Total Maximum Daily Loads for Indicator Bacteria in the Houston Metropolitan Area

Contract No. 582-6-70860
Work Orders No. 582-6-70860-07 and 582-6-70860-12

Quarterly Report No. 1

Prepared by
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CHAPTER 1

INTRODUCTION

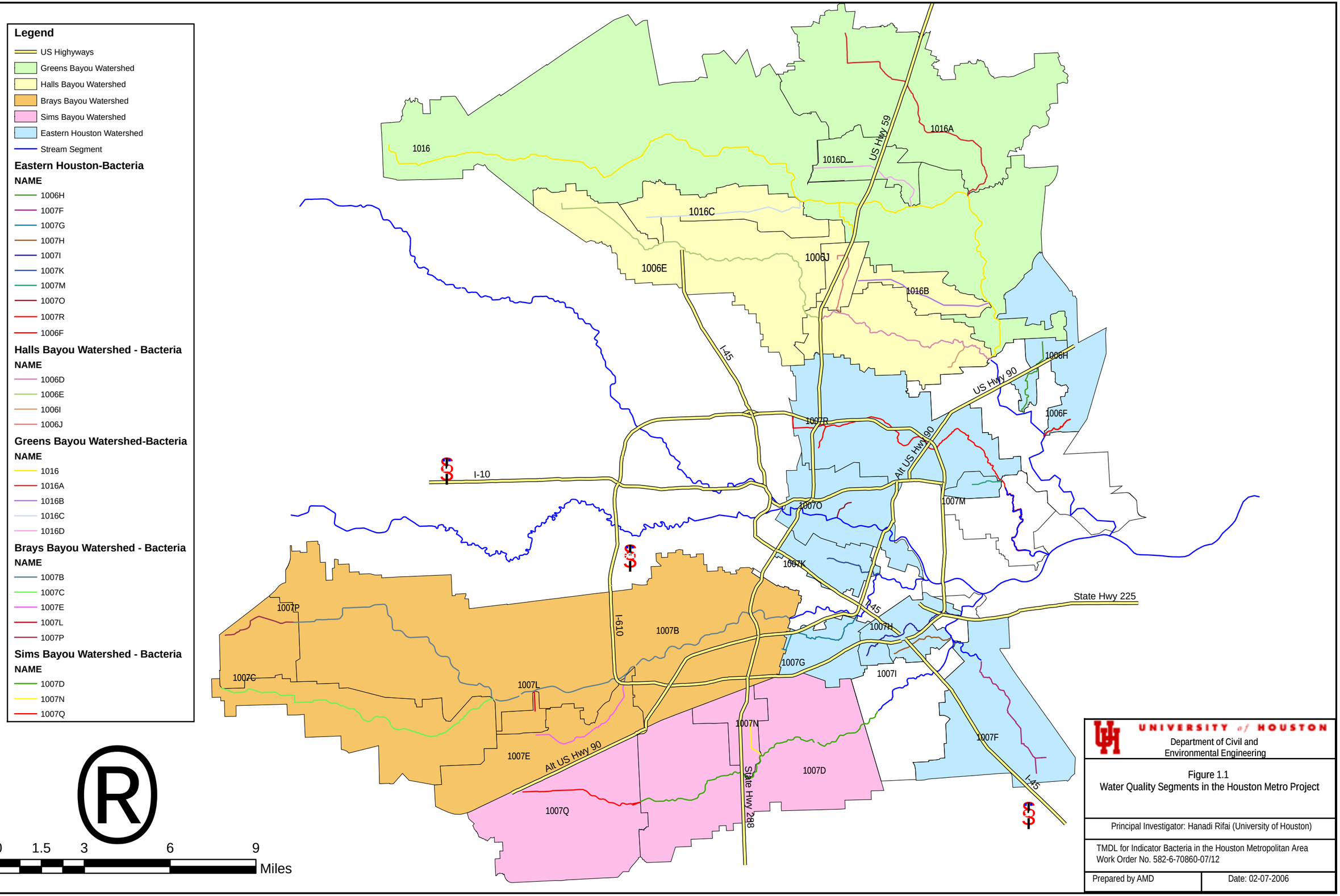
1.1 PROBLEM STATEMENT

The Houston Metropolitan Area project includes 27 segments (see Table 1.1) that are listed on the Texas 2004 303(d) List for not meeting the contact recreation standard for indicator bacteria. These segments are in a number of watersheds in the San Jacinto River basin including, Greens Bayou Watershed, Halls Bayou Watershed, Hunting Bayou Watershed, Brays Bayou Watershed, Sims Bayou Watershed, and the general Houston Ship Channel Watershed. For the purpose of TMDL development, the project has been subdivided into five sub-projects; Greens Bayou Watershed – Bacteria, Halls Bayou Watershed – Bacteria, Brays Bayou Watershed – Bacteria, Sims Bayou Watershed, and Eastern Houston – Bacteria (Figure 1.1). The Eastern Houston project contains all of the bacteria impaired segments in the Houston Ship Channel and Houston Ship Channel/Buffalo Bayou watersheds. All of these segments are fresh water bodies with contact recreation use and they drain into the tidal influenced Houston Ship Channel and Houston Ship Channel/Buffalo Bayou segments with non-contact recreation use.

All of these segments are fresh water and *Escherichia coli* (*E. coli*) is the indicator bacteria for contact recreation.

Table 1.1 Water Quality Segments in the Metro area

TMDL Project Name	Segment Number	Segment Name
Eastern Houston - Bacteria	1006F	Big Gulch Above Tidal
	1006H	Spring Gully Above Tidal
	1007F	Berry Bayou Above Tidal
	1007G	Kuhlman Gully Above Tidal
	1007H	Pine Gully Above Tidal
	1007I	Plum Creek Above Tidal
	1007K	Country Club Bayou
	1007M	Unnamed Non-Tidal Tributary of Hunting Bayou
	1007O	Unnamed Non-Tidal Tributary of Buffalo Bayou
	1007R	Hunting Bayou Above Tidal
Greens Bayou Watershed – Bacteria	1016	Greens Bayou Above Tidal
	1016A	Garners Bayou
	1016B	Unnamed Tributary of Greens Bayou
	1016C	Unnamed Tributary of Greens Bayou
	1016D	Unnamed Tributary of Greens Bayou
Halls Bayou Watershed – Bacteria	1006D	Halls Bayou below US 59
	1006E	Halls Bayou above US 59
	1006I	Unnamed Tributary of Halls Bayou
	1006J	Unnamed Tributary of Halls Bayou
Brays Bayou Watershed – Bacteria	1007B	Brays Bayou Above Tidal
	1007C	Keegans Bayou above tidal
	1007E	Willow Waterhole Bayou Above Tidal
	1007L	Unnamed Non-Tidal Tributary of Brays Bayou
	1007P	Brays Bayou Above Tidal
Sims Bayou Watershed – Bacteria	1007D	Sims Bayou Above Tidal
	1007N	Unnamed Non-Tidal Tributary of Sims Bayou
	1007Q	Sims Bayou Above Tidal


Legend
US Highways
Greens Bayou Watershed
Halls Bayou Watershed
Brays Bayou Watershed
Sims Bayou Watershed
Eastern Houston Watershed
Stream Segment
Eastern Houston-Bacteria
NAME
1006H
1007F
1007G
1007H
1007I
1007K
1007M
1007O
1007R
1006F
Halls Bayou Watershed - Bacteria
NAME
1006D
1006E
1006I
1006J
Greens Bayou Watershed-Bacteria
NAME
1016
1016A
1016B
1016C
1016D
Brays Bayou Watershed - Bacteria
NAME
1007B
1007C
1007E
1007L
1007P
Sims Bayou Watershed - Bacteria
NAME
1007D
1007N
1007Q
1016
1016A
1016B
1016C
1016D
US Hwy 59
1006E
1006J
1006H
1006F
1007R
I-45
US Hwy 90
Alt US Hwy 90
I-10
1007O
1007M
1007K
State Hwy 225
1007H
1007G
1007I
1007P
1007B
I-610
1007C
1007L
1007N
1007F
1007E
1007D
1007Q
State Hwy 288
0 1.5 3 6 9
Miles
UNIVERSITY of HOUSTON
Department of Civil and
Environmental Engineering
Figure 1.1
Water Quality Segments in the Houston Metro Project
Principal Investigator: Hanadi Rifai (University of Houston)
TMDL for Indicator Bacteria in the Houston Metropolitan Area
Work Order No. 582-6-70860-07/12
Prepared by AMD
Date: 02-07-2006

In 2000, the State of Texas adopted new bacteria standards for contact recreation. The *E. coli* indicator bacteria standard was adopted for contact recreation in place of the existing fecal coliform indicator bacteria. For fecal coliform, no sample should exceed 400 colony-forming units (cfu) per 100 mL for contact recreation. In addition, the geometric mean should be less than 200 cfu/100 mL. For *E. coli*, no sample should exceed 394 cfu/ 100 mL and the geometric mean should be less than 126 cfu/100 mL (30 Texas Administrative Code 307.7(b)(A)).

The overall objective of this project is to establish the TMDL allocation equation for the segments listed above.

There are four main tasks in to be completed for WO 5582-6-70860-07:

1. Administer project;
2. Participate in stakeholder process;
3. QAPP/Sampling Plan/ Data Management; and
4. Data Collection

Additionally there are four main tasks for WO 582-6-70860-12

1. Administer project;
2. Participate in stakeholder process;
3. Analyze FY06 data; and
4. Quality Assurance Project Plan (QAPP)/Sampling Plan/Data Management.

This report summarizes the results for the two work orders and describes the progress for the period from September 2005 through November 2006 for the metro project.

1.2 DESCRIPTION OF THE REPORT

This document constitutes the fourth quarterly report for Work Order No. 582-6-70860-07 and the first quarterly report for Work Order No. 582-6-70860-12 of the Bacteria in the Houston Metropolitan Area TMDL Project. The report summarizes the activities undertaken by the University of Houston during the period September 2005 through November 2006. This report reflects the progress made towards all the tasks in the two Project Work Plans listed previously.

Chapter 2 of the report presents a review of the historical data analysis; Chapter 3 documents the Quality Assurance Project Plan (QAPP); Chapter 4 presents the detailed sampling plan and activities; Chapter 5 documents the quality assurance/quality control; Chapter 6 presents the results from the three sampling events conducted from May 06 through July 06, Chapter 7 presents a detailed data analysis and Chapter 8 presents a summary and future activities.

CHAPTER 2

HISTORICAL DATA REVIEW

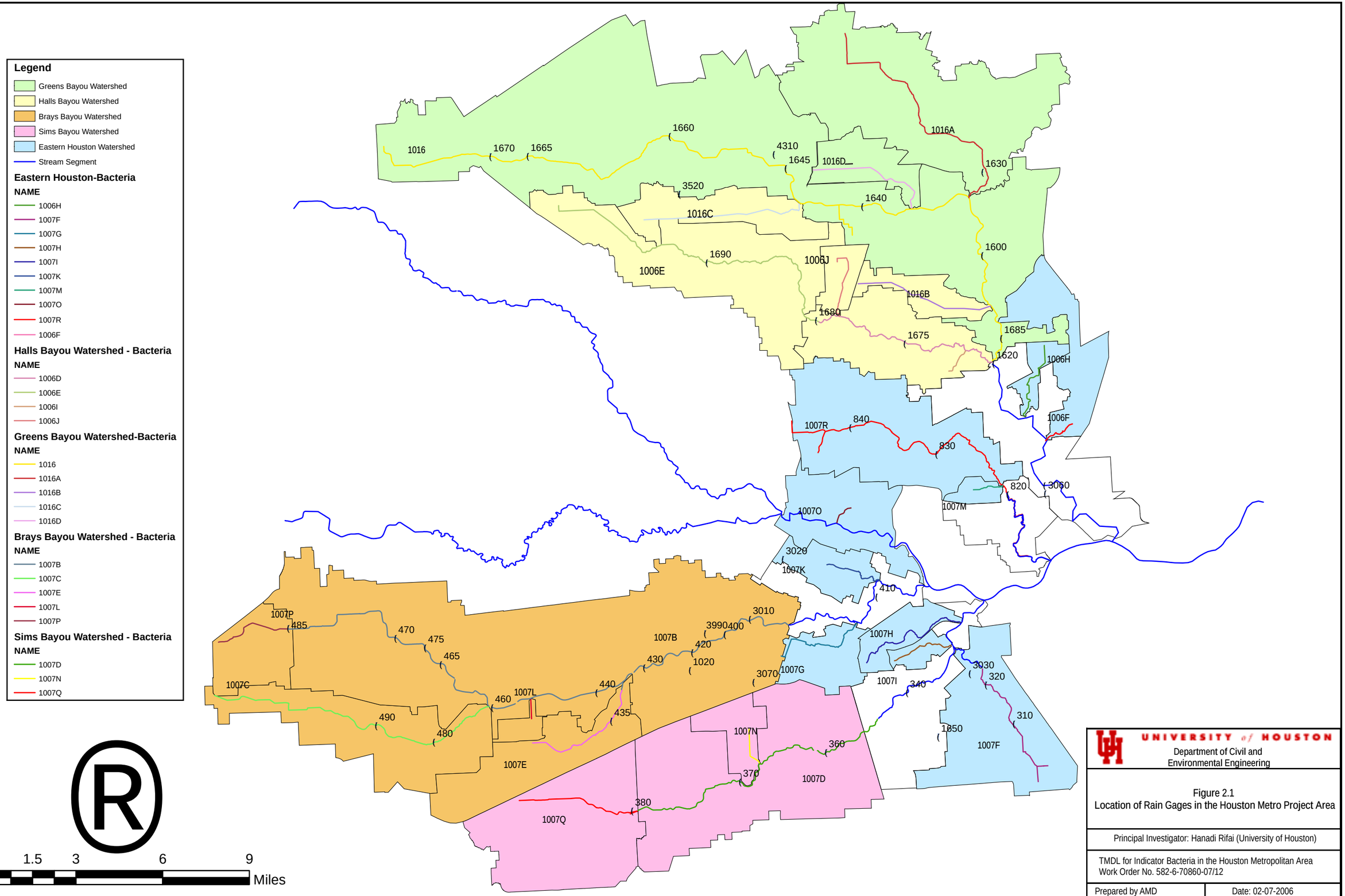
2.1 RAINFALL AND STREAMFLOW

There are 45 Harris County Office of Emergency Management (HCOEM) rain gages in the watersheds within the study area (Figure 2.1). The average annual rainfall for the period 2000-2004 ranged between 33 and 66 inches, with an average of 50 inches. Figure 2.2 illustrates the historical annual precipitation ranges for the entire Houston area obtained by statistically analyzing annual average data for all the existing HCOEM gages (including those outside the TMDL area).

Thirteen USGS flow gages are located in the study area (Figure 2.3), seven of which have relatively complete and current flow records as can be seen in Table 2.1. Figure 2.4 shows scatterplots of available flow data for the thirteen gages located in the Houston Metropolitan area.

Table 2.1 Summary of USGS Gages in the Project Area

USGS Gage ID	Site Name	Segment	Begin Period	End Period
8074800	Keegans Bayou at Roark Rd nr Houston, TX	1007C	9/1/1964	9/30/1981
8074810	Brays Bayou at Gessner Dr, Houston, TX	1007B	10/1/1989	9/30/2004
8075000	Brays Bayou at Houston, TX	1007B	6/1/1936	9/30/2004
8075400	Sims Bayou at Hiram Clarke St, Houston, TX	1007Q	9/1/1964	9/30/2004
8075500	Sims Bayou at Houston, TX	1007D	10/1/1952	9/1/2001
8075650	Berry Bayou at Forest Oaks St, Houston, TX	1007F	5/1/1964	9/30/2001
8075770	Hunting Bayou at IH 610, Houston, TX	1007R	5/1/1964	9/30/2004
8075780	Greens Bayou at Cutten Rd nr Houston, TX	1016	10/1/1997	9/30/2002
8075900	Greens Bayou nr US Hwy 75 nr Houston, TX	1016	8/3/1965	9/30/1992
8076000	Greens Bayou nr Houston, TX	1016	10/1/1952	9/30/2004
8076180	Garners Bayou nr Humble, TX	1016A	2/25/1986	9/30/2004
8076500	Halls Bayou at Houston, TX	1006E	10/1/1952	9/30/2004
8076700	Greens Bayou at Ley Rd, Houston, TX	1016	12/2/1971	9/22/2003


Legend
Greens Bayou Watershed
Halls Bayou Watershed
Brays Bayou Watershed
Sims Bayou Watershed
Eastern Houston Watershed
Stream Segment
Eastern Houston-Bacteria
NAME
1006H
1007F
1007G
1007H
1007I
1007K
1007M
1007O
1007R
1006F
Halls Bayou Watershed - Bacteria
NAME
1006D
1006E
1006I
1006J
Greens Bayou Watershed-Bacteria
NAME
1016
1016A
1016B
1016C
1016D
Brays Bayou Watershed - Bacteria
NAME
1007B
1007C
1007E
1007L
1007P
Sims Bayou Watershed - Bacteria
NAME
1007D
1007N
1007Q
0 1.5 3 6 9
Miles
1016
1670
1665
1660
4310
1645
1016D
1016A
1630
3520
1640
1016C
1600
1690
1006J
1006E
1016B
1680
1685
1675
1620
1006H
1006F
1007R
840
830
820
3060
1007M
1007O
3020
1007K
410
1007P
485
470
475
465
1007B
3990
400
3010
420
1020
430
1007H
3070
1007G
3030
320
1007C
1007L
460
440
1007I
340
490
480
435
310
1850
1007N
360
1007F
1007E
370
1007D
380
1007Q
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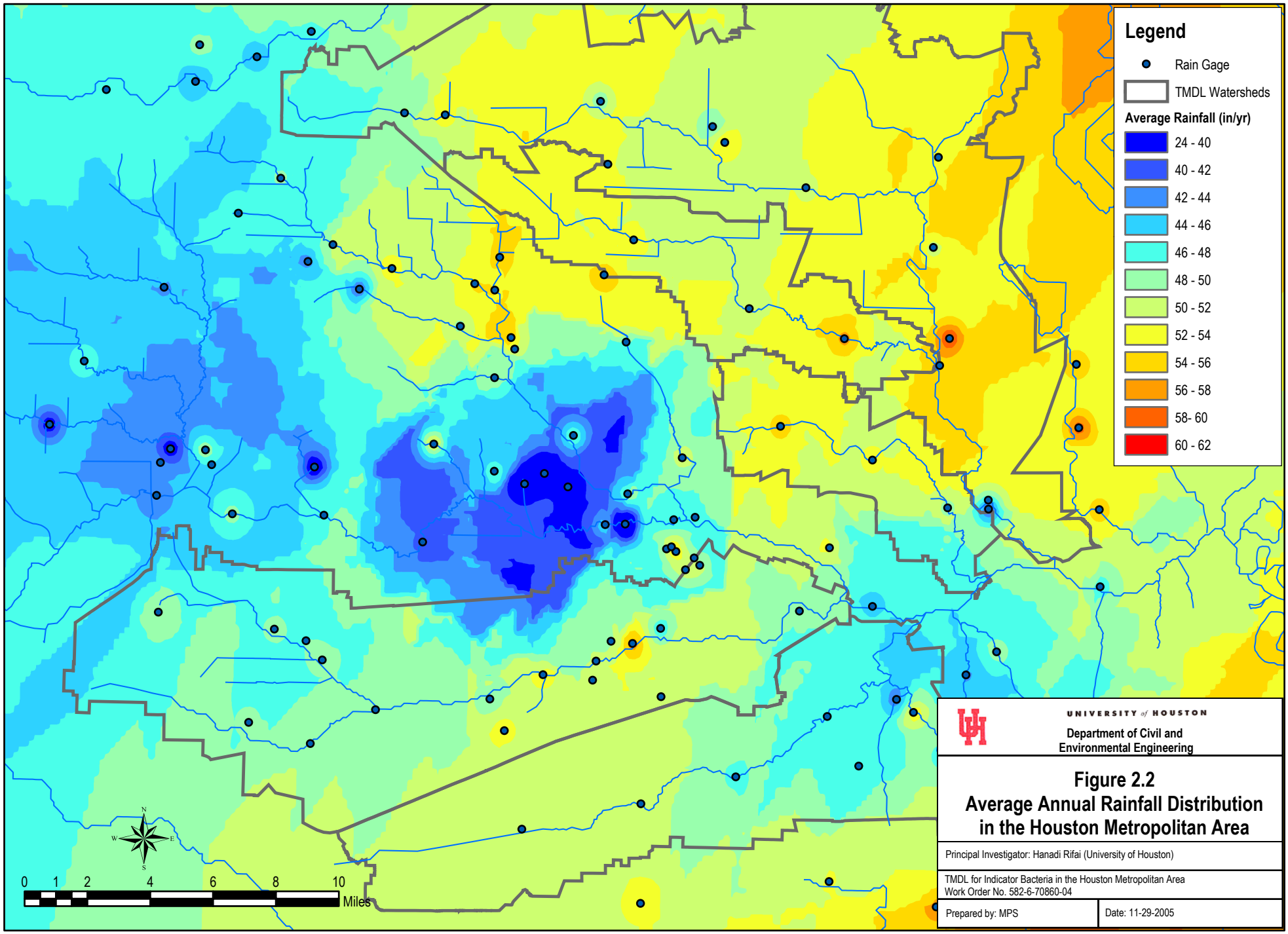
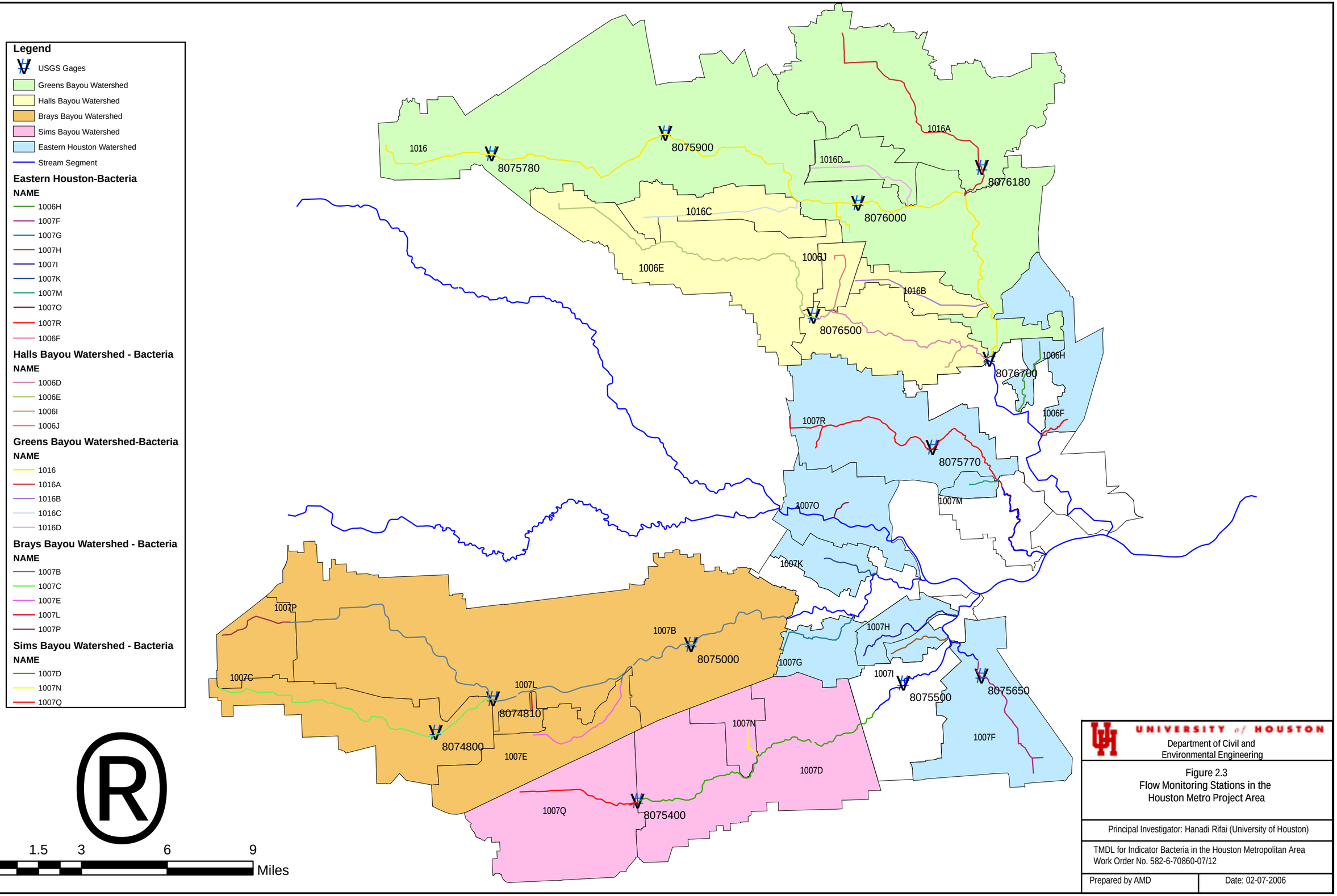
Department of Civil and
Environmental Engineering
Figure 2.1
Location of Rain Gages in the Houston Metro Project Area
Principal Investigator: Hanadi Rifai (University of Houston)
TMDL for Indicator Bacteria in the Houston Metropolitan Area
Work Order No. 582-6-70860-07/12
Prepared by AMD
Date: 02-07-2006


Legend
Rain Gage
TMDL Watersheds
Average Rainfall (in/yr)
24 - 40
40 - 42
42 - 44
44 - 46
46 - 48
48 - 50
50 - 52
52 - 54
54 - 56
56 - 58
58- 60
60 - 62
N
W
E
S
0 1 2 4 6 8 10
Miles
UNIVERSITY of HOUSTON
Department of Civil and Environmental Engineering
Figure 2.2
Average Annual Rainfall Distribution in the Houston Metropolitan Area
Principal Investigator: Hanadi Rifai (University of Houston)
TMDL for Indicator Bacteria in the Houston Metropolitan Area
Work Order No. 582-6-70860-04
Prepared by: MPS
Date: 11-29-2005


Legend
USGS Gages
Greens Bayou Watershed
Halls Bayou Watershed
Brays Bayou Watershed
Sims Bayou Watershed
Eastern Houston Watershed
Stream Segment
Eastern Houston-Bacteria
NAME
1006H
1007F
1007G
1007H
1007I
1007K
1007M
1007O
1007R
1006F
Halls Bayou Watershed - Bacteria
NAME
1006D
1006E
1006I
1006J
Greens Bayou Watershed-Bacteria
NAME
1016
1016A
1016B
1016C
1016D
Brays Bayou Watershed - Bacteria
NAME
1007B
1007C
1007E
1007L
1007P
Sims Bayou Watershed - Bacteria
NAME
1007D
1007N
1007Q
8075780
8075900
8076180
8076000
8076500
8076700
8075770
8075000
8075500
8075650
8074810
8074800
8075400
0 1.5 3 6 9
Miles
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Department of Civil and
Environmental Engineering
Figure 2.3
Flow Monitoring Stations in the
Houston Metro Project Area
Principal Investigator: Hanadi Rifai (University of Houston)
TMDL for Indicator Bacteria in the Houston Metropolitan Area
Work Order No. 582-6-70860-07/12
Prepared by AMD
Date: 02-07-2006

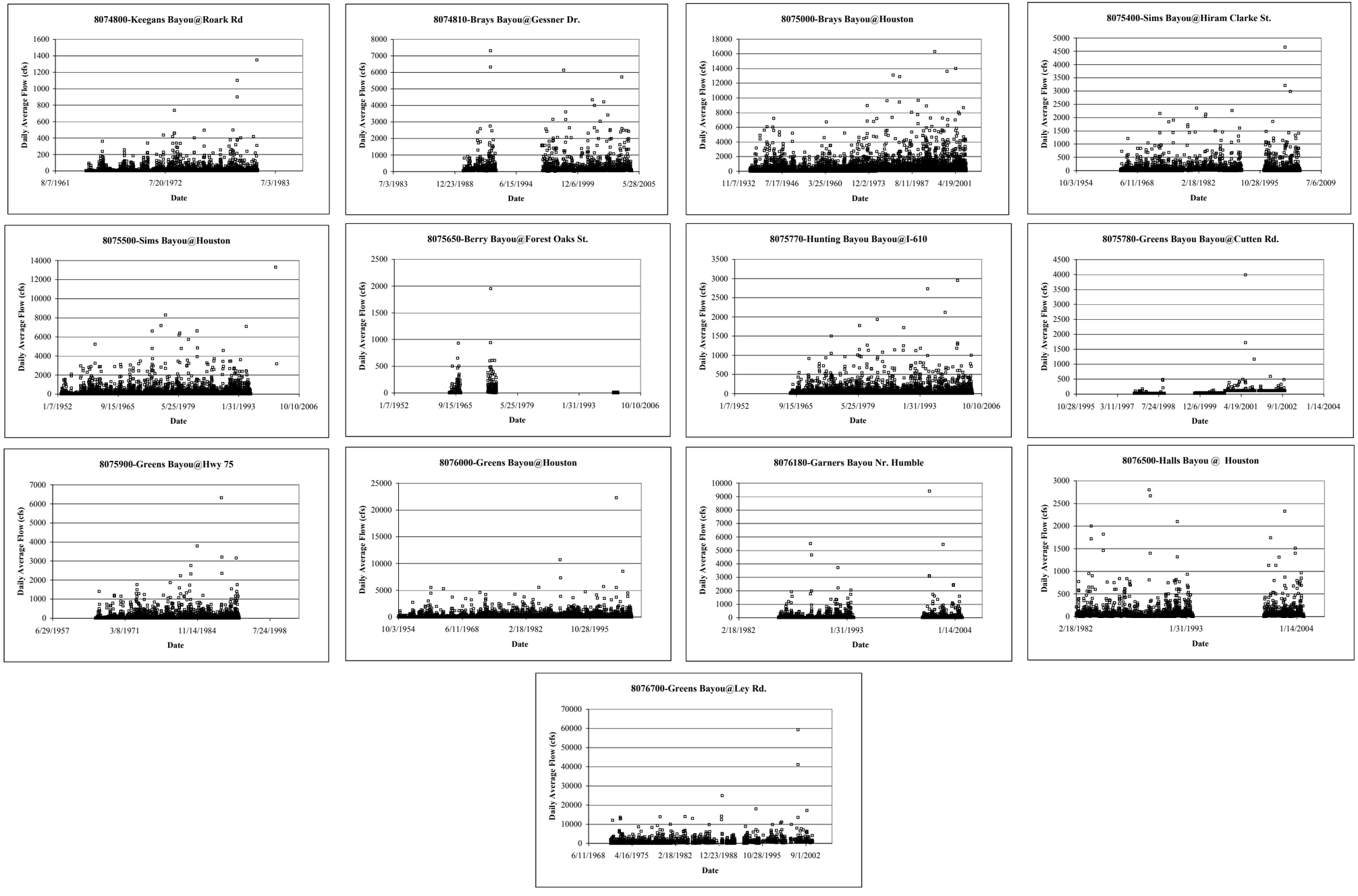


Figure 2.4 Flow Data for USGS Gages located in the Houston Metro TMDL Area

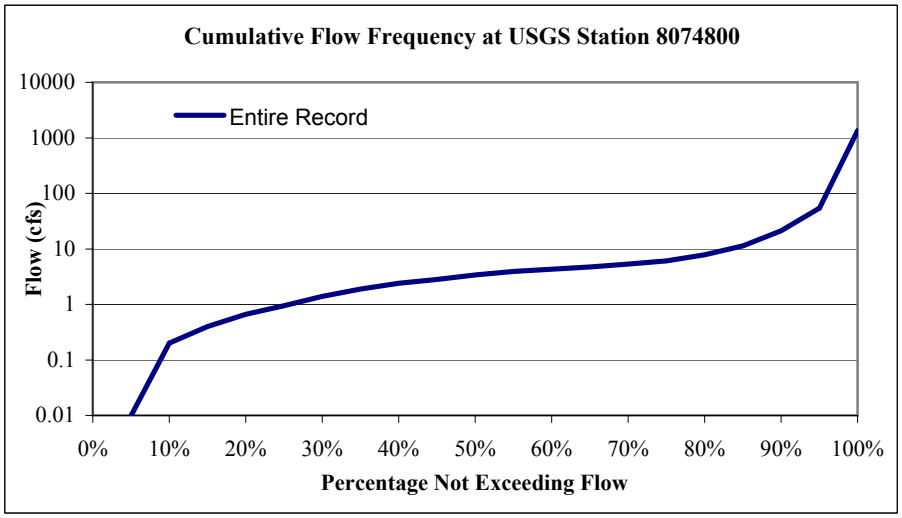
Flow data from the USGS gages were evaluated by constructing flow duration curves as can be seen in Figures 2.5 through 2.9. Flow duration curves were constructed for three different time periods: the data from 1991 to 2004, data up to 1990, and data for the period after 1991. This distinction would identify any changes in flow due to urbanization (1990's) and increases in WWTP discharges. It can be seen in Figures 2.5 through 2.9 that the flow regime for gages 8075400 (Sims at Hiram Clarke) and 8075770 (Hunting at IH 610) appears to be the same for the whole period. On the other hand, gages 8075000 (Brays at Houston), 8076000 (Greens near Houston), 8076180 (Garners at Humble), and 8076500 (Halls at Houston) present consistently higher flows for the period after 1990 compared to those measured prior to 1991. Finally, gage 8074810 (Brays at Gessner) shows a change in the flow regime only for the higher flows (again flows measured after 1990 are higher than those measured prior to 1991).

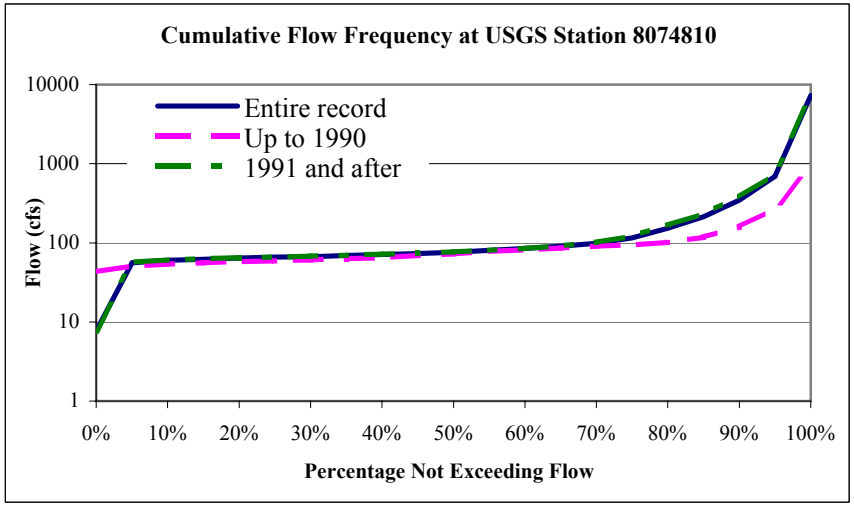
Table 2.2 summarizes median flows using the entire record for the various USGS gages in the study area as well as the changes in median flows for the stations that presented changes in flow regime in the last 15 years as discussed above.

Table 2.2 Median Flows for USGS Gages in Study Area

USGS Gage	Segment	Median Flow (cfs)		
		All data	Prior to 1991	1991-2004
8074800	1007C	34	34	-
8074810	1007B	76	73	77
8075000	1007B	82	45	132
8075400	1007Q	12	12	11
8075500	1007D	38	38	-
8075650	1007F	5.6	5.6	-
8075770	1007R	7.4	7	9
8075780	1016	41	41	-
8075900	1016	13	13	-
8076000	1016	26	17	43
8076180	1016A	14	8.2	17
8076500	1006E	9.7	8.5	16
8076700	1016	700	700	-

Rows highlighted in green correspond to the gages for which the median flow was significantly higher for the period 1991-2004.





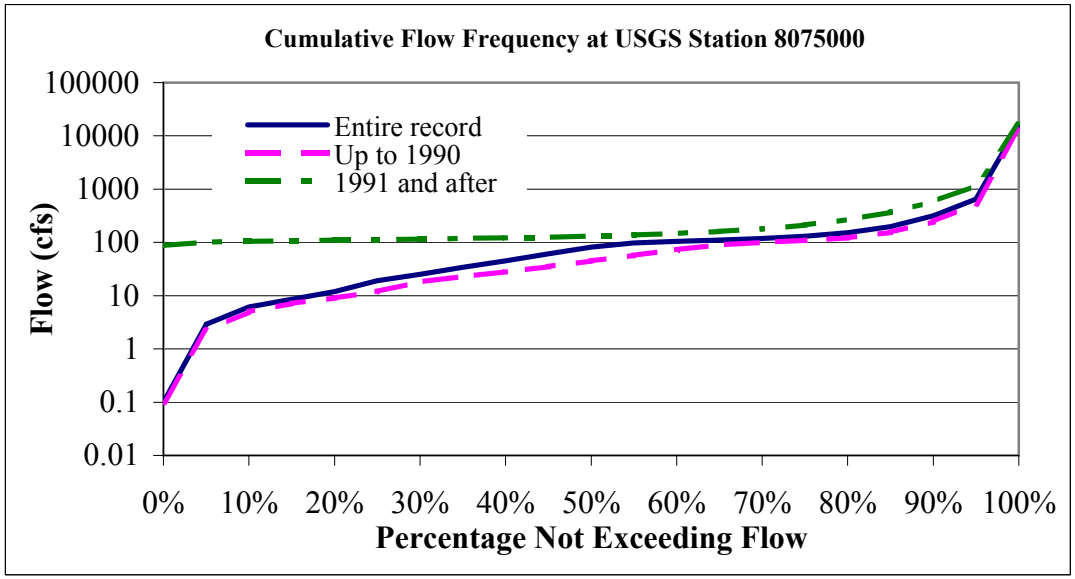


Figure 2.5 Flow Cumulative Curves for USGS Gages in the Brays Bayou Watershed

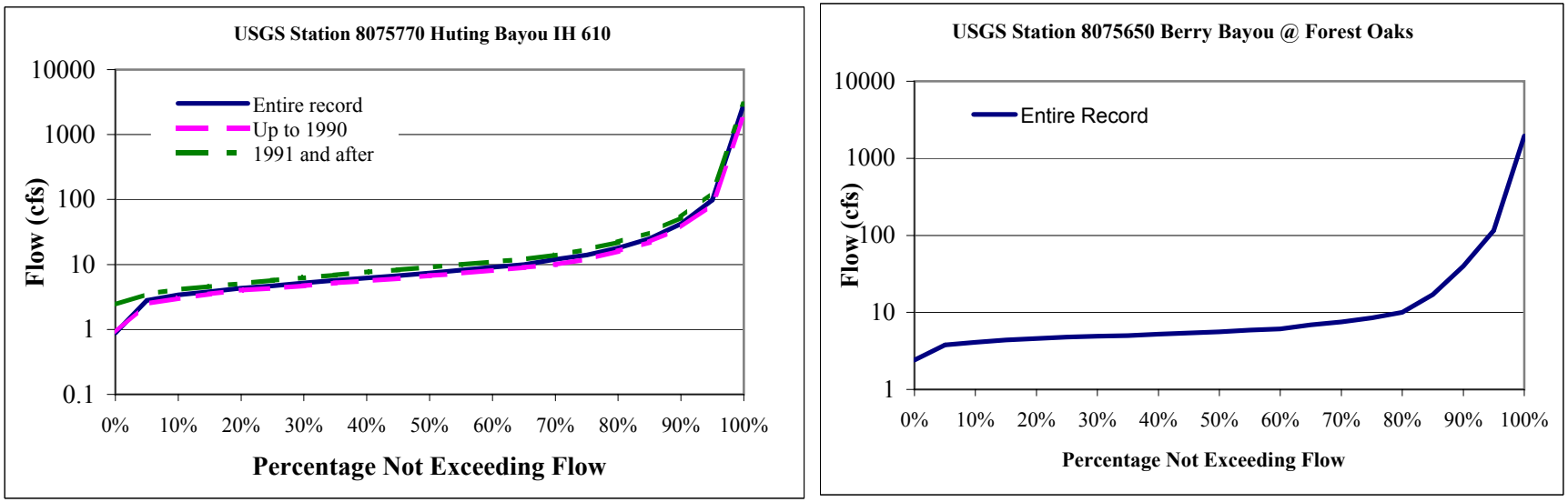


Figure 2.6 Flow Cumulative Curves for USGS Gages in the Sims Bayou Watershed

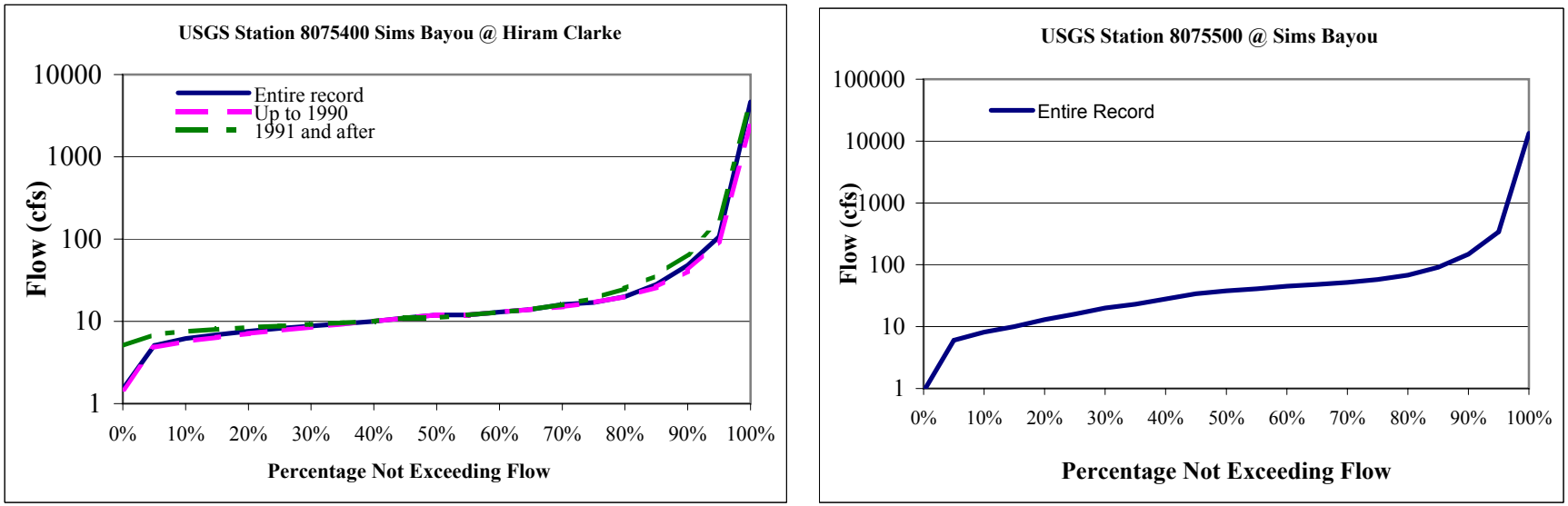
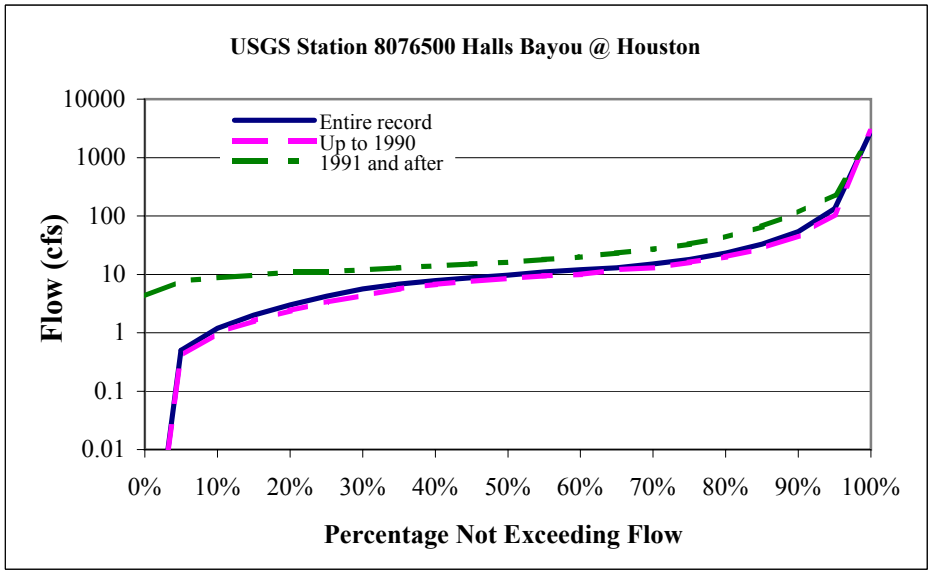


Figure 2.7 Flow Cumulative Curves for USGS Gages in the Eastern Houston Watershed



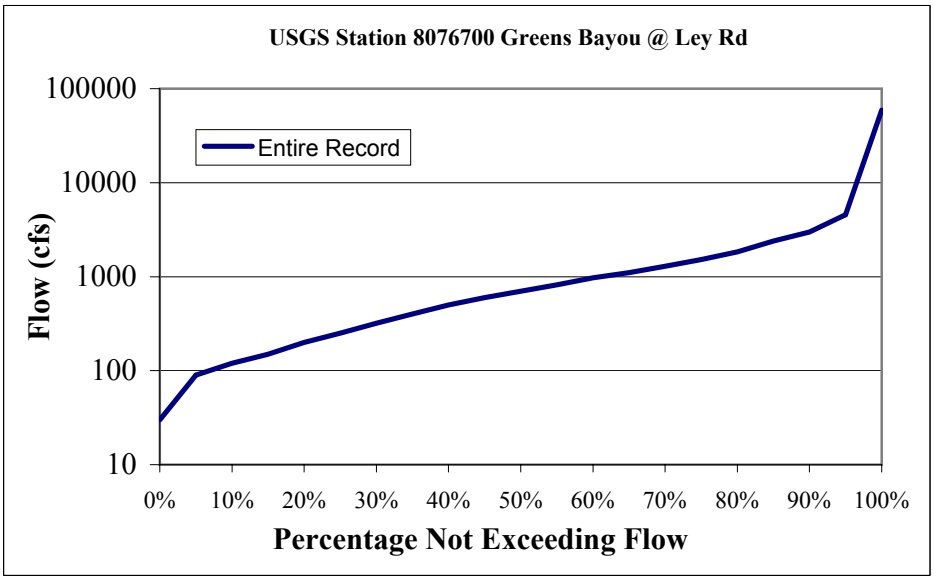
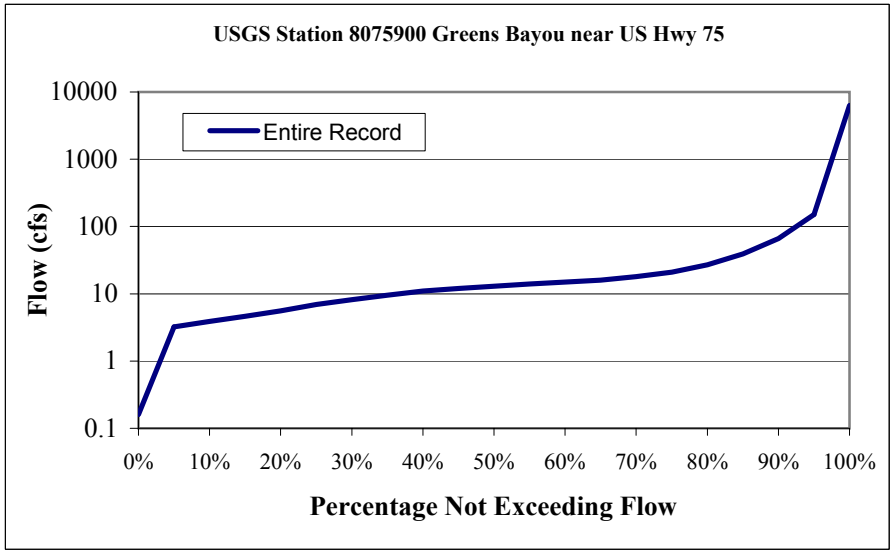
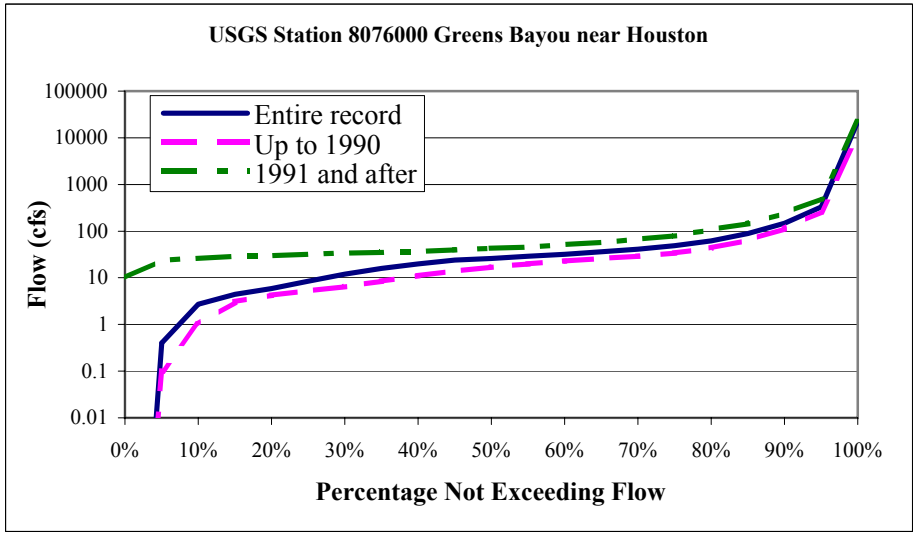
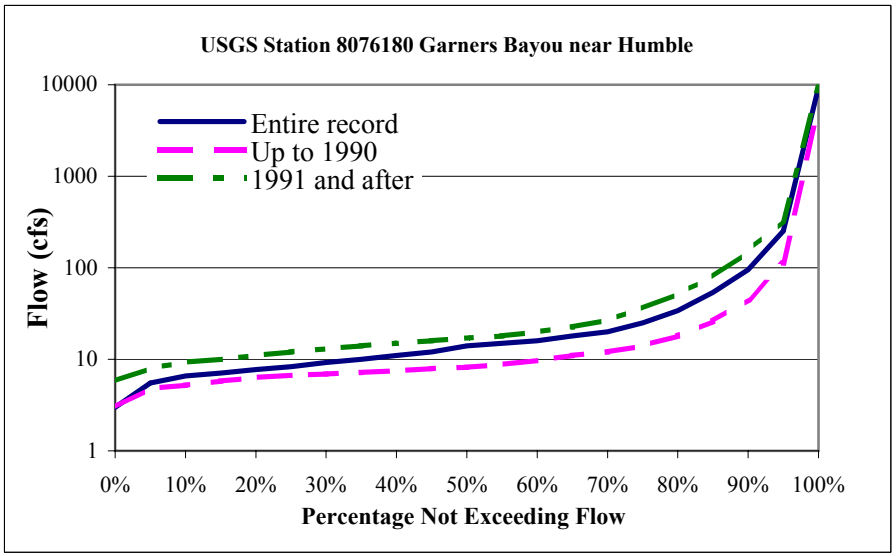


