.

2.1.3 Local Knowledge

Local knowledge was critical to the development of an understanding of historical and current activities within the watershed, identifying data gaps, refining the above-referenced conceptual model, and prioritizing field reconnaissance efforts and planning agency interviews. H-GAC gathered local knowledge using a variety of techniques, explained further in Section 3.5 Public Outreach and Community Involvement, of this report.

2.1.4 Water Quality Monitoring—Bacteria

The occurrence of *E. coli, Enterococcus,* Fecal coliform and Fecal streptococcus bacteria are associated with human sanitary waste, including that generated by malfunctioning OSSFs. They are also connected to fecal bacterial contamination from non-human sources. Data were collected from approximately twenty sites in the Community, plus duplicates, which met sampling criteria, as well as five outfall locations in adjacent Halls Bayou, and one at the WWTP. Initial criteria for selection of sampling locations in the Community included (1) standing water present during dry weather thought to be related to OSSF malfunction, (2) presence of "black water," and (3) sanitary sewage odor. Both dry and wet weather sampling was conducted.

H-GAC established a series of sampling sites after field reconnaissance of the Community. Sites selected were those determined most likely to be contaminated by material from absent or malfunctioning OSSFs. Additional considerations were geographic distribution, availability of safe and continued access, and land use patterns. Year-round standing water locations provided by HCPCT2 are shown in Figure 4. Actual sampling locations were chosen after field reconnaissance (Figure 5). For various reasons, such as water availability and/or safety, it was not possible to sample all locations during both wet and dry periods.

Field reconnaissance established the presence of possible non-human sources of bacterial contamination, including dogs and chickens.

Community—Warwick Street
Five sampling locations were located on Warwick Street. Two were located in the 2100 block, one in the 2300 block, and two in the 2400 block of the street. Water samples were collected from standing water in ditches in front of residences. Ditch water flowed toward the east, from the 2100 block toward the 2400 block, with the terminus of the street's ditch connected to a two foot in diameter conduit under Lazy Lane, which runs along the west bank of the Halls Bayou, leading to an outfall into the Bayou.

Community—Cromwell Street
There were five sampling locations on Cromwell Street, one in the 2400 block, two in the 2500 block and one in the 2700 block of the street. Mosquito larvae were evident in most of the ditches.

Community—Chamberlain Street
No sites, which met sampling criteria during dry weather events, were available on this street.

Community—William Tell Street
Five sampling sites were located on William Tell including one in the 2100 block, one in the 2500 block, two in the 2600 block, and one in the 2700 block.

Community—Kowis Street
There were four sampling locations on Kowis. Three were located in the 2500 block and one in the 2700 block.

Figure 4: Dry Weather Standing Water Locations
(Source: Data - Harris County Public Infrastructure Department
Mapping - Houston Galveston Area Council)

Sampling Frequency and Parameters

Hygeia Laboratories, Missouri City, Texas collected bacteria water quality samples, fecal source identification reference samples, and performed laboratory analysis in accordance with the project QAPP. Specific field techniques, laboratory methods, and other specifications are included in the QAPP. Monitoring parameters include enumeration of *E. coli*, Enterococcus, Total coliform, and Fecal streptococcus; source identification reference library samples (human, canine, and poultry); and bacterial source identification of individual isolates using CUP according to BIOLOG methodology. Statistical regression analysis was performed for source identification.

Sampling occurred on four wet weather events (September, November, and December 2006, and January 2007) and one dry weather event (September 2006). Not all locations were sampled during each event, with later sampling directed toward areas of highest interest.

Figure 5: Westfield Estates, Halls Bayou, and WWTP Sampling Locations

(Source: Houston-Galveston Area Council)

Assessing Water Quality Bacterial Contamination

H-GAC examined water samples for the presence of *Escherichia coli*, Total coliform, Fecal streptococcus, Fecal coliform, and Enterococcus. H-GAC assessed water quality conditions by comparing parameter concentrations against State of Texas criteria for contact recreation and determining if waterborne pathogens at sampling sites pose a possible threat to human health. Where values were significantly elevated, H-GAC used the information in the first two stages of Risk Assessment to aid in the development of a strategy for sewer system remediation, replacement, and/or management bacterial contamination from human and non-human sources. Data derived from this project will be used to increase understanding of water quality conditions in accordance with TCEQ's *Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data.* Findings and results are presented in Section 3.1 Bacterial Analysis and Characterization, and Appendix C Laboratory Results.

2.1.5 Carbon Utilization Profiles (CUP)

Because of the availability of data, the initial method of source identification utilized the ratio of Fecal coliform (FC) to Fecal streptococcal (FS) bacteria as a general indicator to determine the source as human, non-human, or mixed origin. Literature resources are evenly divided on the value of the FC/FS ratios as a broad bacterial source identification indicator. However, samples used in this method are usually collected within rivers or bayous. The FSSI project sampling is somewhat different. Samples came from standing ditch water as well as the bayou. Findings and results are presented in Section 3.2, Bacterial Source Determination, and Appendix C Laboratory Results.

Carbon Utilization Profiles examine the phenotypic bacterium characteristics of catabolism. The BIOLOG method of CUP uses isolates of Enterococcus cultured from the water samples, which are compared to local host-specific isolates. Host specific isolates were obtained from feces of humans and two of the predominant pets in the area, chickens and dogs. Discriminant analyses of sample isolates compared to host libraries determined the potential source of fecal contamination. Statistical analysis was conducted to predict likelihood of human or non-human origin of bacterial species. The method is automated, inexpensive, and allows for a flexible database for identification of bacteria from different sources.

The statistical program SPSS version 15.0 was used to perform discriminate analysis of metabolic traits for three libraries of Enterococcus species, humans, dogs, and chickens. Comparisons were made to derive key metabolic traits from known sources that are likely predictors of group inclusion. After patterns were established, Enterococcus of unknown origin was compared with reference libraries from local sources to determine the likely source of origin. Confidence intervals were initially set at 90%, and resulting origins for unknown were human, dog, chicken, or unknown (if patterns did not fit any of the known groups). Findings and results are presented in Section 3.2, Bacterial Source Determination, and Appendix C Laboratory Results.

2.1.6 Data Management

H-GAC followed the standard data management procedures included in the QAPP. These are analogous to those used for the Clean Rivers Program. H-GAC's Project Data Manager received hard copy and electronic data. All data sets were reviewed for accuracy and completeness. A summary of the data management process is included in the project QAPP (Appendix A Quality Assurance Project Plan).

2.1.7 Enterovirus Companion Study

In a companion study, TAMUG examined certain of the sample sites for human enteric viruses using quantitative polymerase chain reaction to detect and quantify adenovirus from human and non-human bacterial sources. Relatively large quantities of water are necessary for this analysis (10 to 50 liters). Only six of H-GAC's sampling sites had sufficient quantities of water available.

For sample processing, larger particles such as sediment and leaves were removed with a series of 4 filters that decreased in pore size from 10 µm to 0.2 µm. Next, the pre-filtered samples were concentrated down to 500 ml using a vortex ultra-filtration system with a 30 k Dalton cut-off pore size to select for viruses. These samples were further concentrated with centrifuge micro concentrators to give a final volume of 1 to 2 milliliters. Nucleic acids were extracted using a Viral RNA extraction kit and PCR primers specific for human adenovirus were used to detect the virus particles with a thermocycler. Presence of a PCR product indicated presence of the targeted virus. Analysis included examination of PCR assay targets serotypes 1, 2, 3, 4, 5, 9, 16, 17, 19, 21, 28, 37, 40, 41 and Simian 25.

2.2 Public Outreach and Community Involvement

H-GAC implemented an integrated public outreach and community involvement program designed to increase awareness about the extent of bacterial contamination in the Westfield Estate Community, educate municipal officials and citizens about threats to water quality arising from bacterial non-point source pollution, and increase interest in the formation of a community-based stakeholder group to address finding a long term solution to the problem. Key aspects of the program included:

- Hosting public meetings;
- Conducting interviews with local citizens, elected officials, resource agencies;
- Distributing informational brochures on proper maintenance of on-site wastewater treatment systems; and,
- Developing a resource CD on septic system installation, maintenance, regulation, research, funding for remediation and contacts for further information.

2.2.1 Partners and Stakeholders

H-GAC developed partnerships and relationships with stakeholders necessary to quantify, analyze, and develop strategies to resolve bacterial contamination in the Community from failing septic system facilities and other non-human sources. These partners and/or stakeholders included TCEQ Region 12, Harris County Precinct 2, Camp Dresser & McKee, Inc. (contractor for Precinct 2 in the study, *Preliminary Findings in the Unincorporated Area Revitalization Program Needs Assessment)*, Harris County departments (Engineering, Public Health & Environmental Services, Attorney), Aldine Improvement District, Sunbelt FWSD - Oakwilde, Hygeia Laboratories, Texas A & M University Galveston, and Community residents with the intent to increase understanding of Community dynamics and bacterial non-point source pollution. H-GAC personnel conducted interviews in one-on-one or group settings depending upon the audience. Presentations of report findings were prepared for stakeholder groups.

2.2.2 Public Meetings

Methods for announcing public meetings included sending meeting notices and agendas to elected officials, interested citizens, county agencies, and utility district board; posting meeting announcements at the local community center, faith-based organizations, the local grocery store, professional realtor and other businesses; issuing press releases from HCPCT2, FWSD, and H-GAC; and articles submitted to and published in local papers and newsletters (English and Spanish). Meeting announcements, attendance rosters, and other meeting materials have been submitted to GBEP via project progress reports. Copies are located in Appendix D Public Outreach.

2.2.3 Education and Presentations

Outreach and education included presentations at a variety of venues including the FWSD monthly Board of Director's meetings, Westfield Estates Town Meeting, Galveston Bay Estuary Program State of the Bay Symposium, and H-GAC's Natural Resources Advisory Committee (NRAC).

2.2.4 On-Site Sewer Facility Management Brochure and Study Summary

Approximately fifty six percent (56%) of the Westfield Estate population speaks English as a second language at home. H-GAC translated septic system maintenance brochures into Spanish. The one brochure includes installation, care, and maintenance instructions for septic systems. The other tells "How to Flush Responsibly." H-GAC also provided a results summary and risk assessment to the Community in English and Spanish. Modes of distribution included public meetings, local outreach events, and inserts enclosed with water bills. H-GAC also worked with the HCPCT2 elected officials and staff to provide additional copies to persons who expressed an interest in distributing copies through their various communities.

2.2.5 Public Information CD

To raise awareness of the importance of proper on-site septic system maintenance and improve community knowledge base, H-GAC developed and up-dated an On-site Sewer System CD, which include considerations, solutions and resources for individual homeowners in the Community and stakeholders at large. Much of the material is available in Spanish. Proposed locations for distribution and partnerships and stakeholder groups are discussed under Section 3.3 Community Risk Assessment.

3.0 INITIATIVE RESULTS

Project results are presented in five sections: bacteria analysis, bacterial source tracking, Community Risk Assessment, Correction Strategy, and public outreach. Bacterial analysis and source tracking link quantitative data with physical setting, activities, and bacterial non-point source pollution in the Community. In conjunction with the Risk Assessment, bacterial data illuminated the potential impact of bacterial contamination from human and non-human sources on human health, the surrounding environment, and on Halls Bayou and in its watershed. The Correction Strategy addresses current needs mitigated by funding availability and proposes interim solutions. Finally, Public Outreach and Community involvement activities document efforts to increase awareness, develop partnerships, increase local stakeholder involvement, and develop a watershed protection strategy.

3.1 Bacterial Analysis and Characterization

H-GAC analyzed bacterial data to provide information on the magnitude of bacterial contamination in the Community and Halls Bayou and to characterize the source of the contamination, either human or non-human. Determination of the connection between potential human illness and the presence of waterborne pathogens would be possible after completion of a future epidemiological study. This information is useful in the development of outreach strategy targeted towards homeowners, elected officials, and developers.

3.1.1 Field Reconnaissance

Field Reconnaissance was conducted to determine possible sources of bacterial contamination in the Community and to identify sampling locations. Approximately one square mile of the Community was examined. Examples of sampling locations, which conformed to sampling criteria, are shown in Figures 6 and 7. Additional locations are shown in Appendix B Field Reconnaissance.

Varieties of sources for possible bacterial contamination are present in the Community. Most homes and their septic systems are more than twenty years old. Some systems date to the establishment of the Community in the 1940's and have exceeded their normal life expectancy. In many cases, lots whose size was adequate to serve a single-family residence have been subdivided into four or more properties and may not now provide adequately for a drain field for conventional or aerobic septic systems. In many cases, two or more frame houses plus several trailers crowd onto a single lot. Additionally, owing to the low-income levels of many households, septic system maintenance may not be a high priority. Strong “raw sewage” odor was prevalent throughout the Community.

In some locations, presumed septic system outfalls were clearly visible draining into the ditch. In others, septic system outfalls were camouflaged behind broken tiles, shrubbery, tree roots, or plants. Some outfalls were suspected under driveway culverts. Gray water from several homes flowed into ditches as evidenced by larger sized outfall conduit with accompanying soap bubbles and optical brightener “sheen.” Ditches also served as repositories for used motor oil and trash. Construction and maintenance of a number of storm water ditches allowed for water to pool.

Figure 6: Selected Sampling Locations on Warwick and Cromwell Streets

Many dogs roamed the neighborhood, with more behind fences. There were many flocks (peeps or broods) of chickens, some feral, others wandering freely between yards and across streets, some in chicken coops. A few small goats were also seen. Felines were noticeably absent. Few wild birds, other than crows, were prevalent at the time of reconnaissance or sampling. One alligator, approximately two feet long, was seen in Halls Bayou, along with frogs, crows, and the occasional egret.

Several new homes have been construction on lots whose grade has been raised three to four feet because of flooding. Some new homes had visible aerobic systems. However, at least four new homes on Warwick appeared to be on lots too small to support any septic system, including some evidence of perennial wet backyards and aerobic spray on neighbor's yards.

Community—Warwick Street
Samples were collected from standing water in ditches in front of five residences on Warwick. Homes are relatively well maintained along most sections of the street and some new construction has occurred recently at the intersection of Seven Mile Road. Many dogs were present on this street. Soap bubbles and detergent from laundry were evident in standing water in some locations. Ditch water flowed toward the east, from the 2100 block toward the 2400 block, with a two foot in diameter conduit under the Lazy Lane leading to an outfall into Halls Bayou. Several ditch locations need maintenance to prevent storm water pooling.

Community—Cromwell Street
There were five sampling locations on Cromwell Street. At least one automobile repair shop is located on this street. One lot contained five trailers, one of which was covered in part with a blue FEMA tarp. Multiple cars were present on various properties. Motor oil had been dumped into the ditch in several places. The researchers from TAMUG collected samples in the 2500 and 2600 blocks of Cromwell Street for PCR analysis.

Community—Chamberlain Street
No sites on this street met sampling criteria during dry weather events.

Community—William Tell Street
Five sampling sites were located on William Tell. This street has a high concentration of residences needing some form of repair. Several residences have multiple cars in the driveway/front yard. Chickens are present in the street and adjacent yards. Many dogs were also present roaming free or contained within fenced yards.

Community—Kowis Street
There were four sampling locations on Kowis. Some lots contained as many as four trailers, with corrugated fencing providing some privacy from the street. At another location, one small lot contained a frame house with two trailers tucked behind. Researchers from TAMUG collected samples in the 2500 and 2700 blocks of Kowis Street for PCR analysis.

Community—Trenton Street
One sample was collected in the 2700 block of Trenton, adjacent to an automobile salvage yard and across the street from a private residence. Trenton is the southern boundary of the FWSD. An office building with municipal sewage service was close by. Ditch water at this location was relatively clean, although plastic trash bags filled with garbage, an old soccer ball, Styrofoam cups, and plant refuse floated in the water. Collections were made at this location in conjunction with those taken by TAMUG for PCR viral species identification analysis.

Figure 7: – Selected Sampling Locations on William Tell and Kowis Streets

Halls Bayou
Halls Bayou provides the eastern boundary of the study site, with normal channel flow fifteen to twenty feet wide during dry weather. The bayou is channelized with steep, grass-covered banks, except under the Hopper Street Bridge, which is bare ground and gently sloped. Flow is from north to south (Warwick to Kowis). During Tropical Storm Allison, Westfield Estates was covered with several feet of water from the Bayou.

The first sampling location on Halls Bayou was under the Hopper Street Bridge near the northern boundary of the Community on the east bank of the bayou. TAMUG researchers also sampled at this location. There was little water movement at this bank location and little trash was evident. The second sampling location was on the west side of the bayou, at the Cromwell Street outfall. Water exited the culvert and dropped approximately a foot into the bayou. The third location was at the Chamberlain outfall and the fourth at the William Tell outfall, which was partially below the water level of the bayou at the dry sampling event. Water was flowing at a rate of several miles per hour in this location. The fifth sampling location was taken under the walkway across Halls Bayou, approximately 100 feet south of the Kowis Street outfall. Water at this location was moving very slowly. TAMUG also sampled at this location. The Kowis Street outfall into Halls Bayou is partially crushed, restricting outflow into the bayou. Examples of views of Halls Bayou are shown in Figure 8.

Sunbelt FWSD – Oakwilde Outfall
The sixth and final location on Halls Bayou is the Sunbelt FWSD wastewater treatment plant outfall (WQ0010236001, TX0021253), located approximately a quarter mile north of the Hopper Street bridge. Maximum permitted daily flow is 0.450 Million Gallons per Day (MGD), well below the average plant size for the region (0.75 MGD). Average flow in 2006 was 0.239 MGD or 53% of its capacity. The WWTP has exceeded permitted flow in several cases in recent history, three in 2004 (February, June, and May) and one in February 2005. Flow increases significantly during periods of rain, indicating a possible problem with inflow from storm sewers or leaking manhole covers. The WWTP outfall is shown in Figure 8.

3.1.2 Geographic Datasets

Based on a review of land cover, aerial imagery, field observations, and local knowledge, land use within the Community was primarily residential/urban use. In addition to private residences, several small businesses, confirmed as car repair or machine shops, dot the area. Original lot sizes of seven thousand square feet have been subdivided in many cases, with multiple manufactured or frame homes on the same smaller lots. Review of sewer violations (Figure 9) coupled with locations for persistent standing water in ditches during dry weather (Figure 4) via aerial imagery assisted with prioritizing field reconnaissance and site selection. Harris County provided addresses of actual septic system permit violations, not just complaints of problems.

Although Halls Bayou provides open space to the Community, it is a channelized water body and not considered a natural area (See Figure 3 and 8). The Outfalls from the Community into Halls Bayou were initially identified through aerial imagery.

Figure 8: Halls Bayou Sampling Locations

Figure 9: Westfield Estate – On-Site Sewer Violations
(Courtesy Harris County)

3.1.4 Ambient Water Quality—Halls Bayou

Baseline water quality, as measured by levels of E. coli, within Halls Bayou is the subject of ambient monitoring by TCEQ. A water quality monitoring station (11126) is located approximately 1 mile down stream from Westfield Estates in Stream Segment 1006 (Houston Ship Channel).

Ambient water quality data for *E. coli* (MPN/100 ml) for Station 11126 on Halls Bayou were collected at 36 sampling events between December 2001 and November 2004. Of the 36 samples, 34 showed exceedences, or 94%. The minimum value was 190 MPN/100 ml and the maximum was 69,000 MPN/100 ml. Data shows a mean value of 9,310 MPN/100 ml with a median value of 2,900 MPN/100 ml.

More recent sampling shows improvement on Halls Bayou. In 2005, 18 samples were collected at Station 11126. One event showed *E.* coli levels of 98,000 MPN/100 ml. Of the remaining 17 sampling events, the minimum value was zero and the maximum value was 5,600, with an exceedency rate of 35%. Exceedences generally occurred within 4 days of a rain event. The mean value was 213, while the median was 150 (excluding the 98,000 for statistical deviation reasons).

For nine sampling events available for 2006, levels of E. coli were still lower, ranging from zero to 1000,

with three events exceeding State criteria for contact recreation (33%). The *E coli* level of 1000 was recorded within 2 days of a rain event. The median for this period was 210 and the mean at 324.
In the H-GAC study, 13 samples were collected between September and December 2006. *E coli* levels ranged from zero to 1986 MPN/100 ml, with three exceedences (23%).

Complete ambient water quality data for the bayou is available at the H-GAC website **www.h-gac.com** .

3.1.4 Quantitative Bacterial Analysis - Community

Fecal coliform, *E. coli,* and Enterococcus bacteria are "indicator" organisms generally measured to assess microbiological water quality. Presence of these organisms is a predictor of waterborne pathogens, bacteria, viruses, and parasites, which cause human illness and water quality degradation. Infection rates from waterborne pathogens are around 5% in the US, but approach 100% in areas with poor hygiene and contaminated water supplies. Twenty locations were selected in Westfield Estates plus six along Halls Bayou. Multiple grab samples collected.

Sampling events covered different weather conditions and temperatures (See Table 3). The September 26, 2006 sampling event (D) occurred during dry weather, with no rain for an excess of 7 days and temperature around 85$^{?}$ F. The November 28 event (W1) was preceded immediately by 1/2 inch of rain two hours prior(72$^{?}$ F) with the December 11 event (W2) preceded by 1/2 inch or rain an hour before sampling (50$^{?}$ F). The January 30 sampling date (W3) was also followed an inch of rain in the community (45$^{?}$ F).

E .coli quantitative results are shown in Table 3. A summary of analysis for test bacteria (*E. coli*, Total coliform, Fecal streptococcus, Fecal coliform, and Enterococcus) is found in Appendix C Laboratory Results.

E. coli Levels—Community
Data shows the presence of *E. coli* above TCEQ criteria for contact recreation (394 MPN/100ml) at all twenty sampling locations (Table 3). Exceedences range from six to 600 fold above the standard and varied by location, sampling date, weather conditions (wet or dry) and temperature. Approximately 50% of the sights exceeded 100,000 MPN/100ml.

E. coli Levels—Halls Bayou
Data shows the presence of *E. coli* above state criteria at all *E.* coli levels in the Bayou were much lower than those in the Community. Of the 13 samples examined on four different sampling events, three exceeded 100,000 MPN/100ml. The majority of the State standard exceedences were in the 3 to 120--fold range.

E. coli levels at the site under the Hopper Street bridge, upstream of the Community were higher than those down stream (Foot bridge south of Kowis Street outfall), with one exception, the sampling event on December 11 (W2).

Although significant levels of bacterial contamination from the Community entered the Bayou after rain events, levels decreased to upstream bacterial levels by the time effluent reached the footbridge.

Table 3: Bacterial Quantitative Assessment *E. coli* - Community

Address (Block)	Weather	*E. coli* (MPN / 100 ml)
2400 Warwick A	D W1	6600 2000
2400 Warwick B	D W1	19900 1100
2300 Warwick	D (FS) W1	>242000 / >242000 >242000
2100 Warwick A	D W1 (LS)	1500 240000 / >242000
2100 Warwick B	D (LS) W1 (FS)	15300 / 12000 112000 / 173300
2400 Cromwell	D W1 (LS)	1400 68700 / 77000
2500 Cromwell A	D (FS) W1	2800 / 1500 29900
2500 Cromwell B	D W1	800 36500
2500 Cromwell C	D W1	15500 36500
2600 Cromwell A	D (LS) W1 W3 (LS)	13300 / 12100 64900 5100 / 6200
2700 Kowis	D W1 (FS) W3 (FS)	242000 43500 / 41100 4500 / 4000
2500 Kowis Puddle	D W1	16100 36500
2500 Kowis A	D W1	120300 >242000
2500 Kowis B	D W1	>242000 >242000
2700 Trenton	D W1 (FS)	700 61300 / 64900
2700 William Tell A	D W1	7100 155300
2700 William Tell B	D W1	>242000 >242000
2600 William Tell A	D W1	45700 141400
2600 William Tell B	D W1	21400 155300
2100 William Tell	D W1 (LS)	242000 >242000 / >242000

Dilution quickly reduces bacterial concentration. This finding is supported by ambient water sampling at a site approximately 1 mile down stream of the Community. In 2006, levels of *E. coli* for nine sampling events ranged from zero to 1000, with a median (324 MPN/100ml) below the State standard for contact recreation. Only one third of the events exceeded State criteria for contact recreation. The highest *E coli* levels (1000 MPN/100 ml) were reported within 2 days of a rain event. Section 3.1.3 Ambient Water Quality - Halls Bayou, contains additional information.

E. coli Levels—Sunbelt FWSD Oakwilde Outfall
Bacterial analysis showed virtually no bacteria at the outfall on two occasions, both wet weather conditions. Thus, the WWTP is thought not to contribute significantly to the bacteria levels in Halls Bayou on these sampling occasions. See Section 3.1.5 Water Quality - Halls Bayou for further information.

Effects of Sampling Conditions—Weather and Temperature
A detailed analysis of the effects of season, weather, dry or rain event, ambient air temperature, ambient water temperature and other related factors are beyond the scope of this report. However, data (Tables 3 and 4) show that levels of bacteria in ditch water in the Community and Halls Bayou vary considerably depending on sampling date, weather, ambient water temperature, and ambient temperature conditions. Ambient ditch water temperature varied from one to 5 degrees, depending on sampling location event date. Additional information is available on Field Data Sheets, which are available upon request.

3.1.5 Water Quality – Halls Bayou

Sampling for *E. coli* contamination in Halls Bayou was conducted on several dates (Table 4). The Hopper Street Bridge is upstream of Westfield Estates. Levels of bacteria at this location should be an indication of Halls Bayou water quality prior to contact with waters from storm sewer (drainage ditch) outfalls in the Community. This location is directly downstream of the FWSD wastewater treatment plant.

The downstream location chosen is under the footbridge, south of the last Community storm water outfall, from Kowis Street. It serves as a reference point for determining total bacterial contamination coming into the Bayou from the Community.

Several storm water outfalls between these two points were also examined. It was not possible to collect samples at these locations on all of the sampling dates because of safety considerations during or shortly after rain events. The banks of Halls Bayou are very steep and grass covered at these locations and slippery when wet.

The highest concentration of *E. coli* occurred during dry weather upstream of the Community, which exceeded state standards for contact recreation at least 300 fold, with bacteria levels in excess of 100,000 MPN/100 ml. Levels of bacteria at storm water outfalls from the Community were very low in comparison.

At the first wet weather-sampling event (W1), *E. coli* levels for the upstream and downstream locations were both elevated at about three times the State standard. One of the storm water outfalls, Chamberlin Street was above this level. At this location, the conduit was partially submerged under water so a sample was taken adjacent to it from the Bayou. The other two conduits were far enough above water level in the Bayou to collect samples directly. Both locations exhibited significantly elevated levels of *E. coli* of around 100,000 MPN/ 100 ml. However, based on the downstream sample, it appears that bacterial contamination from the Community did not adversely affect water quality in Halls Bayou on this occasion. At the second wet weather sampling event, the upstream location was 20 fold lower than the downstream location.

The third wet water sampling event both upstream and downstream locations showed exceedences above state standards, with the upstream location almost twice as high as the downstream.

Clearly, because of the low number of samples taken and variability in conditions, further studies are required for conclusive results on *E. coli* bacterial contamination in this section of Halls Bayou. However, it is possible bacterial contamination from the Community, at least on these occasions, will not be as significant a contributor to overall water quality degradation as originally thought.

Table 4: Bacterial Quantitative Assessment *E. coli*—Halls Bayou

Address (Block)	**Weather**	***E. coli* (MPN CFU / ml)**
Under Hopper Bridge	D (LS) W 1 W2 (FS) W3	130000 / 198600 11800 1700 / 1000 5200
West Side of Bayou - Cromwell Outfall	D (FS) W1	1000 / 600 98000
West Side of Bayou - Chamberlain Outfall	W1	13800
West Side of Bayou - William Tell Outfall	D W1	1000 141400
West Side of Bayou - Near Kowis Outfall	D W1 W2 (LS) W3	1500 13500 34500 / 48800 2900
Sewage Plant - Outfall	W1 W2	0 0

D= Dry Weather, no rain 7 days, September 26, 2006; 85° F
W1 = Wet Weather, ½ inches of rain preceded sampling by 1 hour on November 28, 2006**; 72** ° F
W2 = Wet Weather, rain preceded sampling by 1 hour on December 11, 2006, 50 ° F
W3 = Wet weather, rain during sampling, January 30, 2007; 45° F
LS = Laboratory Split
FS = Field Split

3.1.6 Water Quality Sunbelt FWSD – Oakwilde Outfall

Historically, persistent bacteria exceedences, especially concentrations in the range shown in this study, appear to be associated with proximity to wastewater treatment outfalls. Often human illness is associated with contact with inadequately treated wastewater from bypass, overflow, or malfunction of the treatment plant.

There have been no recorded violations at the wastewater treatment plant in the past two years. Samples taken at the wastewater treatment plant outfall showed virtually no *E. coli* or Enterococcus on two separate occasions (Table 4).

3.2 Bacterial Source Determination

The most common bacteria indicators from feces of warm-blooded animals are Fecal coliform and Fecal streptococcus (i.e. Enterococcus). Fecal contaminations from human and non-human origins pose a possible health risk to humans.

Fecal coliform includes *Citrobacter freundii, Enterobacter aerogenes, Escherichia coli, and Klebsiella pneumoniae*. Fecal streptococci include *Enterococcus avium* (bird), *Enterococcus faecalis, Enterococcus faecium, Enterococcus gallinarum, Enterococcus bovis* (cow), and *Enterococcus equines* (horse).

Two methods, bacteria ratios and s, assisted in bacterial source determination. The initial method for bacterial source identification utilized the ratio of Fecal coliform to Fecal streptococcal bacteria. In some situations, the ratio is used as a general indicator to determine the bacterial source as human, non-human, or mixed origin. In the case of bacteria from mixed origin plated Fecal streptococcus isolates were used in conjunction with CUP and a limited host-specific library (human, chicken, and dog). Because of a change in sampling partner and location after approval of the QAPP, a species library component was changed from residential/rural to residential/urban: dog was substituted for cow in the library. As the project, progressed, bacterial ratios were judged unreliable and CUP was found to be a better determinant for human vs. non-human bacterial source discrimination.

3.2.1 Bacterial Ratios

Source identification utilizing the ratio of Fecal coliform (FC) to Fecal streptococcal (FS) bacteria as a general indicator to determine the source as human, non-human, or mixed origin has produced mixed results. Literature resources are evenly divided on the value of the FC/FS ratios as a broad bacterial source identification indicator. However, samples used in this method are usually collected within rivers or bayous. The FSSI project sampling is somewhat different in that samples come from standing ditch water as well as the bayou. Additionally, bacterial analysis required for CUP analysis also produced data necessary to determine bacterial FC/FS ratios. This provided an opportunity to examine the utility of the ratio method for source identification. In our study, this method did not show great utility for identifying the source of bacterial contamination. Bacterial FC/FS ratios are Summarized in Appendix C Laboratory Results.

3.2.2 Bacterial Source Tracking—Carbon Utilization Profiles (CUP)

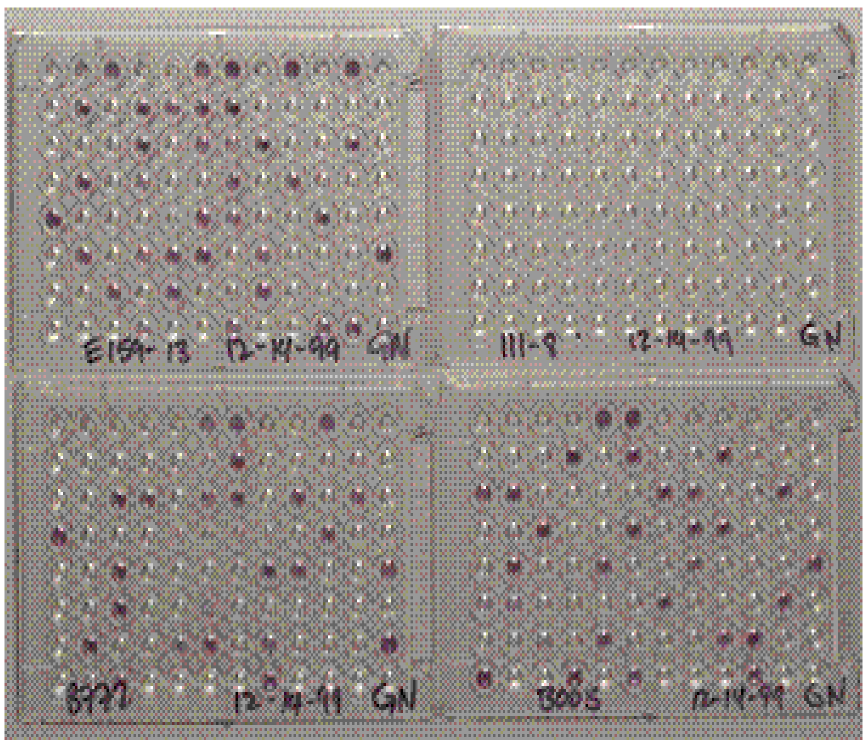
Bacterial Source Tracking determines the host origin of fecal bacteria using a database to compare environmental isolates to a limited reference library. CUP is a phenotypic gene catabolic expression method of bacterium characterization. The BIOLOG Microplates process quantifies catabolism. BIOLOG's identification system is based on the bacterial isolates ability to use a specific carbon source. A bacterial isolate, in pure culture, is suspended into an inoculation fluid and subsequently pipetted into a 96 well microtitre plate, which contains 95 different carbon sources as well as a negative control. Carbon source utilization correlates to increased mitochondrial activity, leading to a color change in the wells and the production of a 96-well metabolic fingerprint. The resulting data, a series of positive and negative reactions, is interpreted by the BIOLOG software for identification and utilized for discriminant analyses.

Twenty-six locations in Westfield Estates and multiple grab samples were taken at each with sterile 250 ml IDEXX bottles (IDEXX Laboratories, Westbrook, ME). All samples were stored on ice in a cooler and processed within 6 hours of collection Aliquots of each sample were plated on mE agar and isolated for BIOLOG identification as described above.

Comparison of *Enterococcus* species of unknown origin with those from known organisms are used in discriminate analysis, which determines what wells are likely predictors of origin by evaluating consistency of results throughout the known library (human, dog, chicken). The predicted combinations are compared with results from unknowns to determine likelihood of fit in a particular group of origin. Examination of samples from Westfield Estates and Halls Bayou coupled with statistical analysis of library bacterial profiles determine source as human or non-human (dog, chicken, unknown). A typical CUP profile is shown in Figure 10. Complete data tables for the BIOLOG Analysis are found in Appendix C.

Figure 10: Typical Carbon Utilization Profile

(Sources: Hygeia Laboratories)



3.2.3 Statistical Analysis

Statistical analysis was performed using Discriminate Analysis (DA) with SAS-JMP Statistical Software. Analysis by DA produces a classification set for every known source isolate as clusters of catabolic wells, which is are compared with reference sources. The average rate of correct classification (ARCC) is determined by averaging the percentages of correctly classified isolates for each source. Subsequently, a database is built for each known source (human, dog, chicken) and the DA compares each set of isolates from an unknown source against the database of known sources and then classifies each isolate into one of the possible sources. (Graves *et al.*, 2002).

Library Development

The Enterococcus library was developed from local sources of fecal material. Source *Enterococcus* isolates were collected from fecal samples of three known local Community hosts: human (five subjects), dog (four subjects) and chicken (two subjects) residing proximal to the sampling locations. One hundred twenty isolates from each known host were subcultured, each isolate was gram stained, tested for catalase and oxidase activity, and streaked onto agar plates, which were incubated and subsequently analyzed for substrate metabolism and identified to species with MicroLog ™ System 4.2 software. Of the 120 isolates from each known host subcultures, some were later identified by BIOLOG analysis as non-Enterococcus and removed. Composition of Source Libraries and number of derivative isolates is shown in Table 5.

Table 5: *Enterococcus spp*. Composition of Source Libraries

Source	Species	No. in Library	Percent Composition
Human	*E. durans*	2	2.08
	E. faecalis	53	55.21
	E. faecium	23	23.96
	E. gallinarum	2	2.08
	E. raffinosus	1	1.04
	E. saccharolyticus	2	2.08
	E. spp.	13	12.50
	Total	**96**	**100.00**
Dog	*E. casseliflavus*	1	1.09
	E. faecalis	37	40.22
	E. faecium	20	21.74
	E. gallinarum	4	4.35
	E. hirae	2	2.17
	E. mundtii	2	2.17
	E. spp.	26	28.26
	Total	**92**	**100.00**
Chicken	*E. casseliflavus*	12	12.77
	E. faecalis	3	3.19
	E. faecium	9	9.57
	E. gallinarum	2	2.13
	E. spp.	68	72.34

Libraries in the current study were modest in comparison to recent, related work but human vs. non-human ARCCs compared favorably to these studies. Graves *et al* (2002) reported a human vs. non-human ARCC of 96.29% with 1,174 *Enterococcus* isolates using antibiotic resistance analyses (ARA) and Hagedorn *et al* (2003) produced a 92.7% ARCC with 365 *Enterococcus* isolates using BIOLOG. Harwood *et al* (2000) used large (> 2,000 isolates) non-*Enterococcus* libraries with ARA but reported relatively low human vs. non-human ARCCs of 60.55% for fecal streptococci and 69.3% for fecal coliforms. Recent reports have suggested that source libraries may have geographic limitations and libraries from one watershed may not be applicable to nearby watersheds (Soule *et al.*, 2006). Therefore, the high rates of ARCC of our relatively small source library may be linked to identifying host sources proximal to sampling locations (Table 6).

Table 6: Rates of Correct Classification by Source from Discriminant Analysis of *Enterococcus* libraries

Classification Scheme	Source	Number of Isolates	% Correctly Classified
3-Way	Human	96	97.9
	Dog (Non-human)	92	95.7
	Chicken (Non-human)	94	92.6
	Total	**282**	**95.4***
2-Way	Human	96	97.9
	Non-human	186	98.9
	Total	**282**	**98.6***

*Average rate of correct classification (ARCC)

Classification of unknown source isolates

One hundred fifty five *Enterococcus* isolates, which included lab and/or field splits, were identified from the Westfield Estates and Halls Bayou. These were apportioned to source using the statistical program (Table 7). In a three-way classification of pooled results, 16.0% of isolates were identified as human, 32.5% as dog, 17.5% as chicken, and 34.0% did not fit into any of the three classifications.

Table 7: Classification of Unknown Source Isolates

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Classification Scheme	Known-Source Classification	Site 1	
		No. of Isolates	%
3-Way	Human	32	16.0
	Dog (Non-human)	65	32.5
	Chicken (Non-human)	36	17.5
	Unknown	68	34.0
	Total	200	100*
2-Way	Human	37	18.5
	Non-human	131	65.5
	Unknown	32	16.0
	Total	200	100*

Percent Classification of Library ARCC: 2-way Average 98.6%, 97.9% Human; 98.9% Nonhuman
3-Way Average95.4%; 97.9% Human; 95.6% Dog; 92.6% Chicken
* Cutoff for unknowns $P<0.95$.

3.2.4 Comparison of Source Identification Methods: Ratio vs. CUP

A comparative analysis of the two bacterial source-tracking methods, ratio of Fecal coliform and Fecal streptococcus was performed. Enterococcus levels in some samples were insufficient to perform CUP analysis. The comparison shows of samples from the Community and Halls Bayou with both Enterococcus and Fecal coliform/Fecal streptococcus bacteria there is very little correlation between the two methods.

3.2.5 Enterovirus Companion Study

Researchers from TAMUG collected 10 to 50 liters of water from each of six sites, four in the community and two along Halls Bayou. Enteric viruses are shed in the feces of infected individuals (approximately 10^6 to 10^{10} infectious viruses per gram of feces) and enter coastal watersheds through wastewater treatment facility effluent, combined sewer overflows, which are systems that receive rainwater and untreated wastewater and overflow during high precipitation events, and leakage from high-density septic tanks (Sair et al. 2002). There is a growing list of pathogenic viruses, collectively referred to as 'enteric viruses'. This list includes several families of viruses: (1) *Adenoviridae* (adenoviruses), (2) *Calciviridae* (noroviruses, astroviruses, caliciviruses, and small round structured viruses), (3) *Picornaviridae* (poliovirus, coxsackieviruses, echoviruses, enteroviruses, and hepatitis A virus), and (4) *Reoviridae* (reoviruses and rotaviruses) (Griffin et al. 2003). Enteric viral contamination of drinking and irrigation water sources, recreational waters, and shellfish harvesting waters pose the greatest risk to the public (Griffin et al. 2003). Enteric viruses are believed to cause the majority of waterborne illnesses (Griffin et al. 2003). Gastroenteritis is the primary manifestation of an enteric viral infection, however there is increasing evidence that enteric viruses are associated with more serious, chronic diseases such as respiratory disease, meningitis, myocarditis and possibly diabetes (Bosch 1998).

Qualitative results for the six sampling sites are shown in Table 8. Quantitative information was not yet available at the time of completion of this report.

Table 8. Detection of Human Adenovirus with PCR in Westfield Estates:
(+ denotes positive PCR assay; - denotes negative PCR assay)

Sample Location	Sample Date 9/18/06	Sample Date 9/26/06
Hall's Bayou at Hopper Street. Bridge	+	+
Hall's Bayou - Foot bridge (Kowis St.)	+	+
2500 Block of Cromwell St.	No Data*	+
2600 Block of Cromwell St.	+	No Data
2500 Block of Kowis St.	+	+
2700 Block Kowis St.	+	No Data
2700 Block of Trenton Rd.	-	No Data

* No Data = Insufficient quantities of water (50 liters) available for sample collection.

3.2.6 Human vs. Non-Human Bacterial Sources

Bacterial Source Tracking results show the primary source of bacterial contamination in both Westfield Estates and Halls Bayou may be non-human. Both human and non-human sources of bacterial contamination occur in the Community. These include human (16%), canine (32.5%), chicken (17.7%) and other non-human (34%) sources, using a three-way classification.

It appears from this study that the largest contributors of bacterial contamination in Westfield Estates and Halls Bayou are non-human. This has significant impact on any correction strategy for bacterial contamination. This finding also has potential effect on corrective measures for TMDLs, whose primary complaint is bacteria levels exceeding contact recreation criteria as a result of failing septic systems and/or failing municipal sewage systems. Even if all the failing septic systems in Westfield Estates were corrected, bacteria levels would not be reduced far enough to meet contact recreation criteria. All sources of bacterial contamination must be addressed in any solution to the bacterial contamination TMDL problem.

The level of unknown source of bacterial contamination is significant. Characterization of bacterial contamination source risk factors is essential to the development and implementation of a correction strategy, since correcting contamination from only a single source, e.g. human, will not significantly reduce contamination in the Community.

Additional examination of previously identified "hot spots" in the Community plus additional sampling in Halls Bayou is needed to reduce the unknown source component. Additional Carbon Utilization Profiles and relatively low cost DNA sequencing are suggested.

3.2.7 Subspecies Variability

Bacterial Source Tracking is complicated by subspecies variability, geographic location, collection time, rainfall and habitat. Thus, the FSSI relied on reference samples collected within the Community. A variety of experimental data suggests that *E. coli* subspecies are variable depending on geographical location. Some animal subspecies (e.g. cattle and horses) vary more with changes in geographic location than others (e.g. chicken and swine) do.

In the case of changes with time, Jenkins et al. (2003) observed that over a nine-month period, only 8.3% of ribotypes were shared at two or more sampling events for six randomly selected cattle. Similar findings were observed for the clonal composition of *E. coli* isolates obtained from feral house mice (Gordon, 1997).

Rainfall also affects the pattern of ribotypes in *E. coli* isolates collected during stream base flow and storm flow conditions (Hartel et al. 2001). In Hartel's study on the Chattahoochee River in Georgia, 74% of the ribotypes remained unique under different rainfall conditions.

Finally, in the case of primary versus secondary habitats, evidence suggests that the clonal composition of *E. coli* changes substantially during the transition from the host to the external environment (Gordon, 2001). Whittam (1989) observed that only 10% of the 113 distinct *E. coli* clones were recovered from both chickens and their litter. A later study by Gordon et al. (2002) of two households and their associated septic tanks showed that "*E. coli* diversity … was high in one household and low in another. Thus, differences in *E. coli* clonal composition may exist between primary and secondary habitats."

3.2.8 Potential Sources of Pollutant Loading

Based on an understanding of bayou dynamics and flooding, high-resolution aerial photography, local knowledge, and bacterial water quality analysis, the following activities could adversely affect water quality within the Community and Halls Bayou. The actual contribution to bacteria and pollutant loading from many of these sources is currently unknown. Based on this limited study, the Sunbelt WWTP did not contribute significantly to the levels of bacteria in Halls Bayou. Possible sources of bacterial contamination include

- On-site septic systems, especially those associated with older homes, multiple homes on a small lot in the Community, or businesses;
- Agricultural animals kept for food and as pets (chickens and pygmy goats);
- Family pets (primarily dogs) and feral animals;
- Migratory birds;
- Excessive landscaping and improper lawn care;
- Improperly managed repair/machine businesses;
- Municipal wastewater treatment bypasses;
- Illegal dumping and littering; and,
- Improperly constructed drainage ditches that allow water to pool.

Identification of possible contamination sources guides future monitoring and assessment activities.

3.3 Community Risk Assessment

All aspects of human life carry some element of risk that harm will occur associated with the activity. Risk assessment is an important part of managing this risk in our daily lives. It can either be qualitative or quantitative dependent on the particular nature of circumstances. Risk associated with any human activity is a function of the magnitude of potential harm or loss and the probability that the harm will occur.

Bacterial contamination in the Community at the beginning of the study used two problems: potential harm to human health and/or potential harm to the environment. Human health risk assessments, which characterize potential adverse effects of human exposures to environmental hazards, include

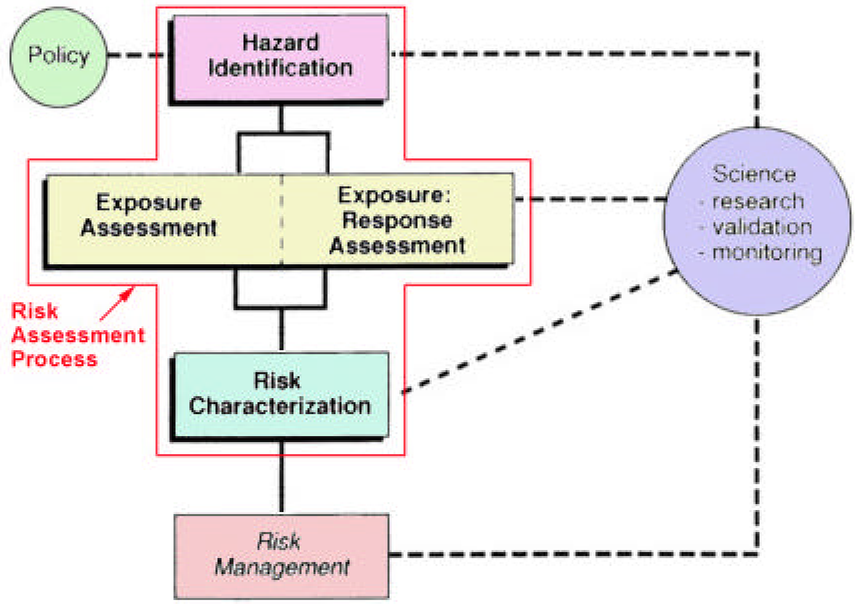
- Planning the study and scoping the target community;
- Identifying acute or chronic hazards;
- Evaluating type and magnitude of harm or toxicity from the causative agent;
- Assessing exposure in dose and duration; and
- Characterizing the risks that result from the exposure.

A schematic representation of human health risk assessment is shown in Table 9.

Ecological risk assessments "evaluate the likelihood that adverse ecological effects may occur or are occurring as a result of exposures to one or more stressors" or agents. Protocol is similar to human health risk assessment with the exception that thought and consideration must be given to specifically formulating and delineating the ecological problem occurring because of the exposure to the stressor or agent. This calls for a systematic approach where:

- Data is organized and evaluated;
- Information, assumptions, presumptions, and uncertainties are each taken into account;
- Hypothesis and predictions of the relationship between stressor/ecological effect formulated; and
- Appropriate policy developed and implemented to address the risk.

Table 9: Human Health Risk Assessment Protocol



Source: EPA - National Academy of Sciences Risk Paradigm

Escherichia coli is used both as a predictor of the presence of waterborne human pathogens and as a measure of whether or not a water body meets State of Texas standards for contact recreation. Levels above State standards were obtained at all locations examined in the Community and Halls Bayou. Exceedences were six to 600-fold higher than the standard. Over half of the locations exceed *E. coli* levels associated with illness from exposure to the water body or source.

However, there have been no recorded incidents of large numbers of persons in the Community becoming ill with diseases associated with waterborne pathogens. Events of illness at levels of *E.* coli exceeding 100,000 MPN/100ml are recorded and thought to be the result of malfunctioning WWTP catastrophic failure or by-pass. An epidemiological study is needed to quantify the risk of human illness associated with exposure to bacterial contamination at levels present in Community.

The source of the bacterial contamination in the Community and the Bayou must be addressed. In addition to human sources, presumably from failing septic systems, dog and chickens, many of which roam freely, contribute significantly to the levels of bacterial contamination. Any plan to address bacterial contamination in the Community and Halls Bayou must include management of fecal material from these sources. Part of the source of bacterial contamination remains unknown. Additional studies will be required to identify additional contributors.

