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April 2013 Update to the Texas Water Quality Management Plan

Prepared by the:
Office of Water, Water Quality Division

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

April 2013 Update to the Texas Water Quality Management Plan

Compiled and distributed by the
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WQMP updates are also available on the TCEQ web site at:

< *www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html* >

Developed in accordance with Sections 205(j), 208,
and 303 of the Federal Clean Water Act
and applicable regulations thereto.

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Introduction

The Texas Water Quality Management Plan (WQMP) is the product of a wastewater treatment facility planning process developed and updated in accordance with provisions of Sections 205(j), 208, and 303 of the federal Clean Water Act (CWA), as amended. The WQMP is an important part of the State's program for accomplishing its clean water goals.[1]

The Texas Department of Water Resources, a predecessor agency of the Texas Commission on Environmental Quality (TCEQ), prepared the initial WQMP for waste treatment management during the late 1970s. The Clean Water Act mandates that the WQMP be updated as needed to fill information gaps and revise earlier certified and approved plans. Any updates to the plan need involve only the elements of the plan that require modification. The original plan and its subsequent updates are collectively referred to as the State of Texas Water Quality Management Plan.

The WQMP is tied to the State's water quality assessments that identify priority water quality problems. The WQMPs are used to direct planning for implementation measures that control and/or prevent water quality problems. Several elements may be contained in the WQMP, such as effluent limitations of wastewater facilities, total maximum daily loads (TMDLs), nonpoint source management controls, identification of designated management agencies, and ground water and source water protection planning. Some of these elements may be contained in separate documents which are prepared independently of the current WQMP update process, but may be referenced as needed to address planning for water quality control measures.

This document, as with previous updates[2], will become part of the WQMP after completion of its public participation process, certification by the TCEQ on behalf of the Governor of Texas, and approval by the United States Environmental Protection Agency (EPA).

The materials presented in this document revise only the information specifically addressed in the following sections. Previously certified and approved water quality management plans remain in effect.

The April 2013 WQMP update addresses the following topics:

1. Projected Effluent Limits Updates for water quality planning purposes
2. Service Area Population for Municipal Wastewater Facilities
3. Designation of Management Agencies for Municipal Wastewater Facilities
4. Total Maximum Daily Load Updates

[1] A formal definition for a water quality management plan is found in 40 Code of Federal Regulations (CFR) 130.2(k).

[2] Fiscal Years 1974, 1975, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984/85, 1986/88, 1989, 1990, 1991, 1992, 1993/94, 1995, 1996, 1997/98, 02/1999, 05/1999, 07/1999, 10/1999, 01/2000, 04/2000, 07/2000, 10/2000, 01/2001, 04/2001, 07/2001, 10/2001, 01/2002, 04/2002, 07/2002, 10/2002, 01/2003, 04/2003, 07/2003, 10/2003, 01/2004, 04/2004, 07/2004, 10/2004, 01/2005, 04/2005, 07/2005, 10/2005, 01/2006, 04/2006, 07/2006, 10/2006, 01/2007, 04/2007, 07/2007, 10/2007, 01/2008, 04/2008, 07/2008, 10/2008, 01/2009, 04/2009, 07/2009, 10/2009, 01/2010, 04/2010, 07/2010,10/2010, 01/2011, 04/2011, 07/2011, 10/2011, BPUB 2011, 01/2012 04/2012, 07/2012, 10/2012, and 01/2013.

The Projected Effluent Limit Update section provides information compiled from February 1, 2013 through April 30, 2013, and is based on water quality standards, and may be used for water quality planning purposes in Texas Pollutant Discharge Elimination System (TPDES) permit actions.

The Service Area Population and Designation of Management Agencies sections for municipal wastewater facilities has been developed and evaluated by the TCEQ in cooperation with the Texas Water Development Board (TWDB) and regional water quality management planning agencies.

The Total Maximum Daily Load (TMDL) Update section provides information on proposed waste load allocations for new dischargers and revisions to existing TMDLs and has been developed by the Water Quality Planning Division, TMDL Program.

Projected Effluent Limit Updates

Table 1 reflects proposed effluent limits for new dischargers and preliminary revisions to original proposed effluent limits for preexisting dischargers (MGD-Million Gallons per Day, $CBOD_5$ – 5 Day Carbonaceous Biochemical Oxygen Demand, NH_3-N – Ammonia-Nitrogen, BOD_5 – 5 Day Biochemical Oxygen Demand and DO – Dissolved Oxygen).

Effluent flows indicated in Table 1 reflect future needs and do not reflect current permits for these facilities. These revisions may be useful for water quality management planning purposes. The effluent flows and constituent limits indicated in the table have been preliminarily determined to be appropriate to satisfy the stream standards for dissolved oxygen in their respective receiving waters. These flow volumes and effluent sets may be modified at the time of permit action. These limits are based on water quality standards (WQS) effective at the time of the TCEQ production of this update. WQS are subject to revision on a triennial basis.

Table 1. Projected Effluent Limit Updates

State Permit Number	Segment Number	EPA ID Number	Permittee Name County	Flow (MGD)	$CBOD_5$ (mg/L)	$CBOD_5$ (lbs/day)	NH_3-N (mg/L)	NH_3-N (lbs/day)	BOD_5 (mg/L)	BOD_5 (lbs/day)	DO (mg/L)	Months/ Comments
10006-001	1228	TX0047155	City of Cleburne Johnson	6.0	5	250.20	1.9	95.08			6	Outfall 003
10038-001	1400	TX0023426	City of Big Lake Reagan	0.525	10	43.79	3	13.14			4	
10681-008	2304	TX0134384	City of Laredo Webb	1.75	10	145.95	3	43.79			4	
11269-001	1913	TX0077232	Cibolo Creek Municipal Authority Bexar *Applicable for Outfalls 001 and 002	10	5	417.00	1.5	125.10			6	Apr.-Oct.
				10	7	583.80	2	166.80			6	Nov.-Mar.
13374-002	2492	TX0112763	Riviera WCID Kleberg	0.06					20	10.01	2	
13819-001	1009	TX0113930	Quadvest, L.P. Harris	0.52	10	43.37	3	13.01			4	
13849-001	0605	TX0134252	Algonquin Water Resources Of Texas Inc. Smith	0.20	10	16.68	3	5.00			4	
14415-003	2202	TX0133841	Agua SUD Hidalgo	7.55	10	629.67	2	125.93			6	
14477-001	1250	TX0126195	City of Liberty Hill Williamson	4.0	5	166.80	2	66.72			5	
14973-001	1008	TX0132632	Aqua Texas, Inc. Montgomery	0.20	10	16.68	3	5.00			4	

14988-001	1908	TX0132837	South Central Water Co. Comal	2.25	5	93.83	2	37.53			6	
15064-001	1810	TX0133892	Walton Texas, L.P. Caldwell	1.55	7	90.49	2	25.85			6	
15068-001	0606	TX0133931	Free State Sewer Service & Water Supply Corp. Van Zandt	0.10	10	8.34	3	2.50			4	
15069-001	1400	TX0133957	South Central Water Co. Howard	0.30					10	25.02	4	
15070-001	0901	TX0133965	Surface Resources, Inc. Chambers	0.045	10	3.75	3	1.13			4	MOA
15071-001	1803	TX0133981	Halepaska Property Management, L.L.C. Victoria	0.02	10	1.67	3	0.50			4	
15072-001	1014	TX0134261	KB Home Lone Star, Inc. Fort Bend	0.50	5	20.85	2	8.34			6	
15078-001	1232	TX0134341	South Central Water Co. Fisher	0.30					10	25.02	4	
15079-001	1901	TX0134350	South Central Water Co. Karnes	0.0125					10	1.04	4	
15080-001	1434	TX0134368	Walton Texas, L.P. Caldwell	0.12	5	5.00	2	2.00			4	

Planning Information Summary

The Water Quality Planning Division of the TCEQ coordinated with the TWDB and regional planning agencies to compile the wastewater facility information in this section. Domestic facility financing decisions under the State Revolving Loan Fund (SRF) program must be consistent with the certified and approved WQMP.

The purpose of this section is to present data reflecting facility planning needs, including previous water quality management plan needs requiring revision. Data are also presented to update other plan information for the TWDB's SRF projects. Table 2 contains the updated Service area population information. The table is organized in alphabetical order and includes the following 10 categories of information:

1. *Planning Area* – Area for which facility needs are proposed. The facility planning areas are subject to change during the facility planning process and any such changes will be documented in a later water quality management plan update. All planning areas listed are also designated management agencies (DMAs) unless otherwise noted in the "Comments" column.

2. *Service Area* – Area that receives the provided wastewater service.

3. *Needs* – A "T" indicates a need for either initial construction of a wastewater treatment plant, additional treatment capacity, or the upgrading of a wastewater treatment plant to meet existing or more stringent effluent requirements. A "C" indicates a need for improvements to, expansion of, rehabilitation of, or the initial construction of a wastewater collection system in the facility planning area. "T/C" indicates a need for both treatment and collection system facilities. More detailed facility planning conducted during a construction project may define additional needs and those needs will be reflected in a future update to the WQMP.

4. *Needs Year* – The year in which the needs were identified for the planning area.

5. *Basin Name* – The river basin or designated planning area where the entity is located. The seven water quality management planning areas designated by the Governor are Corpus Christi [Coastal Bend Council of Governments (CBCOG)], Killeen-Temple [Central Texas Council of Governments (CTCOG)], Texarkana [Ark-Tex Council of Governments (ATCOG)], Southeast Texas [South East Texas Regional Planning Council (SETRPC)], Lower Rio Grande Valley [Lower Rio Grande Valley Development Council (LRGVDC)], Dallas-Fort Worth [North Central Texas Council of Governments (NCTCOG)] and Houston [Houston-Galveston Area Council (H-GAC)]. Basin names are shown for agencies outside one of these areas.

6. *Segment* – The classified stream segment or tributary into which any recommended facility may discharge existing or projected wastewater. In the case of no-discharge facilities, this is the classified stream segment drainage area in which the facilities are located.

7. *County* – The county in which the facility planning area is located.

8. *Date* – The date the planning information was reviewed by the TCEQ.

9. *Comments* – Additional explanation or other information concerning the facility planning area.

10. *Population* – The base year and projected populations for each facility planning area. Population projections presented are consistent with the latest available statewide population projections or represent the most current information obtained from facility planning analyses.

The facility information in this section is intended to be utilized in the preparation of facility plans and the subsequent design and construction of wastewater facilities. Design capacities of the treatment and collection systems will be based upon the population projections contained in this document plus any additional needed capacity established for commercial/industrial flows and documented infiltration/inflow volumes (treatment or rehabilitation). The probable needs shown under the "Needs" heading are preliminary findings; specific needs for an area shall be as established in the completed and certified detailed engineering studies conducted during facility planning under the SRF and other state loan programs.

Specific effluent quality for any wastewater discharges resulting from any of the facilities recommended in this document will be in accordance with the rule on the Texas Surface Water Quality Standards in effect at the time of permit issuance for the specific facility.

Table 2. Service Area Population Updates

Planning Agency	Service Area	Needs	Needs Year	Basin Name / COG	Segment	County	WQMP Date	Comments	Year	Population
City of Edcouch	Edcouch	C	2013	Nueces-Rio Grande / LRGVDC	2491	Hidalgo	2/14/2013	Extension of sanitary sewer lines.	2010	4,076
									2020	4,659
									2030	5,311
									2040	6,013
City of Falfurrias	Falfurrias	C	2012	Nueces-Rio Grande Coastal Basin / CBCOG	2492	Brooks	4/26/2013	Rehabilitation of lift stations, replace main plant force main, and identify repair needs of collection system.	2010	4,981
									2020	5,557
									2030	6,200
									2040	6,916
City of Grand Prairie	Grand Prairie	C	2012	Trinity River / NCTCOG	0841	Dallas	4/25/2013	Replace and/or repair sewer pipes.	2010	170,000
									2020	196,000
									2030	231,011
City of Houston	Houston	C	2013	San Jacinto-Brazos / HGAC	Various	Harris, Fort Bend, & Montgomery	2/14/2013	Replace and/or repair sewer pipes.	2010	2,240,974
									2020	2,520,926
									2030	2,798,278
									2040	3,070,268

Designated Management Agencies

In order to be designated as a management agency for wastewater collection or treatment, an entity must demonstrate the legal, institutional, managerial and financial capability necessary to carry out the entity's responsibilities in accordance with Section 208 (c) of the Clean Water Act (see below list of requirements). Before an entity can apply for a state revolving fund loan, it must be recommended for designation as the management agency in the approved WQMP. Designation as a management agency does not require the designated entity to provide wastewater services, but enables it to apply for grants and loans to provide the services. The facilities listed in Table 3 have submitted Designated Management Agencies (DMA) resolutions to the TCEQ. The TCEQ submits this DMA information to the EPA for approval as an update to the WQMP.