Figure 2.8 Flow Cumulative Curves for USGS Gages in the Halls Bayou Watershed







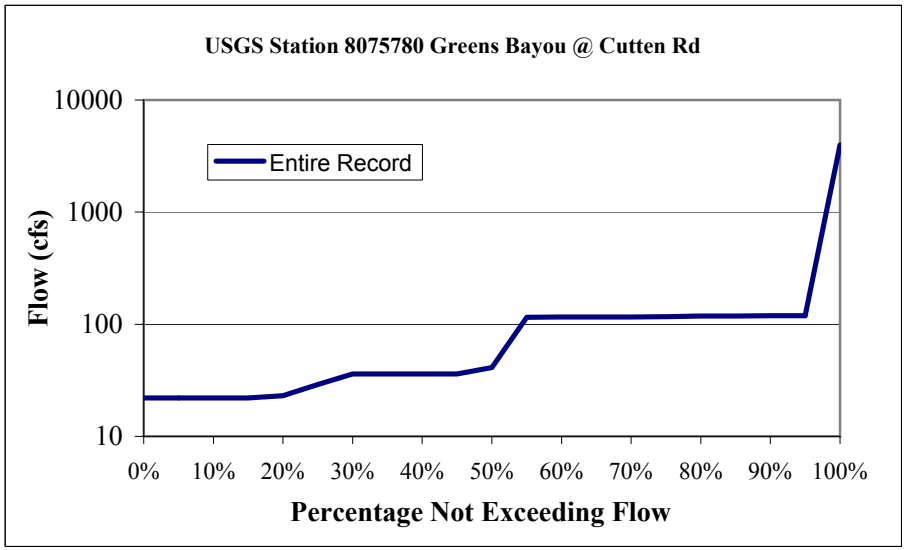
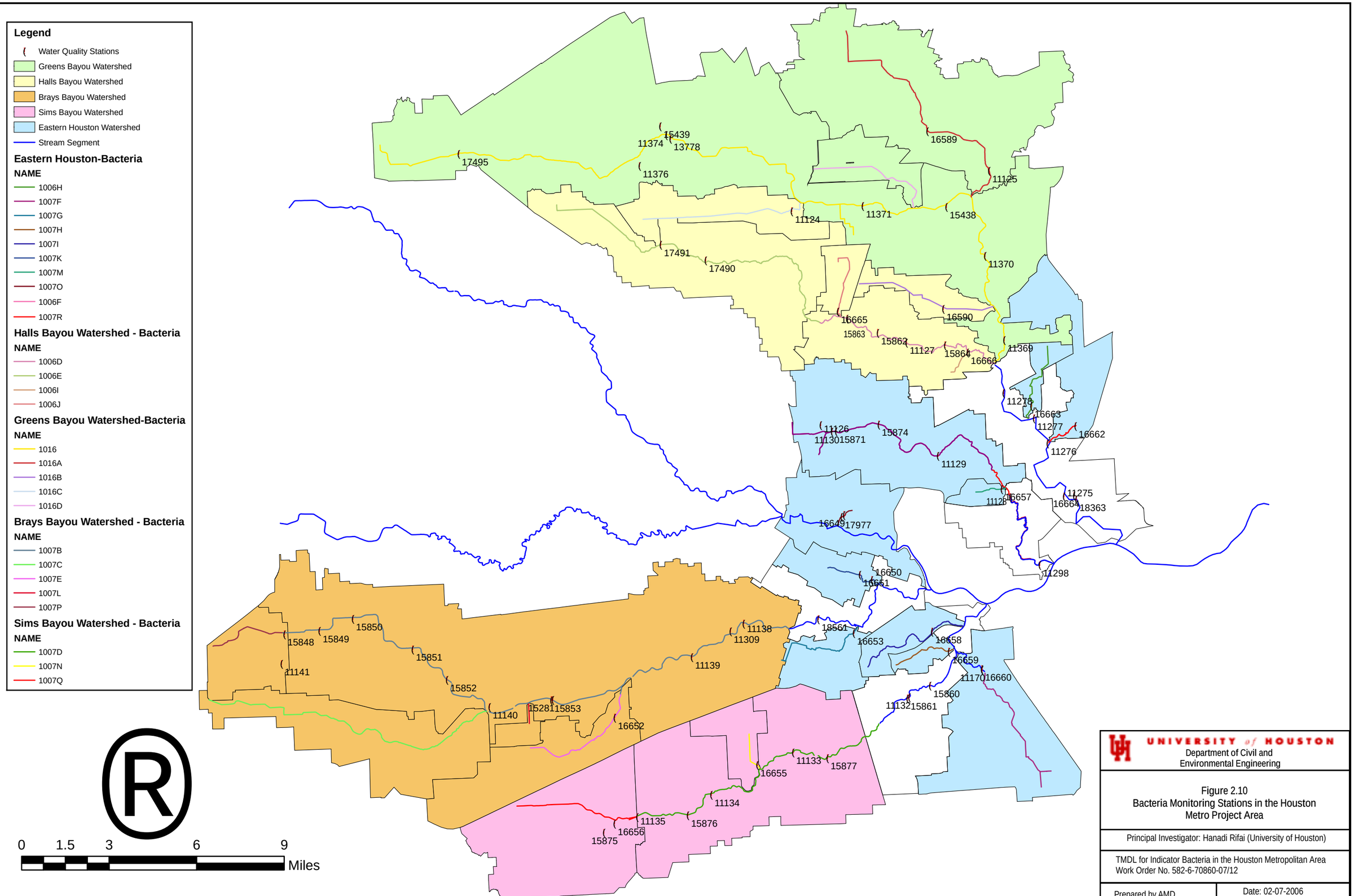


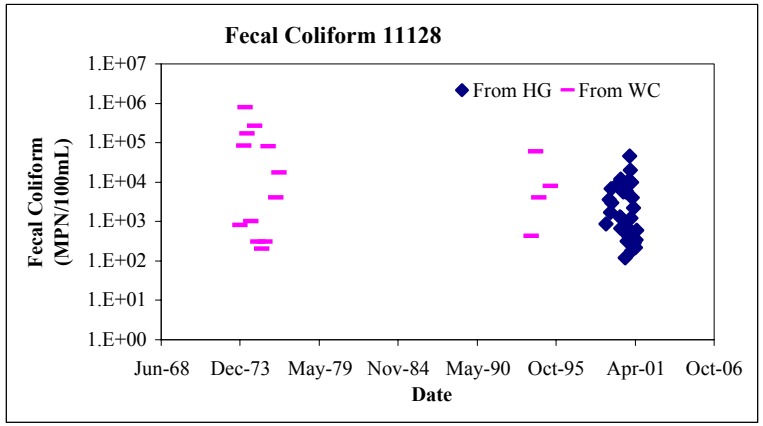
Figure 2.9 Flow Cumulative Curves for USGS Gages in the Greens Bayou Watershed

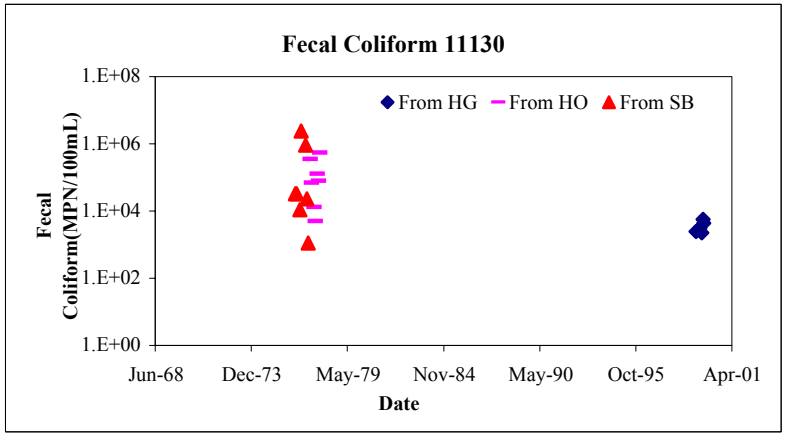
2.2 COMPARISON OF DATASETS COLLECTED BY DIFFERENT AGENCIES

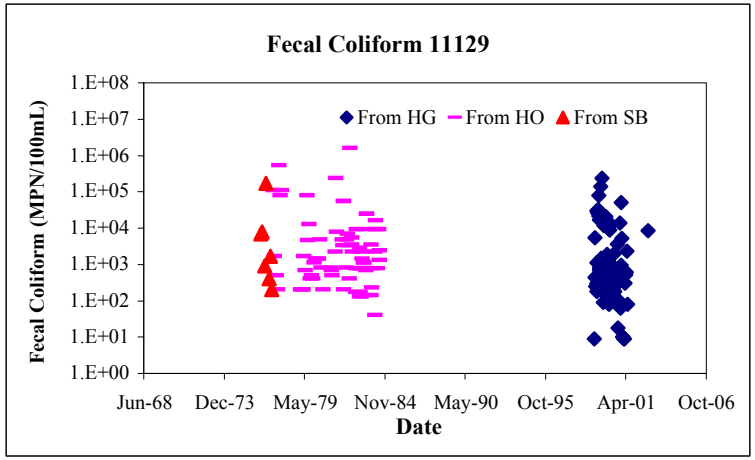
E.coli and fecal coliform data collected from four different agencies, the Texas Commission on Environmental Quality (TCEQ), the City of Houston, the Houston-Galveston Area Council (HGAC), and data collected through Senate Bill 835 were analyzed for statistical significance. A statistical test (*t*-test) was first completed to determine if data sets obtained from the different organizations were significantly different. This evaluation is important in deciding whether the data sets could be combined for analysis or they should be treated independently. Subsequently, the data were analyzed for temporal trends and spatial patterns. In addition, analyses were also performed to demonstrate the effect of flow on *E.coli* concentrations. The statistical significance was determined based on the probability or the p value, which should be less than 0.05 to demonstrate any statistical difference.

Figure 2.10 shows the locations of the sampling stations that have historical bacteria data. Time series for the various stations were plotted by reporting agency in order to complete a visual screening of differences among the datasets. Time series for segments 1007, 1006, and 1016 are shown in Figures 2.11, 2.12, and 2.13, respectively.


Legend
Water Quality Stations
Greens Bayou Watershed
Halls Bayou Watershed
Brays Bayou Watershed
Sims Bayou Watershed
Eastern Houston Watershed
Stream Segment
Eastern Houston-Bacteria
NAME
1006H
1007F
1007G
1007H
1007I
1007K
1007M
1007O
1006F
1007R
Halls Bayou Watershed - Bacteria
NAME
1006D
1006E
1006I
1006J
Greens Bayou Watershed-Bacteria
NAME
1016
1016A
1016B
1016C
1016D
Brays Bayou Watershed - Bacteria
NAME
1007B
1007C
1007E
1007L
1007P
Sims Bayou Watershed - Bacteria
NAME
1007D
1007N
1007Q
0 1.5 3 6 9
Miles
UNIVERSITY of HOUSTON
Department of Civil and Environmental Engineering
Figure 2.10
Bacteria Monitoring Stations in the Houston Metro Project Area
Principal Investigator: Hanadi Rifai (University of Houston)
TMDL for Indicator Bacteria in the Houston Metropolitan Area
Work Order No. 582-6-70860-07/12
Prepared by AMD
Date: 02-07-2006







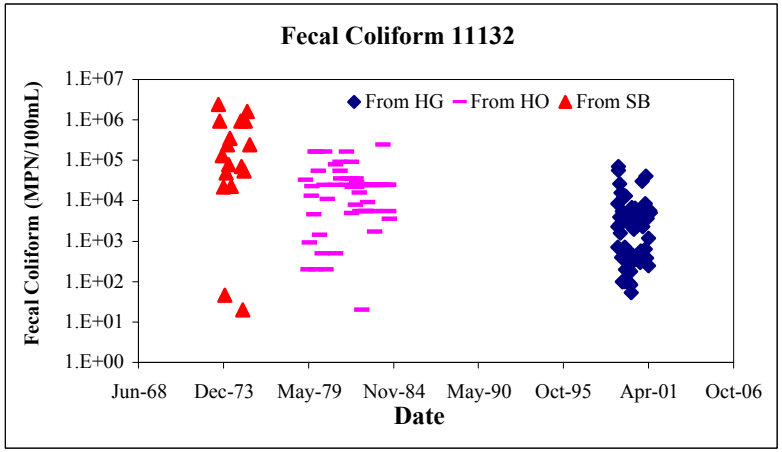
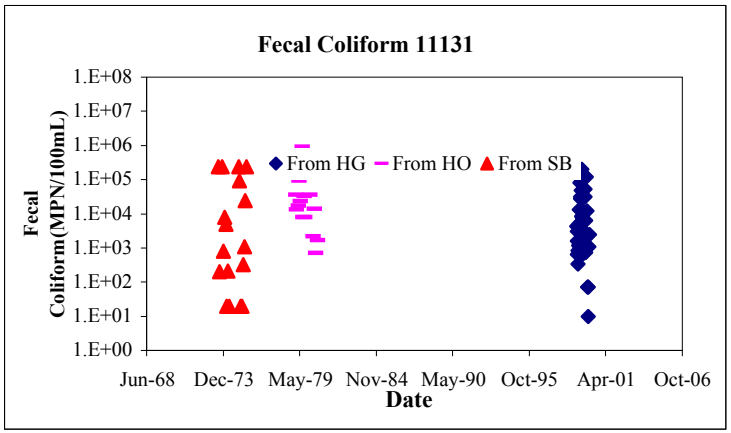
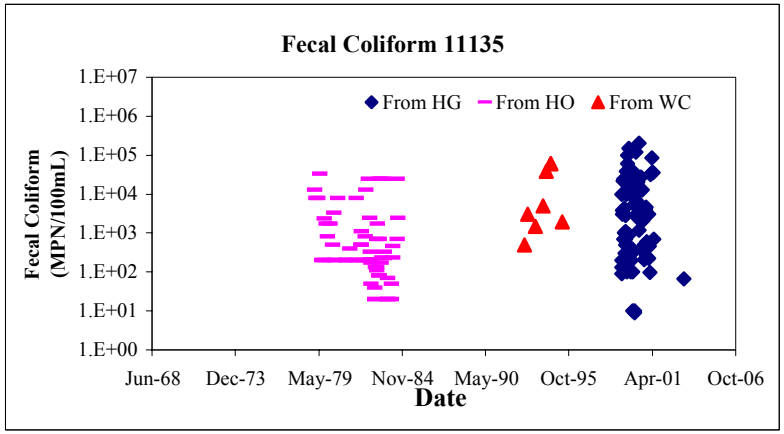
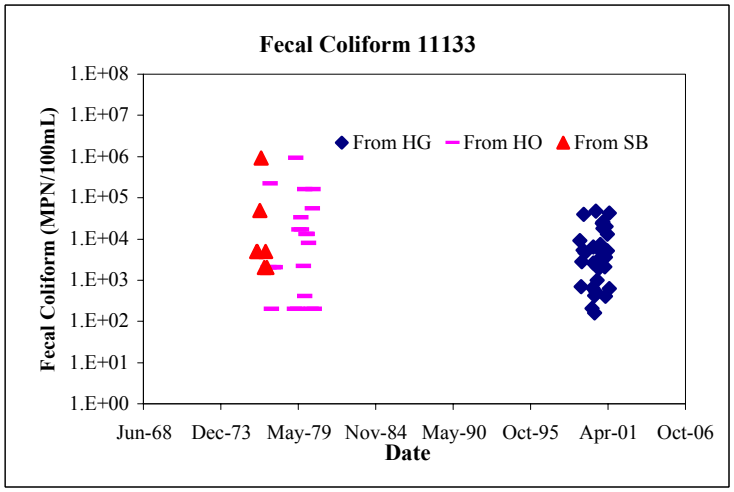


Figure 2.11 Time Series of Indicator Bacteria in Segment 1007







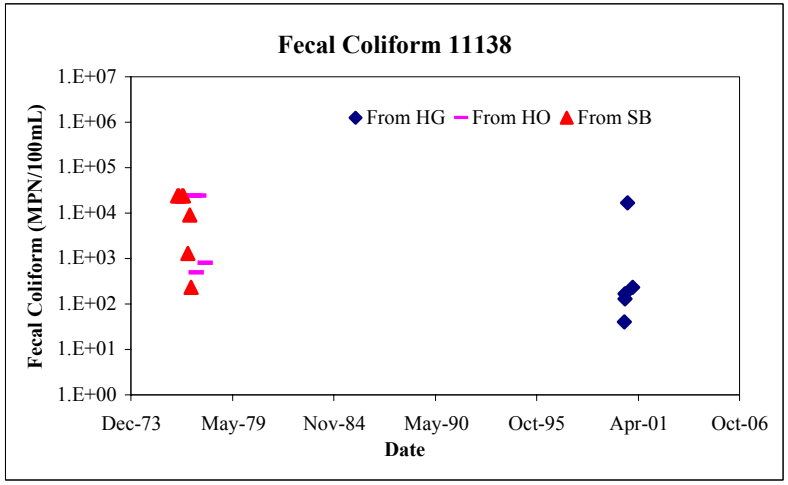
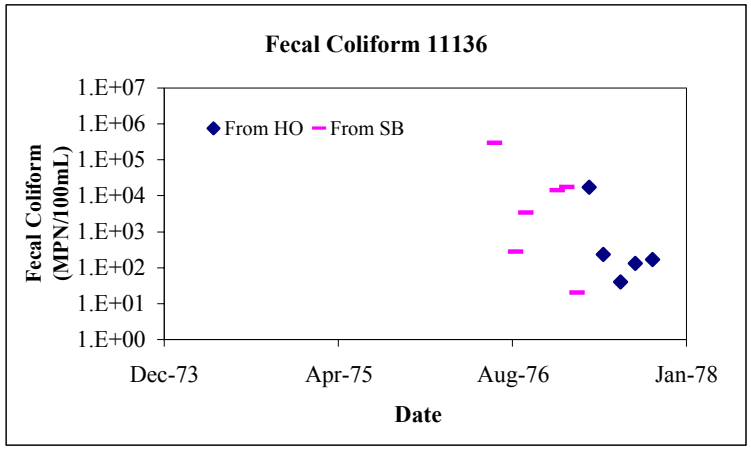
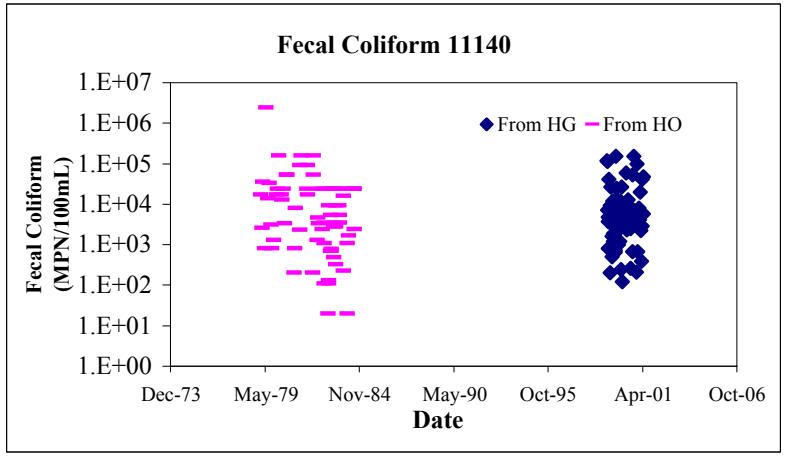
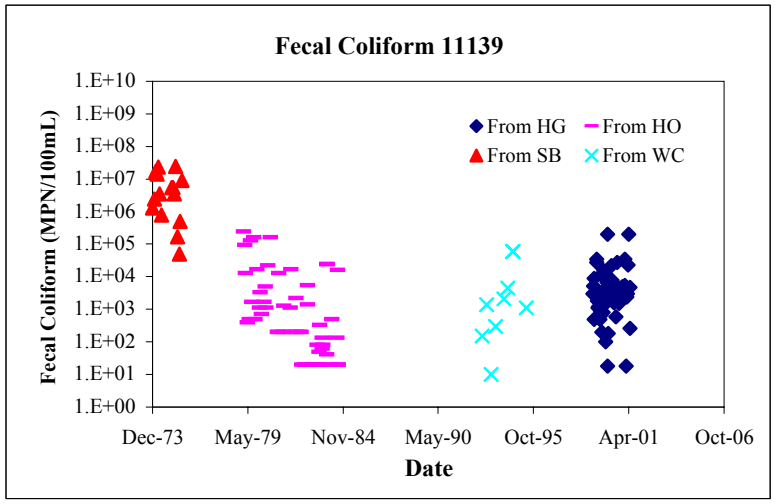


Figure 2.11 Time Series of Indicator Bacteria in Segment 1007 - Cont'd







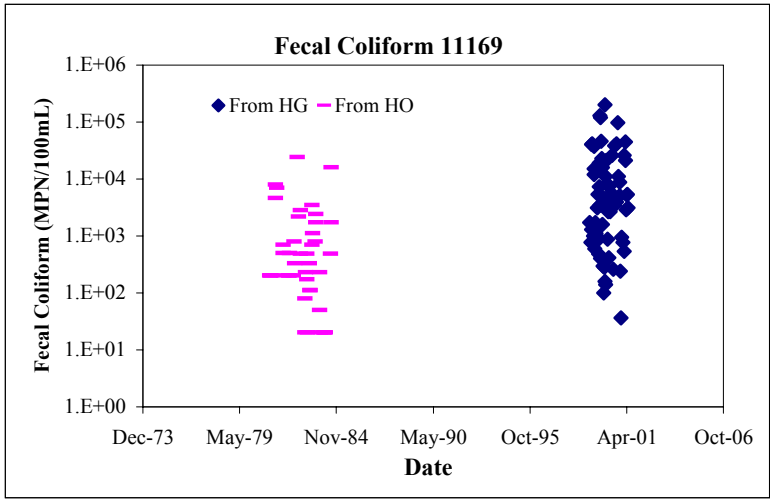
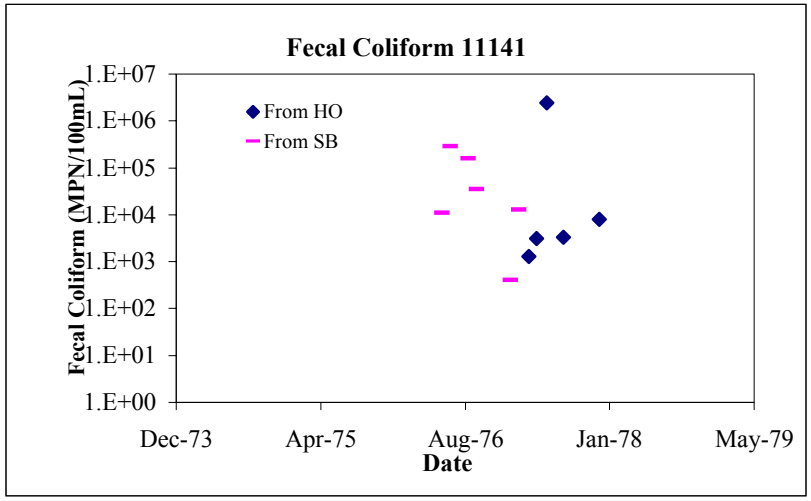
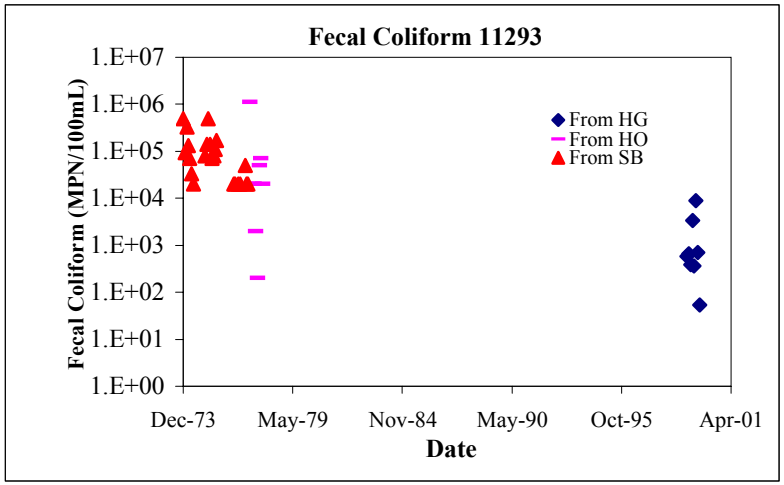
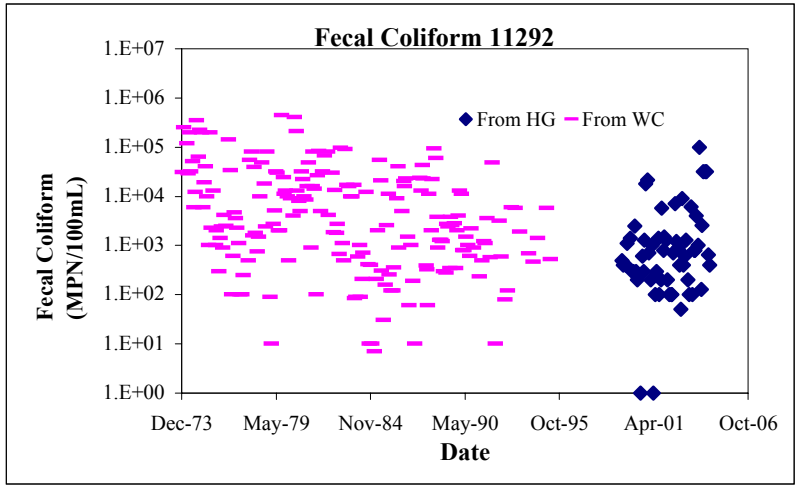


Figure 2.11 Time Series of Indicator Bacteria in Segment 1007 - Cont'd







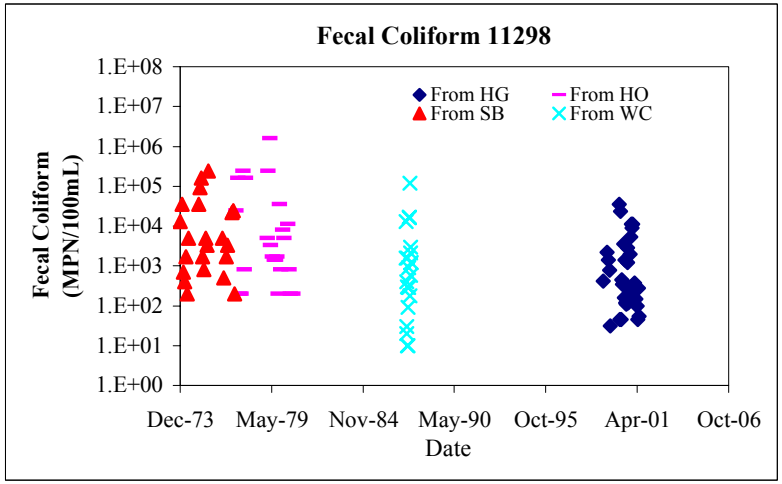
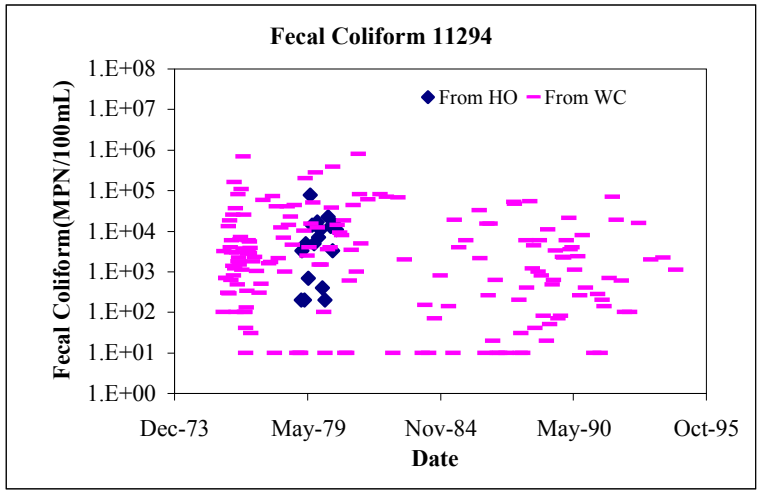
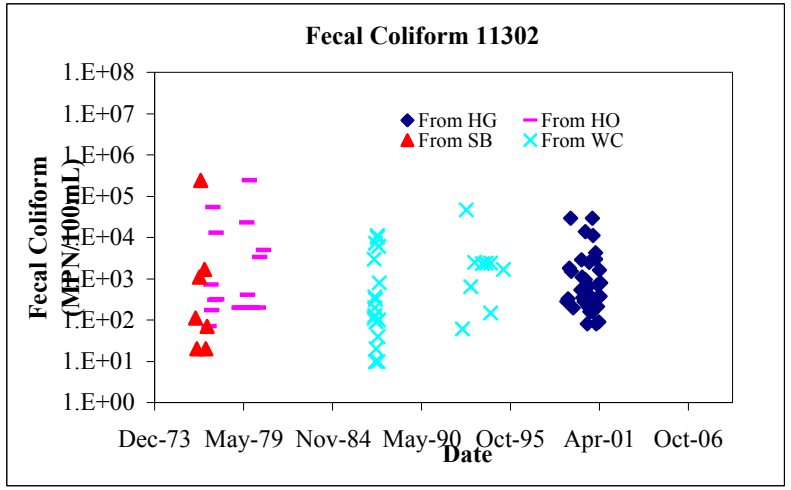
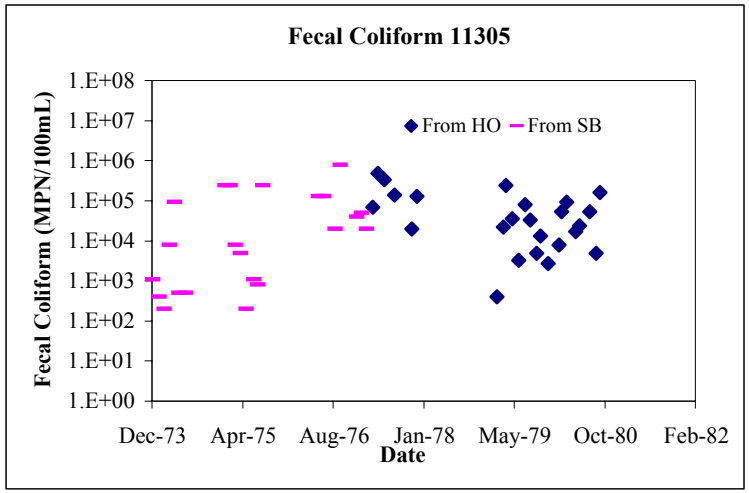


Figure 2.11 Time Series of Indicator Bacteria in Segment 1007 - Cont'd







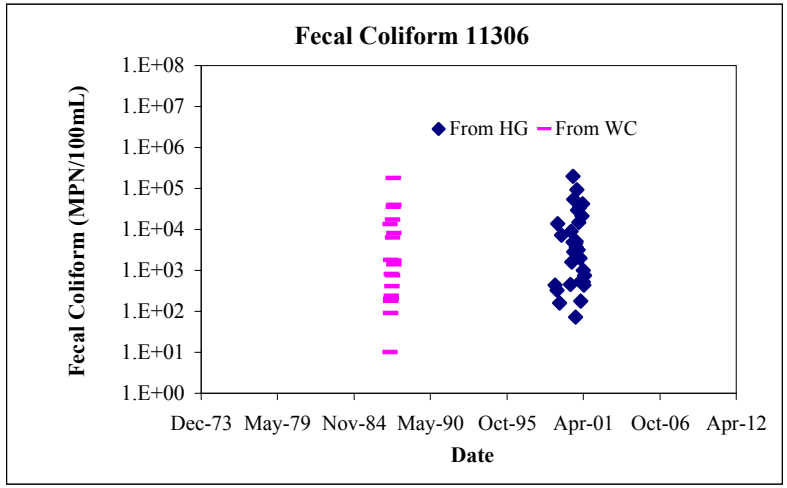
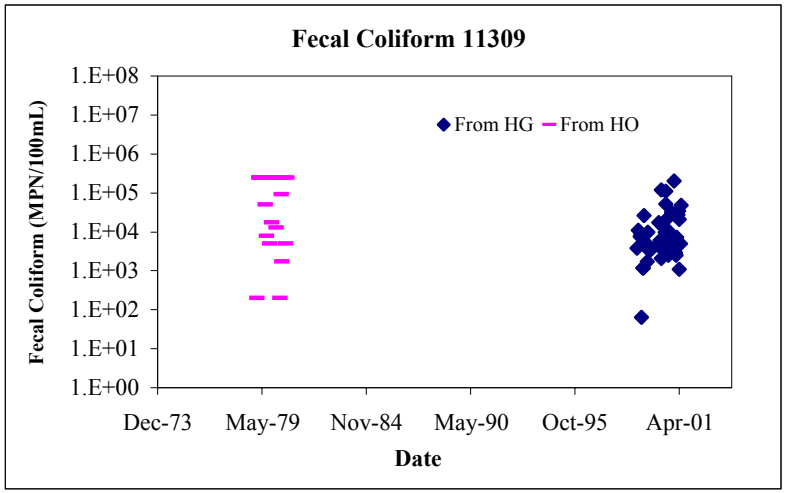
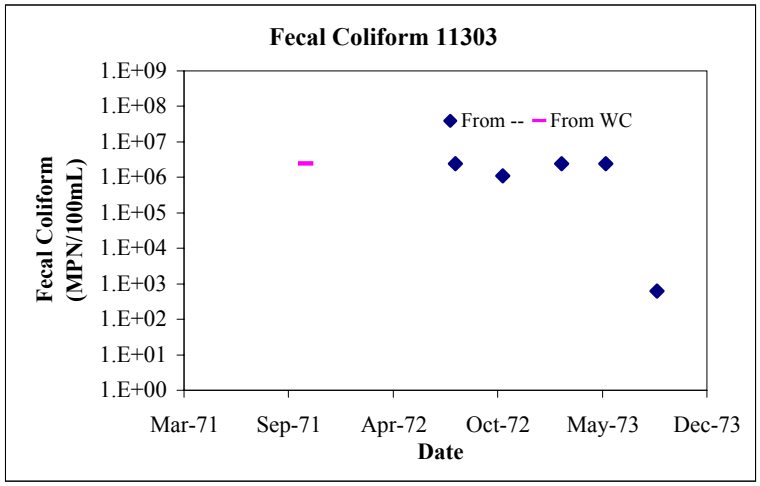


Figure 2.11 Time Series of Indicator Bacteria in Segment 1007 - Cont'd





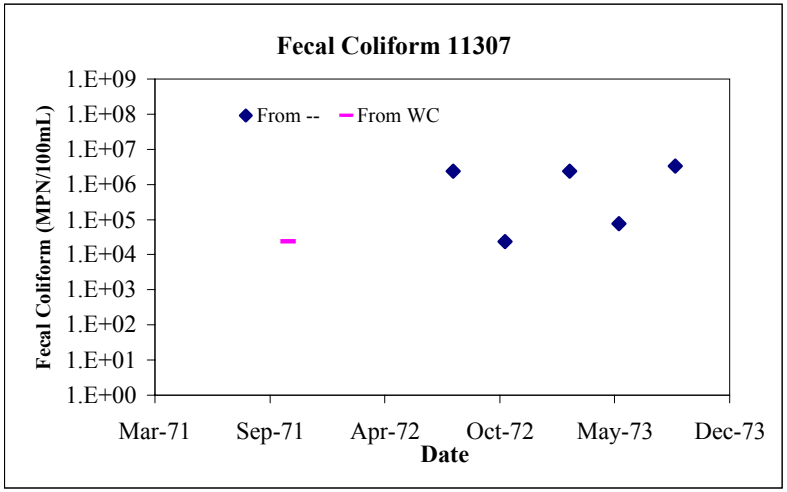
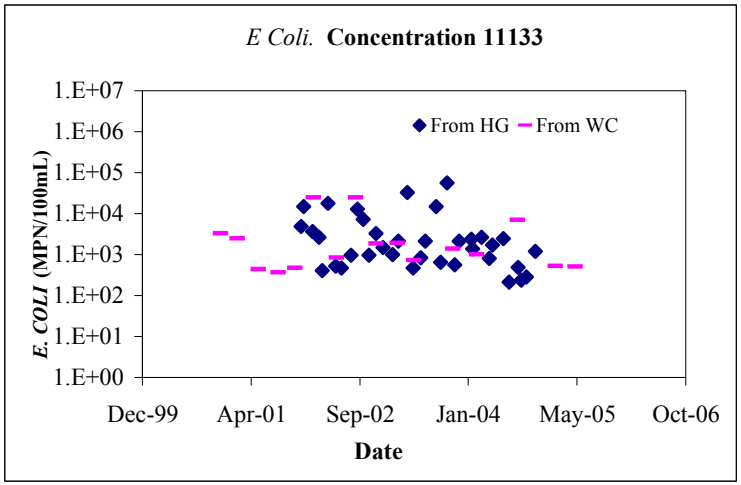
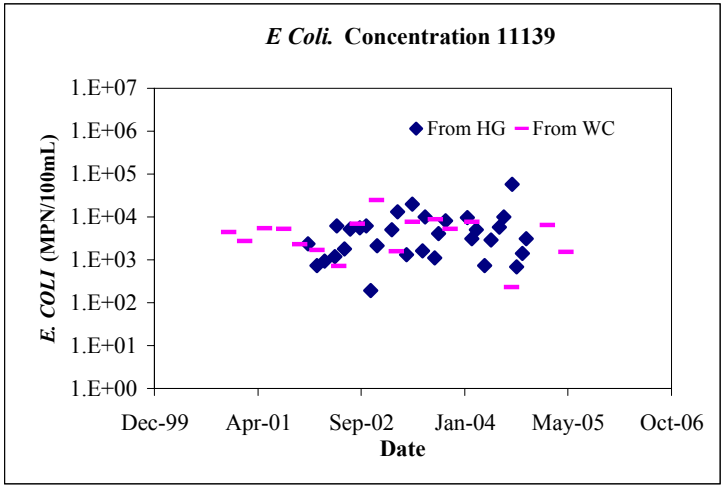


Figure 2.11 Time Series of Indicator Bacteria in Segment 1007 - Cont'd





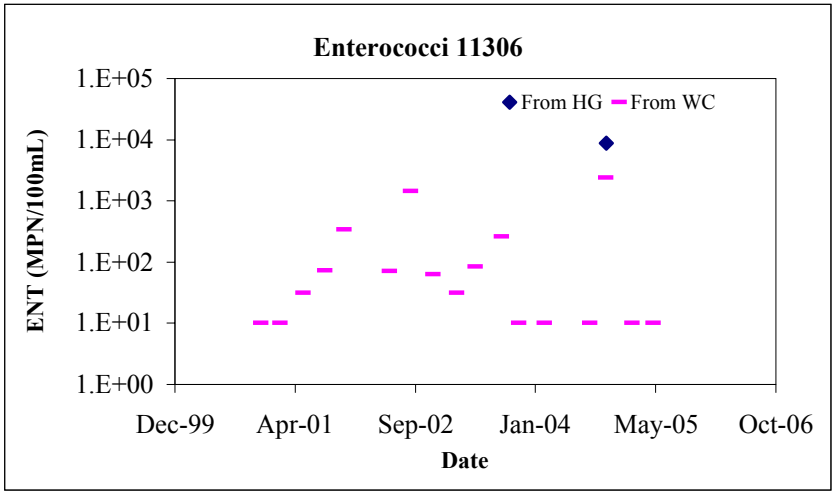
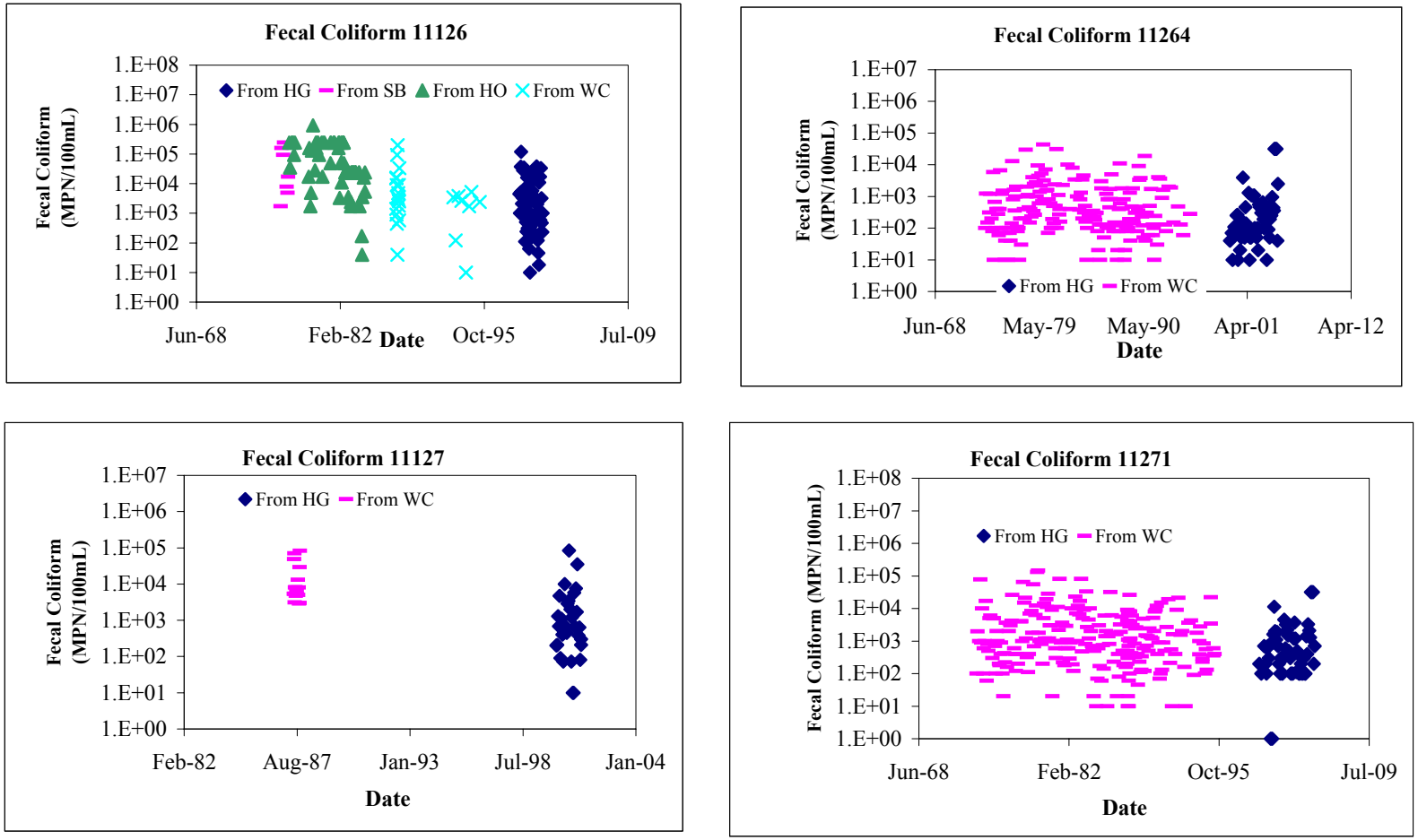
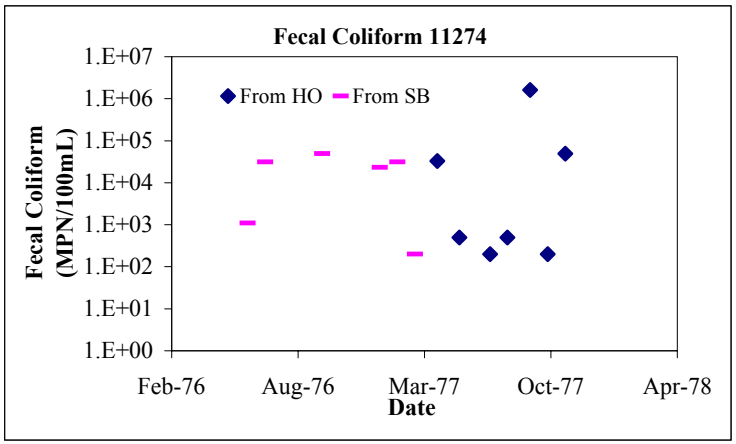


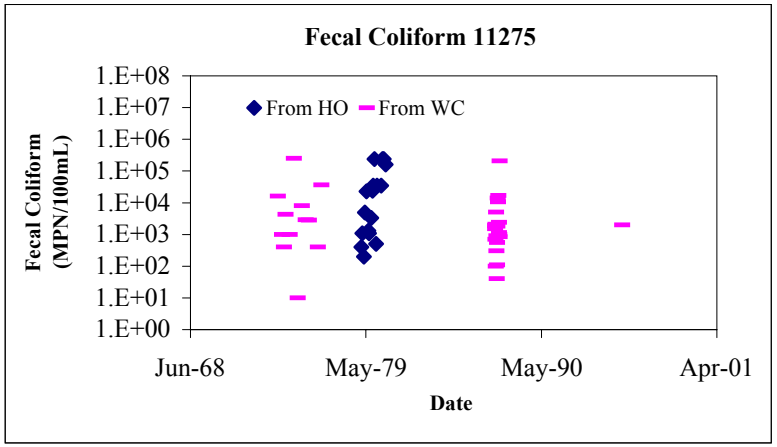
Figure 2.11 Time Series of Indicator Bacteria in Segment 1007 - Cont'd

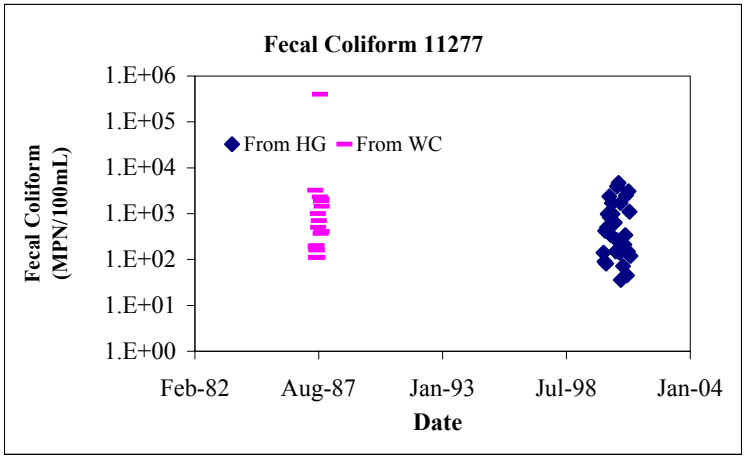


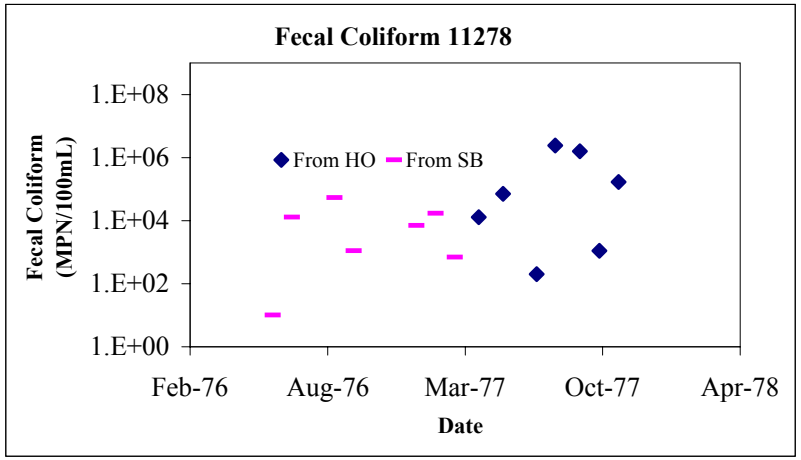
HG=H-GAC, WC=TCEQ, HO=City of Houston, SB=Senate Bill 835