Information gathered at the Public meeting with the Community and other interested parties indicates a concern for standing water in ditches, which is seen, particularly by the residents, as the cause of the bacteria contamination. While it is true that cleaning the ditches may reduce standing water, it will not significantly reduce bacterial contamination from any of the know sources. However, the concern and perception in the Community is such that this issue must be addressed in conjunction with the bacterial contamination source remedies.

3.3.1 Bacterial Contamination and Source

Bacterial contamination in Westfield Estates is widespread and comes from several possible sources. Some derives from human bacterial contamination sources such as failing septic systems overflows or malfunctions, which can contaminate yards, children's playground equipment, pets, gardens, swimming pools, and home interiors.

Untreated or raw sewage contains bacteria such as *E. coli*, the predictor species for human waterborne pathogens, enteric viruses, helminthes (intestinal worms) and parasites (e.g. Cryptosoridium). Most of those stricken suffer stomach cramps and diarrhea (headache, vomiting, and low-grade fever), but untreated sewage also spreads life-threatening ailments like cholera and hepatitis A (Table 10). Individuals with compromised immune systems, those undergoing chemotherapy, dialysis, organ transplant, and/or those with HIV or AIDS, are particularly susceptible to bacterial or viral infections.

The majority of bacterial contamination comes from non-human sources such as dogs, chickens, and other animals. Another possible source of bacterial contamination is the soil. Another is possible regrowth.

The exact number of people actually affected by malfunctioning OSSFs in the H-GAC region is difficult to determine without a definitive epidemiological study. Many of the symptoms of illness related to exposure to raw sewage are similar to common varieties of flu so the connection between illness and exposure to raw sewage is overlooked. Additionally, some affected may not have the financial resources to seek medical attention. There have been no major outbreaks of cholera or hepatitis A in the H-GAC region in the last fifty years. However, according to EPA statistics, 5% of the population could be affected by waterborne pathogens. In Westfield Estates, that translates to approximately 150 people becoming ill from bacterial contamination in their environment at any given time, with infants, elderly, and those with compromised immune systems the most vulnerable.

Because of the lack of quantitative and qualitative data linking human illness to exposure to bacterial contamination from failing septic systems or other sources, an epidemiology study will be required to complete the Community Risk Assessment. Because of Community interest and a nearby medic al clinic, such a study should not be difficult to complete.

Municipal wastewater treatment processes, such as chlorination, successfully eliminate most harmful bacteria before effluents are released into rivers or estuaries. However, chlorination is ineffective at removing pathogenic viruses. Pathogenic viruses can survive up to 120 days in aquatic environments whereas fecal coliforms histor ically have been thought to survive only about 30 to 60 days (Feachem et al. 1983). Therefore, water quality testing based upon enteric bacteria, such as fecal coliforms or *E. coli*, as indicators of fecal contamination are not precise methods of detecting pathogenic viruses (Bosch 1998; Pina et al. 1998; Sair et al. 2002).

3.3.2 Stakeholders

The risk to human health from bacterial contamination needs to be addressed by all stakeholders. Individual residents and their families, as well as the Community as a whole, are at risk for waterborne illness and have a stake in resolving the problem. These stakeholders lack the financial resources or the initiative to do so. Businesses, particularly realtors and homebuilders or renovators, need to address the issue in view of the impact on potential customers and ethical responsibility. Elected officials, including federal, state, county, and utility district entities, have the power but often not the resources to address the risk directly. All must work together to achieve the common goal of adequate sanitary sewer service for the Community.

Table 10: Infectious Agents Potentially Present in Untreated Domestic Wastewater

Organism	Disease Caused
Bacteria	
Escherichia coli	Gastroenteritis
Leptospira	Leptospirosis
Salmonela typhi	Typhoid Fever
Salmonella (= 2,100 serotypes)	Bacilliary dysentery
Vibrio cholerae	Cholera
Protozoa	
Cryptosporidium parvum	Cryptosporidosis
Entamoeba hystolytica	Amoebic dysentery
Giardia lamblia	Giardiasis
Viruses	
Various Enteroviruses	Gastroenertitis, meningitis
Hepatitis A virus	Infectious hepatitis

(Source: EPA Wastewater Technology Fact Sheet: Ultraviolet Disinfection)

3.4 Correction Strategy

Finding realistic and effective solutions that address current and future chronic non-point bacterial contamination requires collaboration between all stakeholders involved. Strong cooperation between all parties will improve degraded water quality, reduce risks to human health, preserve ecological resources, and provide for sound economic development.

H-GAC proposes a Community Management and Correction Strategy (CMCS) that includes the following steps:

- Community Outreach – information and consultation
- Identify long term and interim needs;
- Establish stakeholder advisory group;
- Prioritize BMP types and locations by survey;
- Conduct public education;
- Implement site-specific BMPs and remediation;
- Assess BMP effectiveness; and
- Affect public policy change.

The Community Management and Correction Strategy to reducing bacterial contamination non-point source pollution within the Community and the Halls Bayou watershed provides the basis to achieve the nine elements of the EPA Watershed Protection Plan. CMCS establishes a sustainable community-based stakeholder group, identifies bacteria and other non-point source loading "hot spots," aids in prioritizing sites for best management practice implementation and/or remediation, increases local stewardship, and affects policy changes that accommodate local growth while reducing non-point source pollution. The intent is to develop a Community Management and Correction Strategy, which not only Benefits Westfield Estates, but also is transferable within the H-GAC region, along the Texas Coast, and across the Gulf Coast.

Steps 1 and 2 are essentially complete in the FSSI. The groundwork for establishing the stakeholders group has been laid and several key parties have begun to work on tasks within the CMCS.

3.4.1 Strategy Development

The Community Management Correction Strategy for Westfield Estates addresses likely options available to correct bacterial, contamination issues resulting from failing sewer systems and non-human sources of bacterial contamination in the Community and Halls Bayou. The CMCS utilizes FSSI information, including the Risk Assessment, incorporates current industry OSSF best management practices (BMPs), and proposes interim and long-term solutions.

Options include receiving sanitary sewer service from a municipal source, either City of Houston or the FWSD; interim mitigation of current on-site system problems; and implementation of best management practices for septic systems and non-human sources of bacterial contamination in Westfield Estates. Interim objectives run concurrent with efforts by major stakeholders towards securing funding for the permanent solution.

The magnitude of the Westfield Estates problem is such that no single stakeholder can manage the entire issue independently. Community-wide support coupled with that from elected officials, businesses, county and state agencies are required. Possible changes in substance and/or enforcement of current regulations, ordinances, and permit requirements might be considered. Development also included a series of public outreach events and a town meeting to disseminate information and consult with stakeholders. See Section 3.5 Public Outreach and Community Development.

3.4.2 Correction Options – Permanent

The single most viable long-term solution to the human bacterial contamination in the Community and Halls Bayou is municipal sanitary sewer service. There are two possible service providers, the City of Houston and one FWSD.

City of Houston
According to a variety of sources, the city of Houston has no plans to annex Westfield Estates.

FWSD Expansion of Services
The most permanent solution to the failing septic systems in the Community would be to provide service to the residents from the FWSD wastewater treatment plant. Plans to serve Oakwilde (Westfield Estates) include expanding the current wastewater treatment plant, adding two lift stations, sanitary sewer lines, connection lines from the street to residences and businesses in the Community. The plan requires $16 million for engineering, construction, and road repair.

Halls Bayou itself presents another confounding issue. This bayou has one of the slowest conveyance of any water bodies in Harris County. Plans exist for its substantial modification, which will require relocation of the FWSD sewer plant at additional cost. Timing of providing municipal sanitary service to the Community may be affected. It would be unwise to expand the sewer plant to accommodate

Westfield Estates only to be required to move the plant some months later. Additionally, the FWSD does not currently own land to accommodate the plant relocation and may have to condemn certain residential lots, adding to the cost and time required to complete the municipal service permanent option.

Funding will most likely come from a mix of federal, state and local grants, funds, and loans. While this Community is the highest wastewater treatment service priority for Harris County Precinct 2, funds may not be available in the foreseeable future. FWSD has limited authority to issue bonds or contract loans. Further, U.S. Census demographics indicate Community residents may not be able to shoulder the expense of loan repayments.

Environmental justice issues apply to the Community. Funding sources in this area may be available to implement this program.

However, even if sanitary sewer service is supplied to the Community, the FWSD cannot require residents to use the service. Thus, some form of mitigation of septic system function will need to be addressed long-term.

Non-human Bacterial Contamination Sources

While the contribution of bacterial contamination from humans is significant (16%), one cannot overlook the contribution form non-human bacterial sources such as dogs (33%), chickens (17%), and unknown (34%). Community-wide consensus and action on non-human sources are necessary to reduce the level of bacterial contamination from dogs, chickens and other non-human species in the Community and in Halls Bayou to a level that will achieve state criteria for contact recreation. It is likely that residents, businesses, and community officials are unaware of the significant contribution of these non-human bacterial sources to the Community-wide and Bayou problem.

3.4.3 Correction Options - Interim

With municipal sewer service unavailable for some years, current options to reduce human bacterial contamination from septic systems include proper maintenance, corrective measures where possible, and strict enforcement of permit requirements for new or remodeled construction. Best Management Practices will reduce and minimize human exposure to bacteria and bacteria loading in the Bayou from human sources. Additional measures and strategies will be required to reduce the non-human bacterial contamination in the community and Halls Bayou.

Interim Corrective Maintenance of Existing Septic Systems

Because many residents are apparently unaware of how to operate and maintain on-site septic systems, a Community outreach program would be a useful educational tool. Basic information on the care and maintenance of septic systems should be distributed. Because of the high percentage of Spanish speaking individuals, information should be available in that language. Public meetings with invited speakers demonstrating proper maintenance techniques would also be useful. Northeast Community Center is a likely location for these events. Other organizations might also provide meeting venues.

A volunteer-based community outreach for proper maintenance of on-site septic systems and care of pets and livestock would be useful. Residents should develop technical knowledge through participation in meetings, workshops, and other community outreach activities.

Mitigation—Best Management Practices (BMPs)

Best management practices will reduce and minimize human exposure to bacteria and bacteria loading by addressing human-waste and some non-human related sources of pollutants within Westfield Estates and

Halls Bayou. Theses BMPs include corrective action on failing on-site septic systems associated with homes and businesses, roaming canines and poultry (wild and cooped), plus other potential sources of bacteria contamination (waste water treatment plant bypasses, etc.).

Examples of BMPs identified during the bacteria quantification, source identification, and Risk Assessment project include:

- Establish a stakeholders group for discussion, input, and "buy-in" to BMPs.

- Enhance Harris County's design criteria for on-site septic systems to manage wastewater discharges more effectively. This is especially important in areas like Westfield Estates, where sufficient difficulties exist currently. It would not be advisable to exacerbate them with new construction or substantial remodeling on lots of insufficient size for proper on-site treatment of human waste.

- Develop and implement a Community-wide survey program to assess the condition of on-site septic systems in the Community to identify those systems that are: (1) adequate, (2) inadequate but can be made adequate by proper maintenance, including pump out, (3) inadequate and in need of replacement or installation of a holding tank, (4) no solution is apparent, and (5) prioritization for removal and replacement, maintenance, or other means of addressing failing on-site septic systems. The program would be implemented at the County level and be funded via Community Development Block Grants and other federal and state sources.

- Implement solutions to problems identified in Community Survey, including a determination of which of the BMPs would be most appropriate in a given situation. Eligibility for subsidies and grants for these solutions to be determined based on economic and other needs.

- Establish guidelines for shared septic systems within subdivisions where soil conditions and lot size may preclude effective use of individual systems within subdivisions. Examples of shared systems include package plants and treatment wetlands. Land currently owned or available to the County because of back taxes could be utilized in this regard.

- Establish guidelines for reducing flow to existing septic systems through use of water conservation measures (e.g. grey water discharge, low-flow toilets, faucets, and showerheads) and obtain funding sources for retrofitting.

- Develop strategy, implementation plan, and measurement standard to reduce non-human bacterial contamination from family pets (e.g. dogs) and agricultural animals (chickens and goats).

- Establish regular meetings of the Stakeholders Group to continue to find a permanent solution for the Community, which will be fully embraced by the residents.

- Continue Community outreach in English and Spanish to educate Community residents and business owners about concerns and solutions to bacterial contamination in water bodies in Westfield Estates, including proper care and maintenance of septic systems.

Mitigation - Implementation
Following a Community survey to ascertain particular issues, implementation of solutions to identified problems should follow. These include pumping out septic systems, installing holding tanks, and proper

maintenance for the course of the project. Eligibility for these solutions would be determined based on economic and other needs. Best Management procedures, which will be developed in conjunction with stakeholders, include (1) enhancement of Harris County's design criteria for on-site septic systems to more effectively manage wastewater discharges, (2) develop strategy, implementation plan, and measurement standard to reduce bacterial contamination from family pets (e.g. dogs) and agricultural animals (chickens and goats), (3) community outreach in English and Spanish Community outreach program to educate Community residents on the proper care and maintenance of septic systems, and (4) Establish regular meetings of the Stakeholders Group to continue to find a permanent solution for the Community, which will be fully embraced by the residents.

Achieve Interim Community-Based OSSF Management by FWSD
The ultimate goal of the Correction Strategy is to transfer long-term interim management of septic systems in Westfield Estate to a partnership between Harris County Precinct 2, the FWSD, and a representative group of Community residents. The County is responsible for monitoring OSSF design and installation and monitors complaints for potential violations. Because the Community is within the service area boundary of the FWSD, some funding options to address the failing septic systems are limited. Thus even though it does not receive fees for sewer service, it bears some of the responsibility for mitigating the problem. The FWSD could disseminate maintenance information on a regular basis with its water bills. Grassroots efforts will be necessary to reduce the bacteria contamination in the Community and bacteria loading in Halls Bayou.

BMP Measure of Success
Success will be measured by reduction of specific bacterial loading in Halls Bayou, including *E. coli* and *Enterococcus* and decrease in bacterial contamination from identified species (canine, poultry, and others).

3.4.4 Stakeholder Involvement

Individual Homeowners
Interviews with several homeowners during the field reconnaissance and the Town Meeting indicate residents think municipal sewer systems would be a welcome, long-awaited addition to the Community. Most were pleased with the recently installed municipal water system which was funded through community block grants, although some residents opted not to hook up to the water system. FWSD is a fee-based district, without taxing authority. It must charge for service and maintenance at a rate, which may be prohibitive for many considering the income level of a significant number of residents in the Community. Based on comments received during field reconnaissance and at the town meeting, most homeowners were unaware of the procedures needed to maintain their systems adequately.

Although most residents queried in the field and the majority of those at the town meeting indicated they would like to receive sewer service, they are currently unaware of the need for and use of interim solutions to the bacterial contamination problem. Most were concerned about having their ditches maintained to prevent the occurrence of standing water in front of residences. While this is a reasonable concern, proper ditch maintenance will not decrease bacterial contamination from waterborne pathogens in the Community or Halls Bayou. Ditch maintenance may in fact give residents a false sense of security about the presence of pathogenic bacteria in the Community.

Education explaining the link between failing septic systems and/or unrestrained pets and bacterial contamination is needed. This must be followed with information on how to address each of these issues - proper maintenance of septic system, restraint of pets, and picking up pet waste.

Community
It is essential that a Community consensus be developed to address the current sewage issue. Several factions were evident at the town meeting. Each blamed the other and the "County" for the problem of bacterial contamination. Individual residents and the Community as a whole are encouraged to take ownership of the problem and work toward solutions to address it, in an essential component of the Correction Strategy. In other communities, most notably Tamina in south Montgomery County, considerable time, money, and effort was expended to develop a municipal sewer service for the Community, only to have the plan rejected by residents who were at odds with each other and the political system necessary to achieve successful resolution to the problem of failing septic systems.

There is no overall governing body for the Community. There are five organizations, which could serve to disseminate information and build consensus: The George Foreman Youth and Community Center, Principe de Paz Church, The Church of the Lord Jesus Christ, Templo De Ponder, and St. Luke's Lutheran Church. Additionally, a local grocery store that many residents visit on foot is also a logical site for distributing *Best Management Practices for On-Site Sewer Systems* information. The Northeast Community Center is also an excellent facility, located close to the Community, and available for meetings.

Freshwater Supply District
Sunbelt FWSD was formed by directive from the Texas Commission on Environmental Quality to address suburban water needs in five non-contiguous communities in Harris County. It has seven thousand connections, three water plants, and five sewage plants. Most communities are served with water and sewer, some with water only, and some with neither. FWSD has committed $15 million in funds from a variety sources, including community block grants to improve service within its jurisdiction.

One of Sunbelt FWSD's Communities, called Oakwilde, and includes Westfield Estates. There are approximately 1,900 subdivision plots in FWSD-Oakwilde, 60% served with water and sewer, and 40% served with water only. The FWSD has no authority to levy taxes, either for construction of facilities or maintenance. All service is fee based. Therefore, any permanent solution addressing the sewage issue must include long-term maintenance and building the physical infrastructure. Since resident tax money is not involved, accepting service is optional. The number of subscribers may not be sufficient to support operation costs. Community outreach will be necessary so that residents accept and fully utilize the municipal sewer system when it is installed. The FWSD Board of Directors is committed to resolving wastewater issues in the Community, but lacks the financial resources to do so.

Harris County Precinct 2
Harris County Precinct 2 recently completed a study identifying the needs and approximate cost of providing sewer service to Westfield Estates. The report estimates that approximately $16 million dollars is needed to provide the service. Commissioner Sylvia Garcia has pledged support to the project and is exploring funding options. HCPCT2 was an integral part of the Community outreach program.

Harris County Design Review and Monitoring
Harris County approves permits for new septic service in the area. It is aware of septic system violations in the Community (Figure 8). It does not have a mechanism in place to deal with the currently existing multiple residences (homes or trailers) on a lot permitted for a single-family residence. A permitting addendum could be developed to address this issue coupled with on-site inspection. The difficulty is that if the residents were cited for permit violations, many would be forced to leave their homes, since lots are of insufficient size to provide adequate on-site sewer service. This is a situation no one deems desirable. Remedy might require legislative action.

Homebuilders
Homes continue to be built in the Community. Several homes that had fallen into disrepair have been remodeled and offered for sale by either owner or realtor. Some are on reasonably sized lots to accommodate aerobic septic systems. Others are crowded together on extremely small lots, which barely meet minimum permitting requirements. Often there is more than one residence on the single lot, which circumvents the permitting process. There is some evidence that recent septic system installation at new construction may not conform to Harris county design and inspection criteria. At the Town Meeting and in a subsequent phone conversation, one resident indicated his new aerobic system left his back yard so wet his children could not play in it. His neighbor's yard received spray from his system.

Realtors
Real Estate professionals offer an opportunity to disseminate information on the proper installation and maintenance of on-site sewer systems.

The Houston-Galveston Area Council recommends establishing a broad consortium of partners and stakeholders by developing a Stakeholder Advisory Group to ensure communication and local involvement in the project. To help ensure a balanced and diversified Stakeholder Advisory Group, several key stakeholders need to be identified to be built upon an existing network of county government, FWSD (board members, operators, engineers, and attorneys), resource management agencies, and the public. Meetings will be held to enhance and support participation in the stakeholder process by identifying and discussing issues of concern, reviewing project goals, and informing stakeholders, the public, and other interested parties about project findings and upcoming activities.

3.4.5 Funding Sources—Permanent Solution

The economic burden for the permanent Community bacterial contamination solution is substantial, approximately $16 million according to Harris County Precinct 2's recent study. Sources of funding for the project, with requirements, are listed below.

EPA State and Tribal Grants (STAG)
These are special appropriations grants, which require up to a 45% match from local sources. Approximately $200 million was awarded through these grants in FY2006, ranging in amounts from $50,000 to $5 million, with an average grant amount of $780,000. Funds must be requested no later than August each year with award date in November.

Texas Water Development Board (TWDB) Economically Distressed Areas Program (EDAP)
Funding may cover up to 75% of the project. The applicant must be capable of operating and maintaining the infrastructure. Community median household income must be less than 75% of the state median household income.

Housing and Urban Development's Community Development Block Grant (CDBG) Program
Approximately $7 million were available in FY2006. Applications are due in July of each year.

TWDB Water Supply and Wastewater Facilities Planning Program
Funding may cover up to 50% of the project's cost. It is available to political subdivisions that can plan, develop and operate facilities.

Department of Commerce Public Works Economic Development Program
This funding source covers up to 50% of project costs, with approximately $205 million awarded in

FY2004. Awards ranged from $59,000 to $6 million, with the average being $1.4 million.

TWBD Clean Water State Revolving Loan Fund (SRF) Program
This program has up to $75 million available for loans that can be awarded during the first nine months of the fiscal year. Maximum time for repayment is twenty years. Applications are accepted continuously.

TWDB State Loan Program Texas Water Development Fund II
The process and awards are similar to the other SRF program. Applications are accepted continuously.

TCEQ Supplemental Environmental Projects (SEPs)
TCEQ Supplemental Environmental Projects result from administrative penalties. Violators have the option of offsetting a portion of an administrative penalty into a SEP. These projects are applied for by local governments, non-profits, and political subdivisions, and when approved by TCEQ, are funded as administrative penalties from violators are disbursed into SEPs. Funding and amounts are not guaranteed. Applications are accepted continuously with funding as the moneys become available.

3.5 Public Outreach and Community Involvement

H-GAC's outreach activities strive to raise the awareness of possible risks to human health and the environment from bacterial contamination from human and non-human sources (dog, chicken) in the Community and in Halls Bayou. Target audience includes residents of local and regional communities, elected officials, realtors, developers, businesses, and other stakeholders.

Outreach activities progress in stages. They begin with informal interaction with stakeholder and public participation. The idea is to provide the public with balanced and objective information to assist citizens and stakeholders in understanding the problems, alternatives, and solutions. Fact sheets, websites, and open houses are integral parts of outreach here.

The second stage is to consult with the public to obtain public feedback on analysis, alternatives, and possible solutions. Here the goal is to listen, acknowledge concerns, and provide feedback on how public input influences the ultimate decisions. This is achieved through public comments, focus groups, surveys and public meetings.

Public outreach moves to involve the public in the problem-solving process in its next stage. One works directly with the parties throughout the process to ensure that public issues and concerns are consistently understood and considered. Workshops and deliberate polling ensure that public concerns and issues are directly reflected in the alternatives developed. They provide feedback on how public input influenced the decision.

In the collaborative stage, a partnership is developed between major stakeholders and the public in each aspect of the decision, including the development of alternatives and identification of the preferred solution. Activities at this stage include citizen advisory committees, consensus building, participatory decisions, and making Charrettes.

Finally, the stakeholders empower the public to determine the ultimate solution to the problem. Implementation is based on public decision determined by citizen juries, ballots, and/or delegation.

Information and process developed in this outreach activity is directly applicable to other on-site septic facility communities in the region.

3.5.1 Information Sharing, Consultation, and Partnerships

H-GAC implemented an integrated Community and stakeholder involvement program for information sharing and consultation, stages one and two in the outreach program. These activities were designed to increase awareness about the extent of the bacterial contamination in the Community and Halls Bayou watershed, educate municipal officials and citizens about threats to human health and water quality arising from non-point source bacterial pollution, and increase interest in the formation of a community-based watershed stakeholder group. Understanding failing OSSFs and other non-human sources of bacterial contamination and their links to residents' quality of life and health, ecological health of area water bodies, and ultimately local economics is a necessary foundation for developing outreach stages three through five: problem solving, partnerships, and empowerment, which culminate in a successful correction strategy.

H-GAC accomplished outreach activities through a variety of strategies. Informal meetings and conversations with stakeholders occurred through out the course of the FSSI. Staff listened and responded to residents during field reconnaissance in order to open dialogue, and assess the stakeholder base within the area. As information was developed, more was forthcoming as other stakeholders commented on information. One-on-one conversations and small group meetings (e.g. FWSD) were held. Some of the stakeholders who provided input included:

- Harris County Precinct 2 - Commissioner Garcia, executive staff, community liaisons, consultants (Camp Dresser & McKee, Inc.), public relations, staff at community center, public infrastructure staff;
- Sunbelt Freshwater Supply District - Board of Directors, attorney, engineer, district manager;
- Harris County - Public Infrastructure, Public Health and Environmental Services, and County Attorney's Office;
- Aldine Improvement District - Consultants;
- City of Houston - Health and Human Services;
- Texas Commission on Environmental Quality - TMDL Team, Region 12 Water Section;
- Texas A & M University at Galveston - Department of Marine Sciences;
- Baylor University, Department of Environmental Studies;
- Natural Resources Advisory Committee, H-GAC Board of Directors, and
- Residents (field reconnaissance, FWSD meetings, Town Meetings, and follow-up requests).

Presentations were also provided for a number of stakeholders and interested parties. A summary of interviews and presentations is included in Table 11.

Table 11 – Summary of Public Meetings and Outreach

2006	Location	Activity Type	No. of Persons	Primary Topics	List of organizations
March 9	H-GAC Office	Discuss FSSI partnership with HCPCT 2	4	Draft report HCPCT 2 needs for sewer service and FSSI opportunities	Commissioner Garcia's Staff, CDM (Consulting), H-GAC
May 5	Com. Sylvia Garcia's Office	Present proposal for FSSI partnership	7	FSSI opportunities for partnership	HCPCT 2 staff, H-GAC
June 9	Westfield Estates	Field Reconnaissance	6	Concerns for black water in community ditches	H-GAC, Community Residents
July 7	Westfield Estates	Field Reconnaissance	7	Concerns for black water in community ditches	H-GAC, Community Residents
August 17	GBEP Offices	GBEP - WQS Subcommittee	10	Project up-date and status	GBEP, H-GAC, TCEQ, City of Pasadena, Texas Sea Grant & Texas Cooperative Extension; Gulf Coast Waste Authority
August 30	Westfield Estates	Field Reconnaissance	9	Concerns for black water in community ditches	H-GAC, Community Residents
September 18	Westfield Estates	Outreach During Sampling	10	Concerns for black water in community ditches	H-GAC, Hygeia Laboratories, Texas A & M Galveston, Residents
September 26	Westfield Estates	Outreach During Sampling	11	Concerns for black water in community ditches	H-GAC, Hygeia Laboratories, Texas A & M Galveston, Residents
November 28	Westfield Estates	Outreach During Sampling	5	Concerns for black water in community ditches	H-GAC, Hygeia Laboratories, Residents

2007	Location	Activity Type	No. of Persons	Primary Topics	List of organizations
January 8	Sunbelt FWSD Admin. Building	Board of Director's Meeting	11	Water quality monitoring results, locations, density of on-site septic systems, risk assessment and correction strategy. Inclusion of Septic System Care brochure with water bills.	FWSD Board of Directors, Private citizens, Engineer, Operator, FWSD Attorney.
January 17	Northeast Community Center	Town Meeting	N/A	Water quality monitoring results, locations, density of on-site septic systems, risk assessment and correction strategy.	Meeting cancelled because of inclement weather. See February 13 Meeting Information
January 24, 2007	GBEP – State of the Bay Symposium	Regional Stakeholder Biennial Symposium	55	Water quality monitoring results, locations, density of on-site septic systems, risk assessment and correction strategy.	Galveston Bay Estuary Stakeholders in the Region, TCEQ TMDL Section
February 1	H-GAC Office	NRAC Quarterly Meeting	45	Final FSSI Report including water quality monitoring results, locations, density of on-site septic systems, risk assessment and correction strategy.	County Representatives: Harris, Brazoria, Galveston, Montgomery, Walker, and Liberty; Quest Engineering, San Jacinto River Authority, Galveston Bay Estuary Program, Harris County Flood Control District, Kingwood College, Gulf Coast Waste Disposal, Upper Kirby District, Dannenbaum Engineering, Reliant Energy, Galveston Bay Foundation, Friends of San Bernard River.
2007	**Location**	**Activity Type**	**No. of Persons**	**Primary Topics**	**List of organizations**

February 9	Westfield Estates	Television Interview	Persons Channel 13 viewing area, 6 o'clock News	Promotion of Town Meeting; Water quality monitoring results, locations, density of on-site septic systems, risk assessment.	Houston Channel 13, H-GAC
February 13, 2007	Northeast Community Center	Town Meeting	100	Water quality monitoring results, locations, density of on-site septic systems, risk assessment and correction strategy.	Commissioner Garcia's office – Harris County Precinct 2, Galveston Bay Estuary Program, Sunbelt Freshwater Supply District – Oakwilde, Aldine Improvement District, A & S Engineers, Harris County Public Health and Environmental Services, Harris County Attorney's Office, H-GAC, Houston Chronicle, Northeast News, Private citizens
February 15	H-GAC Office	News Interview	Readers of Northeast News	Follow-up to Town Meeting; Water quality monitoring results, locations, density of on-site septic systems, risk assessment	Northeast News, H-GAC (Interview)
February 16	H-GAC Office	News Interview	Readers of Houston-Chronicle - Aldine and Chron.com	Follow-up to Town Meeting; Water quality monitoring results, locations, density of on-site septic systems, risk assessment	Houston Chronicle - Aldine, Chron.com, H-GAC (Interview)

3.5.2 Public Meeting

H-GAC, in conjunction with its partners, hosted a public town meeting as part of the FSSI to discuss project goals, monitoring data analysis, assess perceptions about threats to human health, to determine environmental awareness, related values, attitudes and traditions. Exploration of the relationships between land use, watershed health, and sustainable economic development options were also discussed.

Specific agencies and offices invited to the public meetings include Harris County Precinct 2 Commissioner Sylvia Garcia's Office, Texas State Senator Kevin Brady's Office, Aldine Improvement District, Sunbelt Freshwater Supply District - Oakwilde, Harris County Attorney's Office, Harris County Public Infrastructure, Harris County Public Health and Environmental Services, TCEQ Region 12 Water Section, and Galveston Bay Estuary Program.

Promotion for the meeting included 1,700 notices in January water bills courtesy of Sunbelt FWSD, 800 notices via the Northeast Community Center mailing list, fliers posted in approximately 30 area businesses and at the Community Center, press releases to many English and Spanish-speaking newspapers, and television media (English and Spanish), H-GAC mailing list for Natural Resources Committee of the Board of Directors, H-GAC Community and Environmental Planning Department News Letter, and H-GAC Press release. It was necessary to conduct two rounds of promotion for the meeting because the first meeting scheduled in January was cancelled because of inclement weather. A summary of meeting attendance and outreach dates, locations, topics, and numbers of attendees is included as Table 12. The Mailing lists, meeting announcements, Town Meeting Summary, and other related materials are included in Appendix D Public Meetings.

H-GAC also compiled electronic photographs and images (maps and figures) for use in public meetings as well as to illustrate the location of Halls Bayou watershed, threats to the watershed and human health from bacterial contamination, and other relevant activities.

3.5.4 Outreach Brochures

Other tools to assist in this outreach were OSSF Problem Correction brochures. Because of the large number of English-as-second-language persons in the Community, H-GAC used an EPA manual for septic system care and maintenance and an EPA "Flush Responsibly" reminder card, which were translated into Spanish. The manual and card in both English and Spanish were disseminated within the watershed, to other H-GAC OSSF communities, and at regional conferences, workshops and symposia. These brochures will also be placed on the H-GAC and other appropriate web sites.

Brochures in English and Spanish were distributed at the Town Meeting (250), with an additional 150 pieces of informational material left at the Northeast Community Center. Brochures were distributed at an additional four earlier Precinct 2 Town Meetings in other areas, GBEP State of the Bay Symposium, and H-GAC Natural Resources Advisory Committee meeting.

H-GAC is currently involved in the Rita Recovery program. Many affected homeowners in the GBEP region use septic systems. Staff provides copies of these brochures to all contacts. Thus far, copies were provided to the City of Crystal Beach in Galveston County (120) and the City of Winnie in Chambers County (75).

The brochure and Outreach CD are available on the H-GAC website (www.h-gac.com). Copies of the brochures are included on the Resource CD in Appendix E.

3.5.5 OSSF Public Information CD

H-GAC developed an inclusive resource for addressing public, business, and local government concerns with failing septic systems. The Resource CD includes a Glossary of Terms, Public Outreach Templates for Local Communities, Funding Sources for Remediation, Information for Homeowners, Resource Organizations, and Information for Realtors, Regulation and Enforcement, Suggestions for Small Communities, Technical Information, Texas Programs, and Frequently Asked Questions. A detailed list of materials found on the CD are listed in Appendix E.

Over seventy-five CDs have been distributed to the public, local officials and other interested parties.

3.6 Recommendations for the Community

Opportunities for failing OSSF correction and non-human bacterial contamination source curtailment are part of H-GAC's process for developing a watershed protection plan. Recommendations for the Community include:

- Establish a stakeholders group;
- Implement site-specific best management practices;
- Achieve Community-based OSSF management;
- Pursue funding sources for interim and permanent solutions;
- Complete bacterial contamination source identification; and
- Quantify human health risk.

3.6.1 Establish Stakeholders Group

It is hoped that a local stakeholder group will be formed to address bacterial contamination in the short and long term. This group should include homeowners and residents from the Community, a wide spectrum of resource agencies, elected officials, and local businesses, especially realtors and builders.

Support provided by Harris County Precinct 2 includes providing a location for stakeholder meetings, assisting with the dissemination of outreach material, supporting plans to implement best management practices to control bacteria contamination, supporting plans for a permanent solution to bacterial contamination in the Community and other parts Precinct 2, and offers to supplement future water quality monitoring efforts through sharing data collected on the Community from County sources.

The FWSD will ultimately be responsible for providing municipal sewer service to the community. Since it already supplies water to almost the entire Community it is also a good partner to work with Harris County Precinct 2 in dissemination information and in implementing interim corrective strategy. It is possible both entities can pursue sources of funding for the final solution to bacterial contamination in the Community, which then flows into Halls Bayou.

Harris County Public Infrastructure Department is also in a position to assist because of their engineering expertise, monitoring, and survey capabilities.

Harris County Subsidence District has a program to reduce use of ground water, which involves retrofitting appliances, which might be useful in this situation.

3.6.2 Implement Site-Specific Best Management Practices

Interim corrective strategies, including best management practices (BMPs) are a reasonable alternative to decrease the risk from bacterial contamination in the Community until the final solution is achieved. The permanent solution to human bacterial contamination in the Community is a municipal sewer system. Cost dictates a variety of funding sources will be required, which will delay implementation for a significant time, perhaps 10 years.

Field Reconnaissance in the original FSSI showed a mix of residences with no septic system, systems well past their useful life expectance, broken system, improperly maintained systems, incorrectly designed system, and properly functioning systems. Environmental justice and/or economic issues also apply to the Community.

A field survey program to assess the condition of on-site septic systems in the Community is proposed. Initially, a few blocks would be surveyed in preparation for a community wide program. Prioritization for removal and replacement, maintenance, or other means of addressing failing on-site septic systems could occur following the survey.

Implementation of solutions to identified problems includes pumping out septic systems, installing holding tanks, and proper maintenance for the course of the project. Eligibility for these solutions would be determined based on economic and other needs basis, perhaps using criteria similar to those developed for Community Block Grant award qualification. Epidemiological study questionnaires could be completed at this time as part of the application process.

3.6.3 Achieve Community-Based OSSF Management

Risk Assessment, Correction Strategy and resources form the foundation for addressing similar OSSF issues in twenty-five other target communities identified in a previous H-GAC study. These are also necessary components of several other H-GAC/GBEP ongoing projects in the region. Targeted monitoring conducted during the development and categorization of failing OSSF sheds light on the specific sources and locations of bacteria loading, assists H-GAC and local partners in rapidly developing and implementing solutions to reduce bacterial contamination and/or water quality degradation, as well as improve existing water quality. These are basic elements in the preparation of proactive watershed protection plans.

Community outreach and the development of stakeholder relationships are necessary keys to successful implementation of any correction strategy. Westfield Estates has many stakeholders interesting in addressing failing septic systems who plan to work together towards a common solution.

3.6.4 Pursue Funding Sources

The economic burden for the permanent Community bacterial contamination solution is substantial, approximately $16 million according to Harris County Precinct 2's recent study, entitled *Unincorporated Revitalization Program Comprehensive Water & Wastewater Engineering.* There is no single source of funding, which will cover the entire cost of the project. Possible sources of funding for the project, each with its own requirements, include: (1) EPA State and Tribal Grants (STAG), (2) Texas Water Development Board (TWDB) Economically Distressed Areas Program (EDAP), (3) Housing and Urban Development's Community Development Block Grant (CDBG) Program, (4) TWDB Water Supply and Wastewater Facilities Planning Program, (5) Department of Commerce Public Works Economic

Development Program, (6) TWBD Clean Water State Revolving Loan Fund (SRF) Program, (7) TWDB State Loan Program Texas Water Development Fund II, and (8) TCEQ Supplemental Environmental Projects (SEPs).

Interims solutions to bacterial contamination from failing septic systems and other sources must be coordinated with the long-term solution. Because of substantially different grant and loan requirements, logistical, and jurisdictional issues, an active and effectively integrated Stakeholders group will be necessary. Application coordination and support will also be required. Community outreach will be necessary so that residents embrace the municipal sewer system when it becomes available. H-GAC proposes to act as coordinator for the outreach activities and stakeholders group.

3.6.5 Additional Bacterial Source Identification

While 65% of the sources of bacterial contamination in the Community have been identified, the level of unknown source of bacterial contamination is significant. Characterization of bacterial contamination source risk factors is essential to the development and implementation of a correction strategy, since correcting bacterial contamination from only a single source, e.g. human, will not significantly reduce bacterial contamination in the Community.

H-GAC proposed to examine the previously identified "hot spots" in the community to reduce the unknown bacterial source component. Additional s and relatively low cost DNA sequencing will be utilized.

3.6.6 Quantify Human Health Risk

Bacterial contamination from both human and non-human sources is widespread in Westfield Estate. However, whether or not an actual risk to human health exists from exposure to bacterial contamination in ditch water at levels seen in the Community or Halls Bayou remains to be determined. An epidemiological study is required to determine the magnitude of the risk, which exists. It should be possible to combine the health survey portion of the study with information required from residents who desire to participate in the interim solution process of septic system remediation. Additionally, a near by health clinic may be able to provide information. Additional funding will be required to complete such an epidemiological study if it is not included in the interim solution process.

4.0 INITIATIVE CONCLUSIONS

Primary conclusions derived from this project can be summed up in six statements:

- Bacterial contamination poses a threat to water quality and possibly human health within the Westfield Estates Community and in adjacent Halls Bayou.
- The majority of this bacterial contamination is of non-human origin.
- Recommended mitigation action focuses on providing municipal sewer service to the Community, for which funding is not yet available.
- Septic systems in the Community need to be properly maintained and/or repaired in the interim, which requires an outreach program.
- Stakeholder involvement is a key and necessary component in problem resolution.
- Targeted sampling may be a useful tool for water managers responsible for completing total maximum daily load (TMDL) implementation plans using *E. coli*.

4.1 Threats to Water Quality and Human Health

Principle threats to water quality in Westfield Estates and Halls Bayou include bacterial contamination as measured by *E. coli* as predictor for human pathogens, population growth and redevelopment, and flooding.

Currently, the discharge of viral pathogens in treated sewage is not regulated, and monitoring relies on bacterial indicators such as fecal coliforms to predict viral contamination (Griffin et al. 2001). Overall sampling results in samples collected in Westfield Estates suggest that standing ditch water in the Community is contaminated with E. coli 6 to 600-fold in excess of state criteria for contact recreation. Similar results occur with Halls Bayou water sampling sites. Bacterial contamination has the potential to affect water quality leading to prohibition of contact recreation for Halls Bayou and possibly requiring a TMDL for this segment of Halls Bayou.

Human health risk cannot be similarly quantified. Without epidemiological studies, one cannot define the nature or magnitude of the risk associated with the presence of the human pathogen predictor, E. *coli*.

Bacterial (*E. coli)* levels in water bodies vary greatly depending on location and ambient conditions. Gordon (2001) suggests that bacterial clonal composition changes during the transition from host to secondary external environmental habitat. In the case of H-GAC's targeted sampling, variable counts may result from transient sources of fecal contamination, whereas high counts are more likely from persistent sources. However, die-off rate of particular bacterial species (see Section 4.2) within the environment can also add to variability. Additional testing, which is outside the scope of the FSSI, is required to determine the reason for this variability.

Bacterial contamination in Westfield Estates could also adversely impact Halls Bayou and other downstream waterbodies. These waterbodies include Greens Bayou, Buffalo Bayou, the Houston Ship Channel, the Galveston Bay Estuary, and ultimately the Gulf of Mexico. Protection of these valuable coastal resources, and their coastal bayou watersheds, is critical to maintaining a healthy ecosystem and supporting high quality outdoor recreation opportunities, and local economies. Protection begins at the Community level in Westfield Estates with implementation of the Correction Strategy.

Population growth and land redevelopment within Westfield Estates and along Halls Bayou show a rise in the number of on-site septic systems, higher traffic levels, more trash and litter, and replacement of open space with impervious cover. As a result, residential and urban non-point bacterial source loads will become a proportionately larger source of impacts of water quality degradation. Growth and development, combined with an increase in contact recreation associated with local and regional growth, plus intermittent but persistent flooding, could pose an increasing risk to human health and public safety, and impair the recreational use of Halls Bayou. It is essential for Community and elected officials to be proactive in addressing this issue.

Flooding concerns affect the viability of interim solutions to failing OSSFs and bacterial contamination from non-human sources. These must be addressed along with solutions to the Westfield Estates problems. Located within the Greens Bayou watershed, Halls Bayou has a long history of flooding. Tropical Storm Allison in 2001 flooded approximately 12,800 residences in the watershed. In 2002, the Harris County Flood Control District developed a thorough and effective Flood Damage Reduction Plan for the citizens living along Halls Bayou. Preliminary estimates place project implementation costs at approximately $120 million. Funding is not currently available from the federal government for this authorized project, which has not even started the Study Phase because of repeated delays in funding.

4.2 Source of Bacterial Contamination

Water quality data, stakeholder discussions, and field reconnaissance indicate that potential sources of bacteria loading can be divided into four basic types, natural, agricultural, residential, and urban. Examples of these sources include migratory birds, wildlife, chickens (cooped and free ranging), goats grazing, failing septic systems, and emergency bypasses from municipal wastewater treatment plants. The potential for all of these exist in Westfield Estates. In addition to the documented bacteria issues, stakeholders have expressed concern over other non-point source pollutants like trash, pesticides, and sediment, which can adversely impact storm water runoff.

This bacterial source tracking is further complicated by *E. coli* subspecies composition variability, geographic location, collection time, rainfall and habitat. In the case of BST methods, a commensurately large host origin database will be required to encompass these compositional changes for greater reliability. In light of these considerations, the FSSI utilized isolates collected at multiple locations under variable sampling conditions in the Community coupled with rigorous statistical analysis. Thus, the FSSI results cover 25 locations and 4 different sampling events. Bacterial sources of contamination are indicative of the Community as a whole rather than a single location. The FSSI reference library was composed of isolates collected within the Community.

While the contribution of bacterial contamination from humans in the FSSI is significant (16%), one cannot overlook the contribution form non-human bacterial sources such as dogs (33%), chickens (17%), and unknown (34%).

4.3 Risk Assessment

Bacterial contamination in the Community from a variety of sources may pose potential harm to human health and/or to the environment.

Escherichia coli is used both as a predictor of the presence of waterborne human pathogens and as a measure of whether or not a water body meets State of Texas criteria for contact recreation. Levels above State criteria were obtained at all locations examined in the Community and Halls Bayou. Exceedences were six to 600-fold higher than the standard. Over half of the locations exceed *E. coli* levels associated with illness from exposure to the water body or source as well as degraded water quality according to State contact recreation standards.

Enteric viral contamination of drinking and irrigation water sources, recreational waters, and shellfish harvesting waters pose the greatest risk to the public. Enteric viruses are believed to cause the majority of waterborne illnesses. However, there have been no recorded incidents of large numbers of persons in the Community becoming ill with diseases associated with waterborne pathogens. Additional epidemiological studies will be required to quantify human health risk associated with exposure to bacterial contamination from various sources in the Community.

The source of the bacterial contamination in the Community and the Bayou must be addressed. In addition to human sources, presumably from failing septic systems, dog and chickens, many of which roam freely, contribute significantly to the levels of bacterial contamination. Any plan to address bacterial contamination in the Community and Halls Bayou must include management of fecal material from these sources. Part of the source of bacterial contamination remains unknown. Additional studies will be required to identify additional contributors.

Information gathered at the Public meeting with the Community and other interested parties indicates a concern for standing water in ditches as potential human health and environmental risks. These

Stakeholders including residents, businesses, elected officials (federal, state, county, and utility district entities) must work together to address concerns and develop solutions.

4.4 Correction Strategy

H-GAC developed a Community Management and Correction Strategy to reducing bacterial contamination non-point source pollution within the Westfield Estates and in the Halls Bayou watershed. A variety of mitigation actions are proposed to address current and future bacterial contamination and water quality threats. The permanent solution would be to provide municipal wastewater treatment to the Community. This option comes with a high price tag, approximately $16 million. Interim solutions are thus a viable course of action while funding sources are developed for the permanent solution. Strategic planning and development of correction options coupled with strong stakeholder involvement are necessary steps towards reducing bacterial contamination from a variety of sources in the area in the short term. Some of the solutions fall under the realm of best management practices, with the basic strategy to identify BMPs that will effectively reduce both pollutant loading and human health risk. Prioritized implementation based on technical feasibility, likelihood of achieving load reductions, correlation with identified stakeholder concerns, available funding and stakeholder initiative will be required for success. Based on the support of local stakeholders, including elected officials, implementation of selected BMPs and other mitigation actions could proceed following funding from additional sources.

4.5 Public Outreach and Community Involvement

Developing a water treatment solution is one of the most efficient methods to allow for measured growth and urban renewal in this once vibrant community. Long-time residents say Westfield Estates was once a lovely community with neat homes, friendly neighbors, and a place where children were safe to play. Adequate wastewater treatment can be used as a tool to enable growth and renewal in a community.

H-GAC’s outreach activities strive to raise the awareness of possible risks to human health and the environment from bacterial contamination from human and non-human sources (dog, chicken) in the Community and in Halls Bayou. Target audience includes residents of local and regional communities, elected officials, realtors, developers, businesses, and other stakeholders. Activities begin with information sharing, consultations, and partnerships between stakeholders to establish basic knowledge of issues and trust between the parties. Public meetings, with both large and small numbers of participants follow as part of consensus building activities. Outreach brochures, in English and Spanish, and CDs with information on septic system care and maintenance are also useful tools for outreach.

Understanding failing OSSFs and other non-human sources of bacterial contamination and their links to residents’ quality of life and health, ecological health of area water bodies, and ultimately local economics is a necessary foundation for developing outreach stages for problem solving, partnerships, and empowerment, which culminate in a successful correction strategy.

4.6 Recommendations for the Community

Opportunities for failing OSSF correction and non-human bacterial contamination source curtailment are part of H-GAC's process for developing watershed protection plan. Recommendations for the Community include:

- Establish a stakeholders group;
- Implement site-specific best management practices;
- Achieve Community-based OSSF management;
- Pursue funding sources for interim and permanent solutions;

- Complete bacterial contamination source identification; and
- Quantify human health risk

5.0 ACTION PLAN

Strong support for the FSSI project was received from Harris County Precinct 2 and Sunbelt Freshwater Supply District, both with jurisdictional authority over the Community. Additionally, residents show strong interest in the project and in resolving issues as evidenced by approximately 100 people attending a Town Meeting held to disseminate information on the FSSI project.

Opportunities exist to:

- Identify remaining unknown source of bacterial contamination;
- Quantify human health and environmental risk;
- Develop and implement interim solutions to bacterial contamination; and
- Initiate plan for a final solution to the problem.

5.1 Additional Studies

Source of Bacterial Contamination

The FSSI showed *E. coli* and Enterococcus bacterial contamination at all sites examined in the Community and the Bayou, at levels significantly above State criteria for recreational activity. Bacterial sources were identified as human (16%), dog (33%), and chicken (17%), and unknown (34%). The level of unknown source of bacterial contamination is significant. Characterization of bacterial contamination source risk factors is essential to the development and implementation of a correction strategy, since correcting bacterial contamination from only a single source, e.g. human, will not significantly reduce bacterial contamination in the Community.

H-GAC proposed to examine the previously identified "hot spots" in the community to reduce the unknown source component. CUP will be utilized to increase the isolates in the reference library and in the Community. Relatively low cost DNA sequencing will be utilized through a partnership with Texas A & M University at Galveston.

Quantification of Human Health Risk

Escherichia coli are used as a predictor of the presence of waterborne human pathogens. Levels of *E.coli* in Community ditch water and in the bayou have been associated with human health effects recorded in the scientific literature. However, there have been no recorded incidents of large numbers of persons in the Community becoming ill with diseases associated with waterborne pathogens. An epidemiological study is needed to quantify the risk of human illness associated with exposure to bacterial contamination at levels present in Community. This study could be performed in conjunction with the interim mitigation process discussed in Section 5.2 at low cost.

5.2 Mitigation Implementation of Interim Solutions

The permanent solution to human bacterial contamination in the Community is a municipal sewer system. Cost dictates a variety of funding sources will be required, which will delay implementation for a significant time, perhaps 10 years. Interim corrective strategies, including best management practices (BMPs) are a reasonable alternative to decrease the risk from bacterial contamination in the Community until the final solution is achieved.

Field Reconnaissance in the original FSSI showed a mix of residences with no septic system, systems well past their useful life expectance, broken system, improperly maintained systems, incorrectly designed system, and properly functioning systems. Environmental justice issues also apply to the Community.