Section 208 (c) (2) Requirements for Management Agency:

208(c)(2)(A): to carry out portions of an area-wide waste treatment plan.
208(c)(2)(B): to manage waste treatment works.
208(c)(2)(C): directly or by contract to design and construct new works.
208(c)(2)(D): to accept and utilize grants.
208(c)(2)(E): to raise revenues, including assessment of waste treatment charges.
208(c)(2)(F): to incur short and long term indebtedness.
208(c)(2)(G): to assure community pays proportionate cost.
208(c)(2)(H): to refuse to receive waste from non-compliant dischargers.
208(c)(2)(I): to accept for treatment industrial wastes.

Table 3. Designated Management Agencies Updates

Planning Agency	Service Area	DMA Needs	DMA Date	DMA Area/Comments
City of Edcouch	City Limits/ETJ	T/C	6/5/2012	

Total Maximum Daily Load Updates

The Total Maximum Daily Load (TMDL) Program works to improve water quality in impaired or threatened waters bodies in Texas. The program is authorized by and created to fulfill the requirements of Section 303(d) of the federal Clean Water Act.

The goal of a TMDL is to restore the full use of a water body that has limited quality in relation to one or more of its uses. The TMDL defines an environmental target and based on that target, the State develops an implementation plan with waste load allocations for point source dischargers to mitigate anthropogenic (human-caused) sources of pollution within the watershed and restore full use of the water body.

The development of TMDLs is a process of intensive data collection and analysis. After adoption by the TCEQ, TMDLs are submitted to the EPA for review and approval.

The attached appendixes may reflect proposed waste load allocations for new dischargers and revisions to TMDLs. To be consistent, updates will be provided in the same units of measure used in the original TMDL document. And note that for bacteria TMDLs, loads may be expressed in counts for day, organisms per day, colony forming units per day, or similar expressions. These typically reflect different lab methods, but for the purposes of the TMDL program, these terms are considered synonymous.

Appendix I. Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries For Segment Numbers 1013, 1013A, 1013C, 1014, 1014A, 1014B, 1014E, 1014H, 1014K, 1014L, 1014M, 1014N, 1014O, 1017, 1017A, 1017B, 1017D, and 1017E

TMDL Updates to the Water Quality Management Plan (WQMP): Buffalo and Whiteoak Bayous and Tributaries (Segments 1013, 1013A, 1013C, 1014, 1014A, 1014B, 1014E, 1014H, 1014K, 1014L, 1014M, 1014N, 1014O, 1017, 1017A, 1017B, 1017D, and 1017E)

The document *Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries For Segment Numbers 1013, 1013A, 1013C, 1014, 1014A, 1014B, 1014E, 1014H, 1014K, 1014L, 1014M, 1014N, 1014O, 1017, 1017A, 1017B, 1017D, and 1017E* was adopted by the TCEQ on 04/08/2009 and approved by EPA on 06/11/09, and became an update to the state's Water Quality Management Plan (WQMP). Six subsequent WQMP updates prior to this one have updated the list of individual waste load allocations (WLAs) found in the original TMDL document.

The purpose of this update is to make the following changes to the TMDL, presented in Table 1:

- add a new permit.

The changes reflected in this update resulted in the shifting of allocations between the sum of the individual WLAs and the allowance for future growth (AFG) in one assessment unit (AU). This was originally presented in Table 53 in the TMDL document, and the affected AU is included here as Table 2.

In Table 54 of the TMDL, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for future growth within each assessment unit. Therefore, these overall numbers did not change, and Table 54 of the TMDL remains the same.

Table 1 – Change to Individual Waste Load Allocation (Updates Table 45, pp. 99-103 in the TMDL document.)

State Permit Number	Outfall	EPA Permit Number	Segment Number	Permittee Name	Flow (MGD)	Waste Load Allocation (WLA) - *E. coli* in Billion MPN/day	TMDL Comments
15072-001	001	TX0134261	1014B_01	KB HOME LONE STAR INC.	0.5	1.19	New permit

Table 2 - *E. coli* TMDL Summary Calculation (Updates Table 53, pp. 118-119 in the TMDL document.)

Assess-sess-ment Unit	TMDL (Billion MPN/day)	WLA_{WWTF} (Billion MPN/day)	$WLA_{Storm-Water}$ (Billion MPN/day)	LA (Billion MPN/day)	MOS (Billion MPN/day)	Upstream Load (Billion MPN/day)	Future Growth (Billion MPN/day)
1014B_01	626.91	88.34	482.44	38.6	0	0	17.53

Appendix II. Fifteen Total Maximum Daily Loads for Indicator Bacteria in Watersheds Upstream of Lake Houston For Segment Numbers 1004E, 1008, 1008H, 1009, 1009C, 1009D, 1009E, 1010, and 1011

TMDL Updates to the Water Quality Management Plan (WQMP): Watersheds Upstream of Lake Houston (1004E, 1008, 1008H, 1009, 1009C, 1009D, 1009E, 1010, and 1011)

The document *Fifteen Total Maximum Daily Loads for Indicator Bacteria in Watersheds Upstream of Lake Houston For Segment Numbers 1004E, 1008, 1008H, 1009, 1009C, 1009D, 1009E, 1010, and 1011* was adopted by the TCEQ on 04/06/11 and approved by EPA on 06/29/11, and became an update to the state's Water Quality Management Plan (WQMP). Six subsequent WQMP updates prior to this one have updated the list of individual waste load allocations (WLAs) found in the original TMDL document.

The purpose of this update is to make the following changes to the TMDL, presented in Table 1:

- update the names and WLAs for two facilities that have increased their permitted discharges,
- add a new permit,
- remove two expired permits, and
- update the name of one facility.

The changes reflected in this update resulted in the shifting of allocations between the sum of the individual WLAs and the allowance for future growth (AFG) in six assessment units (AUs). This was originally presented in Table 18 in the TMDL document, and the six affected AUs are included here as Table 2.

In Table 19 of the TMDL, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for future growth within each assessment unit. Therefore, these overall numbers did not change, and Table 19 of the TMDL remains the same.

Table 1 – Changes to Individual Waste Load Allocations (Updates Table 16, pp. 49-56 in the TMDL document.)

State Permit Number	Outfall	EPA Permit Number	Segment Number	Permittee Name	Flow (MGD)	Waste Load Allocation (WLA) – *E. coli* in Billion MPN/day	TMDL Comments
14973-001	001	TX0132632	1008_03	AQUA TEXAS INC	0.2	0.48	Increased flow and changed name
13819-001	001	TX0113930	1009_04	QUADVEST LP	0.52	1.24	Increased flow and changed name
15041-001	001	TX0133612	1008_03	5732 WOODARD PARTNERS LTD	0.96	2.29	New Permit
14918-001	001	TX0131725	1008C_01*	WOODLANDS DB LP	N/A	N/A	Permit Expired
11887-001	001	TX0073393	1009E_01	GRANT ROAD PUD	N/A	N/A	Permit Expired
12519-001**	001	TX0089915	1008H_01	AQUA TEXAS INC	No change	No change	Name Changed

*Not part of this TMDL project, but a major tributary to impaired segment 1008 (Spring Creek)
**This WWTF is downstream of USGS Gauge 8068325, and is not used in the WLA-WWTF for 1008H_01, but is included in the overall totals for 1008_03 and 1008_04

Table 2 - *E. coli* TMDL Summary Calculations for Lake Houston Assessment Units (Updates Table 18, pp. 61 in the TMDL document.)

Assess-ment Unit	Sampling Location	Stream Name	TMDL (Billion MPN/day)	WLA_{WWTF} (Billion MPN/day)	$WLA_{StormWater}$ (Billion MPN/day)	LA (Billion MPN/day)	MOS (Billion MPN/day)	Future Growth (Billion MPN/day)
1008_03	11313	Spring Creek	1,420	93.7	141	1,050	70.9	62.0
1008_04	11312	Spring Creek	1,510	126	146	1,090	75.7	77.6
1009_02	11331	Cypress Creek	615	71.1	141	325	30.8	47.4
1009_03	11328	Cypress Creek	1,340	155	299	690	67.0	128
1009_04	11324	Cypress Creek	1,550	194	338	779	77.4	160
1009_04	11324	Cypress Creek	1550	194	338	779	77.4	160

Appendix III. Addendum One to Five Total Maximum Daily Loads for Indicator Bacteria in Brays Bayou Above Tidal and Tributaries

Three Total Maximum Daily Loads for Indicator Bacteria in Three Tributaries to Brays Bayou

For Segments 1007S, 1007T, and 1007U
Assessment Units 1007S_01, 1007T_01, and 1007U _01

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted the total maximum daily loads (TMDLs) *Five Total Maximum Daily Loads for Indicator Bacteria in Brays Bayou Above Tidal and Tributaries: Segments 1007B, 1007C, 1007E, and 1007L* (TCEQ 2010a) on 9/15/2010. The TMDLs were approved by the United States Environmental Protection Agency (EPA) on 9/27/10. This document represents an addendum to the original TMDL document.

This addendum includes information specific to three additional segments located within the watershed of the approved TMDL project for bacteria in the Brays Bayou watershed. Concentrations of indicator bacteria in these segments exceed the criteria used to evaluate attainment of the contact recreation standard. This addendum presents the new information associated with the three additional segments. For background or other explanatory information for these three segments, please refer to *Technical Support Document: Bacteria Total Maximum Daily Loads for New/Additional Listings in the Houston Metro Area, Houston, Texas (1007T_01, 1007U_01, 1007S_01, 1007V_01, 1017C_01, and 1007A_01)* (University of Houston and Parsons 2012), which has additional details related to all aspects of this addendum.

Refer to the original, approved TMDL document for details related to the overall project watershed as well as the methods and assumptions used in developing all of these TMDLs. This addendum focuses on the subwatersheds of the additional segments. These subwatersheds, including permitted facilities within them, were addressed in the original TMDL. This addendum provides the details related to developing the TMDL allocations for these additional segments, which were not addressed individually in the original document. These segments are also covered by an implementation plan (I-Plan) that has been drafted by stakeholders in the greater Houston area. The I-Plan addresses multiple watersheds, including Brays Bayou's.

Problem Definition

The TCEQ first identified the bacteria impairments to the segments and assessment units (AUs) included in this addendum in the year 2010 Texas Water Quality Inventory and 303(d) List (Table 1). The impaired AUs are Poor Farm Ditch (1007S_01), Bintliff Ditch (1007T_01), and Mimosa Ditch (1007U_01). See Figure 1 for a map of the watershed.

The Texas surface water quality standards (SWQSs; TCEQ 2010b) provide numeric and narrative criteria to evaluate attainment of designated uses. The basis for water quality targets for all TMDLs developed in this report will be the numeric criteria for bacterial indicators from the 2010 Texas SWQS. *E. coli* is the preferred indicator bacteria for assessing contact recreation use in freshwater.

Table 2 summarizes the ambient water quality data for the TCEQ water quality monitoring (WQM) stations on each impaired water body.

Poor Farm Ditch (Segment 1007S_01): The single sample criterion for *E. coli* was exceeded in 74 percent of the samples at the only WQM station location within this subwatershed. The geometric mean criterion for *E. coli* was also exceeded.

Bintliff Ditch (Segment 1007T_01): The single sample criterion for *E. coli* was exceeded in 88 percent of the samples at the only WQM station location within this subwatershed. The geometric mean criterion for *E. coli* was also exceeded.

Mimosa Ditch (Segment 1007U_01): The single sample criterion for *E. coli* was exceeded in 95 percent of the samples at the only WQM station location within this subwatershed. The geometric mean criterion for *E. coli* was also exceeded.

Watershed Overview

The Brays Bayou Above Tidal watershed encompasses approximately 105 square miles of land located southwest of the City of Houston, Texas. The Brays Bayou Above Tidal watershed is part of the San Jacinto River Basin. The entire watershed's rainfall average is approximately 48 inches per year. Average values for the three subwatersheds are summarized in Table 3.