Figure 2.12 Time Series of Indicator Bacteria in Segment 1006



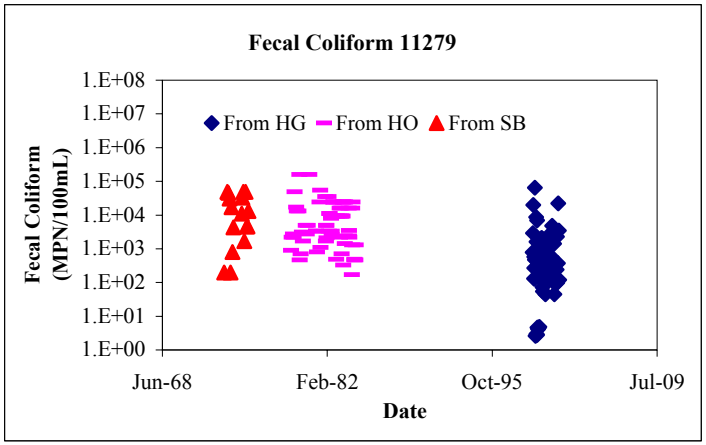


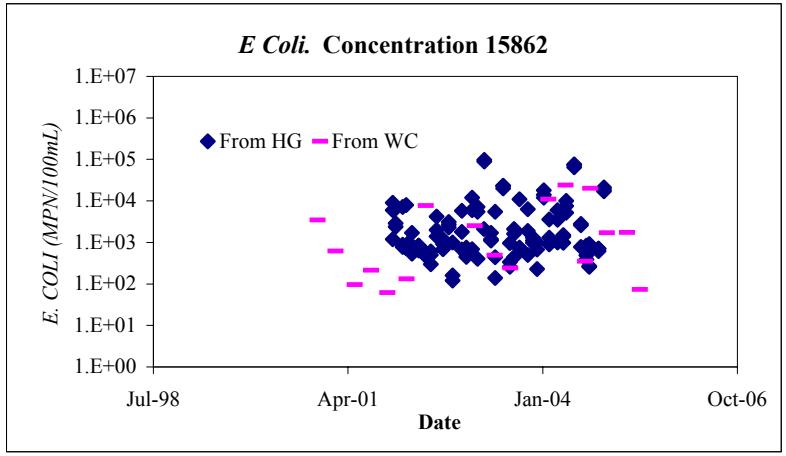


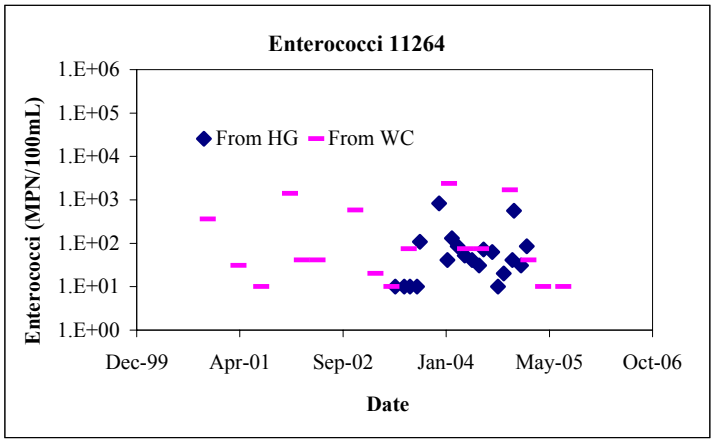


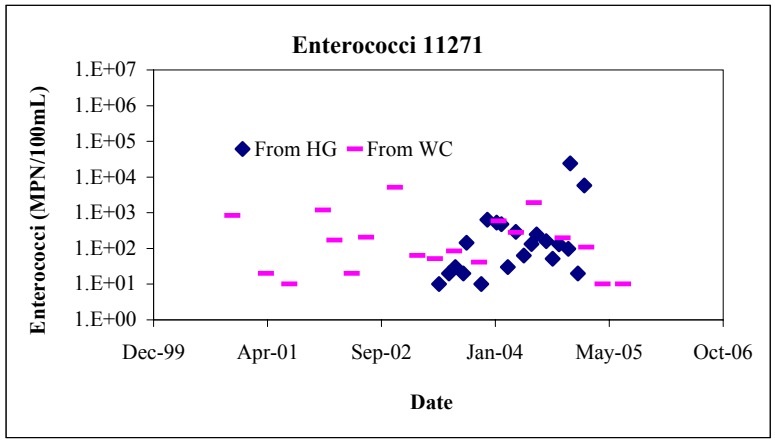
HG=H-GAC, WC=TCEQ, HO=City of Houston, SB=Senate Bill 835

Figure 2.12 Time Series of Indicator Bacteria in Segment 1006 - Cont'd



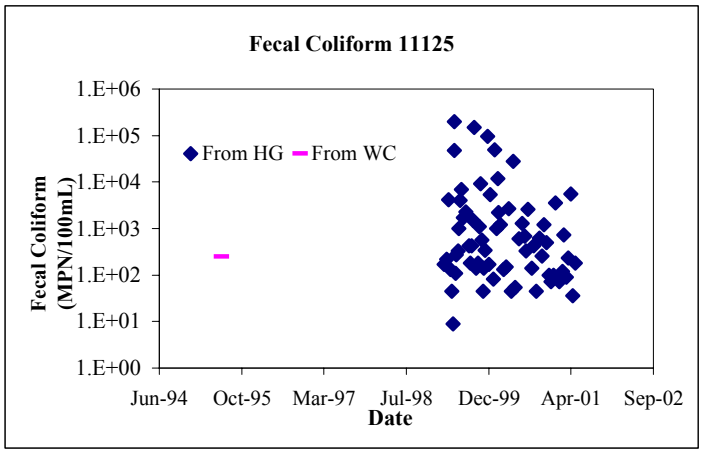


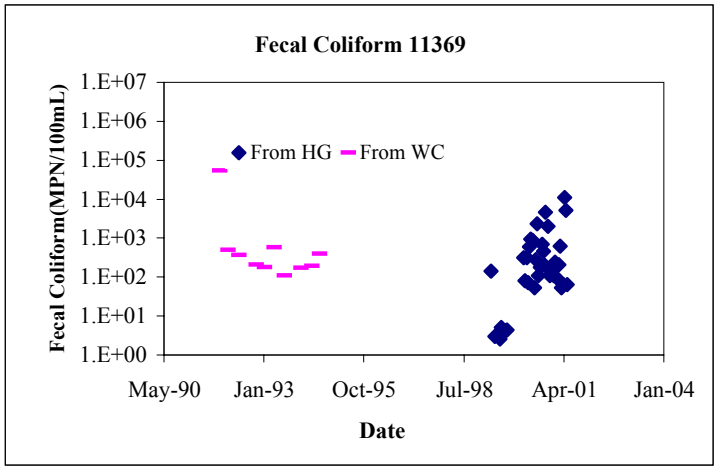


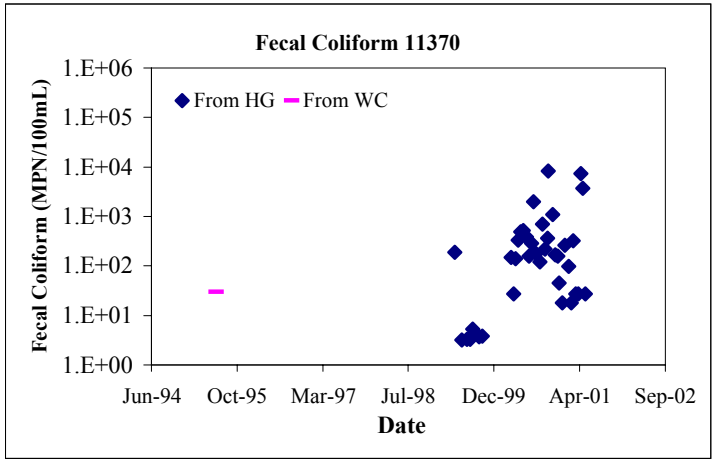


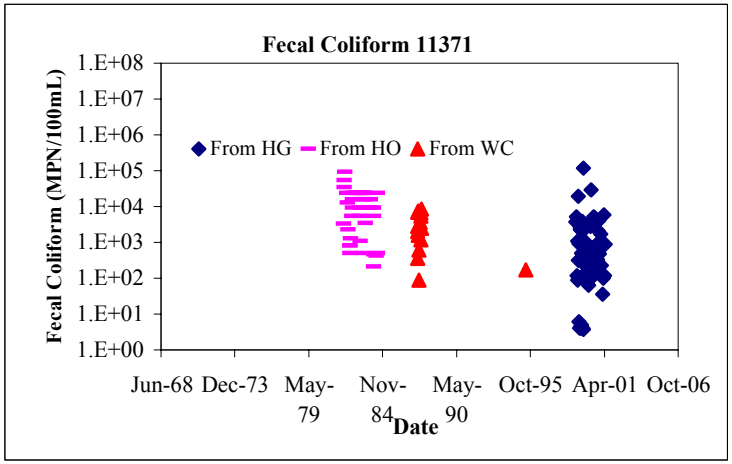
HG=H-GAC, WC=TCEQ, HO=City of Houston, SB=Senate Bill 835

Figure 2.12 Time Series of Indicator Bacteria in Segment 1006 - Cont'd



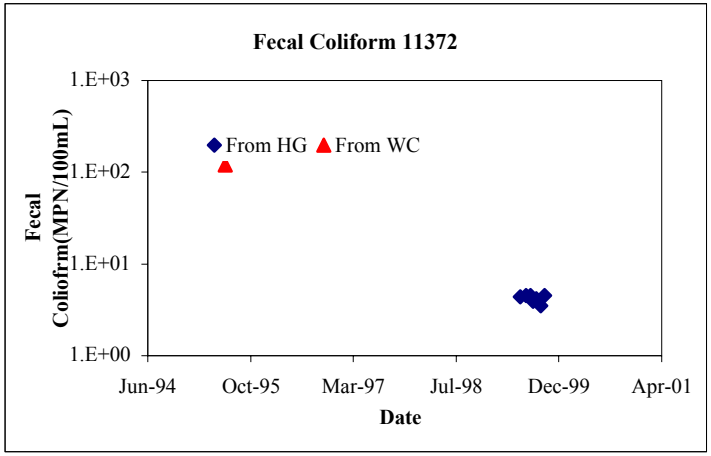


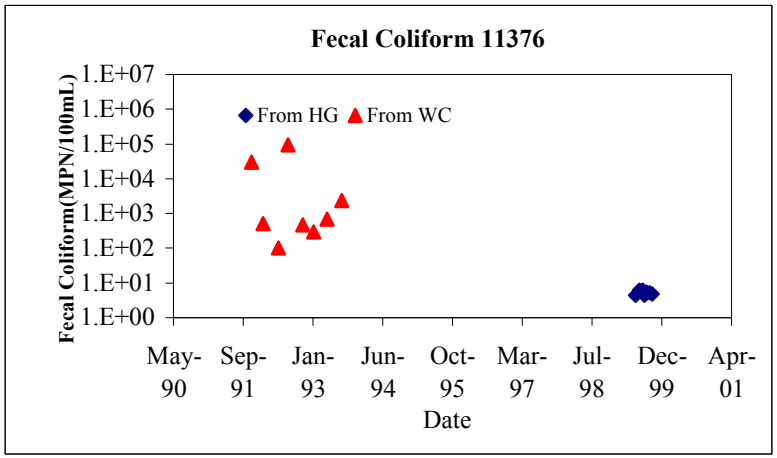


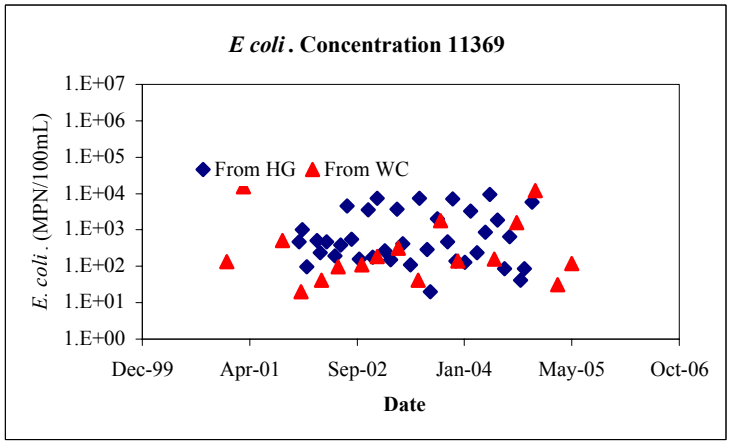


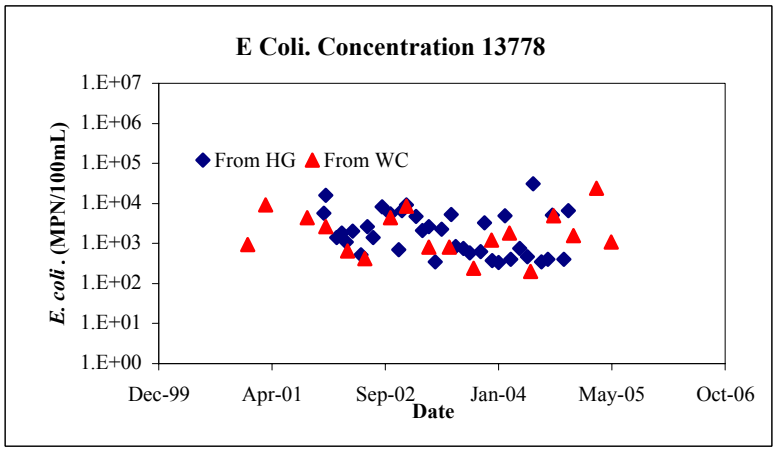
HG=H-GAC, WC=TCEQ, HO=City of Houston, SB=Senate Bill 835

Figure 2.13 Time Series of Indicator Bacteria in Segment 1016



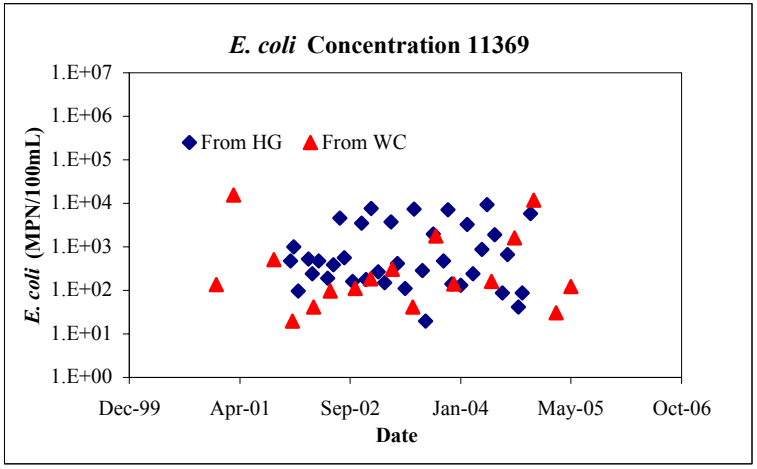


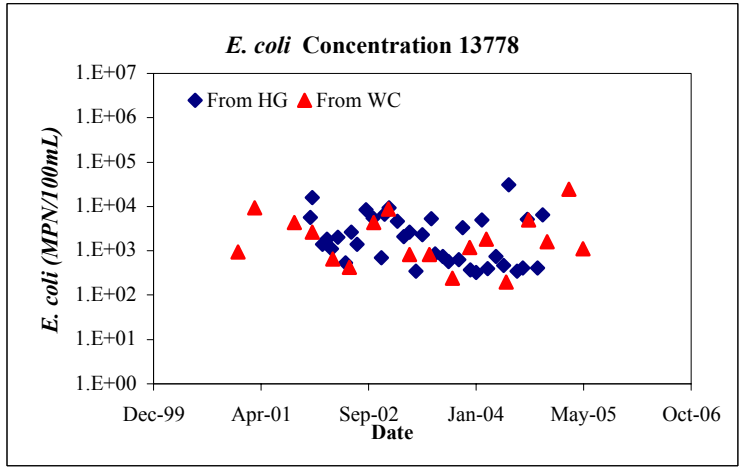




HG=H-GAC, WC=TCEQ, HO=City of Houston, SB=Senate Bill 835

Figure 2.13 Time Series of Indicator Bacteria in Segment 1016 - Cont'd





HG=H-GAC, WC=TCEQ, HO=City of Houston, SB=Senate Bill 835

Figure 2.13 Time Series of Indicator Bacteria in Segment 1016 - Cont'd

Visual inspection of the time series plots indicates that for most of the stations, there does not appear to be a significant difference in the datasets collected by the different agencies. This observation, however, needed to be confirmed by statistical testing.

It can be seen in Table 2.3 that for most of the stations, the datasets did not reflect statistically significant differences with the only exceptions being stations 11132, 11135, 11139, 11292, 11293, 11298, 11309, 11126, 11279, 11271, and 11371. Table 2.3 presents the p-values obtained from regression analyses performed on the data collected from different agencies (p – values less than 0.05 indicate statistical significance and are shown in red).

In order to evaluate the observed differences for the 11 stations listed above, the statistical testing was repeated using log – transformed data. No statistical difference was seen in this case. It is reasonable to log transform the data since the water quality standard will be evaluated on a geometric mean basis. Based on this analysis, it was concluded that data from all agencies could be grouped. Even then, care will need to be taken to assure proper comparisons because at least one agency, the TCEQ, appears to have changed monitoring strategies in recent years.

Table 2.3 Statistical Comparison of Means between Datasets Collected by Different Agencies

Segment	Station ID	HG vs WC	HG vs HO	HG vs SB	HO vs SB	HO vs WC	SB vs WC
	Fecal Coliform						
	11128	0.1014					
	11129		0.1780	0.5087	0.6721		
	11130		0.0710	0.2068	0.3936		
	11131		0.1057	0.0928	0.4253		
	11132		0.0000	0.0120	0.0168		
	11133		0.1385	0.3496	0.6260		
	11135	0.6933	0.0010			0.1055	
	11136				0.3346		
	11138		0.0687	0.0598	0.9360		
	11139	0.7395	0.5381	0.0031	0.0031	0.9189	0.0031
1007	11140		0.2771				
	11141				0.4548		
	11292	0.0000					
	11293		0.2775	0.0006	0.8934		
	11294					0.1068	
	11298	0.3638	0.1455	0.0407	0.2719	0.1698	0.1475
	11302	0.8230	0.2552	0.3920	0.6794	0.2703	0.3990
	11305				0.9286		
	11306	0.8532					
	11309		0.0010				
	E. coli						
	11133	0.6809					
	11139	0.6997					
	Fecal Coliform						
	11126	0.3066	0.0000	0.1049	0.3296	0.0000	0.1482
	11279		0.0006	0.0033	0.3802		
	11127	0.0678					
	11277	0.3090					
	11274				0.3738		
	11278				0.1599		
1006	11264	0.8080					
	11271	0.0146					
	11275					0.0908	
	E. coli						
	15864	0.8712					
	Enterococci						
	11264	0.1235					
	11271	0.4135					
	Fecal Coliform						
	11369	0.1985					
	11371	0.9590	0.0040			0.0033	
1016	11376	0.2128					
	E. coli						
	11369	0.9356					
	13778	0.9674					

Probability values less than 0.05 are in red font, indicating significant statistical difference between the data compared.
HG=H-GAC, WC=TCEQ, HO=City of Houston, SB=Senate Bill 835

2.3 GREENS BAYOU WATERSHED

2.3.1 Temporal Analysis

Table 2.4A lists the monitoring stations in Greens Bayou, the number of samples, the geomean of the samples, the number of samples that exceeded the single sample standard, and the number of samples that exceeded the geomean standard. The historical bacteria data were used for the temporal analysis to determine if correlations existed between indicator concentrations and time. Time series of EC concentrations by station by segments within this watershed are shown in Figure 2.14. A few stations had no *E.coli* data therefore fecal coliform concentrations are shown instead. It can be seen in Figure 2.14 that most of the fecal indicator concentrations for the stations in the Greens Bayou watershed show no trend over time. Only stations 13778 and 16676 exhibited a significant decreasing and increasing trend respectively (Table 2.4B). It was concluded that *E.coli* concentration in the Greens Bayou watershed do not exhibit statistically significant trends over time.

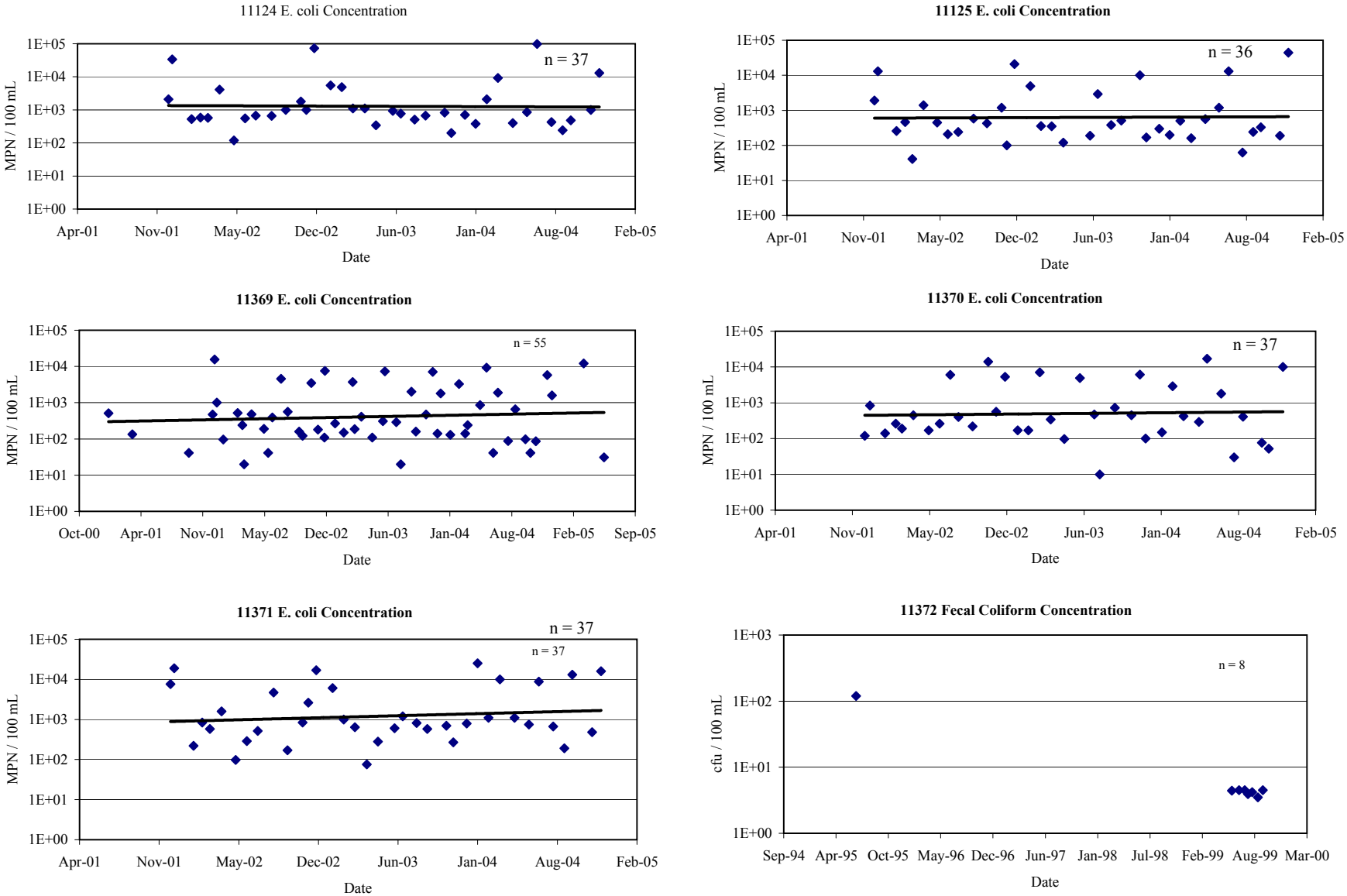
Table 2.4A Summary of Bacteria Data for Greens Bayou

Watershed	Segment ID	Station ID	Tributary	# Samples	Geometric Mean (MPN/dL)	# > 126 MPN/dL	# > 394 MPN/dL
Greens Bayou	1016	11369		55	410	41	25
		11370		37	500	30	19
		11371		37	1210	35	29
		11376		35	492	30	19
		13778		55	1727	55	49
		17495		35	276	27	11
	1016C	11124	x	37	1283	36	32
	1016A	11125	x	36	629	32	18
		16589	x	37	433	28	18
	1016B	16590	x	37	581	29	22
	1016D	16676	x	37	1655	36	29

Table 2.4B Summary of Temporal Trends in Greens Bayou Watershed

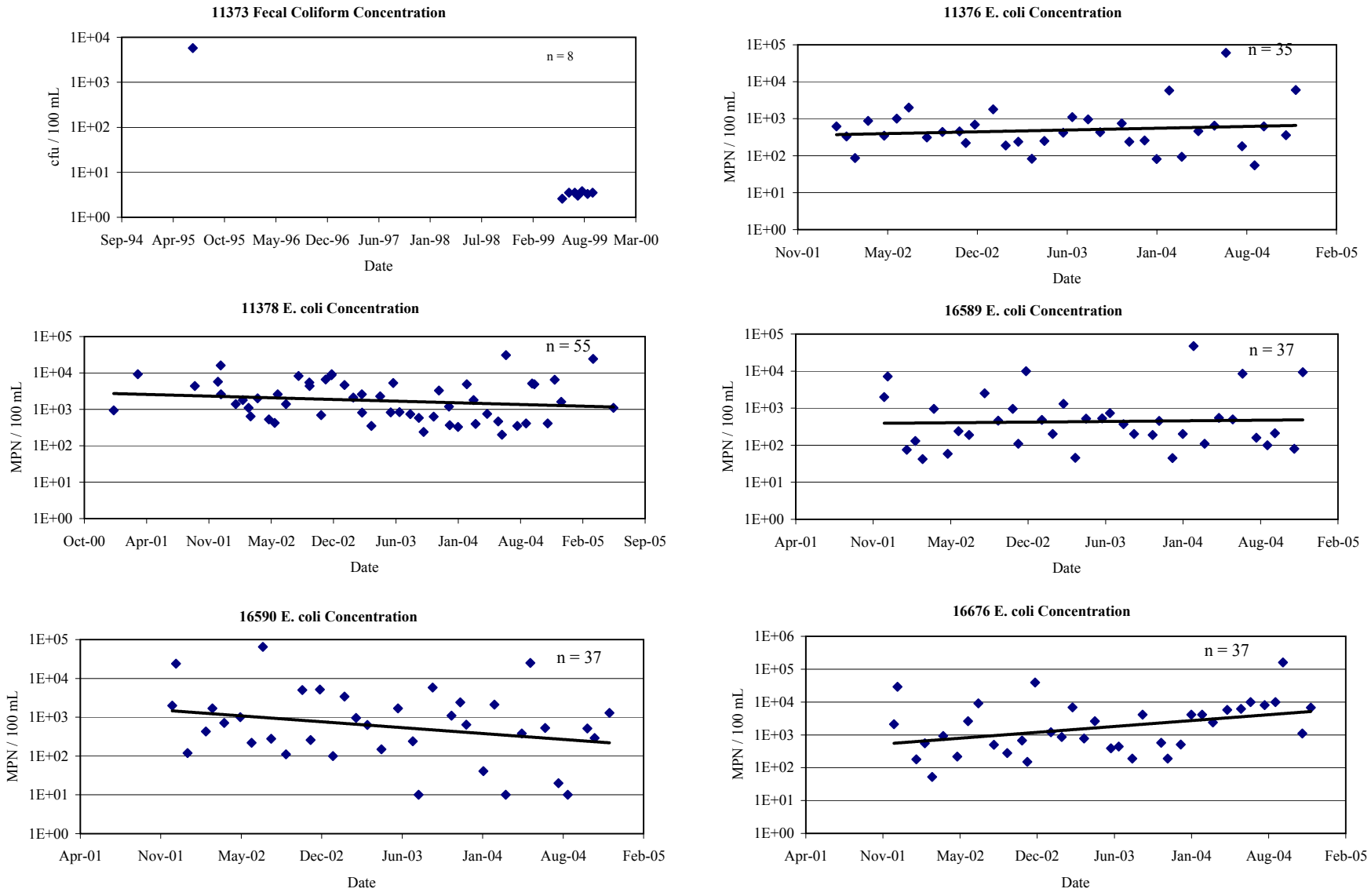
Segment	Station	Slope	Trend	p value	Indicator	No. Obs
1016	11369	0.00002	---	0.9232	*E.coli*	59
	11370	0.0001	---	0.8512	*E.coli*	39
	11376	0.0001	---	0.6474	*E.coli*	37
	13778	-0.0004	Decreasing	0.0116	*E.coli*	59
	17495	0.0015	---	0.1949	*E.coli*	35
1016A	11125	0.00004	---	0.9155	*E.coli*	38
	16589	-0.00001	---	0.9670	*E.coli*	39
1016B	16590	-0.0006	---	0.1538	*E.coli*	39
1016C	11124	-0.0001	---	0.8321	*E.coli*	39
1016D	16676	0.0008	Increasing	0.0144	*E.coli*	39

Highlighted cells indicate statistical significance (P<0.05)



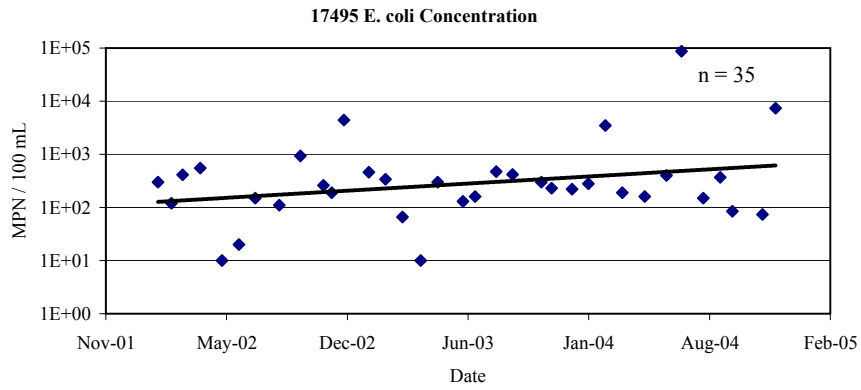
Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.14 *E. Coli* /Fecal Coliform Data in Greens Bayou Watershed



Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.14 *E. Coli* /Fecal Coliform Data in Greens Bayou Watershed - Cont'd

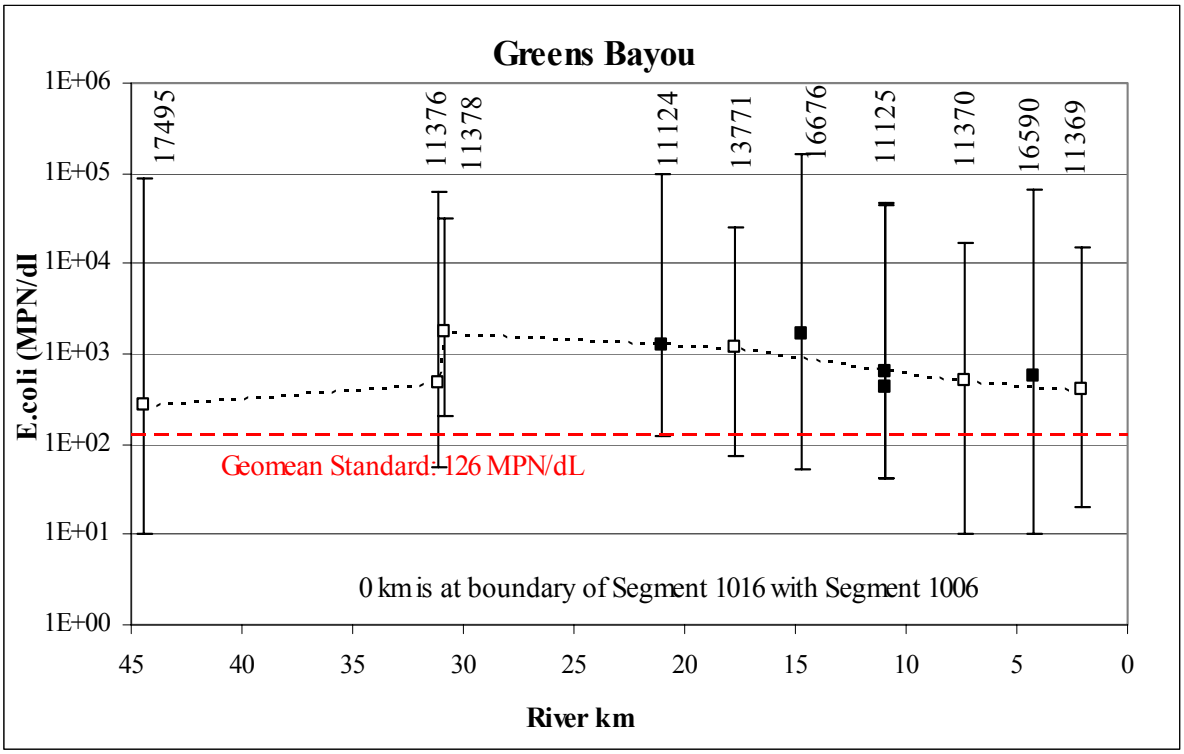


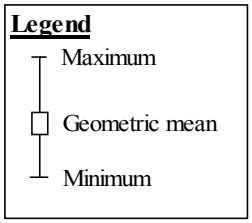
Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.14 *E. Coli* /Fecal Coliform Data in Greens Bayou Watershed - Cont'd

2.3.2 Spatial Analysis

Figure 2.15 shows EC concentration profiles along the Greens Bayou watershed. Data in Figure 2.15 show that the geometric mean standard of 126 MPN/dL is exceeded at all stations in this watershed. Data also show that the geometric mean does not change significantly along the stream and that the EC levels in the tributaries are generally at or below the levels measured in the main stem at the point of discharge. The regression analysis did not indicate any significant spatial trend ($R^2 = 0.008$, p value = 0.8666).





Note: Open Symbols → main stem
Closed Symbols → tributaries

Figure 2.15 Longitudinal EC Profiles for Major Streams in the Greens Bayou Watershed

2.3.3 Effect of Flow on Indicator Concentrations

To determine the effect of flow conditions on bacteria concentrations, the data were separated in two sets based upon the flow conditions under which the samples were collected. Since the stations listed in Greens Bayou watershed do not all have USGS gages, only stations where a USGS gage could be located sufficiently close to it were studied. Flow measurements that were below the 50% or median flow were categorized as low flow conditions, while flow values that were between the median flow and the 90th percentile were separated as high flow data. Generally EC data were used, however, in the absence of sufficient EC data; FC data were used in the analysis. Geometric means were calculated for each station that had flow data. As can be seen in Table 2.5, a flow analysis cannot be completed due to lack of data for low conditions.

Table 2.5 Low and high flow analysis for EC in the Greens Bayou Watershed

USGS gage	Segment ID	Station ID	Low Flow Data		High Flow Data	
			Obs Nos	GM	Obs Nos	GM
8076000	1016C	11124	Low Flow not reported		25	1429
	1016	11371	Low Flow not reported		28	1072
	1016D	16676	Low Flow not reported		26	1346
	1016	11369	Low Flow not reported		39	421
8075900	1016	11376	No flow data available			
	1016	13778	No flow data available			
8076810	1016A	16589	Low Flow not reported		23	277
	1016A	11125	Low Flow not reported		24	441

GM: Geometric mean (MPN/dL), Obs Nos. Number of observations

2.4 HALLS BAYOU WATERSHED

2.4.1 Temporal Analysis

Table 2.6A lists the monitoring stations in Halls Bayou, the number of samples, the geomean of the samples, the number of samples that exceeded the single sample standard, and the number of samples that exceeded the geomean standard. Time series plots of the indicator concentrations are depicted in Fig. 2.16. Visual inspection of plots indicated that most of the fecal indicator concentrations showed no trend over time for the stations in Halls Bayou. Linear regressions performed on the log-transformed data for the Halls Bayou watershed confirmed this for all stations except station 16666 that exhibits a decreasing trend (Table 2.6). Thus it was concluded that the bacteria levels do not change over time for Halls Bayou watershed.

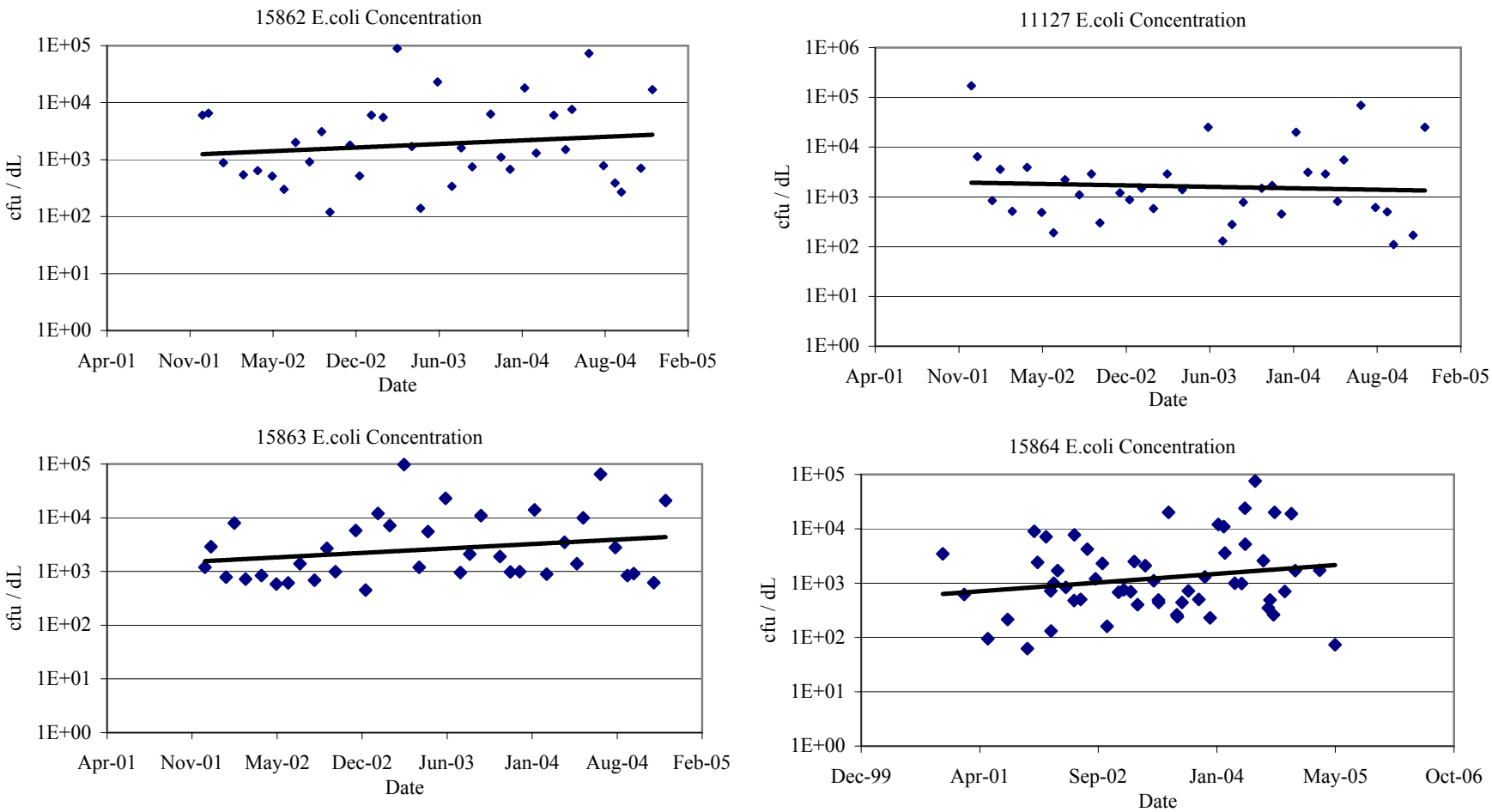
Table 2.6A Summary of Bacteria Data for Halls Bayou Watershed

Watershed	Segment ID	Station ID	Tributary	# samples	Geometric Mean (MPN/dL)	# > 126 MPN/dL	# > 394 MPN/dL
Halls Bayou	1006E	11126		37	3440	37	35
	1006D	11127		36	1614	35	30
		15862		36	1850	35	30
		15863		37	2585	37	37
		15864		55	1220	52	44
	1006J	16665	x	37	2083	36	33
	1006I	16666	x	37	1852	37	33
		16667	x	36	874	36	26

Table 2.6B Summary of Temporal Trends in Halls Bayou Watershed

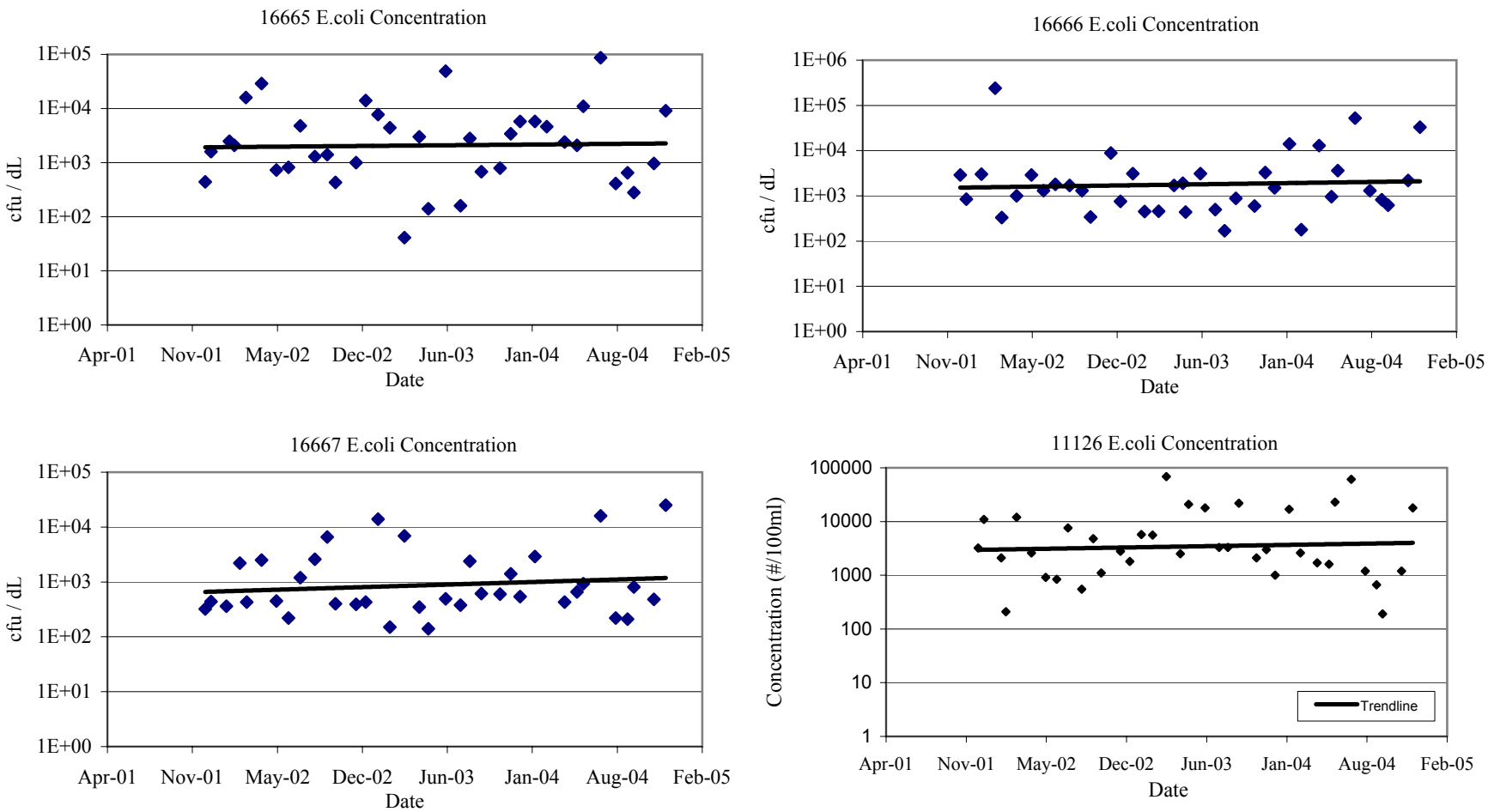
Segment	Station	Slope	Trend	p value	Indicator Bacteria	No. Obs
1006D	15864	0.0001	---	0.6120	*E.coli*	61
	15863	0.0004	---	0.2064	*E.coli*	39
	15862	0.0005	---	0.2086	*E.coli*	38
	11127	0.0001	---	0.8147	*E.coli*	38
1006E	11126	0.0002	---	0.5951	*E.coli*	39
1006J	16665	0.0003	---	0.3708	*E.coli*	39
1006I	16666	-0.001056	Decreasing	0.0029	Fecal Coliform	70
	16667	0.000342	---	0.4109	Fecal Coliform	69

Highlighted cells indicate statistical significance (P<0.05)



Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.16 *E. Coli* /Fecal Coliform Data in Halls Bayou Watershed



Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.16 *E. Coli* /Fecal Coliform Data in Halls Bayou Watershed - Cont'd

2.4.2 Spatial Analysis

Figure 2.17 shows EC concentration profiles along Halls bayou. Data in Figure 2.17 show that the geometric mean standard of 126 MPN/dL is exceeded at all stations in this watershed. Data also show that the geometric mean does not change significantly along the stream and that the EC levels in the tributaries are generally at or below the levels measured in the main stem at the point of discharge. No significant spatial trend was found ($R^2 = 0.167$, p value = 0.4937).

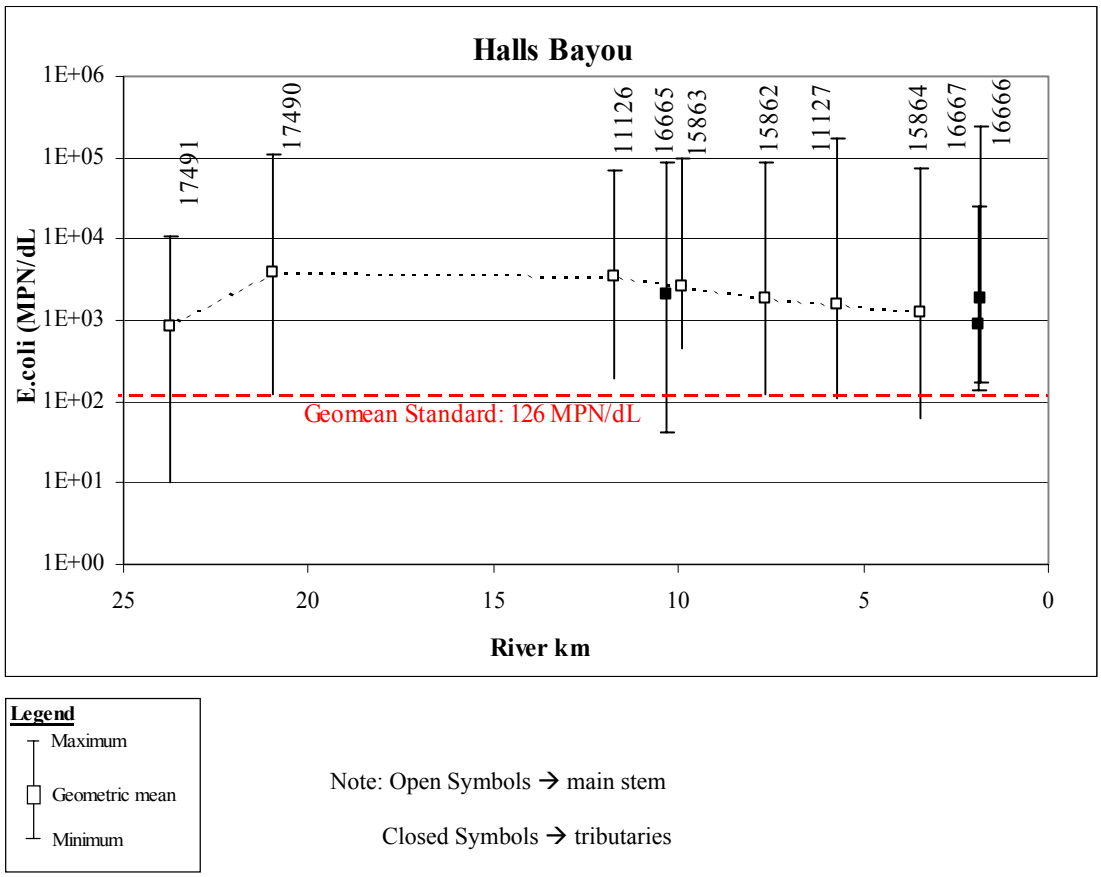


Figure. 2.17 Longitudinal EC Profiles for Major Streams in the Halls Bayou Watershed

2.4.3 Effect of Flow on Indicator Concentrations

There was not sufficient flow data available for any of the stations to conduct a comparison between high and low flow conditions (Table 2.7).