Initially, a survey of septic systems on the ground in a few blocks of the Community would be conducted to identify those systems that are: (1) adequate, (2) inadequate but can be made adequate by proper maintenance, (3) inadequate and in need of replacement or installation of a holding tank, and (4) no solution is apparent. This would allow for a rough cost estimate of what solutions or BMPs are needed. Implementation of solutions to identified problems includes pumping out septic systems, installing holding tanks, and proper maintenance for the course of the project. Additional water conservation measures in the form of low-flush toilets, showerheads and the like would reduce wastewater flow to the septic systems to decrease the frequency of pump-out. Separating grey water from sanitary wastewater might also be an option.

A community-wide field survey program should follow. Prioritization for removal and replacement, maintenance, or other means of addressing failing on-site septic systems would occur based on established criteria. Eligibility for these solutions would be determined based on economic and other needs according to guidelines established for Community Development Block Grants.

Additional Best Management procedures, which will be developed in conjunction with stakeholders, include (1) enhancement of Harris County's design criteria for on-site septic systems to more effectively manage wastewater discharges, (2) develop strategy, implementation plan, and measurement standard to reduce bacterial contamination from family pets (e.g. dogs) and agricultural animals (chickens and goats), (3) English and Spanish Community outreach program to educate Community residents on the proper care and maintenance of septic systems, and (4) Establish regular meetings of the Stakeholders Group to continue to find a permanent solution for the Community that will be fully embraced by the residents.

Success will be measured by reduction of specific bacterial loading in Halls Bayou, including *E. coli* and *Enterococcus* and decrease in the number of species contributing to the loading (human, canine, and poultry).

5.3 Stakeholder involvement in Permanent Solution

The economic burden for the permanent Community bacterial contamination solution is substantial, approximately $16 million according to Harris County Precinct 2's recent study, entitled *Unincorporated Revitalization Program Comprehensive Water & Wastewater Engineering.* There is no single source of funding, which will cover the entire cost of the project. Possible sources of funding for the project, each with its own requirements, include: (1) EPA State and Tribal Grants (STAG), (2) Texas Water Development Board (TWDB) Economically Distressed Areas Program (EDAP), (3) Housing and Urban Development's Community Development Block Grant (CDBG) Program, (4) TWDB Water Supply and Wastewater Facilities Planning Program, (5) Department of Commerce Public Works Economic Development Program, (6) TWBD Clean Water State Revolving Loan Fund (SRF) Program, (7) TWDB State Loan Program Texas Water Development Fund II, and (8) TCEQ Supplemental Environmental Projects (SEPs).

Interims solutions to bacterial contamination from failing septic systems and other sources must be coordinated with the long-term solution. Because of substantially different grant and loan requirements, logistical, and jurisdictional issues, an active and effectively integrated Stakeholders group will be necessary. Application coordination and support will also be required. Additionally, community outreach will be necessary so that residents embrace the municipal sewer system when it becomes available. H-GAC proposes to act as coordinator for the outreach activities and stakeholders group.

6.0 PROJECT EVALUATION - LESSONS LEARNED

The Failing Septic System Initiative was a complex project with many distinct but integrated parts. As with the case of any project, additional insight is gained useful for efficient conduct of future studies. Lessons learned from the FSSI include:

- Maintain partnerships and stakeholder interest;
- Add experimental protocols to increase project understanding;
- Remain flexible and adaptive to unforeseen events;
- Be prepared to quickly adapt to new information and ideas;
- Modifications and adaptations require keen oversight; and
- Keep project goals in the forefront.

6.1 Partnerships and Stakeholders

Input from people who live, work, and play within Westfield Estates along Halls Bayou is critical to understanding the wide spectrum of activities that could threaten Community, Bayou, and watershed health. It also assists in determining the important issues and concerns that resonate with the local Community and the Precinct. By way of example, local knowledge played an immense role in identifying possible sources of failing septic systems, changes in drainage patterns, and flooding along the watershed. This information guided the development of interim and final solutions, and served as a basis for securing project funding. Individual interviews in the field, at "roundtable" discussions, and at public meetings readily identified bacterial pollutant loading hotspots within the Community and in Halls Bayou. This increased understanding of the high value local residents and elected officials place on Community health and the natural resources of Halls Bayou. This set the stage for developing a Correction Strategy that will be supported at the local level.

Gaining the trust of residents and local officials is essential to sharing local knowledge. The importance of fostering relationships and demonstrating that people's thoughts, knowledge, and opinions are important should not be underestimated. Four activities substantially aided in developing relationships and gaining trust during this project:

- Holding productive and informative meetings;
- Being responsive to stakeholder requests;
- Putting technical data and abstract concepts into context with everyday life; and,
- Spending time in the field.

H-GAC staff encouraged an open door policy with stakeholders and provided multiple opportunities for communication (face-to-face meeting, phone, fax, and email). Effectively responding to stakeholder requests required commitment, effort, patience, and persistence.

6.2 Integrate Geographic Information Systems and Geospatial Analysis

H-GAC analyzed a wide variety of geospatial datasets during the source of this project. Moving beyond the mindset of using GIS to create maps simply allowed H-GAC staff to enhance substantially our understanding of watershed dynamics and pollutant loading. From utilizing high-resolution aerial photography to assess land use along the bayous to using addresses and wastewater treatment boundaries to determine the density of on-site septic systems, to identifying and tracking sampling locations, GIS and geospatial analysis played a major role in the success of this project.

6.3 Remain Flexible and Adaptive

The FSSI was initially planned as a 12-month study. Contract delays, partner change, and weather conditions shortened this period to five months. Remaining flexible and being prepared to adapt quickly to new information and ideas allowed H-GAC staff to expand successfully original study design to include BST, find new partners, identify different sampling locations when unforeseen events prevented sampling at the primary site, and adapting to unfavorable weather without losing momentum. However, these factors had a impact on the amount of time the contract laboratory had to complete the work, report and quality assurance review.

Expand Study Design of Project
H-GAC is involved in several projects, including Total Maximum Daily Load (TMDL) regulation development, which is evaluating the source of bacterial loading in region streams. Most methods of BST analysis are costly and labor intensive. The CUP method presented an opportunity to develop a tool with high accuracy, rapid turnaround, and low cost. H-GAC felt it was meaningful to determine if the method had utility for TMDL analysis. Bacterial Source Tracking was added to the original Failing Septic System Initiative after the protocol and Quality Assurance Project Plan were completed. This required initiating a request for proposal process within H-GAC, which took five months to complete. Though addition of BST delayed actual sampling by months, its utility for other studies is clearly demonstrated.

Changing Partners
H-GAC considered two site locations for the project, Brazoria County and Harris County Precinct 2. The Bastrop location was eventually chosen for the FSSI because it was a countywide rather than a community based study. Unfortunately, shortly before FSSI sampling was to begin in April 2006, Brazoria County decided against participating in the project.

Harris County Precinct 2 was approached and the initiative was fully embraced and moved forward with full support of Commissioner Sylvia Garcia. Additional time was required to identify a community and sampling sites for the project.

Weather Condition Delays
With delays resulting from both the change in stakeholder and addition of the BST pushed sampling from April into the dry months of the year. Dry-weather sampling locations were identified and data collection begun in September 2006.

Community outreach was truncated but the FFSI received excellent public relations and meeting organizational support from HCPCT2. The Town Meeting in January was cancelled because of inclement weather. Staff quickly rescheduled the meeting to February and completed another round of public relations work, which include water bill inserts, newspapers, and television.

Change Impact on the Contract Laboratory
The shortened timeframe for conducting the analytical portion of the FSSI plus the newness of the CUP analysis made the FSSI was more analogous to a research project than ambient water quality sampling. These factors had a great impact on the contract laboratory. Hygeia Laboratories was cooperative and responsive throughout the FSSI, providing data in an expedient timeframe. Preliminary results discussed

at the Town Meeting and elsewhere contained a decimal error, which was discovered by the laboratory and corrected. In future studies with truncated timelines, quality assurance checks should be performed throughout the course of the study and not just at the end as specified in the Quality Assurance Project Plan.

H-GAC met each of these challenges and worked through them with the support of its partners, Galveston Bay Estuary Program, and Harris County Precinct 2.

6.6 Keep Project Goals at the Forefront

A project of this complexity and magnitude (data collection efforts, energized stakeholders, variety of project partners, and number of unforeseen problems) resulted in many opportunities to shift priorities and "get lost in the weeds." Recommendations to help keep project goals at the forefront include continually presenting individual stakeholder concerns in the broad context of Community-based solutions; managing contracts and budget allocations integrated into organizational financial structure; illustrating the linkage between individual behavior and human health and water quality impacts; and seeking and nurturing support of key stakeholders throughout the course of both the planned and unplanned aspects of study. Remaining focused on goals enhances stakeholder involvement by moving discussion beyond individual agendas, increasing awareness and concerns, and forming alliances between diverse groups.

7.0 REFERENCES

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APPENDIX A

QUALITY ASSURANCE PROJECT PLAN AND AMENDMENT 1

FAILING SEPTIC SYSTEM INITIATIVE:

ON-SITE SEWAGE FACILITY RISK ASSESSMENT AND OUTREACH
Quality Assurance Project Plan
Contract # 582-5-65075
EPA Agreement CE-00655003

Houston-Galveston Area Council
3555 Timmons Lane, Suite 120
Houston, Texas 77227

Texas Commission on Environmental Quality
P.O. Box 13087, MC 165
Austin, Texas 78711-3087

Galveston Bay Estuary Program
17041 El Camino Real, Ste. 210
Houston, Texas 77058

Effective Period: January 2006 through January 2007

Questions concerning this QAPP should be directed to:

Dr. Kathleen Ramsey, DABT
Project Manager
Houston-Galveston Area Council
3555 Timmons Lane, Suite 120
Houston, TX 77027-6748
(713) 499-6653
kathleen.ramsey@h-gac.com

A1 APPROVAL PAGE

The following signatures are required for the special study:

H-GAC Program Manager	Carl Masterson Community Resources Program Manager	Date
H-GAC Project Manager Quality Assurance Officer:	Kathleen Ramsey, Ph.D. Senior Environmental Planner	Date
GBEP Program and Grant Manager:	Helen Drummond Director, GBEP/TCEQ	Date
GBEP Project Manager:	Steven Johnston Project Coordinator, GBEP /TCEQ	Date
GBEP QA Manager:	Angela Henderson Quality Assurance Officer, GBEP /TCEQ	Date
TCEQ Section Manager:	Thomas Weber Manager, Water Programs, Chief Engineer's Office, TCEQ	Date
TCEQ Division Director:	Jose A. Franco Director of Compliance Support Division, TCEQ	Date
TCEQ QA Manager:	Stephen Stubbs QA Manager, TCEQ	Date

The H-GAC will secure written documentation from each project participant stating the organization's awareness of and commitment to requirements contained in this quality assurance project plan appendix and any amendments of this plan. H-GAC will maintain this documentation as part of the project's quality assurance records and it will be available for review.

A2 TABLE OF CONTENTS

Page

LIST OF ACRONYMS

AWRL	**Ambient Water Reporting Limit**
BMP	**Best Management Practices**
CAR	**Corrective Action Report**
COC	**Chain-of Custody**
DOC	**Demonstration of Capability**
DQO	**Data Quality Objective**
E. Coli	***Escherichia coli***
FSSI	**Failing Septic System Initiative**
FY	**Fiscal Year**
GIS	**Geographic Information System**
GPS	**Global Positioning Systems**
H-GAC	**Houston-Galveston Area Council**
MDMA	**Monitoring Data Management & Analysis**
MS	**Microsoft Corporation**
OSSF	**On-Site Sewer Facility**
QA	**Quality Assurance**
QAM	**Quality Assurance Manual**
QM	**Quality Manual**
QAO	**Quality Assurance Officer**
QAPP	**Quality Assurance Project Plan**
QAS	**Quality Assurance Specialist**
QC	**Quality Control**
QMP	**Quality Management Plan**
RBP	**Rapid Bioassessment Protocol**
RL	**Reporting Limit**
RWA	**Receiving Water Assessment**
SOP	**Standard Operating Procedure**
SWQM	**Surface Water Quality Monitoring**
TMDL	**Total Maximum Daily Load**
TCEQ	**Texas Commission on Environmental Quality**
TRACS	**TCEQ Regulatory Activities and Compliance System**
TSWQS	**Texas Surface Water Quality Standards**
WMT	**Watershed Management Team**
WQMP	**Water Quality Management Plan**
WWTP	**Wastewater Treatment Plant**

A3 DISTRIBUTION LIST

Texas Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

Ms. Helen Drummond, Program and Grant Manager, GBEP/ TCEQ
Mr. Steven R. Johnston, Project Manager, GBEP/TCEQ
Ms. Angela Henderson, Quality Assurance Officer, GBEP/TCEQ
Mr. Thomas Weber, Manager, Water Programs Section/TCEQ
Mr. Stephen Stubbs, Quality Assurance Manager, TCEQ

US EPA, Region 6
1445 Ross Avenue, Ste.1200
Dallas, TX 75202-2733

Ms. Susan Branning, Chief of Assistance Programs Branch, EPA
Ms. Betty Ashley, Project Manager, EPA

Houston-Galveston Area Council
3555 Timmons Lane, Suite 120
Houston, Texas 77027-6478

Mr. Carl Masterson, Program Manager, H-GAC C&E Dept.
Dr. Kathleen Ramsey, Project Manager, Quality Assurance Officer, H-GAC, C&E Dept.

The H-GAC will provide copies of this project plan and any amendments or revisions of this plan to each person on this list and to each sub-tier project participant, e.g., subcontractors, other units of government, laboratories. The H-GAC will document distribution of the plan and any amendments and appendices. It will maintain this documentation as part of the project's quality assurance records and ensure that the document is available for review.

A4 PROJECT/TASK ORGANIZATION

Texas Commission on Environmental Quality (TCEQ)

Galveston Bay Estuary Program Organization
The Galveston Bay Estuary Program (GBEP), a program of the Texas Commission on Environmental Quality (TCEQ), is comprised of advisory groups and staff whose general duties are described below.

Helen Drummond, GBEP Program Manager
The Program Manager guides and oversees the work of the Project Manager. The Program Manager will review projects developed each fiscal year for submission to the Budget & Priorities Workgroup (see description, page 8).

Steven Johnston, GBEP Project Manager
Regional Monitoring and Research Coordinator will function as Project Manager for the Loadings, Water Quality Mapping and Phytoplankton Project, which falls under the Regional Monitoring and Research program areas. In practice, the term Project Manager is used interchangeably with “TCEQ Project Representative”, “GBEP Project Representative” and “Contract Manager”. The Project Manager's responsibility includes:

- Maintaining necessary lines of communication and good working relationships between lead division staff, personnel of other divisions and organizations participating in a project;
- Ensuring the lead division administrative services coordinator or grant budget coordinator, and the TCEQ federal funds coordinator are informed of changes, revisions, or additions to the project;
- Elevating problems and issues requiring resolution to the Division Director, Policy and Regulation, or designee(s) for disposition, when appropriate; assist in preparing contracts and intergovernmental agreements;
- Reviewing the contractor’s performance, including quality and timeliness of deliverables, reasonableness of expenditures, progress on meeting objectives/goals of the contract and enforce corrective action measures to assist contractors in meeting deadlines and scheduled commitments.

TCEQ Executive Director, Deputy Directors, Division Directors, and the quality assurance manager have delegated authority to develop and implement project-related quality systems, including development and maintenance of QAPPs, to Project Managers. These systems shall be developed with the concurrence and assistance of lead project quality assurance staff. GBEP Program Manager selects the GBEP Project Manager.

Angela Henderson, GBEP Quality Assurance Officer
The GBEP Quality Assurance (QA) Officer assists GBEP Project Managers in the development and review of Quality Assurance Project Plans and other QA/QC elements of projects as required by the U.S. Environmental Protection Agency (EPA) and the TCEQ.

GBEP Advisory Groups
GBEP advisory groups include the Galveston Bay Council (GBC), and GBC subcommittees, task forces and workgroups. The advisory groups participate in project management as described below.

Galveston Bay Council
The GBC will:
- Provide an ongoing forum for technical and stakeholders review and involvement during *The Galveston Bay Plan (The Plan*) implementation;
- Contribute to assessments of Plan effectiveness and participate in periodic redirection of *The Plan* initiatives;
- Advise the TCEQ during consistency reviews of eligible federal projects;
- Maintain agency commitments to implement *The Plan*; assure efficient cross-jurisdictional coordination and, if necessary, facilitate resolution of disputes;
- Set annual priorities for the implementation of action plans.

The GBC reviews and approves the annual GBEP work plan during GBC meetings each April. The work plan contains the listing of projects developed through subcommittees and approved by the Budget and Priorities Workgroup.

Budget and Priorities Workgroup
The function of the Budget and Priorities Workgroup (B&P) of the GBC is to focus resources to accomplish major objectives in *The Plan* and advise on redirection of efforts where appropriate. B&P first reviews and approves the draft annual GBEP work plan before submission to the GBC. The B&P is also responsible for recommending resolutions of technical issues or conflicts to the program manager, regarding projects that are not resolvable by the respective subcommittee.

GBC Subcommittees
The GBC Subcommittees advise and comment on, in concurrence with the needs of GBEP and the Subcommittee Coordinator, the Scope of Work, project goals and objectives, specification of deliverables and the review and approval of final deliverables. The breakdown of the subcommittees is as follows:

1. Natural Resource Uses Subcommittee
The Natural Resource Uses (NRU) Subcommittee of the GBC facilitates the implementation of the Habitat/Living Resource Conservation area and three of four components of the Balanced Human Uses area of *The Plan*. Annually, the subcommittee develops projects that implement the following action plans:
- Habitat protection;
- Species population protection;
- Freshwater inflow and bay circulation;
- Spills/dumping;
- Shoreline management.

2. Water and Sediment Quality Subcommittee

The Water and Sediment Quality (WSQ) Subcommittee of the GBC facilitates the implementation of the Water and Sediment Quality Improvement area and one component of the Balanced Human Uses area of *The Plan*. The subcommittee annually develops projects that implement the following action plans:

- Water and sediment quality;
- Non-point sources of pollution;
- Point sources of pollution;
- Public health protection.

3. Public Participation and Education Subcommittee

The Public Participation and Education (PPE) Subcommittee of the GBC facilitates the implementation of the Public Participation and Education Action Plan. The subcommittee provides support for all other Plan actions; annual projects are developed in consideration of the other subcommittees' initiatives.

4. Monitoring and Research Subcommittee

The Monitoring and Research Subcommittee (M&R) of the GBC facilitates the implementation of the Research Action Plan and the Monitoring Program. Similar to the PPE subcommittee, the M&R provides support for all other Plan actions; monitoring and research needs; and funding issues are addressed while considering other subcommittees' initiatives and findings.

GBC Subcommittee Coordinators

Individuals from the GBEP staff are assigned by the GBEP Program Manager to facilitate and coordinate efforts of the following subset of GBC advisory groups:

- NRU Subcommittee
- WSQ Subcommittee
- PPE Subcommittee
- M&R Subcommittee

As subcommittee coordinators, these individuals facilitate quarterly meetings of the advisory groups and develop the listing of annual projects that will be submitted through the GBEP hierarchy and ultimately approved by the GBC.

Houston-Galveston Area Council (H-GAC)

Carl Masterson, H-GAC Program Manager

Program responsibility for implementing and monitoring requirements in contracts, QAPPs, and QAPP amendments and appendices. Ensures that subcontractors are qualified to perform contracted work.

Kathleen Ramsey, H-GAC Project Manager, Quality Assurance Officer

Responsible for implementing and monitoring requirements in contracts, QAPPs, and QAPP amendments and appendices; and coordination of Failing Septic System Initiative (FSSI) planning activities and the work of sub-contractors. The Project Manager ensures the monitoring systems audit is conducted to assure QAPP is followed by H-GAC and subcontractors and that project is producing data of known quality. The Project Manager ensures QA Specialist is notified of deficiencies and non-conformances, and that issues are resolved. Additional Responsibility includes validating that data collected are acceptable for reporting to the TCEQ.

Because of the small size of this study and its design, samples are not a representative of regional water bodies and therefore will not be entered into a TCEQ database, an exemption to staffing the Quality Assurance Office with different persons has been granted. The functions of Project Manager and Quality Assurance Officer are combined. QAO is responsible for

- coordinating the implementation of the QA program;
- writing and maintaining the QAPP and monitoring its implementation;
- maintaining records of QAPP distribution, including appendices and amendments;
- maintaining written records of sub-tier commitment to requirements specified in this QAPP;
- identifying, receiving, and maintaining project quality assurance records;
- coordinates and monitors deficiencies, non-conformances and corrective action;
- coordinates and maintains records of data verification and validation; C
- coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques;
- conducts monitoring systems audits on project participants to determine compliance with project and program specifications;
- issues written reports; and follows through on findings; and ensures that subcontractor field staff receives proper training and that training records are maintained.

Bruce Ridpath, H-GAC Data Manager
Responsible for ensuring that field data are properly reviewed and verified. Responsible for the transfer of basin quality-assured water-quality data to the TCEQ in a format compatible with the SWQM portion of the TRACS database, although this data will not be entered into TRACS. Maintains quality-assured data on H-GAC internet sites.

Sub-contract Laboratory (to be determined)
For Example - Environmental Institute of Houston (EIH) University of Houston Clear Lake (UHCL)

To be determined by Subcontractor
Project Manager, Field Supervisor and Quality Assurance Officer
(E.g. Dr. George Guillen, EIH)
Responsible for meeting the requirements of the contract between H-GAC and the Environmental Institute of Houston (EIH) by implementing Special Study QAPP requirements, the Regional QAPP, and QAPP amendments and appendices. Ensures project oversight is consistent with QAPP requirements and communicates project status to H-GAC Project Manager. Notifies H-GAC Project Manager/QAO of circumstances that may adversely affect quality of data derived from collection and

analysis of samples. Responsible for ensuring that proper methods and protocols are followed during sample collection and that field data are properly reviewed, verified and submitted to H-GAC in a timely manner.

To be determined by Subcontractor (e.g. Susan Moore, EIH)
Data Manager and Lab Tech / QAO for Bacteria Analysis

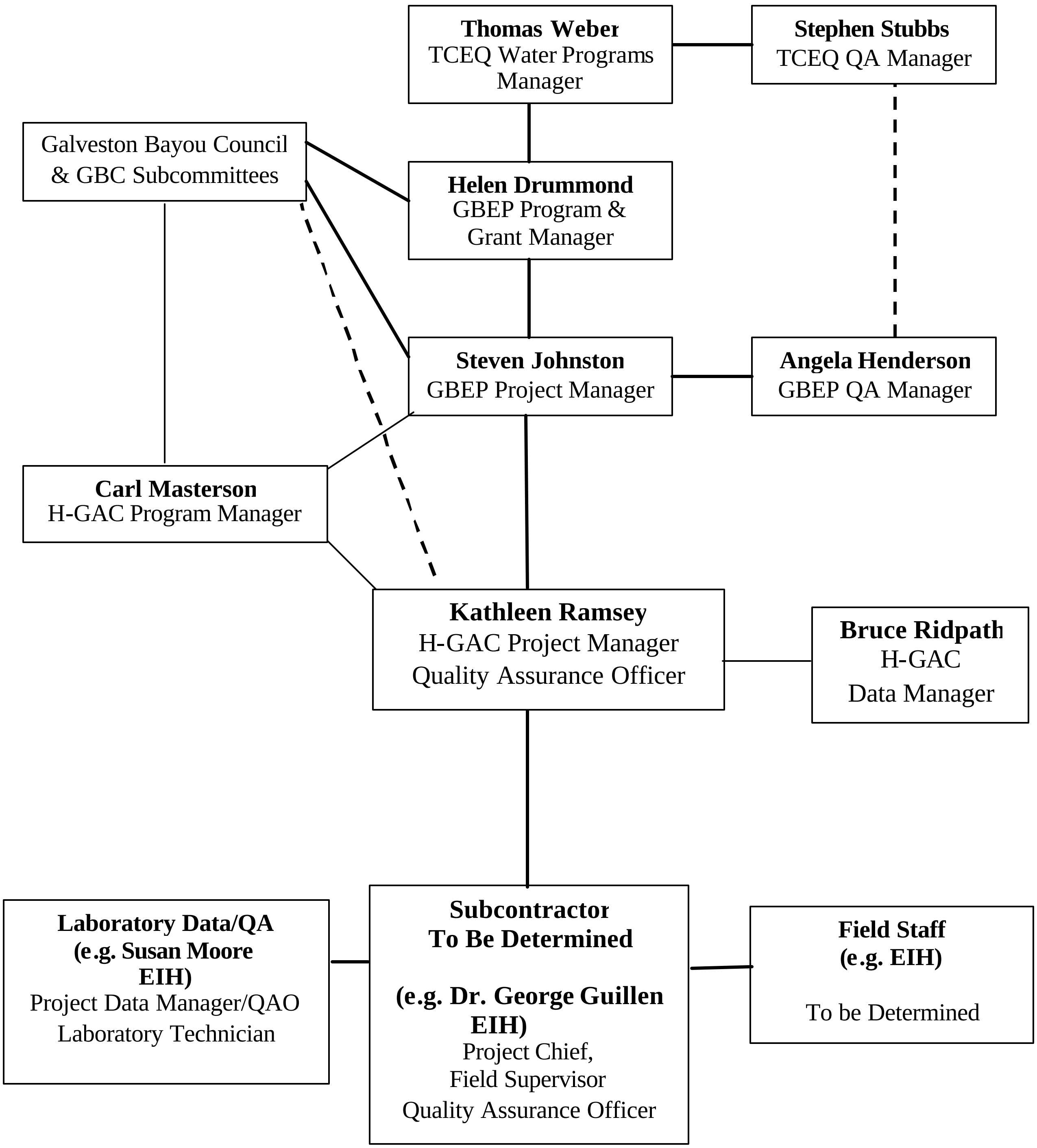
Responsible for entering data in spreadsheets, reviewing and verifying data with field operations and with contract laboratory personnel. Performs lab analysis of bacteria samples. Performs required QA/QC and ensures bacteria results are acceptable data.

To be determined by Subcontractor
Field Technician

Responsible for data collection and management activities to ensure that procedures meet project objectives, and are consistent with applicable portions of this QAPP appendix. This includes adherence to established protocol, data-accuracy criteria, documentation procedures, and entry of information into the database. Responsible for communication with laboratories to ensure compliance with project specifications.

PROJECT ORGANIZATIONAL CHART

Figure 1: A4.1. Organizational Chart – Lines of Communication



A5 PROBLEM DEFINITION

Individual On-Site Sewage Treatment Facilities (OSSFs) are prone to failure, releasing inadequately treated sewage and wastewater into surface and ground waters. Surveys estimate that as much as 17% of the stream pollution in some states is related to OSSF problems versus 13% associated with wastewater treatment plants, and 10% related to storm water pollution. Common reasons for OSSF failure include age and design of the system, soil type, small lot size, improper installation, lack of proper operation, and/or maintenance. Communities that lack access to reliable sanitary sewer services are often a collection of a limited number of residences in low income and/or minority areas.

Malfunctioning OSSFs have the potential to create human health and environmental water quality problems. Health problems may include gastrointestinal infections, infectious hepatitis, cholera, and typhoid fever. In 2001, it was estimated that 12% (17,800) of the H-GAC region's OSSFs were chronically malfunctioning. Potentially 60,000 people could be affected directly by illness plus hundreds of thousands, indirectly, through decreased water quality. In many cases owners, developers, officials, and the judiciary are unaware of the magnitude of potential adverse health and environmental effects of untreated OSSF sewage. While anecdotal estimates have been made concerning the magnitude of these problems (e.g. a survey in 1998 indicated 40 % of the OSSFs examined on the Dickinson Bayou watershed in Galveston County were probably failing), there is little hard evidence of the actual presence of water borne pathogens.

Escherichia coli (*E. coli*) has been shown to be a predictive indicator for water borne pathogens in freshwater and *Enterococcus* in tidal or salt water (e.g. Bastrop Bayou). This project will obtain sampling data from several OSSF communities and determine if *E. coli* or *Enterococcus* are present in the water pooled on site and/or in adjacent water bodies. Data will be used to perform a risk assessment to illustrate the nature of possible health effects from malfunctioning OSSFs to system owners and water bodies in target areas. If the data indicates that bacterial levels from OSSF malfunction pose a human health risk, data will be used to (1) educate elected officials and the judiciary to the magnitude of the problem, (2) encourage developers and homeowners to act responsibly in installation and maintenance of OSSF, and (3) determine if OSSFs contribute to decreased water quality along Bastrop Bayou or in Harris county Precinct 2). The Houston-Galveston Area Council (H-GAC) will work with the Galveston Bay Estuary Program (GBEP) to complete a risk assessment, which will include target local communities/stakeholders input and involvement. This process will include developing a Correction Strategy for Failing OSSFs, a targeted stakeholder resource CD, and Power Point presentations to be used as education and outreach tools (English and Spanish). The risk assessment, strategy and resources will form a foundation for addressing similar OSSF issues in 25 other target communities identified in a previous H-GAC study and supplement another H-GAC/GBEP study on the Bastrop Bayou watershed. Possible monitoring sites are identified in Figure 2: A5.1 and Figure 3: A5.2 for possible locations along Bastrop Bayou and in Harris County, Precinct 2. Additional sites are shown in Appendix H.

This Bastrop Bayou On-Site Sewage Facility Risk Assessment and Outreach project is a partnership between the Houston-Galveston Area Council (H-GAC), and the Galveston Bay Estuary Program (GBEP). Bacterial data will be collected by EIH or another subcontractor of similar capabilities, located geographically close to the sampling sites, and approved according to H-GAC and TCEQ policy.
This QAPP will be reviewed and approved by the TCEQ to ensure that data generated for the purposes described are scientifically valid and legally defensible. This review and approval process will also

Figure 2: A5.1. Bastrop Bayou Possible Sampling Locations (Dot surrounded by brown circles)

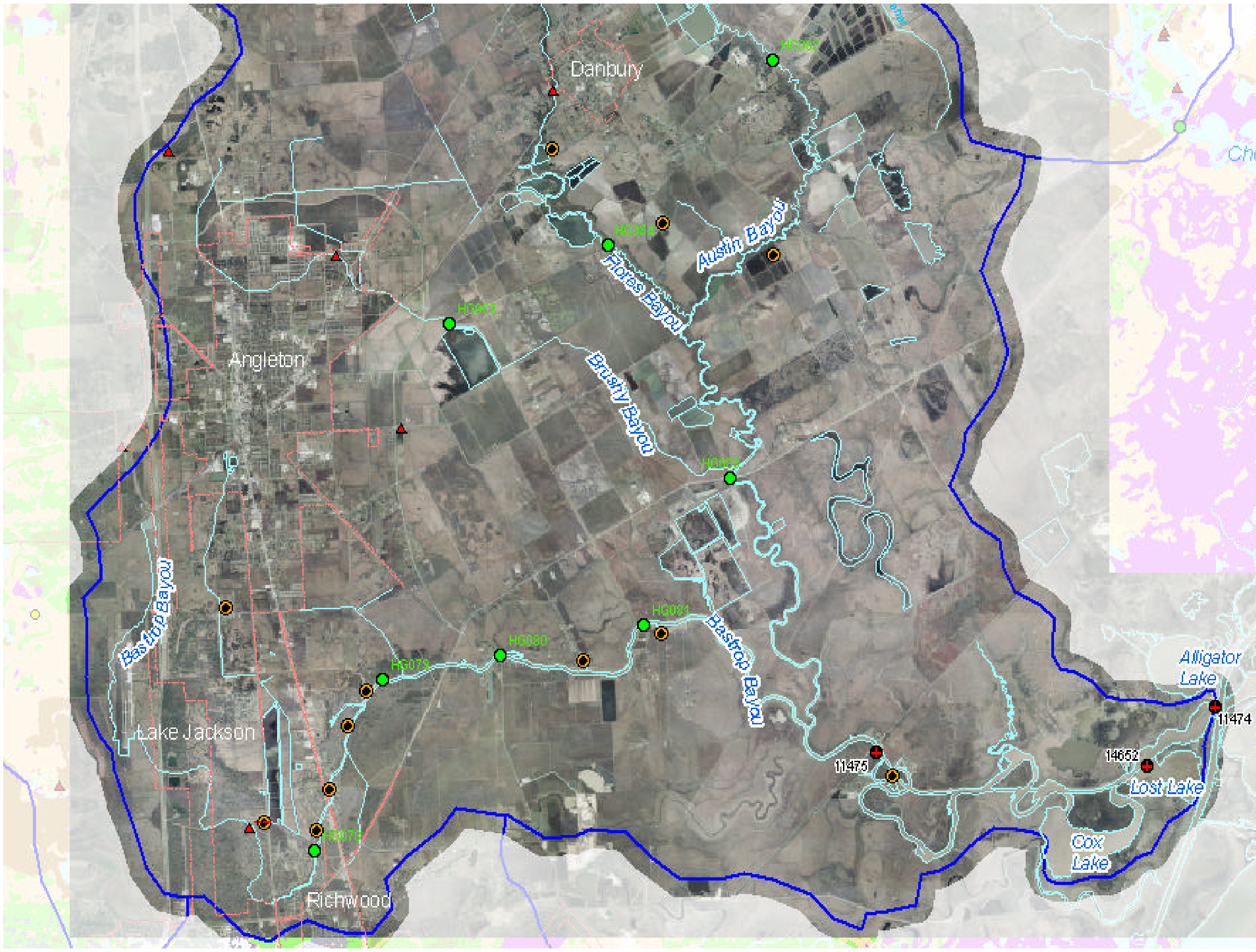
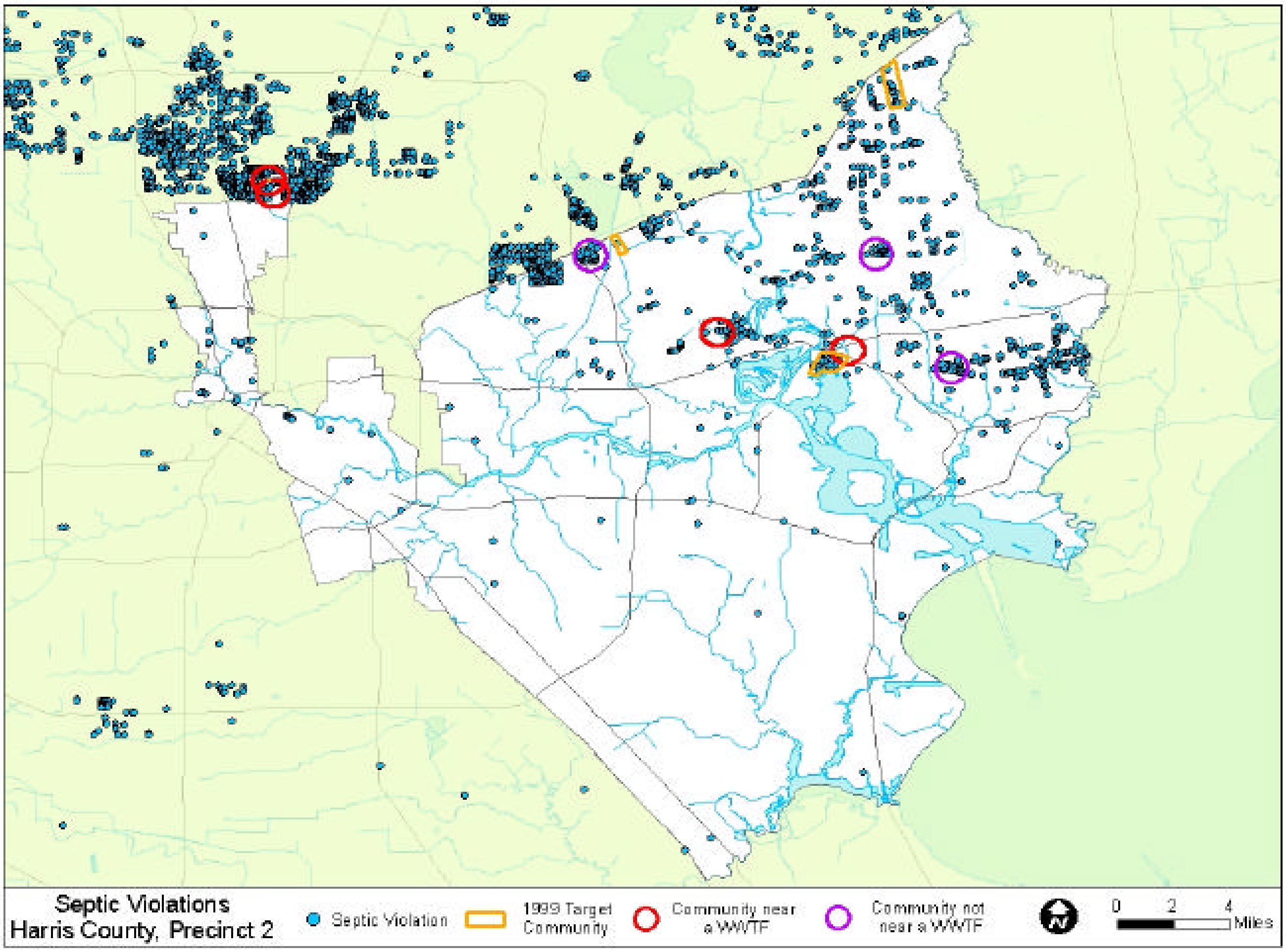


Figure 3 A5.2. Harris County Precinct 2, Septic Violations
Possible sampling locations are circled.



ensure that all project data have been collected, managed, analyzed, and handled in ways that guarantee its reliability and are consistent with existing protocol to ensure data quality compatibility. Because sample site location is neither random nor representative of all OSSFs; this data will not be entered into the state ambient water database.

A6 PROJECT/TASK DESCRIPTION

The overall goal of this project is to determine the presence (concentration) of *E. coli* and/or *Enterococcus* bacteria around/near malfunctioning OSSF facilities that are in selected locations in the GBEP region. These may include sites in violation of county standards along Bastrop Bayou or in Harris County Precinct 2. The project's goal is accomplished by sampling any visible pools of water thought to be related to the malfunction of the OSSF at the site. In addition, if the violation site is immediately adjacent to a water body (e.g. Bastrop Bayou), samples will be collected from the water body to determine whether or not bacteria might affect water quality. Samples will be collected from the water body at the outfall of the OSSF, and up stream of it.

1. Identify and locate OSSF sites adjacent to Bastrop Bayou (Brazoria County) and/or in Harris County Precinct 2 that are in violation of county standards for OSSF operation and maintenance. Bastrop Bayou sites are preferred because H-GAC is currently developing a watershed protection plan for the Bayou, funded through a grant from GBEP. Quantization of non-point source contamination from failing septic systems will aid in its development. It will also provide an additional bridge to continued support from Brazoria County stakeholders.

   Funding under this grant allows for examination of approximately 75 samples, three samples per site for 25 sites. Harris County sites are not immediately adjacent to a bayou and will not require in stream sampling. If the Bastrop Bayou location is chosen, in stream sampling will be possible. However, the total number of sampling sites will be reduced to 15 to accommodate the additional two in stream samples per site.

2. Explore potential contribution of bacterial contamination to overall water quality by collecting bacterial samples from ditches, pooled water, outfalls, and other sources of non-point runoff, which empty into water bodies contiguous to the OSSF sampling site;

3. Manage and analyze data; and

4. Present results of study in electronic data and report format, publish data in H-GAC Water Quality Management Plan (WQMP) as an appendix, make presentations to H-GAC and GBEP committees, and post on the H-GAC WQMP website.

See **Appendix A for the project-related work plan** tasks and schedule of deliverables for a description of work defined in this QAPP.

See **Appendix B for sampling design** pertaining to this QAPP.

Amendments to the QAPP

Revisions to the QAPP may be necessary to address incorrectly documented information or to reflect changes in project organization, tasks, schedules, objectives, and methods. Requests for amendments will be directed from the H-GAC Project Manager to the GBEP Project Manager electronically. They are effective immediately upon approval by the H-GAC Project Manager/QAO, the H-GAC Program Manager, the GBEP Project Manager, the GBEP Program Manager, the GBEP QAO, and the H-GAC Data Manager. They will be incorporated into the QAPP by way of attachment and distributed to personnel on the distribution list by the H-GAC Project Manager. H-GAC will secure written documentation from each sub-tier project participant (e.g., subcontractors, other units of government, laboratories) stating the organization's awareness of and commitment to requirements contained in each amendment to the QAPP. H-GAC will maintain this documentation as part of the project's quality assurance records, and ensure that this documentation will be available for review.

A7 QUALITY OBJECTIVES AND CRITERIA

The purpose of this project is to support an overall assessment of Bastrop Bayou by determining the occurrence of *E. coli* and/or *Enterococcus* bacteria associated with a malfunctioning OSSF, through the collection of data from at least fifteen sites in the Bastrop Bayou watershed and/or other sites in the GBEP region. Data derived from this project will be used to increase understanding of water quality conditions in accordance with TCEQ's *Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data.* Water quality data, and data collected by other organizations (e.g., contract laboratory, TCEQ, etc.), will be subsequently reconciled for use and assessed by the TCEQ as the need arises. Data is not intended for TRACS submission.

Systematic watershed monitoring is defined as sampling that is planned for a short duration (1 to 2 years) and is designed to screen waters that would (1) not normally be included in the routine monitoring program, (2) monitor at sites to check the water quality situation, and (3) investigate areas of potential concern with regard to possible contamination from malfunctioning OSSF. Data will be used to determine whether any locations have values above the TCEQ's water quality criteria or pose a threat to human health based on county and state threshold levels for *E. coli* and/or *Enterococcus*. When values are significantly elevated, H-GAC will use this information to determine future monitoring priorities.

The measurement performance specifications to support the project objectives for a minimum data set for bacterial analysis are specified in Table 1: A7.1 and in the text following. Alternative methods, other than those in the following table, may be used with written permission of the H-GAC and GBEP Project Managers and will be appended to this QAPP as an amendment. Procedures for laboratory analysis must be in accordance with the most recently published edition of Standard Methods for the Examination of Water and Wastewater, 40 CFR 136 and American Society for Testing and Materials (ASTM) Annual Book of Standards.

Table 1: A7.1 - Measurement Performance Specifications *

PARAMETER	UNITS	MATRIX	METHOD	STORET	AWRL	Lab Reporting Limit (RL)	RECOVERY AT RLs	PRECISION (RPD of LCS/LCS dup)	BIAS (%Rec. of LCS)	Per Cent Complete
Field Parameters										
E. coli, IDEXX Colilert	MPN/100 mL	water	SM 9223-B	31699	1		NA	.5**	NA	
Enterococcus, IDEXX Enterolert	MPN/100 mL	water	ASTM D-6503	31701	1		NA	.5**	NA	
Days since last significant rainfall	days	NA	TCEQ SOP	72053	NA*	NA	NA	NA	NA	Field
Flow severity (if no flow measured)	1-no flow, 2-low, 3-normal, 4-flood, 5-high, 6-dry	water	TCEQ SOP	01351	NA*	NA	NA	NA	NA	Field
Present Weather	1-clear 2-partly cloudy 3-cloudy 4-rain	NA	NA	89966	NA*	NA	NA	NA	NA	Field
Temperature	ºC	water	EPA 170.1 and TCEQ SOP	00010	NA*	NA	NA	NA	NA	Field
Water Clarity (if no secchi)	1-excellent 2-good 3-fair 4-poor	water	TCEQ	20424	NA*	NA	NA	NA	NA	Field
Turbidity, Observed (if not lab tested)	1-low 2-medium 3-high	water	TCEQ	88842	NA*	NA	NA	NA	NA	Field
Water Color	1-brownish 2-reddish 3-greenish 4-blackish 5-clear 6-other	water	TCEQ	89969	NA*	NA	NA	NA	NA	Field
Water Odor	1-sewage 2-chemical 3-rotten egg 4-musky 5-fishy 6-none 7-other	water	TCEQ	89971	NA*	NA	NA	NA	NA	Field
Water Surface	1-calm 2-ripples 3-waves	water	NA	89968	NA*	NA	NA	NA	NA	Field
Wind Intensity	1-calm 2-slight 3-moderate 4-strong	NA	NA	89965	NA*	NA	NA	NA	NA	Field

* Procedures for laboratory analysis must be in accordance with the most recently published edition of Standard Methods for the Examination of Water and Wastewater, 40 CFR 136, and TCEQ Surface Water Quality Monitoring Procedures, Vol. 1, September 2003, RG-415.

** Based on a range statistic as described in Standard Methods, 20th Edition, Section 9020-B, "Quality Assurance/Quality Control - Intralaboratory Quality Control Guidelines. This criterion applies to bacteriological duplicates with concentrations >10 MPN/100mL or 10 organisms/100mL.
Reporting to be consistent with SWQM guidance and based on measurement capability.

References for Table A7.1:
TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, 2003 (RG-415).
TCEQ SOP, V2 - TCEQ Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data, 2005 (RG-416)
American Society for Testing and Materials (ASTM) Annual Book of Standards, Vol. 11.02
.

Ambient Water Reporting Limits (AWRLs)

The AWRL establishes the reporting specification at or below which data for a parameter must be reported to be compared with freshwater screening criteria. The AWRLs specified in Table 1: A7.1 are the program-defined reporting specifications for each analyte and yield data acceptable for routine water quality monitoring. While the AWRL is the highest acceptable reporting limit that can be reported for a given parameter, H-GAC will consider all possible uses of the data and specify reporting limits accordingly. The reporting limit is the lowest concentration at which the laboratory will report quantitative data within a specified recovery range. The laboratory will meet two requirements in order to report meaningful results under this study:

- The laboratory's reporting limit for each analyte will be at or below the AWRL; and
- The laboratory will demonstrate and document on an ongoing basis the laboratory's ability to quantitate at its reporting limits.

Acceptance criteria are defined in Section B5.

Precision

Precision is a statistical measure of the variability of a measurement when a collection or an analysis is repeated and includes components of random error. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions.

Comparing sample/duplicate pairs of samples are used to assess the variability of sample handling, preservation, and storage, as well as the analytical process, and are prepared by splitting samples in the field.

Laboratory precision is assessed by comparing sample/duplicate pairs in the case of bacterial analysis. Precision results are plotted on quality control charts, which are based on historical data and used during evaluation of analytical performance. Program-defined measurement performance specifications for laboratory control standard/laboratory control standard duplicate pairs are defined in Table A7.1.

Bias

Bias is a statistical measurement of correctness and includes multiple components of systematic error. A measurement is considered unbiased when the value reported does not differ from the true value. Bias is verified through the analysis of laboratory control standards prepared with certified reference materials and by calculating percent recovery. Results are plotted on quality control charts, which are calculated, based on historical data and used during evaluation of analytical performance. Program-defined measurement performance specifications for laboratory control standards are specified in Table A7.1.

Representativeness

Study design precludes samples meeting total representation of the water body. Site selection is biased towards locations where the county has identified OSSF violation. Sites are selected where there is an increased potential for finding the presence of bacteria, therefore data are neither randomly selected nor representative of OSSFs in the region. The sampling of all pertinent media will be performed where appropriate according to TCEQ and/or subcontractor SOPs. Use of only approved analytical methods will assure that the measurement data represents the conditions at the site. Routine data collected under the H-GAC Clean Rivers Program for water quality assessments is considered spatially and temporally representative of routine water quality conditions. However, this data collection is not routine and representative only of sites with violations in OSSF ordinances. Data may be collected during varying regimes of weather and flow, though attempts will be made to obtain samples under similar physical conditions. Only a very limited number of samples will be collected and evaluated. Therefore, complete representativeness for the OSSFs in the water body cannot be achieved. Therefore, this data is not suitable for inclusion in TRACS.

Comparability

Confidence in the comparability of data sets for this project and for water quality assessments is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP and in TCEQ and laboratory SOPs. Comparability is also guaranteed by reporting data in standard units, by using accepted rules for rounding figures, and by reporting data in a standard format as specified in Section B10, page 32.

Completeness

The completeness of the data is a relationship of how much of the data is available for use compared to the total potential data. Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, insufficient sample volume, broken or lost samples, etc. is to be expected. Therefore, it will be a general goal of the project that 90% data completion is achieved.

A8 SPECIAL TRAINING/CERTIFICATION

There are no special requirements for staff training or certifications for this project. New field personnel must receive training in proper sampling and field analysis from the subcontractor. Before actual sampling or field analysis occurs, they will demonstrate to the H-GAC QA Officer (or designee) their ability to calibrate field equipment, if necessary, and perform field sampling and analysis procedures. Field personnel training is documented and retained in their personnel file at the subcontractor and will be available during a monitoring systems audit. A copy of staff training records will be provided to H-GAC by the subcontractor.

Laboratory analysts have a general knowledge of laboratory operations, test methods, and quality assurance. They also have a combination of education, experience, skill, and training to perform their specific function. Laboratory management maintains records of qualifications and training on each employee. The H-GAC QA officer will visit the laboratory, examine SOPs and related laboratory management criteria prior to the initiation of the study.

A9 DOCUMENTS AND RECORDS

The documents and records that describe, specify, report, or certify activities are listed in Table 2:A9.1. The list below is limited to documents and records that may be requested for review during a monitoring systems audit. Other types of project documents and records as appropriate are listed in Table A9.2 and are to be used for internal H-GAC purposes only. Retention time refers to after commencing after the close of the project. H-GAC reserves the right to retain documents longer than the TCEQ minimum.