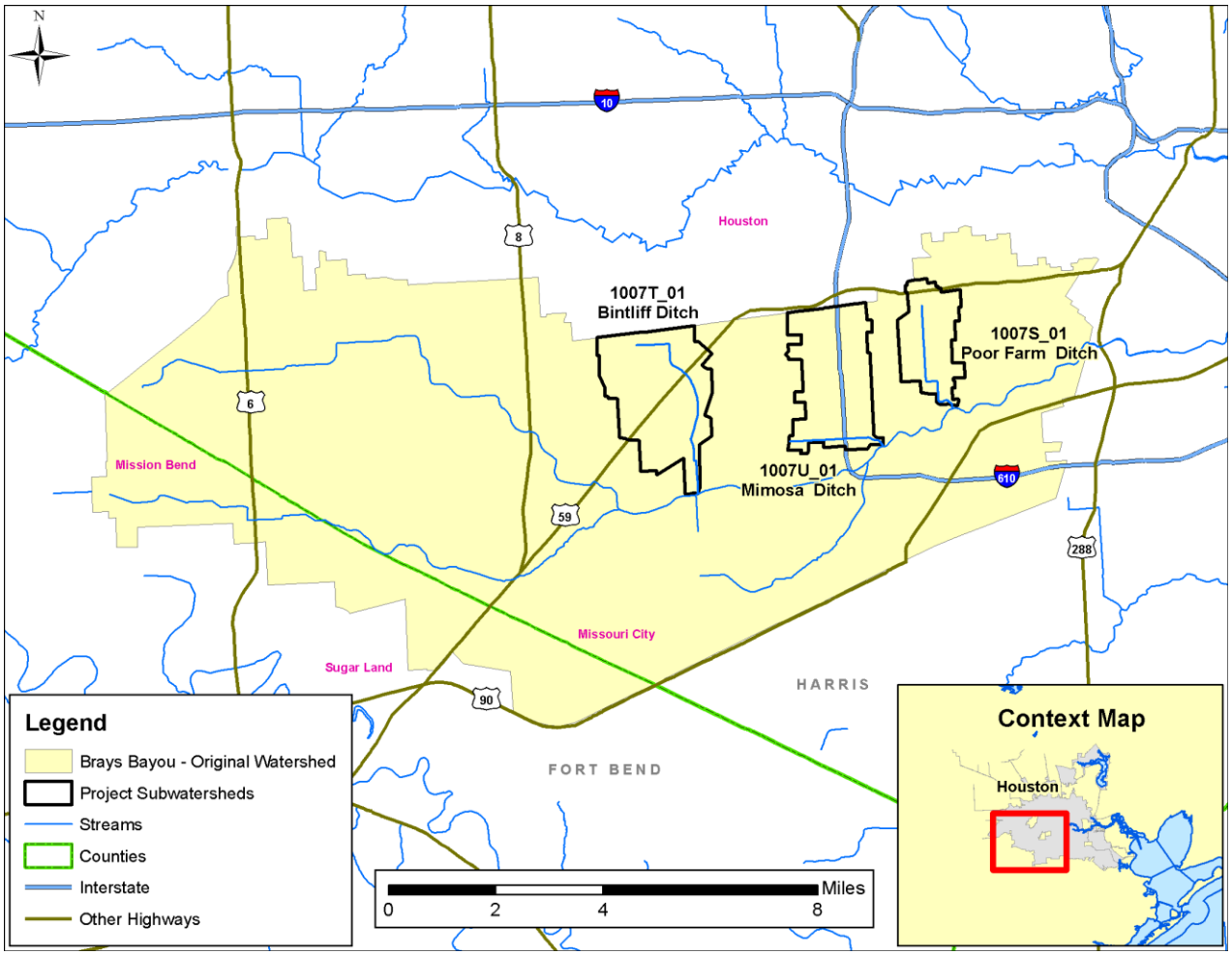


Figure 1. Brays Bayou Watershed [a]

[a] *All maps in this document were developed by the University of Houston and modified by the TMDL Program of the TCEQ. No claims are made to the accuracy or completeness of the data or to its suitability for a particular use. "TSARP" refers to the Tropical Storm Allison Recovery Project, for which some map delineations used in this project were originally created.*

Table 1. Synopsis of Texas Integrated Report for Water Bodies in the Brays Bayou Watershed

Segment ID	Segment Name	Parameter	Contact Recreation Use	Year Impaired	Category	Stream Length (miles)
1007S_01	Poor Farm Ditch	*E. coli*	Nonsupport	2010	5a	2.3
1007T_01	Bintliff Ditch	*E. coli*	Nonsupport	2010	5a	0.35
1007U_01	Mimosa Ditch	*E. coli*	Nonsupport	2010	5a	1.8

Table 2. Water Quality Data for TCEQ Stations from 1999 to 2011

Segment	Station ID	Indicator Bacteria	Geometric Mean Concentration (MPN/100ml)	Number of Samples	Number of Samples Exceeding Single Sample Criterion	% of Samples Exceeding
1007S_01	18692	*E. coli*	1,368	57	42	74%
1007T_01	18690	*E. coli*	5,206	56	49	88%
1007U_01	18691	*E. coli*	3,613	56	53	95%

MPN: Most Probable Number

Geometric Mean Criterion: 126 MPN/100 m.

Single Sample Criterion: 399 MPN/100 ml.

Table 3. Average Annual Precipitation in Study Area Subwatersheds, 1988-2007 (in inches)

Segment Name	Segment ID	Average Annual (Inches)
Poor Farm Ditch	1007S_01	48.98
Bintliff Ditch	1007T_01	46.71
Mimosa Ditch	1007U_01	48.62

Table 4 summarizes the acreages and the corresponding percentages of the land use categories associated with the three subwatersheds in the Brays Bayou Above Tidal watershed. The land use/land cover data were retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Coastal Services Center. The specific land use/land cover data files were derived from the Coastal Change Analysis Program (C-CAP), Texas 2005 Land Cover Data (NOAA 2007). The total acreage of each segment in Table 4 corresponds to the watershed delineation in Figure 2. Based on the data sources that were used, the predominant land use category in these subwatersheds is developed land (all over 99%).

Population estimates and future population projections were examined for counties and cities in the project area. These are discussed in the original TMDL document as well as the technical support document for this addendum.

Endpoint Identification

The water quality target for the TMDLs for these freshwater segments is to maintain concentrations below the geometric mean criterion of 126 MPN/100 mL for *E. coli*. Maintaining the geometric mean criterion for indicator bacteria is expected to be protective of the single sample criterion also and therefore

will ultimately result in the attainment of the contact recreation use. The TMDLs will be based on bacteria allocations required to meet the geometric mean criterion.

Source Analysis

Regulated Sources

There are two National Pollutant Discharge Elimination System (NPDES)/Texas Pollutant Discharge Elimination System (TPDES)-permitted facilities within the project's subwatersheds. In addition, the entire Study Area is regulated under the TPDES municipal separate storm sewer system (MS4) discharge permit jointly held by Harris County, Harris County Flood Control District (HCFCD), City of Houston, and Texas Department of Transportation. There are no NPDES-permitted Concentrated Animal Feeding Operations (CAFOs) within the Study Area.

The two TPDES-permitted facilities that continuously discharge wastewater to surface waters addressed in these TMDLs are listed in Table 5 and shown in Figure 3. The Poor Farm Ditch (1007S_01) and Mimosa Ditch (1007U_01) subwatersheds have one permitted facility each. There are no WWTFs located in the Bintliff Ditch (1007T_01) subwatershed. Figure 3 also shows water quality monitoring (WQM) stations and the MS4 coverage area.

Table 4. Aggregated Land Use Summaries by Segment

Aggregated Land Use Category	1007S_01	1007T_01	1007U_01
Acres of Developed	1,336	2,904	2,361
Acres Cultivated Land	0	0	0
Acres Pasture/Hay	0	0	0
Acres Grassland/Herbaceous	0	0	0
Acres of Woody Land	0.7	3.1	14
Acres of Open Water	1.1	0.4	0.2
Acres of Wetland	0.2	0	0
Acres of Bare/Transitional	0	0.2	0
Watershed Area (acres)	**1,338**	**2,908**	**2,375**
Percent Developed	99.9%	99.9%	99.4%
Percent Cultivated Land	0%	0%	0%
Percent Pasture/Hay	0%	0%	0%
Percent Grassland/Herbaceous	0%	0%	0%
Percent Woody Land	0.05%	0.11%	0.59%
Percent Open Water	0.08%	0.02%	0.01%
Percent Wetland	0.02%	0%	0%
Percent Bare/Transitional	0%	0.08%	0%

Table 5. TPDES-Permitted Facilities in the Study Area

Segment	Receiving Water	TPDES Number	NPDES NUMBER	Facility Name	Facility Type	Permitted Flow (MGD)
1007S_01	Poor Farm Ditch	14850-001	TX0026972	City of Southside Place	Sewerage Systems	0.3
1007U_01	Mimosa Ditch	10550-001	TX0020613	City of Bellaire-WWTP	Sewerage Systems	4.5