Table 2.7 Low and High flow analysis for EC in the Halls Bayou Watershed

USGS gage	Station ID	Low Flow Data		High Flow Data	
		Obs Nos	GM (MPN/100mL)	Obs Nos	GM (MPN/100mL)
8076700	11127	No flow data available			
	11264	No flow data available			
	16666	No flow data available			
	16667	No flow data available			
8076500	15862	Low flow not reported		29	1731
	15863	Low flow not reported		30	2236
	16665	Low flow not reported		30	1934
	11126	Low flow not reported		82	12279

GM: Geometric mean (MPN/dL)

2.5 BRAYS BAYOU WATERSHED

2.5.1 Temporal Analysis

Table 2.8A lists the monitoring stations in Halls Bayou, the number of samples, the geomean of the samples, the number of samples that exceeded the single sample standard, and the number of samples that exceeded the geomean standard. Time series of FC/EC concentrations by station are shown in Figure 2.18. Visual inspection of data indicated that fecal indicator levels in Brays Bayou watershed were stable over time for most of the stations (Figure 2.18). Linear regressions performed on the log-transformed EC data indicated that no significant temporal trends existed in the Brays Bayou watershed (Table 2.8B).

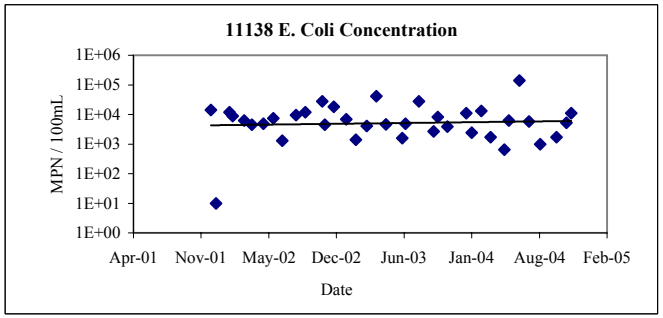
Table 2.8A Summary of Bacteria Data for Brays Bayou Watershed

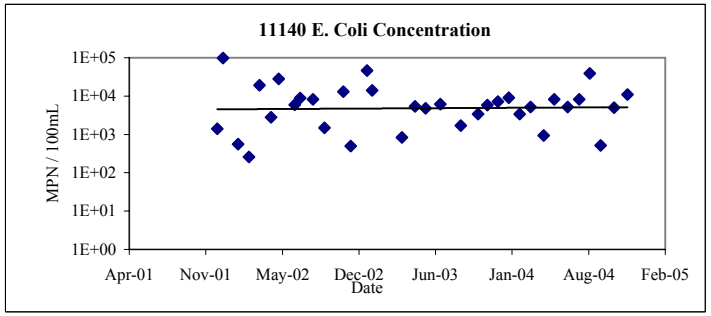
Watershed	Segment ID	Station ID	Tributary	# samples	Geometric Mean (MPN/dL)	# > 126 MPN/dL	# > 394 MPN/dL
Brays Bayou	1007B	11138		37	5078	36	36
		11139		48	3292	48	46
		16479		37	3791	37	37
		11140		34	4807	34	33
		15850		34	1667	34	30
		15851		34	3756	34	31
		15852		34	3641	34	33
		15853		32	4799	32	32
		15854		32	5996	32	32
		15855		32	3052	32	31
		15859		31	3241	31	30
	1007C	11169	x	34	2317	34	34
	1007E	16652	x	32	1761	29	25
	1007L	16654	x	34	1519	34	31
	1007P	15848		33	918	32	23
		15849		34	683	30	22

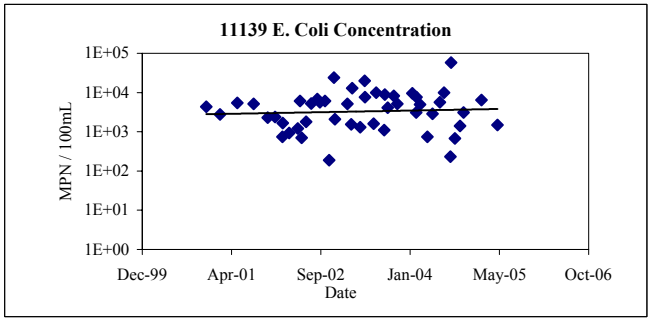
Table 2.8B Summary of Temporal Trends for Brays Bayou Watershed

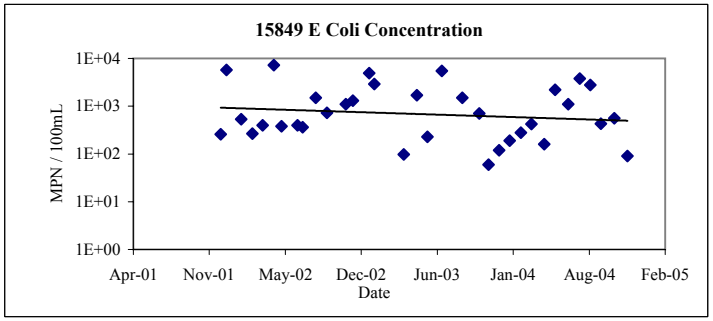
Segment	Station	Slope	Trend	p value	Indicator	No. Obs
1007B	15852	0.0006	---	0.5228	*E.coli*	34
	16479	0.0002	---	0.8507	*E.coli*	37
	11138	0.0001	---	0.6905	*E.coli*	37
	11139	0.0000	---	0.8258	*E.coli*	50
	11140	0.0001	---	0.8707	*E.coli*	34
	15853	0.0013	---	0.1734	*E.coli*	32
	15854	0.0002	---	0.4023	*E.coli*	32
	15855	0.0012	---	0.1549	*E.coli*	32
	15859	0.0002	---	0.5835	*E.coli*	31
	15849	-0.0006	---	0.3933	*E.coli*	34
	15850	-0.001	---	0.1368	*E.coli*	34
	15851	0.0003	---	0.5733	*E.coli*	34
1007C	11169	-0.0001	---	0.6818	*E.coli*	34
1007E	16652	0.0003	---	0.5058	*E.coli*	32
1007L	16654	-0.0001	---	0.6755	*E.coli*	34
1007P	15848	-0.0006	---	0.0618	*E.coli*	33
1007P	11141	-0.0039	---	0.6470	Fecal Coliform	11

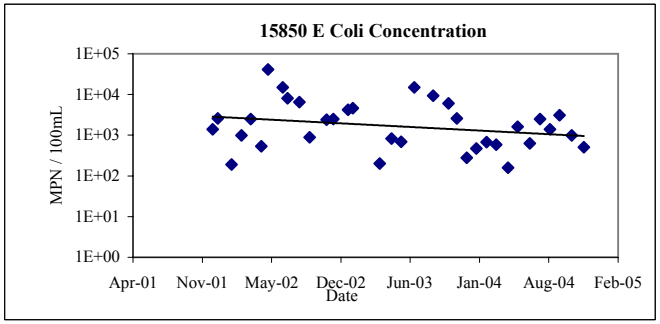
Note: Highlighted cells indicate statistical significance (P<0.05)
No. Obs: Number of Observations

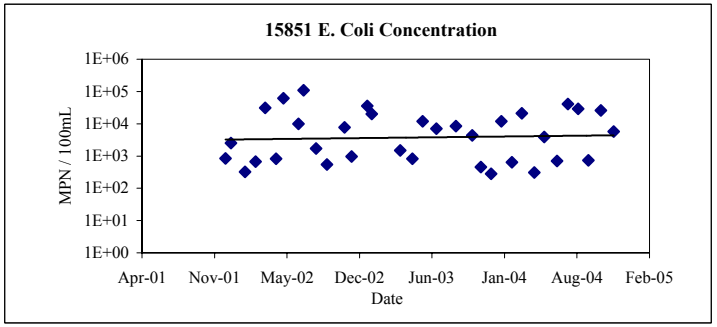






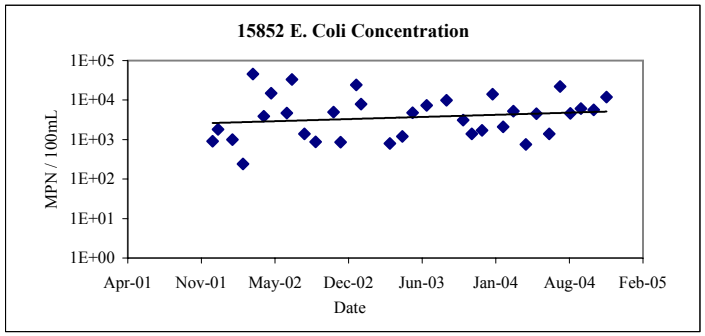


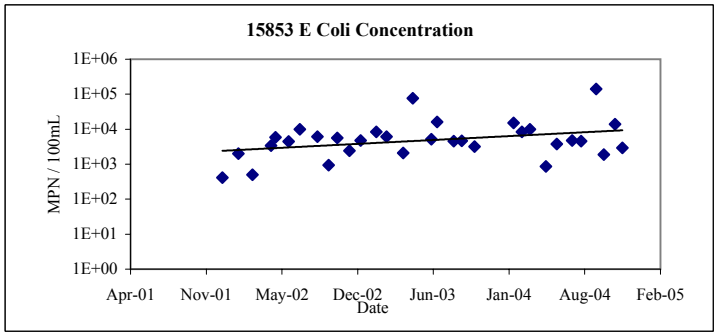


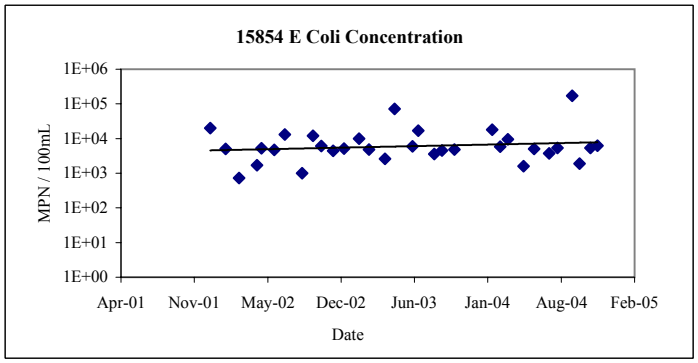


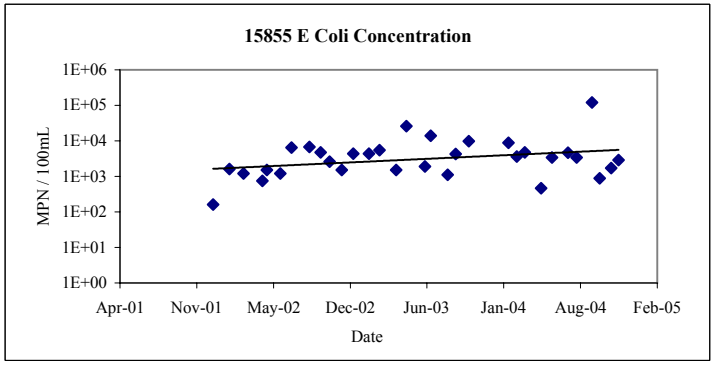
Note: cfu: colony forming units, MPN: Most Probable Number

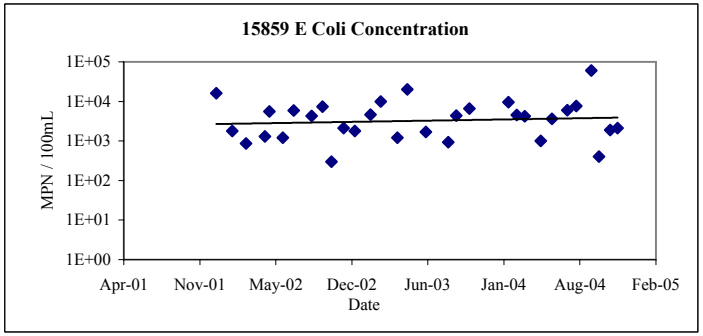
Figure 2.18*E.Coli* /Fecal Coliform Data for Water Quality Stations in the Brays Bayou Watershed

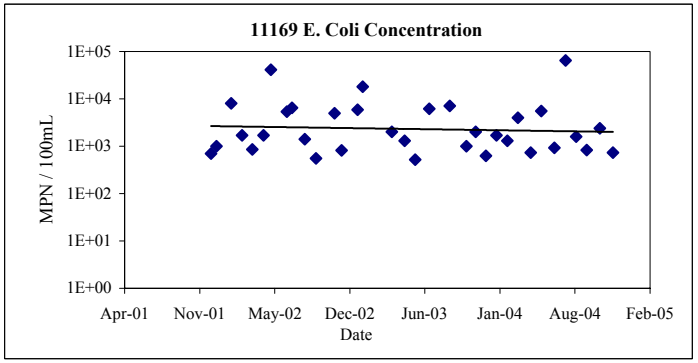






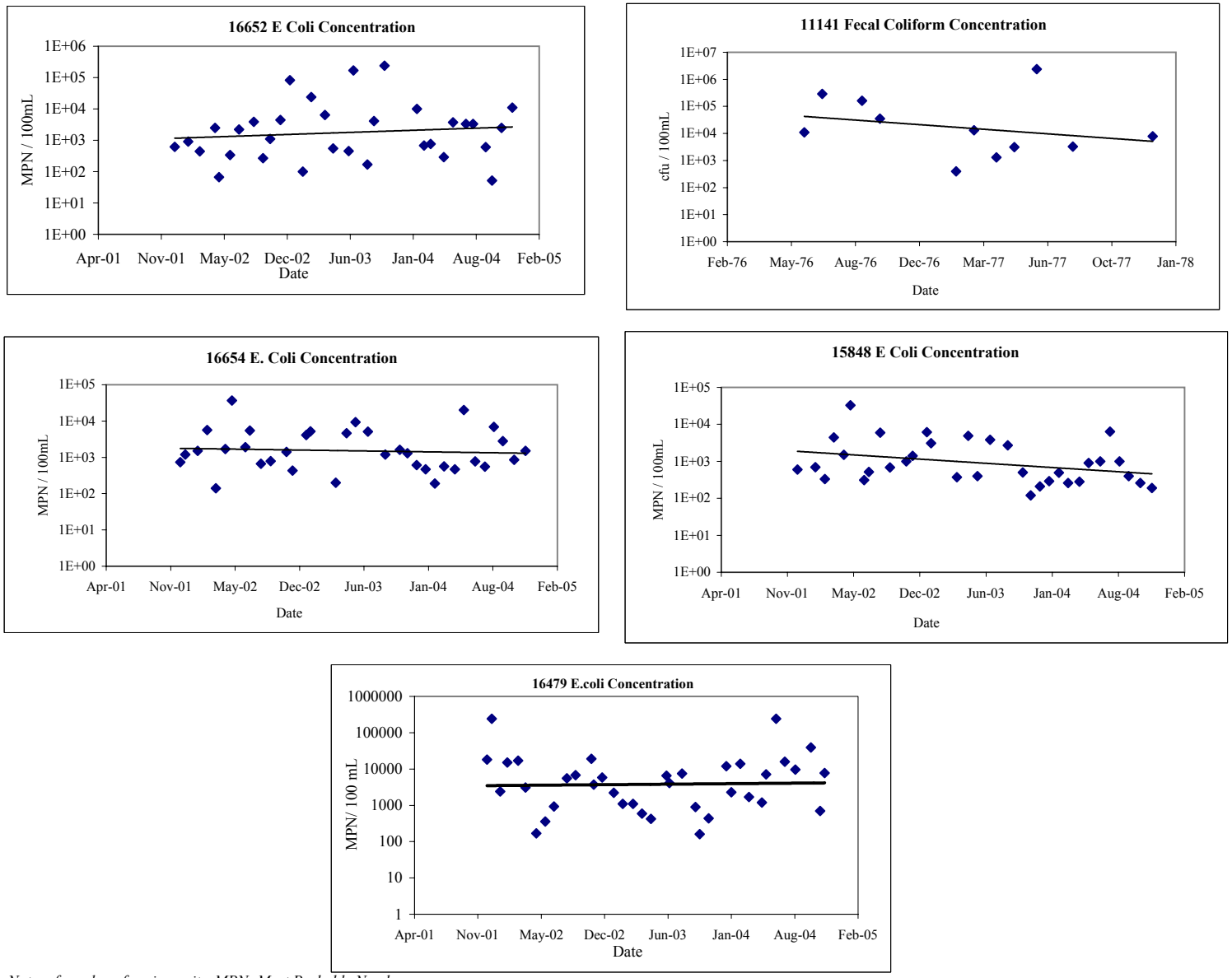






Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.18 *E.Coli* /Fecal Coliform Data for Water Quality Stations in the Brays Bayou Watershed - Cont'd



Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.18 *E.Coli* /Fecal Coliform Data for Water Quality Stations in the Brays Bayou Watershed - Cont'd

2.5.2 Spatial Analysis

Figure 2.19 shows EC concentration profiles along Brays Bayou. Data in Figure 2.19 show that the geometric mean standard of 126 MPN/dL is exceeded at all the stations. Data also show that the geometric mean changes significantly along the stream and that the geomean EC levels in the tributaries are below the levels measured in the main stem at the point of discharge. Regression analysis indicated that Brays Bayou presented a statistically significant spatial trend for which EC geometric means are increasing longitudinally from upstream to downstream ($R^2 = 0.498$, p value = 0.007).

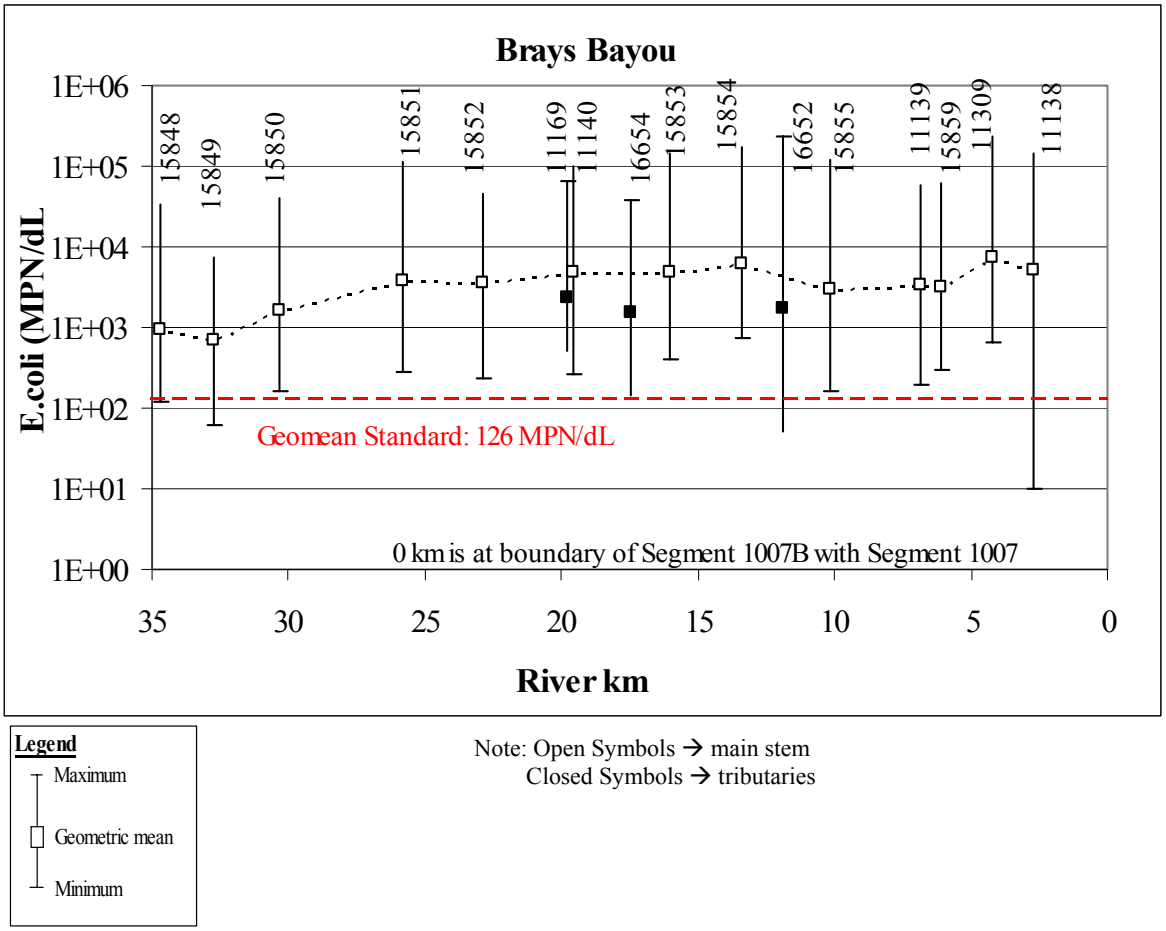


Figure. 2.19 Longitudinal EC Profiles for Major Streams in the Brays Bayou Watershed

2.5.3 Effect of Flow on Indicator Concentrations

Generally EC data were used, however, in the absence of sufficient EC data; FC data were used in the analysis. Geometric means were calculated for each station that had flow data. The geometric means ranged from 990 MPN/100 mL to 6764 MPN/100mL for data collected under high flow conditions and from 585 to 3801 MPN/dL for low flow conditions as can be seen in Table 2.9. Data were collected mainly under high flow periods for the stations in this watershed. The results for the *t*-test are summarized in Table 2.10 and show that the indicator concentrations observed for the low and high periods were not statistically significant.

Table 2.9 Flow Analysis for Brays Bayou Watershed

Segment ID	USGS gage	Station ID	Low Flow Data		High Flow Data	
			Obs Nos	GM	Obs Nos	GM
1007B	8075000	11138	5	EC data not available	23	2791
		11139	10	EC data not available	38	6010
		15855	Low Flow not reported		26	2394
		15859	Low Flow not reported		29	2819
	8074810	11140	13	3463	16	6764
		15849	13	585	16	990
		15853	10	4170	17	4501
		15852	13	1966	14	5012
		15851	13	1709	16	6027
1007C	8074800	11169	No flow data available			
1007E	8075000	16652	Low Flow not reported		25	1310
1007L	8074810	16654	36	3801	27	4877

Table 2.10 *t*-test for low flow and high flow data for Brays Bayou Watershed

Station ID	*Segment ID*	*t* Stat	*t* Critical two-tail	*p* value
11140	1007B	-1.65	2.12	0.12
15849		-1.38	2.08	0.18
15851		-1.7	2.06	0.10
15852		-1.93	2.06	0.07
15853		-0.27	2.13	0.79
16654	1007L	-0.57	2.00	0.57

p<0.05 indicates statistical significance at 95 confidence interval.

2.6 SIMS BAYOU WATERSHED

2.6.1 Temporal Analysis

Table 2.11A lists the monitoring stations in Halls Bayou, the number of samples, the geomean of the samples, the number of samples that exceeded the single sample standard, and the number of samples that exceeded the geomean standard. The historical bacteria monitoring data were analyzed to determine temporal trends, if any. Time series of FC/EC concentrations by station are shown in Figure 2.20. Linear regressions were performed on the log-transformed data and significance was evaluated at a 95% confidence level (α=0.05), assuming the data were log normally distributed (Table 2.11B). Most of the stations within the watershed showed no significant trends, with the exception of station 11133 (1007D) that exhibited a decreasing trend.

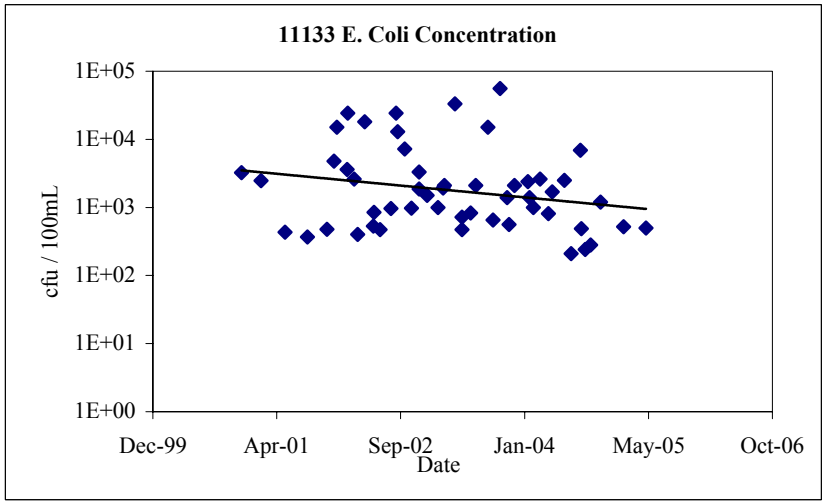
Table 2.11A Summary of Bacteria Data for Sims Bayou Watershed

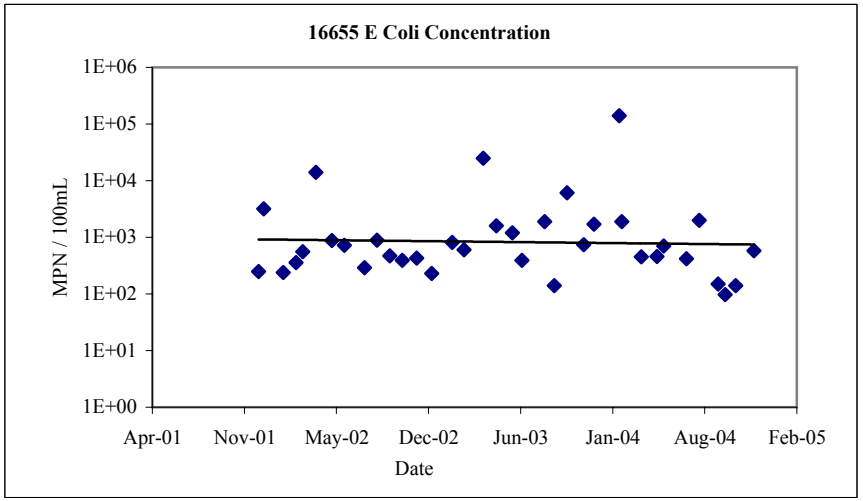
Watershed	Segment ID	Station ID	Tributary	# samples	Geometric Mean (MPN/dL)	# > 126 MPN/dL	# > 394 MPN/dL
Sims Bayou	1007D	11132		37	2014	37	36
		11133		52	1776	52	48
		11134		17	6087	16	13
		15877		36	1699	36	32
	1007Q	11135		36	1183	34	28
		16656		36	592	33	22
		15875	x	36	1222	32	29
	1007N	16655	x	36	829	35	25

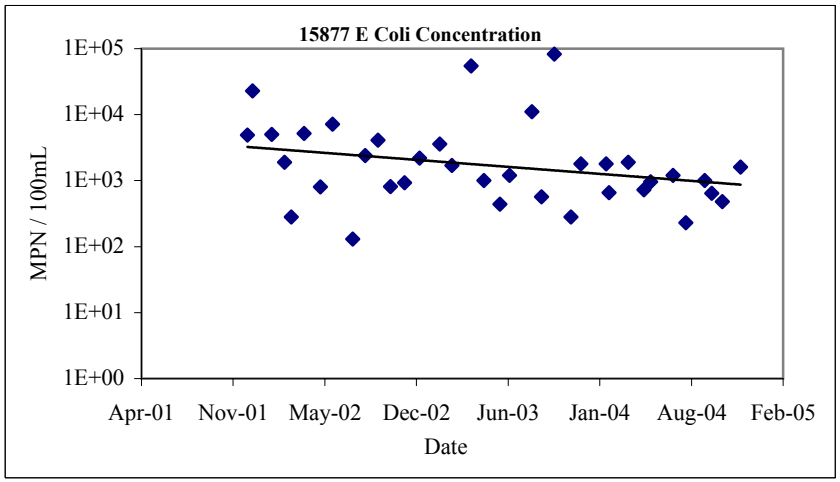
Table 2.11B Summary of Temporal Trends for Sims Bayou Watershed

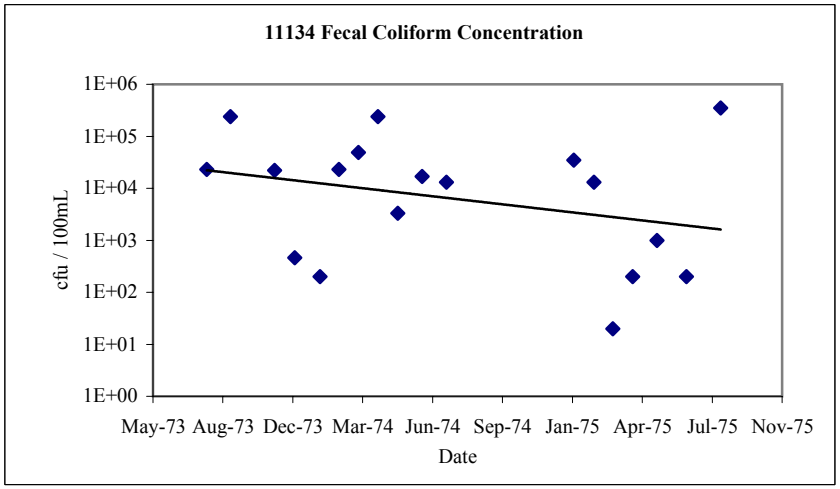
Segment	Station	Slope	Trend	P value	Indicator	No. Obs
1007D	11132	-0.0001	---	0.6797	*E.coli*	37
	15877	-0.0005	---	0.0937	*E.coli*	36
	11134	-0.0036	---	0.8949	Fecal Coliform	17
	11133	-0.0004	Decreasing	0.0382	*E.coli*	54
1007N	16655	-0.0001	---	0.8032	*E.coli*	36
1007Q	16656	-0.0001	---	0.6997	*E.coli*	36
	11135	-0.0002	---	0.6433	*E.coli*	36
	15875	-0.0006	---	0.1529	*E.coli*	36

Highlighted cells indicate $p < 0.05$



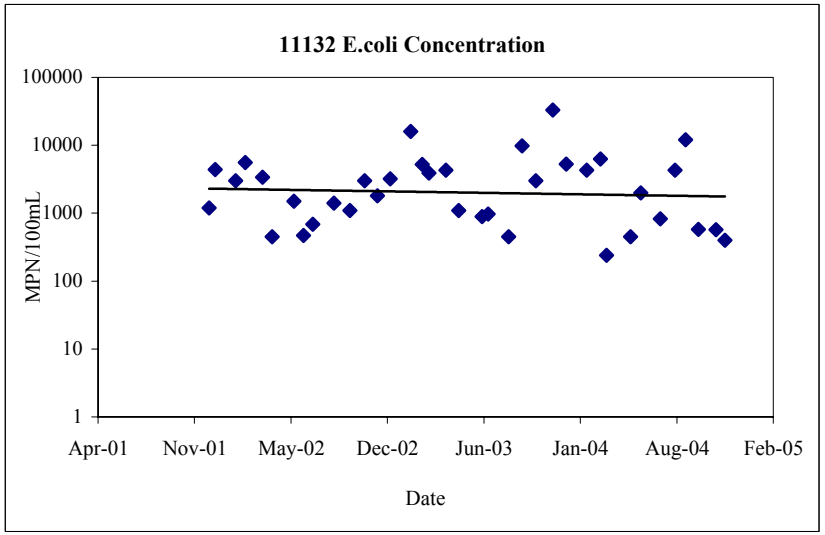


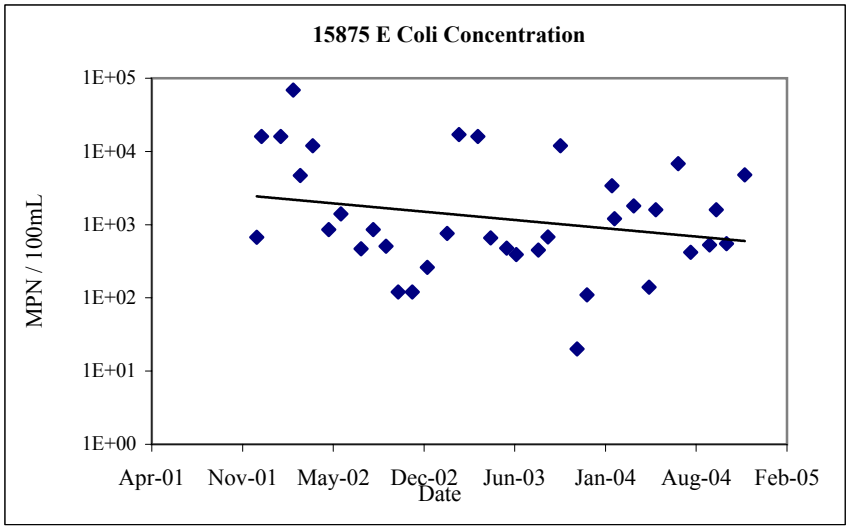


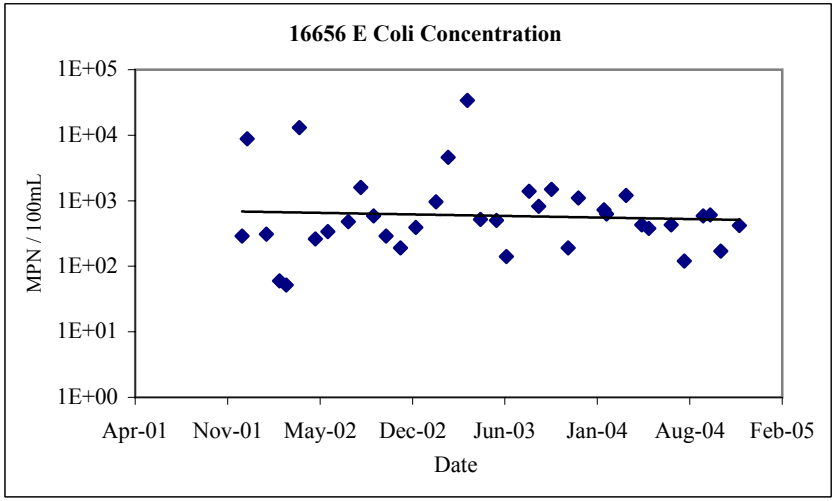


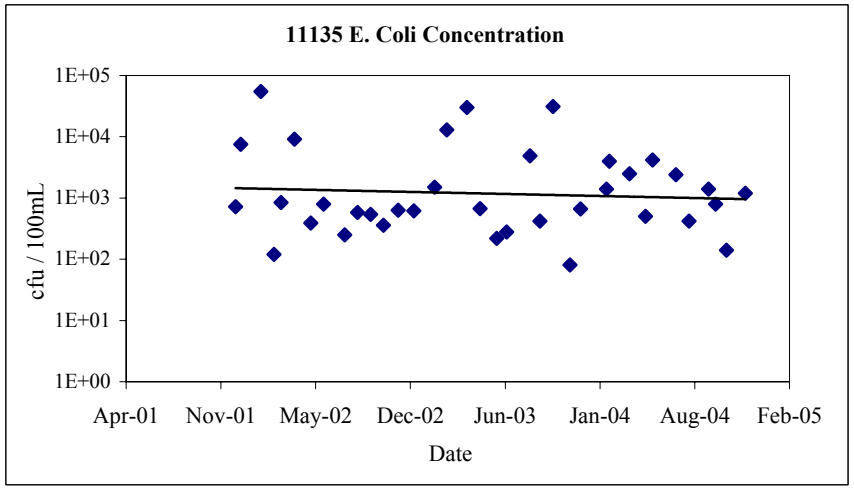
Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.20 E.Coli/Fecal Coliform Data in the Sims Bayou Watershed









Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.20 E.Coli/Fecal Coliform Data in the Sims Bayou Watershed - Cont'd

2.6.2 Spatial Analysis

Figure 2.21 shows EC concentration profiles along Sims Bayou. Data in Figure 2.21 show that the geometric mean standard of 126 MPN/dL is exceeded at all the stations. Data also show that the geometric mean does not change significantly along the stream. One of the tributaries had a geomean that exceeded the geomean in the Sims Bayou but a second tributary had a lower geomean than the main stem. The indicator concentrations did not exhibit a statistically significant spatial trend ($R^2 = 0.074$, p value = 0.6013) for Sims Bayou.

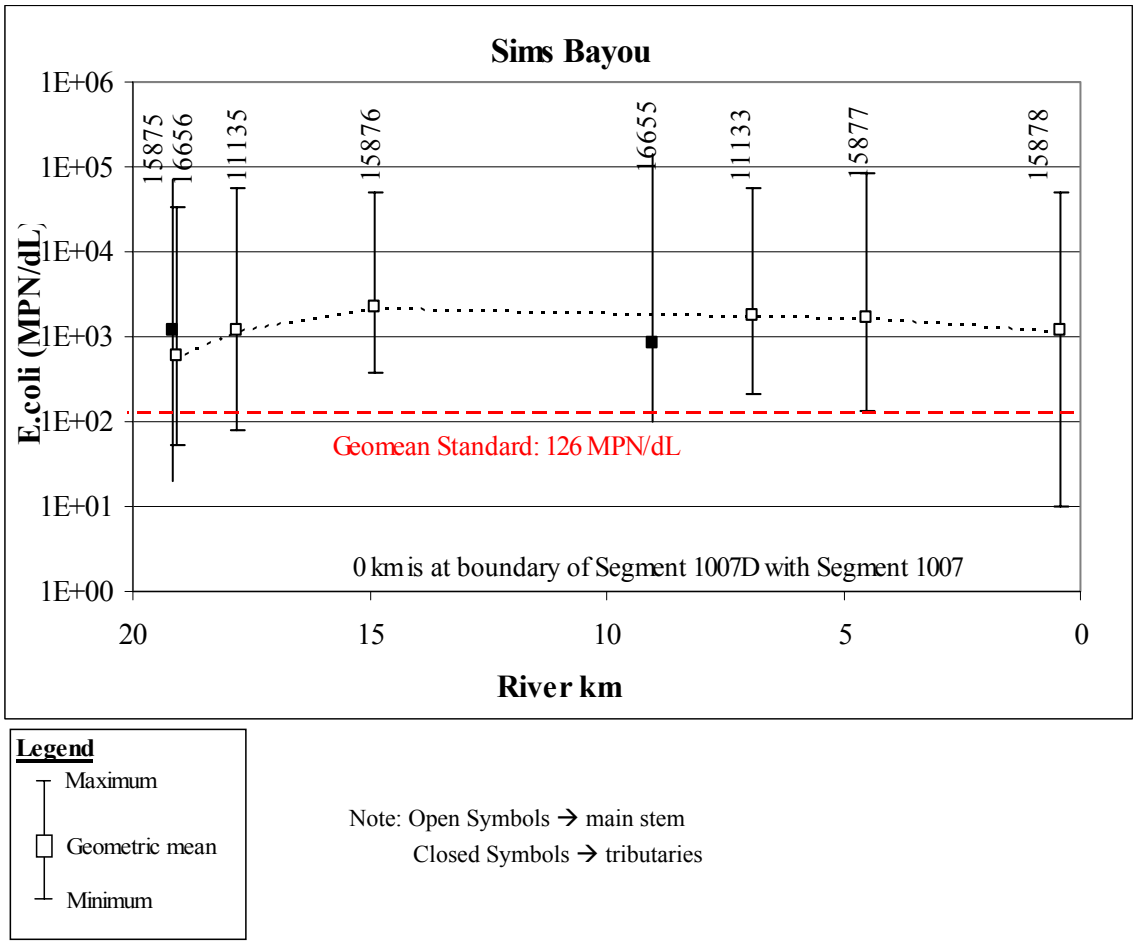


Figure. 2.21 Longitudinal EC Profiles for Major Streams in the Sims Bayou Watershed

2.6.3 Effect of Flow on Indicator Concentrations

An inventory of data under low and high flow conditions is presented in Table 2.12. As can be seen, the geometric means ranged from 813 MPN/dL to 17,082 MPN/dL for data collected under high flow conditions and from 709 to 19,218 MPN/dL under low flow conditions. The results for the *t*-test in Table 2.13 show that the indicator concentrations observed for the low and high periods were not statistically significant.

Table 2.12 Flow Analysis for Sims Bayou Watershed

Segment ID	USGS gage	Station ID	Low Flow Data		High Flow Data	
			Obs Nos	GM	Obs Nos	GM
1007D	**8075500**	15877	No flow data available			
		11132	16	19218	66	17082
		11133	5	3865	22	6490
1007N	**8075500**	16655	13	709	15	813

Highlighted cells indicate FC data were used.
GM: Geometric mean (MPN/dL)

Table 2.13 *t*-test for low flow and high flow data Sims Bayou Watershed

Station ID	t Stat	t Critical two-tail	p value
16655	-0.25	2.12	0.80
11132	-0.06	2.12	0.95
11133	-0.67	2.78	0.54

2.7 EASTERN HOUSTON WATERSHED

The Eastern Houston Watershed includes segments 1006F, 1006H, 1007F, 1007G, 1007H, 1007I, 1007K, 1007M, 1007O, and 1007R. Like the other watersheds in the Houston Metro area, temporal and spatial analyses were conducted for each segment within the watershed. Linear regressions were performed on the log-transformed data to evaluate any temporal/spatial trends. In addition, the effect of flow on indicator bacteria

concentrations was also evaluated for all segments. A statistical *t*-test was performed for the low flow and high flow data to estimate if significant differences existed between the data obtained for the two flow regimes. Flow measurements that were below median flow were categorized as low flow conditions, while flow values that were between the median flow and the 90th percentile were designated as high flow data. Table 2.14A lists the monitoring stations in Eastern Houston, the number of samples, the number of times the single sample was exceeded, and the geomean.

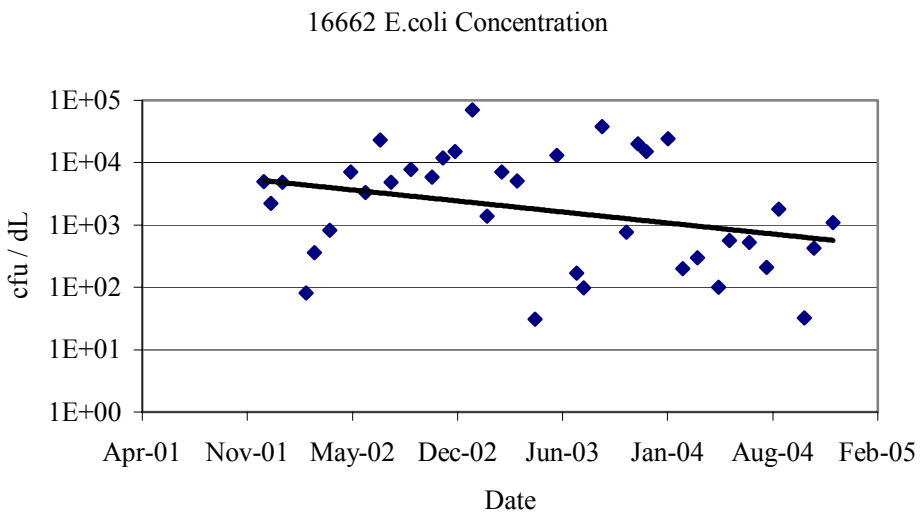
Table 2.14A Summary of Bacteria Data for Eastern Houston Watershed

Watershed	Segment ID	Station ID	Tributary	# samples	Geometric Mean (MPN/dL)	# > 126 MPN/dL	# > 394 MPN/dL
Eastern Houston	1007R	11128		35	866	31	25
		11129		37	335	30	13
		11130		19	27687	19	19
		15867		37	510	32	25
		15871		5	3137	5	5
		15873		37	656	25	20
		15869	x	37	26257	36	35
	1007M	16657	x	37	661	30	24
	1007F	16661		37	1987	35	36
	1007G	16659		37	3994	36	34
	1007H	16653		37	1830	32	22
	1007I	16658		37	7375	35	34
	1007K	16650		37	6932	36	35
		16651		37	5026	35	31
	1006F	16662		37	1766	32	28

2.7.1 Segment 1006F

Temporal Analysis

Time series of EC concentrations by station are shown in Figure 2.22. As can be seen, indicator bacteria concentrations for station 16662 appear to decline over time, however, no statistical significance was found. Linear regressions performed on the log-transformed data for segment 1006F showed that indicator concentrations do not have a significant correlation with time (Table 2.14B). Thus it was concluded, that like the other watersheds, the bacteria levels are not changing with time.



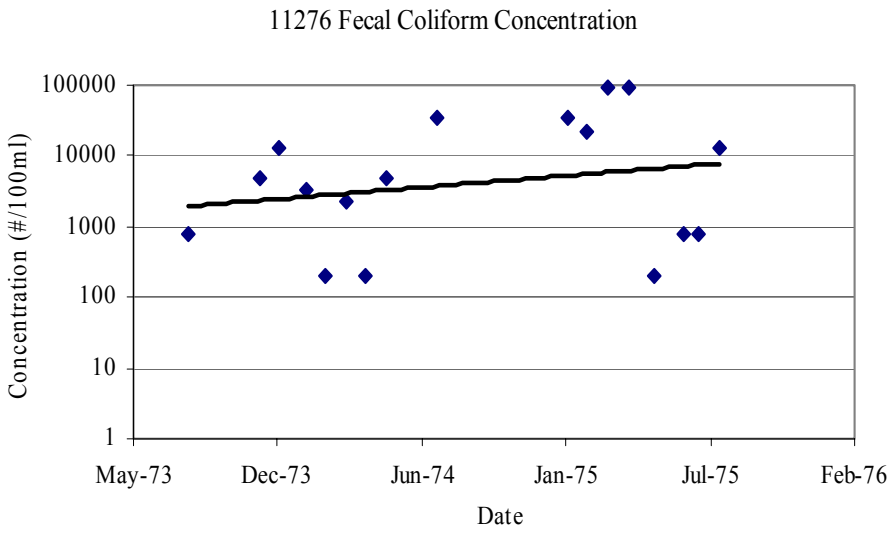


Figure 2.22 Time Series plot for EC Concentration for Segment 1006F in the Eastern Houston Watershed

Table 2.14B Summary of Temporal Trends for Segment 1006F in the Eastern Houston Watershed

Segment	Station	Slope	Trend	p value	Indicator	No. Obs
1006F	16662	-0.000719	----	0.08318	*E.coli*	37
	11276	0.000875	----	0.35960	Fecal Coliform	16

Effect of Flow on Indicator Concentrations

Flow data were not available for stations 11276, 16662 located in segment 1006F; hence no analysis could be conducted for this segment.

2.7.2 Segment 1006H

There were not sufficient data for analysis in this segment at station 16663.

2.7.3 Segment 1007F

Temporal Analysis

EC concentrations over time for station 16661 in Segment 1007F are shown in Figure 2.23. The concentrations appear to decline over time, however the relationship is not statistically significant (p value 0.1460). Thus, it was concluded that the bacteria levels are not changing with time.

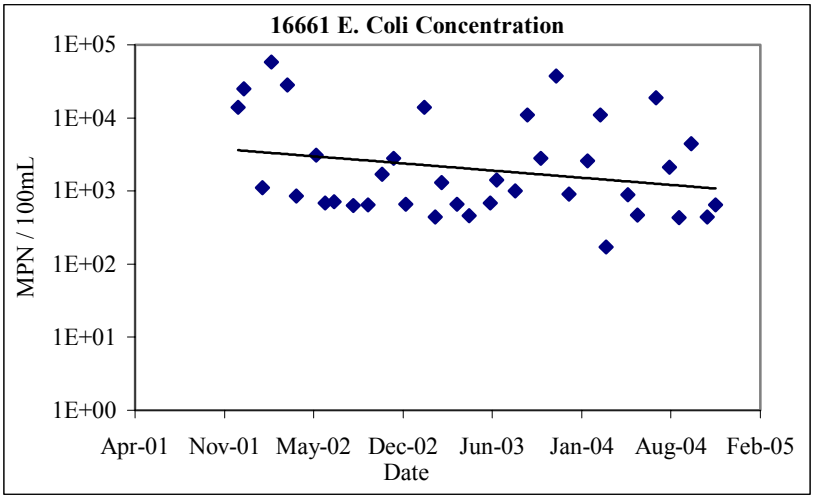


Figure 2.23 EC Data in Segment 1007F in the Eastern Houston Watershed

Effect of Flow on Indicator Concentrations

No flow data were available for station 16661 in segment 1007F; hence no flow analysis could be conducted for this segment.