Table 2: A9.1. Project Documents and Records – For Review During Audits

Document/Record for Review	Location	Retention (yrs)	Format
QAPPs, amendments and appendices	H-GAC	5 years	Electronic/paper
Field SOPs	H-GAC	5 years	Paper
Laboratory QA Manuals	H-GAC/Laboratory(ies)*	5 years	Paper
Laboratory SOPs	H-GAC/Laboratory(ies)*	5 years	Paper
QAPP distribution documentation	H-GAC	2 years	Electronic/paper
Field staff training records	H-GAC/Laboratory	2 years	Paper
Field equipment calibration/maintenance logs	H-GAC	2 years	Paper
Field instrument printouts	H-GAC	2 years	Paper
Field notebooks or data sheets	H-GAC/Laboratory	5 years	Paper
Chain of custody records	H-GAC	5 years	Paper
Laboratory calibration records	Laboratory*	2 years	Electronic/Paper
Laboratory instrument readings/ printouts	Laboratory*	5 years	Paper
Laboratory data reports/results	H-GAC/Laboratory*	5 years	Electronic/Paper
Laboratory equipment maintenance logs	Laboratory*	2 years	Paper
Corrective action documentation	H-GAC/Laboratory*	5 years	Electronic/Paper

* Laboratory to be determined.

Table 3: A9.2 Project Documents and Records – Copies Retained for H-GAC Purposes

Document/Records Not for Review	Location	Retention (yrs)	Format
Bacteriological field samples logs	H-GAC	5 years	Paper
Media/incubation logs	H-GAC	5 years	Paper
Instrument raw data files	H-GAC	5 years	Paper/electronic
Laboratory initial demonstration of capability	H-GAC	5 years	Paper
Laboratory Instrument Performance	H-GAC	5 years	Paper
Laboratory sample reception logs	H-GAC	2 years	Electronic/paper
Laboratory Internal/external standards	H-GAC	2 years	Paper
Laboratory procedures	H-GAC/Laboratory(ies)*	> 7 years	Paper
Laboratory data verification for integrity, precision,, accuracy, and verification	H-GAC/Laboratory(ies)*	2 years	Paper
Quality control verification /validation	H-GAC	2 years	Paper
Progress reports/final reports/data	H-GAC	2 years	Paper
Written Communications and phone logs between Project Manager and Laboratory	H-GAC	2 years	Paper
Written Communications/phone logs between H-GAC and GBEP Project Managers	H-GAC	2 years	Paper
PowerPoint Presentations	H-GAC	2 years	Paper

Laboratory Test Reports

The laboratory will document the test results clearly and accurately in the form of a test report. The test report will include the information necessary for the interpretation and validation of data, including the following:

- title of report and unique identifiers on each page;
- name and address of the laboratory;
- name and address of the client;
- a clear identification of the sample(s) analyzed;
- date and time of sample receipt;
- identification of method used;
- identification of samples that did not meet QA requirements and why (e.g., holding times exceeded);
- sample results;
- clearly identified subcontract laboratory results (as applicable);
- a name and title of person accepting responsibility for the report;
- project-specific quality control results to include sample/duplicate pairs, field split results (as applicable); equipment, trip, and field blank results (as applicable); and RL confirmation (% recovery);

- narrative information on QC failures or deviations from requirements that may affect the quality of results or is necessary for verification and validation of data; and
- any other information deemed appropriate by the laboratory.

Electronic Data

Data will be submitted electronically to the H-GAC Project Manager as an MS Excel file and in the Event/Result file format described in the TCEQ SWQM Data Management Reference Guide as adapted for this study.

B1 SAMPLING PROCESS DESIGN

See **Appendix B for sampling process design** information and monitoring tables associated with data collected under this QAPP.

B2 SAMPLING METHODS

Field Sampling Procedures

Field sampling will be conducted according to procedures documented in the *TCEQ Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, 2003 (RG-415)*. Additional aspects outlined in Section B below reflect specific requirements for sampling under this Program and/or provide additional clarification. Laboratory SOPs apply as well. A copy of Field SOPs will be provided to the H-GAC Project Manager by the subcontractor.

Water samples will be collected according to Laboratory SOPS, e.g. manually in liter bottles for in stream sample collection, or smaller bottles for on-site collection. An acceptable alternative used by some subcontractors (e.g. EIH) uses disposable, sterile, 60 and 120 ml plastic bottles for bacteriological samples. Alternately, Whirl-pak bags may be used for bacteriological samples and may have 1% sodium thiosulfate tablets added.

Sample volume, container types, minimum sample volume, preservation requirements, and holding time requirements. The Subcontractor/Laboratory has the specific information for each analytical test provided in Table 4: B2.1. Preservation of all samples is performed immediately upon collection (within 15 minutes).

Table 4: B2.1 Sample Storage, Preservation and Handling Requirements

Parameter	Matrix	Container	Preservation	Sample Volume	Holding Time
Escherichia coli *IDEXX*	water	Sterile Plastic	Cool to 4°C; 0.008 % $Na_2S_2O_3$	100 mL or maximum amount possible	6 hours
Enterococcus IDEXX	water	Sterile Plastic	Cool to 4°C; 0.008 % $Na_2S_2O_3$	100 mL or maximum amount possible	6 hours

Processes to Prevent Contamination

Procedures outlined in the *TCEQ Surface Water Quality Monitoring Procedures* outline the necessary steps to prevent contamination of samples. These include: direct collection into sample containers, when possible. Field QC samples (identified in Section B5) are collected to verify that contamination has not occurred.

Water Quality Sampling Procedures

Sampling will be conducted using procedures consistent with those described in Section B2 and with the TCEQ SWQM Procedures Manual (2003). All water samples from the bayou will be collected as a “grab sample” from the water body bank, at a depth of one foot, if possible. Total stream depth at the sampling location, as well as depth from which the sample is collected, will be documented on the field form. Appropriate QA/QC samples will be collected, in particular, field splits will comprise a minimum of 10% of the samples. All samples will be immediately preserved and chilled upon collection, and maintained at the appropriate temperature until submitted to the respective laboratories for analysis.

Table 5: B2.2. Sample handling references for regional monitoring entities.

Monitoring Entity	Reference to Sample Handling
Subcontractor to be determined (e.g. Environmental Institute of Houston)	Subcontractor Standard Operating Procedure (SOP) (e.g. Environmental Institute of Houston has a Standard Operating Procedure (SOP) for Bacteria Samples and a Sample Handling SOP, August 2004).

Documentation of Field Sampling Activities

Field sampling activities are documented on field data sheets, which will be provided by the subcontractor and approved by the H-GAC Project Manger. Work sheets may include but are not limited to flow worksheets, and field biological assessment forms and are part of the field data record. As soon as the subcontractor is identified, the field data sheets will be amended to this QAPP. An example is provided in Appendix C.

The following will be recorded for all visits:

1. Station location;
2. Sampling date;
3. Location;
4. Sampling depth;
5. Sampling time;
6. Sample collector's name/signature;
7. Values for all field parameters;
8. Detailed observational data, including:
    - water appearance;
    - weather;
    - biological activity;
    - unusual odors;
    - pertinent observations related to water quality or stream uses (e.g., exceptionally poor water quality conditions/standards not met; stream uses such as swimming, boating, fishing, irrigation pumps, etc.);
    - watershed or in stream activities (events affecting water quality, e.g., bridge construction, livestock watering upstream, etc.);
    - specific sample information ; and
    - missing parameters (i.e., when a scheduled parameter or group of parameters is not collected);
9. Sample bottle/container type and preservative, if applicable; and
10. Description of location from which the sample was taken. Since each sampling location will be unique in configuration, description with schematic should include

- Whether site is on land or in the water body;
- Proximity to OSSF system attachment to residence;
- Photograph;
- Schematic diagram of sampling location(s) with descriptive text;
- Proximity of site to physical structures (e.g. house, trailer, and garage);
- Proximity of site to bayou or water body;
- Names and identifiers of persons witnessing the sampling (e.g. inspector, H-GAC staff); and
- Any other information deemed appropriate at the time of sample collection.

Recording Data

For the purposes of this section and subsequent sections, all field and laboratory personnel follow these basic rules for recording information:

1. Legible writing in indelible ink with no modifications, write-overs or cross-outs;
2. Correction of errors with a single line followed by an initial and date; and
3. Close-outs on incomplete pages with an initialed and dated diagonal line.

All sample bottles will be clearly identified with the site identification, date and time of collection, the sample type/schedule, sampler name, sample identification number, and the preservative used, if applicable

Deficiencies, Non-conformances and Corrective Action Related to Sampling Requirements

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP or other applicable documents. Non-conformances are deficiencies, which affect data quantity and/or quality and render the data unacceptable or indeterminate. Deficiencies related to sampling methods requirements include, but are not limited to, such things as sample container, volume, and preservation variations, improper/inadequate storage temperature, holding-time exceedances, and sample site adjustments.

Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff and reported to the cognizant field or laboratory supervisor who will notify the H-GAC Project Manager. H-GAC's Project Manager will notify the H-GAC QAO of the potential nonconformance. The H-GAC's QAO will initiate a Nonconformance Report (NCR) to document the deficiency.

The H-GAC Project Manager, in consultation with the H-GAC QAO (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined, the activity or item in question does not affect data quality and therefore, is not a valid nonconformance, the NCR will be completed accordingly and the NCR closed. If it is determined a nonconformance does exist, the H-GAC Project Manager in consultation with H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by the contractor QAO by completion of a Corrective Action Report.

Corrective Action Reports (CARs) document: root cause(s); impact(s); specific corrective action(s) to address the deficiency; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and the means by which completion of each corrective action will be documented. CARs will be included with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TCEQ immediately both verbally and in writing.

B3 SAMPLING HANDLING AND CUSTODY

Chain-of-Custody

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis.

A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The Chain-of-Custody (COC) form is used to document sample handling during transfer from the field to the laboratory. The following information concerning the sample is recorded on the COC form (See Appendix D). The following list of items matches the COC form in Appendix D.

1. Date and time of collection;
2. Site identification;
3. Sample matrix;
4. Number of containers;
5. Preservative used or if the sample was filtered;
6. Analyses required – Lab Schedule or Lab Code;
7. Name of collector;
8. Custody transfer signatures and dates and time of transfer;
9. Bill of lading (*if applicable*); and
10. Name of Laboratory Admitting the Sample.

Sample Labeling

Waterproof sample labels that are adhesive backed and capable of being attached directly to the sample container will be used. Alternately, sample bottles, which will accept permanent label information written directly on the bottle may be used. In either case, samples are labeled on the container with an indelible marker or pen. Label information includes as a minimum:

1. Site identification;
2. Date and time of sampling;
3. Preservative added, if applicable;
4. Designations (specific);
5. Sample type (i.e., analysis(es) to be performed);
6. Sampler name (collector); and

7. Where multiple samples are collected at the same site, the precise location at which the sample was collected will be identified by unique number. This number will be recorded on a schematic diagram on the field data sheet. Numbering will be sequentially, beginning with the sample collected closest to the residence at the OSSF location.

Other information may be entered on the sample label if space permits. However, any other information entered on the label must not interfere with the clarity of the required information.

Sample Handling

Upon collection, all local partners immediately immerse their samples in coolers containing ice. If a temperature blank is carried (it is not required), it shall be placed on top of the samples instead of buried in the ice. When the samples arrive at the lab, a lab personnel taking custody of samples will verify the samples are "in the process" of cooling to 4 °C before signing the COC. Internal sample handling, custody, and storage procedures for each of the subcontractors/laboratories supporting H-GAC's monitoring entities are described in the Quality Assurance Manuals (QMS) and Standard Operating Procedures (SOP) for the laboratory. The laboratory will provide a copy of its QMS to the H-GAC Project Manager and it will be kept on file with H–GAC. For example, the reference for EIH is "Standard Operating Procedure (SOP) for Bacteria Samples and a Sample Handling SOP, August 2004."

Deficiencies, Non-conformances and Corrective Action Related to Chain-of-Custody

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP or other applicable documents. Non-conformances are deficiencies, which affect data quantity and/or quality and render the data unacceptable or indeterminate. Deficiencies related to chain-of-custody include but are not limited to delays in transfer, resulting in holding time violations; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc.

Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff and reported to the cognizant field or laboratory supervisor who will notify the H-GAC Project Manager. The H-GAC Project Manager will notify the H-GAC QAO of the potential nonconformance. The H-GAC QAO will initiate a Nonconformance Report (NCR) to document the deficiency.

The H-GAC Project Manager, in consultation with the H-GAC QAO (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined, the activity or item in question does not affect data quality and therefore, is not a valid nonconformance, the NCR will be completed accordingly and the NCR closed. If it is determined a nonconformance does exist, the H-GAC Project Manager in consultation with the H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by the H-GAC QAO by completion of a Corrective Action Report.

Corrective Action Reports (CARs) document: root cause(s); impact(s); specific corrective action(s) to address the deficiency; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and the means by which completion of each corrective action will be documented. CARs will be included with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the GBEP immediately both verbally and in writing.

B4 ANALYTICAL METHODS

The analytical methods are listed in Table 1: A7.1. The analyses cited in the table are EPA approved methods as cited in TCEQ SWQM Procedures Vol. 1 and in 40 Code of Federal Regulations, Section 136, Part B. Copies of laboratory SOPs are retained by H-GAC and are available for review by the GBEP or TCEQ. Laboratory SOPs are consistent with EPA requirements as specified in the method. At a minimum, laboratories producing data under this QAPP are compliant with ISO/IEC Guide 25. It is the responsibility of the Laboratory Project Manager and QAO to confirm the completeness, adequacy, and consistency of participants' and subcontractors' SOPs falling under this QAPP.

Standards Traceability

All standards used in the field and laboratory are traceable to certified reference materials. Standards preparation is fully documented and maintained in a "standards log book." Each documentation includes information concerning the standard identification, starting materials, including concentration; amount used and lot number, date prepared, expiration date and preparer's initials/signature. The reagent bottle is labeled in a way that will trace the reagent back to preparation.

Analytical Method Modification

Only data generated using approved analytical methodologies as specified in this QAPP will be submitted to the GBEP/TCEQ. Requests for method modifications will be documented on form TCEQ-10364, the TCEQ Application for Analytical Method Modification, and submitted for approval to the TCEQ Quality Assurance Section. Work will begin only after the modified procedures have been approved.

Deficiencies, Nonconformances and Corrective Action Related to Analytical Methods

Deficiencies are documented in logbooks, on field data sheets, etc. by field or laboratory staff and reported to the cognizant field or laboratory supervisor or local project manager who will notify the H-GAC Project Manager or QAO. The H-GAC Project Manager will notify the H-GAC QAO of the potential nonconformance if need be so the H-GAC QAO can initiate a Nonconformance Report (NCR) to document the deficiency. Deficiencies and NCR's may be initiated by either a local partner or the H-GAC QAO depending on who found the deficiency and which direction the line of communication went.

The H-GAC Project Manager, in consultation with H-GAC QAO (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined, the activity or item in question does not affect data quality and therefore, is not a valid nonconformance, the NCR will be completed accordingly and the NCR closed. If it is determined a nonconformance does exist, the H-GAC Project Manager in consultation with the H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by the H-GAC QAO by completion of a Corrective Action Report.

Corrective Action Reports (CARs) document: root cause(s); impact(s); specific corrective action(s) to address the deficiency; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and, the means by which completion of each corrective action will be documented. CARs will be included with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TCEQ immediately both verbally and in writing.

B5 QUALITY CONTROL

Sampling Quality Control Requirements and Acceptability Criteria

The minimum field quality control (QC) requirements are outlined in the *TCEQ Surface Water Quality Monitoring Procedures Manual.* Field QC samples are submitted as separate samples to the laboratory and reported accordingly on the data reports. Specific requirements are outlined below. Field QC Samples are reported with the data report. See Section C2.

Additional method specific QC requirements -- Additional QC samples are run (e.g., surrogates, internal standards, continuing calibration samples, interference check samples) as specified in the methods. The requirements for these samples, their acceptance criteria, and corrective actions are method-specific. Acceptable criteria for field splits will be 30% RPD. Bacteriological duplicates will be employed at a 10% frequency

Field Split - A field split is a single sample subdivided by field staff immediately following collection and submitted to the laboratory as two separately identified samples according to procedures specified in the *SWQM Procedures*. Split samples are preserved, handled, shipped, and analyzed identically and are used to assess variability in all of these processes. Field splits apply to conventional samples only and are collected on a 10% basis or one per batch, whichever is greater. The precision of field split results is calculated by relative percent difference (RPD) using the following equation:

$$RPD = (X1-X2)/((X1+X2)/2))$$

A 30% RPD criteria will be used to screen field split results as a possible indicator of excessive variability in the sample handling and analytical system. If it is determined that elevated quantities of analyte (i.e., > 5 times the RL) were measured and analytical variability can be eliminated as a factor, than variability in field split results will primarily be used as a trigger for discussion with field staff to ensure samples are being handled in the field correctly. Some individual sample results may be invalidated based on the examination of extenuating information. The information derived from field splits is generally considered to be event specific and would not normally be used to determine the validity of an entire batch; however, some batches of samples may be invalidated depending on the situation. Professional judgment during data validation will be relied upon to interpret the results and take appropriate action. The qualification (i.e., invalidation) of data will be documented on the Data Summary. Deficiencies will be addressed as specified in this section under Deficiencies, Nonconformances, and Correction Action related to Quality Control.

Laboratory Duplicates - A laboratory duplicate is prepared in the laboratory by splitting aliquots of an LCS. Both samples are carried through the entire preparation and analytical process. LCS duplicates are used to assess precision and are performed at a rate of one per batch. A batch is defined as a set of environmental samples that are prepared and/or analyzed together within the same process using the same lot of reagents.

For most parameters, precision is calculated by the relative percent difference (RPD) of LCS duplicate results as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, X_1 and X_2, the RPD is calculated from the following equation:

$$RPD = (X_1 - X_2)/\{(X_1+X_2)/2\} * 100$$

A bacteriological duplicate is considered to be a special type of laboratory duplicate and applies when bacteriological samples are run in the field as well as in the lab. Bacteriological duplicate analyses are performed on samples from the sample bottle on a 10% basis. Results of bacteriological duplicates are evaluated by calculating the logarithm of each result and determining the range of each pair.

Performance limits and control charts are used to determine the acceptability of duplicate analyses. The specifications for bacteriological duplicates in Table A7.1 apply to samples with concentrations > 10 org./100mL.

Deficiencies, Nonconformance and Corrective Action Related to Quality Control

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP. Nonconformances are deficiencies, which affect data quantity and/or quality and render the data unacceptable or indeterminate. Deficiencies related to quality control include but are not limited to field and laboratory quality control sample failures.

Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff and reported to the cognizant field or laboratory supervisor or local project manager who will notify the H-GAC Project Manager or QAO. The H-GAC Project Manager will notify the H-GAC QAO of the potential nonconformance if need be so the H-GAC QAO can initiate a Nonconformance Report (NCR) to document the deficiency. Deficiencies and NCR's may be initiated by either a local partner or the H-GAC QAO depending on who found the deficiency and which direction the line of communication went.

The H-GAC Project Manager, in consultation with H-GAC QAO (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined, the activity or item in question does not affect data quality and therefore, is not a valid nonconformance, the NCR will be completed accordingly and the NCR closed. If it is determined a nonconformance does exist, the H-GAC Project Manager in consultation with the H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by the H-GAC QAO by completion of a Corrective Action Report.

Corrective Action Reports (CARs) document: root cause(s); impact(s); specific corrective action(s) to address the deficiency; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and, the means by which completion of each corrective action will be documented. CARs will be included with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TCEQ immediately both verbally and in writing.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

All sampling equipment testing and maintenance requirements are detailed in the *TCEQ Surface Water Quality Monitoring Procedures Manual*. Sampling equipment is inspected and tested upon receipt and is assured appropriate for use. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within laboratory Quality Assurance Manuals (QAM). Testing and maintenance records are maintained and are available for inspection by the TCEQ. Instruments requiring daily or in-use testing include, but are not limited to, water baths, ovens, autoclaves, incubators, refrigerators, and laboratory-pure water. Critical spare parts for essential equipment are maintained to prevent downtime. Maintenance records are available for inspection by the TCEQ. The Laboratory University Project Manager/QAO assumes responsibility for compliance of the QAM Quality Assurance Management Plan from the laboratory with the QAPP requirements.

B7 INSTRUMENT CALIBRATION AND FREQUENCY

No field equipment in this study requires calibration.

Detailed laboratory calibrations are contained within the QAM(s). The laboratory QAM identifies all tools, gauges, instruments, and other sampling, measuring, and test equipment used for data collection activities affecting quality that must be controlled and, at specified periods, calibrated to maintain bias within specified limits. Calibration records are maintained and are available for inspection by the TCEQ. Equipment requiring periodic calibrations include, but are not limited to, thermometers, pH meters, balances, incubators, turbidity meters, and analytical instruments. Calibration records are available to the TCEQ for review. The Laboratory Project Manager/QAO and the Laboratory Managers assume responsibility for compliance of the QAM Quality Assurance Management Plan from the laboratory with the QAPP.

B8 INSPECTION/ACCEPTANCE REQUIREMENT FOR SUPPLIES AND CONSUMABLES

All field supplies and consumables will be inspected and accepted for use in this project by the field staff. Acceptance criteria for such supplies and consumable, in order to satisfy the technical and quality objectives of this project, are documented in the individual laboratories' QMs.

All laboratory related items will be inspected and accepted for use in this project by the laboratories. Each new batch of supplies is tested before use to verify that they function properly and are not contaminated. Acceptance criteria for such supplies and consumables, in order to satisfy the technical and quality objectives of this project, are documented in the individual laboratories QAMS.

B9 NON-DIRECT MEASUREMENTS

No data will be acquired from sources not described in this QAPP.

B10 DATA MANAGEMENT

Data Management Process

Data Management Protocols are addressed in the Data Management Plan, which is in Appendix E of this document. The data management process is outlined in a flow chart found in Appendix E.1 H-GAC's Data Manager receives hard copy and electronic data from the Laboratory. The data are reviewed for accuracy and completeness then eventually submitted to TCEQ as an appendix to the final report.

Data Errors and Loss

All field forms used as part of this study are located in Appendix C.

A Data Submittal Form (F.1) and Review Check List (Appendix F.2) is completed and submitted by the laboratory when data is sent to the H-GAC Data Manager. The form includes a list of the number of sample events included and the number of results that should accompany the data submittal. Additionally, copies of field sheets, Chain-of-Custody forms and Lab Data reports or QC back up are received with each electronic submittal. Some reviews are performed manually by the H-GAC Data Manager through sorting processes in Microsoft (MS) Excel, others are completed using scripts written in MS Access. Electronic copies are made of all data sets. Only the copies are manipulated, not original data sets. There is plenty of space for notes of other data management activities on each set of data review sheets.

Record Keeping and Data Storage

The laboratory submits electronic data along with hard copies of field sheets and COC forms. In addition, the laboratory is required to submit a Data Review Checklist to H-GAC. Electronic data is stored in folders on the H-GAC network as "originals" and as copies for data management, verification, and validation. Daily and weekly backups are completed on H-GAC's server. Hard copies are filed in filing cabinets for use as needed. All data is maintained according to the schedule in Section A9 of this QAPP.

Data Handling, Hardware, and Software Requirements

H-GAC maintains several networked computers to store and manage ambient monitoring data. All PC's are equipped with at least MS Windows 2000 and MS Office 2000, which includes MS Excel 2000 and MS Access 2000.

Information Resource Management Requirements

Data will be managed in accordance with the TCEQ Surface Water Quality Monitoring Data Management Reference Guide and applicable H-GAC information resource management policies. The grantee does not create TCEQ certified locational data using Global Positions System (GPS) equipment. GPS equipment may be used as a component of acquiring the information required by the Station Location (SLOC) request process however, TCEQ staff are responsible for creating the certified locational data that may ultimately be entered into the TCEQ's Surface Water Quality Monitoring database.

H-GAC includes an Information Resource Management Department responsible for maintaining all computer hardware and software, including but not limited to servers, network accounts, data back-ups, security, firewalls, etc. Daily management is conducted along with regular maintenance and upgrades to the system.

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following table (Table 6: C1.1) represents the types of assessments and response action for data collection activities applicable to this QAPP appendix.

Corrective Action

A field audit will be conducted during the effective period of this QAPP – weather permitting. In the event timing becomes an issue, a desktop audit will be conducted instead. Findings from the audit will be documented on a checklist, summarized in an audit report and sent to the sub-contractor for review and determination of a corrective action response. The sub-contractor will have 30-days to determine how findings will be addressed and respond to H-GAC regarding changes and a timetable for implementation. The H-GAC QAO is responsible for implementing and tracking corrective action procedures as a result of audit findings. Records of audit findings and corrective actions are maintained by both the sub-contractor and the H-GAC QAO. Corrective action documentation will be submitted to GBEP with the Progress Reports.

Table 6: C1.1. Assessment and Response Requirements

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	H-GAC	Monitoring of the project status and records to ensure requirements are being fulfilled. Monitoring and review of contract laboratory performance and data quality	Sub-contractor project manager reports to H-GAC in Quarterly Report and ensures project requirements are being fulfilled. H-GAC project manager reports to GBEP in Quarterly Report.
Laboratory/Sub-Contractor Inspections	Beginning of Study	H-GAC QAO	Requirements appearing in lab SOPs and Quality Assurance Manual. NELAC certification requirements may be applied but certification is not required.	Laboratory QAO implements corrective action and sends report to H-GAC QAO as requested.
Monitoring Systems Audit of H-GAC	Dates to be determined by GBEP	GBEP	Field sampling, handling and measurements; facility review; and data management as they relate to Failing Septic System Initiative (FSSI)	30 days to respond in writing to GBEP to address corrective actions
Laboratory Inspections	Dates to be determined by TCEQ	TCEQ Laboratory Inspector	Requirements appearing in lab SOPs and QAPP, ISO/IEC Standard 17025, applicable EPA methods and Standard Methods, 40 CFR 136, and other documents applicable to FSSI program including portions of the Texas Administrative Code and the Code of Federal Regulations.	30 days to respond in writing to the H-GAC. H-GAC will then report problems/results to TCEQ in Progress Report.
Monitoring Systems Audit of Sub-contractors	Dates to be determined by H-GAC	H-GAC	Field sampling, handling and measurement; facility review; and data management as they relate to malfunctioning OSSF Risk Assessment	30 days to respond in writing to H-GAC to address corrective actions. Sub-contractor laboratory sends report to H-GAC QAO and resolves any deficiencies as needed.

C2 REPORTS TO MANAGEMENT

Reports to H-GAC Project Management

The H-GAC is required to report the status of implementation of the procedures discussed in this project plan and, thereby, the status of data quality. In addition, a written progress report will be provided to H-GAC by the sub-contractor that summarizes project accomplishments and/or problems on a quarterly basis in the form of a written report.

After evaluation of the information collected and review of data submitted, the H-GAC QAO and Data Manager will either investigate suspected problems with the data or complete information for the Data Summary Sheet that accompanies the quarterly report data submittal to GBEP. It is essential that the sub-contractor QAO is informed either informally (phone call), by fax or by e-mail memoranda of any quality assurance problems encountered and the solutions adopted. This information will be transmitted by the H-GAC's Program Manager and the H-GAC Data Manager when data is submitted in quarterly reports.

This information will be reported to the GBEP Project Manager and GBEP Quality Assurance Specialist as required under this contract. The results of field and laboratory monitoring system audits will be detailed in reports to the local program managers and/or the person who directly supervises field activities. This information will also be reported to the GBEP by means of status reports to be included in the quarterly progress reports. Responses from local agencies regarding the audit reports and findings will also be included in the quarterly progress reports to GBEP.

Reports to GBEP/TCEQ Project Management

All reports detailed in this section are contract deliverables and are transferred to the GBEP in accordance with contract requirements.

Quarterly Progress Report - Summarizes the H-GAC's activities for each task; reports monitoring status, problems, delays, and corrective actions; and outlines the status of each task's deliverables.

Monitoring Systems Audit Report and Response - Following any audit performed by H-GAC, a report of findings, recommendations and response is sent to the TCEQ in the quarterly progress report.

Reports by GBEP/TCEQ Project Management

Contractor Evaluation - The H-GAC participates in a Contractor Evaluation by the TCEQ annually for compliance with administrative and programmatic standards. Results of the evaluation are submitted to the TCEQ Financial Administration Division, Procurement and Contracts Section.

D1 DATA REVIEW, VERIFICATION, AND VALIDATION

All field and laboratory data will be reviewed and verified for integrity and continuity, reasonableness, and conformance to project requirements, and then validated against the data quality objectives, which are listed in Section A7. Only those data, which are supported by appropriate quality control data and meet the data quality objectives defined for this project will be considered acceptable and will be reported to GBEP.

The procedures for verification and validation of data are described in Section D2 below. The Field Data manager and the H-GAC Data Manager are responsible for ensuring that field data are properly reviewed, verified, and submitted in the required format to the project database. The Laboratory Manager is responsible for ensuring that laboratory data are reviewed, verified, and submitted in the required format to the H-GAC project database. Finally, the H-GAC QAO is responsible for confirming the validation of all collected data and ensuring that all reported data meet the data quality objectives of the project and are suitable for reporting to TCEQ.

D2 VERIFICATION AND VALIDATION METHODS

All field and laboratory data will be reviewed, verified and validated to ensure they conform to project specifications and meet the conditions of end use as described in Section A7, page 17 of this document.

Data review, verification, and validation will be performed using self-assessments and peer and management review as appropriate to the project task. The data review tasks to be performed by field and laboratory staff are listed in the first two sections of Table D2.1, respectively. Potential errors are identified by examination of documentation and by manual *(or computer-assisted)* examination of corollary or unreasonable data. If a question arises or an error is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues, which can be corrected, are corrected and documented. If an issue cannot be corrected, the task manager consults with higher-level project management to establish the appropriate course of action, or the data associated with the issue are rejected. Field and laboratory reviews, verifications, and validations are documented.

After the field and laboratory data are reviewed, another level of review is performed once the data are combined into a data set. This review step as specified in Table D2.1 is performed by H-GAC Data Manager and QAO. Data review, verification, and validation tasks to be performed on the data set include, but are not limited to, the confirmation of lab and field data review, evaluation of field QC results, additional evaluation of anomalies and outliers, analysis of sampling and analytical gaps, and confirmation that all parameters and sampling sites are included in the QAPP.

Another element of the data validation process is consideration of any findings identified during the monitoring systems audit conducted by the TCEQ Lead Quality Assurance Specialist. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. After the data are reviewed and documented, the H-GAC Project Manager validates that the data meet the data quality objectives of the project and are suitable for reporting to TCEQ.

Table 7: D2.1. Data Review/Verification Tasks

Field Data Review	**Responsibility**
Field data reviewed for conformance with data collection, sample handling and chain of custody, analytical and QC requirements	Subcontractor & H-GAC QAO
Post-calibrations checked to ensure compliance with error limits	Subcontractor QAO
Field data calculated, reduced, and transcribed correctly	Subcontractor QAO
Laboratory Data Review	
Laboratory data reviewed for conformance with data collection, sample handling and chain of custody, analytical and QC requirements to include documentation, holding times, sample receipt, sample preparation, sample analysis, project and program QC results, and reporting	Subcontractor Lab QAO
Laboratory data calculated, reduced, and transcribed correctly	Subcontractor Lab QAO
Reporting limits consistent with requirements for Ambient Water Reporting Limits.	Subcontractor Lab QAO & H-GAC QAO
Analytical data documentation evaluated for consistency, reasonableness and/or improper practices	Subcontractor Lab QAO
Analytical QC information evaluated to determine impact on individual analyses	Subcontractor Lab QAO
All laboratory samples analyzed for all parameters	H-GAC QAO
Data Set Review	
The test report has all required information as described in Section A9 of the QAPP	Subcontractor Data Mgr. & H-GAC Data Mgr.
Confirmation that field and lab data have been reviewed	Subcontractor & H-GAC Data Managers &/or Subcontractor Lab & H-GAC QAOs
Data set (to include field and laboratory data) evaluated for reasonableness and if corollary data agree	Subcontractor QAO & H-GAC Data Manager or QAO
Outliers confirmed and documented	Subcontractor & H-GAC Data Managers or Subcontractor & H-GAC QAO
Field QC acceptable (e.g., field splits and trip, field and equipment blanks)	Subcontractor & H-GAC QAO
Sampling and analytical data gaps checked and documented	H-GAC QAO
Verification and validation confirmed. Data meets conditions of end use and are reportable	H-GAC Program Manager

D3 Reconciliation With User Requirements

The quality objectives and criteria described in Section A7, page 17 of this document are deemed to be consistent with and support the intended use of data set forth in the same section. Data will be evaluated continually by laboratory representatives (Project Manager, Quality Assurance Officer, and Data Manager) during the life-term of the project to ensure that they are of sufficient quality and quantity to meet the project goals. If the data do not meet the goals specified in Section A7, page 17, they will not be transferred to the TCEQ to be used in decision-making nor will the data be used in the calculations of aquatic life subcategories and bioassessment metrics. Any instances where data are rejected will be documented in project quarterly reports.

APPENDIX A. Work Plan (pages 39-42)

Task 1: Project Administration

Deliverables:

- Quarterly progress reports (11/30/05, 2/28/06, 5/31/06, 8/31/06, 11/30/06)
- Quarterly reimbursement vouchers and required documentation (11/30/05, 2/28/06, 5/31/06, 8/31/05, 11/30/05)
- Interim report (5/31/06)
- Written Final Draft Report (10/15/06)
- Written Final Report (11/30/06)
- Summary Presentation to Galveston Bay Council (After 11/30/06)

Approach:

The H-GAC Project Manager and Grants Administration Specialist will coordinate closely with the GBEP Project Manager to ensure that all administrative requirements are met, any issues of concern are resolved, and that the project is managed and implemented efficiently and cost-effectively. H-GAC will prepare a written interim report and written draft final report for review by the GBEP project manager and after comments are received, considered and incorporated appropriately, will prepare a Final Report. This task will be ongoing for the life of the project. Following completion of the project, the H-GAC project manager will work closely with the GBEP project manager to prepare and make a summary presentation to the Galveston Bay Council on the activities and results of this project.

Measures of Success:

- Timely reporting and accurate documentation (Quarterly project reports, financial reports, draft and final project reports)
- Effective project management
- Summary Presentation to Galveston Bay Council

Task 2: Develop a Quality Assurance Project Plan (QAPP)

Deliverables:

- Written Quality Assurance Project Plan for E. coli and Enterococcus (Bacteria) water quality monitoring (Approved QAPP in place)

Approach:

- H-GAC will develop a QAPP developed under TCEQ guidelines for all Bacteria water quality monitoring at OSSF sites.

Measures of Success:

- QAPP submitted for review (10/02/05)
- QAPP Approved (11/31/05)

Task 3: Data Collection

Deliverables:

- Bacteria data obtained. (3/31/06)

Approach:
The Environmental Institute of Houston, H-GAC's Clean Rivers Partner, or other qualified laboratory will collect E. coli water quality samples at two OSSF community locations. The first is along Bastrop Bayou consisting of approximately 10 homes (exact location to be determined). Approximately four samples (two from an outside faucet, one at a location of pooling and/or outfall, plus control) will be taken from each home, and three from the adjacent bayou (upstream control, midstream and downstream). A second sampling site consisting of 30 homes will be located in a Hispanic OSSF community in Harris County Precinct 2 (exact location to be determined). Approximately four samples will be collected at each home in the manner described above. An additional reserve of 15% of the total samples from each location will be maintained in the event Bacteria are identified and additional sampling must be performed. The samples will be analyzed in an approved laboratory. This monitoring and analysis (lab and field) is covered under the QAPP developed for this Special Study along TCEQ guidelines.

Measure of Success:
- Inclusion of water quality data in H-GAC's OSSF strategy plan for community outreach.

Task 4: Data Management
Deliverables:
- Data to H-GAC (3/31/06)

Approach:
H-GAC's Project Manager receives hard copy and electronic data from the laboratory. Sets of data are reviewed for accuracy and completeness. A Data Review Check List is completed and submitted by the laboratory whenever data is sent to the Program Manager. The form includes a list of the number of sample events included and the number of results that should accompany the data submittal. Additionally, copies of field sheets, Chain-of-Custody forms and Lab Data reports or Quality Control back up are received with each electronic submittal. Each category and form is completed and checked off as the data is reviewed. The hardcopies (field data sheets) are then filed. Some reviews are performed manually through sorting processes in Microsoft (MS) Excel, others are completed using scripts written in MS Access. Electronic copies are made of all data sets. Only the copies are manipulated, not original data sets. There is plenty of space for notes of other data management activities on each set of data review sheets.

Measures of Success:
- Acceptance of Data by Project Manager

Task 5: Data Analysis and Risk Assessment
Deliverables:
- OSSF Target Community Risk Assessment and Interim report (3/31/06)

Approach:
H-GAC will analyze monitoring data to provide information to determine if the data support the connection between potential risk from failing OSSF and human illness from the presence of water borne

pathogens. If the connection is established, information will be used to develop an outreach strategy targets at homeowners, elected officials, the judiciary, and developers.

Measures of Success:

- Written summary with community risk assessment.

Task 6: Failing OSSF Correction Strategy

Deliverables:

- Written strategy document (Interim Report, 3/31/2006)
- Final Draft and Final Report

Approach:

H-GAC will develop a failing OSSF correction strategy based on the risk assessment in coordination with target and surrounding homeowners, communities, and other stakeholders. The strategy will include methods for implementation of the strategy and watershed quality indicators to illustrate progress. This strategy will be designed with the goal of implementation at the local level by homeowners, community leaders, municipalities, Brazoria and Harris County, developers, inspectors, and installers. The strategy will identify known and suspected threats to the quality of the communities' health, possible sources of contaminant loadings and incorporate currently used OSSF best management practices. H-GAC will develop the strategy based on information developed through the Risk Assessment as well as the results of public meetings, listening sessions, and interviews with homeowners, elected officials, developers and organizations that will help create the strategy with a goal of implementation at the local level.

Measures of Success:

- Acceptance of the Correction Strategy

Task 7: Conduct Outreach Efforts

Deliverables:

- Public meetings to involve target OSSF community stakeholders in developing an OSSF Correction strategy
- Development a Target OSSF Correction Resource CD (5/31/06)
- Documentation of efforts to educate and involve community and government stakeholders in the development and implementation of OSSF Strategies (Submitted with Quarterly Progress Reports)
- Electronic photographs and images (As available)
- Recommendations for landowner, developer, elected official, and citizen participation in the implementation of the OSSF strategy (Final Report, 11/31/06)
- Final Draft/Final Report
- Summary presentation to Galveston Bay Council (7/2006)
- OSSF Problem correction Brochure (Final Report)

Approach:

The overriding purpose of H-GAC's outreach activities will be to raise the awareness of local and regional communities, elected officials including the judiciary, and developers. It will include an understanding of the links between the affect of failing OSSFs on the residents' quality of life and health, ecological health of area water bodies, and ultimately local economics. H-GAC will identify local and regional target communities through interviews of elected officials, community leaders, chambers of commerce, developers and others. H-GAC proposes to accomplish outreach activities through public meeting(s) at location(s) within the community to discuss project goals and assess perceptions about threats to human health, environmental awareness, and related values, attitudes and traditions. It suggests listening sessions in rural communities to open dialogue with residents, assessing the stakeholder base within surrounding areas. Finally, stakeholder meetings will be held to present analyses of monitoring data, relationships between land use and watershed health, sustainable economic development options, and opportunities for OSSF correction and watershed protection. Another tool to assist in this outreach will be an OSSF education and prevention packet of information or CD, which will be disseminated within watersheds where sampling occurred. Ultimately, as additional funding is received, outreach to 25 other target OSSF communities, and at regional and national conferences, workshops and symposia could occur. Materials will be placed on the H-GAC and other appropriate web sites. The 25 target OSSF communities were identified by H-GAC in 1999 and encompass approximately 3600 households with an estimated population of 37,000. H-GAC will also compile electronic photographs and images (maps, etc.) for use in public meetings as well as to illustrate the watershed, threats to the watershed and human health, and other relevant activities.

Measures of Success:

- Documentation of outreach efforts such as meeting notices, sign-in sheets and meeting summaries;
- Number of citizens, civic groups, or other groups involved in the project;
- Final Resource CD and brochures; and
- Number of OSSF brochures and CDs distributed to stakeholders within the communities.

APPENDIX B. Sampling Design and Procedure (pages 43-49)

Appendix B. 1. Sampling Process Design and Monitoring Schedule

Sample Design Rationale

TCEQ has been tasked with providing data and information to characterize water quality conditions, to identify the presence or absence of impairments of designated water body uses, and to support water quality modeling, site-specific water quality standard revisions and other information needs. Malfunctioning On-site Sewer Facilities (OSSF) have long been thought to play a role in water quality by adversely affecting receiving waters with bacterial contamination. The sample design is based on the goals of the special study, which are to determine if malfunctioning OSSF generate quantities of bacteria (E. coli or Enterococcus) at levels sufficient to pose a health risk to humans. The sample design rationale is E. coli or Enteroccocal bacteria depending on the salinity of the sample location. Bastrop Bayou is a tidal water body and the bacterial sampling marker is Enterococcus. These data will be used, in conjunction with additional water-quality data collected by H-GAC, to assess current conditions in Bastrop Bayou.

Site Selection Criteria

This data collection effort encompasses passive sampling of observed malfunctioning OSSF, as identified by county enforcement officials. Discharge from these such systems may enter into water bodies and thereby adversely affect "in-stream" water quality. To date sampling sites have not been selected. A list of the monitoring sites as well as the criteria followed for the selection will be submitted as an amendment to this QAPP once they have been determined. Such sites may include at least 10 sampling sites in rural areas along Bastrop Bayou, and/or an urban area in a Hispanic community identified in Harris County Precinct 2. All monitoring activities will be developed in coordination with the GBEP.

To this end, some general guidelines are followed when selecting sample sites, as identified below. Overall consideration is given to accessibility and safety. All monitoring activities have been developed with coordination with the H-GAC.

1. Monitoring sites are representative of malfunctioning OSSF in the watershed in proximity to and representative of possible in-stream water quality affects and hydrology during the study period. Where possible, sites are representative of a specific type of land use. Sites will be located upstream from known point sources of potential contaminants.

2. Monitoring sites are chosen based on accessibility and safety.

Once a site has been identified in the field for sampling, the site location will be determined using a high-resolution GPS unit. The differentially corrected GPS has a reported accuracy of within a 1-meter radius. Additionally, site locations will be plotted in the field on USGS quadrangle maps, described relative to surrounding landmarks in field notes, and, if necessary, plotted on smaller scale site maps. All GPS coordinates will also be plotted on high-resolution aerial photography with an accuracy of ±8 feet. Using these data collection and verification techniques, the TCEQ's Agency Horizontal Accuracy (Level 2 or higher) locational accuracy standards will be met.

The data collection design is summarized in Table B1 (Sampling Sites and Monitoring Frequencies) and Figure B1 (Sample Site Map).

Monitoring Sites

A list of sites to be sampled under this QAPP will be included as an amendment to this document after approval by GBEP/TCEQ.

Sampling Procedure

Specific sampling procedures will be determined by the uniqueness of each sampling location and in conjunction with EIH's ability to collect samples from meaningful sites. For rural sites along Bastrop Bayou, samples will most likely include (1) a control, (2) a sample from outside the residence nearest to the observable connection of the OSSF, (3) at least one sample from pooling or outflow on site if evident, (4) a sample in the water body nearest to the OSSF outfall into the water body, and (5) a sample upstream (control) and at the outfall, if they present themselves. If sampling is performed in urban areas, in stream samples will be omitted.

Critical vs. Non-critical Measurements

Because sample site location is biased, in an attempt to show possible presence of bacteria, which may affect human health, the limited number of samples involved, the nature of this program as a "pilot study," and the fact that these data will not be entered into any TCEQ database, data is considered non-critical.

Appendix B.2. Field Sampling Procedures

1.0 Scope & Application

1.1. This document outlines the procedures used to collect samples from malfunctioning OSSFs. Location of OSSF sampling site will be determined after consultation with county health & environmental enforcement officials, one of whom will be present during sampling procedure. Site will be chosen based on previous violation/citation with the county as to malfunctioning OSSF.

2.0 Summary

2.1. Investigators will be assigned sampling runs by the laboratory Project Manager. The investigator will be expected to prepare for the run by reviewing the computer generated sampling record sheets and associated information, then collecting and calibrating the appropriate sampling equipment. The investigator will then precede to the designated OSSF site where he/she will identify himself join county enforcement staff and as necessary the H-GAC Project Manager. Contact will be made with the OSSF site resident by the enforcement official. The property will be inspected to determine appropriate sampling sites. The runs will usually consist of sampling (1) the discharge of malfunctioning OSSF into an adjacent water body (if applicable, including upstream and down stream locations, (2) pooled water within close proximity to the residence served by the OSSF, and (3) any other pooled or standing water on the site, including ditches. All samples collected will be stored on ice and custody will be maintained until the investigator returns to the Laboratory. The laboratory secretary or other laboratory personnel identified in the laboratory SOP will then take custody of the samples. The investigator will note all observed and/or determined in the field, or found during laboratory sample analysis.

3.0 References

3.1. TCEQ SOP - Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, 2003; RG-415.
3.2. Standard Methods for the Examination of Water and Wastewater, 40 CFR 136.
3.3. Laboratory SOP.
3.4 American Society for Testing and Materials, Annual Book of Standards, Vol. 11.02

4.0 Definitions

4.1. Grab Sample - An individual sample collected in less than 15 minutes.
4.2. Split Sample – A single, homogeneous sample that has been equally divided into two or more sub-samples.
4.3. Direct Sample – sample collected directly into the sample receptacle from the designated discharge point, sample spigot, or source.
4.4. Indirect Sample – Sample collected in a sample bucket or container from the sampling point before being poured into the sample receptacle.
4.5. Custody – the act or right of caring or guarding.

5.0 Health & Safety

5.1. Be alert to environmental dangers and use discretion to determine if it is safe to exit your vehicle and collect a sample. These dangers may include unfriendly dogs, biting insects, rusted or unsafe structures, slip or trip hazards, wet catwalks, and ongoing upsets at industrial facilities.

5.2. Do not enter confined spaces.
5.3. Follow safety rules.
5.4. Wear appropriate eye and hand protection when collecting and handling the samples.
5.5. Wear appropriate footwear. Footwear required for industrial facilities may differ from that required at municipal facilities.
5.6. In case of spill or exposure, wash the exposed area thoroughly and disinfect with Sanigel or similar product. If preservative is spilled on an object, neutralize with baking soda and dilute with water.
5.7. Prepare for weather extremes. Carry ice and potable water during the summer and wear warm clothing during the winter.
5.8. Report any injuries to the Laboratory Safety Officer as soon as possible and complete an accident report form. If a site representative is present, notify them also.

6.0 Sample Handling and Preservation

6.1. Complete a custody/sampling record for each sample collected.
6.2. Make sure that each sample bottle is labeled with the date and time it was collected, the name of the site sampled, the outfall number, the type of preservative used and the investigator's signature. Since multiple samples will be obtained at each sight, number these sequentially, beginning with the sampling location closest to the residence and ending with the outfall down stream sample (if applicable). Not all sites may be adjacent to the water body.
6.3. Maintain sample custody until it can be relinquished to the identified laboratory personnel.
6.4. The laboratory prepares sample bottles with the appropriate preservative. Each bottle is labeled with the preservative it contains. Refer to attached list "Aqueous Samples, Containers, Preservation, and Holding Time" in the laboratory SOP.
6.5. Store all samples on ice or as appropriate.
6.6. Do not allow foreign objects to enter the sample bottle. Conduct all testing directly in the outfall or in the sample collection container after the sample has been poured into the sample bottles.
6.7. Once a sample bottle is closed, do not open it.
6.8. Report any sample bottles damaged during transit to the Laboratory Director.

7.0 Equipment and Apparatus

7.1. See laboratory SOP titled "Routine Sample Checklist" for equipment list.
7.2. Potable Water
7.3. UV Protective glasses (sunglasses) for facilities utilizing UV disinfection.

8.0 Reagents and Standards

8.1. Not Applicable

9.0 Procedure

9.1 Run Preparation and Timing
9.1.1. Review the sampling run assigned by the Laboratory Supervisor.
9.1.1.1. Establish a sampling route using Key Maps or knowledge of the area. Plan the run so that there is enough time allotted to collect samples and return to the Laboratory by 3:30 PM.
9.1.1.2. Check sampling history for any recent violations.

9.1.1.3. Read any special instructions detailed in the sample record.
9.1.1.4. Speak to Laboratory Supervisor if any questions arise.
9.1.2. Assemble all equipment necessary to complete the run including keys, bottles, and coolers.
9.1.3. Check assembled bottles for cleanliness and damage.
9.1.4. Calibrate and run QA/QC on all equipment that requires it according to the appropriate SOPs.

9.2 Arrival at a site

9.2.1. Meet county enforcement official at the site. Residents may not be present at all sites
9.2.1.1. Be prepared to present photo identification. If the designated enforcement official is not available, contact the laboratory project manager. Document the name of the enforcement official and resident present on the sample record.
9.2.2. Exercise discretion when waiting for the enforcement official, a 15-20 minute wait is not considered unreasonable. Representatives may not be available during the lunch hour; it may be necessary to return at a later time.
9.2.3. Upon being contacted, the resident may or not wish to accompany you. If the resident does not wish to accompany you, clarify any questions you may have regarding the site before proceeding. Record the name of the resident and the enforcement officer on the sample record sheet.
9.2.4. Follow reasonable the safety and security procedures. Photograph the site, including residence, location of OSSF and field, pooled or standing water, and outfall.
9.2.5. If you cannot sample at an assigned site, indicate this on the sample record sheet and explain why it was not possible to collect a sample at that time.