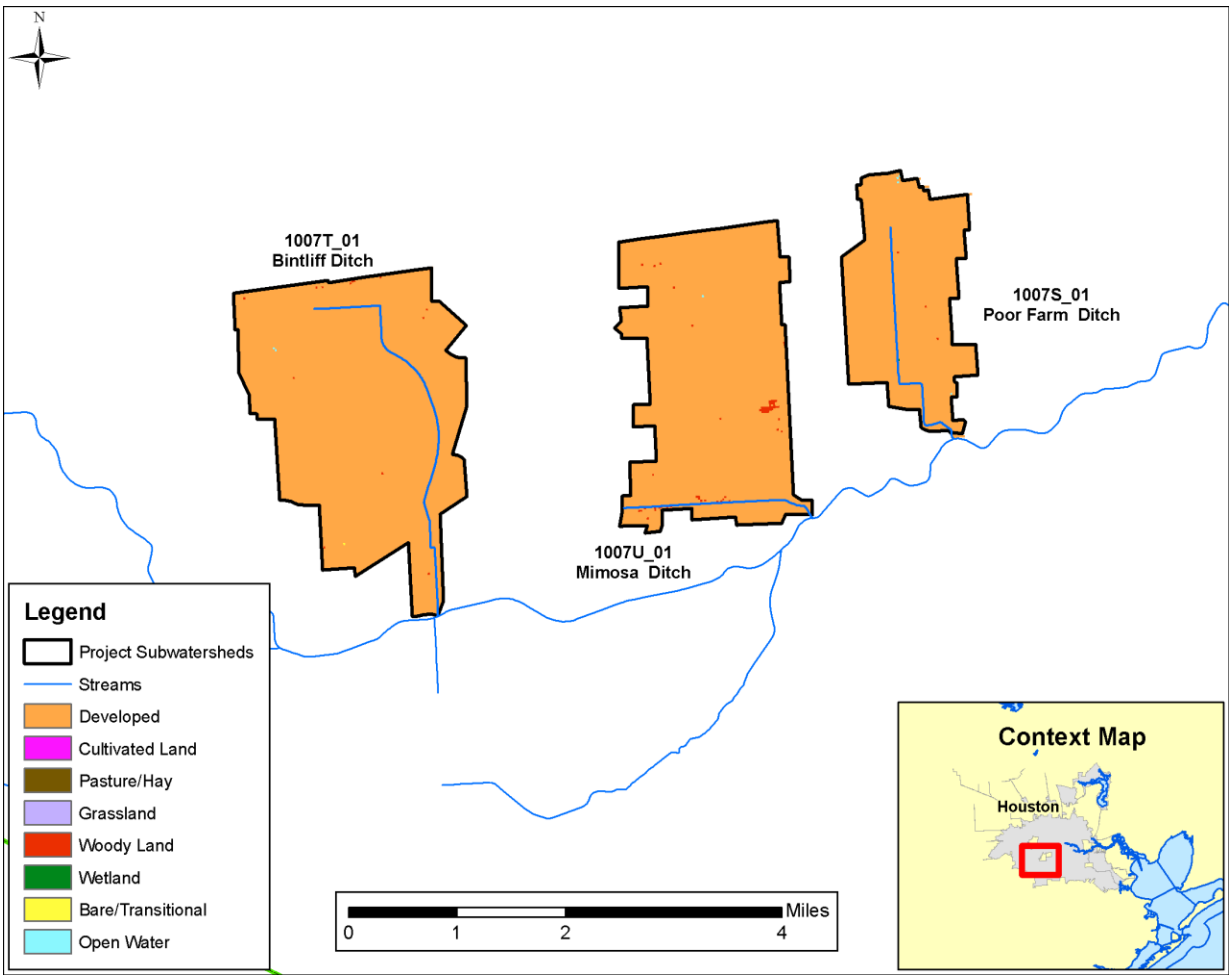
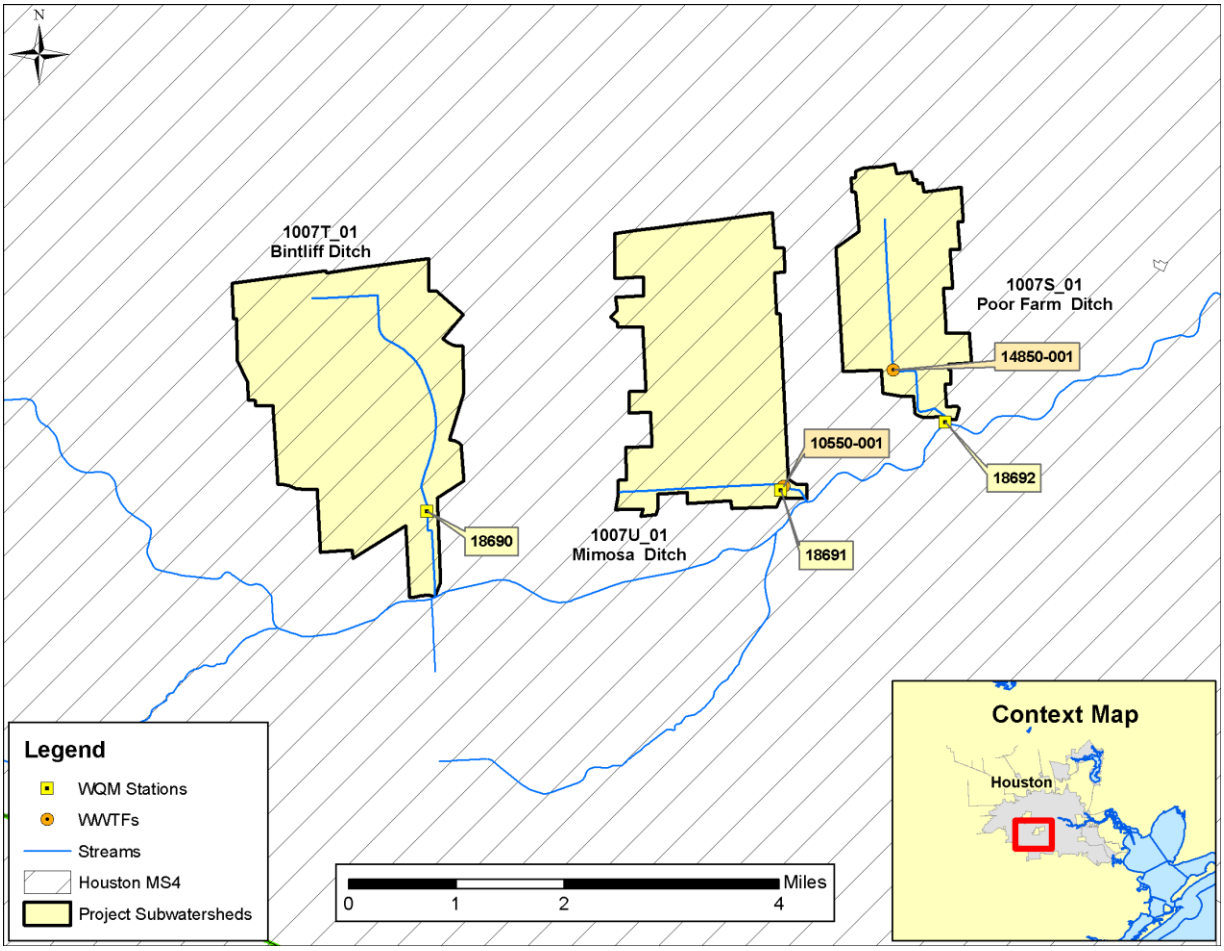


Figure 2. Land Use for Project Subwatersheds



Source: The jurisdictional boundary of the Houston MS4 permit is derived from Urbanized Area Map Results for Texas which can be found at the USEPA website <cfpub.epa.gov/npdes/stormwater/urbanmapresult.cfm?state=TX>.

Figure 3. TPDES-Permitted Facilities, WQM Stations, and MS4 Coverage Area in the Brays Bayou Above Tidal Subwatersheds

Sanitary Sewer Overflows

TCEQ Region 12-Houston provided two database queries for sanitary sewer overflow (SSO) data – one is collected by the City of Houston and the other is compiled from the remainder of the wastewater dischargers in the Study Area (Rice 2005).

These data are included in Table 6. The locations and magnitudes of the reported SSOs are displayed in Figure 4. The WWTF service area boundaries are also shown in Figure 4. The loads from these SSOs were accounted for in the original TMDL document. They are being assigned to specific subwatersheds in this addendum.

Table 6. Sanitary Sewer Overflow (SSO) Summary

Facility Name	NPDES Permit No.	TPDES Permit No.	# of Occur-rences	Date Range – From	Date Range – To	Gal-lons (Min)	Gal-lons (Max)	Gal-lons (Avg.)	Segment
City of Houston - Almeda Sims	TX0034924	10495-003	4	08/23/02	04/01/03	53	7166	1852	1007S_01
City of Houston - Southwest	TX0062995	10495-037	2	06/16/01	03/31/03	1640	11225	6433	1007S_01
City of Houston - Southwest	TX0062995	10495-037	18	02/25/01	07/23/03	76	10448	1725	1007T_01
City of Houston - Keegans Bayou	TX0098191	10495-119	10	07/27/01	07/30/03	70	15000	3562	1007T_01
City of Houston - Southwest	TX0062995	10495-037	1	03/09/01	03/09/01	3060	3060	3060	1007U_01

TPDES-Regulated Stormwater

The entirety of each subwatershed in the Study Area is covered under the City of Houston County MS4 permit (TPDES Permit No. WQ0004685000). Under the City of Houston/Harris County discharge permit, Harris County, HCFCD, City of Houston, and Texas Department of Transportation are designated as co-permittees.

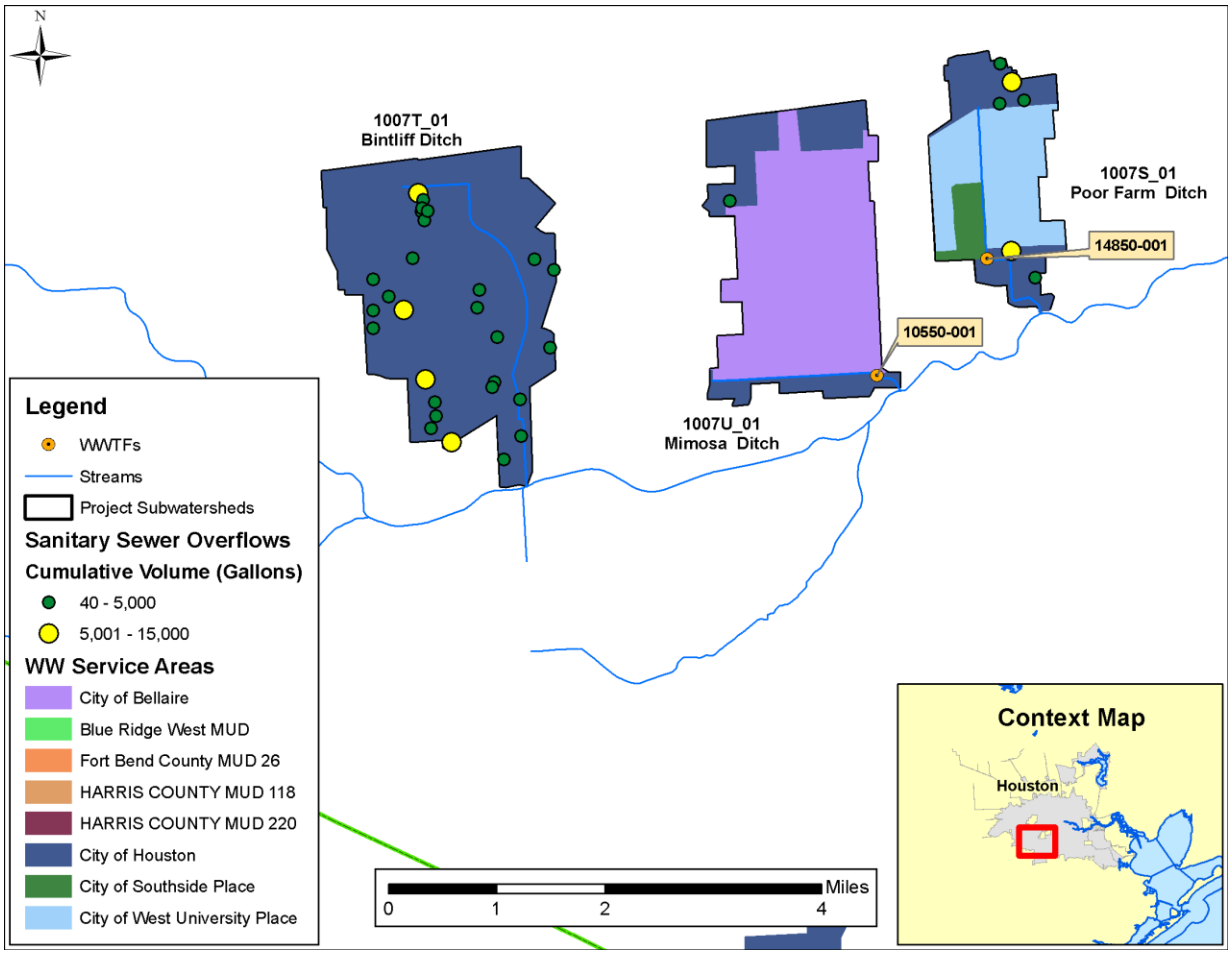


Figure 4. Locations of Sanitary Sewer Overflows

Unregulated Sources

Pollutants from unregulated sources enter the impaired AUs through distributed, nonspecific locations, which may include urban runoff not covered by a permit, wildlife, various agricultural activities and animals, land application fields, failing onsite sewage facilities (OSSFs), and domestic pets.

Wildlife and Unmanaged Animal Contributions

Currently there are insufficient data available to estimate populations and spatial distribution of wildlife and avian species by subwatershed. Consequently, it is difficult to assess the magnitude of bacteria contributions from wildlife species as a general category.

Unregulated Agricultural Activities and Domesticated Animals

A number of agricultural activities that do not require permits can also be sources of fecal bacteria loading. Given the fact that the TMDL Study Area is highly urbanized, livestock and other domesticated animals are either not found in these watersheds or exist in small numbers. Therefore, livestock and other domesticated animals are not considered as a contributor of bacteria loads.

Failing On-site Sewage Facilities

To estimate the potential magnitude of fecal bacteria loading from OSSFs, the number of OSSFs was estimated for the subwatersheds. The estimate of OSSFs was derived by using data from the 1990 U.S. Census (U.S. Census Bureau 2000) and a GIS shape file obtained from the Houston-Galveston Area Council (H-GAC) showing all areas where wastewater service currently exists. This analysis indicated that there are no unsewered areas with OSSFs in the project's subwatersheds. Therefore, OSSFs are not considered as a contributor of bacteria loads.

Domestic Pets

Fecal matter from dogs and cats is transported to streams by runoff from urban and suburban areas and can be a potential source of bacteria loading. On average nationally, there are 0.58 dogs per household and 0.66 cats per household (American Veterinary Medical Association 2007). Using the U.S. Census data at the block level (U.S. Census Bureau 2010), dog and cat populations can be estimated for each subwatershed. Table 7 summarizes the estimated number of dogs and cats for the subwatersheds of the Study Area. Only a small portion of the bacteria load from pets is expected to reach water bodies, through wash-off of land surfaces and conveyance in runoff. The pet number estimates were accounted for in the original TMDL document. They are being assigned to specific subwatersheds in this addendum.

Table 7. Estimated Numbers of Pets

Segment	Stream Name	Dogs	Cats
1007S_01	Poor Farm Ditch	4,201	4,739
1007T_01	Bintliff Ditch	8,444	9,526
1007U_01	Mimosa Ditch	4,611	5,202

Linkage Analysis

Load duration curve (LDC) analyses (including flow duration curve (FDC) analyses) were used for analyzing indicator bacteria loads and instream water quality for the segments in this project. The Technical Support Document has details about these analyses.