2.7.4 Segment 1007G

Temporal Analysis

EC concentrations over time for station 16659 in Segment 1007G are shown in Figure 2.24. No trends were discerned (p value 0.2705).

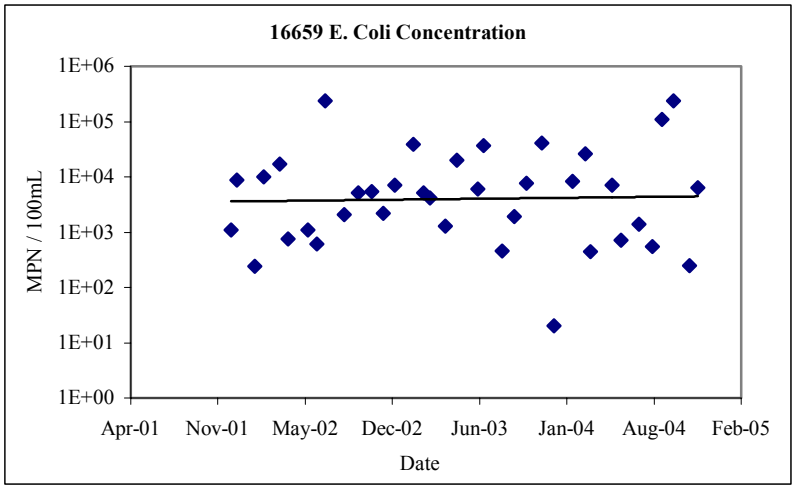


Figure 2.24 EC Data in Segment 1007G in the Eastern Houston Watershed

Effect of Flow on Indicator Concentrations

No flow data were available for station 16659 in segment 1007G; hence no flow analysis could be conducted for this segment.

2.7.5 Segment 1007H

Temporal Analysis

EC concentrations over time for station 16653 in Segment 1007H are shown in Figure 2.25. The concentrations did not have a significant correlation with time (p value 0.8483).

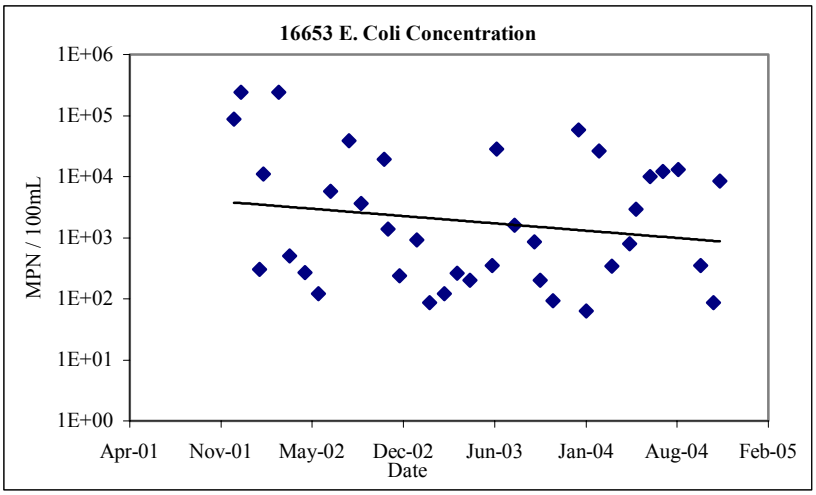


Figure 2.25 EC Data in Segment 1007H in the Eastern Houston Watershed

Effect of Flow on Indicator Concentrations

No flow data were available for segment 1007H; hence no flow analysis could be conducted for this segment.

2.7.6 Segment 1007I

Temporal Analysis

Time series of EC concentrations for station 16658 in Segment 1007I are shown in Figure 2.26. The concentrations did not have a significant correlation with time (p value 0.0999).

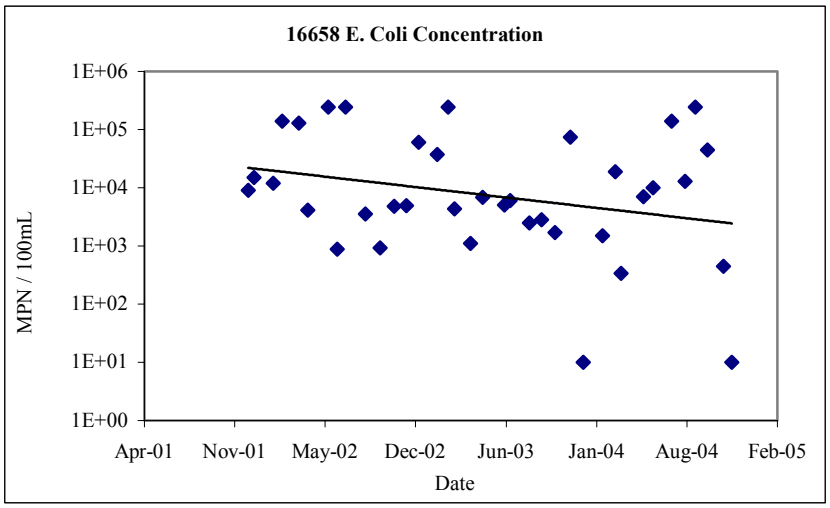


Figure 2.26 EC Data in Segment 1007I in the Eastern Houston Watershed

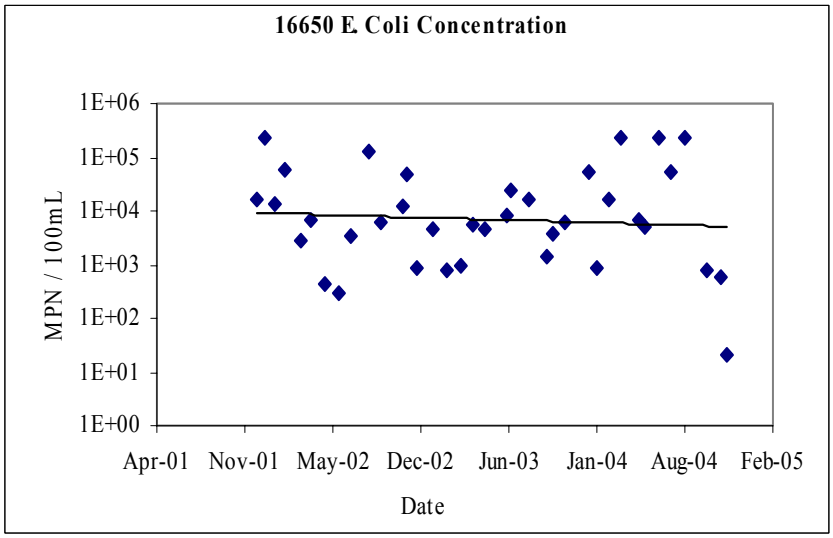
Effect of Flow on Indicator Concentrations

No flow data were available for segment 1007I; hence no flow analysis could be conducted for this segment.

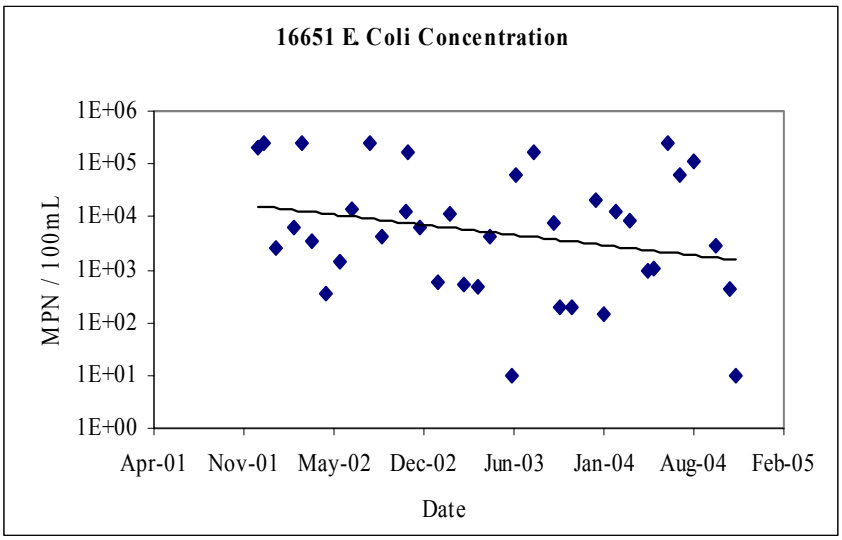
2.7.7 Segment 1007K

Temporal Analysis

EC concentrations over time are shown in Figure 2.27. Fecal indicator levels in Segment 1007K did not have a significant correlation with time (Table 2.15). Thus it was concluded that the bacteria levels are not changing with time.



(a)



(b)

Figure 2.27 EC Data in Segment 1007K in the Eastern Houston Watershed

Table 2.15 Summary of Temporal Trends for Segment 1007 K

Segment	Station	Slope	Trend	p value	Indicator	No. Obs
1007K	16651	-0.0010	---	0.1145	*E.coli*	37
	16650	-0.0002	---	0.6208	*E.coli*	37

Effect of Flow on Indicator Concentrations

An inventory of data under low and high flow conditions is presented in Table 2.16. As can be seen, low flow data were not available for stations 16650 and 16651. Hence no flow analysis could be conducted for this segment.

Table 2.16 Flow Analysis for Eastern Houston Segment 1007K

Segment ID	USGS gage	Station ID	Low Flow Data		High Flow Data	
			Obs Nos	GM (MPN/100mL)	Obs Nos	GM (MPN/100mL)
1007K	**8075000**	16650	Low Flow not reported		23	5603
		16651	Low Flow not reported		24	3599

GM: Geometric mean (MPN/dL)

2.7.8 Segment 1007O

Temporal Analysis

EC concentrations over time are shown in Figure 2.28. The relationship was not statistically significant (p value 0.9939) thus indicating no change over time.

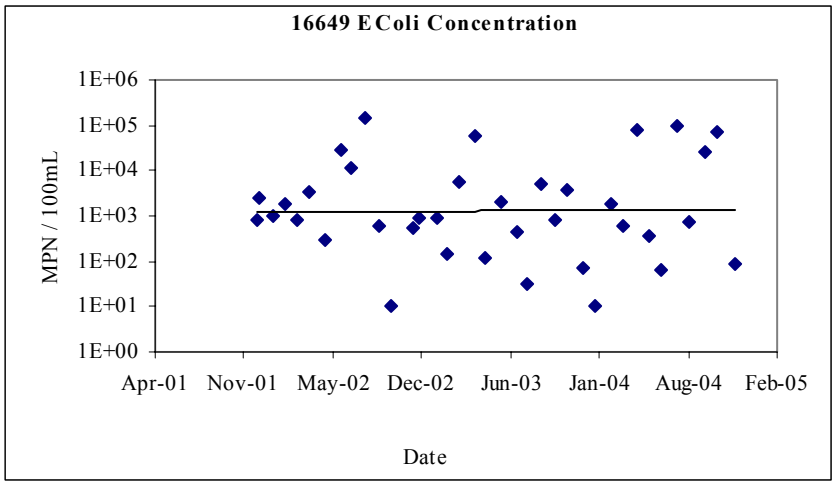


Figure 2.28 EC Data in Segment 1007O in the Eastern Houston Watershed

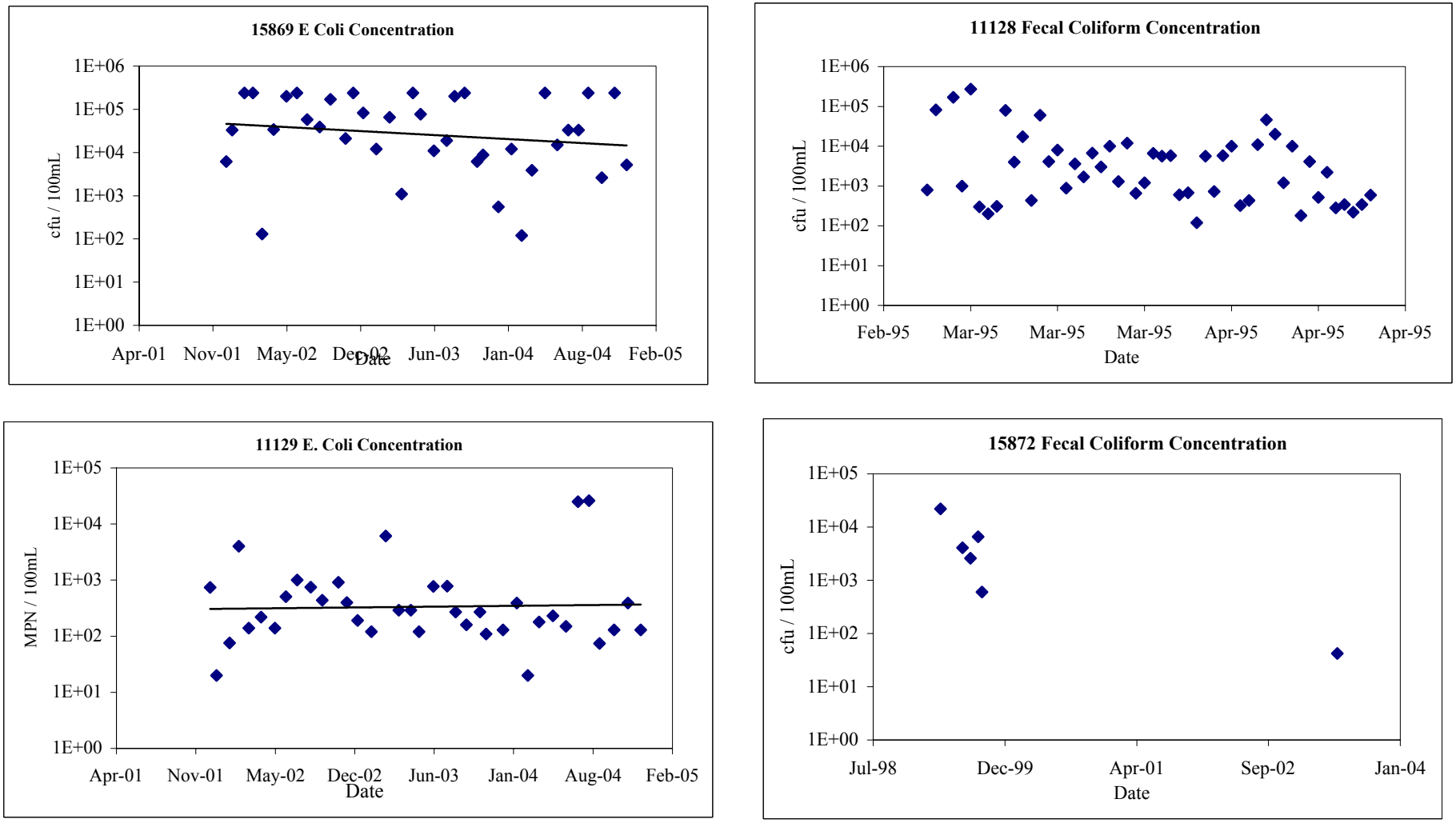
2.7.9 Segments 1007M and 1007R

Temporal Analysis

Time series of FC/EC concentrations by station are shown in Figure 2.29. Fecal indicator levels in the 1007 non-tidal segments do not have a significant correlation with time (Table 2.17). Thus, it was concluded that the bacteria levels are not changing with time.

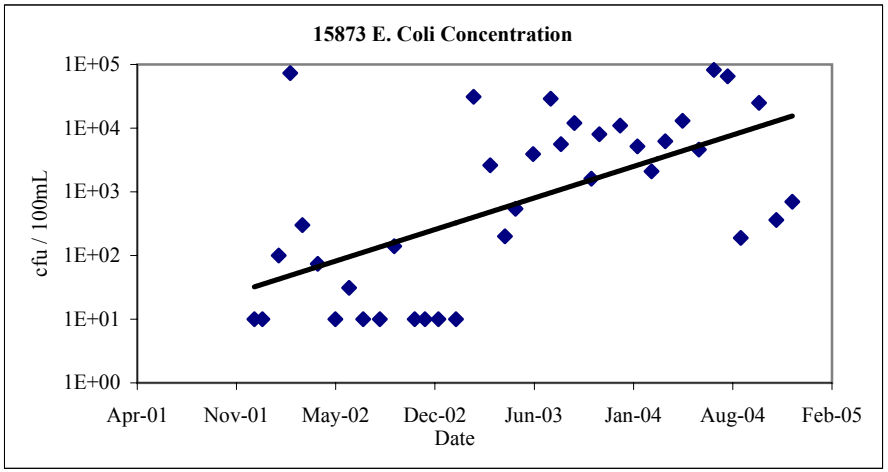
Table 2.17 Summary of Temporal Trends for Segment 1007 M and R

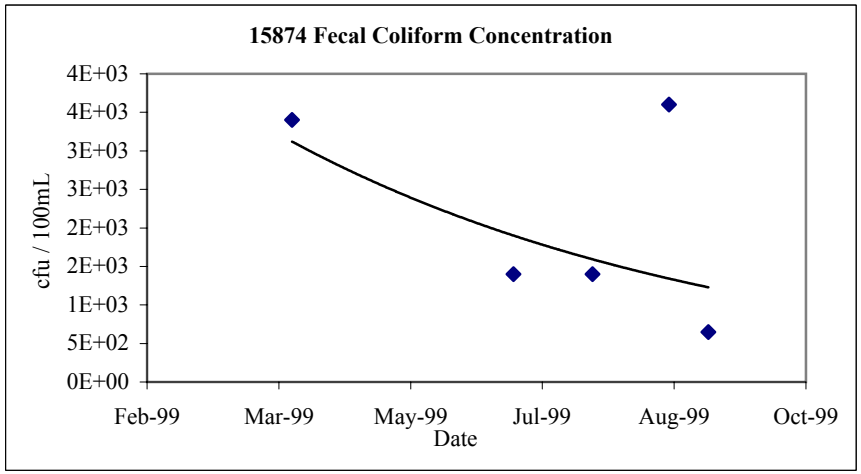
Segment	Station	Slope	Trend	p value	Indicator	No. Obs
1007M	16657	-0.0007	---	0.0852	*E.coli*	37
1007R	15869	-0.0005	---	0.3286	*E.coli*	37
	11129	0.0002	---	0.1284	*E.coli*	37
	11128	0.0003	---	0.1238	*E.coli*	35
	15873	0.0057	---	0.1961	*E.coli*	37
	15874	-0.0059	---	0.4481	*Fecal Coliform*	5
	15871	-0.0008	---	0.6805	*Fecal Coliform*	5
	11130	-0.0003	---	0.1986	*Fecal Coliform*	19

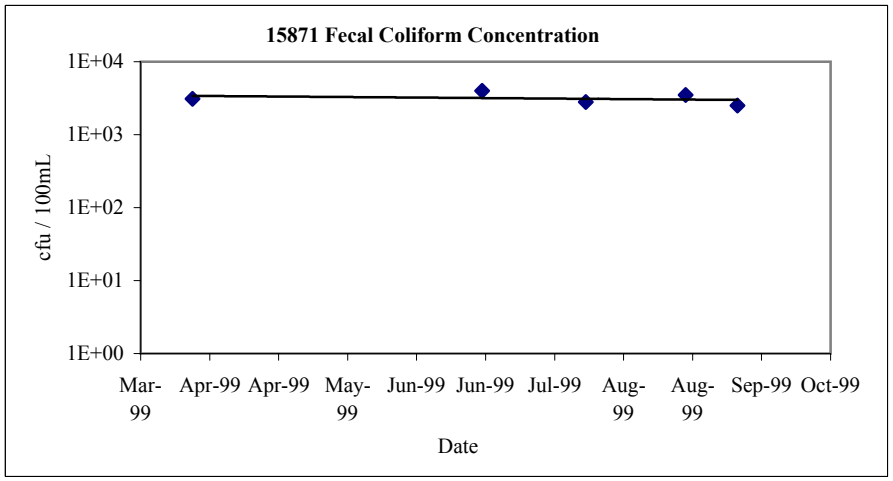


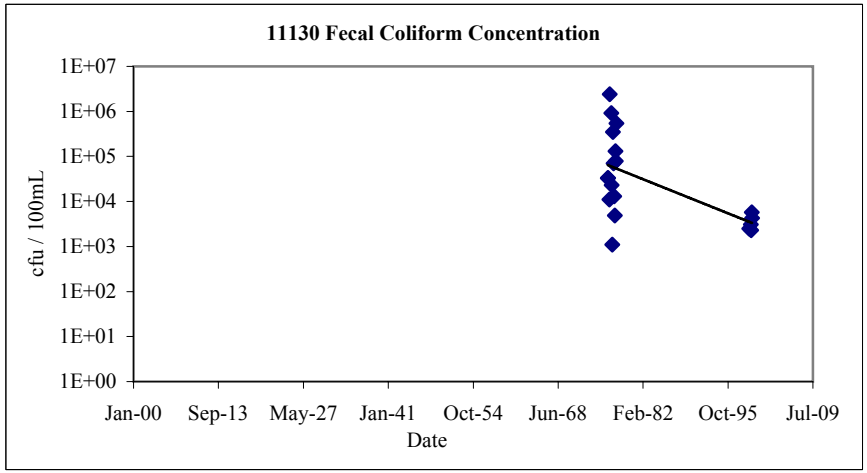
Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.29 E.Coli/Fecal Coliform Data for Water Quality Stations - 1007 K and R









Note: cfu: colony forming units, MPN: Most Probable Number

Figure 2.29 E.Coli/Fecal Coliform Data for Water Quality Stations - 1007 R (Cont'd)

Effect of Flow on Indicator Concentrations

An inventory of data under low and high flow conditions is presented in Table 2.18. As can be seen, geometric means ranged from 885 MPN/dL to 22,231 MPN/dL during high flow condition. Under low flow conditions, the geometric means ranged from 213 to 30,201 MPN/dL. The results for the *t*-test are summarized in Table 2.19 and reveal that the indicator concentrations observed for the low and high periods are statistically significant only for station 16657.

Table 2.18 Flow Analysis for Eastern Houston Segments 1007R and 1007M

Segment ID	USGS gage	Station ID	Low Flow Data		High Flow Data	
			Obs Nos	GM (MPN/100mL)	Obs Nos	GM (MPN/100mL)
1007R	**8075770**	16657	10	213	20	885
	8075770	15869	10	30201	20	22231
1007K	**8075000**	16650	Low Flow not reported		23	5603
		16651	Low Flow not reported		24	3599

GM: Geometric mean (MPN/dL)

Table 2.19 *t*-test for low flow and high flow data for segment 1007R and 1007M

Station ID	*t* Stat	*t* Critical two-tail	*p* value
15869	0.84	2.08	0.41
16657	-2.8	2.06	0.01

Highlighted stations presented statistical significant differences between the two datasets.

Spatial Analysis

Figure 2.30 shows EC concentration profiles along the Eastern Houston segments. Data in Figure 2.30 show that the geometric mean standard of 126 MPN/dL is exceeded at all stations. Data also show that the geometric mean does not change significantly

along the stream and that the EC levels in the tributaries are generally at or below the levels measured in the main stem at the point of discharge. For the Eastern Houston watershed, the indicator concentrations did not exhibit a statistically significant spatial trend ($R^2 = 0.167$, p value = 0.4937).

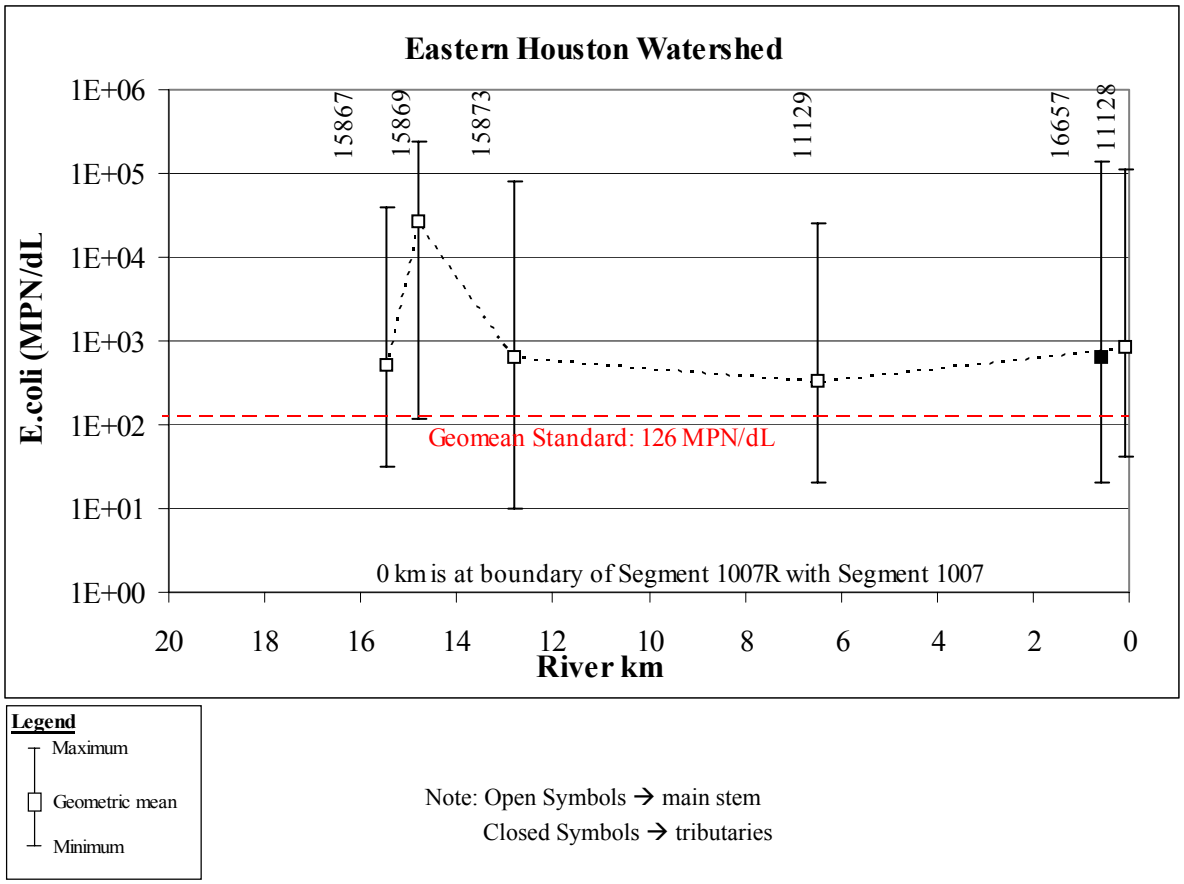


Figure. 2.30 Longitudinal EC Profiles for Major Streams in the Eastern Houston Watershed

CHAPTER 3

QUALITY ASSURANCE PROJECT PLAN DEVELOPMENT

The goal of this task was to develop a Quality Assurance Project Plan (QAPP) for additional data collection that meets the needs for the TMDL. The QAPP is a document that describes the tasks, management, structure, and policies that will be implemented in the monitoring program for this project. The QAPP ensures that the data collected under this work order will be reliable, scientifically valid, and legally defensible.

During the reporting period, the first draft of the QAPP was prepared based on the proposed sampling activities outlined in the previous chapter. Revision 0 of the QAPP was submitted to the TCEQ on March 7, 2006. Comments were received and the QAPP was revised on April 11 and April 18, 2006. The QAPP was subsequently approved on April 20, 2006. The final QAPP is included in Appendix A.

CHAPTER 4

DETAILED SAMPLING PLAN FY – 06

4.1 Introduction

As part of the Houston Metro TMDL project, the University of Houston and Parsons Water and Infrastructure collected additional field data on concentrations of fecal pathogens in the segments of concern to provide sufficient data for the development of Load Duration Curves (LDCs).

4.2 Monitoring and Data Collection

The monitoring program included two major components: (1) data gathering and field reconnaissance and survey and (2) sampling. Flow and *E.coli* data were collected as part of the preliminary sampling.

4.2.1 *E.coli* Sampling

The sampling approach was designed to provide sufficient data for development of load duration curves. Thus, three intensive surveys were completed for obtaining flow and EC data for twenty – one proposed locations. The locations that were sampled are shown in Figure 3.1 A reconnaissance survey was conducted by the sampling crew prior to the first sampling event that occurred in May 06. Following the reconnaissance, and due to difficulty of access, station 15438 was replaced with station 11371 in the sampling plan. Sampling frequencies and parameters are listed in Table 3.1.

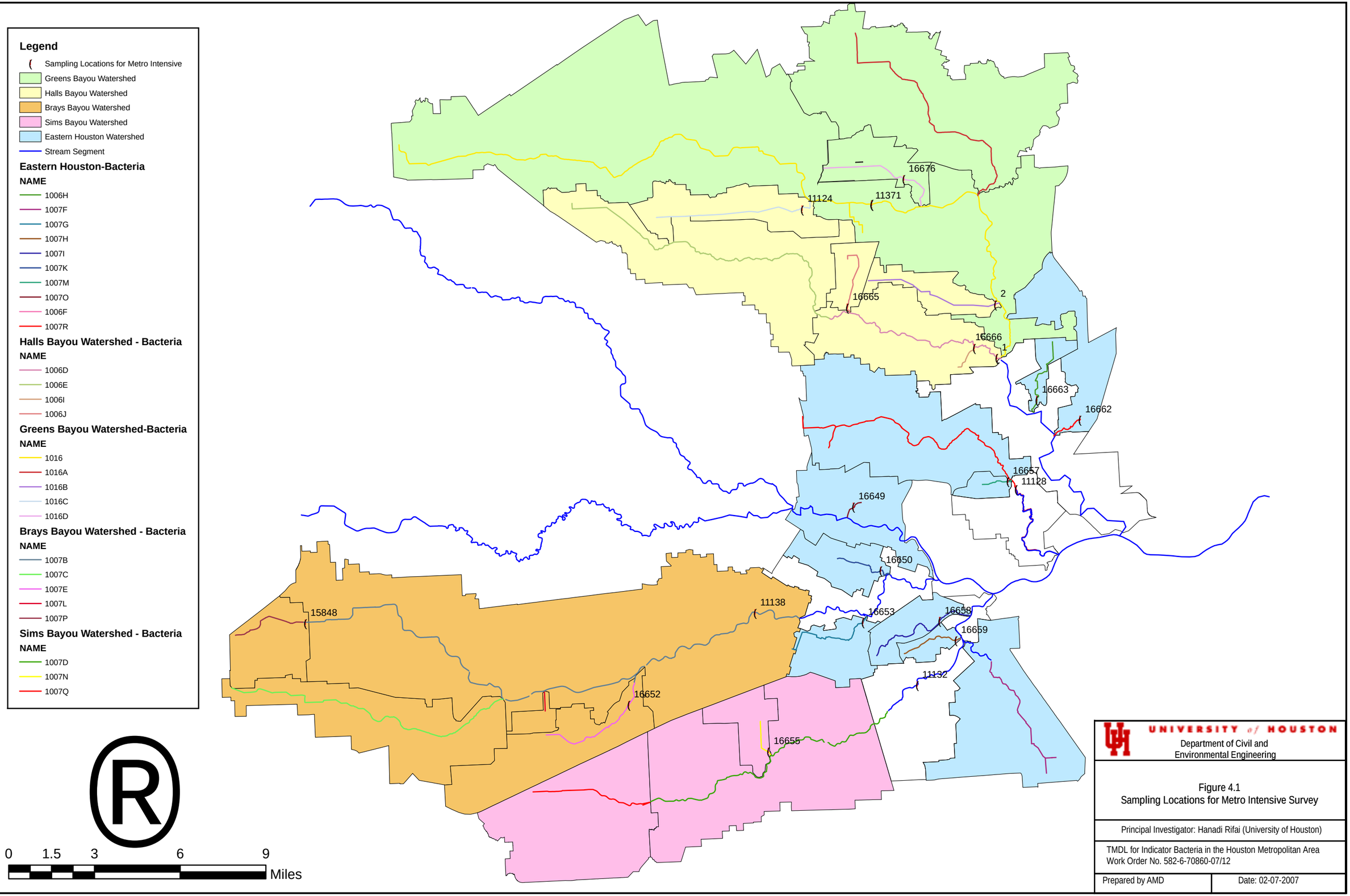

Legend
Sampling Locations for Metro Intensive
Greens Bayou Watershed
Halls Bayou Watershed
Brays Bayou Watershed
Sims Bayou Watershed
Eastern Houston Watershed
Stream Segment
Eastern Houston-Bacteria
NAME
1006H
1007F
1007G
1007H
1007I
1007K
1007M
1007O
1006F
1007R
Halls Bayou Watershed - Bacteria
NAME
1006D
1006E
1006I
1006J
Greens Bayou Watershed-Bacteria
NAME
1016
1016A
1016B
1016C
1016D
Brays Bayou Watershed - Bacteria
NAME
1007B
1007C
1007E
1007L
1007P
Sims Bayou Watershed - Bacteria
NAME
1007D
1007N
1007Q
16676
11124
11371
16665
2
16666
1
16663
16662
16657
11128
16649
16650
15848
11138
16653
16658
16659
11132
16652
16655
0
1.5
3
6
9
Miles
UNIVERSITY of HOUSTON
Department of Civil and
Environmental Engineering
Figure 4.1
Sampling Locations for Metro Intensive Survey
Principal Investigator: Hanadi Rifai (University of Houston)
TMDL for Indicator Bacteria in the Houston Metropolitan Area
Work Order No. 582-6-70860-07/12
Prepared by AMD
Date: 02-07-2007

Table 4.1 Monitoring Sites and Frequencies

Location ID	TCEQ Short Description	Segment	Monitoring frequencies				
			Field parameters[a]	Flow	*E. Coli* in water	Turbidity	TSS
TBD – 1[b]	Halls Bayou at Mouth	1006D	15-18	15-18	15-18	15-18	15-18
16662	Big Gulch at Wallisville Rd	1006F	15-18	15-18	15-18	15-18	15-18
16663	Spring Gully at Barnesworth D	1006H	15-18	15-18	15-18	15-18	15-18
16666	Trib Halls Bayou at Talton St	1006I	15-18	15-18	15-18	15-18	15-18
16665	Trib Halls Bayou at Langley R	1006J	15-18	15-18	15-18	15-18	15-18
11138	Brays Bayou at Almeda Rd	1007B	15-18	15-18	15-18	15-18	15-18
11132	Sims Bayou at Telephone (SH35)	1007	15-18	15-18	15-18	15-18	15-18
16652	Willow Waterhole at Mcdermed	1007E	15-18	15-18	15-18	15-18	15-18
16653	Kuhlman Gully at Brock St	1007G	15-18	15-18	15-18	15-18	15-18
16659	Pine Gully at Old Galveston R	1007H	15-18	15-18	15-18	15-18	15-18
16658	Plum Creek at Old Galveston R	1007I	15-18	15-18	15-18	15-18	15-18
16650	Country Club Bayou at Wayside	1007K	15-18	15-18	15-18	15-18	15-18
16657	Trib of Hunting Bayou at Ralston	1007M	15-18	15-18	15-18	15-18	15-18
16655	Trib of Hunting Bayou at Ralston	1007N	15-18	15-18	15-18	15-18	15-18
16649	Trib of Buffalo Bayou/Clinton Dr.	1007O	15-18	15-18	15-18	15-18	15-18
15848	Brays Bayou at SH 6	1007P	15-18	15-18	15-18	15-18	15-18
11128	Hunting Bayou at IH 10	1007R	15-18	15-18	15-18	15-18	15-18
15438	Greens Bayou at El Dorado Golf Course	1016	15-18	15-18	15-18	15-18	15-18
11371[c]	Greens Bayou at I59 NW Corner access	1016	15-18	15-18	15-18	15-18	15-18
TBD – 2[b]	Unnamed trib of Halls Bayou at Mouth	1016B	15-18	15-18	15-18	15-18	15-18
11124	Unnamed trib of Greens Bayou	1016C	15-18	15-18	15-18	15-18	15-18
16676	Unnamed trib of Greens Bayou	1016D	15-18	15-18	15-18	15-18	15-18

[a] Field parameters include temperature, DO, pH, conductivity, and flow severity

[b] TBD- to be defined following submittal of Station Location request form (SLOC). A SLOC request has been submitted to the TCEQ.

[c] Site selected in place of 15438 due to accessibility difficulty with 15438.

4.2.2 Flow Measurements

While flow data for a number of USGS gages throughout the study area are available, there are no flow data available for the twenty-one stations sampled during the intensive surveys. The only exception is station 11132, however, recent flow data were not available for this station as well. Thus, during water sample collection for EC, flow and velocity measurements were made for all the stations included in the project sampling plan as listed in Table 3.1 (or as close to the sample location as possible taking into account stream access and sampling crew safety).

CHAPTER 5

QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC)

The quality assurance/quality control report for the gathered data is included in Appendix B.

CHAPTER 6

SAMPLING RESULTS

A total of three intensive surveys were conducted during the period from May 06 through July 06 to collect flow and *E.coli* data at 21 locations.

6.1 INTENSIVE SURVEY # 1

The first intensive survey could not be classified as a dry weather event because rainfall occurred on May 14, 06 prior to the sampling event. The magnitude and distribution of the rainfall over a period of one day at each of the rain gage stations were statistically analyzed to estimate rainfall over the entire area (Fig. 6.1). The accumulation of rainfall on subsequent days was close to zero. As can be seen in Fig. 6.1, most of the rain was experienced by parts of Eastern Houston, Greens Bayou, and Halls Bayou where rainfall ranged from trace amounts to 1.1 inches (Table 6.1). The observations for *E.coli* and TSS measured at each of stations are summarized in Table 6.2.

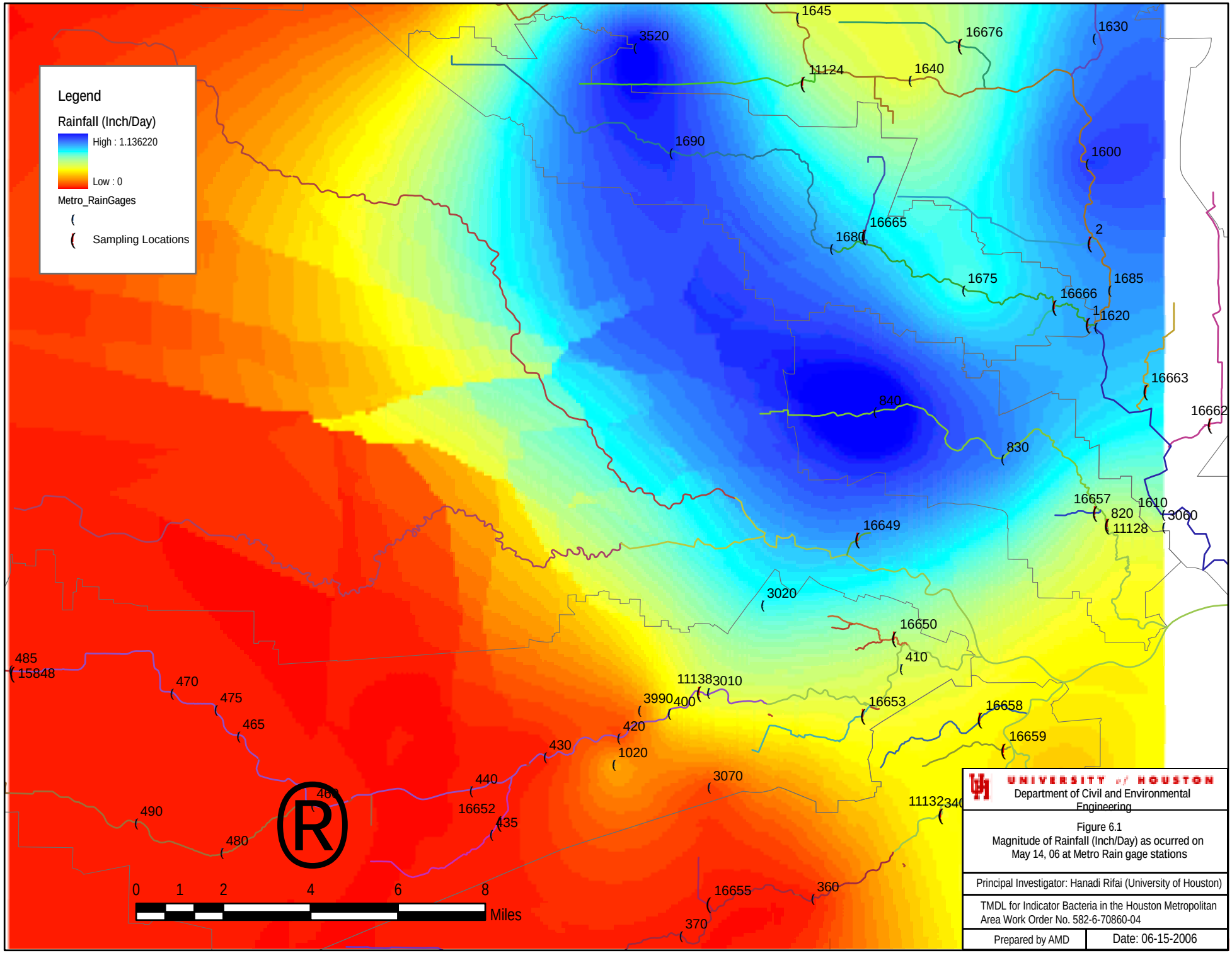

Legend
Rainfall (Inch/Day)
High : 1.136220
Low : 0
Metro_RainGages
Sampling Locations
1645
3520
16676
1630
11124
1640
1690
1600
16665
1680
2
1675
1685
16666
1
1620
16663
840
16662
830
16657
1610
820
3060
11128
16649
3020
16650
410
485
15848
470
11138
3010
475
3990
400
16653
16658
465
420
16659
430
1020
3070
440
460
16652
435
490
480
11132
340
16655
360
370
0 1 2 4 6 8
Miles
UNIVERSITY of HOUSTON
Department of Civil and Environmental Engineering
Figure 6.1
Magnitude of Rainfall (Inch/Day) as ocurred on May 14, 06 at Metro Rain gage stations
Principal Investigator: Hanadi Rifai (University of Houston)
TMDL for Indicator Bacteria in the Houston Metropolitan Area Work Order No. 582-6-70860-04
Prepared by AMD
Date: 06-15-2006

Table 6.1 Rainfall Magnitude on May 14, 06 during Intensive Survey #1

GAGE NAME	Gage ID	Rainfall Magnitude (Inch)
C106 Berry Bayou @ Nevada	310	0.51
C106 Berry Bayou @ Forest	320	0.16
C100 Sims Bayou @ Telephone	340	0.35
C100 Sims Bayou @ Martin	360	0.00
C100 Sims Bayou @ SH-288	370	0.00
C100 Sims Bayou @ Hiram-C	380	0.00
D109 Harris Gulley @ S. M	400	0.31
D100 Brays Bayou @ Lawndale	410	0.43
D100 Brays Bayou @ South	420	0.04
D100 Brays Bayou @ Stella	430	0.00
D100 Willow Watering Hole	435	0.00
D100 Brays Bayou @ Rice	440	0.00
D100 Brays Bayou @ Gessner	460	0.00
D100 Brays Bayou @ Beltway	465	0.00
D100 Brays Bayou @ Belle	470	0.00
D100 Brays Bayou @ Bellaire	475	0.00
D118 Keegans Bayou @ Roar	480	0.00
D100 Brays Bayou @ SH 6	485	0.00
D118 Keegans Bayou @ Keegans	490	0.00
H100 Hunting Bayou @ IH-1	820	0.43
H100 Hunting Bayou @ Loop	830	0.87
H100 Hunting Bayou @ Lock	840	1.14
Reliant Park	1020	0.20
P100 Greens Bayou @ Mt. H	1600	0.98
P100 Greens Bayou @ Norma	1610	0.55
P100 Greens Bayou @ Ley Rd	1620	0.83
P130 Garners Bayou @ Belt	1630	0.87
P100 Greens Bayou @ US-59	1640	0.39
P100 Greens Bayou @ Beltway	1645	0.43
P130 Garners @ Rankin Rd	1650	0.39
P100 Greens Bayou @ Knobc	1660	0.55
P100 Greens Bayou @ Bamme	1665	0.04
P100 Greens Bayou @ Cutter	1670	0.04
P118 Halls Bayou @ Tidwell	1675	0.63
P118 Halls Bayou @ Jensen	1680	0.83
P100 Greens Bayou @ Tidwell	1685	0.83
P118 Halls Bayou @ Airline	1690	0.98
SH 288 @ MacGregor	3010	0.43
IH 45 S HOV @ DwT Terminus	3020	0.67
Galveston Rd @ Allendale	3030	0.24
IH 10 @ Normandy	3060	0.43
SH 288 @ Loop 610	3070	0.04
IH 45 W Road HOV Entrance	3520	1.10
Metro Rail @ Fannin	3990	0.12
Brazos River @ SH 36	4310	…..

A YSI 6920 multiparameter probe (YSI, Inc., Yellow Springs, Ohio) was used for measurement of field parameters, such as temperature, specific conductance, pH, dissolved oxygen and turbidity. The instrument was calibrated prior to use each day to ensure accurate and valid measurements. Table 6.3 depicts the YSI readings measured each day of the Intensive Survey # 1. For station 16649, standing water was sampled since there was no observable flow in the bayou. Conditions of no detectable flow represent a critical condition especially in the development of load duration because loads cannot be calculated. In addition, stations such as 16676, TBD # 2, 16666, 16652, 16655, 16659, and 16657 have flow values in the range of 0.01cfs to 3 cfs.