9.3 Sample Collection

9.3.1. Verify that the outfall or designated sample collection point(s) the sample is being collected from is the correct location.
9.3.1.1. Check the description on the sample record sheet.
9.3.1.2. Check for any signs or markers.
9.3.1.3. Ask the resident.
9.3.1.4. Ask the enforcement official
9.3.2. Prepare sample bottles, making sure that each bottle is labeled.
9.3.3. Collect the representative grab sample.
9.3.3.1. Where possible, collect the sample directly from the outfall or designated sample point into the sample bottle. This is a direct grab sample.
9.3.3.2. In areas where there are confined spaces or physical impediments, use a sample collection bucket on a rope or pole to collect the sample. Rinse the sample bucket a minimum of three times with effluent before collecting a sample to prevent contamination. This is an indirect grab sample. Pour the sample from the bucket into the sample bottles.
9.3.3.3. When a split sample is requested, use a sample collection bucket or common glass or plastic container (since larger volumes are needed) to collect the sample. Rinse the sample bucket or collection container a minimum of three times with effluent before collecting the sample. Once the sample is collected, pour equal portions into the waiting sample bottles. Between each series of pours, swirl the collection container gently to prevent separation and settling.

9.3.3.4. When collecting the sample, do not allow the sample bucket or collection container to lie on the bottom of or scrape the sides of the outfall where it can collect accumulated residue or algae. This may result in a non-representative sample.

9.3.3.5. Document the type and method of sample collection on the sample record sheet. Also, document whether a plant representative collected a sample and whether it was a split sample.

9.3.3.6. After conducting some field tests, it may be necessary to go back and collect additional samples (i.e. fecal). Repeat steps 9.3.3.1 through 9.3.3.6 to collect these samples.

9.4 Field Tests and Measurements

9.4.1. Field tests should be conducted as soon as the sample is collected.

9.4.2. All additional tests will be conducted according to the SOP associated with that specific test equipment or method.

9.5 Field Observations

9.5.1. Observe the discharge and the sample collected. Record any observations including clarity, color, surface conditions, and odors. Observations such as oil present in greater than trace amounts, visible foam, and floating solids are direct violations of the county/TCEQ permit. Other observations may indicate a problem with the effluent that may later be determined during laboratory analysis. They may also indicate a problem with facility operations.

9.5.2. If a problem at the site is observed, record the conditions observed in the receiving stream. Conditions may include but are not limited to sludge build up, discoloration, odor, and dead vegetation or aquatic life. These observations detail the environmental impact the discharge is having on the receiving stream.

9.5.3. If a resident is present, document any remarks he/she makes with regard to problems with OSSF operations.

9.5.4. Record all observations on the sample record sheet. The back of the sheet may also be used for more detail.

9.6 Returning to the Laboratory

9.6.1. Return all samples to the Laboratory by 3:30 PM. If you are delayed, contact the Laboratory Secretary by telephone and inform her of the reason.

9.6.2. Conduct any QA/QC testing required by the equipment used. Document on the Routine Sampling Check List.

9.6.3. Make sure all samples are correctly labeled and all paperwork is complete then place the samples into Laboratory Secretary's custody.

9.6.4. If samples are collected after hours, make sure all samples are correctly labeled and all paperwork is complete. Place the samples in the after hours refrigerator behind the locked laboratory doors and place the accompanying paperwork on top of the refrigerator.

10.0 Quality Control

10.1. QC Equipment

10.1.1. Operate all equipment in accordance with the applicable SOP.

10.2. Method Performance and Demonstration of Capability

10.2.1. All investigators will be trained on the procedures to conduct routine sampling and will demonstrate ability to follow the procedures before being allowed to conduct routine sampling unsupervised.

10.2.2. All investigators will receive additional training on use of field equipment required to conduct routine sampling.

11.0 Documentation

11.1. Record QA/QC for equipment used during routine sampling on the Routine Sampling Check List.

11.2. Record observations and data described in section 9.0 in the appropriate section of the Sample Record sheet.

12.0 Pollution Prevention and Waste Management

12.1. All waste will be placed in an appropriate waste container or returned to the laboratory office for proper disposal.

13.0 Attachments

13.1. Routine Sampling Check List

13.2. Sample Record sheet

13.3. Flow Charts

APPENDIX C. FIELD DATA SHEETS(S) Example

Field Data Sheets specific to the laboratory will be added after choice of sub-contractor is confirmed.

FIELD DATA SHEETS: FECAL PATHOGENS STUDY (PAGE 1 OF 3)

Project Name/Location									
Job Number									
Sampler(s) (signature)									
Date	Time	Sample No.	Location Sample Site (Draw schematic on back of page 1)*	Analysis E. coli	Analysis Enteroc.	Sample Depth	Water Appear	Present Weather

* Description of location should include whether site is on land or in the water body; proximity to OSSF system attached to residence; descriptive text; proximity of sampling site to physical structures (e.g. house, trailer, and garage); proximity of site to bayou or water body; any other pertinent information

APPENDIX C. FIELD DATA SHEETS(S) Example

Field Data Sheets specific to the laboratory will be added after choice of sub-contractor is confirmed.

FIELD DATA SHEETS: FECAL PATHOGENS STUDY (PAGE 2 OF 3)

Project Name/Location								
Job Number								
Sampler(s) (signature)								
Sample No.	Biol. Activity	Water Odor	Stream/Site Activity	Missing Parameter	Sample Bottle Type	Witnesses to Sampling	Photo	Observations on Water Quality

APPENDIX C. FIELD DATA SHEETS(S) Example

Field Data Sheets specific to the laboratory will be added after choice of sub-contractor is confirmed.

FIELD DATA SHEETS: FECAL PATHOGENS STUDY (PAGE 3 OF 3)

Project Name/Location								
Job Number								
Sampler(s) (signature)								
Sample No.	Days Since Last Rain	Flow Severity	Temperature (water)	Water Clarity	Turbidity Observed	Water Color	Water Surface	Wind Intensity

APPENDIX D. Chain of Custody Form (s)

NAME OF SUBCONTRACTOR/ LABORATORY
Address
Phone

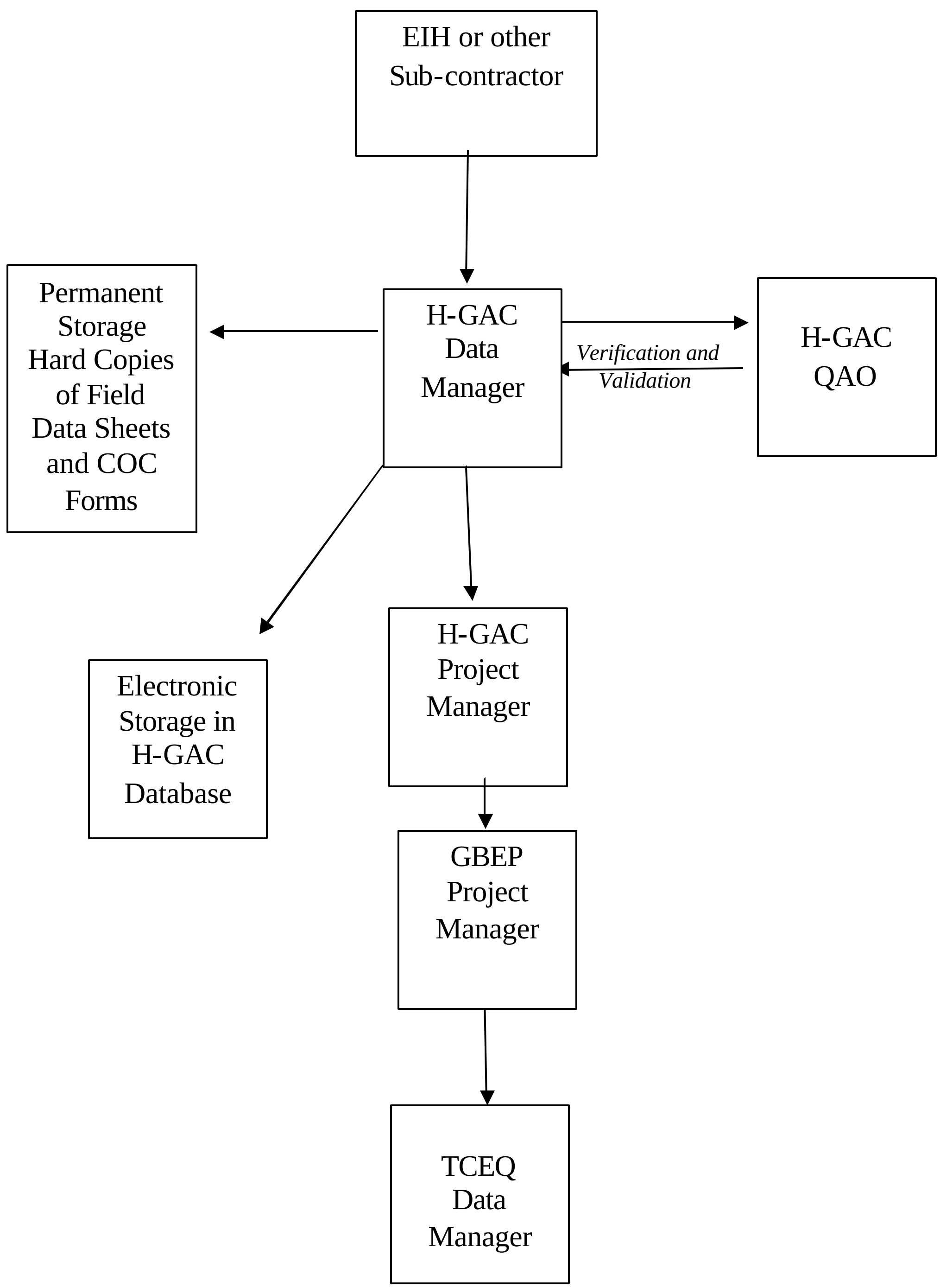
CHAIN OF CUSTODY RECORD

Project Name:					**# of containers**	**Analyses Required**			**Sample ID**
OSSF Site Location/ Sample site	**Date**	**Time (24hr)**	**Matrix**	**Description**		**Enteroc occus**	**E. coli**	**Preservative or filtration**	
Collected by: (signature)			Date:	Time:	Received by: (signature)		Date:	Time:	Laboratory remarks:
Relinquished by: (signature)			Date:	Time:	Received by: (signature)		Date:	Time:	
Relinquished by: (signature)			Date:	Time:	Received by: (signature)		Date:	Time:	Lab log #

APPENDIX E: Data Management Plan

Appendix E.1: Data Flow Sheet

Electronic data, field data sheets, and COC forms are submitted to H-GAC by the Sub-contractor.



Appendix E.2. Data Management Plan
Personnel

Dr. Kathleen Ramsey is responsible for managing the project for the lead organization. She is responsible for ensuring that data is managed by H-GAC and its subcontractors according to this data management plan and QAPP.

Bruce Ridpath is responsible for reviewing the water quality data from EIH or other laboratory, performing all quality control checks on the data, converting the data to the required format, archiving the data, backing up the data at H-GAC

Dr. George Guillen, or similarly credentialed individual if an alternate sub-contractor is utilized, is responsible for managing the water quality data and ensuring that the data comply with this QAPP. He will submit the evaluated data to H-GAC.

The Sub-contractor/Laboratory Manager is responsible for ensuring that the data resulting from laboratory analyses for this project is managed according to the lab QMPs and this QAPP.

Systems Design – Data will be entered into, stored in, and transmitted between personal computers operating on Microsoft Windows 2000/XP, and using common commercially available software. Microsoft Access or Excel 2000/XP, will be used as databases, and data files created by these software programs will be transmitted between computers via the Internet. The TCEQ database hardware and software are described elsewhere and available from the TCEQ Data Manager. Although TRAC format is not required for this study, it may be provided as a supplement to the final project report.

Data Dictionary

Tag_id	A7	This field is the key between the event and results tables and is 7 characters long. The first character(s) is the prefix code for the submitting agency.
Station	A9	This is a combination of the segment_id and the sequence of a site within a segment Stationid A5 This is a unique id that identifies each sampling station. This number is generated by the TNRCC.
Enddate	A10	The date the sample was collected in the form of MM/DD/YYYY
Endtime	A5	The time the sample was collected in military format (HH:MM)
Enddepth	A6	This is the depth in meters at which the sample was collected.
Startdate	A10	This field is only required for composite samples and is the beginning date in the form of MM/DD/YYYY
Starttime	A5	This field is only required for composite samples and is the beginning time (in military format) at which the sample was collected (HH:MM)
Startdepth	A6	This field is only required for composite samples and is the depth nearest surface (in meters) at which the sample was collected.
Category	A1	This field is only required for composite samples and should correspond to the following codes: T is for time composites S is for space composites (i.e.depth)

		B is for both space and time composites F is for flow weighted composites
Calculatn	A1	This field is no longer used and should be left blank
Type	A2	This field is only required for composite samples and should correspond to the following codes: CN for continuous ## where ## is the number of grabs in the composite GB where the number of grabs is unknown
Comment	A135	This is a text field where record of any observational data is included with the sample
Source1	A2	The TCEQ assigned code for the submitting agency.
Source2	A2	An optional field that may be used to further identify the sample
Program	A2	A field that further identifies the sample. This field may be used to tie targeted monitoring to specific permits.
Storetcode	A5	This is a five digit code which identifies the substance or measurement.
Gtlt	A1	If the value is above the detection limit then this field should contain an . If the value is below the detection limit then this field should contain an <.
Value	A8	This is the test result and should be reported in units according to the storet description

The following table outlines the codes that will be used when submitting data under this QAPP.

Name of Monitoring Entity	**Source Code 1**	**Source Code 2**	**Program Code**
EIH, or other similarly qualified laboratory	TBD	TBD	TBD

TBD = to be determined

Storet codes for data collected under this project include the following:

00530	RESIDUE, TOTAL NONFILTRABLE (MG/L)
31648	E. COLI, MTEC, MF, #/100ML
31700	E. COLI, MF PARTITION PROCEDURE
01351	FLOW: 1=NO FLOW, 2=LOW, 3=NORMAL, 4=FLOOD, 5=HIGH, 6=D
31649	ENTEROCOCCUS, MF

Data Management Plan Implementation – Implementation of the data management plan is displayed graphically in Appendix G. Figure G.1. Field data will be recorded on field data reporting forms, then conveyed to Laboratory Data Manager, who will enter them into a database file. All values in the electronic file will be compared to the paper forms after entry. Field data forms will be maintained at the EIH/Laboratory for five years.

The results *E. coli* and Enterococcus tests at the EIH/commercial Laboratories will be provided on paper forms, then entered into an electronic database file by a technician to be specified at a later date. After this operation, each value in the database is compared to the value on paper for accuracy.

If any calculations are made, at least 10% will be checked by hand for accuracy. A technician to be identified at a later date will convert the electronic file to MS Access format, and following manual accuracy checks, archive copies of each file to CD-ROM format. The Data file, along with a data management checklist, will be then transferred to the GBEP Project Manager by e-mail. After approving the data management checklist, the GBEP Project manager will convey the file to the GBEP Data Manager. GBEP Data manager will run the TCEQ automated screening procedure on the file to check for errors and outliers, then forward the results to the TCEQ Project Manager. Upon approval of the TCEQ Project manager, the TCEQ Data Manager will add this data to the TCEQ database if appropriate.

Quality Assurance/Control - See Section D of this QAPP. The EIH Quality assurance Officer will confirm that QA/QC procedures are followed using a quality control checklist (see Appendix F).

Backup/Disaster Recovery – Data files stored on the network servers at EIH, H-GAC, and TCEQ computer systems are routinely backed up. After a summary report is produced at EIH, it will then be saved to a CD-ROM for distribution and archive at the EIH offices. Copies of the field data reporting forms and laboratory paper records will be maintained, at the EIH/ Laboratory, for a period of five years as additional insurance against data loss.

Archives/Data Retention - Complete original data sets are archived on permanent media (zip disk or CD-ROM) and retained on-site by EIH for a retention period specified in the original QAPP approved by the TCEQ Project Manager

Appendix E.3: Data Summary

Data Summary Sheet

Data Source: ____

Date Submitted: ____

Tag_ID Range: ____

Date Range: ____

Comments:

____

____

____

____

____

____

____

____

____

____

____

Houston-Galveston Area Council
Data Manager__________________________________Date_______________

Quality Assurance Officer________________Date_______________

APPENDIX F. Data Submittal Form & Data Review Check List and Comment Sheet

Appendix F: DATA SUBMITTAL FORM & DATA REVIEW CHECK LIST

Appendix F.1. Data Submittal Form

Please complete this form, sign where applicable, and submit with copies of Field Sheets, Chain-of-Custody Forms & Lab Data Reports pertaining to the data in this submittal. One form is required for each submission. Failure to complete and submit this form will impede the process whereby data is submitted to TCEQ or included in the H-GAC database.

Laboratory:___________________________

Water Body:__________________________

Data Start Date:_______________________ Data End Date:________________________

Total Number of Events in this Data Submittal: ______________________________
(Total number of sample sites monitored times the number of monitoring visits to each site)

Total Number of Results in this Data Submittal:__________________________________
(Each event contains multiple field &/or laboratory results)

Appendix F.2.2. Field Data Review Check List

List equipment used to collect field measurements.______________________________
Were all field parameters measured & documented for each station location? Yes ____ No____
Were water samples collected for all required laboratory parameters at every station location? Yes___ No___
Were water samples "iced" immediately upon collection or acidified in the field as required? Yes___ No___
Were all field sheets completed using indelible ink? Yes___ No___
Were errors on the field sheets corrected using a single line with initials of person making the correction & the date corrected? Yes___ No___
*If no, explain.*____

Were empty sections of every field sheet closed-out with a diagonal line, initials and the date
closed-out? Yes___ No___
Were problems encountered while collecting any field measurements? *Explain.*______________

Were these problem(s) documented on the field sheets? Yes___ No___
Were the problems encountered in the field, communicated to the supervisor so the H-GAC Project Manager could be notified as required by the QAPP? Yes___ No___
Were all chain-of-custody forms &/or field data sheets filled out completely and accurately? Yes___ No___
Were empty sections of every Chain of Custody form &/or field data sheet closed-out with a diagonal line, initials and the date closed-out? Yes___ No___
Have the field data sheet(s) or chain-of-custody form(s) changed since the last data submittal to H-GAC? Yes___ No___
*Explain, if yes or attach a new form*______________________________________

Additional comments about Field Data ______________________________________

Person who reviewed the field sheets for accuracy & completeness:

*Print Name*__________________________*Signature*_____________________*Date*________

Appendix F. 4. Lab Data Quality Review

Were all holding times confirmed? Yes___ No____

Were samples received at the lab "iced down" and in the process of cooling to 4ºC ± 2ºC?
Yes____ No____
*Explain if no*____

Were any water samples analyzed and reported that exceeded holding time requirements?
Yes___ No____

Were empty sections of the Chain of Custody form closed-out with diagonal lines, initials and the date closed-out? Yes___ No____

Are all the lab values reported consistent with the Lab Reporting Limits (LRL) in Table A7.1 of the Regional QAPP? Yes___ No____
*Explain if no*____

Have errors on the lab sheets been corrected using a single line with initials of person making the correction & the date corrected? Yes___ No____

Were empty sections of every lab sheet closed-out with a diagonal line, initials and the date closed-out? Yes___ No____

Did all field splits fall within the 30% Relative Percent Difference (RPD) used to determine potential excessive variability? Yes__ No____
*Explain if no*____
____

Were there any results that were not reported by the lab? Yes___ No____
*Explain if yes*____

Data reasonableness and correctness of analysis have been confirmed and <u>documented in the electronic database</u> for the following situations.

- For bacteria densities that are too few or too numerous to count, are the values reported as < or > the applicable minimum or maximum value? Yes___ No____
- Are there any results in this data set greater than the maximum screening values or less than the minimum screening values? Yes___ No____
- Are there any result values in the data set that "Best Professional Judgment" would indicate a possible error and an investigation is warranted? Yes___ No____
- Are there result values in the data set, which are part of a "hold time exceeded" or "did not pass QA" or "received hot, __ ºC" but could still be included in the set because a parameter does not require special handling? (ie. TDS does not have to be iced) Yes___ No____
- *If yes to any previously bulleted questions*, have the results been reconfirmed and <u>documented in the database</u> as being accurate? Yes___ No____

What kind of QA/QC data is provided with this data submittal?___________________________
____

Additional comments about Lab Data ____
____

Person who reviewed the lab sheets & results for accuracy & completeness:

*Print Name*___________________________*Signature*______________________*Date*_____

Data Entry, Formatting and Table Structure

Are all sampling START TIMEs and END TIMEs data entered using
the 24-hour clock format with leading zeros as necessary? Yes___ No___
Are all sample *DEPTHs* reported in meters? Yes___ No___
Were any samples collected from depths greater than 0.3 meters? Yes___ No___
*Explain if yes*____
____
If the sample was not a grab, was the composite information recorded? Yes___ No___
Have all asterisks (*) been removed from the database being submitted to H-GAC?
(An asterisk will interfere with queries, searches, etc.) Yes___ No___

Are there any blank fields in the database? Yes___ No___
*Explain if yes*____
____
If there are no results to enter due to lab or sampling problems, is there an
explanation for the blank field in the comment section? Yes___ No___
Are only the sample sites listed in the current QAPP, Coordinated Monitoring Schedule (CMS), or most recent amendment included with the data being submitted to H-GAC?
Yes______ No______
*Explain if no*____
____
Was data reviewed for outliers? Yes___ No___
(Refer to www.tceq.state.tx.us/water/quality/data/wmt/storet.html

Are all outliers confirmed, documented and identified so the H-GAC Data Manager
can review them? Yes___ No___
Are the appropriate quality assurance/quality control information or results included with the data set for verification and validation by H-GAC? Yes___ No___
Have at least 10% of the data in the data set been reviewed against the field
and laboratory data sheets? Yes___ No___

Additional comments about Data Entry, Formatting and Table Structure________________
____
____
____

Person who reviewed the database for accuracy & completeness:

*Print Name*___________________________*Signature*______________________*Date*________

Electronic data set was submitted to H-GAC on ____________________________
Electronic data set was submitted to H-GAC by:

*Print Name*___________________________*Signature*______________________*Date*________

Appendix F.3. MICROBIOLOGICAL QA COMMENT SHEET

A. Are holding times confirmed? _____

B. Have checks on correctness of analysis or data reasonableness been performed? _____

Explain any answers that may indicate a problem with the data (attach another page if necessary):

Site Location	Date of sample	Comments

APPENDIX G: Letter to document adherence to the project QAPP.

DATE: date

TO: Kathleen Ramsey
Houston-Galveston Area Council

FROM: Project Manager
Sub-contractor/Laboratory

RE: Occurrence of Bacteria on Samples from OSSF Violation Sites in Bastrop Bayou, near ____________________, Texas

Please sign and return this form by date ______to:

Sub-Contractor/Laboratory
Address
City, State Zip code
ATTN: Project Manager

I acknowledge receipt of the referenced document(s). I understand the document(s) describe quality assurance, quality control, data management and reporting, and other technical activities that must be implemented to ensure the results of work performed will satisfy stated performance criteria.

____

Signature Date

Copies of the signed forms should be sent by H-GAC to the GBEP Project Manager within 60 days of TCEQ approval of the QAPP.

Appendix H. Possible sampling sites

Possible Locations of Sampling Sites. Specific sites to be identified after the QAPP is approved by TCEQ, and after consultation with county enforcement officials. Representative clusters of OSSF violations are shown in aerial views for one location along Bastrop Bayou. Other possible locations are shown in Figures 3 through 5 in Appendix J.

Figure 4: H.1. Bastrop Bayou Possible Sampling Location 1, Mims

Figure 5: H.3. Bastrop Bayou, Possible Location 2, Holiday Beach

Amendment # 1
to the Houston-Galveston Area Council

FAILING SEPTIC SYSTEM INITIATIVE:

ON-SITE SEWAGE FACILITY RISK ASSESSMENT AND OUTREACH
Quality Assurance Project Plan
Contract # 582-5-65075
EPA Agreement CE-00655003

Prepared by the Houston-Galveston Area Council
In Cooperation with the
Texas Commission on Environmental Quality (TCEQ)

Questions concerning this QAPP should be directed to:

Dr. Kathleen Ramsey, DABT
Houston-Galveston Area Council
3555 Timmons Lane, suite 120
Houston, Texas
Phone #713-499-6653
FAX #713-993-4503
e-mail: kathleen.ramsey@h-gac.com

Effective: May 2006

Justification:

The following are changes to the Houston-Galveston Area Council's Failing Septic System Initiative (FSSI) FY 2005-2006. The purpose of the FSSI project is to support an overall assessment of Bastrop Bayou by determining the occurrence of *E. coli* and/or Enterococcus bacteria associated with malfunctioning OSSFs in the Bastrop Bayou region. The changes will provide limited source identification for bacteria in water samples collected during the course of the original study. This is determined to be desirable by the H-GAC Program Manager, H-GAC Project Manager, and GBEP Project Manager. This amendment addresses methods, practices, and procedures recommended to obtain the source identification information.

Summary of Changes:

1. Section A7, Page 17 - Quality Objectives and Criteria. Addition of Bacteria Source Identification objectives and criteria descriptive text.

2. Section A7, Page 18 - Table 1: A7.1 - Measurement Performance Specifications. Addition of laboratory method for analysis of water samples for total fecal coliform and fecal streptococcus.

Detail of Changes:

1. Section A7, Page 17 - Quality Objectives and Criteria.

The original QAPP sample analysis calls for the enumeration of *E. coli* or Enterococcus bacteria. An additional, duplicate grab sample will be taken at the same time as the original and analysis will be performed to determine enumeration of total fecal coliform and fecal streptococcus. The second sample aliquot will be plated and the plates stored under refrigeration for up to 2 – 3 weeks pending the results of initial fecal coliform and streptococcus analysis. A fecal coliform to fecal streptococcus ratio will be calculated. In those cases where mixed results are obtained, source identification may follow.

For source identification, the initial method will utilize the ratio of fecal coliform to fecal streptococcal bacteria according to the study, "Bacteriological Assessment of the Lower San Antonio River Segment 1901. [San Antonio River Authority, 2004] This method is a general indicator to determine the source as human, non-human, or mixed origin in the initial bacterial analysis using the ratio of fecal coliform to fecal streptococcal bacteria. This report can be found on the San Antonio River Authority website (www.sara-tx.org; click on the Water Quality button at the top of the page then follow the drop down boxes through Water Quality Monitoring to Projects and Studies.)

In the case of bacteria from mixed origin, the laboratory will use the stored plates to identify individual isolates according to the method of Hagedorn and Crozier et.al. [Hagedorn et.al. J. Applied Microbiol. 2003. 94(5):792-9]. Isolates from the stored fecal streptococci plates will be identified to species and carbon utilization profiles (CUP) will be generated for each. CUP profiles will be used to generate a very limited host-specific library and categorize isolates to source. A minimum of 15 isolates will be used for each specific library (human, cow, and bird), with the exact number used determined by H-GAC following sampling, assessment of the total FSSI site samples collected, and funds available. Since the total contract amount is fixed, available funds must be apportioned between bacterial analysis and source identification. If fewer sampling sites are identified than anticipated, funds can be shifted to additional isolates.

The following methods will be utilized:

- Enumeration of Total Fecal Coliforms: *Standard Methods for the Examination of Water & Wastewater*, 20th Edition, Method 9222-D. Membrane filtration technique

- Enumeration of Fecal Streptococcus: *Standard Methods for the Examination of Water & Wastewater*, 20th Edition, Method 9230-C. Membrane filtration technique

- Identification of Individual Isolates: Catabolic Utilization Profiles and Biolog identification required using Microlog 1 System (Model 41401), Gram Negative Database (22601D) and GN2 Microplates, Gram Positive Database (22604D) and GP2 Microplates, and a Microplate 96-well Reader.

2. Section A7, Page 18 - Table 1: A7.1

Table 1: A7.1 - Measurement Performance Specifications *

PARAMETER	UNITS	MATRIX	METHOD	STORET	AWRL	Lab Reporting Limit (RL)	RECOVERY AT RLs	PRECISION (RPD of LCS/LCS dup)	BIAS (%Rec. of LCS)	Per Cent Complete
Field Parameters										
E. coli, IDEXX Colilert	MPN/100 mL	water	SM 9223-B	31699	1		NA	.5**	NA	
Enterococcus, IDEXX Enterolert	MPN/100 mL	water	ASTM D-6503	31701	1		NA	.5**	NA	
Total Fecal coliform	MPN/100 mL	water	SM 9222-D	31616	1		NA	.5	NA	
Total Fecal Streptococcus	MPN/100 mL	water	SM 9230-C	31673	1		NA	.5	NA	
Days since last significant rainfall	days	NA	TCEQ SOP	72053	NA*	NA	NA	NA	NA	Field
Flow severity (if no flow measured)	1-no flow, 2-low, 3-normal, 4-flood, 5-high, 6-dry	water	TCEQ SOP	01351	NA*	NA	NA	NA	NA	Field
Carbon Utilization Profile (CUP) - Biolog	Fingerprint Pattern	water	Hagedorn et.al. J. Applied Microbiol. 2003. 94(5):792-9	N/A	NA*	NA	NA	NA	NA	

Distribution: QAPP Amendments will be distributed to all personnel on the distribution list maintained by the Houston-Galveston Area Council.

These changes will be incorporated into the QAPP document and TCEQ and the Houston-Galveston Area Council will acknowledge and accept these changes by signing this amendment.

H-GAC Program Manager	Carl Masterson Community Resources Program Manager	Date
H-GAC Project Manager Quality Assurance Officer:	Kathleen Ramsey, Ph.D. Environmental Planner	Date
H-GAC Study Data Manager:	Bruce Ridpath Senior Environmental Planner	Date
GBEP Program and Grant Manager:	Helen Drummond Director, GBEP/TCEQ	Date
GBEP Project Manager:	Steven Johnston Project Coordinator, GBEP /TCEQ	Date
GBEP QA Manager:	Angela Henderson Quality Assurance Officer, GBEP /TCEQ	Date

APPENDIX B
FIELD RECONAISSANCE

FAILING SEPTIC SYSTEM INITIATIVE
FIELD RECONNAISSANCE
SEPTEMBER THROUGH NOVEMBER, 2006
CONTRACT NO. 582-4-65075

Address (Block Number)	**Date**	**Notes**	**Latitude**	**Longitude**
2400 Warwick B	9/18/06 9/26/06 11/28/06	Black water Black water, floating scum and black slim. Odor. Sample taking near pipe hidden in ditch by brick. Small terrior dog (12 lb.) 1 picture of house. Strong septic odor; shed behind house 2 pic. Note: New home across the street with septic system. Lot 40 feet wide. From back fence to back of house is 18 paces or approximately 36 feet. Neighbor (trailer their for 30 years) says mound system installed. Four brand new homes on the Corner with Seven Mile Road	N29.45602	W95.05375
2400 Warwick A	9/18/06 9/26/06 11/28/06	Not Sampled Water only under sulvert. Whiteish, possible detergent. Directly across from new construction (2413) Well kept brick home	N29.45602	W95.05375
2300 Warwick	9/18/06 9/26/06 11/28/06	Black water Little water. Scum, floating debris, black water. There are two houses on this very narrow lot. Blue house with trim. Sample looked clean, no odor	N29.87860	W95.35039
2100 Warwick A	9/18/06 9/26/06 11/28 LS	Standing water. FC Plate reacted adversely with sample due to positive chem rxn. Positive for bacteria. Blue color. Small amount of water under and near cilvert. Two small dogs Pipe runs from right of driveway into ditch. Spoke to resident.	29.87854	95.35351
2100 Warwick B	9/18/06 9/26/06 11/28 FS	Standing water Odor coming from ditch. 1 small dog. Spoke with gentleman - 16 year resident. Ditch needs cleaning. Forward to county for action. Sewer odor, some turbidity, cars in drive, 2 pics	29.87855	95.35332
2100 Warwick	9/18/06 9/26/06	9/18 No samples No sampling; Spoke with "Robert" ditch has detergent. House two houses west runs grease trap and laundry into the ditch. His ditch is deeper so water collects in front of his house.		

FAILING SEPTIC SYSTEM INITIATIVE
FIELD RECONNAISSANCE
SEPTEMBER THROUGH NOVEMBER, 2006
CONTRACT NO. 582-4-65075

Address (Block Number)	**Date**	**Notes**	**Latitude**	**Longitude**
2400 Cromwell	9/18/06	FC Plate reacted adversely with sample due to positive chem rxn. Lab split		
	9/26/06	Left side of driveway, Clear grey water. Rt side same. TX A & M sample - small. Check address	29.87766	95.34768
	11/28 LS	Mosquito fish (1/2 inch), very active; trailer turquoise and white; Pipe to right of drive site. Lots of concrete to hold ditch. Front yard entirely concrete.		
2500 Cromwell A	9/18/06	Sample at west property line. Next to house with blue above ground pool with grey trailer. Black water.		
	9/26/06	Rt of driveway sample under bouganvillia. Minnows, clear water. Mosquito larvae. Lots of plants around ditch - are they phyto filers?	29.87781	95.34608
	11/28/06	Flow in ditch		
2500 Cromwell B	9/18/06	Black water to right of gravel in front of house. Multiple pipes empty into ditch		
	9/26/06	Sample between driveway. Blackish water.	29.87598	95.34616
	11/28/06	Yellow house half brick fence, wrought iron above. 3 pics. Took sample to right of lot where multiple pipes.		
2500 Cromwell C	9/18/06	9/18 Black water. House "falling in" Cars in front of house.		
	9/26/06	Sewer odor. Multiple cars in yard. Blue tarp on house over front door. Dog (part pitbull) with ribs showing. 2 pictures. A & M Viral sample. At 2538 Cromwell, gentleman pouting used motor oil on the ground.	29.87773	95.3462
	11/28/06	Sample with pole, 1 pic.		
2600 Cromwell A	9/18/06			
	9/26/06	May be "relative" address. Mailbox of 2606 is to the east. Odor. Location, looking south there are two driveways. Sample to the right to the rignt (west) most driveway. Water fairly clear. 3 small dogs. Mosquito larvae in water. Location across the st	29.87779	95.34536
	11/28/06	Sample with pole, blue house with palms, pipe/hose next to big elm tree draining into ditch		
2600 Cromwell B	9/18/06	Goats and Chickens		
	9/26/06	Goats and Chickens		
	11/28/07	Goats and Chickens		

FAILING SEPTIC SYSTEM INITIATIVE
FIELD RECONNAISSANCE
SEPTEMBER THROUGH NOVEMBER, 2006
CONTRACT NO. 582-4-65075

Address (Block Number)	**Date**	**Notes**	**Latitude**	**Longitude**
2700 Kowis	9/18/06	Black water with odor. Drains 2722 and 2718.		
	9/26/06	Lots of mosquito larvae in sample collection beaker. Standing water with no movement. 3 pictures	29.87515	95.3431
	11/28 FS	Grey house. Sample right of drive way. Large tree root with balck small diameter pipe draining to ditch. Also 1 inch whitePVC pipe above ground to right of drive. 3 pics		
2500 Kowis Rain puddle in street C	9/18/06	Storm Water puddle sample taken in street to 2534 Kowis		
2500 Kowis - Driveway Puddle	9/26/06	Standing water - driveway puddle 4 feet in diameter		
	11/28/06	Puddle 20 feet in diameter. House with two trailers on lot, one along back fence and one on east side.		
2500 Kowis B	9/18/06	Not as black as other samples but strong sewer odor. A & M viral sample		
	9/26/06	Sheen to water. Mottled looking with sparkle or effervesence. According to Dr. Brinkman, might be Rotifers. She wil examine under scope. Property has one house and trailer immediately behind it, occupied, and a second trailer along the east lot line p	29.87517	95.34589
	11/28/06	Mosquito larvae. One of few sites where seen this trip. No odor.		
2500 Kowis A	9/18/06	Black water		
	9/26/06	Sampling site actually located at 2514 but very closs to lot line with 2522, which is what the site was called in the firs sampling. Mosquito larvae. Corrugated tin fence (8' high) along front property line. Screens 4 trailers on the same lot. Two trai	29.87508	95.34666
	10/28/06	Lots of mosquito larvae, no pic. Four manufactured homes at angles on lot.		
2700 William Tell	9/18/2006 A	Ditch - to left of driveway. Black and smells. Cold water, possibly rain filled because at end of street with gravity flow towards it. B sample taken		
	9/18/2006 B	Spoke with Maria. Small dog.		
	9/26/06 A	Several dogs. Spoke with Maria's son	29.87602	95.34394
	9/26/2006 B			
	11/28/06 A	Spoke with Maria. 3 large dogs, one small		
	11/28/2006 A			

Address (Block Number)	**Date**	**Notes**	**Latitude**	**Longitude**
2600 William Tell A	9/18/06	Black water.		
	9/26/06	2609 Has multiple cars in yard. Dog at 2616	29.87607	95.34485
	11/28/06	Small Black dog and dalmation		
2600 William Tell B	9/18/06	Between 2616 & 2618 trailer pipes empty into ditch. Flows from 2616 to 2618		
	9/26/06	Cat ran into front yard from across street.	29.87603	95.34483
	11/28/06	Large angry brown dog, German Shepherd		
2400 William Tell		No sample. Chickens in yard.		
	9/26/06	No sample. Chickens in yard.		
2100 William Tell	9/18/06	Black water		
	9/26/06		29.87599	95.35215
	11/28 LS	Red Brick half fence, 3 pic. 2 large dogs in picture		
2700 Trenton	9/18/06	Relatively clear. Ditch with plastic garbage.		
	9/26/06	Across the street from 2710 which as a nice home and a large lot. Immediately to east, there is a 5 story building with parking lot. On the sampling side of the street (north) a high feence hides what appears to be a junk car lot. You can see cars upen	29.87602	95.35218
	11/28/ FS	More water in ditch, less trash		
<u>Halls Bayou</u>				
Under Hopper Bridge.	9/18/06	No sample		
	9/26/06	Sampled under bridge. Still water, brown in color. Approximately 35 ' north of the bridge, a large culvert discharged into the Bayou from the west bank. Immediately south of bridge (30') two large (3' diameter) culverts discharged into the bayou.	29.87926	95.34361
	11/28/06			
West Side of Bayou - Cromwell Outfall	9/18/06	No Sample		
	9/26/06	Culvert discharged to bayou, small flow. Appeared to be in line with Cromwell drainage ditches and culvert under Shady Lane. Sample taken from end of culvert.	29.87927	95.34359
	11/28/06			
West Side of Bayou - Chamberlain Outfall	11/28/06			

FAILING SEPTIC SYSTEM INITIATIVE
FIELD RECONNAISSANCE
SEPTEMBER THROUGH NOVEMBER, 2006
CONTRACT NO. 582-4-65075

Address (Block Number)	**Date**	**Notes**	**Latitude**	**Longitude**
West Side of Bayou - William Tell Outfall	9/18/06	No sample		
	9/26/06	Similar situation to Cromwell culvert. Sampled in stream to left of culvert because end of culvert submerged in bayou.	29.87701	95.34403
	11/28/06			
West Side of Bayou - Near Kowis Outfall	9/18/06	Sample taken under foot bridge.		
	9/26/06	Sampled directly under foot bridge. Kowis Culvert crushed so very little flow possible. (Contact county to fix to avoid flooding back up Kowis St). Kowis culvert was approximately 25' upsteam from foot bridge. Same location as 9/18 sample.	29.87518	95.34254
	11/28/06			
Sewage Plant - Outfall	11/28/06			
	11/28/06			
		2160 - 2150 Kowis - Neighbor says raw sewage comes from 2150 to sit infront of her house at 2160		

* MPN CFU/ml
** Threshold E. coli = 394
Threshold Enterococci = 89

9/18 Split
2147 Wm. Tell - Lab
2537 Kowis - Field
2431 Cromwell - Lab
2420 Warwick - Field
Trip Blank

Westfield Estates - Sampling Locations




Westfield Estates - Sampling Locations

Westfield Estates - Sampling Locations






Westfield Estates - Sampling Locations






Westfield Estates - Sampling Locations






Westfield Estates - Sampling Locations






APPENDIX C
BACTERIAL SAMPLING RESULTS
And
SOURCE IDENTIFICATION

Hygeia Laboratories

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Escherichia coli Quantification as a Presumptive Indicator of Failing On-Site Sewage Treatment Facilities (OSSFs)

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Kenneth G. Wunch
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Introduction

Individual On-Site Sewage Treatment Facilities (OSSFs) are prone to failure, releasing inadequately treated sewage and wastewater into surface and ground waters. Surveys estimate that as much as 17% of the stream pollution in some states is related to OSSF problems versus 13% associated with wastewater treatment plants, and 10% related to storm water. In 2001, an estimated 12% (17,800) of OSSFs in the Houston-Galveston Area Council (H-GAC) region were chronically malfunctioning. Common reasons for OSSF failure included age and design of the system, soil type, lot size, improper installation, lack of proper operation, and/or maintenance.

Malfunctioning OSSFs have the potential to create human health and water quality problems. Water borne pathogens from raw sewage may cause gastrointestinal infections, infectious hepatitis, cholera, and typhoid fever. While there is little hard evidence to connect human illness in the H-GAC region with the presence of pathogens from malfunctioning OSSFs, there is a potential impact to 60,000 people directly and hundreds of thousands, indirectly, through degraded water quality. Therefore, correlating individual malfunctioning OSSFs to fecal contamination isolated from surface and ground waters is the ultimate goal of this study.

Fecal coliforms normally reside in the intestinal tract of warm-blooded animals. Outside of a warm-blooded host, fecal coliforms are short-lived compared to the coliform bacteria that are free-living and not associated with the digestive tract of man or animals. In 1892, Shardinger proposed the use of the fecal coliform, *Escherichia coli* as an indicator of fecal contamination. This was based on the premise that *E. coli* is abundant in human and animal feces and not usually found in other niches. Furthermore, since *E. coli* could be easily detected by its ability to ferment lactose, it was easier to isolate than known gastrointestinal pathogens. Hence, the presence of *E. coli* in food or water became accepted as indicative of recent fecal contamination and the possible presence of pathogens (Feng *et al*, 2002).

In 1999, the U.S. Environmental Protection Agency (USEPA) set forth an Action Plan for Beaches and Recreational Waters, as Americans faced the risk of illness associated with exposure to surface waters contaminated with disease-causing microorganisms (USEPA, 1999). Previous epidemiological studies performed by the USEPA demonstrated a direct relationship between the density of *E. coli* in surface waters and an increase in swimmer-associated gastroenteritis (USEPA, 1986). Limits were established as guidelines for recreational water quality based on this information. For freshwater, the present single-sample advisory limits are 235 CFU/100 mL for *E. coli* as determined by the USEPA and 394 CFU/100 mL as determined by the Texas Commission on Environmental Quality (TCEQ).

The overall purpose of this study is to correlate the prevalence of indicator bacterial species to the presence of human feces from OSSFs. However, since *E. coli* is the predominant facultative anaerobe in the intestine of humans and warm-blooded animals *E. coli* quantification in our samples is indicative of general fecal contamination, not human-specific contamination.

Materials & Methods

Environmental Sampling

Westfield Estates in Harris County, TX was chosen as a sampling site due to an evaluated need for public sewer services and a potential for its residents to be exposed to water-borne pathogens. Twenty six locations were selected in this area and multiple grab samples were taken at each with sterile 250 ml IDEXX bottles (IDEXX Laboratories, Westbrook, ME). All samples were stored on ice in a cooler and processed within 6 h of sampling.

E. coli Quantification

For the recovery and quantification of *E. coli*, the IDEXX Colilert-18 chemical detection method was utilized. Undiluted freshwater samples and a 1:100 dilution made with sterile deionized water were each mixed with reagent and placed in a Quantitray/2000 according to the manufacturer's instructions (Colilert-18 product insert; IDEXX Laboratories). Quantitrays were sealed and placed in a 35°C incubator for 24 h. Following incubation, Quantitray wells were read for yellowness (total coliform) revealing *o*-nitrophenyl-ß-D-galactopyranoside (ONPG) hydrolysis and fluorescence, which indicate 4-methylumbelliferyl-ß-d-glucuronide (MUG) cleavage, with the aid of a UV light box (366 nm). The number of wells producing fluorescence was compared to the manufacturer-provided most-probable-number (MPN) table to enumerate *E. coli* in terms of MPN/100 ml.

Results & Discussion

According to TCEQ, contact recreational waters should not exceed 394 CFU/100 mL of *E. coli* on any given sample. *E. coli* quantitative results from community samples are shown in Table 1 and from Halls Bayou samples are shown in Figure 2. All samples on all of sampling dates, with the exception of the Sunbelt sewage plant, exceeded state mandated limits. Samples ranged from 600 CFU / mL to greater than 24,200 CFU / mL. Both sampling events from the Sunbelt sewage plant recorded no *E. coli* in the outfall.

Baseline water quality, as measured by levels of *E. coli*, within Halls Bayou is the subject of ambient monitoring by TCEQ through its Clean Rivers Program. A water quality information station (11126) is located approximately one mile down stream from Westfield Estates in Stream Segment 1006 (Houston Ship Channel). Ambient water quality information on *E. coli* (MPN/100 ml) for Station 11126 on Halls Bayou was collected from December 2001 through November 2004 with 94% of the samples exceeding state limits. Sampling in 2005 showed exceedences of only 35%. Data is not currently available for 2006 samples for Station 11126 but a considerable portion of *E. coli* contamination can be attributed to effluent from Westfield Estates. Bacterial exceedences, especially concentrations above 1,000 MPN/100ml, have been historically attributed to wastewater treatment outfalls. However, the Sunbelt sewage released no *E. coli* in both sampling events.

Address (Block)	**Weather**	***E. coli* (MPN / 100 ml)**
2400 Warwick A	D W1	6600 2000
2400 Warwick B	D W1	19900 1100
2300 Warwick	D (FS) W1	>242000 / >242000 >242000
2100 Warwick A	D W1 (LS)	1500 240000 / >242000
2100 Warwick B	D (LS) W1 (FS)	15300 / 12000 112000 / 173300
2400 Cromwell	D W1 (LS)	1400 68700 / 77000
2500 Cromw ell A	D (FS) W1	2800 / 1500 29900
2500 Cromwell B	D W1	800 36500
2500 Cromwell C	D W1	15500 36500
2600 Cromwell A	D (LS) W1	13300 / 12100 64900
	W3 (LS)	5100 / 6200
2700 Kowis	D W1 (FS)	242000 43500 / 41100
	W3 (FS)	4500 / 4000
2500 Kowis Puddle	D W1	16100 36500
2500 Kowis A	D W1	120300 >242000
2500 Kowis B	D W1	>242000 >242000
2700 Trenton	D W1 (FS)	700 61300 / 64900

2700 William Tell A	D W1	7100 155300
2700 William Tell B	D W1	>242000 >242000
2600 William Tell A	D W1	45700 141400
2600 William Tell B	D W1	21400 155300
2100 William Tell	D W1 (LS)	242000 >242000 / >242000

Table 1: *E. coli* quantifications from community samples.

D= Dry Weather, no rain 7 days, September 26, 2006; Temperature – 85° F
W1 = Wet Weather,1/2 inch of rain proceeded sampling by 1 hour on November 28, 2006;Temp.-72°F
W3 = Wet weather, rain during sampling, January 30, 2007; Temperature - 45° F
LS = Lab Split; FS = Field Split

Address (Block)	**Weather**	***E. coli* (MPN CFU / ml)**
Under Hopper Bridge	D (LS) W 1 W2 (FS) W3	130000 / 198600 11800 1700 / 1000 5200
West Side of Bayou - Cromwell Outfall	D (FS) W1	1000 / 600 98000
West Side of Bayou - Chamberlain Outfall	W1	13800
West Side of Bayou - William Tell Outfall	D W1	1000 141400
West Side of Bayou - Near Kowis Outfall	D W1 W2 (LS) W3	1500 13500 34500 / 48800 2900
Sunbelt Sewage Plant - Outfall	W1 W2	0 0

Table 2: *E. coli* quantifications from Halls Bayou samples.

D= Dry Weather, no rain 7 days, September 26, 2006; Temperature – 85° F
W1 = Wet Weather, ½ inches of rain preceded sampling by 1 hour on November 28, 2006**;** Temperature 72 ° F
W2 = Wet Weather, rain preceded sampling by 1 hour on December 11, 2006, 50 ° F
W3 = Wet weather, rain during sampling, January 30, 2007; Temperature - 45° F
LS = Laboratory Split FS = Field Split

Summary

Characterization of Individual On-Site Sewage Treatment Facilities failure requires a methodology to track fecal bacteria to a host origin. *E. coli* quantification is a useful technique to monitor fecal contamination in a water body but cannot be used to track contaminants to a host source. All samples on all of sampling dates, with the exception of the Sunbelt sewage plant, exceeded state mandated limits. These results implicate failing septic systems in the Westfield Estates area but definitive sources of the contamination cannot be elucidated from this study.

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Carbon Source Utilization Profiles as a Method for the Indication of Failing On-Site Sewage Treatment Facilities (OSSFs)

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Introduction

Individual On-Site Sewage Treatment Facilities (OSSFs) are prone to failure, releasing inadequately treated sewage and wastewater into surface and ground waters. Surveys estimate that as much as 17% of the stream pollution in some states is related to OSSF problems versus 13% associated with wastewater treatment plants, and 10% related to storm water. In 2001, an estimated 12% (17,800) of OSSFs in the Houston-Galveston Area Council (H-GAC) region were chronically malfunctioning. Common reasons for OSSF failure included age and design of the system, soil type, lot size, improper installation, lack of proper operation, and/or maintenance.