Margin of Safety

The TMDLs covered by this report incorporate an explicit margin of safety (MOS) by setting a target for indicator bacteria loads that is 5 percent lower than the single sample criterion. The MOS was used because of the limited amount of data available for the sampling locations. For contact recreation, this equates to a single sample target of 379 MPN/100mL for *E. coli* and a geometric mean target of 120 MPN/100mL. The net effect of the TMDL with MOS is that the assimilative capacity or allowable pollutant loading of each water body is slightly reduced. The TMDLs covered by this report incorporate an explicit MOS in each LDC by using 95 percent of the single sample criterion.

Pollutant Load Allocation

Pollutant load allocations were developed using analysis of the FDC and the LDC method. To establish the subwatershed targets, TMDL calculations and associated allocations are established for the most-downstream sampling locations in the subwatersheds. This establishes a distinct TMDL for the 303(d) listed water bodies.

To calculate the bacteria load at the criterion for the segments, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*24,465,755 dL/ft3 * seconds/day*) and the *E. coli* criterion. This calculation produces the maximum bacteria load in the stream without exceeding the instantaneous standard over the range of flow conditions. *E. coli* loads are plotted versus flow exceedance percentiles as an LDC. The x-axis indicates the flow exceedance percentile, while the y-axis is expressed in terms of a bacteria load.

To estimate existing loading in the Study Area, bacteria observations from 1999 to 2011 are paired with the flows measured or estimated in that segment on the same date. Pollutant loads are then calculated by multiplying the measured bacteria concentration by the flow rate and a unit conversion factor of *24,465,755 dL/ft3 * seconds/day*. The associated flow exceedance percentile is then matched with the measured flow. The observed bacteria loads are added to the LDC plot as points. These points represent individual ambient water quality samples of bacteria. Points above the LDC indicate the bacteria instantaneous standard was exceeded at the time of sampling. Conversely, points under the LDC indicate the sample met the criterion.

The LDC approach recognizes that the assimilative capacity of a water body depends on the flow, and that maximum allowable loading varies with flow condition. Existing loading and loads that meet the TMDL water quality target can also be calculated under different flow conditions.

The load allocation goal for these segments is based on data analysis using the geometric mean criterion since it is anticipated that achieving the geometric mean over an extended period of time will likely ensure that the single sample criterion will also be achieved.

Figure 5 represents the LDC for Poor Farm Ditch and is based on *E. coli* bacteria measurements at sampling location 18692 (Poor Farm Ditch at N Braeswood). The LDC indicates that *E. coli* levels exceed the instantaneous and geometric mean water quality criteria under all flow conditions. Wet weather influenced *E. coli* observations are found under all flow conditions. The allocation goal for the segment used in the final TMDL equation was based on the flow regime with the highest bacteria load (0–20th percentile).

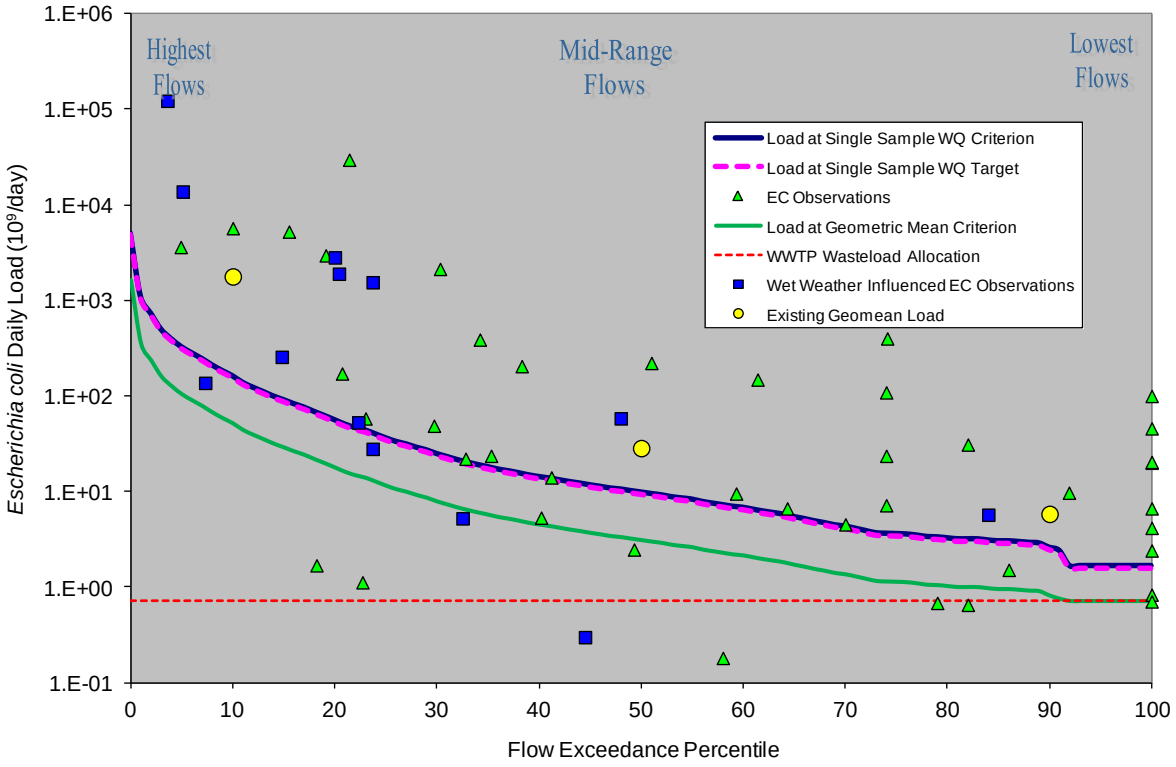


Figure 5. Load Duration Curve for Poor Farm Ditch (1007S_01)

Figure 6 represents the LDC for Bintliff Ditch and is based on *E. coli* bacteria measurements at sampling location 18690 (Bintliff Ditch at Bissonnet). The LDC indicates that *E. coli* levels exceed the instantaneous and geometric mean water quality criteria under high and mid-range flow conditions. Wet weather influenced *E. coli* observations are found under high and mid-range flow conditions. The allocation goal for the segment used in the final TMDL equation was based on the flow regime with the highest bacteria load (0–20th percentile).

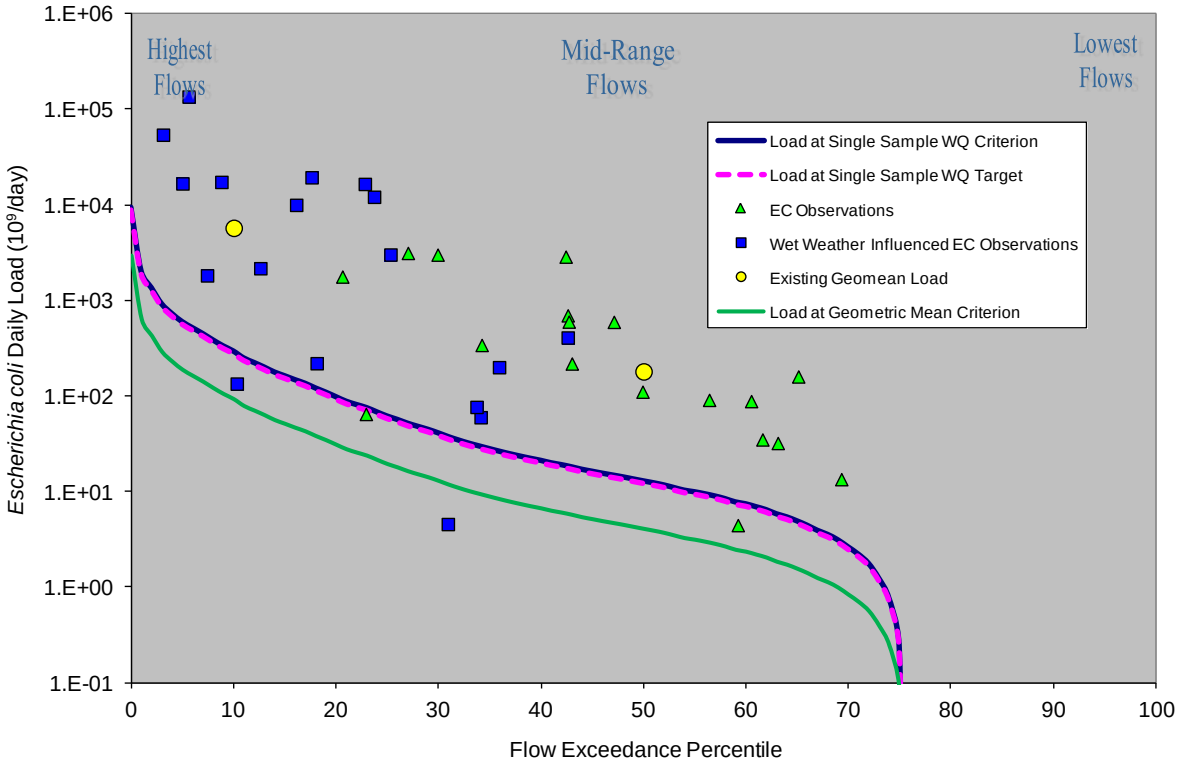


Figure 6. Load Duration Curve for Bintliff Ditch (1007T_01)

Figure 7 represents the LDC for Mimosa Ditch and is based on *E. coli* bacteria measurements at sampling location 18691 (Mimosa Ditch at Newcastle Dr.). The LDC indicates that *E. coli* levels exceed the instantaneous and geometric mean water quality criteria under all flow conditions. Wet weather influenced *E. coli* observations are found under high and mid-range flow conditions. The allocation goal for the segment used in the final TMDL equation was based on the flow regime with the highest bacteria load (0–20th percentile).

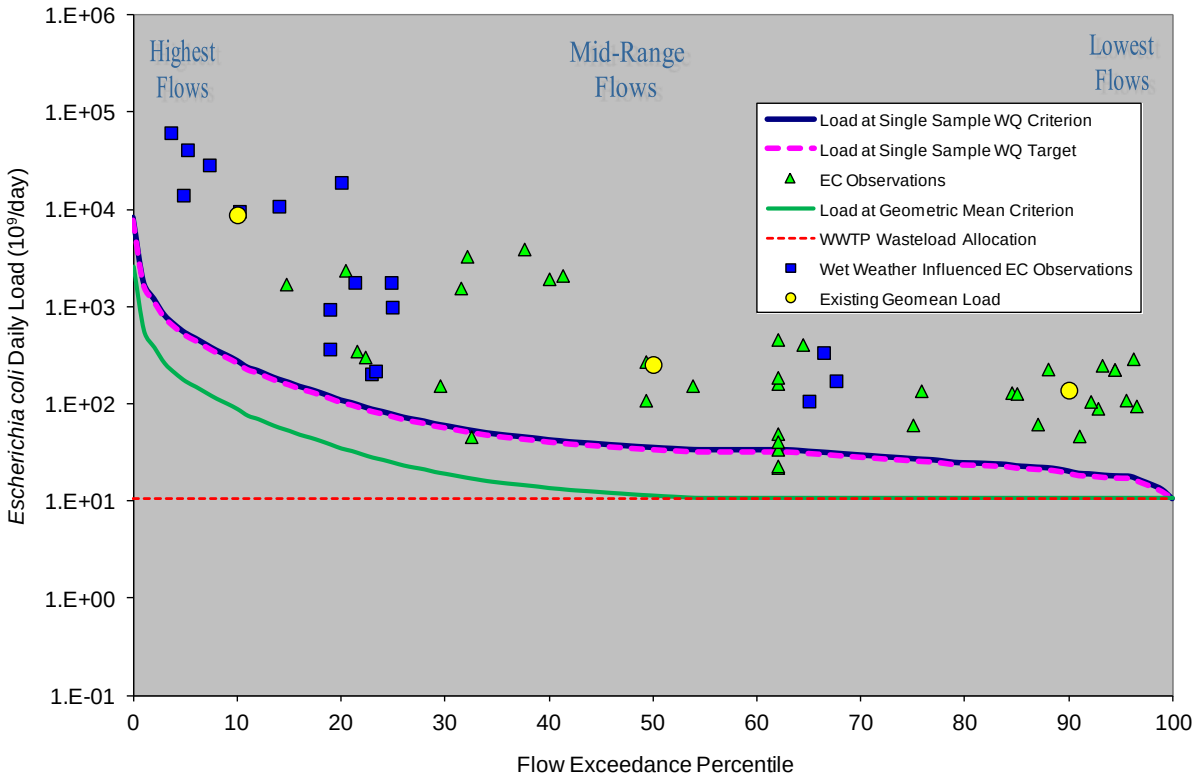


Figure 7. Load Duration Curve for Mimosa Ditch (1007U_01)

Wasteload Allocation

The wasteload allocation (WLA) is the sum of loads from regulated sources.