Table 6.2 *E.coli* , TSS and Flow Data from Intensive Survey # 1

Watershed	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	*Flow (cfs)*	*TSS*
GREENS BAYOU	1016C	5/15/2006	11124	8:55	13905	5.20	8.8
		5/16/2006		8:45	1519	1.56	4.4
		5/17/2006		14:40	1497	1.13	30.4
		5/18/2006		8:50	1523	0.47	<4.0
		5/18/2006		17:44	1877	0.85	4.4
		5/19/2006		14:45	1195	1.50	<4.0
	1016D	5/15/2006	16676	9:55	12640	1.33	7.6
		5/16/2006		9:29	4413	0.36	<4.0
		5/17/2006		15:15	1316	0.31	5.6
		5/18/2006		9:31	196	0.11	<4.0
		5/18/2006		18:14	155	0.41	<4.0
		5/19/2006		15:20	118	0.83	<4.0
	1016	5/15/2006	11371	10:35	24385	87.5	72
		5/16/2006		10:00	20435	32.4	23.6
		5/17/2006		13:30	554	26.0	57.6
		5/18/2006		10:10	398	20.9	25.6
		5/19/2006		8:12	186	27.0	24.4
		5/19/2006		15:40	95	24.1	18
	1016B	5/15/2006	TBD # 2	12:15	46390	0.44	12.8
		5/16/2006		11:02	702	-0.02	<4.0
		5/16/2006		17:01	458	0.10	<4.0
		5/17/2006		12:50	475	0.10	4
		5/18/2006		11:23	140	0.04	4.4
		5/19/2006		9:43	144	0.07	<4.0
HALLS BAYOU	1006J	5/15/2006	16665	11:40	42895	2.96	11.6
		5/16/2006		10:28	1235	1.44	<4.0
		5/17/2006		15:45	1440	0.14	<4.0
		5/18/2006		10:47	670	0.12	<4.0
		5/19/2006		9:13	823	0.07	4
		5/19/2006		16:16	1009	0.04	4.4
	1006D	5/15/2006	TBD # 1	13:25	89840	64.2	29.2
		5/16/2006		11:58	1646	26.1	7.6
		5/16/2006		18:01	811	24.4	9.6
		5/17/2006		11:05	1045	15.8	123
		5/18/2006		12:10	112	12.1	8
		5/19/2006		10:26	88	13.2	6
	1006I	5/15/2006	16666	12:45	98350	0.08	44.4
		5/16/2006		11:28	1537	0.01	8.8
		5/16/2006		17:46	472	0.01	<4.0
		5/17/2006		11:27	1035	0.00	4
		5/18/2006		11:45	1194	-0.02	4.4
		5/19/2006		10:05	384	-0.03	4.4

Table 6.2 *E.coli* , TSS and Flow Data from Intensive Survey # 1 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	*Flow (cfs)*	*TSS*
BRAYS BAYOU	1007P	5/15/2006	15848	9:10	649	3.72	63.2
		5/16/2006		9:10	368	8.05	83.2
		5/17/2006		12:30	157	10.51	37.2
		5/18/2006		12:15	106	2.51	34.8
		5/18/2006		17:45	323	4.97	32
		5/19/2006		8:55	491	2.99	50.4
	1007E	5/15/2006	16652	9:55	986	0.06	9.6
		5/16/2006		10:00	2795	0.07	8
		5/17/2006		11:50	777	0.84	4.8
		5/17/2006		18:45	578	0.78	<4.0
		5/18/2006		13:00	676	0.57	6
		5/19/2006		9:55	1636	0.97	<4.0
	1007B	5/15/2006	11138	15:30	4748	60.3	24
		5/16/2006		14:15	1029	104.7	26.8
		5/16/2006		17:55	1096	115.3	26
		5/17/2006		15:05	2004	107.0	26.8
		5/18/2006		15:45	704	111.5	19.6
		5/19/2006		11:05	4310	169.7	26
SIMS BAYOU	1007N	5/15/2006	16655	10:45	576	0.51	26.8
		5/16/2006		10:40	380	0.94	42.8
		5/17/2006		11:12	491	0.25	15.2
		5/17/2006		17:35	83	1.15	12.4
		5/18/2006		14:10	71	0.42	16.4
		5/19/2006		10:20	278	0.04	13.6
	1007	5/15/2006	11132	13:10	809	17.2	72
		5/16/2006		11:15	650	3.55	57.6
		5/17/2006		9:25	488	-6.15	69.2
		5/17/2006		16:55	366	67.1	57.6
		5/18/2006		15:00	466	61.7	64.8
		5/18/2006		18:55	441	44.9	68

Table 6.2 *E.coli* , TSS and Flow Data from Intensive Survey # 1 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	*Flow (cfs)*	*TSS*
EASTERN HOUSTON WATERSHED	1007H	5/15/2006	16659	14:04	92080	0.02	7.6
		5/16/2006		12:05	1106	0.80	<4.0
		5/17/2006		10:35	947	-0.05	4
		5/17/2006		16:15	613	0.30	<4.0
		5/18/2006		8:35	650	0.11	<4.0
		5/19/2006		13:30	411	-0.03	<4.0
	1007I	5/15/2006	16658	14:35	>241960	1.20	85.6
		5/16/2006		12:25	>241960	1.72	8.8
		5/16/2006		17:00	30745	1.50	6.8
		5/17/2006		15:50	13115	1.02	<4.0
		5/18/2006		9:20	6665	0.31	7.6
		5/19/2006		13:55	5310	taken	45.6
	1007G	5/15/2006	16653	16:16	141360	0.69	6.8
		5/16/2006		15:00	7685	1.72	<4.0
		5/16/2006		17:25	5465	1.27	<4.0
		5/17/2006		14:35	600	0.98	<4.0
		5/18/2006		16:20	549	0.95	<4.0
		5/19/2006		12:35	436	0.59	<4.0
	1007K	5/15/2006	16650	16:59	>241960	No consistent	13.2
		5/16/2006		15:40	8190	2.13	13.2
		5/16/2006		18:45	4695	7.51	10.8
		5/17/2006		14:10	2274	3.90	11.2
		5/18/2006		10:10	5675	1.07	<4.0
		5/19/2006		14:25	10960	0.94	14.8

Table 6.2 *E.coli*, TSS and Flow Data from Intensive Survey # 1 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	*Flow (cfs)*	*TSS*
EASTERN HOUSTON WATERSHED	1007O	5/15/2006	16649	17:50	>241960	0.00	21.6
		5/16/2006		15:40	26845	0.39	4.8
		5/17/2006		8:15	13450	0.27	<4.0
		5/18/2006		11:05	2503	0.00	4
		5/19/2006		8:05	4955	0.00	<4.0
		5/19/2006		15:10	3880	0.00	<4.0
	1006H	5/15/2006	16663	15:25	10430	6.86	13.2
		5/16/2006		13:50	407	2.50	4.8
		5/17/2006		10:05	151	0.52	5.2
		5/17/2006		16:48	428	1.94	6
		5/18/2006		16:32	97	2.00	<4.0
		5/19/2006		11:11	96	1.32	4
	1006F	5/15/2006	16662	16:25	7580	3.58	12.8
		5/16/2006		14:20	521	0.82	6.8
		5/17/2006		9:40	269	0.60	9.6
		5/17/2006		17:22	621	0.18	38.4
		5/18/2006		15:34	51	0.19	12.8
		5/19/2006		12:00	80	0.23	<4.0
	1007M	5/15/2006	16657	17:35	1656	0.88	13.2
		5/16/2006		15:15	112	0.16	10
		5/17/2006		8:35	169	0.10	22.4
		5/17/2006		18:20	48	0.05	11.2
		5/18/2006		13:10	28	0.02	8.8
		5/19/2006		12:31	16	0.01	10
	1007R	5/15/2006	11128	17:05	71	33.8	16
		5/16/2006		14:48	4	20.2	7.6
		5/17/2006		9:05	2	24.5	<4.0
		5/17/2006		17:59	5	23.2	7.6
		5/18/2006		14:35	3	25.2	7.2
		5/19/2006		13:11	9	21.2	7.2

Legend for the Field Measurements and E.coli Data Tables

Color	Description
	Precision Criteria for EC Failed
	Holding times for EC Not met
	TSS Field Duplicate Criteria Failed
	EC Field Duplicate Criteria Failed

Table 6.3 Field parameters recorded during Metro Intensive # 1

Watershed	SEGMENT ID	DATE	SITE ID	TIME	TEMP	COND	SAL	TURB
GREENS BAYOU	1016C	5/15/2006	11124	8:55	20.74	244	0.12	10.5
		5/16/2006		8:45	19.17	580	0.28	…..
		5/17/2006		14:40	23.36	337	0.16	3.4
		5/18/2006		8:50	21.46	319	0.15	5.6
		5/18/2006		17:44	25.01	353	0.17	3.4
		5/19/2006		14:45	26.49	456	0.22	2.8
	1016D	5/15/2006	16676	9:55	22.09	188	0.09	12.3
		5/16/2006		9:29	26.83	656	0.32	…..
		5/17/2006		15:15	22.36	565	0.27	0.1
		5/18/2006		9:31	20.94	535	0.26	2.0
		5/18/2006		18:14	24.51	550	0.27	1.4
		5/19/2006		15:20	25.38	650	0.31	0.3
	1016	5/15/2006	11371	10:35	22.52	309	0.15	47.1
		5/16/2006		10:00	22.98	505	0.24	….
		5/17/2006		13:30	25.69	631	0.3	31.0
		5/18/2006		10:10	24.42	611	0.3	25.9
		5/19/2006		8:12	26.13	785	0.38	21.8
		5/19/2006		15:40	30.19	792	0.38	24.0
	1016B	5/15/2006	TBD # 2	12:15	22.86	262	0.12	16.3
		5/16/2006		11:02	32.75	223	0.1	…..
		5/16/2006		17:01	21.70	378	0.18	…..
		5/17/2006		12:50	23.67	377	0.18	4.7
		5/18/2006		11:23	24.00	379	0.16	5.0
		5/19/2006		9:43	22.89	414	0.2	4.4
HALLS BAYOU	1006J	5/15/2006	16665	11:40	21.92	321	0.15	15.1
		5/16/2006		10:28	21.73	554	0.27	
		5/17/2006		15:45	25.93	678	0.33	3.7
		5/18/2006		10:47	20.58	499	0.24	3.2
		5/19/2006		9:13	22.63	595	0.29	2.3
		5/19/2006		16:16	26.05	755	0.37	2.5
	1006D	5/15/2006	TBD # 1	13:25	24.16	322	0.15	26.1
		5/16/2006		11:58	22.63	137	0.06	…..
		5/16/2006		18:01	25.52	491	0.24	…..
		5/17/2006		11:05	24.12	543	0.26	11.7
		5/18/2006		12:10	26.50	523	0.24	10.6
		5/19/2006		10:26	26.45	666	0.32	7.3
	1006I	5/15/2006	16666	12:45	22.86	603	0.29	61.6
		5/16/2006		11:28	19.71	829	0.41	…..
		5/16/2006		17:46	20.98	922	0.46	…..
		5/17/2006		11:27	19.45	1010	0.5	10.4
		5/18/2006		11:45	20.10	1005	0.5	6.2
		5/19/2006		10:05	22.58	1368	0.68	29.1

Table 6.3 Field parameters recorded during Metro Intensive # 1 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	TEMP	COND	SAL	TURB
BRAYS BAYOU	1007P	5/15/2006	15848	9:10	23.40	891	0.44	41.8
		5/16/2006		9:10	22.46	720	0.35	55.5
		5/17/2006		12:30	25.87	835	0.41	36.5
		5/18/2006		12:15	26.27	779	0.38	26.0
		5/18/2006		17:45	32.40	732	0.35	37.1
		5/19/2006		8:55	25.05	858	0.42	54.4
	1007E	5/15/2006	16652	9:55	23.82	931	0.46	0.5
		5/16/2006		10:00	22.90	752	0.37	2.3
		5/17/2006		11:50	29.82	775	0.37	2.6
		5/17/2006		18:45	25.73	752	0.37	2.3
		5/18/2006		13:00	35.02	638	0.3	9.1
		5/19/2006		9:55	26.10	827	0.4	15.1
	1007B	5/15/2006	11138	15:30	29.19	786	0.38	17.0
		5/16/2006		14:15	27.93	744	0.36	19.3
		5/16/2006		17:55	28.34	740	0.36	23.0
		5/17/2006		15:05	29.88	856	0.42	31.9
		5/18/2006		15:45	31.73	760	0.37	15.9
		5/19/2006		11:05	28.46	815	0.41	19.4
SIMS BAYOU	1007N	5/15/2006	16655	10:45	23.26	852	0.42	27.6
		5/16/2006		10:40	22.14	800	0.39	20.9
		5/17/2006		11:12	21.64	981	0.48	23.4
		5/17/2006		17:35	26.46	969	0.47	16.5
		5/18/2006		14:10	24.08	847	0.41	14.1
		5/19/2006		10:20	25.33	955	0.47	20.3
	1007	5/15/2006	11132	13:10	25.49	893	0.44	58.2
		5/16/2006		11:15	25.04	859	0.42	56.6
		5/17/2006		9:25	23.66	991	0.49	55.6
		5/17/2006		16:55	28.43	984	0.48	86.8
		5/18/2006		15:00	28.99	881	0.43	78.8
		5/18/2006		18:55	29.41	863	0.42	62.7

Table 6.3 Field parameters recorded during Metro Intensive # 1 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	TEMP	COND	SAL	TURB
EASTERN HOUSTON WATERSHED	1007H	5/15/2006	16659	14:04	23.83	294	0.14	10.3
		5/16/2006		12:05	22.58	350	0.17	2.1
		5/17/2006		10:35	21.01	503	0.24	7.1
		5/17/2006		16:15	24.85	518	0.25	26.1
		5/18/2006		8:35	21.52	477	0.32	5.2
		5/19/2006		13:30	25.73	553	0.27	5.1
	1007I	5/15/2006	16658	14:35	24.32	227	0.11	17.3
		5/16/2006		12:25	21.39	374	0.18	5.3
		5/16/2006		17:00	22.86	270	0.13	10.0
		5/17/2006		15:50	21.85	402	0.19	5.6
		5/18/2006		9:20	22.51	404	0.19	3.7
		5/19/2006		13:55	24.75	490	0.24	26.2
	1007G	5/15/2006	16653	16:16	25.21	276	0.13	7.6
		5/16/2006		15:00	…..	…..	…..	1.2
		5/16/2006		17:25	24.54	284	0.14	3.6
		5/17/2006		14:35	23.93	456	0.22	2.6
		5/18/2006		16:20	25.18	465	0.22	2.0
		5/19/2006		12:35	24.94	529	0.25	2.0
	1007K	5/15/2006	16650	16:59	27.07	226	0.11	13.9
		5/16/2006		15:40	25.78	246	0.12	11.2
		5/16/2006		18:45	25.67	254	0.12	13.9
		5/17/2006		14:10	26.49	411	0.2	15.9
		5/18/2006		10:10	22.82	473	0.23	4.6
		5/19/2006		14:25	29.62	585	0.28	26.2

Table 6.3 Field parameters recorded during Metro Intensive # 1 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	TEMP	COND	SAL	TURB
EASTERN HOUSTON WATERSHED	1007O	5/15/2006	16649	17:50	22.06	123	0.06	58.1
		5/16/2006		15:40	…..	…..	…..	…..
		5/17/2006		8:15	21.90	228	0.11	2.6
		5/18/2006		11:05	24.06	329	0.16	3.8
		5/19/2006		8:05	22.25	595	0.29	2.3
		5/19/2006		15:10	27.94	389	0.18	2.0
	1006H	5/15/2006	16663	15:25	23.85	710	0.35	13.3
		5/16/2006		13:50	23.56	710	0.35	…..
		5/17/2006		10:05	22.25	719	0.35	6.3
		5/17/2006		16:48	25.17	545	0.26	4.3
		5/18/2006		16:32	23.81	471	0.235	9.0
		5/19/2006		11:11	23.44	510	0.25	3.0
	1006F	5/15/2006	16662	16:25	25.08	307	0.15	4.2
		5/16/2006		14:20	22.09	57	0.03	…..
		5/17/2006		9:40	21.95	500	0.24	31.7
		5/17/2006		17:22	29.03	537	0.26	12.3
		5/18/2006		15:34	…..	416	0.2	6.7
		5/19/2006		12:00	29.60	601	0.29	3.1
	1007M	5/15/2006	16657	17:35	26.63	307	0.15	13.1
		5/16/2006		15:15	22.09	57	0.03	…..
		5/17/2006		8:35	22.04	495	0.24	14.7
		5/17/2006		18:20	29.14	529	0.25	13.1
		5/18/2006		13:10	28.50	521	0.25	0.6
		5/19/2006		12:31	29.12	670	0.32	23.1
	1007R	5/15/2006	11128	17:05	25.93	437	0.21	16.8
		5/16/2006		14:48	22.09	57	0.03	…..
		5/17/2006		9:05	22.73	587	0.28	2.8
		5/17/2006		17:59	26.98	595	0.29	4.3
		5/18/2006		14:35	26.53	495	0.24	5.2
		5/19/2006		13:11	26.84	585	0.28	4.7

The YSI probe reported unreasonably high DO concentrations and pH values. These data are not included in the Table.

Units		
TURB	Turbidity	NTU
SAL	Salinity	ppt
COND	Conductivity	uS/cm
TEMP	Temperature	^{o}C

6.2 INTENSIVE SURVEY # 2

The sampling event was considered a wet weather event since the majority of the Houston Metro area experienced accumulations ranging from 0.4 to 1.8 inches beginning the first day of sampling. The rainfall totals over a 24 hr period for rain gages within the Houston Metro area are summarized in Table 6.4. It can be observed that most of the rain gages within the watershed exhibited precipitation greater than 1 inch on the second day and increasing to greater than 2 inches on the third day. Each of the twenty-one locations was sampled 6 times during the event for *E.coli* and flow. The *E.coli* concentrations, flow and total suspended solids (TSS) measured at each station are summarized in Table 6.5. Table 6.6 depicts the YSI readings measured each day of the second intensive survey.

Table 6.4 Rainfall Totals over a 24 period during Intensive Survey # 2

GAGE NAME	Rain Gage ID	Rainfall Totals for a 24 hr period (inch)					
		06/16/06	06/17/06	06/18/06	06/19/06	06/20/06	06/21/06
C106 Berry Bayou @ Nevada	310	0.04	1.22	2.56	9.84	0.35	0.00
C106 Berry Bayou @ Forest	320	0.04	1.06	2.64	7.99	0.28	0.00
C100 Sims Bayou @ Telephone	340	0.00	0.71	1.06	10.67	0.39	0.00
C100 Sims Bayou @ Martin	360	0.12	1.38	1.65	6.93	0.20	0.00
C100 Sims Bayou @ SH-288	370	0.12	2.44	1.10	3.86	0.39	0.00
C100 Sims Bayou @ Hiram-C	380	0.08	1.97	0.98	1.81	0.35	0.00
D109 Harris Gulley @ S. M	400	0.04	2.09	0.63	3.03	0.16	0.00
D100 Brays Bayou @ Lawnda	410	0.00	1.18	1.50	7.52	0.16	0.00
D100 Brays Bayou @ South	420	0.12	0.98	0.51	2.44	0.04	0.04
D100 Brays Bayou @ Stella	430	0.04	1.02	0.12	2.32	0.31	0.04
D100 Willow Watering Hole	435	0.08	0.71	0.20	0.63	0.47	0.00
D100 Brays Bayou @ Rice	440	0.08	0.51	0.08	0.04	0.16	0.00
D100 Brays Bayou @ Gessner	460	0.00	0.31	0.24	0.51	0.91	0.00
D100 Brays Bayou @ Beltway	465	0.00	0.98	0.28	0.71	1.06	0.00
D100 Brays Bayou @ Belle	470	0.00	1.10	0.75	0.83	1.02	0.00
D100 Brays Bayou @ Bellaire	475	0.00	0.87	0.39	0.67	0.79	0.00
D118 Keegans Bayou @ Roar	480	0.00	0.67	0.43	0.28	0.79	0.00
D100 Brays Bayou @ SH 6	485	0.00	1.38	0.51	0.91	1.18	0.00
D118 Keegans Bayou @ Keegans	490	0.00	1.30	0.43	0.28	0.67	0.00
H100 Hunting Bayou @ IH-1	820	0.00	0.87	1.89	6.02	0.59	0.00
H100 Hunting Bayou @ Loop	830	0.00	0.91	1.50	3.62	0.39	0.00
H100 Hunting Bayou @ Lock	840	0.00	2.28	1.34	5.08	0.31	0.00
Reliant Park	1020	0.08	1.14	0.39	2.99	0.31	0.00
P100 Greens Bayou @ Mt. H	1600	0.00	2.32	2.52	6.10	0.59	0.04
P100 Greens Bayou @ Norma	1610	0.00	1.06	1.73	6.89	0.79	0.04
P100 Greens Bayou @ Ley R	1620	0.00	1.85	2.13	6.93	0.51	0.00
P130 Garners Bayou @ Belt	1630	0.00	1.50	1.93	4.06	0.16	0.00
P100 Greens Bayou @ US-59	1640	0.00	1.14	0.59	3.74	0.47	0.00
P100 Greens Bayou @ Beltway	1645	0.00	1.50	0.75	7.68	0.28	0.00
P130 Garners @ Rankin Rd	1650	0.00	0.75	1.06	2.17	0.20	0.00
P100 Greens Bayou @ Knobc	1660	0.00	0.83	0.71	2.44	0.12	0.00
P100 Greens Bayou @ Bamme	1665	0.16	1.22	0.75	4.41	0.51	0.00
P100 Greens Bayou @ Cutte	1670	0.28	1.42	1.14	4.17	0.28	0.00
P118 Halls Bayou @ Tidwell	1675	0.00	1.73	1.73	4.88	0.43	0.00
P118 Halls Bayou @ Jensen	1680	0.00	1.02	0.24	2.28	0.08	0.00
P100 Greens Bayou @ Tidwel	1685	0.00	2.13	2.01	8.03	0.51	0.00
P118 Halls Bayou @ Airline	1690	0.00	1.93	0.63	4.09	0.12	0.08
SH 288 @ MacGregor	3010	0.12	2.56	0.83	4.06	0.24	0.00
IH 45 S HOV @ DwT Terminus	3020	0.20	2.64	1.57	4.37	0.12	0.00
Galveston Rd @ Allendale	3030	0.04	1.14	2.68	12.95	0.28	0.00
IH 10 @ Normandy	3060	0.00	0.91	2.09	7.05	0.91	0.00
SH 288 @ Loop 610	3070	0.04	2.60	0.63	5.24	0.24	0.00
IH 45 W Road HOV Entrance	3520	0.00	1.22	0.79	3.31	0.12	0.00
Metro Rail @ Fannin	3990	0.08	1.38	0.51	3.43	0.35	0.00
Brazos River @ SH 36	4310	1.06	0.00	0.04	2.72	1.42	0.00

Table 6.5 *E.coli*, TSS and Flow Data from Intensive Survey # 2

Watershed	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	Flow (cfs)	TSS
GREENS BAYOU	1016C	6/18/2006	11124	10:00	9840	55.86	70.8
		6/18/2006		15:30	10010	18.36	10
		6/21/2006		8:30	2356	10.47	7.6
		6/21/2006		15:25	1819	7.60	6
		6/22/2006		13:00	936	5.31	96.4
		6/22/2006		16:02	1013	3.27	4.8
	1016D	6/18/2006	16676	10:30	7640	21.69	14.8
		6/18/2006		16:00	4242	10.90	5.6
		6/21/2006		9:40	960	4.12	<4.0
		6/21/2006		16:08	5435	6.07	<4.0
		6/22/2006		12:13	4618	2.06	<4.0
		6/22/2006		15:40	1565	1.41	7.6
	1016	6/17/2006	11371	20:20	21440	36.63	114
		6/18/2006		16:20	10740	96.83	100
		6/21/2006		9:00	696	48.18	48
		6/21/2006		15:50	402	83.59	34.4
		6/22/2006		12:37	409	69.67	32.8
		6/22/2006		15:15	411	45.60	10.8
	1016B	6/17/2006	TBD # 2	19:15	176970	11.22	257
		6/18/2006		17:15	12165	5.28	153
		6/20/2006		18:19	8310	6.66	12.8
		6/21/2006		10:55	648	2.37	28.4
		6/21/2006		17:08	808	2.43	6.4
		6/22/2006		11:20	376	1.77	8
HALLS BAYOU	1006J	6/17/2006	16665	19:45	74855	18.19	18.4
		6/18/2006		16:45	11670	4.88	6
		6/20/2006		17:00	6025	7.37	8.4
		6/21/2006		10:15	957	1.85	<4.0
		6/21/2006		11:45	1690	1.65	<4.0
		6/22/2006		16:45	1968	1.07	<4.0
	1006D	6/17/2006	TBD # 1	17:55	94500	28.75	392
		6/18/2006		18:05	37635	38.87	114
		6/20/2006		17:45	42270	69.92	61.6
		6/21/2006		12:20	7070	62.12	112
		6/21/2006		10:37	744	34.34	43.2
		6/22/2006		18:00	2734	18.90	64.4
	1006I	6/17/2006	16666	18:40	7	1.20	20
		6/18/2006		17:40	92340	0.18	35.6
		6/20/2006		17:20	4612	>1.2	14.4
		6/21/2006		11:30	386	0.64	206
		6/21/2006		17:35	1233	0.09	18
		6/22/2006		11:00	1974	0.03	16.4

Table 6.5 *E.coli*, TSS and Flow Data from Intensive Survey # 2 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	Flow (cfs)	TSS
BRAYS BAYOU	1007P	6/17/2006	15848	17:38	50430	Erroneous flow	177
		6/18/2006		12:55	19745	23.0	44.8
		6/20/2006		1:45	15440	38.6	35.2
		6/21/2006		9:50	1087	13.7	4
		6/21/2006		15:15	531	10.9	18
		6/22/2006		8:35	690	8.9	<4.0
	1007E	6/17/2006	16652	18:35	56515	5.0	9.2
		6/18/2006		14:20	2445	4.1	7.2
		6/20/2006		2:55	19090	14.6	25.2
		6/21/2006		10:30	407	0.4	26.4
		6/21/2006		15:50	116160	0.8	5.2
		6/22/2006		9:25	7933	0.4	19.2
	1007B	6/17/2006	11138	19:35	70685	Depth	474
		6/18/2006		15:20	21945	Incomplete	108
		6/20/2006		18:30	18205	174.3	15.2
		6/21/2006		13:40	2319	180.9	28
		6/21/2006		19:20	4182	168.5	16.8
		6/22/2006		13:05	10990	137.8	56.4
SIMS BAYOU	1007N	6/17/2006	16655	19:05	12210	53.7	133
		6/18/2006		14:55	7495	7.6	37.6
		6/20/2006		15:35	NO READING	10.2	43.2
		6/21/2006		10:56	24196	5.0	27.6
		6/21/2006		16:20	36605	4.5	26.8
		6/22/2006		9:45	62210	3.2	64.8
	1007	6/18/2006	11132	11:55	34785	not precise	111
		6/20/2006		16:05	6875	194.7	117
		6/21/2006		9:15	4805	81.0	9.6
		6/21/2006		11:25	1968	72.5	19.6
		6/21/2006		18:57	4106	67.7	20.8
		6/22/2006		10:25	6405	37.3	<4.0

Table 6.5 *E.coli*, TSS and Flow Data from Intensive Survey # 2 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	Flow (cfs)	TSS
EASTERN HOUSTON WATERSHED	1007H	6/18/2006	16659	11:15	53235	12.47	30.8
		6/20/2006		16:40	17850	2.37	12.4
		6/20/2006		19:03	12750	4.77	23.6
		6/21/2006		11:49	991	1.13	6.8
		6/21/2006		17:15	1043	1.19	8
		6/22/2006		10:50	1052	0.90	<4.0
	1007I	6/18/2006	16658	10:40	64150	75.52	36.4
		6/20/2006		16:55	198630	10.64	30.8
		6/20/2006		19:19	132685	No flow	30
		6/21/2006		12:00	6100	4.05	10.8
		6/21/2006		17:30	3352	1.35	<4.0
		6/22/2006		11:00	5635	0.00	5.6
	1007G	6/17/2006	16653	20:10	48925	11.38	53.6
		6/18/2006		16:05	50730	22.71	26
		6/20/2006		17:55	25490	6.60	40.8
		6/21/2006		13:15	54200	2.04	<4.0
		6/21/2006		18:50	36305	1.46	<4.0
		6/22/2006		12:25	43585	0.84	<4.0
	1007K	6/18/2006	16650	9:30	69160	110.93	54
		6/20/2006		17:25	10735	8.23	12
		6/20/2006		19:35	42270	2.40	10
		6/21/2006		12:20	6350	-1.08	14.4
		6/21/2006		17:50	73975	3.00	<4.0
		6/22/2006		11:25	11990	5.37	8.4

Table 6.5 *E.coli*, TSS and Flow Data from Intensive Survey # 2 - Cont'd

Watershed	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	Flow (cfs)	TSS
EASTERN HOUSTON WATERSHED	1007O	6/18/2006	16649	9:56	61710	11.055	42
		6/20/2006		13:20	18370	0.43	19.2
		6/21/2006		8:25	7905	0	35.2
		6/21/2006		12:52	8835	No flow	23.6
		6/21/2006		18:15	5160	No flow	5.2
		6/22/2006		12:10	5982	No flow	6.4
	1006H	6/18/2006	16663	11:45	25065	52.0	118
		6/18/2006		18:45	11245	45.0	38
		6/20/2006		16:30	1238	15.9	60.8
		6/21/2006		12:50	565	5.86	43.2
		6/21/2006		18:40	293	9.19	40.8
		6/22/2006		10:00	378	4.29	24.8
	1006F	6/18/2006	16662	12:30	17005	49.7	72.4
		6/18/2006		19:25	8665	42.2	90
		6/20/2006		16:05	5971	31.2	40.8
		6/21/2006		13:15	505	21.6	14.8
		6/21/2006		19:03	1456	2.56	28.8
		6/22/2006		9:15	602	6.93	14.8
	1007M	6/18/2006	16657	13:30	33650	10.5	37.2
		6/20/2006		14:40	5550	10.5	14.8
		6/21/2006		14:45	1213	23.3	9.2
		6/22/2006		8:25	1235	1.42	18.4
		6/22/2006		13:40	1248	1.09	4
		6/22/2006		16:45	1107	0.91	21.2
	1007R	6/18/2006	11128	13:05	30050	52.2	72.4
		6/20/2006		14:55	5420	47.2	42.8
		6/21/2006		14:25	575	42.4	31.6
		6/21/2006		19:35	1000	57.5	18
		6/22/2006		8:52	494	24.6	17.2
		6/22/2006		14:49	441	53.9	18.8

Legend for the Field Measurements and E.coli Data Tables

Color	Description
	Precision Criteria for EC Failed
	Holding times for EC Not met
	TSS Field Duplicate Criteria Failed
	EC Field Duplicate Criteria Failed

Table 6.6 Field parameters recorded during Metro Intensive # 2

WATERSHED	SEGMENT ID	DATE	SITE ID	TIME	TEMP	COND	SAL	TURB
GREENS BAYOU	1016C	6/18/2006	11124	10:00	24.88	210	0.1	49.0
		6/18/2006		15:30	27.33	251	0.12	11.3
		6/21/2006		8:30	25.62	292	0.17	7.9
		6/21/2006		15:25	28.73	312	0.14	4.9
		6/22/2006		13:00	28.75	326	0.15	5.6
		6/22/2006		16:02	29.38	316	0.15	4.6
	1016D	6/18/2006	16676	10:30	25.09	162	0.08	14.9
		6/18/2006		16:00	27.91	194	0.09	10.8
		6/21/2006		9:40	26.40	232	0.11	5.6
		6/21/2006		16:08	29.08	241	0.11	4.6
		6/22/2006		12:13	28.41	301	0.14	3.0
		6/22/2006		15:40	28.78	323	0.15	3.0
	1016	6/17/2006	11371	20:20	25.29	215	0.1	145.7
		6/18/2006		16:20	26.98	190	0.09	81.4
		6/21/2006		9:00	25.68	228	0.11	45.6
		6/21/2006		15:50	29.57	251	0.12	53.4
		6/22/2006		12:37	29.51	350	0.16	52.3
		6/22/2006		15:15	30.47	354	0.17	47.9
	1016B	6/17/2006	TBD # 2	19:15	25.01	166	0.08	203.7
		6/18/2006		17:15	28.58	241	0.11	144.0
		6/20/2006		18:19	26.82	234	0.11	10.3
		6/21/2006		10:55	26.67	568	0.27	11.3
		6/21/2006		17:08	28.71	638	0.31	89.0
		6/22/2006		11:20	29.22	878	0.43	8.6
HALLS BAYOU	1006J	6/17/2006	16665	19:45	25.33	158	0.7	22.8
		6/18/2006		16:45	28.01	197	0.09	10.8
		6/20/2006		17:00	27.27	415	0.2	5.5
		6/21/2006		10:15	29.06	523	0.25	2.3
		6/21/2006		11:45	25.82	498	0.24	4.2
		6/22/2006		16:45	27.70	556	0.27	1.4
	1006D	6/17/2006	TBD # 1	17:55	24.78	226	0.11	290.0
		6/18/2006		18:05	27.81	271	0.13	84.4
		6/20/2006		17:45	26.09	226	0.11	121.3
		6/21/2006		12:20	27.32	325	0.15	95.7
		6/21/2006		10:37	28.37	398	0.19	46.0
		6/22/2006		18:00	29.57	347	0.16	71.3
	1006I	6/17/2006	16666	18:40	23.73	134	0.06	45.5
		6/18/2006		17:40	27.47	259	0.12	46.5
		6/20/2006		17:20	25.13	174	0.08	21.6
		6/21/2006		11:30	26.57	868	0.32	193.6
		6/21/2006		17:35	27.96	828	0.4	14.6
		6/22/2006		11:00	26.40	1232	0.61	9.3

Table 6.6 Field parameters recorded during Metro Intensive # 2 - Cont'd

WATERSHED	SEGMENT ID	DATE	SITE ID	TIME	TEMP	COND	SAL	TURB
BRAYS BAYOU	1007P	6/17/2006	15848	17:38	26.65	310	0.15	166.0
		6/18/2006		12:55	28.56	846	0.41	24.6
		6/20/2006		1:45	27.41	354	0.17	21.8
		6/21/2006		9:50	27.60	558	0.27	18.0
		6/21/2006		15:15	32.96	1025	0.5	17.9
		6/22/2006		8:35	27.53	752	0.36	21.3
	1007E	6/17/2006	16652	18:35	28.62	339	0.16	13.6
		6/18/2006		14:20	32.13	816	0.39	11.3
		6/20/2006		2:55	27.15	256	0.12	18.1
		6/21/2006		10:30	30.46	341	0.16	7.1
		6/21/2006		15:50	36.07	620	0.33	19.9
		6/22/2006		9:25	27.99	396	0.19	7.7
	1007B	6/17/2006	11138	19:35	26.64	349	0.17	330.0
		6/18/2006		15:20	28.16	590	0.28	58.7
		6/20/2006		18:30	27.51	371	0.18	37.4
		6/21/2006		13:40	31.63	645	0.31	17.9
		6/21/2006		19:20	31.26	650	0.31	20.5
		6/22/2006		13:05	31.20	687	0.33	22.8
SIMS BAYOU	1007N	6/17/2006	16655	19:05	25.49	293	0.14	168.0
		6/18/2006		14:55	28.05	672	0.33	41.8
		6/20/2006		15:35	27.35	438	0.21	33.3
		6/21/2006		10:56	27.20	503	0.24	20.4
		6/21/2006		16:20	31.47	910	0.44	20.1
		6/22/2006		9:45	27.54	552	0.26	23.4
	1007	6/18/2006	11132	11:55	24.99	649	0.31	103.1
		6/20/2006		16:05	27.63	456	0.22	89.6
		6/21/2006		9:15	26.92	503	0.24	89.9
		6/21/2006		11:25	27.82	512	0.24	90.5
		6/21/2006		18:57	16.50	720	0.36	74.0
		6/22/2006		10:25	27.00	468	0.22	58.2

Table 6.6 Field parameters recorded during Metro Intensive # 2 - Cont'd

WATERSHED	SEGMENT ID	DATE	SITE ID	TIME	TEMP	COND	SAL	TURB
EASTERN HOUSTON WATERSHED	1007H	6/18/2006	16659	11:15	24.41	605	0.29	31.7
		6/20/2006		16:40	25.70	502	0.24	5.2
		6/20/2006		19:03	25.31	520	0.25	7.9
		6/21/2006		11:49	26.38	579	0.28	7.7
		6/21/2006		17:15	28.09	533	0.26	6.5
		6/22/2006		10:50	27.39	391	0.19	9.4
	1007I	6/18/2006	16658	10:40	24.11	557	0.27	32.2
		6/20/2006		16:55	26.07	406	0.19	30.9
		6/20/2006		19:19	26.36	425	0.2	25.5
		6/21/2006		12:00	26.78	498	0.24	4.8
		6/21/2006		17:30	29.17	546	0.31	4.9
		6/22/2006		11:00	26.56	609	0.29	3.1
	1007G	6/17/2006	16653	20:10	25.48	259	0.12	73.8
		6/18/2006		16:05	26.40	430	0.23	29.1
		6/20/2006		17:55	26.08	463	0.22	33.7
		6/21/2006		13:15	27.31	532	0.26	12.1
		6/21/2006		18:50	28.06	596	0.29	7.5
		6/22/2006		12:25	27.83	532	0.25	3.3
	1007K	6/18/2006	16650	9:30	24.41	440	0.21	32.8
		6/20/2006		17:25	26.20	413	0.2	5.4
		6/20/2006		19:35	26.28	439	0.21	4.1
		6/21/2006		12:20	27.42	526	0.25	8.4
		6/21/2006		17:50	30.55	591	0.28	9.0
		6/22/2006		11:25	26.96	545	0.26	5.8

Table 6.6 Field parameters recorded during Metro Intensive # 2 - Cont'd

WATERSHED	SEGMENT ID	DATE	SITE ID	TIME	TEMP	COND	SAL	TURB
EASTERN HOUSTON WATERSHED	1007O	6/18/2006	16649	9:56	24.22	524	0.25	25.9
		6/20/2006		13:20	25.06	246	0.12	10.9
		6/21/2006		8:25	21.99	331	0.18	4.7
		6/21/2006		12:52	25.27	464	0.22	5.1
		6/21/2006		18:15	25.21	580	0.28	4.4
		6/22/2006		12:10	25.14	394	0.19	3.0
	1006H	6/18/2006	16663	11:45	24.23	184	0.09	123.8
		6/18/2006		18:45	27.62	296	0.14	28.8
		6/20/2006		16:30	26.16	305	0.14	61.6
		6/21/2006		12:50	26.49	453	0.22	65.7
		6/21/2006		18:40	27.94	455	0.22	70.6
		6/22/2006		10:00	27.54	508	0.24	88.9
	1006F	6/18/2006	16662	12:30	24.49	162	0.08	61.7
		6/18/2006		19:25	28.01	216	0.1	89.9
		6/20/2006		16:05	27.02	140	0.06	37.8
		6/21/2006		13:15	27.55	188	0.09	23.3
		6/21/2006		19:03	30.57	197	0.09	72.5
		6/22/2006		9:15	27.63	250	0.12	44.6
	1007M	6/18/2006	16657	13:30	25.51	153	0.07	31.0
		6/20/2006		14:40	26.02	172	0.08	13.6
		6/21/2006		14:45	29.73	281	0.13	9.4
		6/22/2006		8:25	27.74	325	0.15	34.5
		6/22/2006		13:40	30.27	327	0.15	40.9
		6/22/2006		16:45	30.90	338	0.16	34.2
	1007R	6/18/2006	11128	13:05	24.88	175	0.08	947.8
		6/20/2006		14:55	26.13	257	0.12	58.4
		6/21/2006		14:25	28.82	439	0.21	19.2
		6/21/2006		19:35	29.50	434	0.21	14.1
		6/22/2006		8:52	27.79	554	0.27	14.0
		6/22/2006		14:49	29.52	561	0.27	11.6

The YSI probe reported unreasonably high DO concentrations and pH values. These data are not included in the Table.

Units		
TURB	Turbidity	NTU
SAL	Salinity	ppt
COND	Conductivity	uS/cm
TEMP	Temperature	^{o}C

6.3 INTENSIVE SURVEY # 3

The third intensive event was a low flow event due to three days of antecedent dry weather conditions. Each of the 21 locations within the Metro area was sampled 6 times for *E.coli* and flow. The *E.coli* concentrations, flow and total suspended solids (TSS) measured at each station are summarized in Table 6.7. Table 6.8 depicts the YSI readings measured each day of the third intensive survey.

Table 6.7 *E.coli*, Flow and TSS Data from Intensive Survey # 3

WATERSHED	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	*Flow (cfs)*	*TSS*
GREENS BAYOU	1016C	7/17/2006	11124	11:05	424	0.58	<4.0
		7/17/2006		17:25	986	0.65	<4.0
		7/19/2006		11:20	1698	0.64	<4.0
		7/19/2006		16:40	641	0.53	<4.0
		7/20/2006		12:45	1150	0.97	4.4
		7/20/2006		18:15	571	0.72	<4.0
	1016D	7/17/2006	16676	11:25	16355	0.18	<4.0
		7/17/2006		17:50	3189	0.20	<4.0
		7/19/2006		12:10	3096	0.27	<4.0
		7/19/2006		18:10	1011	0.21	<4.0
		7/20/2006		13:08	2255	0.48	<4.0
		7/20/2006		18:35	1378	0.31	<4.0
	1016	7/17/2006	11371	11:45	222	20.54	22
		7/17/2006		18:10	36	13.20	12.4
		7/19/2006		11:55	1329	22.19	14.8
		7/19/2006		18:40	452	10.38	12.8
		7/20/2006		13:24	266	10.93	21.6
		7/21/2006		9:45	452	22.48	4.4
	1016B	7/17/2006	TBD # 2	13:04	28	0.00	4
		7/17/2006		18:50	368	1.10	4.4
		7/19/2006		13:10	54	0.14	10
		7/20/2006		9:55	71	0.23	<4.0
		7/20/2006		14:10	31	0.21	<4.0
		7/21/2006		10:45	63	0.04	4
HALLS BAYOU	1006J	7/17/2006	16665	12:37	1063	0.22	<4.0
		7/17/2006		18:30	260	0.20	<4.0
		7/19/2006		12:50	217	0.39	4
		7/20/2006		9:20	524	0.00	<4.0
		7/20/2006		13:50	525	0.43	4.4
		7/21/2006		10:05	301	0.10	9.4
	1006D	7/18/2006	TBD # 1	9:45	95	4.13	17.6
		7/19/2006		14:03	7	14.39	8
		7/20/2006		10:30	72	10.80	<4.0
		7/20/2006		15:40	64	17.39	8.8
		7/21/2006		11:35	30	9.90	6.4
	1006I	7/17/2006	16666	14:25	560	0.00	153
		7/18/2006		9:30	518	0.00	10
		7/19/2006		13:30	658	0.00	246
		7/20/2006		10:10	473	0.00	10.4
		7/20/2006		15:25	565	0.00	9.2
		7/21/2006		11:08	211	0.00	162

Table 6.7 *E.coli*, Flow and TSS Data from Intensive Survey # 3 – *Cont'd*

WATERSHED	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	*Flow (cfs)*	*TSS*
BRAYS BAYOU	1007P	7/17/2006	15848	10:35	515	5.747818125	29.6
		7/18/2006		10:00	20140	11.812	43.2
		7/19/2006		12:15	5515	10.930625	23.6
		7/20/2006		9:25	898	6.87465	24
		7/20/2006		14:50	715	9.638125	26.8
		7/21/2006			721	3.81256875	32.4
	1007E	7/17/2006	16652	11:25	3551	2.090909091	<4.0
		7/18/2006		10:45	177	0.166002656	<4.0
		7/19/2006		13:10	29	0.68286322	<4.0
		7/20/2006		10:00	328	0.279894907	<4.0
		7/20/2006		15:30	9	0.282627869	<4.0
		7/21/2006			221	0.206650514	< 4.0
	1007B	7/17/2006	11138	12:10	608	measurements	18
		7/19/2006		11:35	18605	177.3	27.2
		7/19/2006		16:50	1508	141.8	16.4
		7/20/2006		13:00	1729	146.9545	21.2
		7/20/2006		18:05	733	131.564	19.2
		7/21/2006		12:55	568	131.042	19.2
SIMS BAYOU	1007N	7/17/2006	16655	11:50	42690	0.101	10.4
		7/18/2006		11:11	9234	0.15675	12
		7/19/2006		1405	817	1.109875	26
		7/20/2006		10:15	551	0.863125	42.8
		7/20/2006		16:00	849	0.90953125	35.2
		7/21/2006		10:45	548	-0.651	41.6
	1007	7/17/2006	11132	14:40	462	7.397745	86.8
		7/19/2006		10:30	7235	142.6852649	134
		7/19/2006		14:40	4030	190.3363492	153
		7/20/2006		11:00	1017	85.03752898	82
		7/20/2006		16:20	984	102.511776	89
		7/21/2006		11:10	845	50.90663875	81.2

Table 6.7 *E.coli,* Flow and TSS Data from Intensive Survey # 3 – *Cont'd*

WATERSHED	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	*Flow (cfs)*	*TSS*
EASTERN HOUSTON WATERSHED	1007H	7/17/2006	16659	15:15	770	0.645333333	<4.0
		7/19/2006		10:00	155310	0.373125	11.6
		7/19/2006		15:15	17125	0.105625	8
		7/20/2006		11:25	4133	0.277	6.4
		7/20/2006		16:45	2618	0.5465625	13.2
		7/21/2006		11:35	796	0.0969375	< 4.0
	1007I	7/17/2006	16658	17:45	1424	1.1	4.4
		7/19/2006		16:55	185965	-0.924	23.6
		7/19/2006		11:50	220295	-2.4	20
		7/20/2006		11:40	>241900.6	4.5	18.4
		7/20/2006		9:45	>241900.6	6.12	18.4
		7/21/2006		15:30	>241900.6	-4.455	23.6
	1007G	7/17/2006	16653	12:35	667	1.12119	<4.0
		7/19/2006		11:00	121335	3.7375	8.8
		7/19/2006		17:10	19830	1.2537	<4.0
		7/20/2006		13:25	4762	1.655625	<4.0
		7/20/2006		18:35	3365	1.43125	<4.0
		7/21/2006		13:25	2207	0.71728125	< 4.0
	1007K	7/17/2006	16650	18:25	12015	1.2718125	17.2
		7/19/2006		15:50	41660	3.267375	4
		7/19/2006		12:00	20640	1.8765625	4
		7/20/2006		17:25	38925	0.6204375	34.4
		7/20/2006		12:10	11450	34.51125	< 4.0
		7/21/2006		9:10	>241900.6	5.1615625	4

Table 6.7 *E.coli,* Flow and TSS Data from Intensive Survey # 3 – *Cont'd*

WATERSHED	SEGMENT ID	DATE	SITE ID	TIME	*E.coli* (MPN/100mL)	*Flow (cfs)*	*TSS*
EASTERN HOUSTON WATERSHED	1007O	7/18/2006	16649	9:15	26180	0	4.8
		7/19/2006		8:45	24860	0	6.8
		7/19/2006		16:15	23725	0	5.6
		7/20/2006		12:31	31785	0	7.2
		7/20/2006		17:45	38730	0	23.2
		7/21/2006		12:30	72840	0	17.2
	1006H	7/17/2006	16663	15:14	61	0.55	<4.0
		7/18/2006		10:35	398	3.42	10.8
		7/19/2006		15:30	78	1.38	10.4
		7/20/2006		11:00	83	2.40	13.6
		7/20/2006		16:10	54	2.40	10
		7/21/2006		12:15	72	1.26	11.2
	1006F	7/17/2006	16662	15:51	570	0.08	6.8
		7/19/2006		9:45	1496	0.36	6
		7/19/2006		16:00	518	0.27	6.4
		7/20/2006		11:38	230	0.16	<4.0
		7/20/2006		16:40	169	0.08	11.6
		7/21/2006		12:40	89	0.36	< 4.0
	1007M	7/17/2006	16657	16:40	75	0.20	16
		7/19/2006		10:55	5850	0.88	10.8
		7/19/2006		17:00	3990	0.43	8.8
		7/20/2006		12:15	2618	0.15	12.8
		7/20/2006		17:40	943	0.14	12.4
		7/21/2006		13:40	376	0.12	16
	1007R	7/17/2006	11128	16:15	27	11.83	16.8
		7/19/2006		10:35	763	10.61	16.4
		7/19/2006		16:35	435	18.51	15.2
		7/20/2006		12:00	59	46.29	12
		7/20/2006		17:20	51	31.00	12.4
		7/21/2006		13:10	39	22.29	17.6

Legend for the Field Measurements and E.coli Data Tables

Color	Description
	Precision Criteria for EC Failed
	Holding times for EC Not met
	TSS Field Duplicate Criteria Failed
	EC Field Duplicate Criteria Failed

Table 6.8 Field parameters recorded during Intensive Survey # 3

WATERSHED	SEGMENT ID	DATE	SITE ID	TEMP	COND	SAL	TURB
GREENS BAYOU	1016C	7/17/2006	11124	29.54	629	0.3	1.3
		7/17/2006		30.41	642	0.31	1.9
		7/19/2006		28.65	498	0.24	5.4
		7/19/2006		29.82	531	0.25	1.8
		7/20/2006		29.16	437	0.21	2.7
		7/20/2006		29.22	420	0.2	7.3
	1016D	7/17/2006	16676	28.38	705	0.34	0.3
		7/17/2006		29.66	756	0.36	2.6
		7/19/2006		27.69	825	0.4	0.6
		7/19/2006		29.20	817	0.4	0.6
		7/20/2006		28.16	491	0.23	1.8
		7/20/2006		29.51	616	0.3	1.6
	1016	7/17/2006	11371	31.66	776	0.37	17.0
		7/17/2006		35.18	765	0.37	14.6
		7/19/2006		31.07	655	0.31	13.0
		7/19/2006		33.38	655	0.31	13.1
		7/20/2006		…..	…..	…..	…..
		7/21/2006		30.55	822	0.4	24.2
	1016B	7/17/2006	TBD # 2	31.73	1122	0.55	10.3
		7/17/2006		30.15	803	0.39	3.9
		7/19/2006		31.64	1505	0.75	3.1
		7/20/2006		29.44	1121	0.55	4.2
		7/20/2006		31.86	1129	0.55	3.5
		7/21/2006		29.81	1555	0.78	1.0
HALLS BAYOU	1006J	7/17/2006	16665	29.25	739	0.36	2.4
		7/17/2006		30.68	743	0.36	2.4
		7/19/2006		28.46	801	0.39	1.5
		7/20/2006		27.16	626	0.3	3.2
		7/20/2006		28.67	547	0.26	2.6
		7/21/2006		27.23	…..	0.12	5.9
	1006D	7/18/2006	TBD # 1	31.09	789	0.38	6.8
		7/19/2006		33.01	784	0.38	7.4
		7/20/2006		29.97	632	0.3	6.5
		7/20/2006		32.86	612	0.29	25.7
		7/21/2006		30.75	665	0.32	8.0
	1006I	7/17/2006	16666	28.71	2073	1.05	4.8
		7/18/2006		27.24	2224	1.13	9.3
		7/19/2006		28.90	2068	1.05	9.8
		7/20/2006		26.26	1297	0.64	12.3
		7/20/2006		29.01	1442	0.72	8.4
		7/21/2006		19.23	1002	0.49	4.4

Table 6.8 Field parameters recorded during Intensive Survey # 3 - Cont'd

WATERSHED	SEGMENT ID	DATE	SITE ID	TEMP	COND	SAL	TURB
BRAYS BAYOU	1007P	7/17/2006	15848	29.83	930	0.45	21.3
		7/18/2006		36.98	796	0.38	26.7
		7/19/2006		30.93	607	0.29	18.1
		7/20/2006		38.72	455	0.21	16.2
		7/20/2006		51.73	368	0.17	28.6
		7/21/2006		28.8	753	0.36	22.1
	1007E	7/17/2006	16652	33.35	725	0.35	0.1
		7/18/2006		38.16	587	0.27	1.5
		7/19/2006		50.53	251	0.11	22.8
		7/20/2006		36.73	219	0.1	2.2
		7/20/2006		50.16	184	0.08	1.7
		7/21/2006		29.12	401	0.19	-0.2
	1007B	7/17/2006	11138	36.60	837	0.4	0.1
		7/19/2006		30.72	557	0.27	22.3
		7/19/2006		46.91	519	0.24	16.6
		7/20/2006		51.61	337	0.15	16.3
		7/20/2006		35.36	445	0.21	14.8
		7/21/2006		30.72	654	0.35	17.2
SIMS BAYOU	1007N	7/17/2006	16655	31.67	1197	0.59	16.7
		7/18/2006		37.96	1085	0.52	14.9
		7/19/2006		44.86	573	0.27	36.0
		7/20/2006		41.53	390	0.18	19.2
		7/20/2006		50.50	367	0.16	32.2
		7/21/2006		32.47	643	0.39	19.1
	1007	7/17/2006	11132	34.63	1060	0.51	64.6
		7/19/2006		41.98	478	0.22	117.0
		7/19/2006		41.75	380	0.18	133.1
		7/20/2006		46.53	223	0.1	73.2
		7/20/2006		50.83	227	0.1	73.9
		7/21/2006		30.06	530	0.25	81.2

Table 6.8 Field parameters recorded during Intensive Survey # 3 - Cont'd

WATERSHED	SEGMENT ID	DATE	SITE ID	TEMP	COND	SAL	TURB
EASTERN HOUSTON WATERSHED	1007H	7/17/2006	16659	37.03	537	0.25	1.8
		7/19/2006		38.70	341	0.16	12.3
		7/19/2006		48.90	338	0.15	7.7
		7/20/2006		45.72	213	0.1	3.5
		7/20/2006		46.30	257	0.12	7.9
		7/21/2006		29.00	480	0.23	0.3
	1007I	7/17/2006	16658	31.23	662	0.32	12.2
		7/19/2006		42.47	245	0.11	28.4
		7/19/2006		40.41	279	0.13	23.2
		7/20/2006		49.80	153	0.07	18.9
		7/20/2006		48.90	152	0.07	34.9
		7/21/2006		28.06	355	0.18	12.3
	1007G	7/17/2006	16653	33.99	546	0.26	0.3
		7/19/2006		28.74	281	0.13	7.6
		7/19/2006		49.10	234	0.11	1.8
		7/20/2006		47.27	170	0.08	0.9
		7/20/2006		29.78	241	0.11	0.8
		7/21/2006		29.44	417	0.2	1.8
	1007K	7/17/2006	16650	36.92	792	0.38	13.4
		7/19/2006		41.68	223	0.1	4.0
		7/19/2006		51.74	225	0.1	2.5
		7/20/2006		48.25	165	0.07	0.5
		7/20/2006		46.97	169	0.08	28.0
		7/21/2006		30.30	307	0.14	1.7

Table 6.8 Field parameters recorded during Intensive Survey # 3 - Cont'd

WATERSHED	SEGMENT ID	DATE	SITE ID	TEMP	COND	SAL	TURB
EASTERN HOUSTON WATERSHED	1007O	7/18/2006	16649	35.14	824	0.4	4.6
		7/19/2006		39.18	614	0.29	7.7
		7/19/2006		45.56	548	0.28	7.9
		7/20/2006		45.25	333	0.15	7.1
		7/20/2006		44.89	240	0.11	24.0
		7/21/2006		32.03	467	0.22	12.2
	1006H	7/17/2006	16663	29.90	906	0.44	2.8
		7/18/2006		29.42	1269	0.63	20.1
		7/19/2006		30.16	1289	0.64	15.1
		7/20/2006		28.64	1033	0.51	15.0
		7/20/2006		30.04	1018	0.5	14.4
		7/21/2006		28.84	1085	0.53	10.7
	1006F	7/17/2006	16662	36.97	610	0.29	45.7
		7/19/2006		29.05	584	0.28	3.6
		7/19/2006		34.90	579	0.27	5.1
		7/20/2006		31.65	475	0.22	9.3
		7/20/2006		34.22	477	0.22	12.3
		7/21/2006		32.77	791	0.09	2.2
	1007M	7/17/2006	16657	35.35	451	0.21	15.1
		7/19/2006		29.34	408	0.19	10.0
		7/19/2006		32.79	418	0.2	7.5
		7/20/2006		30.23	353	0.17	14.2
		7/20/2006		32.25	361	0.17	11.0
		7/21/2006		32.73	587	0.28	11.2
	1007R	7/17/2006	11128	32.74	565	0.27	9.2
		7/19/2006		29.57	604	0.29	8.5
		7/19/2006		32.04	621	0.3	9.5
		7/20/2006		29.92	488	0.23	8.8
		7/20/2006		32.01	496	0.24	10.6
		7/21/2006		31.04	708	0.34	10.1

The YSI probe reported unreasonably high DO concentrations these are not included in the Table.