Malfunctioning OSSFs have the potential to create human health and water quality problems. Water borne pathogens from raw sewage may cause gastrointestinal infections, infectious hepatitis, cholera, and typhoid fever. While there is little hard evidence to connect human illness in the H-GAC region with the presence of pathogens from malfunctioning OSSFs, there is a potential impact to 60,000 people directly and hundreds of thousands, indirectly, through degraded water quality. Therefore, correlating individual malfunctioning OSSFs to fecal contamination isolated from surface and ground waters is the ultimate goal of this study. However, differentiating between human and non-human sources of fecal contamination remains problematic.

Determination of sources of fecal pollution in waters has recently advanced with the development of "microbial source tracking" methodologies. These procedures target numerous microbial markers (viral, bacterial, or protozoan) to apportion fecal contaminants to host sources (Soule *et al*., 2006). The identification of host-specific bacteria, also known as bacterial source tracking (BST) has been the subject of numerous reviews (Scott *et al*., 2002; Simpson *et al*., 2002; Meays *et al*., 2004). BST may use one of several methods to differentiate between potential sources of fecal contamination grouped into three major sources: human, livestock, or wildlife. In more urban watersheds, a fourth category of domesticated pets may be added. Each source produces unique, identifiable strains of fecal bacteria (*Escherichia coli*, *Enterococcus*, or *Streptococcus*) because the intestinal environments and selective pressures to which the bacteria are subjected differ from source to source (EPA, Water Technology – Bacterial Source Tracking, 2002).

The purpose of this study is to apply the work of Hagedorn et al (2003) using the commercial Biolog system to identify sources of fecal pollution in the HGAC region. Biolog's identification system is based on the bacterial isolates ability to use a specific carbon source. A bacterial isolate, in pure culture, is suspended into an inoculation fluid and subsequently pipetted into a 96 well microtitre plate, which contains 95 different carbon sources as well as a negative control. Carbon source utilization correlates to increased mitochondrial activity, leading to a color change in the wells and the production of a 96-well metabolic fingerprint. The resulting data, a series of positive and negative reactions, is interpreted by the Biolog software for identification and utilized for discriminant analyses.

Materials & Methods

Enterococcus libraries

Known source *Enterococcus* isolates were collected from fecal samples of three known hosts: human (5 subjects), dog (4 subjects) and chicken (2 subjects) residing proximal to the sampling locations. Fecal samples were diluted in Hach buffered dilution water (Hach Company, Loveland, CO) with 0.1 ml or 0.01 ml aliquots plated on mE agar (Healthlink Inc., Jacksonville, FL) and incubated at 41^{o} C for 48 h. One hundred twenty isolates from each known host were subcultured onto tryptic soy agar with 5% sheep's blood (Healthlink) at 35^{o} C for 72 h in preparation for Biolog (Hayward, CA) protocols. Briefly, each isolate was gram stained, tested for catalase and oxidase activity, and streaked onto Biolog Universal Growth (BUG) agar at 35^{o} C for 16-18 h. Liquid suspensions of each isolate were made in GN/GP inoculating fluid according to Biolog turbidity standards and inoculated into a 96-well GP2 MicroPlate ^{TM}. MicroPlates were incubated at 37^{o} C for 72 h and subsequently analyzed for substrate metabolism and identified to species with MicroLog ^{TM} System 4.2 software.

Unknown source isolates

Westfield Estates in Harris County, TX was chosen as a sampling site due to an evaluated need for public sewer services and a potential for its residents to be exposed to water-borne pathogens. Twenty six locations were selected in this area and multiple grab samples were taken at each with sterile 250 ml IDEXX bottles (IDEXX Laboratories, Westbrook, ME). All samples were stored on ice in a cooler and processed within 6 h. Aliquots of each sample were plated on mE agar and isolated for Biolog identification as described above.

Discriminant analysis

Data on the ability of known source *Enterococcus* isolates to metabolize substrates in each of the 95 wells (well A-1 is negative control) of the GP2 MicroPlate was analyzed by discriminant analysis (DA) with SAS-JMP statistical software (version 15.0, SAS Institute Inc., Cary, NC). DA has been recently used to classify *Enterococcus* to source by Hagedorn *et al*. (2003) and other researchers have used this statistical method to classify *E. coli* and fecal streptococci (Bower, 2001; Bowman *et al*., 2000, Harwood *et al*., 2000; Wiggins *et al*., 1999). Analysis by DA produces a classification set for every known source isolate. The average rate of correct classification (ARCC) is determined by averaging the percentages of correctly classified isolates for each source. Subsequently, a database is built for each known source (human, dog, chicken) and the DA compares each set of isolates from an unknown source against the database of known sources and then classifies each isolate into one of the possible sources. (Graves *et al*., 2002).

Results & Discussion

Library development

One hundred twenty presumptive *Enterococcus* isolates were isolated from each of the three known fecal sources (human, dog, chicken). However, after Biolog speciation, numerous colonies were identified as non-*Enterococcus* species and excluded from the library. Therefore, the resulting library was developed with 282 known source isolates, 96 from human, 92 from dog and 94 from chicken (Table 1). For a three-way classification of human vs. dog vs. chicken, the ARCC was 95.4% with human correctly classified 97.9% of the time. For a two-way classification of human vs. non-human the ARCC was 98.6% with human correctly classified 97.9% of the time (Table 2).

Libraries in the current study were modest in comparison to recent, related work but human vs. non-human ARCCs compared favorably to these studies. Graves *et al* (2002) reported a human vs. non-human ARCC of 96.29% with 1,174 *Enterococcus* isolates using antibiotic resistance analyses (ARA) and Hagedorn *et al* (2003) produced a 92.7% ARCC with 365 *Enterococcus* isolates using Biolog. Harwood *et al* (2000) used large (> 2,000 isolates) non-*Enterococcus* libraries with ARA but reported relatively low human vs. non-human ARCCs of 60.55% for fecal streptococci and 69.3% for fecal coliforms. Recent reports have suggested that source libraries may have geographic limitations and libraries from one watershed may not be applicable to nearby watersheds (Soule *et al*., 2006). Therefore, the high rates of ARCC of our relatively small source library may be linked to identifying host sources proximal to sampling locations.

Classification of unknown source isolates

One hundred fifty five *Enterococcus* isolates were identified from the Westfield Estates watershed and apportioned to source (Table 3). In a three-way classification of pooled results, 18.7% of isolates were identified as human, 34.2% as dog, 11.6% as chicken, and 35.5% did not fit into any of the three classifications.

Source	Species	No. in Library	Percent Composition
Human	*E. durans*	2	2.08
	E. faecalis	53	55.21
	E. faecium	23	23.96
	E. gallinarum	2	2.08
	E. raffinosus	1	1.04
	E. saccharolyticus	2	2.08
	E. spp.	13	12.50
	Total	**96**	**100.00**
Dog	*E. casseliflavus*	1	1.09
	E. faecalis	37	40.22
	E. faecium	20	21.74
	E. gallinarum	4	4.35
	E. hirae	2	2.17
	E. mundtii	2	2.17
	E. spp.	26	28.26
	Total	**92**	**100.00**
Chicken	*E. casseliflavus*	12	12.77
	E. faecalis	3	3.19
	E. faecium	9	9.57
	E. gallinarum	2	2.13
	E. spp.	68	72.34
	Total	**94**	**100.00**

Table 1. *Enterococcus spp*. composition of source libraries.

Classification Scheme	Source	Number of Isolates	% Correctly Classified
3-Way	Human	96	97.9
	Dog (Non-human)	92	95.7
	Chicken (Non-human)	94	92.6
	Total	**282**	**95.4***
2-Way	Human	96	97.9
	Non-human	186	98.9
	Total	**282**	**98.6***

*Average rate of correct classification (ARCC)

Table 2. Rates of correct classification by source based on discriminant analysis of *Enterococcus* libraries.

Classification Scheme	Known-Source Classification	Site 1	
		No. of Isolates	%
3-Way	Human	29	18.7
	Dog (Non-human)	53	34.2
	Chicken (Non-human)	18	11.6
	Unknown	55	35.5
	Total	155	100
2-Way	Human	32	20.6
	Non-human	95	61.3
	Unknown	28	18.1
	Total	155	100

Table 3. Classification of unknown source isolates.

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Classification Results for Individual *Enterococcus* Isolates

Sampling Date	Location	Species	3-Way[a]	2-Way[a]
September 18, 2006	2300 Warwick	*E. faecium*	Unknown	Nonhuman
September 18, 2006	2300 Warwick	*E. faecium*	Unknown	Nonhuman
September 18, 2006	2300 Warwick	*E. hirae*	Dog	Nonhuman
September 18, 2006	2400 B Warwick - FS-1	*E. faecium*	Unknown	Nonhuman
September 18, 2006	2400 B Warwick - FS-2	*E. faecium*	Dog	Nonhuman
September 18, 2006	2400 B Warwick - FS-2	*E. gallinarum*	Dog	Nonhuman
September 18, 2006	2400 B Warwick - FS-2	*E. gallinarum*	Dog	Nonhuman
September 18, 2006	2400 B Warwick - FS-2	*E. gallinarum*	Unknown	Nonhuman
September 18, 2006	2400 B Warwick - FS-2	*E. hirae*	Human	Human
September 18, 2006	2500 A Cromwell	*E. durans*	Human	Human
September 18, 2006	2500 A Cromwell	*E. faecium*	Chicken	Unknown
September 18, 2006	2500 B Kowis - FS-2	*E. durans*	Human	Human
September 18, 2006	2500 C Cromwell	*E. faecium*	Unknown	Unknown
September 18, 2006	2500 C Cromwell	*E. gallinarum*	Dog	Nonhuman
September 18, 2006	2606 Cromwell	*E. mundtii*	Dog	Nonhuman
September 18, 2006	2600 A William Tell	*E. mundtii*	Human	Human
September 18, 2006	2600 A William Tell	*E. spp.*	Human	Human
September 18, 2006	2600 B William Tell	*E. spp.*	Unknown	Unknown
September 18, 2006	2600 B William Tell	*E. faecalis*	Unknown	Unknown
September 18, 2006	2600 B William Tell	*E. spp.*	Unknown	Unknown
September 18, 2006	2700 William Tell A	*E. mundtii*	Chicken	Unknown
September 18, 2006	2700 William Tell B	*E. gallinarum*	Dog	Nonhuman
September 18, 2006	2700 William Tell B	*E. gallinarum*	Dog	Nonhuman
September 18, 2006	2700 Kowis	*E. faecium*	Unknown	Nonhuman
September 18, 2006	2700 Kowis	*E. mundtii*	Unknown	Unknown

September 18, 2006	2700 Kowis	*E. spp.*	Human	Human
September 18, 2006	Halls Bayou	*E. mundtii*	Unknown	Nonhuman
September 18, 2006	Storm Puddle	*E. faecalis*	Dog	Nonhuman
September 18, 2006	Storm Puddle	*E. faecium*	Dog	Nonhuman
September 26, 2006	2300 Warwick - FS-1	*E. faecalis*	Dog	Nonhuman
September 26, 2006	2300 Warwick - FS-1	*E. spp.*	Human	Human
September 26, 2006	2300 Warwick - FS-1	*E. spp.*	Human	Human
September 26, 2006	2300 Warwick - FS-1	*E. spp.*	Unknown	Human
September 26, 2006	2300 Warwick - FS-2	*E. faecalis*	Dog	Nonhuman
September 26, 2006	2300 Warwick - FS-2	*E. faecalis*	Dog	Nonhuman
September 26, 2006	2300 Warwick - FS-2	*E. spp.*	Unknown	Nonhuman
September 26, 2006	2300 Warwick - FS-2	*E. spp.*	Unknown	Nonhuman
September 26, 2006	2300 Warwick - FS-2	*E.spp.*	Human	Human
September 26, 2006	2400 Warwick	*E. faecalis*	Dog	Nonhuman
September 26, 2006	2400 Warwick	*E. faecalis*	Human	Human
September 26, 2006	2400 Warwick	*E. flavescens*	Human	Human
September 26, 2006	2400 Warwick	*E. gallinarum*	Chicken	Nonhuman
September 26, 2006	2500 A Kowis	*E. dispar*	Chicken	Nonhuman
September 26, 2006	2500 A Kowis	*E. durans*	Unknown	Unknown
September 26, 2006	2500 A Kowis	*E. faecalis*	Human	Human
September 26, 2006	2500 A Kowis	*E. spp.*	Unknown	Unknown
September 26, 2006	2500 A Kowis	*E. spp.*	Unknown	Nonhuman
September 26, 2006	2500 A Kowis	*E. spp.*	Unknown	Nonhuman
September 26, 2006	2500 B Kowis	*E. casseliflavus*	Chicken	Nonhuman
September 26, 2006	2500 B Kowis	*E. faecalis*	Dog	Nonhuman
September 26, 2006	2500 B Kowis	*E. spp.*	Unknown	Nonhuman
September 26, 2006	2500 C Cromwell	*E. casseliflavus*	Chicken	Nonhuman

September 26, 2006	2500 C Cromwell	*E. casseliflavus*	Chicken	Nonhuman
September 26, 2006	2500 C Cromwell	*E. gallinarum*	Unknown	Unknown
September 26, 2006	2500 C Cromwell	*E. gallinarum*	Unknown	Unknown
September 26, 2006	2500 C Cromwell	*E. mundtii*	Dog	Nonhuman
September 26, 2006	2600 Cromwell - LS-1	*E. faecalis*	Dog	Nonhuman
September 26, 2006	2600 Cromwell - LS-1	*E. faecalis*	Unknown	Nonhuman
September 26, 2006	2600 Cromwell - LS-1	*E. faecium*	Dog	Nonhuman
September 26, 2006	2600 Cromwell - LS-1	*E. faecium*	Dog	Nonhuman
September 26, 2006	2600 Cromwell - LS-1	*E. mundtii*	Dog	Nonhuman
September 26, 2006	2600 Cromwell - LS-1	*E. spp.*	Unknown	Nonhuman
September 26, 2006	2600 Cromwell - LS-1	*E. spp.*	Unknown	Nonhuman
September 26, 2006	2600 Cromwell - LS-1	*E. spp.*	Unknown	Unknown
September 26, 2006	2600 Cromwell - LS-1	*E.spp.*	Human	Human
September 26, 2006	2600 Cromwell - LS-2	*E. spp.*	Human	Human
September 26, 2006	2600 A William Tell	*E. faecalis*	Dog	Nonhuman
September 26, 2006	2600 A William Tell	*E. faecium*	Dog	Nonhuman
September 26, 2006	2600 A William Tell	*E. faecium*	Dog	Nonhuman
September 26, 2006	2600 A William Tell	*E. faecium*	Dog	Nonhuman
September 26, 2006	2600 A William Tell	*E. faecium*	Dog	Unknown
September 26, 2006	2600 A William Tell	*E. faecium*	Dog	Unknown
September 26, 2006	2600 A William Tell	*E. faecium*	Dog	Unknown
September 26, 2006	2600 A William Tell	*E. faecium*	Human	Human
September 26, 2006	2600 A William Tell	*E. faecium*	Unknown	Unknown
September 26, 2006	2600 A William Tell	*E. faecium*	Unknown	Unknown
September 26, 2006	2600 B William Tell	*E. flavescens*	Human	Human
September 26, 2006	2600 B William Tell	*E. gallinarum*	Human	Human
September 26, 2006	2700 Kowis	*E. faecium*	Human	Human
September 26,	2700 Kowis	*E. faecium*	Unknown	Human

2006				
September 26, 2006	2700 Kowis	*E. mundtii*	Dog	Nonhuman
September 26, 2006	2700 Kowis	*E. spp.*	Human	Human
September 26, 2006	2700 Kowis	*E. spp.*	Unknown	Unknown
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. casseliflavus*	Unknown	Nonhuman
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. faecalis*	Dog	Nonhuman
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. faecalis*	Dog	Nonhuman
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. faecium*	Dog	Nonhuman
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. faecium*	Dog	Nonhuman
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. faecium*	Human	Human
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. spp.*	Dog	Nonhuman
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. spp.*	Human	Human
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. spp.*	Unknown	Unknown
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	*E. spp.*	Unknown	Unknown
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-2	*E. spp.*	Human	Human
November 28, 2006	2100 A Warwick - LS-1	*E. casseliflavus*	Chicken	Nonhuman
November 28, 2006	2100 A Warwick - LS-1	*E. spp.*	Dog	Nonhuman
November 28, 2006	2100 A Warwick - LS-2	*E. mundtii*	Dog	Nonhuman
November 28, 2006	2100 A Warwick - LS-2	*E. mundtii*	Dog	Nonhuman
November 28, 2006	2100 A William Tell - LS-1	*E. gallinarum*	Dog	Nonhuman
November 28, 2006	2100 A William Tell - LS-1	*E. spp.*	Dog	Nonhuman
November 28, 2006	2100 A William Tell - LS-2	*E. spp.*	Chicken	Nonhuman
November 28, 2006	2100 A William Tell - LS-2	*E. spp.*	Unknown	Human
November 28, 2006	2300 Warwick	*E. faecalis*	Unknown	Nonhuman
November 28, 2006	2300 Warwick	*E. spp.*	Human	Human
November 28, 2006	2400 Warwick	*E. spp.*	Chicken	Nonhuman
November 28, 2006	2500 A Kowis	*E. faecalis*	Unknown	Nonhuman
November 28, 2006	2500 A Kowis	*E. spp.*	Human	Human

November 28, 2006	2500 A Cromwell - LS-1	*E. spp.*	Chicken	Nonhuman
November 28, 2006	2500 A Cromwell - LS-2	*E. faecalis*	Dog	Nonhuman
November 28, 2006	2500 A Cromwell - LS-2	*E. flavescens*	Chicken	Nonhuman
November 28, 2006	2500 B Cromwell	*E. faecium*	Dog	Nonhuman
November 28, 2006	2500 B Kowis	*E. spp.*	Chicken	Nonhuman
November 28, 2006	2500 Kowis Puddle	*E. faecalis*	Chicken	Nonhuman
November 28, 2006	2500 Kowis Puddle	*E. spp.*	Unknown	Nonhuman
November 28, 2006	2500 C Cromwell	*E. faecium*	Dog	Nonhuman
November 28, 2006	2500 C Cromwell	*E. spp.*	Unknown	Nonhuman
November 28, 2006	2600 Cromwell	*E. casseliflavus*	Dog	Nonhuman
November 28, 2006	2600 Cromwell	*E. spp.*	Unknown	Unknown
November 28, 2006	2600 A William Tell	*E. spp.*	Unknown	Nonhuman
November 28, 2006	2600 B William Tell	*E. spp.*	Unknown	Unknown
November 28, 2006	2700 William Tell A	*E. spp.*	Dog	Nonhuman
November 28, 2006	2700 Trenton - FS-1	*E. spp.*	Unknown	Unknown
November 28, 2006	2700 Trenton - FS-2	*E. spp.*	Unknown	Unknown
November 28, 2006	2722 Kowis - FS-1	*E. faecalis*	Dog	Nonhuman
November 28, 2006	2700 Kowis - FS-1	*E. faecalis*	Dog	Nonhuman
November 28, 2006	2700 Kowis - FS-2	*E. faecalis*	Chicken	Nonhuman
November 28, 2006	2700 Kowis - FS-2	*E. spp.*	Unknown	Nonhuman
November 28, 2006	Chamberlain Outfall	*E. faecalis*	Unknown	Nonhuman
November 28, 2006	Chamberlain Outfall	*E. spp.*	Chicken	Nonhuman
November 28, 2006	Cromwell Outfall	*E. faecalis*	Dog	Nonhuman
November 28, 2006	Cromwell Outfall	*E. faecalis*	Dog	Nonhuman
November 28, 2006	Cromwell Outfall	*E. spp.*	Dog	Nonhuman
November 28, 2006	Halls Bayou	*E. spp.*	Unknown	Nonhuman
November 28, 2006	Halls Bayou	*E. spp.*	Unknown	Nonhuman
November 28,	William Tell Outfall	*E. faecalis*	Dog	Nonhuman

2006				
November 28, 2006	William Tell Outfall	*E. spp.*	Unknown	Nonhuman
December 11, 2006	E. Side Under Bridge - FS-1	*E. faecalis*	Unknown	Unknown
December 11, 2006	E. Side Under Bridge - FS-1	*E. spp.*	Unknown	Unknown
December 11, 2006	E. Side Under Bridge - FS-2	*E. casseliflavus*	Chicken	Nonhuman
December 11, 2006	E. Side Under Bridge - FS-2	*E. faecalis*	Chicken	Nonhuman
December 11, 2006	E. Side Under Bridge - FS-2	*E. faecalis*	Human	Human
December 11, 2006	E. Side Under Bridge - FS-2	*E. faecalis*	Unknown	Unknown
December 11, 2006	E. Side Under Bridge - FS-2	*E. faecalis*	Unknown	Nonhuman
December 11, 2006	E. Side Under Bridge - FS-2	*E. faecium*	Dog	Nonhuman
December 11, 2006	Halls Bayou - LS-1	*E. avium*	Human	Human
December 11, 2006	Halls Bayou - LS-1	*E. faecalis*	Human	Human
December 11, 2006	Halls Bayou - LS-1	*E. faecalis*	Human	Human
December 11, 2006	Halls Bayou - LS-1	*E. faecalis*	Unknown	Nonhuman
December 11, 2006	Halls Bayou - LS-1	*E. spp.*	Unknown	Unknown
December 11, 2006	Halls Bayou - LS-2	*E. faecalis*	Dog	Nonhuman
December 11, 2006	Halls Bayou - LS-2	*E. faecalis*	Unknown	Nonhuman
December 11, 2006	Halls Bayou - LS-2	*E. pseudoavium*	Human	Human
December 11, 2006	Halls Bayou - LS-2	*E. spp.*	Dog	Nonhuman
December 11, 2006	Halls Bayou - LS-2	*E. spp.*	Dog	Nonhuman
December 11, 2006	Halls Bayou - LS-2	*E. spp.*	Unknown	Nonhuman
January 30, 2007	2600 A Cromwell	*E. faecalis*	Human	Human
January 30, 2007	2600 A Cromwell	*E. spp.*	Dog	Nonhuman
January 30, 2007	2600 A Cromwell	*E. mundtii*	Dog	Unknown
January 30, 2007	2600 A Cromwell	*E. faecium*	Unknown	Nonhuman
January 30, 2007	2600 A Cromwell	*E. spp.*	Dog	Unknown
January 30, 2007	2600 A Cromwell	*E. spp.*	Human	Nonhuman
January 30, 2007	2600 A Cromwell	*E. casseliflavus*	Chicken	Unknown
January 30, 2007	2600 A Cromwell	*E. mundtii*	Dog	Nonhuman
January 30, 2007	2600 A Cromwell	*E. faecium*	Dog	Nonhuman
January 30, 2007	2600 A Cromwell	*E. casseliflavus*	Chicken	Nonhuman

January 30, 2007	2600 A Cromwell	*E. casseliflavus*	Chicken	Nonhuman
January 30, 2007	2600 A Cromwell	*E. faecalis*	Unknown	Nonhuman
January 30, 2007	2600 A Cromwell	*E. mundtii*	Dog	Human
January 30, 2007	2600 A Cromwell	*E. casseliflavus*	Chicken	Nonhuman
January 30, 2007	2600 A Cromwell	*E. faecium*	Unknown	Nonhuman
January 30, 2007	2600 A Cromwell	*E. spp.*	Chicken	Nonhuman
January 30, 2007	2600 A Cromwell	*E. mundtii*	Dog	Nonhuman
January 30, 2007	2600 A Cromwell	*E. mundtii*	Unknown	Nonhuman
January 30, 2007	2600 A Cromwell	*E. spp.*	Chicken	Nonhuman
January 30, 2007	260 A Cromwell	*E. mundtii*	Dog	Nonhuman
January 30, 2007	2700 Kowis	*E. faecalis*	Unknown	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Chicken	Nonhuman
January 30, 2007	2700 Kowis	*E. durans*	Chicken	Nonhuman
January 30, 2007	2700 Kowis	*E. faecalis*	Human	Human
January 30, 2007	2700 Kowis	*E. spp.*	Dog	Human
January 30, 2007	2700 Kowis	*E. faecalis*	Unknown	Nonhuman
January 30, 2007	2700 Kowis	*E. faecalis*	Chicken	Nonhuman
January 30, 2007	2700 Kowis	*E. faecalis*	Unknown	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Chicken	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Unknown	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Chicken	Nonhuman
January 30, 2007	2700 Kowis	*E. faecium*	Dog	Human
January 30, 2007	2700 Kowis	*E. faecalis*	Chicken	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Chicken	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Dog	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Unknown	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Dog	Nonhuman
January 30, 2007	2700 Kowis	*E. faecalis*	Chicken	Nonhuman
January 30, 2007	2700 Kowis	*E. spp.*	Chicken	Nonhuman
January 30, 2007	Halls Bayou	*E. faecalis*	Unknown	Unknown
January 30, 2007	Halls Bayou	*E. spp.*	Unknown	Nonhuman
January 30, 2007	Halls Bayou	*E. spp.*	Chicken	Nonhuman
January 30, 2007	E. Side Under Bridge	*E. spp.*	Unknown	Nonhuman
January 30, 2007	E. Side Under Bridge	*E. faecalis*	Unknown	Nonhuman
January 30, 2007	E. Side Under Bridge	*E. faecalis*	Chicken	Nonhuman
	Percentages	Human	16.00	18.50
		Dog	32.50	N/A
		Chicken	17.50	N/A
		Nonhuman	N/A	65.50
		Unknown	34.00	16.00

Number of *Enterococcus spp*. Isolated (3-Way Classification)

Sampling Date	Location	Number of Isolates			
		Human	Dog	Chicken	Unknown[a]
September 18, 2006	2300 Warwick		1		2
September 18, 2006	2400 Warwick - FS-1				1
September 18, 2006	2400 B Warwick - FS-2	1	3		1
September 18, 2006	2500 A Cromwell	1		1	
September 18, 2006	2500 Kowis - FS-2	1			
September 18, 2006	2500 C Cromwell		1		1
September 18, 2006	2600 Cromwell		1		
September 18, 2006	2600 A William Tell	2			1
September 18, 2006	2600 B William Tell				2
September 18, 2006	2700 William Tell A			1	
September 18, 2006	2700 William Tell B		2		
September 18, 2006	2700 Kowis	1			2
September 18, 2006	Halls Bayou				1
September 18, 2006	Storm Puddle		2		
September 26, 2006	2300 Warwick - FS-1	2	1		1
September 26, 2006	2300 Warwick - FS-2	1	2		2
September 26, 2006	2400 B Warwick	2	1	1	
September 26, 2006	2500 A Kowis	1		1	4
September 26, 2006	2500 B Kowis		1	1	1
September 26, 2006	2500 C Cromwell		1	2	2
September 26, 2006	2600 Cromwell - LS-1	1	4		4
September 26, 2006	2600 Cromwell - LS-2	1			
September 26, 2006	2600 A William Tell	1	7		2
September 26, 2006	2600 B William Tell	2			
September 26, 2006	2700 Kowis	2	1		2
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	2	5		3
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-2	1			
November 28, 2006	2100 A Warwick - LS-1		1	1	
November 28, 2006	2100 A Warwick - LS-2		2		
November 28, 2006	2100 B William Tell - LS-1		2		
November 28, 2006	2100 B William Tell - LS-2			1	1
November 28, 2006	2302 Warwick	1			1
November 28, 2006	2400 C Warwick			1	
November 28, 2006	2500 Kowis	1			1
November 28, 2006	2500 A Cromwell - LS-1			1	
November 28, 2006	2500 A Cromwell - LS-2		1	1	
November 28, 2006	2500 A Cromwell		1		
November 28, 2006	2500 B Kowis			1	
November 28, 2006	2500 Kowis Puddle			1	1
November 28, 2006	2500 C Cromwell		1		1
November 28, 2006	2600 Cromwell		1		1
November 28, 2006	2600 A William Tell				1
November 28, 2006	2600 A William Tell				1
November 28, 2006	2700 William Tell A		1		

November 28, 2006	2700 Trenton - FS-1				1
November 28, 2006	2700 Trenton - FS-2				1
November 28, 2006	2700 Kowis - FS-1		2		
November 28, 2006	2700 Kowis - FS-2			1	1
November 28, 2006	Chamberlain Outfall			1	1
November 28, 2006	Cromwell Outfall		3		
November 28, 2006	Halls Bayou				2
November 28, 2006	William Tell Outfall		1		1
December 11, 2006	E. Side Under Bridge - FS-1				2
December 11, 2006	E. Side Under Bridge - FS-2	1	1	2	2
December 11, 2006	Halls Bayou - LS-1	3			2
December 11, 2006	Halls Bayou - LS-2	1	3		2
January 30, 2007	2600 A Cromwell	2	8	6	4
January 30, 2007	2700 Kowis	1	4	9	5
January 30, 2007	Halls Bayou			1	2
January 30, 2007	E. Side Under Bridge			1	2
	Percentages	**16.00**	**32.50**	**17.50**	**34.00**

Number of *Enterococcus spp*. Isolated by Location (3-Way Classification)

Location	Number of Isolates			
	Human	Dog	Chicken	Unknown[a]
2100 Warwick[b]		3	1	
2100 William Tell[b]		2	1	1
2300 Warwick[b]	4	4		6
2400 Warwick[b]	3	4	1	2
2400 Warwick			1	
2500 A Kowis	2		1	5
2500 A Cromwell[b]		1	2	
2500 A Cromwell	1	1	1	
2500 B Kowis[b]	1	1	2	1
2500 Kowis Puddle			1	1
2500 A Cromwell		2		2
2500 B Cromwell		1	2	2
2600 Cromwell		1		1
2600 Cromwell[b]	2	5		4
2600 A William Tell	3	7		4
2600 A William Tell	2			3
2700 William Tell A		1	1	
2700 William Tell B		2		
2700 Trenton[b]				2
2700 Kowis[b]	4	7	10	10
Chamberlain Outfall			1	1
Cromwell Outfall		3		
E. Side Under Bridge / Halls Bayou[b]	4	6	3	9
Halls Bayou[b]	4	3	1	9
Storm Puddle		2		
William Tell Outfall		1		1
2600 A Cromwell	2	8	6	4
Percentages	**16.00**	**32.50**	**17.50**	**34.00**

Percent correct classification of library: Average 98.6%; 97.9% Human; 98.9% Non-Human.
a Cutoff for unknowns P<0.95
b Includes lab and/or field splits

Number of *Enterococcus spp*. Isolated (2-Way Classification)

Sampling Date	Location	Number of Isolates		
		Human	Nonhuman	Unknown[a]
September 18, 2006	2300 Warwick		3	
September 18, 2006	2400 Warwick - FS-1		1	
September 18, 2006	2400 Warwick - FS-2	1	4	
September 18, 2006	2500 Cromwell	1		1
September 18, 2006	2500 B Kowis - FS-2	1		
September 18, 2006	2500 Cromwell		1	1
September 18, 2006	2600 Cromwell		1	
September 18, 2006	2600 A William Tell	2		1
September 18, 2006	2600 B William Tell			2
September 18, 2006	2700 William Tell A			1
September 18, 2006	2700 William Tell B		2	
September 18, 2006	2700 Kowis	1	1	1
September 18, 2006	Halls Bayou		1	
September 18, 2006	Storm Puddle		2	
September 26, 2006	2300 Warwick - FS-1	3	1	
September 26, 2006	2300 Warwick - FS-2	1	4	
September 26, 2006	2400 Warwick	2	2	
September 26, 2006	2500 A Kowis	1	3	2
September 26, 2006	2500 B Kowis		3	
September 26, 2006	2500 C Cromwell		3	2
September 26, 2006	2600 Cromwell - LS-1	1	7	1
September 26, 2006	2600 Cromwell - LS-2	1		
September 26, 2006	2600 A William Tell	1	4	5
September 26, 2006	2600 B William Tell	2		
September 26, 2006	2700 Kowis	3	1	1

September 26, 2006	E Side Under Bridge / Halls Bayou - LS-1	2	6	2
September 26, 2006	E Side Under Bridge / Halls Bayou - LS-2	1		
November 28, 2006	2100 A Warwick - LS-1		2	
November 28, 2006	2100 A Warwick - LS-2		2	
November 28, 2006	2100 B William Tell - LS-1		2	
November 28, 2006	2100 B William Tell - LS-2	1	1	
November 28, 2006	2300 Warwick	1	1	
November 28, 2006	2400 B Warwick		1	
November 28, 2006	2500 Kowis	1	1	
November 28, 2006	2500 A Cromwell - LS-1		1	
November 28, 2006	2500 A Cromwell - LS-2		2	
November 28, 2006	2500 B Cromwell		1	
November 28, 2006	2500 A Kowis		1	
November 28, 2006	2500 Kowis Puddle		2	
November 28, 2006	2500 Cromwell		2	
November 28, 2006	2600 Cromwell		1	1
November 28, 2006	2600 A William Tell		1	
November 28, 2006	2600 A William Tell			1
November 28, 2006	2700 William Tell A		1	
November 28, 2006	2700 Trenton - FS-1			1
November 28, 2006	2700 Trenton - FS-2			1
November 28, 2006	2700 Kowis - FS-1		2	
November 28, 2006	2700 Kowis - FS-2		2	
November 28, 2006	Chamberlain Outfall		2	
November 28, 2006	Cromwell Outfall		3	
November 28, 2006	Halls Bayou		2	
November 28, 2006	William Tell Outfall		2	
December 11, 2006	E. Side Under Bridge - FS-1			2
December 11, 2006	E. Side Under Bridge - FS-2	1	4	1
December 11, 2006	Halls Bayou - LS-1	3	1	1
December 11, 2006	Halls Bayou - LS-2	1	5	
January 30, 2007	2600 A Cromwell	2	15	3
January 30, 2007	2700 Kowis	3	16	
January 30, 2007	Halls Bayou		2	1
January 30, 2007	E. Side Under Bridge		3	
	Percentages	**18.50**	**65.50**	**16.00**

Number of *Enterococcus spp*. Isolated by Location (2-Way Classification)

Location	Number of Isolates		
	Human	Nonhuman	Unknown[a]
2140 Warwick[b]		4	
2147 William Tell[b]	1	3	
2302 Warwick[b]	5	9	
2420 Warwick[b]	3	7	
2470 Warwick		1	
2522 Kowis	2	4	2
2531 Cromwell[b]		3	
2533 Cromwell	1	1	1
2537 Kowis[b]	1	4	
2537 Kowis Puddle		2	
2541 Cromwell		3	1
2542 Cromwell		3	2
2600 Cromwell		1	1
2606 Cromwell[b]	2	8	1
2617 William Tell	3	5	6
2618 William Tell	2		3
2706 William Tell A		1	1
2706 William Tell B		2	
2711 Trenton[b]			2
2722 Kowis[b]	7	22	2
Chamberlain Outfall		2	
Cromwell Outfall		3	
E. Side Under Bridge / Halls Bayou[b]	4	13	5
Halls Bayou[b]	4	11	2
Storm Puddle		2	
William Tell Outfall		2	
2601 Cromwell	2	15	3
Percentages	**18.50**	**65.50**	**16.00**

Percent correct classification of library: Average 98.6%; 97.9% Human; 98.9% Non-Human.
a Cutoff for unknowns P<0.95
b Includes lab and/or field splits

Number of *Enterococcus spp*. Isolated by Location (2-Way Classification)

Location	Number of Isolates		
	Human	Nonhuman	Unknown[a]
2140 Warwick[b]		4	
2147 William Tell[b]	1	3	
2302 Warwick[b]	5	9	
2420 Warwick[b]	3	7	
2470 Warwick		1	
2522 Kowis	2	4	2
2531 Cromwell[b]		3	
2533 Cromwell	1	1	1
2537 Kowis[b]	1	4	
2537 Kowis Puddle		2	
2541 Cromwell		3	1
2542 Cromwell		3	2
2600 Cromwell		1	1
2606 Cromwell[b]	2	8	1
2617 William Tell	3	5	6
2618 William Tell	2		3
2706 William Tell A		1	1
2706 William Tell B		2	
2711 Trenton[b]			2
2722 Kowis[b]	7	22	2
Chamberlain Outfall		2	
Cromwell Outfall		3	
E. Side Under Bridge / Halls Bayou[b]	4	13	5
Halls Bayou[b]	4	11	2
Storm Puddle		2	
William Tell Outfall		2	
2601 Cromwell	2	15	3
Percentages	**18.50**	**65.50**	**16.00**

Percent correct classification of library: Average 98.6%; 97.9% Human; 98.9% Non-Human.
a Cutoff for unknowns P<0.95
b Includes lab and/or field splits

MicroLog™ Worksheet (SOP-23)
Hygeia Laboratories Inc.

Hygeia Reference No. ____________________

Date Analyzed ____________________

Analyst ____________________

Hygeia Sample ID/Isolate ____________________

BUG Streak		
Date	Time	Initials

↓ Incubate 16-18 hours

Gram

+ (GP) - (GN)

Morphology

Coccus (C) Bacillus (B)

(GP) → Catalase: + -

(GN) → Oxidase: + (NENT) - (ENT)

TSI Slant? Y / N

Code: GP-C GP-R GP-R SB

GN-FAS GN-NENT GN-ENT

↓ Blank Turbidometer (100% Trans)

Standard Transmittance ____________ %

↓ Add 3 drops sodium thioglycalate for all but GP-R SB & GN-NENT

Create Inoculum (±2% standard)

Inoculum Transmittance ____________ %

*****Inoculate MicroPlate™ within 20 minutes*****

MicroPlate™ Inoculated		
Date	Time	Initials

↓ Incubate 4-6 & 16-24 hours

Positive (+) Negative (-) Borderline (B)

A12	B12	C12	D12	E12	F12	G12	H12
A11	B11	C11	D11	E11	F11	G11	H11
A10	B10	C10	D10	E10	F10	G10	H10
A9	B9	C9	D9	E9	F9	G9	H9
A8	B8	C8	D8	E8	F8	G8	H8
A7	B7	C7	D7	E7	F7	G7	H7
A6	B6	C6	D6	E6	F6	G6	H6
A5	B5	C5	D5	E5	F5	G5	H5
A4	B4	C4	D4	E4	F4	G4	H4
A3	B3	C3	D3	E3	F3	G3	H3
A2	B2	C2	D2	E2	F2	G2	H2
A1	B1	C1	D1	E1	F1	G1	H1

Identification ____ % ____________________

____ % ____________________

____ % ____________________

____ % ____________________

Sampling Date: September 18, 2006

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

September 20, 2006

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Ms. Kathleen Ramsey
Houston-Galveston Area Council
3555 Timmons
Houston, TX 77227

EV5501 Failing Septic System Initiative

Hygeia Reference No.: **31980060001HO**
Date Collected: September 18, 2006
Date Received: September 18, 2006
Date Analyzed: September 19, 2006
Samples Analyzed: 24

Hygeia Sample ID	48300-1b	48300-2b	48301b	48302b
Client Sample ID	**#1**	**#1**	**#2**	**#3**
Location	2420 Warwick - Field Split	2420 Warwick - Field Split	2302 Warwick	2140 Warwick
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Colilert® / Colisure® with MUG*

Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	>2,420	>24
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	>2,420	>24

Enterolert with MUG*

Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments	*Field Split RPD = 0.00*	*Field Split RPD = 0.00*		

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060001HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	48303b	48304-1b QC X	48304-2b	48305b
Client Sample ID	**#4**	**#5**	**#5**	**#6**
Location	2142 Warwick	2431 Cromwell - Lab Split	2431 Cromwell - Lab Split	2541 Cromwell
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Colilert® / Colisure® with MUG*

	48303b		48304-1b		48304-2b		48305b	
Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	>2,420	>24
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	1,986	20	1,733	17	>2,420	>24

Enterolert with MUG*

	48303b		48304-1b		48304-2b		48305b	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments		*Lab Split RPD = 1.48*	*Lab Split RPD = 1.48*	

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060001HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	48306b	48307b	48308b	48309-1b
Client Sample ID	**#7**	**#8**	**#9**	**#10**
Location	2542 Cromwell	2606 Cromwell	2722 Kowis	2537 Kowis - Field Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Colilert® / Colisure® with MUG*

	#7		#8		#9		#10	
Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	>2,420	>24
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	>2,420	>24

Enterolert with MUG*

	#7		#8		#9		#10	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				*Field Split RPD = 0.00*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060001HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	48309-2b	48310b	48311b	48312b
Client Sample ID	**#10**	**#11**	**#12**	**#13**
Location	2537 Kowis - Field Split	Storm Puddle	2706 William Tell A	2706 William Tell B
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Colilert® / Colisure® with MUG*

	#10		#11		#12		#13	
Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	>2,420	>24
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	>2,420	>24

Enterolert with MUG*

	#10		#11		#12		#13	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments	#10	#11	#12	#13
	Field Split RPD = 0.00			

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060001HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	48313b	48314b	48315-1b	48315-2b
Client Sample ID	**#14**	**#15**	**#16**	**#16**
Location	2617 William Tell	2618 William Tell	2147 William Tell - Lab Split	2147 William Tell - Lab Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Colilert® / Colisure® with MUG*

	48313b		48314b		48315-1b		48315-2b	
Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	>2,420	>24
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	2,420	24

Enterolert with MUG*

	48313b		48314b		48315-1b		48315-2b	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments			*Lab Split RPD = 0.00*	*Lab Split RPD = 0.00*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060001HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	48316b	48317b	48318b	48320b
Client Sample ID	**#17**	**#18**	**#19**	**#21**
Location	Hall Bayou	2522 Kowis	2533 Cromwell	Trip Blank
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Colilert® / Colisure® with MUG*

	#17		#18		#19		#21	
Coliforms	**Present**		**Present**		**Present**		**Absent**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	>2,420	>24	>2,420	>24	n/a	n/a
Escherichia coli	**Present**		**Present**		**Present**		**Absent**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>24	2,420	24	>2,420	>24	n/a	n/a

Enterolert with MUG*

	#17		#18		#19		#21	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				

CFU = colony forming units

*MUG = 4-methylumbelliferyl-β-D-glucuronide, a sensitive confirmation indicator for *E. coli* and Enterococcus group

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Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

September 21, 2006

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EV5501 Failing Septic System Initiative

Hygeia Reference No.: **31980060001HO**
Date Collected: September 18, 2006
Date Received: September 18, 2006
Date Analyzed: September 20, 2006
Samples Analyzed: 24

Hygeia Sample ID	48300-1a		48300-2a		48301a		48302a	
Client Sample ID	**#1**		**#1**		**#2**		**#3**	
Location	2420 Warwick - Field Split		2420 Warwick - Field Split		2302 Warwick		2140 Warwick	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.1 mL	
Media Used	m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	1	100	2	200	26	2,600	0	
Fecal Streptococci	383	38,300	413	41,300	63	6,300	21	210
Enterococcus	2	200	2	200	14	1,400	0	
Total CFU	38,600 / mL		41,700 / mL		10,300 / mL		210 / mL	
Comments	*FC:FS = 0.003 (non-human) Field split RPD = 3.83*		*FC:FS = 0.002 (non-human) Field split RPD = 3.83*		*FC:FS = 0.413 (non-human)*		*m-FC plate reacted adversely with sample due to possible chem rxn*	

 kk

Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

Hygeia Reference No.: 31980060001HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	48303a		48304-1a		48304-2a		48305a	
Client Sample ID	**#4**		**#5**		**#5**		**#6**	
Location	2142 Warwick		2431 Cromwell - Lab Split		2431 Cromwell - Lab Split		2541 Cromwell	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		1 mL		0.1 mL		0.1 mL	
Media Used	m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	112	11,200	0		0		2	20
Fecal Streptococci	1	100	12	12	21	210	65	650
Enterococcus	0		0		0		1	10
Total CFU	11,300 / mL		12 / mL		210 / mL		680 / mL	
Comments	*FC:FS = 112 (human)*		*m-FC plate reacted adversely with sample; Lab split RPD = 13.63*		*m-FC plate reacted adversely with sample; Lab split RPD = 13.63*		*FC:FS = 0.031 (non-human)*	

Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

Hygeia Reference No.: 31980060001HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	48306a		48307a		48308a		48309-1a	
Client Sample ID	**#7**		**#8**		**#9**		**#10**	
Location	2542 Cromwell		2606 Cromwell		2722 Kowis		2537 Kowis - Field Split	
Sample Type	water		water		water		water	
Sample Amount	0.1 mL		0.1 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	5	50	1	10	0		15	1,500
Fecal Streptococci	24	240	11	110	24	2,400	94	9,400
Enterococcus	0		1	10	8	800	0	
Total CFU	290 / mL		130 / mL		3,200 / mL		10,900 / mL	
Comments	*FC:FS = 0.250 (non-human)*		*FC:FS =0.091 (non-human)*		*FC:FS =0.000 (non-human)*		*FC:FS = 0.160 (non-human) Field split RPD = 1.34*	

 kk

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060001HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	48309-2a		48310a		48311a		48312a	
Client Sample ID	**#10**		**#11**		**#12**		**#13**	
Location	2537 Kowis - Field Split		Storm Puddle		2706 William Tell A		2706 William Tell B	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	5	500	2	200	12	1,200	1	100
Fecal Streptococci	109	10,900	37	3,700	11	1,100	56	5,600
Enterococcus	1	100	4	400	1	100	10	1,000
Total CFU	11,500 / mL		4,300 / mL		2,400 / mL		6,700 / mL	
Comments	*FC:FS = 0.046 (non-human)* *Field split RPD = 1.34*		*FC:FS = 0.054 (non-human)*		*FC:FS = 1.091 (mixed)*		*FC:FS = 0.018 (non-human)*	

 kk

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060001HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	48313a		48314a		48315-1a		48315-2a	
Client Sample ID	**#14**		**#15**		**#16**		**#16**	
Location	2617 William Tell		2618 William Tell		2147 William Tell Lab Split		2147 William Tell Lab Split	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.1 mL		0.1 mL		0.1 mL	
Media Used	m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	0		16	160	205	2,050	217	2,170
Fecal Streptococci	22	2,200	22	220	0		0	
Enterococcus	1	100	3	30	0		0	
Total CFU	2,300 / mL		410 / mL		2,050 / mL		2,170 / mL	
Comments	*FC:FS = 0.000 (non-human)*		*FC:FS = 0.727 (mixed)*		*FC:FS unavailable (human) Lab split RPD = 1.42*		*FC:FS unavailable (human) Lab split RPD = 1.42*	

 kk

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060001HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	48316a		48317a		48318a		48320a	
Client Sample ID	**#17**		**#18**		**#19**		**#21**	
Location	Hall Bayou		2522 Kowis		2533 Cromwell		Trip Blank	
Sample Type	water		water		water		water	
Sample Amount	0.1 mL		0.1 mL		0.1 mL		0.1 mL	
Media Used	m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE		m-FC, m Ent, mE	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	0		27	270	4	40	0	
Fecal Streptococci	7	70	8	80	20	200	0	
Enterococcus	1	10	1	10	6	60	0	
Total CFU	80 / mL		360 / mL		300 / mL		<10 / mL	
Comments	*FC:FS = 0.000 (non-human)*		*FC:FS = 3.38 (mixed)*		*FC:FS = 0.200 (non-human)*			

CFU = colony forming units

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

October 17, 2006

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Dr. Kathleen Ramsey
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EV5501 Biolog ID from 9/18/06

Hygeia Reference No.: **31980060003HO**
Date Collected: September 18, 2006
Date Received: September 18, 2006
Date Analyzed: October 12, 2006
Samples Analyzed: 14

Hygeia Sample ID	49292	49293	49294	49295
Client Sample ID	**48300**	**48301**	**48305**	**48307**
Location	2420 Warwick (6)	2302 Warwick (3)	2541 Cromwell (2)	2606 Cromwell (1)
Sample Type	mE isolate	mE isolate	mE isolate	mE isolate
Sample Amount	1 plate	1 plate	1 plate	1 plate
Media Used	BioLog	BioLog	BioLog	BioLog
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis								
Enterococcus durans								
Enterococcus faecalis								
Enterococcus faecium	2	2	2	2	1	1		
Enterococcus gallinarum	3	3			1	1		
Enterococcus hirae	1	1	1	1				
Enterococcus mundtii							1	1
Enterococcus spp.								
Pediococcus acidilacti								
Pediococcus pentosaceus								
Total CFU	6 / plate		3 / plate		2 / plate		1 / plate	
Comments								

 kw

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980060003HO

EV5501 Biolog ID from 9/18/06

Hygeia Sample ID	49296		49297		49298		49299	
Client Sample ID	**48308**		**48309**		**48310**		**48311**	
Location	2722 Kowis (3)		2537 Kowis (3)		Storm Puddle (2)		2706 William Tell A (2)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis			1	1				
Enterococcus durans			2	2				
Enterococcus faecalis					1	1		
Enterococcus faecium					1	1		
Enterococcus gallinarum								
Enterococcus hirae								
Enterococcus mundtii								
Enterococcus spp.	3	3						
Pediococcus acidilacti								
Pediococcus pentosaceus							2	2
Total CFU	3 / plate		3 / plate		2 / plate		2 / plate	
Comments								

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980060003HO

EV5501 Biolog ID from 9/18/06

Hygeia Sample ID	49300	49301	49302	49303
Client Sample ID	**48312**	**48313**	**48314**	**48316**
Location	2706 William Tell B (3)	2617 William Tell (3)	2618 William Tell (3)	Hall Bayou (1)
Sample Type	mE isolate	mE isolate	mE isolate	mE isolate
Sample Amount	1 plate	1 plate	1 plate	1 plate
Media Used	BioLog	BioLog	BioLog	BioLog
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis								
Enterococcus durans								
Enterococcus faecalis					1	1		
Enterococcus faecium								
Enterococcus gallinarum	2	2						
Enterococcus hirae								
Enterococcus mundtii			1	1	1	1	1	1
Enterococcus spp.			2	2	1	1		
Pediococcus acidilacti	1	1						
Pediococcus pentosaceus								
Total CFU	3 / plate		3 / plate		3 / plate		1 / plate	
Comments								

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

Hygeia Reference No.: 31980060003HO
EV5501 Biolog ID from 9/18/06

Hygeia Sample ID	49304		49305	
Client Sample ID	**48317**		**48318**	
Location	2522 Kowis (1)		2533 Cromwell (3)	
Sample Type	mE isolate		mE isolate	
Sample Amount	1 plate		1 plate	
Media Used	BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis				
Enterococcus durans			1	1
Enterococcus faecalis				
Enterococcus faecium			1	1
Enterococcus gallinarum				
Enterococcus hirae				
Enterococcus mundtii				
Enterococcus spp.	1	1	1	1
Pediococcus acidilacti				
Pediococcus pentosaceus				
Total CFU	1 / plate		3 / plate	
Comments				

CFU = colony forming units

Sampling Date: September 26, 2006

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

October 2, 2006

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Houston, TX 77227

EV55-01 Failing Septic System Initiative

Hygeia Reference No.: **31980060002HO**
Date Collected: September 26, 2006
Date Received: September 26, 2006
Date Analyzed: September 27, 2006
Samples Analyzed: 30

Hygeia Sample ID	48540b	48541b	48542b	48543b
Client Sample ID	**1**	**2**	**3**	**3a**
Location	2418 Warwick	2420 Warwick	2302 Warwick - Field Split	2302 Warwick - Field Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	1		2		3		3a	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	66	66	199	199	>2,420	>2,420	>2,420	>2,420

Enterolert® with MUG*

	1		2		3		3a	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments			*Field Split RPD = 0.00*	*Field Split RPD = 0.00*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060002HO

EV55-01 Failing Septic System Initiative

Hygeia Sample ID	48544b	48545b-1	48545b-2	48546b
Client Sample ID	**4**	**5**	**5**	**6**
Location	2140 Warwick	2142 Warwick - Lab Split	2142 Warwick - Lab Split	2431 Cromwell
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	48544b		48545b-1		48545b-2		48546b	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	15	15	153	153	120	120	15	14

Enterolert® with MUG*

	48544b		48545b-1		48545b-2		48546b	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments		*Lab Split RPD = 24.18*	*Lab Split RPD = 24.18*	

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(Hygeia SOP-10)

Hygeia Reference No..: 31980060002HO
EV55-01 Failing Septic System Initiative

Hygeia Sample ID	48547b	48548b	48549b-1	48549b-2
Client Sample ID	**7**	**7a**	**8**	**8**
Location	2533 Cromwell - Field Split	2533 Cromwell - Field Split	2606 Cromwell - Lab Split	2606 Cromwell - Lab Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	48547b		48548b		48549b-1		48549b-2	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	1,986	1,986	1,120	1,120	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	28	28	15	15	133	133	121	121

Enterolert® with MUG*

	48547b		48548b		48549b-1		48549b-2	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments	*Field Split RPD = 42.00*	*Field Split RPD = 42.00*	*Lab Split RPD = 9.45*	*Lab Split RPD = 9.45*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060002HO

EV55-01 Failing Septic System Initiative

Hygeia Sample ID	48550b	48551b	48552b	48553b
Client Sample ID	**9**	**10**	**11**	**12**
Location	2542 Cromwell	2541 Cromwell	2722 Kowis	2537 Kowis
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

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Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	1,011	1,011	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420

Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	155	155	8	8	2,420	2,420	>2,420	>2,420

Enterolert® with MUG*

Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060002HO

EV55-01 Failing Septic System Initiative

Hygeia Sample ID	48554b	48555b	48556b	48557b
Client Sample ID	**13**	**14**	**15**	**16**
Location	Puddle @ 2537 Kowis	2522 Kowis	2706 William Tell A	2706 William Tell B
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	48554b		48555b		48556b		48557b	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	548	548	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	161	161	1,203	1,203	71	71	>2,420	>2,420

Enterolert® with MUG*

	48554b		48555b		48556b		48557b	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060002HO
EV55-01 Failing Septic System Initiative

Hygeia Sample ID	48558b	48559b	48560b	48561b
Client Sample ID	**17**	**18**	**19**	**20**
Location	2617 William Tell	2618 William Tell	2147 William Tell	2711 Trenton
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	48558b		48559b		48560b		48561b	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	249	249
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	457	457	214	214	2,420	2,420	7	7

Enterolert® with MUG*

	48558b		48559b		48560b		48561b	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060002HO
EV55-01 Failing Septic System Initiative

Hygeia Sample ID	48562b-1	48562b-2	48563b	48564b
Client Sample ID	**21**	**21**	**22a**	**22a**
Location	E. Side Under Happer Bridge / Halls Bayou - Lab Split	E. Side Under Happer Bridge / Halls Bayou - Lab Split	Cromwell Outfall - Field Split	Cromwell Outfall - Field Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	48562b-1		48562b-2		48563b		48564b	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	457	457	548	548
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	1,300	1,300	1,986	1,986	10	10	6	6

Enterolert® with MUG*

	48562b-1		48562b-2		48563b		48564b	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments	*Lab Split RPD = 15.56*	*Lab Split RPD = 15.56*	*Field Split RPD - 17.04*	*Field Split RPD - 17.04*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060002HO

EV55-01 Failing Septic System Initiative

Hygeia Sample ID	48565b	48566b
Client Sample ID	**23**	**24**
Location	William Tell Outfall	Halls Bayou
Sample Type	water	water
Sample Amount	100 mL	100 mL
Media Used	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*

Colilert® / Colisure® with MUG*

	48565b		48566b	
Total Coliforms	**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	921	921	727	727
Escherichia coli	**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	10	10	15	15

Enterolert® with MUG*

	48565b		48566b	
Enterococci	**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a

Comments		

CFU = colony forming units

*MUG = 4-methylumbelliferyl-β-D-glucuronide, a sensitive confirmation indicator for *E. coli* and enterococcis group.