WWTFs

TPDES-permitted WWTFs are allocated a daily wasteload (WLA_{WWTF}) calculated as their permitted discharge flow rate multiplied by one-half the instream geometric mean water quality criterion. One-half of the water quality criterion is used as the target to provide instream and downstream load capacity, and to provide consistency with other TMDLs developed in the Houston area.

Table 8 summarizes the WLA for the TPDES-permitted facilities within the Study Area. WLAs were established for the facilities throughout the Brays Bayou Above Tidal watersheds in the original TMDL document and its subsequent Water Quality Management Plan (WQMP) updates. These facilities are being assigned to specific subwatersheds in this addendum.

Table 8. Wasteload Allocations for TPDES-Permitted Facilities

Assessment Unit	Stream Name	TPDES Number	NPDES Number	Facility Name	Final Permitted Flow (MGD)	*E. coli* WLA_{WWTF} (Billion MPN/day)
1007S_01	Poor Farm Ditch	14850-001	TX0026972	City of Southside Place	0.3	0.715
1007U_01	Mimosa Ditch	10550-001	TX0020613	City of Bellaire-WWTP	4.5	10.7

Stormwater

Stormwater discharges from MS4, industrial, and construction areas are considered permitted or regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). A simplified approach for estimating the WLA for these areas was used in the development of these TMDLs due to the limited amount of data available, the complexities associated with simulating rainfall runoff, and the variability of stormwater loading.

The percentage of the subwatersheds that are under the jurisdiction of stormwater permits (i.e., defined as the area designated as urbanized area in the 2000 US Census) is used to estimate the amount of the overall runoff load to be allocated as the regulated stormwater contribution in the WLA_{SW} component of the TMDL. The load allocation (LA) component of the TMDL corresponds to direct nonpoint source runoff and is the difference between the total load from stormwater runoff and the portion allocated to WLA_{SW}. For the subwatershed addressed in this TMDL, 100 percent of the area is within the urbanized area.

Load Allocation

The LA is the sum of loads from unregulated sources. Since the entirety of these subwatersheds is within the urbanized area, there is no LA for this TMDL.

Allowance for Future Growth

As described in the original TMDL document, future growth of existing or new point sources is not limited by these TMDLs as long as the sources do not cause indicator bacteria to exceed the limits. The assimilative capacity of streams increases as the amount of flow increases. Consequently, increases in flow allow for additional indicator bacteria loads if the concentrations are at or below the contact recreation standard. New or amended permits for wastewater discharge facilities will be evaluated case by case.

To account for the probability that increased or additional flows from WWTFs may occur in Poor Farm Ditch or Mimosa Ditch, a provision for future growth was included in the TMDL calculations by estimating permitted flows to year 2035 using population projections completed by H-GAC.

The three-tiered antidegradation policy in the SWQSs prohibits an increase in loading that would cause or contribute to degradation of an existing use. The antidegradation policy applies to both point and nonpoint source pollutant discharges. In general, antidegradation procedures establish a process for reviewing individual proposed actions to determine if the activity will degrade water quality. The TMDLs in this document will result in protection of existing beneficial uses and conform to Texas's antidegradation policy.

TMDL Calculations

Table 9 summarizes the estimated maximum allowable load of *E. coli* for the AUs included in this project.

The final TMDL allocations required to comply with the requirements of 40 CFR 130.7 are summarized in Table 10. In this table, the future capacity for WWTF has been added to the WLA_{WWTF}.

TMDL values and allocations in Table 10 are derived from calculations using the existing water quality criteria for *E. coli*. However, designated uses and water quality criteria for these water bodies are subject to change through the TCEQ SWQS revision process. Figures 8 through 10 were developed to demonstrate how assimilative capacity, TMDL calculations, and pollutant load allocations change in relation to a number of hypothetical water quality criteria. The equations

provided along with Figures 8 through 10 allow the calculation of new TMDLs and pollutant load allocations based on any potential new water quality criteria for *E. coli*.

Table 9. *E. coli* TMDL Summary Calculations for Poor Farm Ditch (1007S_01), Bintliff Ditch (1007T_01), and Mimosa Ditch (1007U_01)

All loads expressed as Billion MPN/day

Assessment Unit	TMDL[a]	WLA_{WWTF}[b]	$WLA_{STORMWATER}$[c]	LA[d]	MOS[e]	Future Growth[f]
1007S_01	51.3	0.715	48.0	0	2.57	0.0358
1007T_01	92.8	0	88.2	0	4.64	0
1007U_01	102	10.7	86.0	0	5.12	0.429

[a] *Maximum allowable load for the highest flow range (0 to 20th percentile flows)*

[b] *Sum of loads from the WWTF discharging upstream of the TMDL station. Individual loads are calculated as permitted flow * 126/2 (*E. coli*) MPN/100mL*conversion factor*

[c] $WLA_{STORMWATER}$ *= (TMDL – MOS –*WLA_{WWTF}*)*(percent of drainage area covered by stormwater permits)*

[d] *LA = TMDL – MOS –*WLA_{WWTF} *–*$WLA_{STORMWATER}$*-Future growth*

[e] *MOS = TMDL x 0.05*

[f] *Projected increase in WWTF permitted flows*126/2*conversion factor*

Table 10. Final TMDL Allocations

All loads expressed as Billion MPN/day

Assessment Unit	TMDL[a]	WLA_{WWTF}[b]	$WLA_{STORMWATER}$	LA	MOS
1007S_01	51.3	0.751	48.0	0	2.57
1007T_01	92.8	0[c]	88.2	0	4.64
1007U_01	102	11.1	86.0	0	5.12

[a] *TMDL=* WLA_{WWTF} *+* $WLA_{STORMWATER}$ *+ LA + MOS*

[b] WLA_{WWTF}*=* WLA_{WWTF} *+ Future Growth*

[c] *A* WLA_{WWTF} *of zero for this AU does not preclude the inclusion of future WWTFs in this watershed. Any new permitted discharges will be held to the same bacteria criteria used in this allocation process. Additional discharges would lead to additional flow in the affected segment. The assimilative capacity of streams increases as the amount of flow increases. Consequently, increases in flow allow for additional indicator bacteria loads if the concentrations are at or below the contact recreation standard.*

Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. Seasonal variation was accounted for in these TMDLs by using more than five years of water quality data and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing historical bacteria concentrations collected in the warmer months against those collected during the cooler months. Analysis of available *E. coli* data showed no significant difference.

Public Participation

A presentation on this addendum was given at the annual meeting of the Bacteria Implementation Group (BIG) in Houston on May 22, 2012. The public will have an opportunity to comment on this document during a 30-day WQMP comment period. Notice of the public comment period will be sent to the BIG group and posted at <http://www.tceq.texas.gov/permitting/wqmp/WQmanagement _comment.html>, and the document will be posted at <http://www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html>. The technical support document for this project is posted on the TMDL project page at <http://www.tceq.texas.gov/waterquality/tmdl/nav/42-houstonbacteria/42-houstonareabacteria-library>.

Implementation and Reasonable Assurance

The three segments covered by this addendum are within the existing Brays Bayou Above Tidal bacteria TMDL project watershed. This watershed is within the area covered by the I-Plan developed by the BIG for bacteria TMDLs throughout the greater Houston area. Please refer to the original TMDL document for additional information regarding implementation and reasonable assurance.

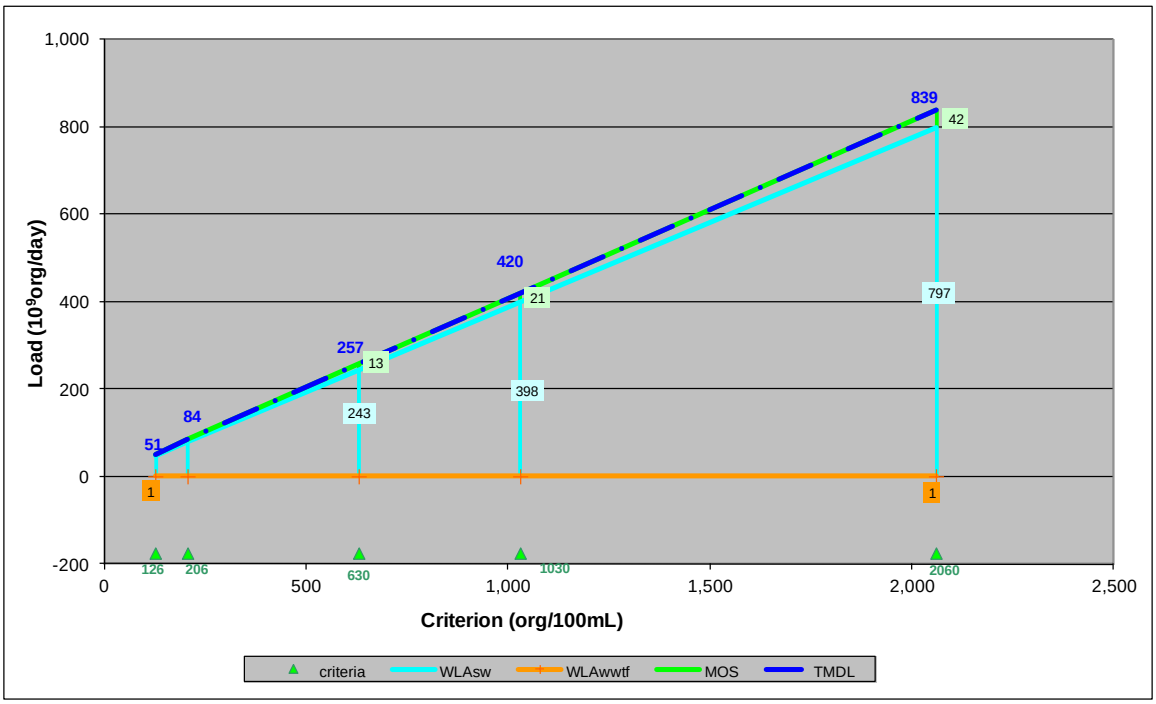


Figure 8. Allocation Loads for AU 1007S_01 as a Function of Water Quality Criteria

Equations for Calculating New TMDL and Allocations

TMDL = 0.4074*Std
LA = 0
WLA_{WWTF} = 63*0.0119 = 1
$WLA_{STORM\ WATER}$ = 0.387*Std-0.751
MOS = 0.05*TMDL

Where:

WLA_{WWTF} = waste load allocation (permitted WWTF)
$WLA_{STORM\ WATER}$ = waste load allocation (permitted storm water)
LA = load allocation (non-permitted source contributions)
Std = Revised Contact Recreation Standard
MOS = Margin of Safety

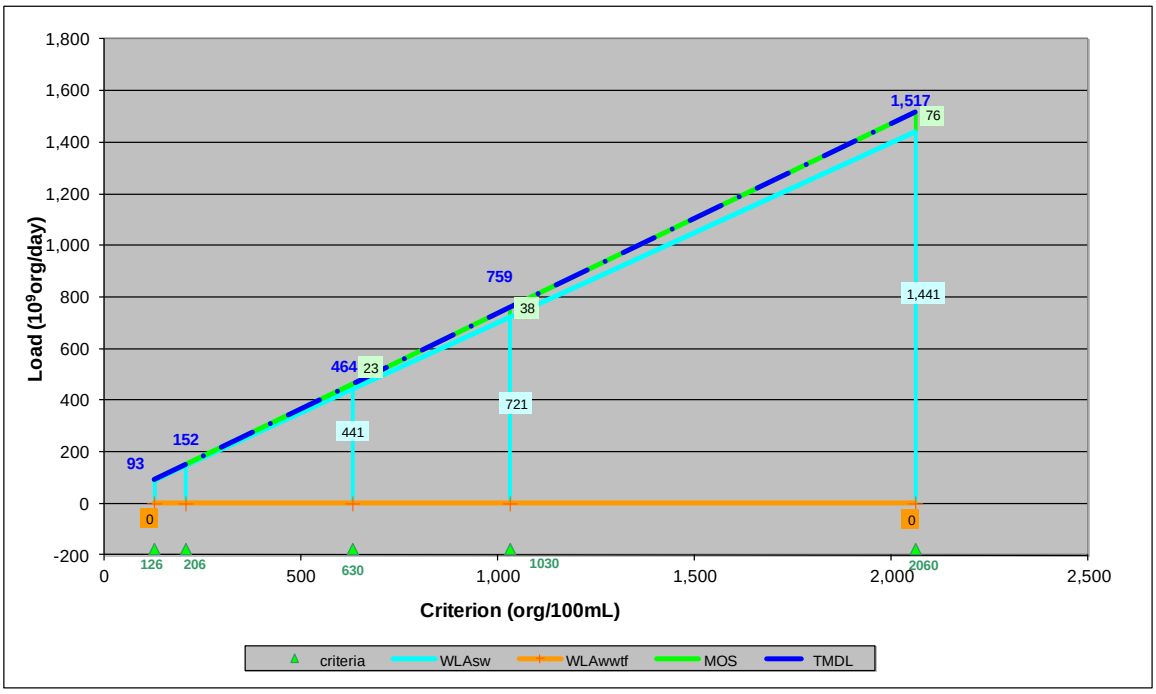


Figure 9. Allocation Loads for AU 1007T_01 as a Function of Water Quality Criteria