Units		
TURB	Turbidity	NTU
SAL	Salinity	ppt
COND	Conductivity	uS/cm
TEMP	Temperature	^{o}C

CHAPTER 7

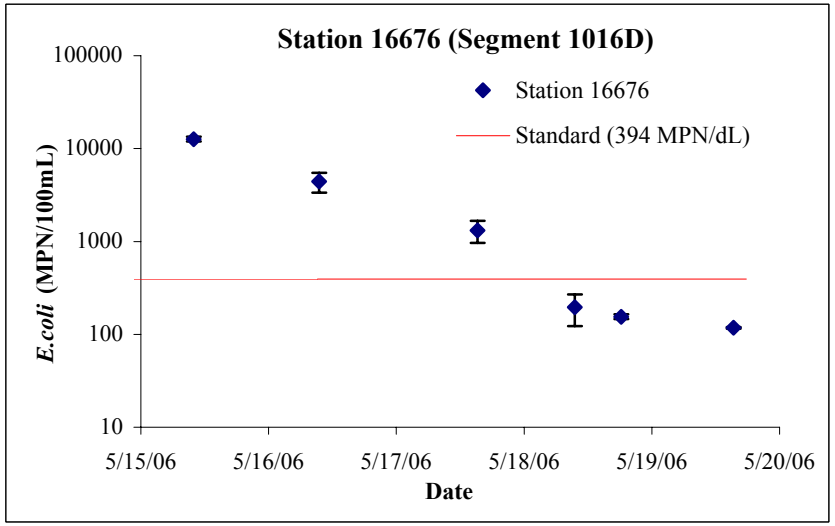
DATA ANALYSIS

7.1 INTRODUCTION

The data collected from the three intensive surveys were analyzed to determine temporal trends, if any.

7.2 *E.coli* CONCENTRATION TRENDS DURING INTENSIVE SURVEY # 1

Bacteria stations for Eastern Houston, Greens Bayou, and the Halls Bayou watersheds exhibited relatively high *E.coli* concentrations when compared to those in Brays and Sims Bayou. Figures 7.1 through 7.5 show the E.coli concentrations over time. Declines in *E.coli* concentrations over the sampling period can be seen in the plots.



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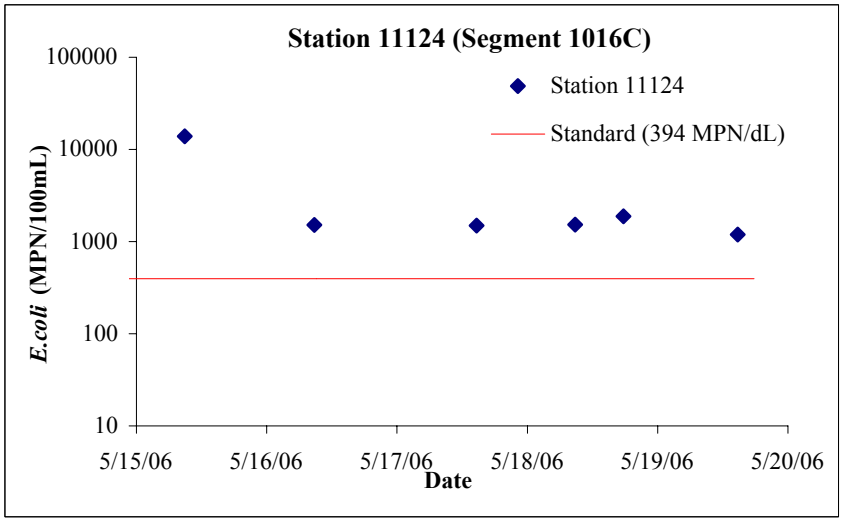
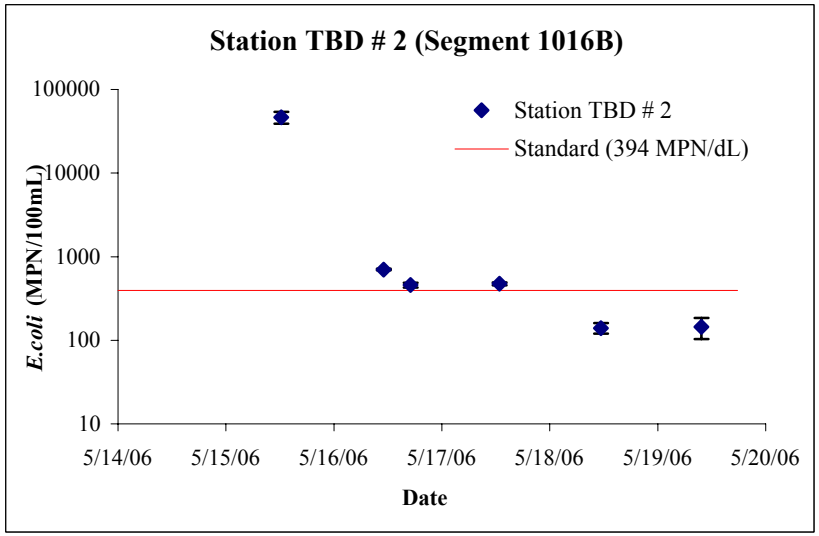


(b)



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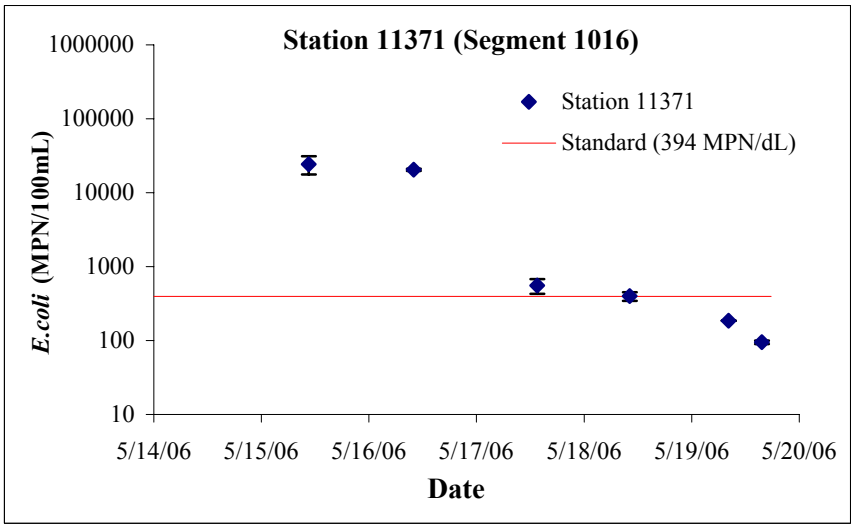
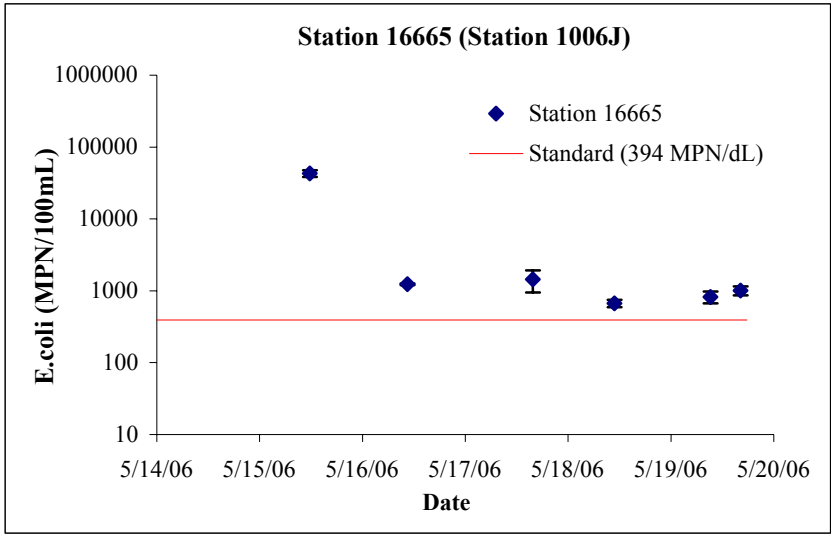


(d)

Fig. 7.1 *E.coli* Concentration Trends During Metro Intensive # 1 in the Greens Bayou Watershed



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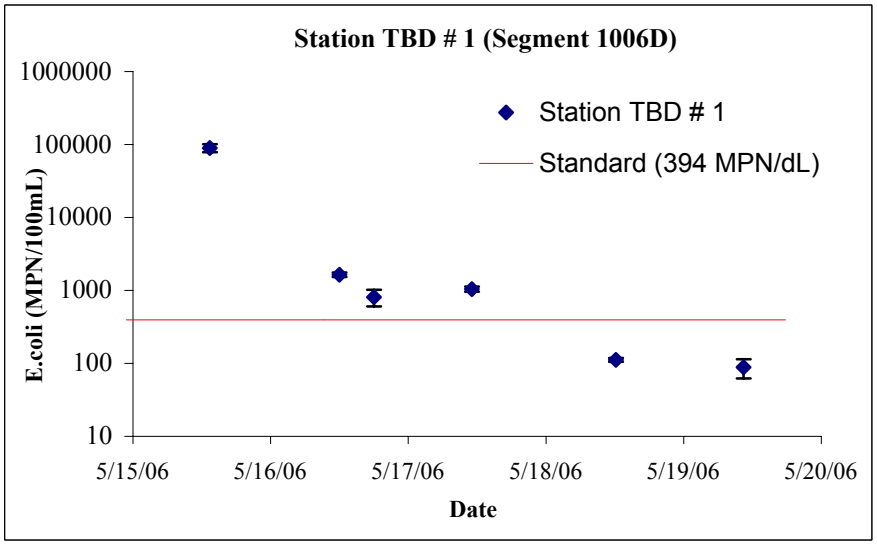

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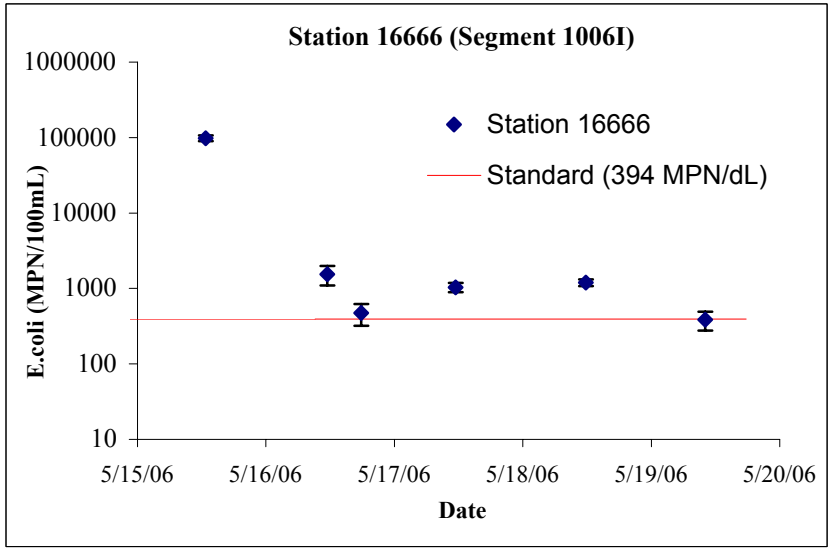
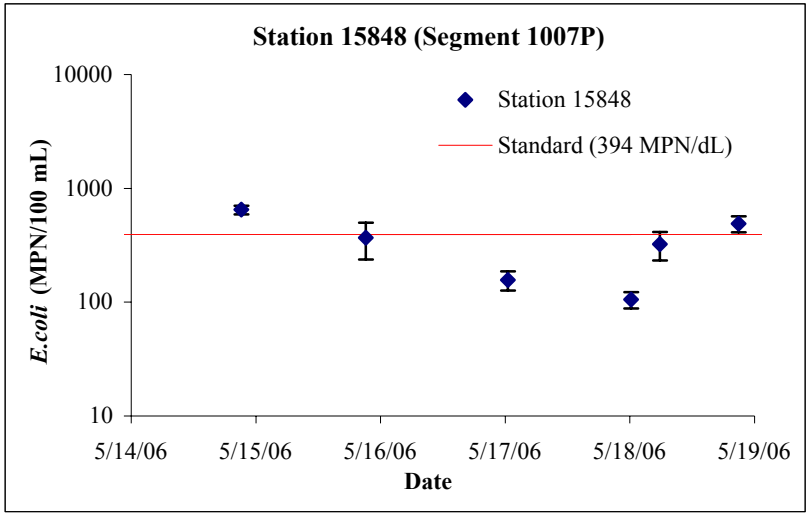


(c)

Fig7.2 *E.coli* Concentration Trends During Metro Intensive # 1 in the Halls Bayou Watershed



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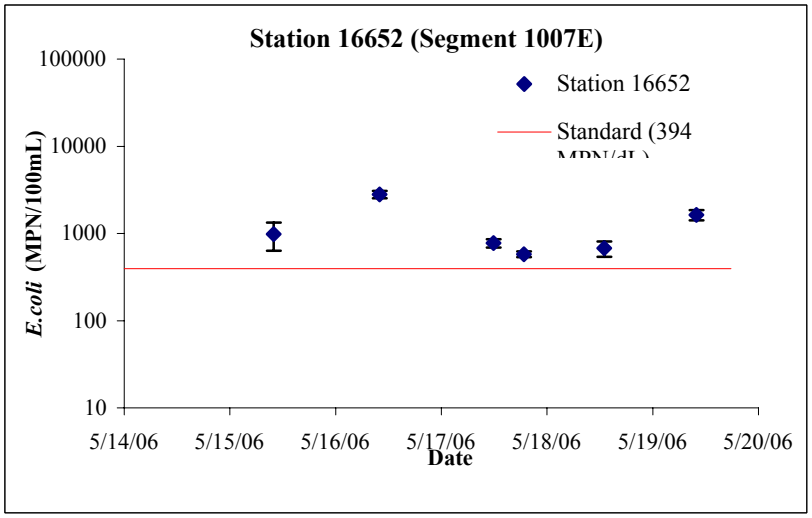

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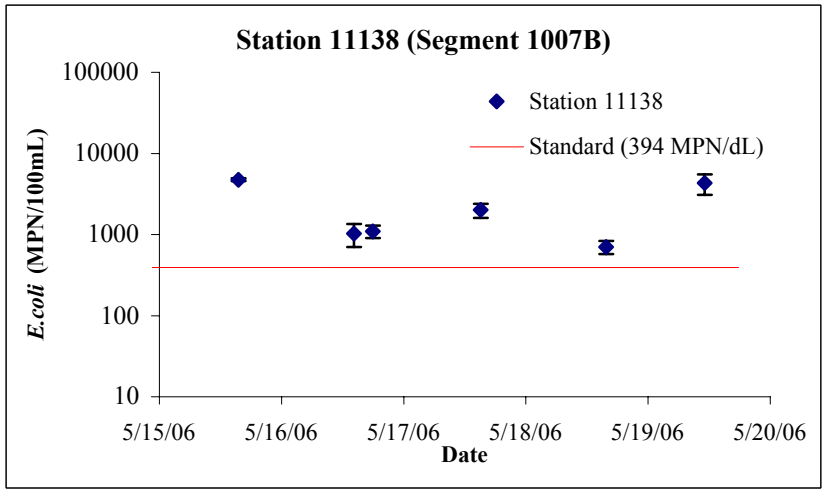
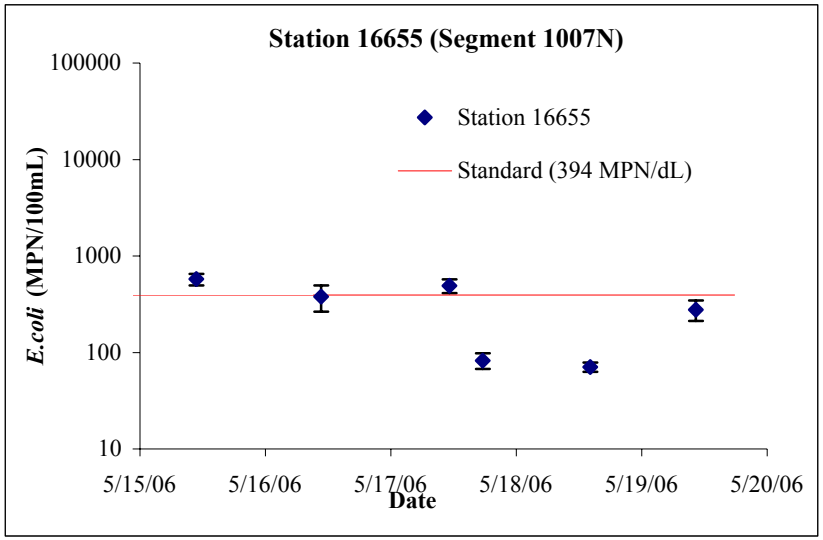


(c)

Fig.7.3 *E.coli* Concentration Trends During Metro Intensive # 1 in the Brays Bayou Watershed



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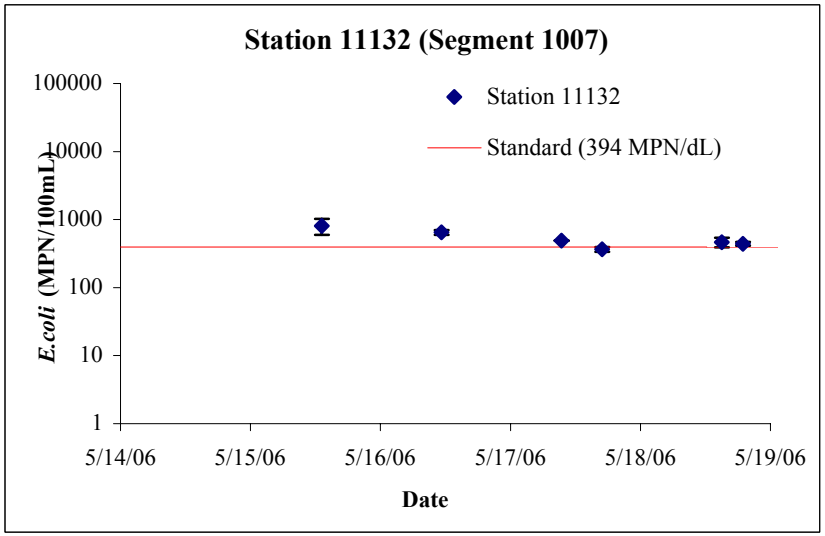
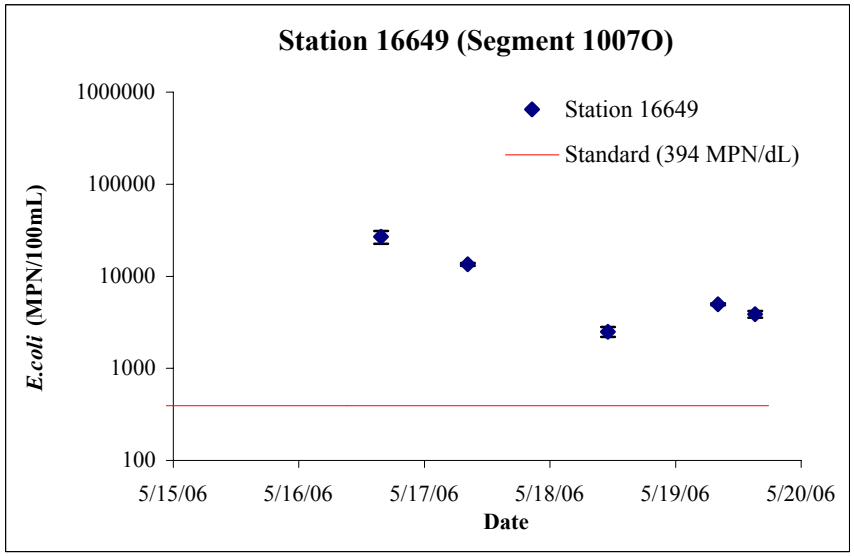


(b)

Fig.7.4 *E.coli* Concentration Trends During Metro Intensive # 1 in the Sims Bayou Watershed



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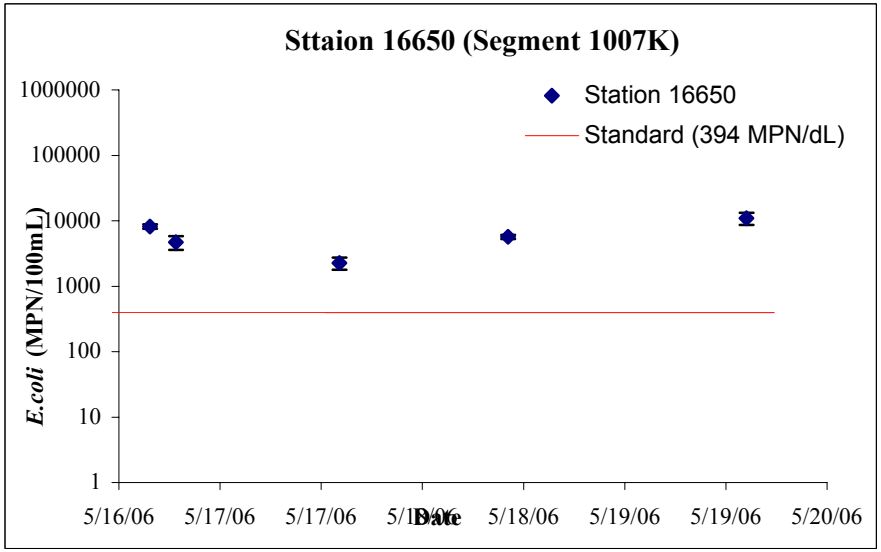
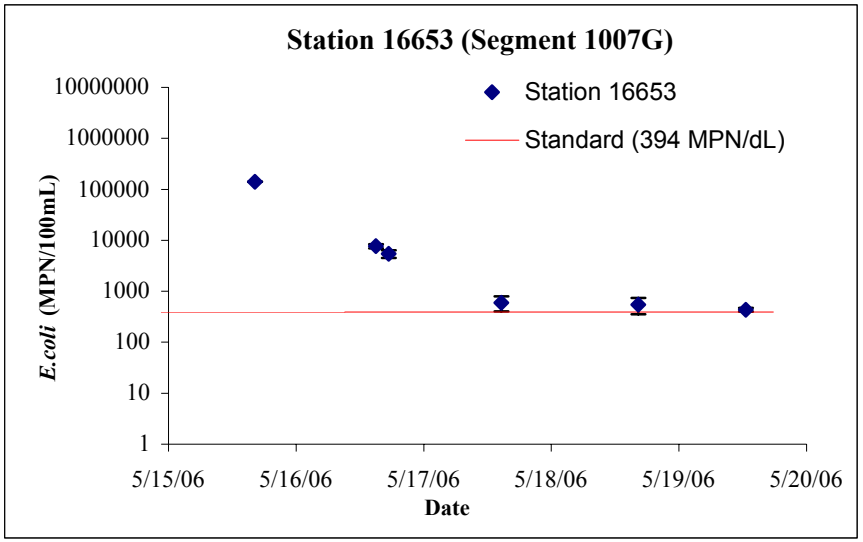
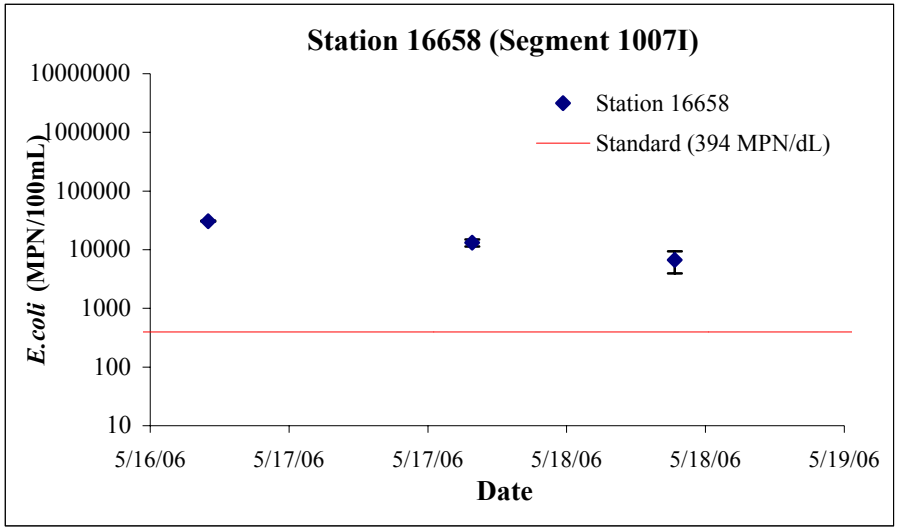


(b)



(c)

Fig. 7.5 *E.coli* Concentration Trends During Metro Intensive # 1 in the Eastern Houston Watershed



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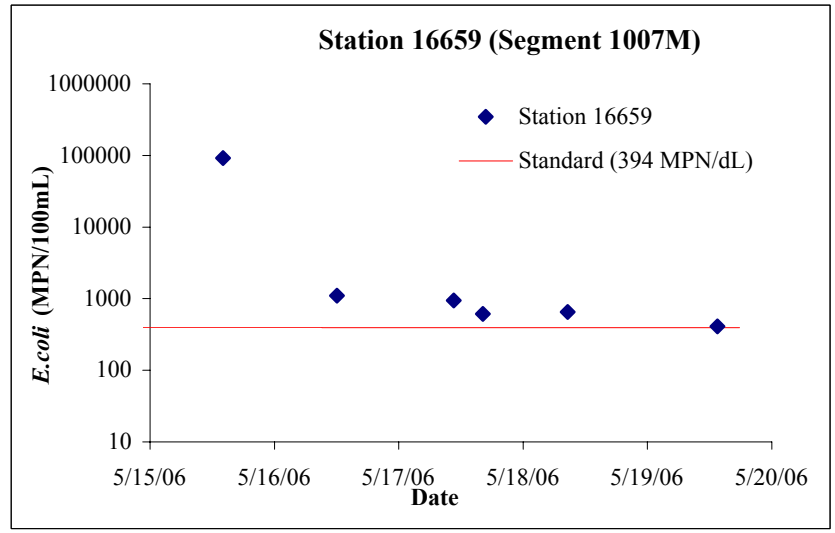

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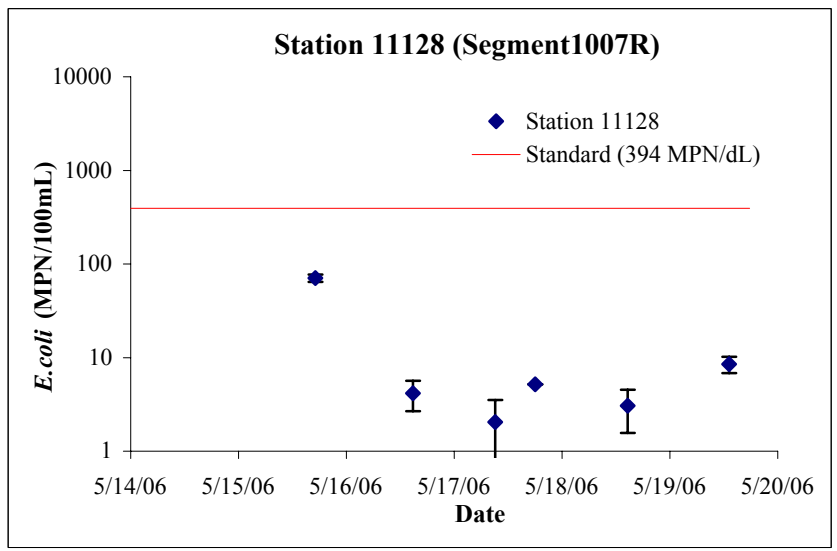
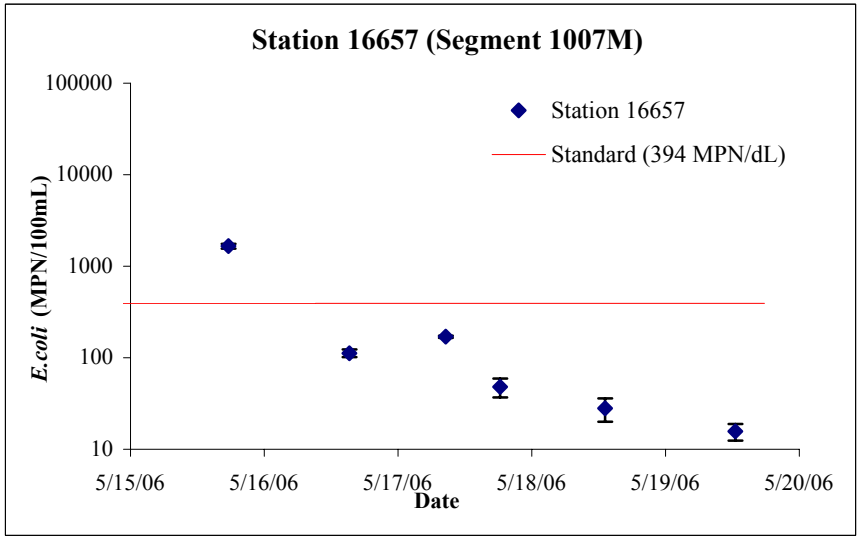
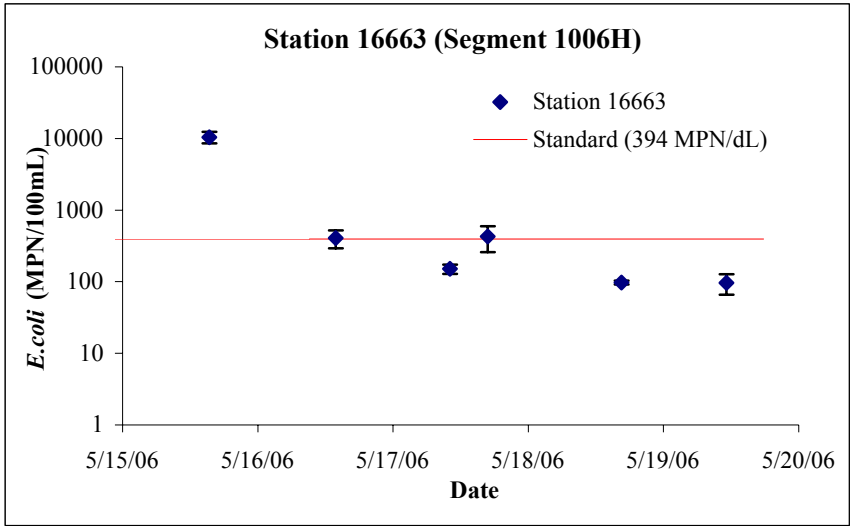


(c)

Fig. 7.5 *E.coli* Concentration Trends During Metro Intensive # 1 in the Eastern Houston Watershed - Cont'd



(a)



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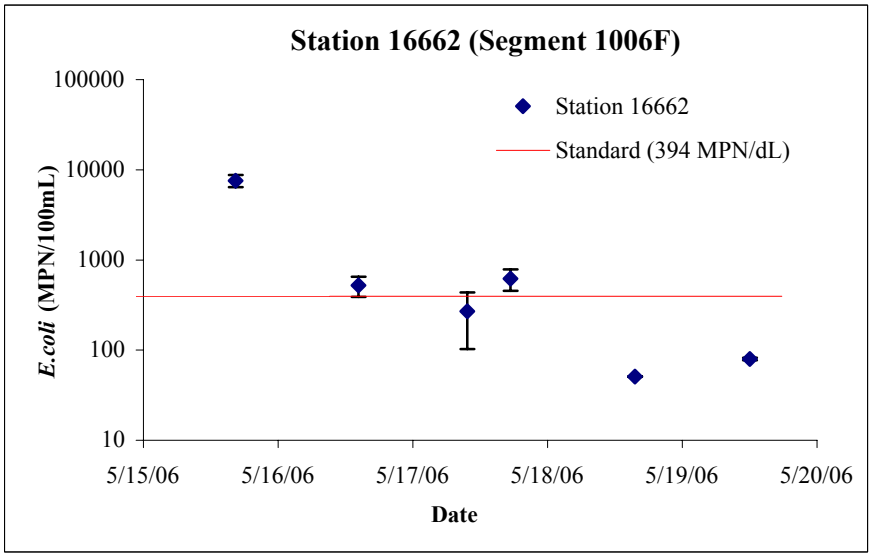


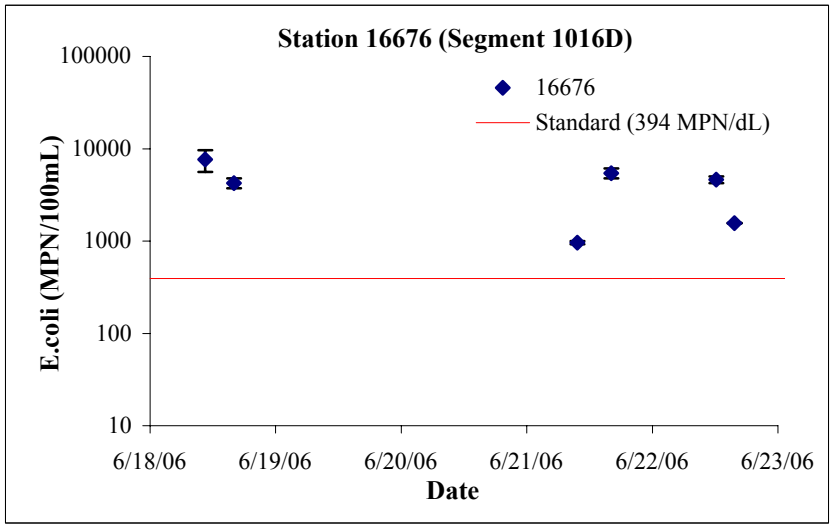
(c)

Fig. 7.5 *E.coli* Concentration Trends During Metro Intensive # 1 in the Eastern Houston Watershed - Cont'd

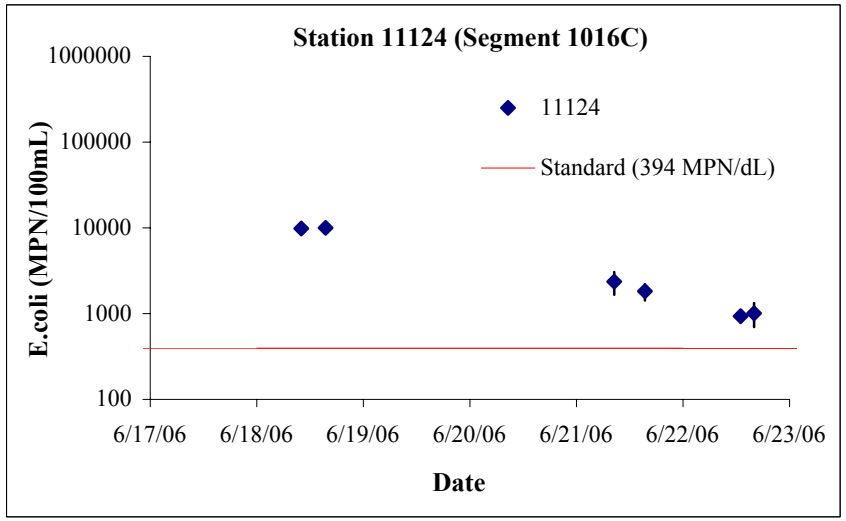
The *E.coli* concentrations at most of the sampling locations exhibited a decreasing trend in bacteria concentrations except stations 16652 (Fig. 7.3), 11132 (Fig. 7.5), 16655 (Fig. 7.4), 11138 (Fig. 7.3), and 16650 (Fig. 7.5) where the variation in concentrations appeared to be independent of time. At stations 16653 (Fig. 7.5) and 16659 (Fig. 7.5), the concentrations decline from greater than a log value of 100,000 MPN/100mL on day 0 to below the single sample standard on day 4. However, at station 16658 (Fig. 7.5), the concentration of *E.coli* on day 0 was greater than 242,000 MPN/100mL and decreased to 5,310 MPN/100mL on day 4. At stations 16676 (Fig. 7.1), 16663 (Fig.7.5), 16657 (Fig. 7.5), 16662 (Fig. 7.5), 11371 (Fig.7.1) and TBD # 1 (Fig.7.2), concentrations decrease to below the single sample standard in approximately 5 days following the rainfall event. Thus, the effects of rainfall on bacteria concentrations are evident and these effects may be observed for at least 3 to 5 days following the rainfall event.

7.3 *E.coli* CONCENTRATION TRENDS DURING INTENSIVE SURVEY # 2

The graphs depicted in Figs. 7.6 through 7.10 indicate that *E.coli* concentrations exhibited a strong decline in concentrations in approximately 4 days, and concentrations at 11371, TBD # 2, 15848, 11128, and 16663 dropped below the standard on the fifth day after the rainfall. The first day of the intensive survey had elevated concentrations at the majority of the stations and the decline in concentrations following the rainfall event ranged from 75 to 99% with a few exceptions like stations 16653, 16666, 16652, and 16655 where concentrations remained relatively stable with no substantial decline. This may be due to the relatively small flows associated with these stations. Station 16658 (Fig. 7.10) showed the highest concentration of *E.coli* of 198,630 MPN/dL, and the concentrations remained above the standard even after day 3.