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

October 31, 2006

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EV5501 Biolog ID From 9/26/06

Hygeia Reference No.: **31980060004HO**
Date Collected: September 26, 2006
Date Received: September 26, 2006
Date Analyzed: October 23, 2006
Samples Analyzed: 10

Hygeia Sample ID	49623		49624		49625		49626	
Client Sample ID	**48541**		**48542/43**		**48549**		**48550**	
Location	2420 Warwick (11)		2302 Warwick (10)		2606 Cromwell (10)		2542 Cromwell (5)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis					1	1		
Enterococcus casseliflavus							2	2
Enterococcus durans								
Enterococcus faecalis	2	2	3	3	2	2		
Enterococcus faecium			4	4	4	4		
Enterococcus flavescens	1	1						
Enterococcus gallinarum	1	1					2	2
Enterococcus mundtii			1	1	1	1	1	1
Enterococcus spp.			1	1	1	1		
Pediococcus acidilacti			1	1				
Streptococcus gallolyticus	6	6						
Streptococcus mutans	1	1						
Streptococcus suis								
Streptococcus infantarius								
Enterococcus dispar								
Total CFU	11 / plate		10 / plate		9 / plate		5 / plate	
Comments								

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980060004HO

EV5501 Biolog ID From 9/26/06

Hygeia Sample ID	49627		49628		49629		49630	
Client Sample ID	**48552**		**48553**		**48555**		**48558**	
Location	2722 Kowis (9)		2537 Kowis (2)		2522 Kowis (9)		2617 William Tell (10)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis	4	4			1	1		
Enterococcus casseliflavus			1	1				
Enterococcus durans					1	1		
Enterococcus faecalis			1	1	1	1	1	1
Enterococcus faecium	4	4			1	1	9	9
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii	1	1			1	1		
Enterococcus spp.					2	2		
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus mutans								
Streptococcus suis					1	1		
Streptococcus infantarius					1	1		
Enterococcus dispar					1	1		
Total CFU	9 / plate		2 / plate		10 / plate		10 / plate	
Comments								

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980060004HO

EV5501 Biolog ID From 9/26/06

Hygeia Sample ID	49631		49632	
Client Sample ID	**48559**		**48562**	
Location	2618 William Tell (2)		E Side Under Bridge (10)	
Sample Type	mE isolate		mE isolate	
Sample Amount	1 plate		1 plate	
Media Used	BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis				
Enterococcus casseliflavus			1	1
Enterococcus durans				
Enterococcus faecalis	1	1	2	2
Enterococcus faecium			5	5
Enterococcus flavescens	1	1		
Enterococcus gallinarum				
Enterococcus mundtii			1	1
Enterococcus spp.			1	1
Pediococcus acidilacti				
Streptococcus gallolyticus				
Streptococcus mutans				
Streptococcus suis				
Streptococcus infantarius				
Enterococcus dispar				
Total CFU	2 / plate		10 / plate	
Comments				

CFU = colony forming units

Sampling Date: November 28, 2006

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

November 30, 2006

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Ms. Kathleen Ramsey
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EV5501 Failing Septic System Initiative

Hygeia Reference No.: **31980060007HO**
Date Collected: November 28, 2006
Date Received: November 28, 2006
Date Analyzed: November 29, 2006
Samples Analyzed: 33

Hygeia Sample ID	50626a-1	50626a-1a	50627a	50628a QC X
Client Sample ID	**#1**	**#1**	**#2**	**#3**
Location	2140 Warwick - Lab Split	2140 Warwick - Lab Split	2142 Warwick - Field Split	2142 Warwick - Field Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	50626a-1		50626a-1a		50627a		50628a	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	2,420	2,420	>2,420	>2,420	1,120	1,120	1,733	1,733

Enterolert® with MUG*

	50626a-1		50626a-1a		50627a		50628a	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments	*Lab Split RPD = 0*	*Lab Split RPD = 0*	*Field Split RPD = 15.96*	*Field Split RPD = 15.96*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50629a	50630a QC X	50631a	50632a
Client Sample ID	**#4**	**#5**	**#6**	**#7**
Location	2302 Warwick	2418 Warwock	2470 Warwick	2600 Cromwell
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	#4		#5		#6		#7	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	20	20	11	11	649	649

Enterolert® with MUG*

	#4		#5		#6		#7	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50633a	50634a	50635a	50636a-1
Client Sample ID	**#8**	**#9**	**#10**	**#11**
Location	2541 Cromwell	2542 Cromwell	2533 Cromwell	2531 Cromwell - Lab Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	50633a		50634a		50635a		50636a-1	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	365	365	365	365	299	299	687	687

Enterolert® with MUG*

	50633a		50634a		50635a		50636a-1	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				*Lab Split RPD = 2.64*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50636a-1a	50637a	50638a	50639a
Client Sample ID	**#11**	**#12**	**#13**	**#14**
Location	2531 Cromwell - Lab Split	2722 Kowis - Field Split	2722 Kowis - Field Split	2537 Kowis
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	50636a-1a		50637a		50638a		50639a	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	770	770	435	435	411	411	>2,420	>2,420

Enterolert® with MUG*

	50636a-1a		50637a		50638a		50639a	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments	*Lab Split RPD = 2.64*	*Field Split RPD = 0.86*	*Field Split RPD = 0.84*	

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060007HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	50640a	50641a	50642a	50643a
Client Sample ID	**#15**	**#16**	**#17**	**#18**
Location	2537 Kowis Puddle	2522 Kowis	2706 William Tell A	2706 William Tell B
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	#15		#16		#17		#18	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	365	365	>2,420	>2,420	1,553	1,553	>2,420	>2,420

Enterolert® with MUG*

	#15		#16		#17		#18	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50644a	50645a	50646a-1	50646a-1a
Client Sample ID	**#19**	**#20**	**#21**	**#21**
Location	2617 William Tell	2618 William Tell	2147 William Tell - Lab Split	2147 William Tell - Lab Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	50644a		50645a		50646a-1		50646a-1a	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	1,414	1,414	1,553	1,553	>2,420	>2,420	>2,420	>2,420

Enterolert® with MUG*

	50644a		50645a		50646a-1		50646a-1a	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments			*Lab Split RPD = 0*	*Lab Split RPD = 0*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50647a	50648a	50649a	50650a
Client Sample ID	**#22**	**#23**	**#24**	**#25**
Location	2711 Trenton - Field Split	2711 Trenton - Field Split	Halls Bayou	William Tell Outfall
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	50647a		50648a		50649a		50650a	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	613	613	649	649	135	135	1,414	1,414

Enterolert® with MUG*

	50647a		50648a		50649a		50650a	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				
	Field Split RPD = 1.18	*Field Split RPD = 1.18*		

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50651a	50652a	50653a	50654a
Client Sample ID	**#26**	**#27**	**#28**	**#29**
Location	Chamberlain Outfall	Cromwell Outfall	E - Side Under Bridge	Sewage Plant #1
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	50651a		50652a		50653a		50654a	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	>2,420	>2,420	9	8
Escherichia coli	**Present**		**Present**		**Present**		**Absent**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	138	138	980	980	118	118	n/a	n/a

Enterolert® with MUG*

	50651a		50652a		50653a		50654a	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments				

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060007HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	50655a
Client Sample ID	**#30**
Location	Sewage Plant #2
Sample Type	water
Sample Amount	100 mL
Media Used	Colilert
Dilution Factor(s)	1:100*

Colilert® / Colisure® with MUG*

Total Coliforms	**Present**	
	Sample Counts	*MPN CFU / mL*
	1	1

Escherichia coli	**Absent**	
	Sample Counts	*MPN CFU / mL*
	n/a	n/a

Enterolert® with MUG*

Enterococci	**n/a**	
	Sample Counts	*MPN CFU / mL*
	n/a	n/a

Comments	

CFU = colony forming units

*MUG = 4-methylumbelliferyl-β-D-glucuronide, a sensitive confirmation indicator for *E. coli* and enterococcis group.

Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

December 8, 2006

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EV5501 Failing Septic System Initiative

Hygeia Reference No.: **31980060007HO**
Date Collected: November 28, 2006
Date Received: November 28, 2006
Date Analyzed: November 30, 2006
Samples Analyzed: 33

Hygeia Sample ID	50626-1		50626-1a		50627		50628	
Client Sample ID	**#1**		**#1**		**#2**		**#3**	
Location	2140 Warwick -Lab Split		2140 Warwick - Lab Split		2142 Warwick - Field Split		2142 Warwick - Field Split	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	123	12,300	217	21,700	4	400	2	200
Fecal streptococci	151	15,100	128	12,800	0		0	
Enterococcus	13	1,300	4	400	0		0	
Total CFU	28,700 / mL		34,900 / mL		400 / mL		200 / mL	
Comments	*FC:FS = 0.815 (mixed) Lab Split RPD = 19.50*		*FC:FS = 1.70 (mixed) Lab Split RPD = 19.50*		*FC:FS = unavailable (human) Field Split RPD = 66.67*		*FC:FS = unavailable (human) Field Split RPD = 66.67*	

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Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50629		50630		50631		50632	
Client Sample ID	**#4**		**#5**		**#6**		**#7**	
Location	2302 Warwick		2418 Warwick		2470 Warwick		2600 Cromwell	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	11	1,100	0		2	200	2	200
Fecal streptococci	30	3,000	32	3,200	0		34	3,400
Enterococcus	3	300	0		0		1	100
Total CFU	4,400 / mL		3,200 / mL		200 / mL		3,700 / mL	
Comments	*FC:FS = 0.37 (non-human)*		*FC:FS = 0.00 (non-human)*		*FC:FS = unavailable (human)*		*FC:FS = 0.06 (non-human)*	

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Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

Hygeia Reference No.: 31980060007HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	50633		50634		50635		50636-1	
Client Sample ID	**#8**		**#9**		**#10**		**#11**	
Location	2541 Cromwell		2542 Cromwell		2533 Cromwell		2531 Cromwell - Lab Split	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	0		3	300	1	100	10	1,000
Fecal streptococci	15	1,500	48	4,800	12	1,200	57	5,700
Enterococcus	2	200	3	300	1	100	2	200
Total CFU	1,700 / mL		5,400 / mL		1,400 / mL		6,900 / mL	
Comments	*FC:FS = 0.00 (non-human)*		*FC:FS =0.06 (non-human)*		*FC:FS = 0.08 (non-human)*		*FC:FS = 0.18 (non-human)* *Lab Split RPD = 26.23*	

Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

Hygeia Reference No.: 31980060007HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	50636-1a		50637		50638		50639	
Client Sample ID	**#11**		**#12**		**#13**		**#14**	
Location	2531 Cromwell - Lab Split		2722 Kowis - Field Split		2722 Kowis - Field Split		2537 Kowis	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	9	900	0		1	100	28	2,800
Fecal streptococci	32	3,200	18	1,800	5	500	36	3,600
Enterococcus	12	1,200	3	300	6	600	37	3,700
Total CFU	5,300 / mL		2,100 / mL		1,200 / mL		10,100 / mL	
Comments	*FC:FS = 0.28 (non-human) Lab Split RPD = 26.23*		*FC:FS = 0.00 (non-human) Field Split RPD = 53.57*		*FC:FS = 0.02 (non-human) Field Split RPD = 53.57*		*FC:FS = 0.78 (mixed)*	

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Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

Hygeia Reference No.: 31980060007HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	50640 QC X		50641		50642		50643	
Client Sample ID	**#15**		**#16**		**#17**		**#18**	
Location	2537 Kowis Puddle		2522 Kowis		2706 William Tell A		2706 William Tell B	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	15	1,500	81	8,100	34	3,400	49	4,900
Fecal streptococci	39	3,900	24	2,400	65	6,500	609	60,900
Enterococcus	13	1,300	24	2,400	14	1,400	12	1,200
Total CFU	6,700 / mL		12,900 / mL		11,300 / mL		67,000 / mL	
Comments	*FC:FS = 0.38 (non-human)*		*FC:FS = 3.38 (mixed)*		*FC:FS = 0.52 (mixed)*		*FC:FS = 0.08 (non-human)*	

 kk

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50644		50645		50646-1		50646-1a	
Client Sample ID	**#19**		**#20**		**#21**		**#21**	
Location	2617 William Tell		2618 William Tell		2147 William Tell - Lab Split		2147 William Tell - Lab Split	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	16	1,600	61	6,100	82	8,200	38	3,800
Fecal streptococci	43	4,300	52	5,200	19	1,900	28	2,800
Enterococcus	35	3,500	22	2,200	21	2,100	19	1,900
Total CFU	9,400 / mL		13,500 / mL		12,200 / mL		8,500 / mL	
Comments	*FC:FS = 0.37 (non-human)*		*FC:FS = 1.17 (mixed)*		*FC:FS = 4.32 (human) Lab Split RPD = 35.75*		*FC:FS = 1.35 (mixed) Lab Split RPD = 35.75*	

 kk

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50647		50648		50649 QC X		50650	
Client Sample ID	**#22**		**#23**		**#24**		**#25**	
Location	2711 Trenton - Field Split		2711 Trenton - Field Split		Halls Bayou		William Tell Outfall	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.01 mL		0.01 mL		0.01 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	23	2,300	12	1,200	1	100	12	1,200
Fecal streptococci	19	1,900	14	1,400	1	100	74	7,400
Enterococcus	15	1,500	11	1,100	1	100	19	1,900
Total CFU	5,700 / mL		3,700 / mL		300 / mL		10,500 / mL	
Comments	*FC:FS = 1.21 (mixed) Field Split RPD = 32.55*		*FC:FS = 0.86 (mixed) Field Split RPD = 32.55*		*FC:FS = 1.00 (mixed)*		*FC:FS = 0.16 (non-human)*	

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50651		50652		50653		50654	
Client Sample ID	**#26**		**#27**		**#28**		**#29**	
Location	Chamberlain Outfall		Cromwell Outfall		E - Side Under Bridge		Sewage Plant #1	
Sample Type	water		water		water		water	
Sample Amount	0.01 mL		0.1 mL		0.1 mL		0.1 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	7	700	24	240	3	30	0	
Fecal streptococci	1	100	273	2,730	10	100	0	
Enterococcus	0		690	6,900	0		0	
Total CFU	800 / mL		9,870 / mL		130 / mL		<10 / mL	
Comments	*FC:FS = 7.00 (human)*		*FC:FS = 0.88 (mixed)*		*FC:FS = 0.30 (non-human)*		*FC:FS = N/A*	

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060007HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	50655
Client Sample ID	**#30**
Location	Sewage Plant #2
Sample Type	water
Sample Amount	0.1 mL
Media Used	m-FC, m Entero, m E
Dilution Factor(s)	1:1*

Bacteria Isolated:	*Sample Counts*	*CFU / mL*
Fecal coliforms	0	
Fecal streptococci	0	
Enterococcus	0	
Total CFU	<10 / mL	
Comments	*FC:FS = N/A*	

CFU = colony forming units

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

December 15, 2006

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Dr. Kathleen Ramsey
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3555 Timmons
Houston, TX 77227

EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Reference No.: **31980070002HO**
Date Collected: November 28, 2006
Date Received: November 28, 2006
Date Analyzed: December 15, 2006
Samples Analyzed: 25

Hygeia Sample ID	52329a		52329b		52329c		52329d	
Client Sample ID	**50626-1**		**50626-1a**		**50629**		**50632**	
Location	2140 Warwick - Lab Split (3)		2140 Warwick - Lab Split (3)		2302 Warwick (3)		2600 Cromwell (4)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis								
Enterococcus casseliflavus	1	1					1	1
Enterococcus durans					1	1		
Enterococcus faecalis								
Enterococcus faecium								
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.	1	1	2	2	1	1	2	2
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus infantarius							1	1
Streptococcus mutans			1	1				
Unknown	1	1			1	1	1	1
Total CFU	3 / plate		3 / plate		3 / plate		5 / plate	
Comments								

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO

EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329e		52329f		52329g		52329h	
Client Sample ID	**50633**		**50634**		**50635**		**50636-1**	
Location	2541 Cromwell (4)		2542 Cromwell (1)		2533 Cromwell (2)		2531 Cromwell - Lab Split (3)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis	2	2	1	1				
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis								
Enterococcus faecium	1	1			1	1		
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.	1	1					1	1
Pediococcus acidilacti								
Streptococcus gallolyticus							1	1
Streptococcus infantarius								
Streptococcus mutans							1	1
Unknown					1	1		
Total CFU	4 / plate		1 / plate		2 / plate		3 / plate	
Comments								

 kw

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO

EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329i		52329j		52329k		52329l	
Client Sample ID	**50636-1a**		**50637**		**50638**		**50639**	
Location	2531 Cromwell - Lab Split (3)		2722 Kowis - Field Split (4)		2722 Kowis - Field Split (3)		2537 Kowis (2)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis	1	1					1	1
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis	1	1	2	2	1	1		
Enterococcus faecium								
Enterococcus flavescens	1	1						
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.					1	1	1	1
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus infantarius					1	1		
Streptococcus mutans								
Unknown			2	2				
Total CFU	3 / plate		4 / plate		3 / plate		2 / plate	
Comments								

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO
EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329m		52329n		52329o		52329p	
Client Sample ID	**50640**		**50641**		**50642**		**50643**	
Location	2537 Kowis Puddle (4)		2522 Kowis (3)		2706 William Tell A (2)		2706 William Tell B (3)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis			1	1				
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis	1	1	1	1				
Enterococcus faecium								
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.	1	1	1	1	1	1		
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus infantarius								
Streptococcus mutans								
Unknown	2	2			1	1	3	3
Total CFU	4 / plate		3 / plate		2 / plate		3 / plate	
Comments								

 kw

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO

EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329q	52329r	52329s	52329t
Client Sample ID	**50644**	**50645**	**50646-1**	**50646-1a**
Location	2617 William Tell (1)	2618 William Tell (2)	2147 William Tell - Lab Split (4)	2147 William Tell - Lab Split (4)
Sample Type	mE isolate	mE isolate	mE isolate	mE isolate
Sample Amount	1 plate	1 plate	1 plate	1 plate
Media Used	BioLog	BioLog	BioLog	BioLog
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis			1	1				
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis								
Enterococcus faecium								
Enterococcus flavescens								
Enterococcus gallinarum					1	1		
Enterococcus mundtii								
Enterococcus spp.	1	1	1	1	1	1	2	2
Pediococcus acidilacti					2	2	2	2
Streptococcus gallolyticus								
Streptococcus infantarius								
Streptococcus mutans								
Unknown								
Total CFU	1 / plate		2 / plate		4 / plate		4 / plate	
Comments								

 kw

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO
EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329u		52329v		52329w		52329x	
Client Sample ID	**50647**		**50648**		**50649**		**50650**	
Location	2711 Trenton - Field Split (3)		2711 Trenton - Field Split (3)		Halls Bayou (4)		William Tell Outfall (2)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis								
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis								
Enterococcus faecium								
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.	1	1	1	1	2	2	2	2
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus infantarius								
Streptococcus mutans								
Unknown	2	2	2	2	2	2		
Total CFU	3 / plate		3 / plate		4 / plate		2 / plate	
Comments								

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO
EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329y
Client Sample ID	**50652**
Location	Cromwell Outfall (7)
Sample Type	mE isolate
Sample Amount	1 plate
Media Used	BioLog
Dilution Factor(s)	1:1*

Bacteria Isolated:	*Sample Counts*	*CFU / plate*
Alloiococcus otitis		
Enterococcus casseliflavus		
Enterococcus durans		
Enterococcus faecalis	2	2
Enterococcus faecium		
Enterococcus flavescens		
Enterococcus gallinarum		
Enterococcus mundtii		
Enterococcus spp.	1	1
Pediococcus acidilacti		
Streptococcus gallolyticus		
Streptococcus infantarius		
Streptococcus mutans		
Unknown	4	4
Total CFU	7 / plate	
Comments		

CFU = colony forming units

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Sampling Date: December 11, 2006

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

January 2, 2007

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Houston, TX 77227

EV5501 Failing Septic System Initiative

Hygeia Reference No.: **31980060008HO**
Date Collected: December 11, 2006
Date Received: December 11, 2006
Date Analyzed: December 12, 2006
Samples Analyzed: 5

Hygeia Sample ID	51039a-1	51039a-1a	51040a	51041a QC X
Client Sample ID	**#1**	**#1**	**#2**	**#3**
Location	Halls Bayou - Lab Split	Halls Bayou - Lab Split	E. Side Under Bridge - Field Split	E. Side Under Bridge - Field Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:100*	1:100*	1:100*	1:100*

Colilert® / Colisure® with MUG*

	51039a-1		51039a-1a		51040a		51041a	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	>2,420	>2,420	>2,420	>2,420	249	249	248	248
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	345	345	488	488	17	17	10	10

Enterolert® with MUG*

	51039a-1		51039a-1a		51040a		51041a	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments	*Lab Split RPD =5.04*	*Lab Split RPD = 5.04*	*Field Split RPD = 3.05*	*Field Split RPD = 3.05*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980060008HO

EV5501 Failing Septic System Initiative

Hygeia Sample ID	51042a
Client Sample ID	**#4**
Location	Sewage Plant
Sample Type	water
Sample Amount	100 mL
Media Used	Colilert
Dilution Factor(s)	1:100*

Colilert® / Colisure® with MUG*

Total Coliforms	**Present**	
	Sample Counts	*MPN CFU / mL*
	117	117

Escherichia coli	**Absent**	
	Sample Counts	*MPN CFU / mL*
	n/a	n/a

Enterolert® with MUG*

Enterococci	**n/a**	
	Sample Counts	*MPN CFU / mL*
	n/a	n/a

Comments	

CFU = colony forming units

*MUG = 4-methylumbelliferyl-β-D-glucuronide, a sensitive confirmation indicator for *E. coli* and enterococcis group.

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

January 2, 2007

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Houston, TX 77227

EV5501 Failing Septic System Initiative

Hygeia Reference No.: **31980060008HO**
Date Collected: December 11, 2006
Date Received: December 11, 2006
Date Analyzed: December 12, 2007
Samples Analyzed: 5

Hygeia Sample ID	51039-1 QC X		51039-1a		51040 QC X		51041	
Client Sample ID	**#1**		**#1**		**#2**		**#3**	
Location	Halls Bayou - Lab Split		Halls Bayou - Lab Split		E. Side Under Bridge - Field Split		E. Side Under Bridge - Field Split	
Sample Type	water		water		water		water	
Sample Amount	0.1 mL		1 mL		1 mL		1 mL	
Media Used	m-FC, mE, m Entero		m-FC, mE, m Entero		m-FC, mE, m Entero		m-FC, mE, m Entero	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	16	160	1	1	16	16	12	12
Fecal streptococci	160	1,600	1,600	1,600	3,220	3,220	4,300	4,300
Enterococcus	50	500	290	290	20	20	200	200
Total CFU	2,260 / mL		1,891 / mL		3,256 / mL		4,512 / mL	
Comments	*FC:FS = 0.10 (non-human) Lab Split RPD = 17.53*		*FC:FS = 0.00 (non-human) Lab Split RPD = 17.53*		*FC:FS = 0.00 (non-human) Field Split RPD = 32.34*		*FC:FS = 0.00 (non-human)Field Split RPD = 32.34*	

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980060008HO
EV5501 Failing Septic System Initiative

Hygeia Sample ID	51042 QC	X
Client Sample ID	**#4**	
Location	Sewage Plant	
Sample Type	water	
Sample Amount	0.1 mL	
Media Used	m-FC, mE, m Entero	
Dilution Factor(s)	1:1*	

Bacteria Isolated:	*Sample Counts*	*CFU / mL*
Fecal coliforms	0	
Fecal streptococci	0	
Enterococcus	0	
Total CFU	<10 / mL	
Comments	*FC:FS = 0.10*	

CFU = colony forming units

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Houston-Galveston Area Council
Project: EV5501 Failing Septic System Initiative

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Hygeia Reference No.: 31980060008HO

Analyst ______________________ Date *1/12/2007*
Adan Carranza QB3

Analyst ______________________ Date *1/12/2007*
Katie Kieke Coliform (MUG)

Lab Director ______________________ Date *1/12/2007*
Kenneth Wunch

Thank you for using Hygeia Laboratories Inc. We strive to provide superior quality and service.

Hygeia is a participant in AIHA's Environmental Microbiology Proficiency Analytical Testing program. EMPAT # 167400.

The data within this report is reliable to two significant figures.

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Guidelines for Interpretation:
No accepted quantitative regulatory standards currently exist by which to assess the health risks related to fungal and bacterial exposure. Fungi and bacteria have been associated with a variety of health effects and sensitivity varies from person to person.

Several organizations, including: the American Conference of Government Industrial Hygienists (ACGIH); the American Industrial Hygiene Association (AIHA); the Indoor Air Quality Association (IAQA); the United States Environmental Protection Agency (USEPA); and the Centers for Disease Control (CDC) have all published guidelines for assessment and interpretation of mold resulting from water intrusion in buildings.

Interpretation of the data and information within this document is left to the company, consultant, and/or persons who conducted the fieldwork.

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

December 15, 2006

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EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Reference No.: **31980070002HO**
Date Collected: November 28, 2006
Date Received: November 28, 2006
Date Analyzed: December 15, 2006
Samples Analyzed: 25

Hygeia Sample ID	52329a		52329b		52329c		52329d	
Client Sample ID	**50626-1**		**50626-1a**		**50629**		**50632**	
Location	2140 Warwick - Lab Split (3)		2140 Warwick - Lab Split (3)		2302 Warwick (3)		2600 Cromwell (4)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis								
Enterococcus casseliflavus	1	1					1	1
Enterococcus durans					1	1		
Enterococcus faecalis								
Enterococcus faecium								
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.	1	1	2	2	1	1	2	2
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus infantarius							1	1
Streptococcus mutans			1	1				
Unknown	1	1			1	1	1	1
Total CFU	3 / plate		3 / plate		3 / plate		5 / plate	
Comments								

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO
EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329e	52329f	52329g	52329h
Client Sample ID	**50633**	**50634**	**50635**	**50636-1**
Location	2541 Cromwell (4)	2542 Cromwell (1)	2533 Cromwell (2)	2531 Cromwell - Lab Split (3)
Sample Type	mE isolate	mE isolate	mE isolate	mE isolate
Sample Amount	1 plate	1 plate	1 plate	1 plate
Media Used	BioLog	BioLog	BioLog	BioLog
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis	2	2	1	1				
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis								
Enterococcus faecium	1	1			1	1		
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.	1	1					1	1
Pediococcus acidilacti								
Streptococcus gallolyticus							1	1
Streptococcus infantarius								
Streptococcus mutans							1	1
Unknown					1	1		
Total CFU	4 / plate		1 / plate		2 / plate		3 / plate	
Comments								

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO

EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329i		52329j		52329k		52329l	
Client Sample ID	**50636-1a**		**50637**		**50638**		**50639**	
Location	2531 Cromwell - Lab Split (3)		2722 Kowis - Field Split (4)		2722 Kowis - Field Split (3)		2537 Kowis (2)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis	1	1					1	1
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis	1	1	2	2	1	1		
Enterococcus faecium								
Enterococcus flavescens	1	1						
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.					1	1	1	1
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus infantarius					1	1		
Streptococcus mutans								
Unknown			2	2				
Total CFU	3 / plate		4 / plate		3 / plate		2 / plate	
Comments								

 kw

Quantitative Bacterial Report

MicroLog

(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO

EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329m		52329n		52329o		52329p	
Client Sample ID	**50640**		**50641**		**50642**		**50643**	
Location	2537 Kowis Puddle (4)		2522 Kowis (3)		2706 William Tell A (2)		2706 William Tell B (3)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis			1	1				
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis	1	1	1	1				
Enterococcus faecium								
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.	1	1	1	1	1	1		
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus infantarius								
Streptococcus mutans								
Unknown	2	2			1	1	3	3
Total CFU	4 / plate		3 / plate		2 / plate		3 / plate	
Comments								

kw

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO
EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329q		52329r		52329s		52329t	
Client Sample ID	**50644**		**50645**		**50646-1**		**50646-1a**	
Location	2617 William Tell (1)		2618 William Tell (2)		2147 William Tell - Lab Split (4)		2147 William Tell - Lab Split (4)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis			1	1				
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis								
Enterococcus faecium								
Enterococcus flavescens								
Enterococcus gallinarum					1	1		
Enterococcus mundtii								
Enterococcus spp.	1	1	1	1	1	1	2	2
Pediococcus acidilacti					2	2	2	2
Streptococcus gallolyticus								
Streptococcus infantarius								
Streptococcus mutans								
Unknown								
Total CFU	1 / plate		2 / plate		4 / plate		4 / plate	
Comments								

 kw

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO
EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329u		52329v		52329w		52329x	
Client Sample ID	**50647**		**50648**		**50649**		**50650**	
Location	2711 Trenton - Field Split (3)		2711 Trenton - Field Split (3)		Halls Bayou (4)		William Tell Outfall (2)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis								
Enterococcus casseliflavus								
Enterococcus durans								
Enterococcus faecalis								
Enterococcus faecium								
Enterococcus flavescens								
Enterococcus gallinarum								
Enterococcus mundtii								
Enterococcus spp.	1	1	1	1	2	2	2	2
Pediococcus acidilacti								
Streptococcus gallolyticus								
Streptococcus infantarius								
Streptococcus mutans								
Unknown	2	2	2	2	2	2		
Total CFU	3 / plate		3 / plate		4 / plate		2 / plate	
Comments								

 kw

Quantitative Bacterial Report
MicroLog
(Hygeia SOP-23)

Hygeia Reference No.: 31980070002HO
EV5501 Failing Septic System Initiative - Biolog ID from 11/18/06

Hygeia Sample ID	52329y
Client Sample ID	**50652**
Location	Cromwell Outfall (7)
Sample Type	mE isolate
Sample Amount	1 plate
Media Used	BioLog
Dilution Factor(s)	1:1*

Bacteria Isolated:	*Sample Counts*	*CFU / plate*
Alloiococcus otitis		
Enterococcus casseliflavus		
Enterococcus durans		
Enterococcus faecalis	2	2
Enterococcus faecium		
Enterococcus flavescens		
Enterococcus gallinarum		
Enterococcus mundtii		
Enterococcus spp.	1	1
Pediococcus acidilacti		
Streptococcus gallolyticus		
Streptococcus infantarius		
Streptococcus mutans		
Unknown	4	4
Total CFU	7 / plate	
Comments		

CFU = colony forming units

This report may not be reproduced except in full, and only with the written approval of this laboratory. Please contact Hygeia regarding any questions about these results.

Sampling Date: January 30, 2007

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

February 2, 2007

Hygeia Laboratories Inc.
3924 Bluebonnet Drive
Stafford, TX 77477
(281) 242-1000 (281) 242-1030 Fax
www.hygeialabsinc.com

Dr. Kathleen Ramsey
Houston-Galveston Area Council
3555 Timmons
Houston, TX 77227

EV5501 Failing Septic System Initiative - Final Sampling Event

Hygeia Reference No.: **31980070005HO**
Date Collected: January 31, 2007
Date Received: January 30, 2007
Date Analyzed: January 31, 2007
Samples Analyzed: 6

Hygeia Sample ID	52688-1a	52688a	52689a	52690a
Client Sample ID	**#1**	**#1**	**#2**	**#3**
Location	2601 Cromwell - Lab Split	2601 Cromwell - Lab Split	2722 Kowis - Field Split	2722 Kowis - Field Split
Sample Type	water	water	water	water
Sample Amount	100 mL	100 mL	100 mL	100 mL
Media Used	Colilert	Colilert	Colilert	Colilert
Dilution Factor(s)	1:1*	1:1*	1:1*	1:1*

Colilert® / Colisure® with MUG*

	52688-1a		52688a		52689a		52690a	
Total Coliforms	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	249	2	291	3	>2,420	>24	>2,420	>24
Escherichia coli	**Present**		**Present**		**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	51	1	62	1	45	<1	40	<1

Enterolert® with MUG*

	52688-1a		52688a		52689a		52690a	
Enterococci	**n/a**		**n/a**		**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Comments	*Lab Split RPD = 8.12*	*Lab Split RPD = 8.12*	*Field Split RPD = 0.10*	*Field Split RPD = 0.10*

Colilert® / Colisure® / Enterolert® Bacterial Report

(Hygeia SOP-10)

Hygeia Reference No..: 31980070005HO
EV5501 Failing Septic System Initiative - Final Sampling Event

Hygeia Sample ID	52691a	52692a
Client Sample ID	**#4**	**#5**
Location	Halls Bayou	E. Side Under Bridge
Sample Type	water	water
Sample Amount	100 mL	100 mL
Media Used	Colilert	Colilert
Dilution Factor(s)	1:1*	1:1*

Colilert® / Colisure® with MUG*

	#4		#5	
Total Coliforms	**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	517	5	770	8
Escherichia coli	**Present**		**Present**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	29	<1	52	1

Enterolert® with MUG*

	#4		#5	
Enterococci	**n/a**		**n/a**	
	Sample Counts	*MPN CFU / mL*	*Sample Counts*	*MPN CFU / mL*
	n/a	n/a	n/a	n/a

Comments		

CFU = colony forming units

*MUG = 4-methylumbelliferyl-β-D-glucuronide, a sensitive confirmation indicator for *E. coli* and enterococcus group.

Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

February 2, 2007

Hygeia Laboratories Inc.
3924 Bluebonnet Drive
Stafford, TX 77477
(281) 242-1000 (281) 242-1030 Fax
www.hygeialabsinc.com

Dr. Kathleen Ramsey
Houston-Galveston Area Council
3555 Timmons
Houston, TX 77227

EV5501 Failing Septic System Initiative - Final Sampling Event

Hygeia Reference No.: **31980070005HO**
Date Collected: January 30, 2007
Date Received: January 30, 2007
Date Analyzed: February 1, 2007
Samples Analyzed: 6

Hygeia Sample ID	52688		52688-1		52689		52690	
Client Sample ID	**#1**		**#1**		**#2**		**#3**	
Location	2601 Cromwell - Lab Split		2601 Cromwell - Lab Split		2722 Kowis - Field Split		2722 Kowis - Field Split	
Sample Type	water		water		water		water	
Sample Amount	0.1 mL		0.1 mL		0.1 mL		0.1 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	12	120	20	200	40	400	45	450
Fecal streptococci	6	60	3	30	30	300	12	120
Enterococcus	2	20	5	50	5	50	5	50
Total CFU	200 / mL		280 / mL		750 / mL		620 / mL	
Comments	*FC:FS = 2.00 (mixed) Lab Split RPD = 16.67*		*FC:FS = 6.67 (human) Lab Split RPD = 16.67*		*FC:FS = 1.33 (mixed) Field Split RPD = 9.48*		*FC:FS = 3.75 (mixed) Field Split RPD = 9.48*	

 AC

Quantitative Bacterial Report
Enumeration and Gram Stain, 3 Media
(Hygeia SOP-09)

Hygeia Reference No.: 31980070005HO
EV5501 Failing Septic System Initiative - Final Sampling Event

Hygeia Sample ID	52691		52692 QC X	
Client Sample ID	**#4**		**#5**	
Location	Halls Bayou		E. Side Under Bridge	
Sample Type	water		water	
Sample Amount	0.1 mL		0.1 mL	
Media Used	m-FC, m Entero, m E		m-FC, m Entero, m E	
Dilution Factor(s)	1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / mL*	*Sample Counts*	*CFU / mL*
Fecal coliforms	11	110	6	60
Fecal streptococci	4	40	2	20
Enterococcus	0		0	
Total CFU	150 / mL		80 / mL	
Comments	*FC:FS = 2.75 (mixed)*		*FC:FS = 3.00 (mixed)*	

CFU = colony forming units

Quantitative Bacterial Report

Enumeration and Gram Stain, 3 Media

(Hygeia SOP-09)

March 2, 2007

Hygeia Laboratories Inc.
3924 Bluebonnet Drive
Stafford, TX 77477
(281) 242-1000 (281) 242-1030 Fax
www.hygeialabsinc.com

Dr. Kathleen Ramsey
Houston-Galveston Area Council
3555 Timmons
Houston, TX 77227

EV5501 Biolog ID from 1/30/07

Hygeia Reference No.: 31980070006HO
Date Collected: January 30, 2007
Date Received: January 30, 2007
Date Analyzed: February 26, 2007
Samples Analyzed: 4

Hygeia Sample ID	533433		533434		533435		533436	
Client Sample ID	**52688**		**52689**		**52690**		**52691**	
Location	2601 Cromwell (24)		2722 Kowis (23)		Halls Bayou (6)		E. Side Under Bridge (3)	
Sample Type	mE isolate		mE isolate		mE isolate		mE isolate	
Sample Amount	1 plate		1 plate		1 plate		1 plate	
Media Used	BioLog		BioLog		BioLog		BioLog	
Dilution Factor(s)	1:1*		1:1*		1:1*		1:1*	
Bacteria Isolated:	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*	*Sample Counts*	*CFU / plate*
Alloiococcus otitis			1	1	1	1		
Enterococcus casseliflavus	4	4						
Enterococcus durans			1	1				
Enterococcus faecalis	2	2	7	7	1	1	2	2
Enterococcus faecium	3	3	2	2	1	1		
Enterococcus flavescens					1	1		
Enterococcus mundtii	6	6	1	1				
Enterococcus spp.	5	5	8	8				
Lactococcus lactis			1	1				
Pediococcus acidilacti			1	1				
Streptococcus infantarius	2	2			2	2		
Streptococcus mutans	1	1						
Streptococcus spp.	1	1						
Unknown			1	1			1	1
Total CFU	24 / plate		23 / plate		6 / plate		3 / plate	
Comments								

CFU = colony forming units

Quality Assurance Audit Report
Laboratory Audit

Failing Septic System Initiative
Contract # 582-5-65075
EPA Agreement CE-00655003

Bruce Ridpath

Subject: Laboratory Audit for the Failing Septic System Initiative

Purpose: The audit was to ensure laboratory protocols were properly implemented and documented for sampling events conducted at Westfield Estates in northern Harris County and adherence to the Quality Assurance Project Plan (QAPP).

The audit was based on the following documents:

- On-Site Sewage Facility Risk Assessment and Outreach Quality Assurance Project Plan (QAPP)
- TCEQ Surface Water Quality Monitoring Manual (SWQM) – December 2003
- Bacteria analysis utilizing IDEXX method
  - Enterolet – Enterococcus ASTM D-6503
  - Colilert – *E. coli* SM 9223-B

Information regarding the following areas were discussed/audited:

1. Laboratory Conformance with QAPP
2. Field Data Sheets
3. Lab Data Quality Review Sheet
4. Colilert Bacterial Report
5. Quantitative Bacterial Report Enumeration & Gram Stain
6. Quantitative Bacterial Report Microlog
7. Chain of Custody Forms

1. Laboratory Conformance with QAPP

Due to the variability in bacteria concentrations in Houston-area waters, city, county and contract laboratories usually dilute samples 1:100 before any bacterial analysis is performed. Samples collected on September 18, 2006 were not diluted before analysis. Therefore, all 23 coliform results exceeded the laboratory limit of 2420 MPN/mL and 21 out of 23 *E. coli* results exceeded the Laboratory reporting limit.

In addition, all September results were reported in incorrect units as stated in the QAPP. Results were reported in MPN/mL instead of MPN/100mL.

H-GAC corrected all results by multiplying by 100. The result was a Lab Reporting Limit of 242,000 MPN/100mL instead of 2420.

Subsequent results were reported in MPN/100 mL.

2. Field Data Sheets

All appropriate information was listed on the field data sheets including date, time, location, depth, sampler, site conditions, days since last significant rainfall, etc. Any errors on field data sheets were crossed-out with a single line, initialed and dated.

3. Lab Data Quality Review Sheet

All sections of the Lab Data Review Sheet were properly filled out, except for the September sampling event which reported the incorrect Lab Reporting Limit.

4. Colilert Bacterial Report

The September Bacterial report did not list results in proper units. H-GAC corrected the September results. All subsequent data was reported in the correct units.

5. Quantitative Bacterial Report Enumeration & Gram Stain

The Quantitative Bacterial Report with individual isolates and counts are reported

6. Quantitative Bacterial Report Microlog

Individual sample counts from the Bacterial Report Microlog sheets did not reflect the Summary Table listing Classification Results for Individual Enterococcus Isolates. Several isolates were not properly recorded or counted. H-GAC corrected the Summary Table from the individual sheets.

7. Chain of Custody Forms

Appropriate information was listed on the chain-of-custody (COC) forms including date, time, and depth of collection; site identification; sample matrix; number of containers; preservative used; analyses required; and custody transfer signatures.

APPENDIX D

PUBLIC MEETINGS AND OUTREACH

FOR IMMEDIATE RELEASE
CONTACT INFORMATION:

Kathleen S. Ramsey, Ph.D.
Houston-Galveston Area Council
kathleen.ramsey@h-gac.com
713-499-6653

Carl Masterson
Houston-Galveston Area Council
cmasterson@h-gac.com
713-993-4561

Septic System Initiative

H-GAC to host public meeting for Septic System Initiative in North Harris County for Westfield Estates and Oakwilde

Houston – The Houston-Galveston Area Council (H-GAC) along with Harris County Precinct 2 (HCPC2) and the Galveston Bay Estuary Program (GBEP) will host a public meeting January, 17 from 6:30 to 8 PM to discuss results of the Failing Septic System Initiative Study. The public meeting will be held at the Northeast Community Center, 10918- 1/2 Bentley, Houston, Texas 77093 with staff from H-GAC, HCPC2, and GBEP present to discuss the study and respond to public comment.

The purpose of the meeting is to present to local stakeholders, area residents, businesses, realtors, homebuilders the results of the study, discuss correction strategies, and provide information on the proper care and maintenance of septic systems to protect public health and the environment in the community.

Westfield Estates is a well-established community in North Harris County with sewer service provided by septic systems. Bacterial contamination from old or failing systems may pose a problem. Contamination, along with pressures from regional population growth and flooding threaten the water quality of adjacent Halls Bayou.

This public meeting is the final phase of a study covering the Westfield Estates and surrounding area. Featured improvement strategies could decrease bacteria levels in the community and improve water quality in Halls Bayou. H-GAC hopes that the Failing Septic System Initiative Study will serve as a template for future studies and actions to address septic system usage in developing areas.

ABOUT H-GAC

The Houston-Galveston Area Council is a voluntary association of local governments and local elected officials from the 13-county Gulf Coast Planning Region—an area of 12,500 square miles with more than 5 million people. H-GAC works to promote efficient and accountable use of local, state and federal tax dollars; serves as a problem-solving and information forum for local governments; and helps local governments, businesses and civic organizations analyze trends and conditions affecting the area in order to respond to their needs.

Septic System Initiative

Public Meeting: January 17, 2007, 6:30 - 8:00 PM

Location: Northeast community Center

Address: 10918 - 1/2 Bentley

City: Houston, Texas 77093

Contact Phone: 713-499-6653

XXX

Sylvia R. Garcia
Commissioner

For release: January 5, 2007

Contact: Mark Seegers
713-755-6220
Cell: 713-444-2255
mark_seegers@hctx.net

Clean Water Town Hall for Westfield Residents

The results of a wastewater study in the Westfield area will be announced at a Town Hall meeting hosted by Harris County Precinct Two on Wednesday, January 17th beginning at 6:30 p.m. in the Northeast Community Center located at 10918-1/2 Bentley.

The year long study looked at bacteria in surface water found in ditches along streets in Westfield and how septic systems may contribute to this problem and affect nearby Halls Bayou.

Representatives from Harris County, the Houston-Galveston Area Council (which conducted the study), and the Galveston Bay Estuary Program will all be on hand to discuss the study and take questions from Westfield residents.

For information about the meeting call (713) 499-6653 or (713) 924-3975.