Equations for Calculating New TMDL and Allocations

TMDL = 0.7365*Std
LA = 0
WLA_{WWTF} = 0
$WLA_{STORM\ WATER}$ = 0.6996*Std
MOS = 0.05*TMDL

Where:

WLA_{WWTF} = waste load allocation (permitted WWTF)
$WLA_{STORM\ WATER}$ = waste load allocation (permitted storm water)
LA = load allocation (non-permitted source contributions)
Std = Revised Contact Recreation Standard
MOS = Margin of Safety

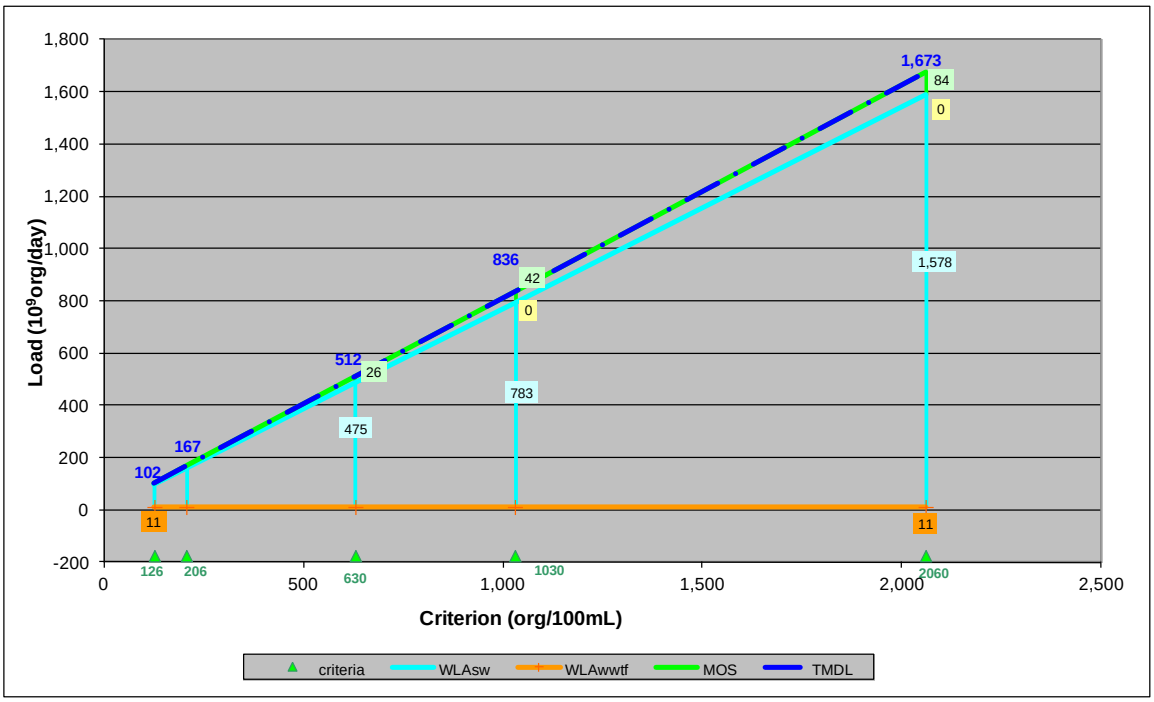


Figure 10. Allocation Loads for AU 1007U_01 as a Function of Water Quality Criteria

Equations for Calculating New TMDL and Allocations

TMDL = 0.8121*Std
LA = 0
WLA_{WWTF} = 63*0.177 = 11
$WLA_{STORM\ WATER}$ = 0.7715*Std-11.161
MOS = 0.05*TMDL

Where:

WLA_{WWTF} = waste load allocation (permitted WWTF)
$WLA_{STORM\ WATER}$ = waste load allocation (permitted storm water)
LA = load allocation (non-permitted source contributions)
Std = Revised Contact Recreation Standard
MOS = Margin of Safety

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Appendix IV. Addendum One to Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries

One Total Maximum Daily Load for Bacteria in Vogel Creek

For Segment 1017C
Assessment Unit 1017C_01

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted the total maximum daily loads (TMDLs) *Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries: Segments 1013, 1013A, 1013C, 1014, 1014A, 1014B, 1014E, 1014H, 1014K, 1014L, 1014M, 1014N, 1014O, 1017, 1017A, 1017B, 1017D, and 1017E* (TCEQ 2009) on 4/8/2009. The TMDLs were approved by the United States Environmental Protection Agency (EPA) on 6/11/2009. This document represents an addendum to the original TMDL document.

This addendum includes information specific to one additional segment located within the watershed of the approved TMDL project for bacteria in the Buffalo and Whiteoak Bayous watershed. Concentrations of indicator bacteria in this segment exceed the criteria used to evaluate attainment of the contact recreation standard. This addendum presents the new information associated with the additional segment. For background or other explanatory information for this segment, please refer to *Technical Support Document: Bacteria Total Maximum Daily Loads for New/Additional Listings in the Houston Metro Area, Houston, Texas (1007T_01, 1007U_01, 1007S_01, 1007V_01, 1017C_01, and 1007A_01)* (University of Houston and Parsons 2012), which has additional details related to all aspects of this addendum.

Refer to the original, approved TMDL document for details related to the overall project watershed as well as the methods and assumptions used in developing this TMDL. This addendum focuses on the subwatershed of the additional segment. This subwatershed, including permitted facilities within it, was addressed in the original TMDL. This addendum provides the details related to developing the TMDL allocation for the additional segment, which was not addressed individually in the original document. This segment is also covered by an implementation plan (I-Plan) that has been drafted by stakeholders in the greater Houston area. The I-Plan addresses multiple watersheds, including those for Buffalo and Whiteoak Bayous.

Problem Definition

The TCEQ first identified the bacteria impairment to the segment and assessment unit (AU) included in this addendum in the year 2010 Texas Water Quality Inventory and 303(d) List (Table 1). The impaired AU is Vogel Creek (1017C_01). See Figure 1 for a map of the watershed.

The Texas surface water quality standards (SWQSs; TCEQ 2010) provide numeric and narrative criteria to evaluate attainment of designated uses. The basis for water quality targets for the TMDL developed in this report will be the numeric criteria for bacterial indicators from the 2010 Texas SWQS. *E. coli* is the preferred indicator bacteria for assessing contact recreation use in freshwater.

Table 2 summarizes the ambient water quality data for the TCEQ water quality monitoring (WQM) station on the impaired water body.

Vogel Creek (Segment 1017C_01): The single sample criterion for *E. coli* was exceeded in 41 percent of the samples at the only WQM station location at which *E. coli* data were collected within this subwatershed. The geometric mean criterion for *E. coli* was also exceeded.

Watershed Overview

The Buffalo and Whiteoak Bayous watershed encompasses approximately 492 square miles of land in portions of Harris, Fort Bend, and Waller counties, including the cities of Houston, Jersey Village, and Katy, Texas. The Buffalo and Whiteoak Bayous watershed is part of the San Jacinto River Basin. The entire watershed's rainfall average is approximately 50 inches per year. The average value for the subwatershed is summarized in Table 3.

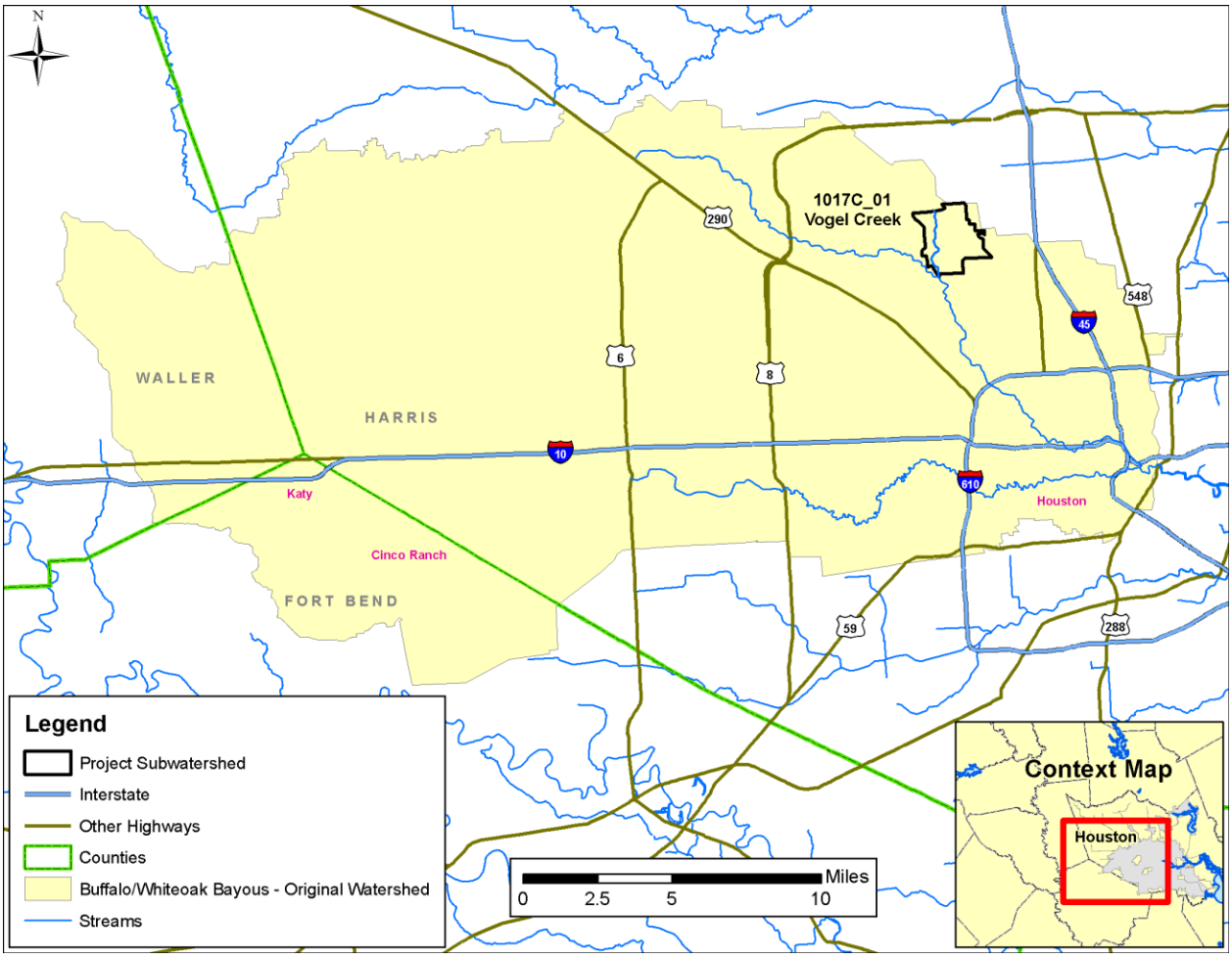


Figure 1. Buffalo and Whiteoak Bayous Watershed [a]

[a] *All maps in this document were developed by the University of Houston and modified by the TMDL Program of the TCEQ. No claims are made to the accuracy or completeness of the data or to its suitability for a particular use. "TSARP" refers to the Tropical Storm Allison Recovery Project, for which some map delineations used in this project were originally created.*

Table 1. Synopsis of Texas Integrated Report for Water Bodies in the Buffalo/Whiteoak Watershed

Segment ID	Segment Name	Parameter	Contact Recreation Use	Year Impaired	Category	Stream Length (miles)
1017C_01	Vogel Creek	*E. coli*	Nonsupport	2010	5a	2.0

Table 2. Water Quality Data for TCEQ Stations from 1999 to 2011

Segment	Station ID	Indicator Bacteria	Geometric Mean Concentration (MPN/100ml)	Number of Samples	Number of Samples Exceeding Single Sample Criterion	% of Samples Exceeding
1017C_01	11155	*E. coli*	386	69	28	41%

MPN: Most Probable Number

Geometric Mean Criterion: 126 MPN/100 m.