(a)



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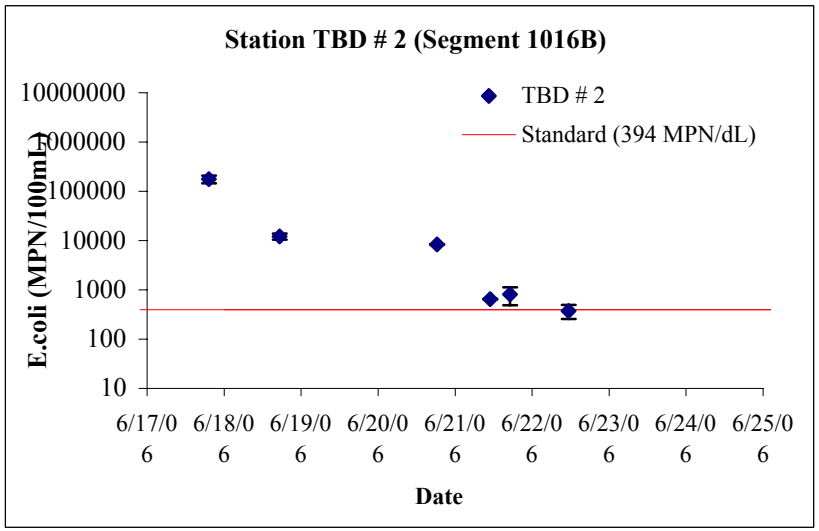

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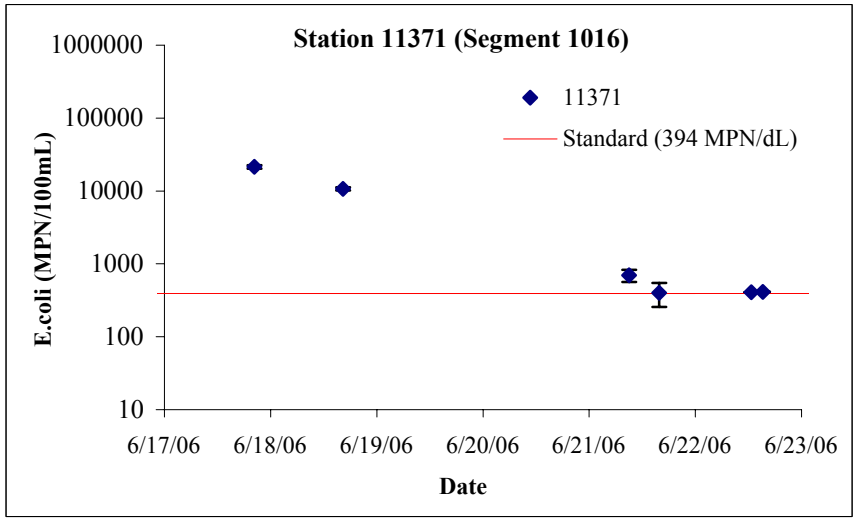
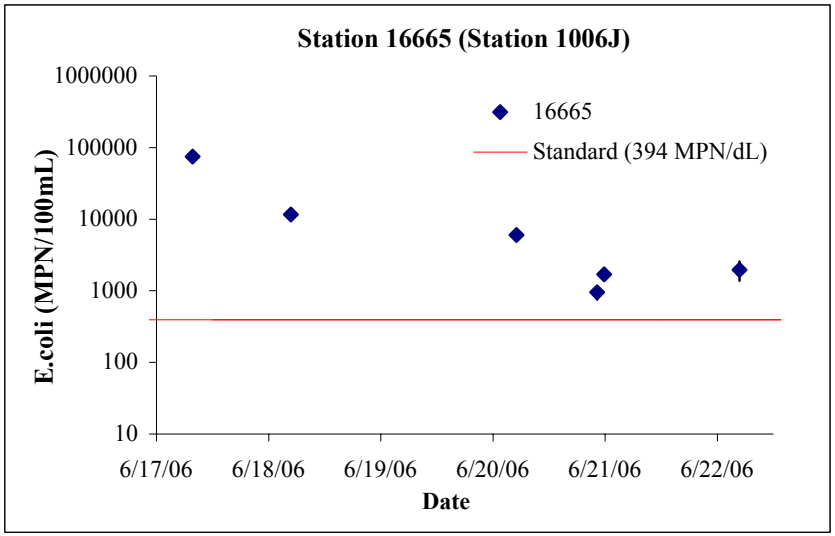


(d)

Fig.7.6 *E.coli* Concentration Trends During Metro Intensive # 2 in the Greens Bayou Watershed



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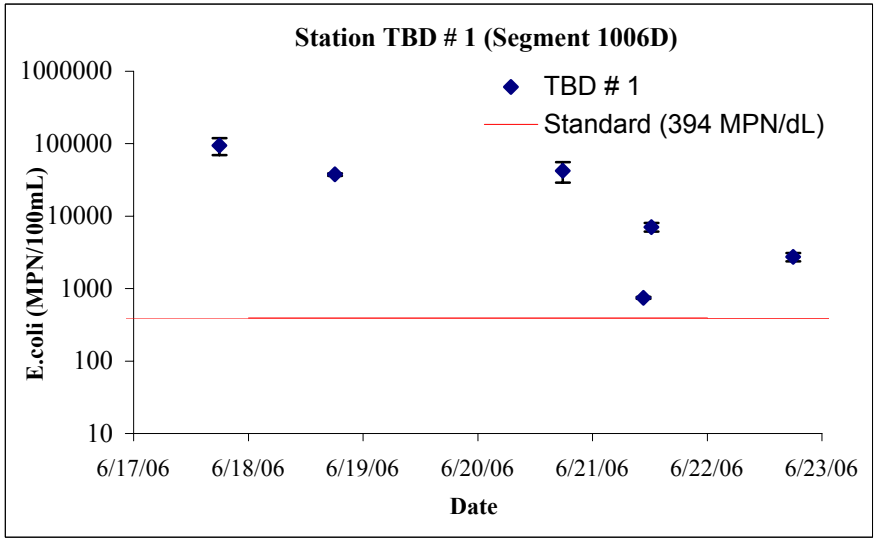

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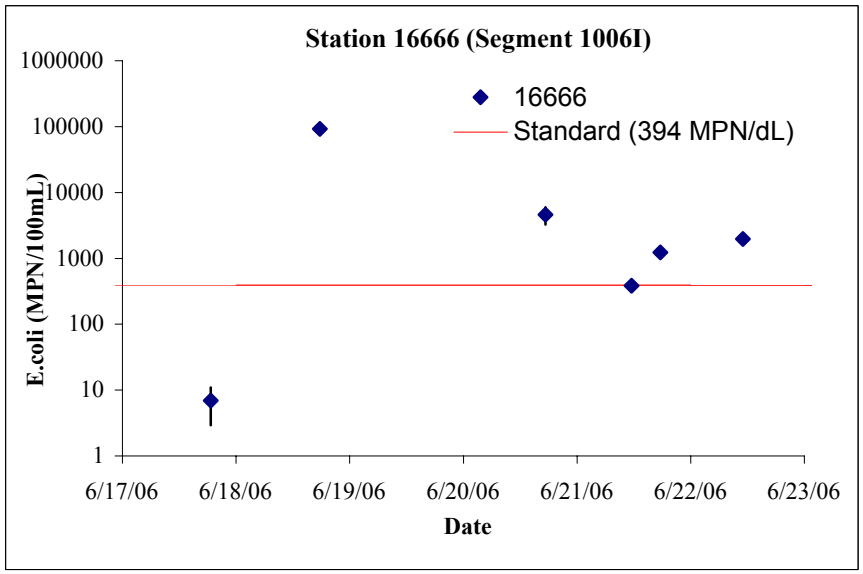
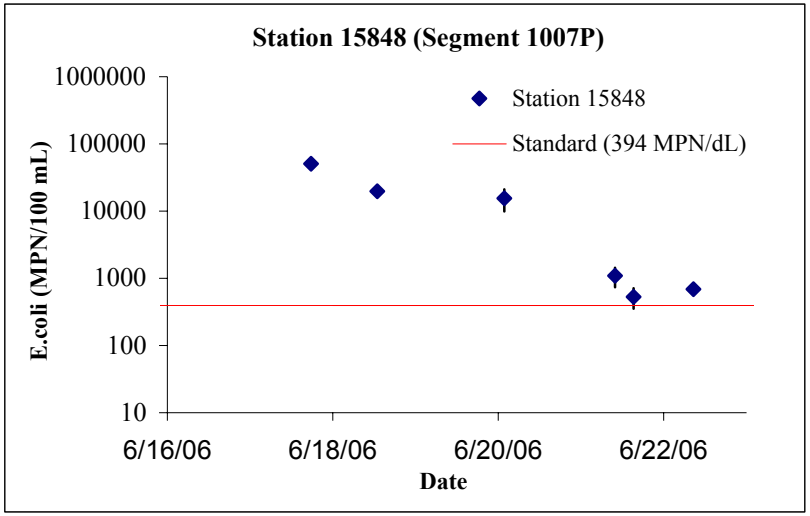


(c)

Fig.7.7 *E.coli* Concentration Trends During Metro Intensive # 2 in the Halls Bayou Watershed



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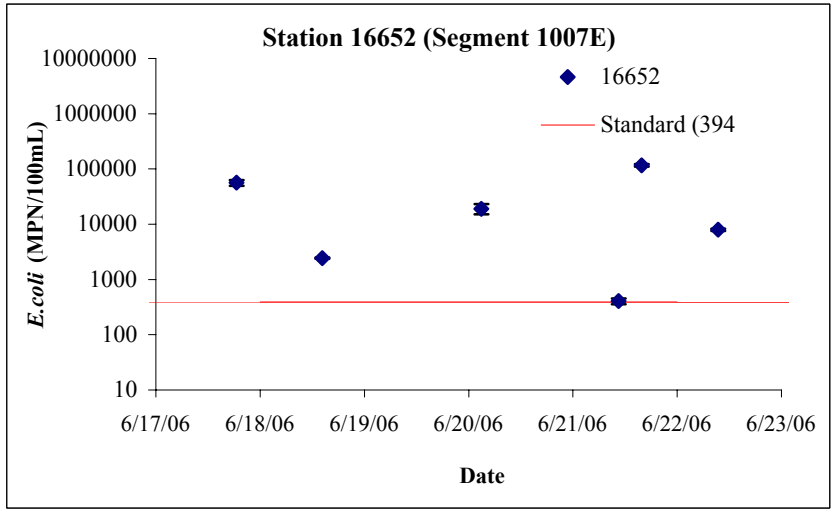

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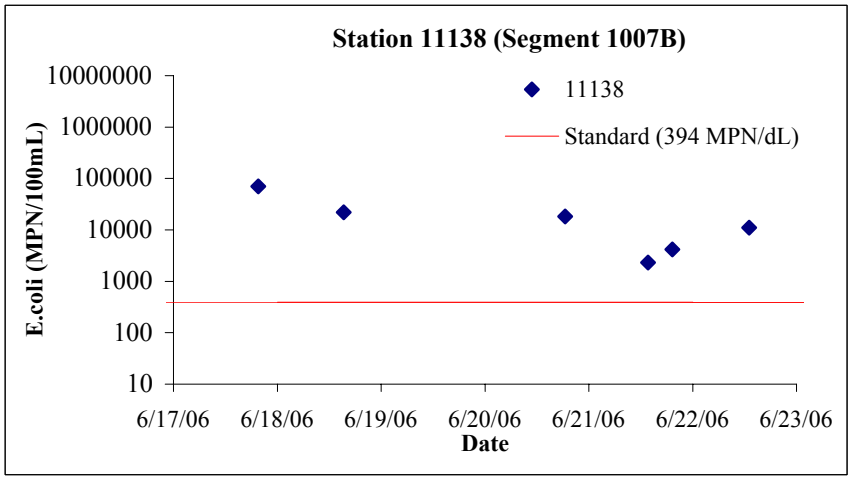
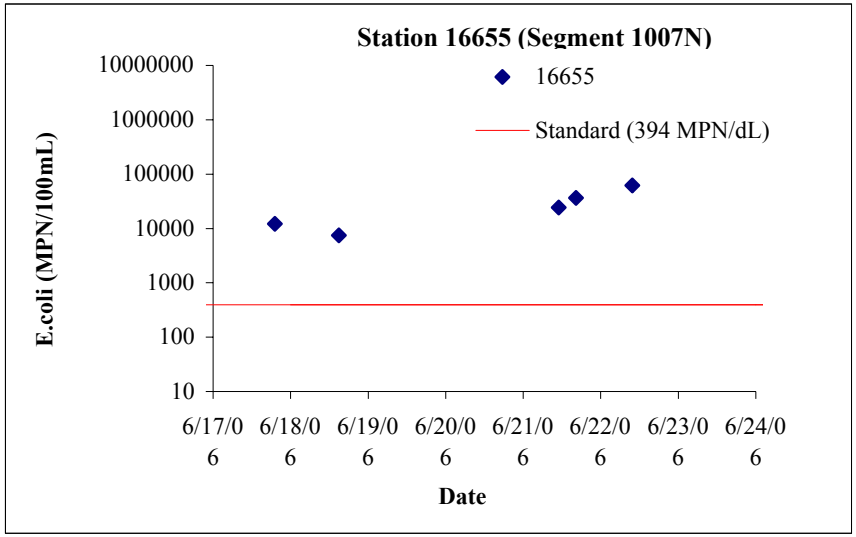


(c)

Fig. 7.8 *E.coli* Concentration Trends During Metro Intensive # 2 in the Brays Bayou Watershed



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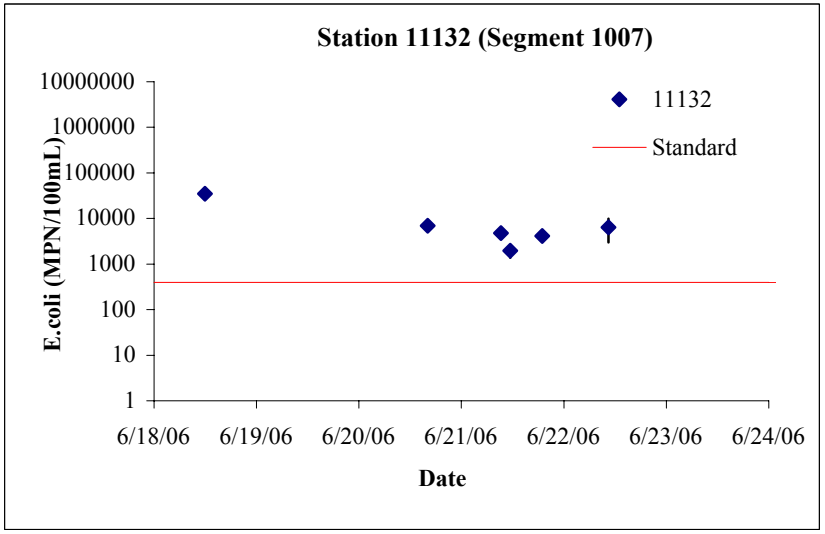
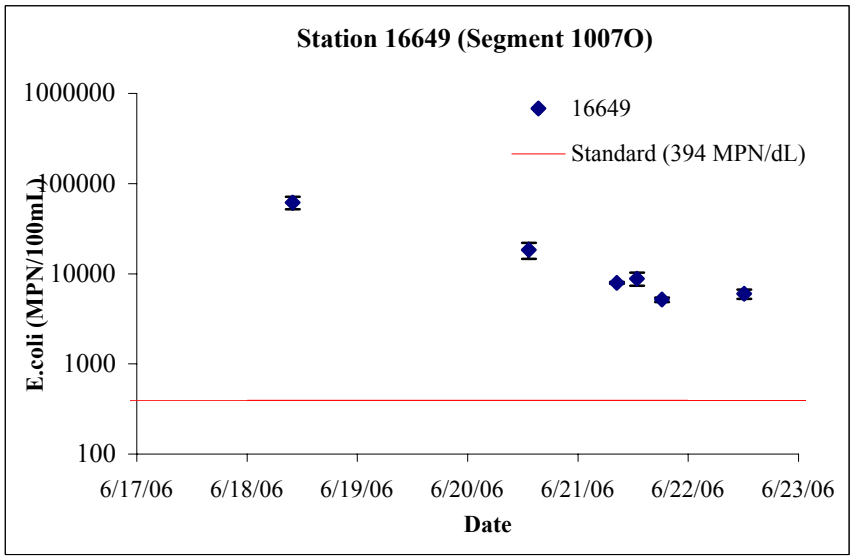


(b)

Fig. 7.9 *E.coli* Concentration Trends During Metro Intensive # 2 in the Sims Bayou Watershed



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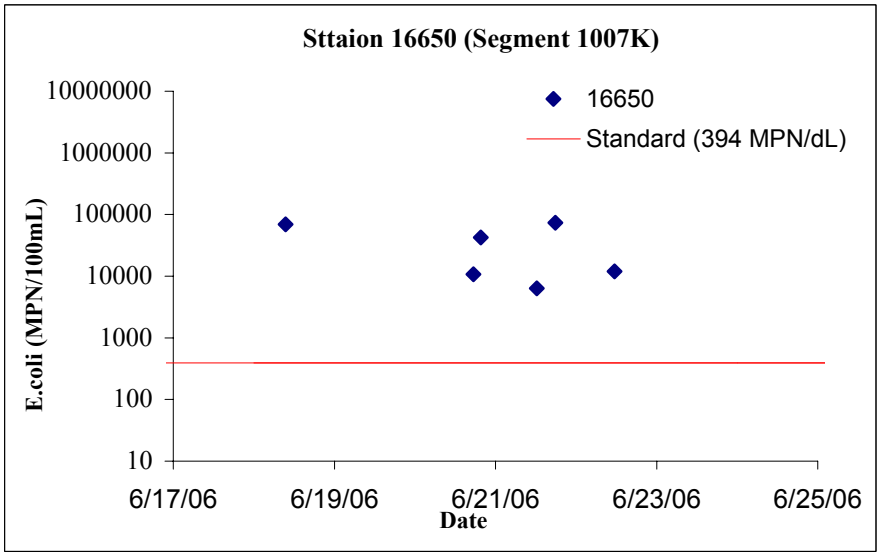

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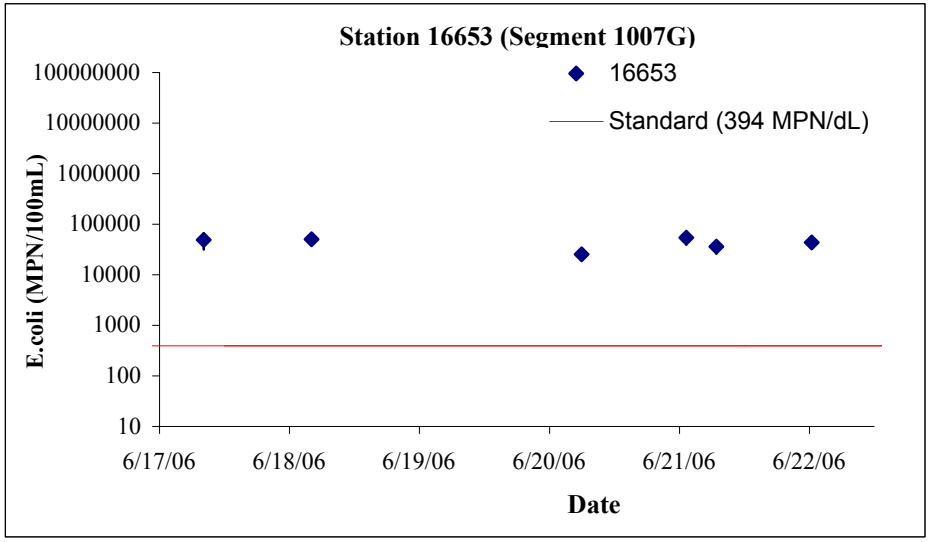

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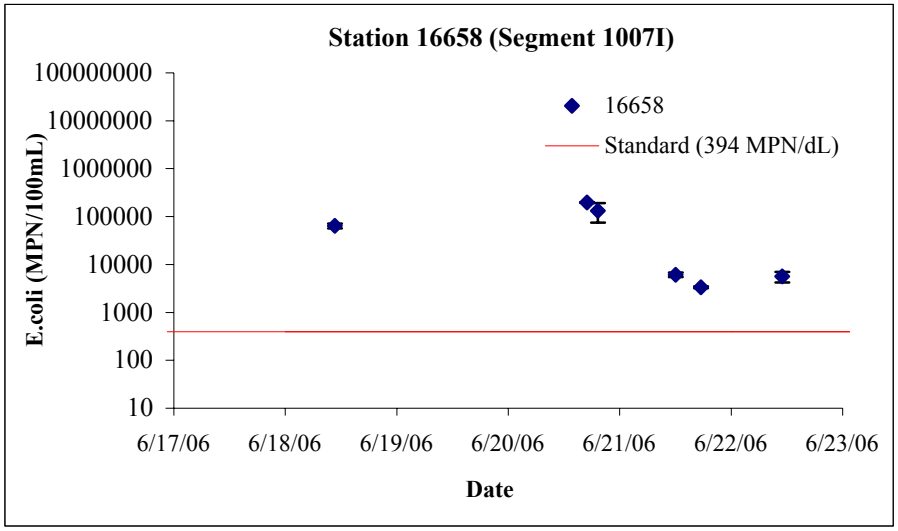
Fig. 7.10 *E.coli* Concentration Trends During Metro Intensive # 2 in the Eastern Houston Watershed



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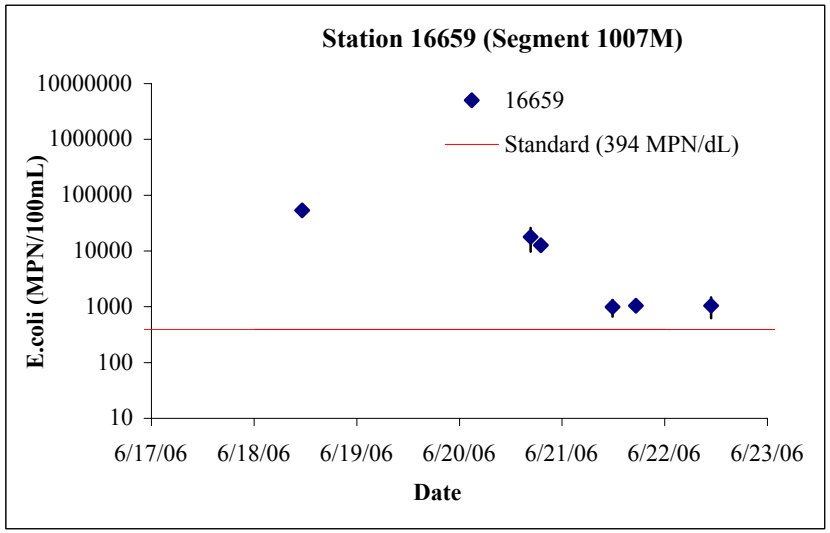

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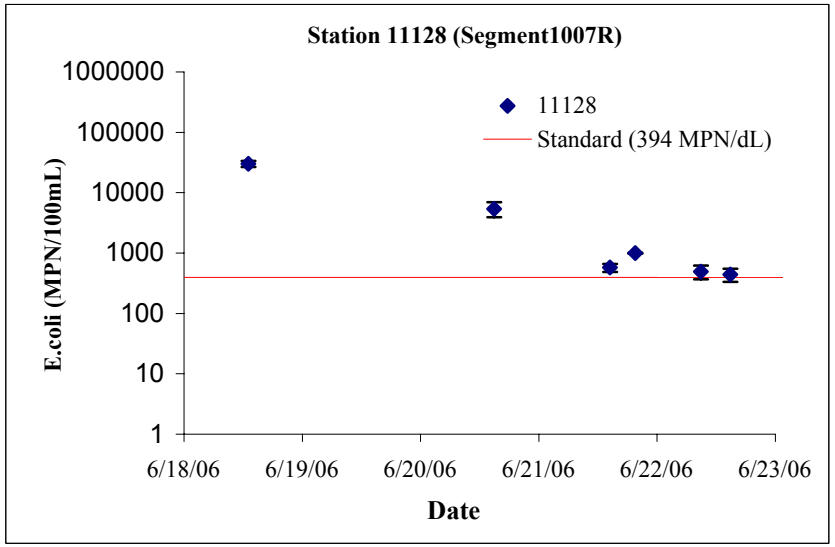
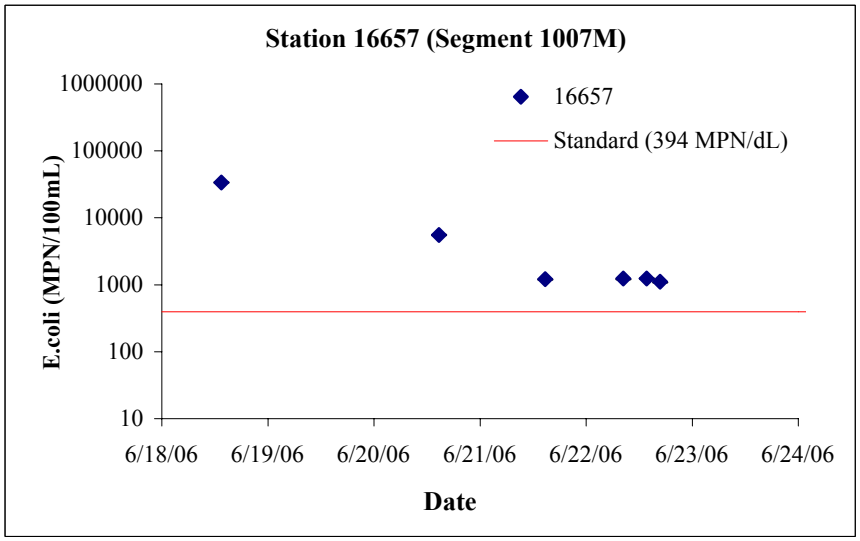


(c)

Fig. 7.10 *E.coli* Concentration Trends During Metro Intensive # 2 in the Eastern Houston Watershed - Cont'd



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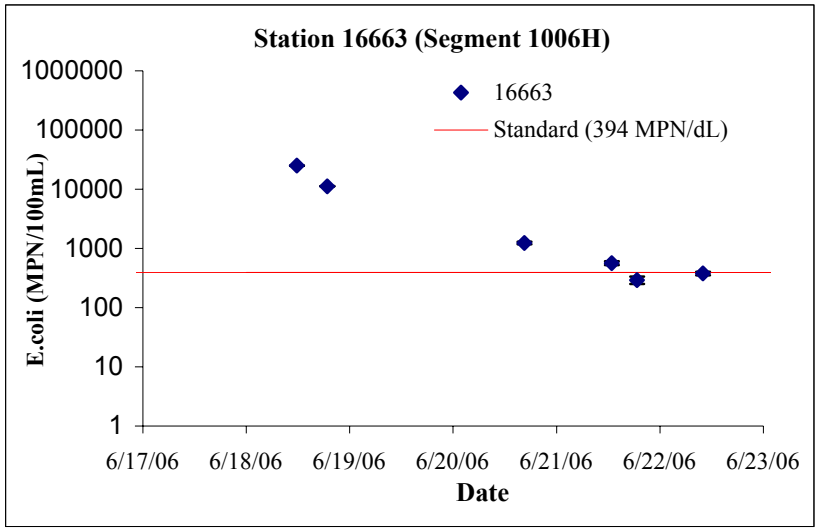

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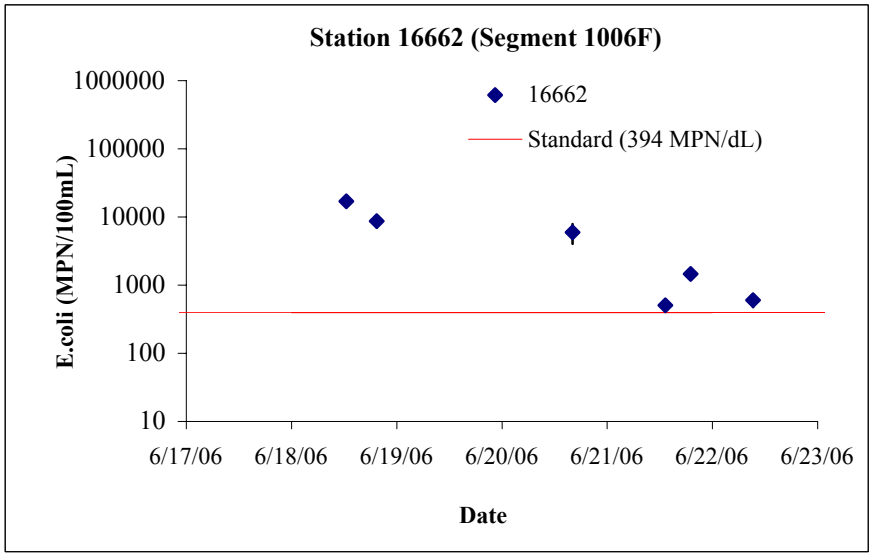
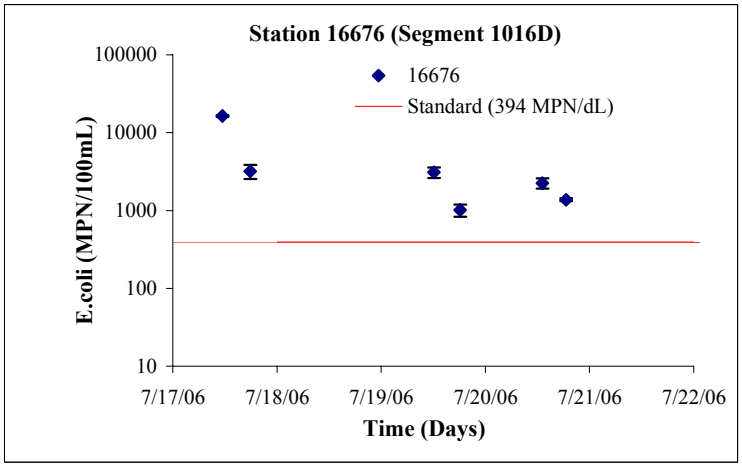


(c)

Fig. 7.10 *E.coli* Concentration Trends During Metro Intensive # 2 in the Eastern Houston Watershed - Cont'd

7.4 *E.coli* CONCENTRATION TRENDS DURING INTENSIVE SURVEY # 3

The temporal variation in *E.coli* concentrations for intensive survey # 3 is depicted in Figs. 7.11 through 7.15. The dry weather concentrations for the majority of the stations remained relatively stable. The concentrations at all stations were above the standard except at station TBD # 1 and TBD # 2. The single sample standard was met only 1 or 2 out of the 6 times that the sites were sampled. The *E.coli* concentrations at some of the stations (for example, 16655, 16659 and 16676) had declining concentrations during the intensive survey.



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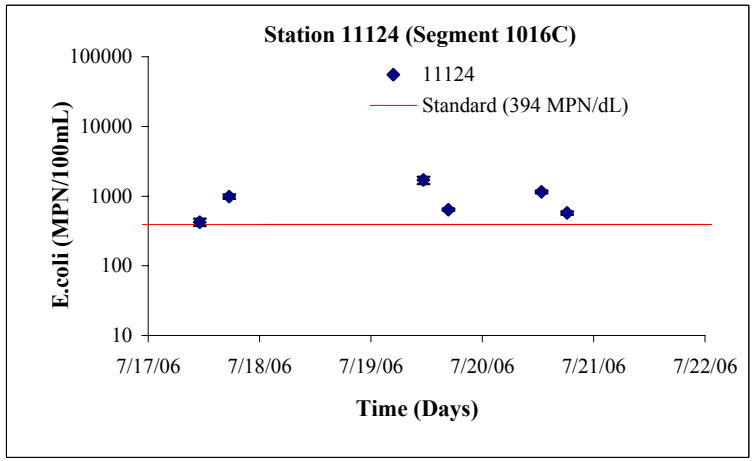

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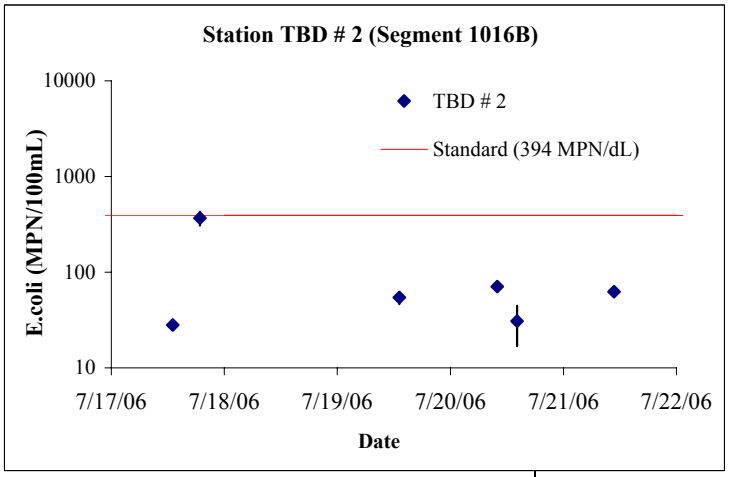

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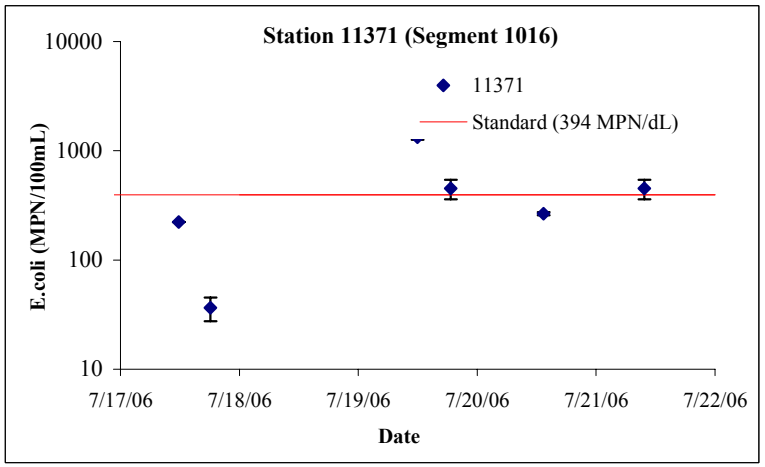

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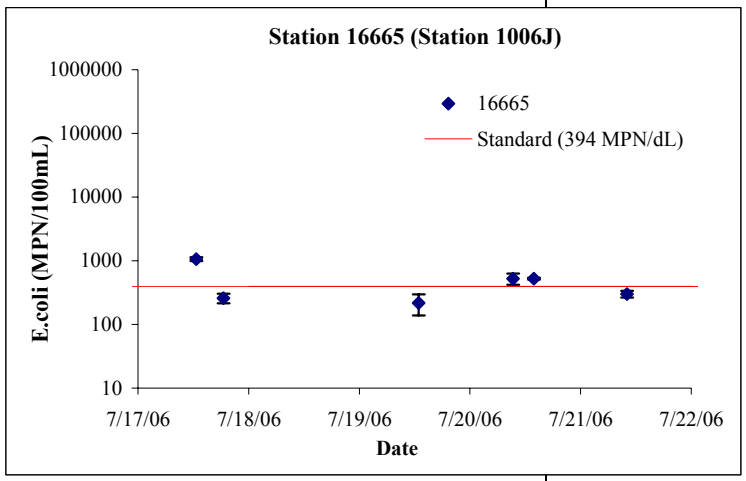
Fig 7.11 *E.coli* Concentration Trends During Metro Intensive # 3 in the Greens Bayou Watershed



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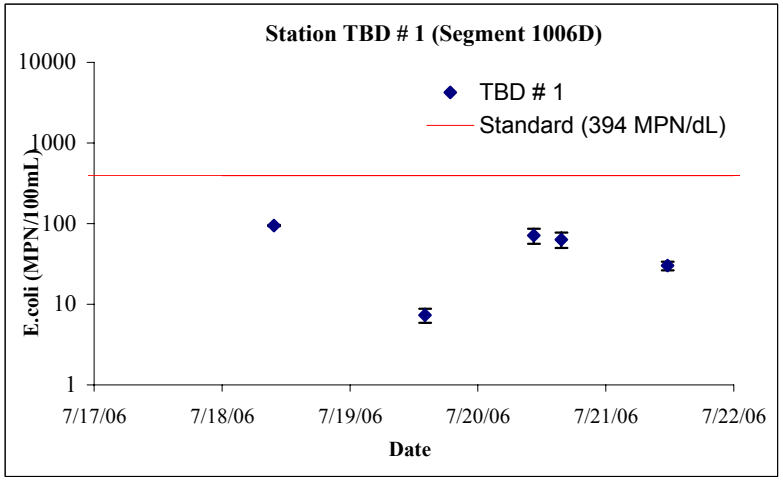

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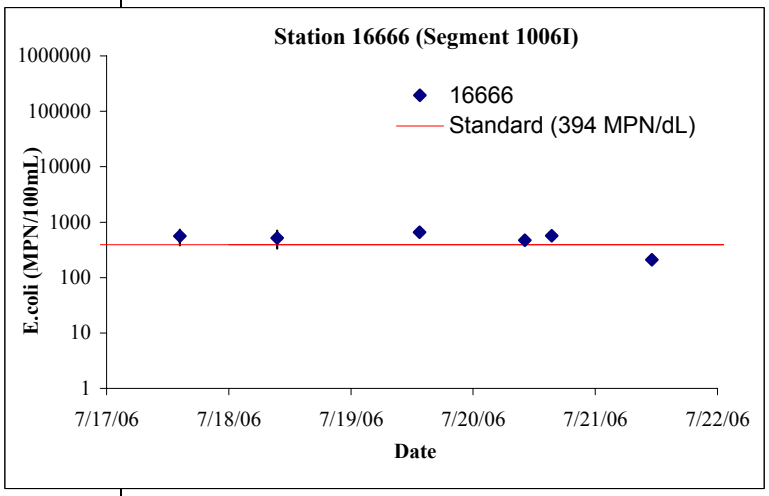
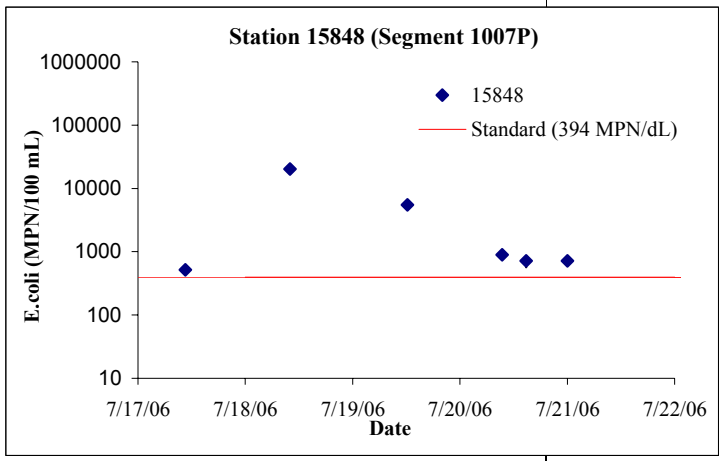


(c)

Fig.7.12 *E.coli* Concentration Trends During Metro Intensive # 3 in the Halls Bayou Watershed



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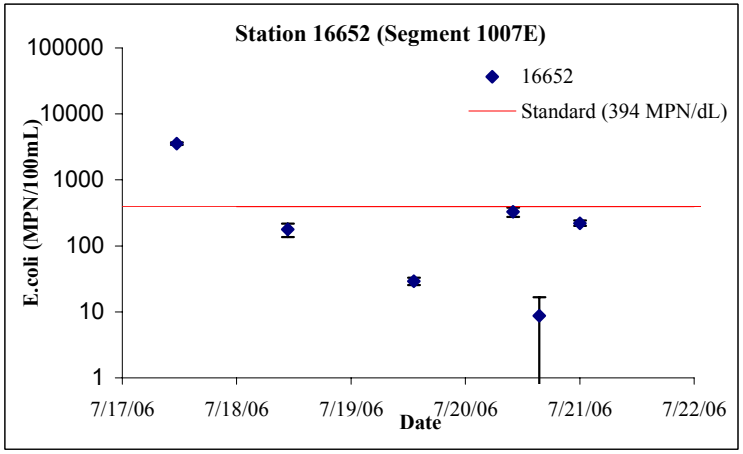

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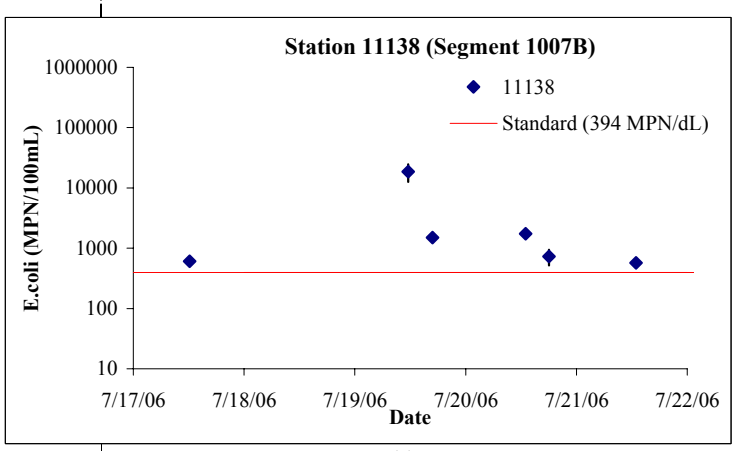
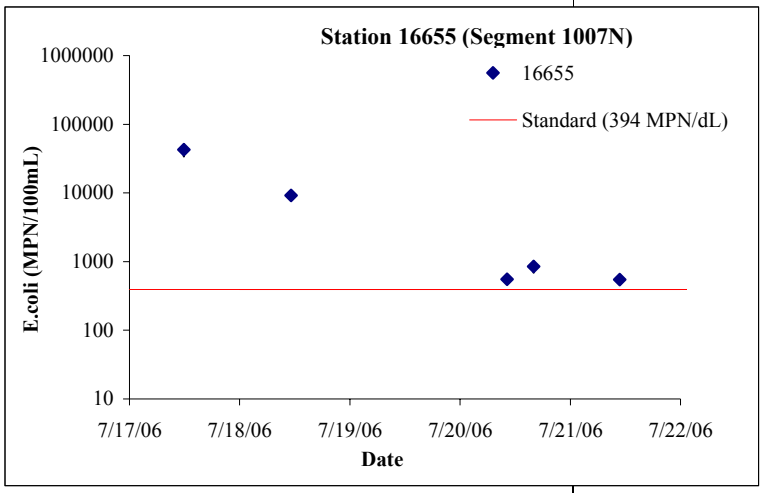


(c)

Fig.7.13 *E.coli* Concentration Trends During Metro Intensive # 3 in the Brays Bayou Watershed



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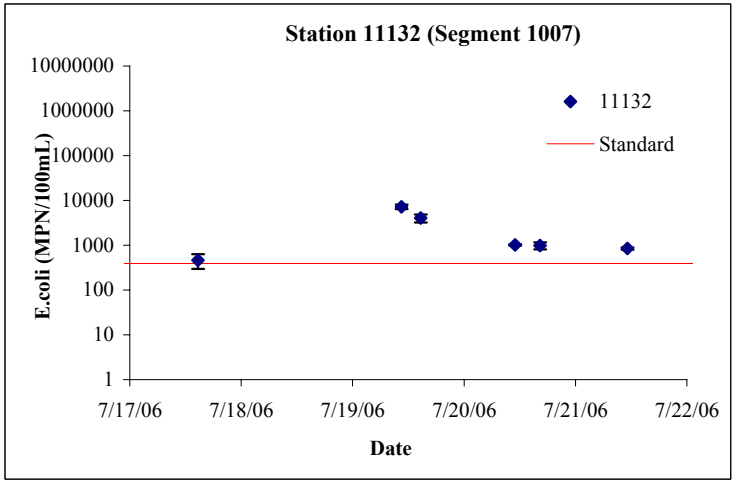
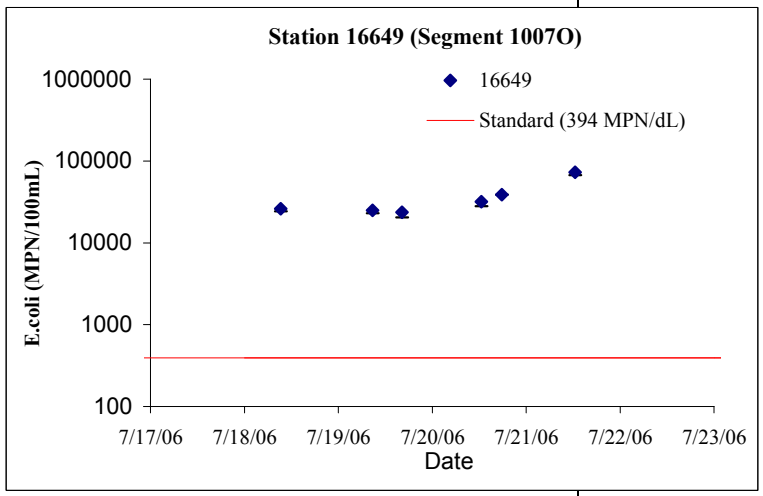


(b)

Fig 7.14 *E.coli* Concentration Trends During Metro Intensive # 3 in the Sims Bayou Watershed



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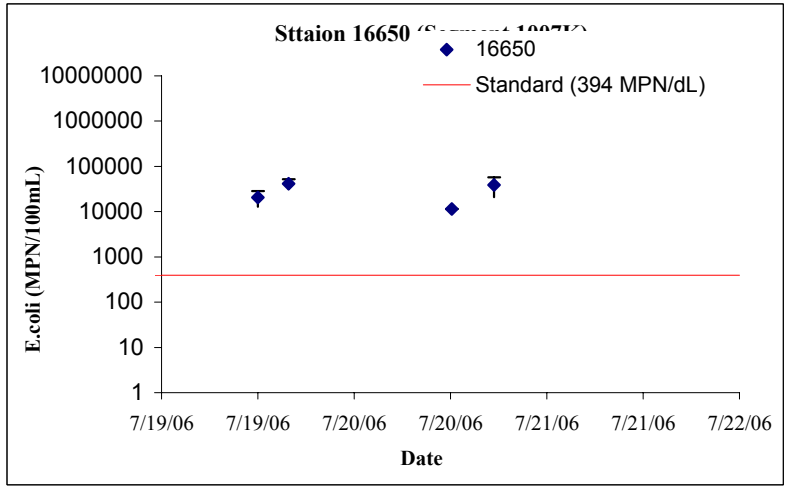

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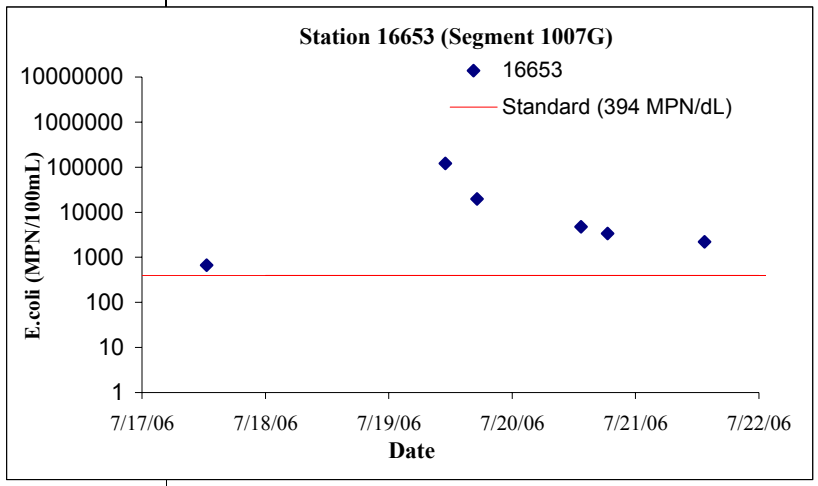
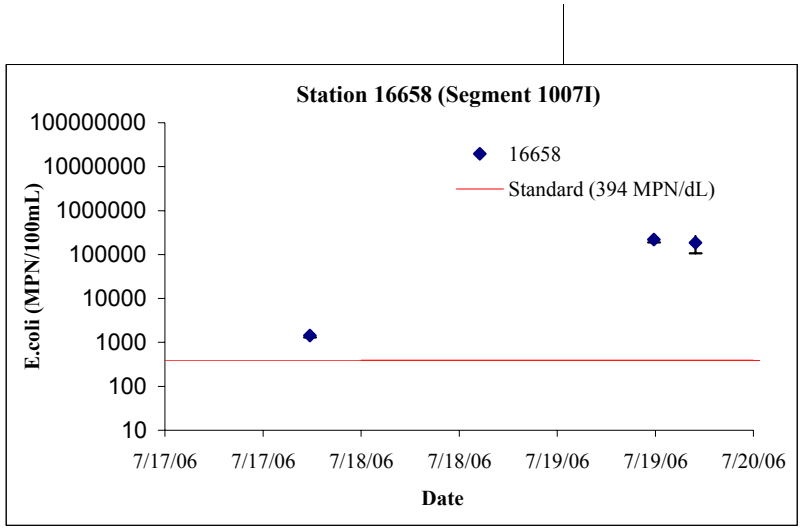


(c)

Fig 7.15 *E.coli* Concentration Trends During Metro Intensive # 3 in the Eastern Houston Watershed



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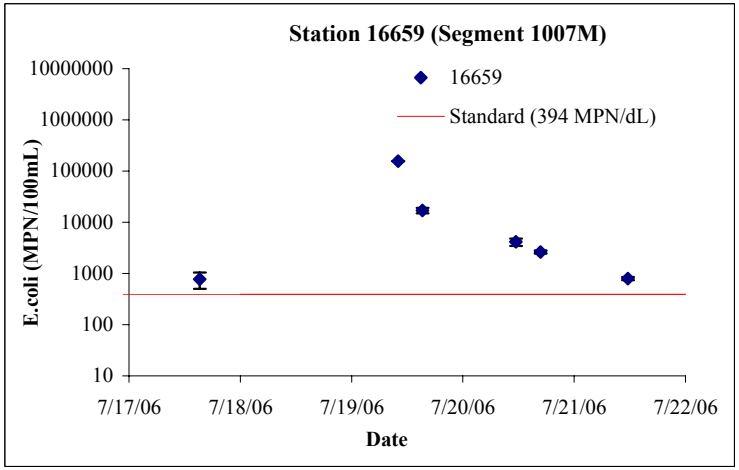

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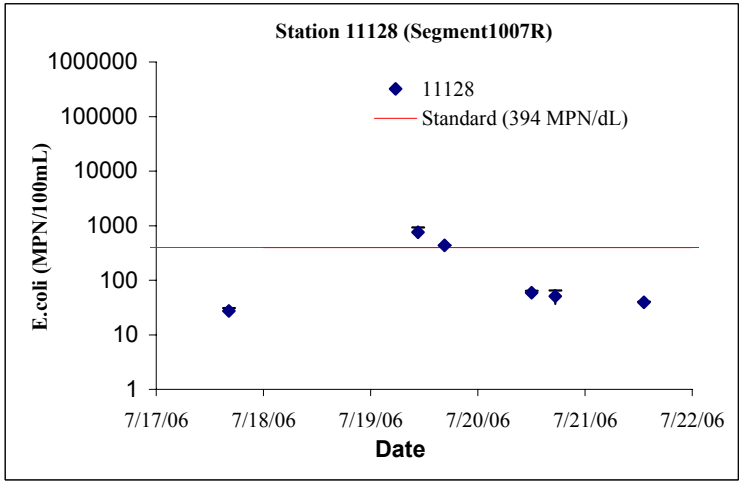
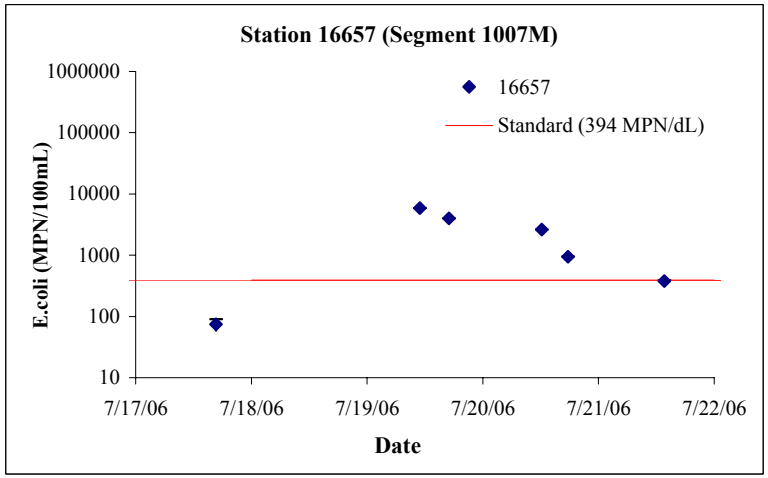


(c)

Fig 7.15 *E.coli* Concentration Trends During Metro Intensive # 3 in the Eastern Houston Watershed - Cont'd



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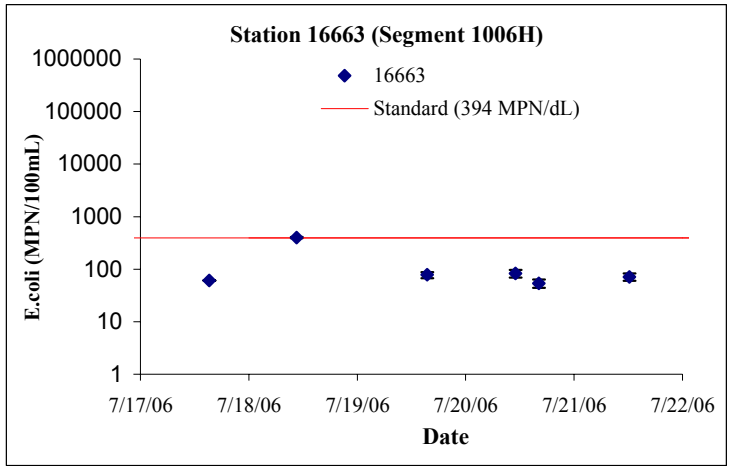

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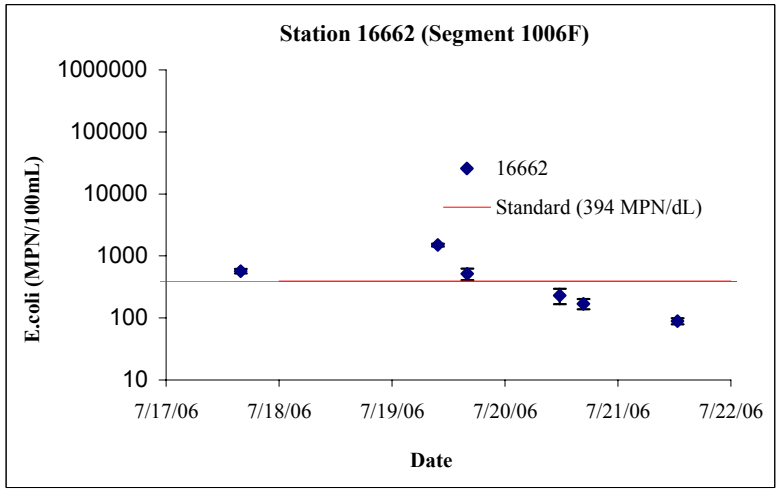

(c)

Fig 7.15 *E.coli* Concentration Trends During Metro Intensive # 3 in the Eastern Houston Watershed - Cont'd

CHAPTER 8

SUMMARY AND FUTURE ACTIVITIES

8.1 SUMMARY

Results from the sampling conducted at 21 locations in the Houston Metro area during FY 06 were presented. The data were used to construct load duration curves for the 21 locations. In addition, the report presented the historical data as well as temporal and spatial analysis of trends. The historical data analysis indicated that no temporal or spatial trends could be discerned and that sources of bacteria in the Metro area are likely to be diverse in nature and of point and non point origin.

8.2 PLANNED ACTIVITIES FOR THE FUTURE

The next quarter will focus on further analysis of the data from the Metro intensive surveys 1 through 3 and developing a strategy for calculating the TMDL.

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

(Electronic)

APPENDIX B

QUALITY ASSURANCE/QUALITY CONTROL

(Electronic)