###

1001 Preston Suite 950
Houston, Texas 77002
713-755-6220

Sylvia R. García
Comisionada

Boletín de Prensa: Enero 5, 2007

Contacte: Mark Seegers
713-755-6220 o 713-444-2255
Mark_Seegers@hctx.net

REUNIÓN COMUNITARIA DE AGUA LIMPIA PARA LOS RESIDENTES DE WESTFIELD

Los resultados de un estudio de agua del área de Westfield serán anunciados en una reunión comunitaria con el Recinto Dos del Condado de Harris como anfitrión el miércoles 17 de enero a las 6:30 PM en el Northeast Community Center localizado en 10918-1/2 Bentley.

El estudio de un año miro las bacterias en la superficie del agua encontrada en zanjas a lo largo de las calles en Westfield y también cómo los sistemas sépticos pueden contribuir al problema y afectar el Bayou Halls.

Los representantes del Condado de Harris, el Consejo del Área de Houston-Galveston (que condujo el estudio), y el Programa del Estuario de Galveston Bay estarán a la mano para hablar sobre el estudio y tomar preguntas de los residentes de Westfield.

Para la información sobre la reunión llame al (713) 499-6653 o (713) 924-3975.

###

1001 Preston Suite 950
Houston, Texas 77002
713-755-6220

TOWN HALL MEETING

WESTFIELD ESTATES SEPTIC SYSTEM INITIATIVE

Does your septic system work properly?
Want to know what happens when it doesn't?

Learn the results of a water quality study in YOUR neighborhood.

Wednesday, January 17th
Northeast Community Center
10918-½ Bentley Houston, TX 77093
6:30 PM - 8:00 PM

Representatives will be present from the Houston-Galveston Area Council, Harris County Precinct Two, and the Galveston Bay Estuary Program.

Houston-Galveston Area Council

GALVESTON BAY ESTUARY PROGRAM

HARRIS COUNTY PRECINCT 2
Sylvia R. Garcia
Commissioner

For more information call 713-499-6653 or 713-924-3975

REUNIÓN COMUNITARIA

Westfield Estates
Iniciativa de Sistema Séptico

¿Trabaja su sistema séptico correctamente?
¿Desea saber qué sucede cuando no lo hace?

Aprenda los resultados de un estudio de la calidad del agua de su vecindad.

El Miércoles, 17 de enero.
Northeast Community Center
10918-½ Bentley Houston, TX 77093
6:30 PM - 8:00 PM

Representantes estarán presentes del Consejo del Área de Houston-Galveston, de Recinto dos del Condado de Harris, y del Programa del Estuario de Galveston Bay.

H-GAC Houston-Galveston Area Council

Galveston Bay Estuary Program

Harris County Precinct 2
Sylvia R. Garcia
Commissioner

Para más información llame al 713-499-6653 o 713-924-3975.

From: Seegers, Mark (Commissioner Precinct 2) [Mark_Seegers@itc.co.harris.tx.us]
Sent: Friday, January 05, 2007 9:22 AM
To: thisweek@chron.com; GrafikStar@aol.com
Cc: Mabry, Paul (Commissioner Precinct 2); Miranda, Hattie (Commissioner Precinct 2); Gallegos, Robert (Commissioner Precinct 2); Ramsey, Kathleen
Subject: Town Hall Meeting

Please help us get the word out about this Town Hall meeting which is important to the residents of the Westfield area north of downtown.
Thank you.

Mark Seegers
Public Information Officer
Harris County PCT 2
(713) 755-6220
Cell – (713) 444-2255

From: Seegers, Mark (Commissioner Precinct 2) [Mark_Seegers@itc.co.harris.tx.us]
Sent: Friday, January 05, 2007 9:47 AM
To: olivia.blanco@chron.com; editorial@semananews.com; editorial@diariosrumbo.com; news@diariosrumbo.com; newsdesk@eldiausa.com; noticias@telemundohouston.com; Roxann Martinez Fisher
Cc: Mabry, Paul (Commissioner Precinct 2); Miranda, Hattie (Commissioner Precinct 2); Gallegos, Robert (Commissioner Precinct 2); Ramsey, Kathleen
Subject: News & Calendar Item

Mark Seegers
Public Information Officer
Harris County PCT 2
(713) 755-6220
Cell – (713) 444-2255

SUNBELT FRESH WATER SUPPLY DISTRICT

NOTICE OF SPECIAL PUBLIC MEETING

NOTICE is hereby given to all interested members of the public that the Board of Supervisors of the Sunbelt Fresh Water Supply District will meet in special session, open to the public, on **Wednesday, January 10, 2007**, at **5:00 p.m.**, held at **410 W. Gulf Bank, Houston, Texas 77037**, for the following purposes.

1. Presentation by Harris-Galveston Area Council related to analysis of septic systems.

EXECUTED this 5th day of January, 2007.

(DISTRICT SEAL)

SUNBELT FRESH WATER SUPPLY DISTRICT

By: ______________________________

Ross J. Radcliffe
Johnson Radcliffe Petrov and Bobbitt PLLC
Attorneys for the District

TOWN HALL MEETING

WESTFIELD ESTATES
SEPTIC SYSTEM INITIATIVE

Does your septic system work properly?
Want to know what happens when it doesn't?

Learn the results of a water quality study in YOUR neighborhood.

Tuesday, February 13th
Northeast Community Center
10918-½ Bentley Houston, TX 77093
6:30 PM - 8:00 PM

Representatives will be present from the Houston-Galveston Area Council, Harris County Precinct Two, and the Galveston Bay Estuary Program.

Houston-Galveston Area Council

GALVESTON BAY ESTUARY PROGRAM

HARRIS COUNTY PRECINCT 2
Sylvia R. Garcia
Commissioner

For more information
call 713-499-6653 or 713-924-3975

REUNIÓN COMUNITARIA

WESTFIELD ESTATES

INICIATIVA DE SISTEMA SÉPTICO

¿Trabaja su sistema séptico correctamente?
¿Desea saber qué sucede cuando no lo hace?

Aprenda los resultados de un estudio de la calidad del agua de su vecindad.

El Martes, 13 de Febrero.
Northeast Community Center
10918-½ Bentley Houston, TX 77093
6:30 PM - 8:00 PM

Representantes estarán presentes del Consejo del Área de Houston-Galveston, de Recinto Dos del Condado de Harris, y del Programa del Estuario de Galveston Bay.

Houston-Galveston Area Council

Galveston Bay Estuary Program

Harris County Precinct 2
Sylvia R. Garcia
Commissioner

Para más información llame al 713-499-6653 o 713-924-3975.

From: Seegers, Mark (Commissioner Precinct 2) [Mark.Seegers@pct2.hctx.net]
Sent: Thursday, February 01, 2007 2:07 PM
To: olivia.blanco@chron.com; editorial@diariosrumbo.com; maru.garcia@chron.com; editorial@semananews.com; Roxann Martinez Fisher; noticias@ktmd.com; nxgarcia@telemundo.com
Cc: Mabry, Paul (Commissioner Precinct 2); Miranda, Hattie (Commissioner Precinct 2); Ramsey, Kathleen; Gallegos, Robert (Commissioner Precinct 2)
Subject: News Release

Thank you.

Mark Seegers
Public Information Officer
Harris County PCT 2
(713) 755-6220
Cell – (713) 444-2255

From: Seegers, Mark (Commissioner Precinct 2) [Mark.Seegers@pct2.hctx.net]
Sent: Thursday, February 01, 2007 2:08 PM
To: Seegers, Mark (Commissioner Precinct 2); olivia.blanco@chron.com; editorial@diariosrumbo.com; maru.garcia@chron.com; editorial@semananews.com; Roxann Martinez Fisher; noticias@ktmd.com; nxgarcia@telemundo.com
Cc: Mabry, Paul (Commissioner Precinct 2); Miranda, Hattie (Commissioner Precinct 2); Ramsey, Kathleen; Gallegos, Robert (Commissioner Precinct 2)
Subject: RE: News Release

Now, with the attachment.

From: Seegers, Mark (Commissioner Precinct 2)
Sent: Thursday, February 01, 2007 2:07 PM
To: 'olivia.blanco@chron.com'; 'editorial@diariosrumbo.com'; 'maru.garcia@chron.com'; 'editorial@semananews.com'; 'Roxann Martinez Fisher'; 'noticias@ktmd.com'; 'nxgarcia@telemundo.com'
Cc: Mabry, Paul (Commissioner Precinct 2); Miranda, Hattie (Commissioner Precinct 2); 'Ramsey, Kathleen'; Gallegos, Robert (Commissioner Precinct 2)
Subject: News Release

Thank you.

Mark Seegers
Public Information Officer
Harris County PCT 2
(713) 755-6220
Cell – (713) 444-2255

16/64

Failing Septic System Initiative

February 13, 2007 - Northeast Community Center

Name	Organization	Address	City	Zip Code	Phone	E-mail Address
Frances Campbell		2226 Warwick	Hou.	77093	713-894-5380	—
George Meriwether	A&S Engineers	3101 Richmond Ave	Hou	77077	713-297-3150	gmeriwether@ainsworth-sherwood
Sandra Salas	Church	2501 Trenton	Hou	77093	832 8725 703	Sansalas@gmail.com
Maria Salas	—	2510 Lone Oak	"	"		
Hilario Salas	—	2510 Lone Oak	"	"		
Carlos Velasco		2214 Cromwell St.	Houston	77093	281-987-3407	
Leslie W.B. Houston	—	2626 Kowis	Houston	77093	7-451-9687	—
C.A. Boley		2910 Cedar Hill Ln	Houston	77093	281 442 6410	
Margarita Corrales	—	2607 Kowis Houst. Tx-77093	Houston	77093	281-227-6365	—
Juan C Hernandez	—	2325 Kowis	Houston	77093	281-449-4301	—
Victoria C Correa		2625 William Tell	Hou	77093	713-498-3896	vcdynamite66@yahoo.
Maria N Munoz		2406 Kowis.	Houston.	77093	281-590-7466	
Isabel & Alfonso Garcia		2634 Lone Oak Rd.	Houston	77093	281-987-3151	igarcia281@sbcglobal.net
Martin Vasquez		2525 Kowis St.	Houston.	77093	281 219 4191.	
Maria L Vasquez		2525 Kowis St	Houston.	77093	281 219 4191.	
Maria Gomez		2130 Kowis st.	Houston	77093	281-227-9893	
Susana Almanza		2009 Cromwell st.	"	"		

Failing Septic System Initiative

February 13, 2007 - Northeast Community Center

Name	Organization	Address	City	Zip Code	Phone	E-mail Address
Margarita Gallegos	—	2110 William Tell	Houston	77093	281-348-6866	—
Sarah Jones		1413 Lone Oak	Houston	77093	713 6958495	
Jeff Taebel	HGAC	3555 TIMMONS #120	Hou	77027	713 993-4560	jtaebel@h-g... com
Helen Drummond	GBEP		Houston	77058	281 486-1240	hdrummond@tceq.state.tx.us
MARY VILLAREAL	GBEP	17140 El Camino Real #210	HOUSTON	77058	281-486-1241	mvillare@
Steve Johnston	GBEP	"	"	"	281.486.1244	tceq.state.tx.us.
Maria Tuero		2638 Kowis	Houston	77093	281-442-8889	
Madonna Rangel		2582 Cromwell	Houston	77093	2814420594	
ARCHIE HENDERSON		5001 HARTWICK	HOUSTON	77093	281-443-8487	—
Maria Leal		2637 Kowis	Houston	77093	281-219-0708	
Antonio Arredondo		2405 KOWIS	Houston	77093		
Ana Rodriguez		2133 KOWIS	Houston	77093	8322308172	
Hortencia Valle		2225 Cromwell	Houston	77093	2814428404	
Mike Ledbetter	Aldine Improvement	1825 SUNNY Dr	HOUSTON	77093	449-1800	
Pedro Ruiz						
Bruce Ridpath	H-GAC	3555 Timmons	Houston	77027	832-681-2537	

Failing Septic System Initiative

February 13, 2007 - Northeast Community Center

Name	Organization	Address	City	Zip Code	Phone	E-mail Address
Dolores Floriano		2219 Cromwell	Houston	77093	281-442-9041	
Phil Floriano		2219 Cromwell	"	"	" "	
Troy & Sonia Lavedo		2018 William Tell	"	"	281-449-7869	
Janie Garcia		2018 William Tell	"	"	281-755-1715	
Corral Manuel		1100 Bentley	Hous.	77093	281 442-1550	
Anthony Vigaon	Pct 2 Harris Cty	10988 Bentley	Hou	77093	2-452-1182	
Lisa May	Pct 2 Harris Cty	10918 ½ Bentley	Hou	77093	281-442-7950	
Mary J. Parker	Pct 2 Harris County	12611 Bauman Rd.	Houston	77037	281-445-1983	
Dolores Resendiz		3209 Mierianne	Hou	77093	281-590-1893	
Javier Rivera		1823 Sunny Dr	Houston	77093	281-9877272	
Maria Medrano		1802 Lone Oak Dr.	Houston	77093	281-2277574	
Josie Sanchez		2210 Chamberlain	Houston	77093	281 44 23138	
Olivia Mejia		2517 Hopper Rd	Houston	77093	281 4423648	
Marilyn Overturff		2414 Trenton	Houston	77093	281-442-0200	
Gerald Overturff		2414 Trenton Rd	Houston	77093	281-442-0200	
Charles P. Mitchell		2219 Myra	Houston	77039	281-442-9856	

Failing Septic System Initiative
February 13, 2007 - Northeast Community Center

Name	Organization	Address	City	Zip Code	Phone	E-mail Address
Elizabeth Santiago	Board of Director	2402 Kowis #	Houston	77093	281-227-1243	
Francisco Santiago		2402 Kowis	Houston	77093	281-227-1243	
Maria Madrid		2407 warwick	Houston	77093	281 4496889	
Maria Vallejo		2634 Kowis	Houston	77093	281-219-1331	
Jose Vallejo		2634 Kowis	HOUSTON	77093		
Ofelia Lopez		2410 Kowis	Houston	77093	281-227 1983	
Virgilio Ruiz		2541 Kowis	Houston	77093	281 987 9440	vmruiz7@yahoo.com
Nicolas Santiago		11006 Seven Mile Ln	Houston	77093	281-219-06-45	
[illegible] R		2417 Trenton	Houston	77093		
Alejandro corrales		20620 chamberlain	Hosto	77093	832 567-3518	
Ruben Vallejo		2630 Kowis	Hou. TX.	77093	281-987-3652	—
Gregorio Corrales		2607 Kowis	Houstontx	77093.		
Kathleen Downey	H-GAC					

Failing Septic System Initiative

February 13, 2007 - Northeast Community Center

Name	Organization	Address	City	Zip Code	Phone	E-mail Address
B. Bush	Hst - Chronicle					
GILBERT HOFFMAN	NORTHEAST NEWS.					

Community & Environmental Planning

MEETING NOTICE

THURSDAY
February 1, 2007 at 1:30 P.M.
HOUSTON - GALVESTON AREA COUNCIL
HOUSTON, TEXAS

Please plan to attend the February 1st meeting of the H-GAC Natural Resources Advisory Committee as noted above. The meeting will be held in H-GAC's Conference Room **A** on the second floor. If you need directions, please contact Carl Masterson at 713.993.4561. Business topics include:

Action Items:

- Request approval of the November 2, 2006 Meeting Report. ***(Agenda Item 5)***

Tentative Presentations:

- *Friends of the San Bernard River*
- *Failing Septic System Initiative*
- *Waterborne Education Center*

Other:

- If you have any item you wish to bring to the Committee's attention or present for discussion, please take advantage of ***Agenda Item 10,*** *Other Business and Announcements.* If you need to make copies or need staff assistance, please call **Carl Masterson** at **713/993-4561** no later than noon, January 31st.
- If you have any comments or questions regarding the tentative agenda or enclosed material, or will be unable to make the February 1 meeting, **please** call **Carl Masterson at 713/993-4561.**

SEE YOU ON FEBRUARY 1ST!

PLEASE BRING YOUR E-MAILOUT MATERIALS TO THE MEETING

Community &
Environmental
Planning

...Natural Resources Advisory Committee

TENTATIVE AGENDA

Thursday, February 1, 2007 1:30 PM
H-GAC Meeting Room A
(3555 Timmons Lane, 2nd Floor)

1. **Call to Order/Welcome/Introductions**

2. **Certify Quorum**

   A quorum of 12 is required to conduct committee business.

3. **Public Comment**

4. **Approve Meeting Report**

   Request approval of November 2, 2006 meeting report. Copy Enclosed

5. **Membership**

   The 2006-2008 NRAC roster is enclosed. Please review to make sure all your information is correct and give any changes to Carl Masterson at the meeting.

6. **Subcommittees**

7. **Topics of the Day**

   Friends of the San Bernard River: *The mouth of the San Bernard River has closed and its connection to the Gulf has moved down the coast. Representatives of Friends of the San Bernard River will update the NRAC on projects relating to the opening of the mouth of the San Bernard River.*

   Failing Septic System Initiative: *This project has just been completed and covers an area that lies within the Aldine Improvement District but jurisdiction-wise is in the Sunbelt Fresh Water Supply District that provides water supply but not* *wastewater collection and treatment. Kathy Ramsey will present the results of bacteria monitoring and source identification. This project was conducted with funding from the Galveston Bay Estuary Program and in coordination with Harris County Pct. 2.*

Waterborne Education Center: *Sandra Pickett sits on the Board of the Waterborne Education Center (WEC) and will give a brief presentation on the Center's outreach activities. The WEC is based in Anahuac and is chaired by Anahuac Mayor Guy Robert Jackson. The WEC is making an effort to do some outreach programs and acquaint other individuals and organizations about the opportunity to participate in the boat trips WEC offers on Trinity Bay and elsewhere.*

8. Environmental Program Highlights

H-GAC staff will present news about H-GAC environmental and related activities.

Envirocast
Buddy Garcia as new TCEQ commissioner
State of the Bay
Disaster resistant and resilient communities (?)

9. Other Business & Announcements

This is where NRAC members can bring up issues of import and/or interest for edification and/or discussion at this time or as a 'Topic of the Day' for a future meeting. Please take advantage of this agenda item.

10. Next Meeting Date

Unless otherwise notified, the next scheduled meeting is Thursday, May 3rd, 2007 in H-GAC's Conference Room A (2nd Floor) from 1:30 – 3:30 PM. Remaining scheduled dates for 2007 meetings are: August 2nd and November 1st.

11. Adjourn

In Compliance with the Americans with Disabilities Act, H-GAC provides for reasonable accommodation for persons attending H-GAC functions. Requests should be received by H-GAC 24 hours prior to the function.

FAILING SEPTIC SYSTEM INITIATIVE

TOWN MEETING - February 13, 2006

Executive Summary

Purpose: Dissemination of results of Failing Septic System Initiative (FSSI) to Westfield Estates community (Community).

Escherichia coli levels exceeding State of Texas criteria for contact recreation were seen at 12 of 20 ditch water-sampling sites within the Community and three of five locations in Halls Bayou. No detectable bacteria were found at the Sunbelt Wastewater treatment plant outfall. The source of the bacteria appears to be human (19%), dog (35%), chicken (11%), and non-human unknown sources (35%). Possible human health and environmental risks exist in the community because of this contamination.

Presentation on the FSSI study lasted about 45 minutes with 45 minutes in question and answer format.

Attendee Concerns:

1. Community Drainage Ditches are in need of cleaning;
2. Community is in need of municipal sanitary sewer;
3. Requests for services had not been addressed in the past; and
4. Possible health effects of bacterial contamination in the Community.

Residents circulated a petition requesting Harris County address concerns.

Although Harris County was well represented by Harris County Precinct 2 staff (Claudia Segura), Harris County Public Infrastructure (Mellisa _____) and Harris County Public Health and Environmental Services (Mildred Christian) none of the individuals choose to address residents' concerns during or after the meeting.

H-GAC was represented by Kathleen Ramsey, Bruce Ridpath, and Jeff Taebel. Ramsey spoke to address resident concerns about the FSSI, including bacterial contamination in ditch water and Halls Bayou. Some resident questions were translated for Ramsey by Lisa Mary, Acting Director at Northeast Community Center.

Following the meeting, several phone calls were received by Ramsey, requesting follow up information. These included three residents and a reporter for the Houston Chronicle.

Attendance: Approximately 100 residents from the community, local businesses, representatives form H-GAC, Galveston Bay Estuary Program, Sunbelt Freshwater Supply District, Harris Count Precinct 2, Harris County Infrastructure Department, Harris County Public Health and Environmental Services, Houston Chronicle, Northeast ?. Chronicle. (Check sign-in sheets)

Invited to attend: Aldine Improvement District

Outreach Material on FSSI Disseminated:

150 Brochures on Septic System Maintenance (Color, English)
30 Brochures on Septic System Maintenance (Color, Spanish)
100 Flush Responsibly cards (Color, English)
30 Flush Responsibly cards (Color, Spanish)
50 Brochures on Proper Care and Maintenance of Septic Systems (B & W, English)
30 Basin Summary Reports (Color, English)
15 Basin Summary Reports (Color, English)
25 Technical Bulletins on Septic System Installation (Color, English)
30 Hiking Trail Maps (English)

75 Copies of related H-GAC promotional material on water quality

Additional copies of FSSI Septic System material were left with Northeast Community staff, approximately 50 of each type, 250 total.

Promotion of Meeting:
Leadership provided by Harris County Precinct 2

1700 fliers in Sunbelt Freshwater Supply District Water bills
800 notices to residents on Northeast Community Center mailing list
30 notices posted in area businesses
Notice on H-GAC Website
Notice in H-GAC Newsletter
6 Newspapers contacted (English)
3 newspapers contacted (Spanish)
TV news interview with Channel 13 Debra Wrigley, aired February 9, 6 O'clock News

Facilities and Logistical Support:
Facilities were excellent and provided by Harris County Precinct 2 at no charge. Room was comfortable. It will hold 300, which will allow for increased attendance as community interest increases. Sound system worked well. Lighting was problematic with PowerPoint projected on the wall, but acceptable. Sign-in and outreach material table provided along with coffee.

Facility staff (3) were very responsive and helpful. One handled the sound system and assisted with projector set up, another welcomed at the door, a third acted as translator. The facility's director was very helpful with a variety of tasks and needs of the attendees and presenters.

Recommendations:

1. Interest in the topic was strong as evidenced by the attendance and question and answer session. Future presentations should either be translated into Spanish.

Alternately, the room is large enough to use two projectors with side-by-side PowerPoint in English and Spanish. H-GAC has some presentations in Spanish. Harris County Precinct 2 might be able to help with translating others.

2. Stakeholder representatives should be included in formal presentation.

3. The majority of residents attended because a neighbor told them about the meeting. This activity should be encouraged and supported with meeting notices for distribution.

4. Because of strong resident interest, future town meetings should be scheduled. Proposed topics (1) Care and Maintenance of Septic Systems and (2) Harris County activities in support of providing municipal septic system service.

5. Formation of a stakeholders group to address Community concerns is feasible.

APPENDIX E

OUTREACH BROCHURES AND CD

Failing Septic System Initiative

OUTREACH CD TABLE OF CONTENTS

5. Organizations

National Small Flows Clearinghouse
NSFC Septic News Files
Community Resource Group
National Small Flows Clearinghouse
NESC
NSFC Septic News

6. On-site Sewer Facilities (OSSF) Information in Spanish

Flush Responsable Brochure
Homeowner Guide
Cama de evapotranspiración
Cámaras de percolación
Cloración con pastille
Distribución por goteo subterráneo
Distribución por rociado
Dosificación de baja presión
EPA's publication in Spanish – especially Sort Version of the Homeowners Guide and Homeowner Septic System Checklist
Facilidades en Sitio para el Tratamiento de las Aguas Negras – Inspeccion de Bienes Raices – parte 1
Facilidades en Sitio para el Tratamiento de las Aguas Negras – parte 2b
Filtro de Area
Filtro percolador
Fosa séptica convencional campo de drenaje
Fosa séptica y campo de absorción
Guía completa de Sistemas Sépticos para el Dueño de Hogar
Guía completa de Sistemas Sépticos para el Dueño de Hogar (PDF)
Guía de Sistemas Sépticos para el Dueño de Hogar
Guía de Sistemas Sépticos para el Dueño de Hogar (PDF)
Guía Del Dueño 06-06
Humedales artificiales
Ilustraciones-Breve Guía para el Dueño de Hogar
Jale la Cadena Responsablemente
Operación y mantenimiento
Responsable Flushing - Spanish
Selección y autor ización
Sistemas de recolección alternativos
Sistemas descentralizados de absorción al suelo
Taller para el Dueño de Hogar 2004
Tanque bomba
Tubería sin grava
Unidad de tratamiento aeróbico

Spanish Publications with English Titles

2004 Homeowners Workshop – PowerPoint
Cama de evapotranspiración
Cámaras de percolación

Cloración con pastille
Distribución por goteo subterráneo
Distribución por rociado
Dosificación de baja presión
Filtro de Area
Filtro percolador
Fosa séptica convencional campo de drenaje
Fosa séptica y campo de absorción
Homeowners Guide Long – Spanish – (Word)
Homeowners Guide Long – Spanish – (PDF)
Homeowners Guide Long – Spanish, Final
Humedales artificiales
Illustrations Homeowners Guide Short
Illustrations Homeowners Guide Short –Spanish
Homeowners Guide 2 Pages – Spanish (Word)
Homeowners Guide 2 Pages – Spanish (PDF)
On Site Sewage Facility Mortgage Inspection Part 1
On Site Sewage Facility Mortgage Inspection Part 2b
Operación y mantenimiento
Responsible Flushing – Spanish (Word)
Responsible Flushing – Spanish (PDF)
Selecci – Spanish (Word)
Responsible Flushing – Spanish (PDF)
Selección y autorización
Sistemas descentralizados de absorción al suelo
Systemas de recolección alternativas
Tanque bomba
Tuberia sin grava
Unidad de tratamiento aerón alternativas
Tanque bomba
Tuberia sin grava
Unidad de tratamiento aeróbico

8. Realtors

On Site Sewage Facility Mortgage Inspection Part 1
On Site Sewage Facility Mortgage Inspection Part 2b

9. Regulations and Enforcement

NOWA Reform Regulation
Galveston County Septic Order
Fort Bend County Septic Order
Harris County Septic Order
Montgomery County Septic Order
San Jacinto River Authority Septic Order
Trinity River Authority Septic Order

10. Small Communities

Drinking water, wastewater, and environmental training information for America's small communities!
National Small Flows Clearinghouse files
Drinking water, wastewater, and environmental training information for America's small communities! – Web site
EPA Management Fact Sheet
EPA Septic System Management Guidelines
Guide to Public Management Septic systems
National Small Flows Clearinghouse – web site
Systems Manual
Website Brochure

11. Technical Information

Alternate Collection Systems
Constructed Wetlands
Conventional Septic Tanks
Decentralized System Fact Sheet
Decentralized System Filter Fact Sheet
Decentralized System Soil Fact Sheet
Decentralized System Tank Polish Fact Sheet
Evapotranspiration Bed
Gravel-less Pipe
Leaching Chambers
Low-Pressure Dosing
Mound System
Operation & Maintenance
Pump Tank
Sand Filters
Selecting and Permitting
Septic Tank – Soil Absorption Field
Spray Distribution
Subsurface Drip Distribution
Tablet Chlorination
Trickling Filters

12. Texas Programs

TCEQ TX On-Site Sewage Facility (Septic Tank) Program – files
TCEQ TX On-Site Sewage Facility (Septic Tank) Programs – web site

13. Frequently Asked Questions

If you have a septic system…

Septic systems can provide long-term, effective treatment of household wastewater if properly designed, constructed, and maintained.

Things to keep in mind:

- ✓ **Inspect your system (every 1 to 3 years) and pump your tank (as necessary, generally every 5 years).**
- ✓ **Use water efficiently.**
- ✓ **Don't dispose of household hazardous wastes in sinks and toilets.**
- ✓ **Plant only grass over and near your septic system. Roots from nearby trees or shrubs might clog and damage the drainfield.**
- ✓ **Don't drive or park vehicles on any part of your septic system. Doing so can compact the soil in your drainfield or damage pipes, tank, or other septic system components.**

Not in My Septic System!

✗ Cloggers

diapers, cat litter, cigarette filters, coffee grounds, grease, feminine hygiene products, etc.

✗ Killers

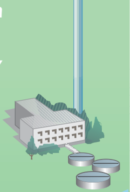
household chemicals, gasoline, oil, pesticides, antifreeze, paint, etc.

For more information, contact:

U.S. Environmental Protection Agency,
www.epa.gov/owm/onsite

If you're on a sanitary sewer system...

What you flush from your home affects the streams, lakes, and coastal waters in our community.



- ✓ **Don't pour household products such as cleansers, beauty products, medicine, auto fluids, paint, and lawn care products down the drain.**

  Wastewater treatment facilities are designed to treat organic materials, **not hazardous chemicals**.

  Don't put excess household grease (meat fats, cooking oil, butter and margarine, etc.), diapers, condoms, and personal hygiene products down a drain or flush them.

- ✓ These materials can clog pipes, and cause raw sewage to overflow in your home or yard, or in public areas.

  Don't pour used motor oil down the drain.

  Used motor oil can diminish the effectiveness of the treatment process and might allow contaminants to be discharged into local waterways.

When the wastewater flushed from your toilet or drained from your household sinks, washing machine, or dishwasher leaves your home, it flows through your community's sanitary sewer system to a wastewater treatment facility. The wastewater is treated by the wastewater treatment facility to reduce or remove pollutants.

Flush Responsibly!

For more information, contact:

U.S. Environmental Protection Agency, www.epa.gov/owm

¿Por qué debo mantener el sistema séptico?

Una buena razón para mantener su sistema séptico es ¡para ahorrar dinero! Los sistemas que están fallando son muy caros de reparar o reemplazar; regularmente la falta de mantenimiento es la causa principal para las reparaciones. El inspeccionar el sistema séptico con regularidad (al menos cada 3 años) es relativamente barato en comparación al costo de tener que reemplazarlo. Su sistema necesitará bombeo de cada 3 a 5 años, dependiendo del número de personas en el hogar y el tamaño del tanque. Un sistema séptico que no funciona correctamente puede depreciar el valor de su propiedad, y podría traerle consecuencias legales.

Otra buena razón para brindarle un tratamiento adecuado a las aguas negras es la prevención de infecciones y enfermedades, así como el bienestar ecológico de nuestros recursos hídricos. Los contaminantes comunes que se encuentran en las aguas negras son el nitrógeno, el fósforo, las bacterias y los virus que causan enfermedades.

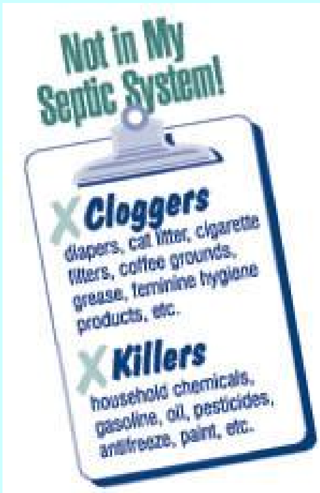
El nitrógeno y el fósforo son nutrientes acuáticos que pueden causar un crecimiento excesivo de algas. El exceso de nitrato de nitrógeno en el agua potable puede causar complicaciones en el embarazo, y el síndrome del bebé azul en la infancia. Los patógenos pueden causar enfermedades contagiosas por medio del contacto corporal directo o indirecto, o por la ingestión de agua o mariscos que hayan sido contaminados. Si un sistema séptico está funcionando adecuadamente, éste removerá efectivamente la mayoría de estos contaminantes.

¿Cómo cuidar el área de drenaje?

- **Plante solamente césped en las áreas cerca y sobre el área de drenaje. Las raíces de árboles y otras plantas pueden atascar y dañar el área de drenaje.**

- **No maneje o estacione automóviles encima de ninguna parte de su sistema séptico. Los automóviles pueden compactar el suelo del área de drenaje o pueden dañar las tuberías, la fosa, u otros componentes de su sistema séptico.**

- **Mantenga todas las cañerías del techo, las alcantarillas, las bombas de descargas del sótano, etc., lejos del área de drenaje. Un exceso de agua o una inundación al área podría disminuir o detener los procesos de tratamiento, y causar problemas de cañerías obstruidas.**



Nombre

Agencia

Dirección

Teléfono y E-mail (correo electrónico)

Para más información por favor visítenos en:
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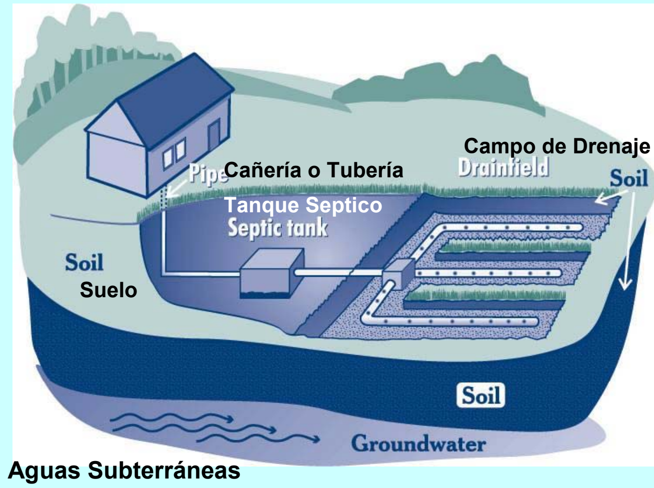
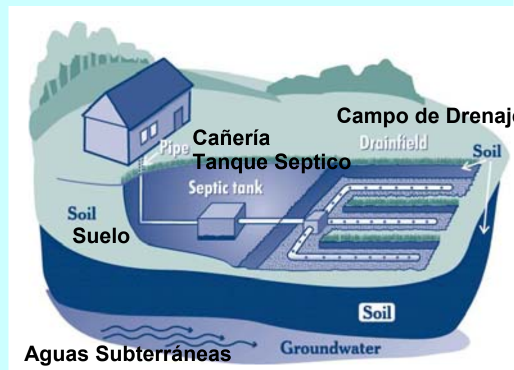


Guía del dueño de hogar para sistemas sépticos

Su sistema séptico es su responsabilidad

¿Sabía que como dueño de hogar usted es responsable por el mantenimiento del sistema séptico? ¿Sabía que el mantenimiento de su sistema séptico protege la inversión de su vivienda? ¿Sabía que su sistema séptico debe ser inspeccionado y bombeado periódicamente?



Un sistema séptico bien diseñado, construido, y mantenido, puede proveer tratamiento efectivo de las aguas negras por un largo plazo. Si su sistema no recibe un mantenimiento correcto, podría tener que ser reemplazarlo, lo cual le podría costaría miles de dólares. Un sistema en mal funcionamiento podría contaminar el agua subterránea, la cual en muchos casos podría ser una fuente de agua potable. También, si decide vender su casa, su sistema séptico deberá estar en buenas condiciones.

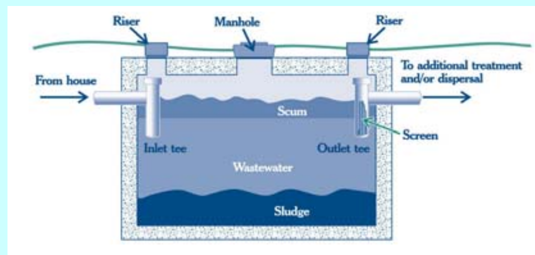
Proteja su sistema séptico:

1. **Inspeccione su sistema (cada 3 aňos), y bombee su tanque cuando sea necesario (generalmente cada 3 a 5 aňos)**
2. **Use el agua eficiente**
3. **No deseche materiales químicos o tóxicos en el lavabo o inodoro**
4. **Cuide el campo de drenaje. Evite manejar o estacionar automóviles en el área de drenaje. Siembre solamente césped sobre y en las cercanías de esta área, ya que las raíces de las plantas pueden daňar el sistema.**

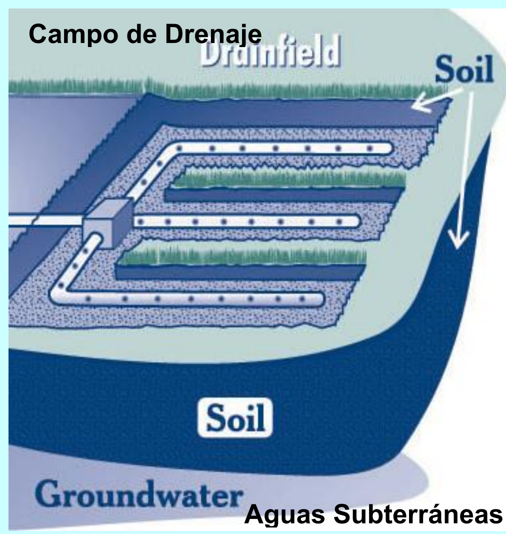
¿Como funciona?

Un sistema séptico común tiene 4 componentes principales: (1) una cañería proveniente de la casa, (2) un tanque séptico, (3) un campo de drenaje, y (4) el suelo. Los microbios en el suelo digieren o remueven la mayoría de los contaminantes de las aguas negras antes de que lleguen a las aguas subterráneas. El tanque séptico es un contenedor hermético enterrado bajo la tierra. Comúnmente está hecho de concreto, fibra de vidrio, o polietileno.

La fosa retiene las aguas negras el tiempo suficiente para permitir que los desechos sólidos se asienten en el fondo formando un fango o lodo; y que las grasas y aceites floten hacia la superficie (como espuma). También permite la descomposición parcial de los sólidos retenidos. Los compartimientos y un desagüe en forma de "T" evitan que el fango y la espuma se escapen hacia el área de drenaje.



También se recomiendan las rejillas y mallas para que los sólidos no entren al área de drenaje. Las aguas residuales son vertidas sobre el área de drenaje para ser tratadas posteriormente en el suelo. Los microorganismos en el suelo proveen el tratamiento final, removiendo las bacterias nocivas, los virus y los nutrientes.



¿Como debo mantener mi sistema séptico?

Bombéelo frecuentemente
Su sistema séptico tiene que ser inspeccionado por un profesional al menos cada tres años, y el tanque debe ser bombeado cada vez que sea necesario (generalmente 3 a 5 años).

Use el agua eficazmente
El uso promedio de agua dentro de un hogar común es de 70 galones por persona por día. Los grifos que gotean pueden desperdiciar alrededor de 2000 galones de agua por año. Los inodoros con escapes de agua pueden desperdiciar hasta 200 galones por día. Mientras más ahorre el agua en el hogar, menor será la cantidad de agua que entrará al sistema séptico, añadiéndole mayor tiempo de vida a dicho sistema.

Sea responsable al desechar los residuos en el inodoro
El hilo dental, los productos higiénicos femeninos, los condones, los pañales, los hisopos (palitos de algodón para limpiarse las orejas), los filtros de cigarro, los granos de café molido, la arenilla de gato, las toallas de papel, y otros artículos de la cocina y el baño pueden atascar, y posiblemente dañar los componentes del sistema séptico.

Use el agua eficazmente

- **Llene la tina con el agua que va a necesitar.**
- **Cierre la llave mientras se rasura o cepilla los dientes.**
- **Use la lavadora de platos y la lavadora de ropa sólo cuando tenga cargas completas.**
- **Use el inodoro sólo para necesidades sanitarias, no para otros desperdicios.**
- **Asegúrese que todas las llaves estén cerradas.**
- **Dé mantenimiento a las cañerías para eliminar fugas.**
- **Instale aereadores de agua en la regadera y las llaves de la cocina.**
- **Reemplace las máquinas de lava-platos, las lavadoras de ropa, e inodoros con modelos nuevos y más eficientes.**

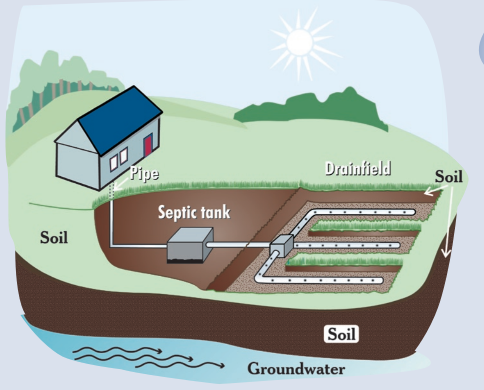
Para más información sobre cómo ahorrar el agua, por favor visítenos en:
www.epa.gov/owm/waterefficiency

El tirar químicos caseros, gasolina, aceite, pesticidas, anticongelante, o pintura pueden dañar o destruir el tratamiento biológico de su sistema, y también pueden contaminar las aguas superficiales y subterráneas.

Your septic system is your responsibility!

Did you know that as a homeowner you're responsible for maintaining your septic system? Did you know that maintaining your septic system protects your investment in your home? Did you know that you should periodically inspect your system and pump out your septic tank?

If properly designed, constructed, and maintained, your septic system can provide long-term, effective treatment of household wastewater. If your septic system isn't maintained, you might need to replace it, costing you thousands of dollars. A malfunctioning system can contaminate groundwater that might be a source of drinking water. And if you sell your home, your septic system must be in good working order.

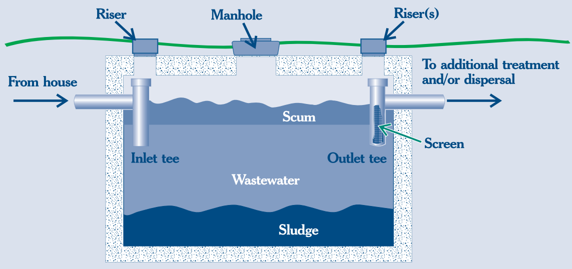


Protect Your Septic System

1 **Inspect your system (every 3 years) and pump your tank as necessary (generally every 3 to 5 years).**
2 **Use water efficiently.**
3 **Don't dispose of household hazardous wastes in sinks or toilets.**
4 **Care for your drainfield. Avoid driving or parking vehicles on your drainfield. Plant only grass over and near your drainfield to avoid damage from roots.**

How does it work?

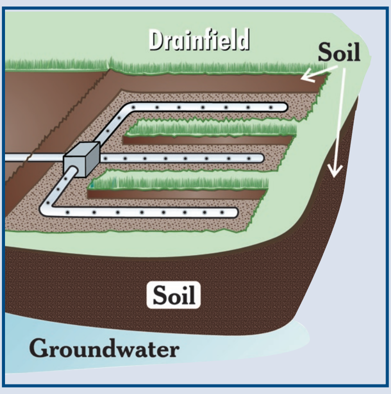
A typical septic system has four main components: a pipe from the home, a septic tank, a drainfield, and the soil. Microbes in the soil digest or remove most contaminants from wastewater before it eventually reaches groundwater.



The septic tank is a buried, watertight container typically made of concrete, fiberglass, or polyethylene. It holds the wastewater long enough to allow solids to settle out (forming sludge) and oil and grease to float to the surface (as scum). It also allows partial decomposition of the solid materials. Compartments and a T-shaped outlet in the septic tank prevent the sludge and scum from leaving the tank and traveling into the drainfield area. Screens are also recommended to keep solids from entering the drainfield.

The wastewater exits the septic tank and is discharged into the drainfield for further treatment by the soil.

Microorganisms in the soil provide final treatment by removing harmful bacteria, viruses, and nutrients.



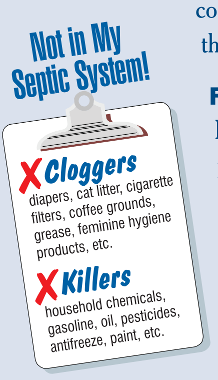
How do I maintain my septic system?

Pump frequently

You should have your septic system inspected at least every 3 years by a professional and your tank pumped as necessary (generally every 3 to 5 years).

Use water efficiently

Average indoor water use in the typical single-family home is almost 70 gallons per person per day. Dripping faucets can waste about 2,000 gallons of water each year. Leaky toilets can waste as much as 200 gallons each day. The more water a household conserves, the less water enters the septic system.



Flush responsibly

Dental floss, feminine hygiene products, condoms, diapers, cotton swabs, cigarette butts, coffee grounds, cat litter, paper towels, and other kitchen and bathroom items can clog and potentially damage septic system components. Flushing household chemicals, gasoline, oil, pesticides, antifreeze, and paint can stress or destroy the biological treatment taking place in the system or might contaminate surface waters and groundwater.

Use Water Efficiently!

- **Fill the bathtub with only as much water as you need**
- **Turn off faucets while shaving or brushing your teeth**
- **Run the dishwasher and clothes washer only when they're full**
- **Use toilets to flush sanitary waste only (not kitty litter, diapers, or other trash)**
- **Make sure all faucets are completely turned off when not in use**
- **Maintain your plumbing to eliminate leaks**
- **Install aerators in the faucets in your kitchen and bathroom**
- **Replace old dishwashers, toilets, and clothes washers with new, high-efficiency models**

For more information on water conservation, please visit www.epa.gov/owm/water-efficiency

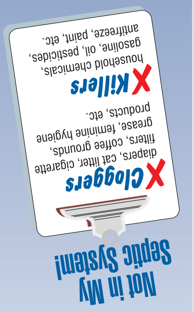
Why should I maintain my septic system?

A key reason to maintain your septic system is to save money! Failing septic systems are expensive to repair or replace, and poor maintenance is often the culprit. Having your septic system inspected (at least every 3 years) is a bargain when you consider the cost of replacing the entire system. Your system will need pumping every 3 to 5 years, depending on how many people live in the house and the size of the system. An unusable septic system or one in disrepair will lower your property's value and could pose a legal liability.

Other good reasons for safe treatment of sewage include preventing the spread of infection and disease and protecting water resources. Typical pollutants in household wastewater are nitrogen, phosphorus, and disease-causing bacteria and viruses. Nitrogen and phosphorus are aquatic plant nutrients that can cause unsightly algae blooms. Excessive nitrate-nitrogen in drinking water can cause pregnancy complications, as well as methemoglobinemia (also known as blue baby syndrome) in infancy. Pathogens can cause communicable diseases through direct or indirect body contact or ingestion of contaminated water or shellfish. If a septic system is working properly, it will effectively remove most of these pollutants.

How to treat your drainfield

- **Plant only grass over and near your septic system. Roots from nearby trees or shrubs might clog and damage the drainfield.**
- **Don't drive or park vehicles on any part of your septic system. Doing so can compact the soil in your drainfield or damage the pipes, tank, or other septic system components.**
- **Keep roof drains, basement sump pump drains, and other rainwater or surface water drainage systems away from the drainfield. Flooding the drainfield with excessive water slows down or stops treatment processes and can cause plumbing fixtures to back up.**



For more information, contact your local health department or visit www.epa.gov/owm/onsite

EPA United States Environmental Protection Agency

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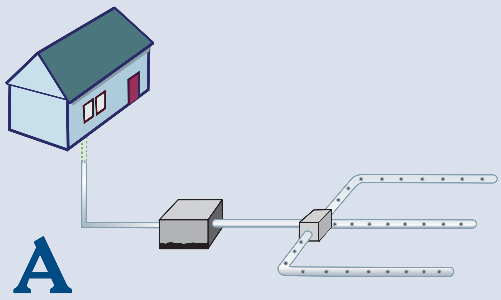

A Homeowner's Guide to Septic Systems

Si usted tiene un sistema de alcantarillado….

Lo que usted eche al agua de su casa afecta a los ríos, lagos, y aguas costaneras en su comunidad.

- No se deshaga de productos caseros como limpiadores, productos de belleza, medicina, productos de auto, pinturas y productos del jardín tirándolos por la cañería.
  Las plantas de tratamiento de agua sólo pueden tratar materia orgánica, ***no sustancias químicas peligrosas o tóxicas.***
  No deseche exceso de grasas de la cocina (carnes, aceites, margarina y mantequilla, etc), pañales, condones, o productos higiénicos personales en la cañería.
- Estos materiales pueden atascar la cañería y causar que aguas negras se derramen en su casa, patio, o áreas públicas.
  No se deshaga del aceite de automóvil a través de la cañería
  El aceite de automóvil puede disminuir la eficacia de los tratamientos de su sistema, y podrían ocasionar que contaminantes entren a cuerpos de agua locales.

Cuando las aguas del inodoro, lavabo y lavadoras de ropa o platos salen de su hogar, corren por el sistema de alcantarillado de su comunidad hacia una planta de tratamiento de aguas negras. Las aguas negras son tratadas por la planta para reducir o remover los contaminantes.

Flush Reponsibly =
Hale la cadena responsablemente

Flush Responsibly!

Si usted tiene un sistema séptico ….

Los sistemas sépticos pueden proveer un tratamiento efectivo para las aguas negras del hogar si son diseñados, construidos, y mantenidos correctamente.

Cosas que debe recordar:

- Inspeccione su sistema (cada 1 a 3 años), y bombee su tanque cuando sea necesario (generalmente cada 3 a 5 años)
- Use el agua eficazmente
- No deseche materiales químicos o tóxicos en el lavabo o inodoro
- Cuide su campo de drenaje. Evite manejar o estacionar automóviles sobre su campo de drenaje.
- Plante solamente pasto sobre y cerca de su campo de drenaje, ya que plantas de raíz pueden dañar su sistema.

Evite que estos artículos entren a su sistema séptico:

✗ Artículos que tapan o atascan:

- Pañales, arenilla de gato, filtros de cigarro, granos de café molidos, grasa, productos femeninos, etc.

✗ Substancias que pueden matar:

- Solventes, productos químicos y tóxicos caseros, gasolina, aceite, pesticidas, anticongelante, pinturas, etc.

Para mas información visite:

U.S. Environmental Protection Agency
www.epa.gov/owm/onsite

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