Single Sample Criterion: 399 MPN/100 ml.

Table 3. Average Annual Precipitation in Study Area Subwatershed, 1988-2007 (in inches)

Segment Name	Segment ID	Average Annual (Inches)
Vogel Creek	1017C_01	52.17

Table 4 summarizes the acreages and the corresponding percentages of the land use categories associated with the project subwatershed in the Buffalo and Whiteoak Bayous watershed. The land use/land cover data were retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Coastal Services Center. The specific land use/land cover data files were derived from the Coastal Change Analysis Program (C-CAP), Texas 2005 Land Cover Data (NOAA 2007). The total acreage of the segment in Table 4 corresponds to the watershed delineation in Figure 2. Based on the data sources that were used, the predominant land use category in this subwatershed is developed land (90%) followed by woody land (8.5%).

Population estimates and future population projections were examined for counties and cities in the project area. These are discussed in the original TMDL document as well as the technical support document for this addendum.

Endpoint Identification

The water quality target for the TMDL for this freshwater segment is to maintain concentrations below the geometric mean criterion of 126 MPN/100 mL for *E. coli*. Maintaining the geometric mean criterion for indicator bacteria is expected to be protective of the single sample criterion also and therefore will ultimately result in the attainment of the contact recreation use. The TMDL will be based on bacteria allocations required to meet the geometric mean criterion.

Source Analysis

Regulated Sources

There is one National Pollutant Discharge Elimination System (NPDES)/Texas Pollutant Discharge Elimination System (TPDES)-permitted facility within the project's subwatershed. In addition, the entire Study Area is regulated under the TPDES municipal separate storm sewer system (MS4) discharge permit

jointly held by Harris County, Harris County Flood Control District (HCFCD), City of Houston, and Texas Department of Transportation. There are no NPDES-permitted Concentrated Animal Feeding Operations (CAFOs) within the Study Area.

The TPDES-permitted facility that continuously discharges wastewater to surface waters addressed in this TMDL is listed in Table 5 and shown in Figure 3. Figure 3 also shows water quality monitoring (WQM) stations and the MS4 coverage area.

Table 4. Aggregated Land Use Summaries by Segment

Aggregated Land Use Category	1017C_01
Acres of Developed	2,150
Acres Cultivated Land	0
Acres Pasture/Hay	5.6
Acres Grassland/Herbaceous	19
Acres of Woody Land	203
Acres of Open Water	0
Acres of Wetland	9.1
Acres of Bare/Transitional	8.0
Watershed Area (acres)	**2,394**
Percent Developed	89.8%
Percent Cultivated Land	0%
Percent Pasture/Hay	0.2%
Percent Grassland/Herbaceous	0.8%
Percent Woody Land	8.5%
Percent Open Water	0%
Percent Wetland	0.38%
Percent Bare/Transitional	0.33%

Table 5. TPDES-Permitted Facilities in the Study Area

Segment	Receiving Water	TPDES Number	NPDES NUMBER	Facility Name	Facility Type	Permitted Flow (MGD)
1017C_01	Vogel Creek	11005-001	TX0020095	Champ's Water Company, W. Montgomery Subdivision-WWTP	Sewerage Systems	0.28

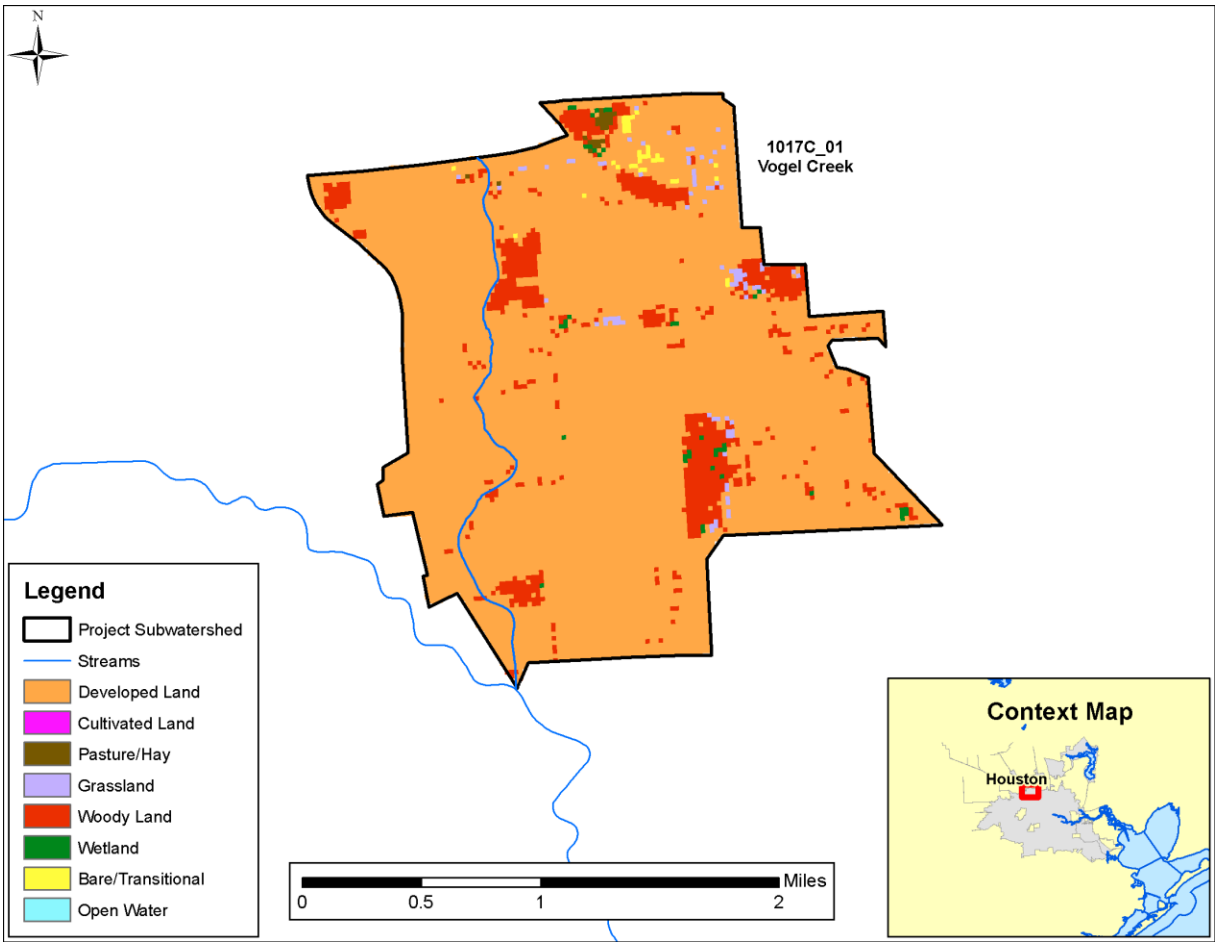
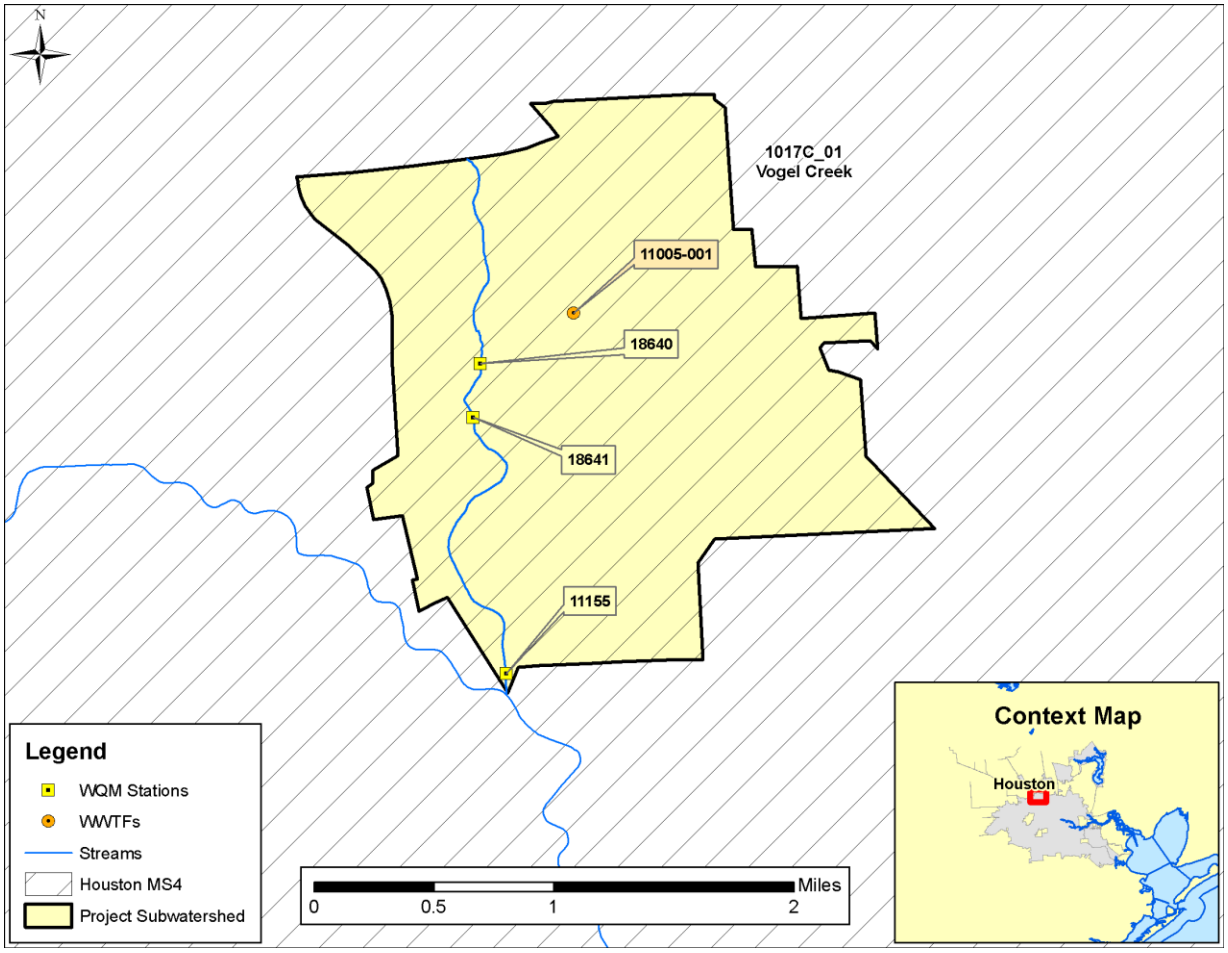


Figure 2. Land Use for Project Subwatersheds



Source: The jurisdictional boundary of the Houston MS4 permit is derived from Urbanized Area Map Results for Texas which can be found at the USEPA website <cfpub.epa.gov/npdes/stormwater/urbanmapresult.cfm?state=TX>.

Figure 3. TPDES-Permitted Facility, WQM Stations, and MS4 Coverage Area in the Buffalo and White-oak Bayous Subwatershed

Sanitary Sewer Overflows

TCEQ Region 12-Houston provided two database queries for sanitary sewer overflow (SSO) data – one is collected by the City of Houston and the other is compiled from the remainder of the wastewater dischargers in the Study Area (Rice 2005).

These data are included in Table 6. The locations and magnitudes of the reported SSOs are displayed in Figure 4. The WWTF service area boundaries are also shown in Figure 4. The loads from these SSOs were accounted for in the original TMDL document. They are being assigned to the specific subwatershed in this addendum.

Table 6. Sanitary Sewer Overflow (SSO) Summary

Facility Name	NPDES Permit No.	TPDES Permit No.	# of Occurrences	Date Range – From	Date Range – To	Gallons (Min)	Gallons (Max)	Gallons (Avg.)	Segment
City of Houston - North West Plant	TX0063011	10495-076	18	03/13/01	10/16/03	40	18514	2545	1017C_01

TPDES-Regulated Stormwater

The entirety of the subwatershed in the Study Area is covered under the City of Houston County MS4 permit (TPDES Permit No. WQ0004685000). Under the City of Houston/Harris County discharge permit, Harris County, HCFCD, City of Houston, and Texas Department of Transportation are designated as co-permittees.

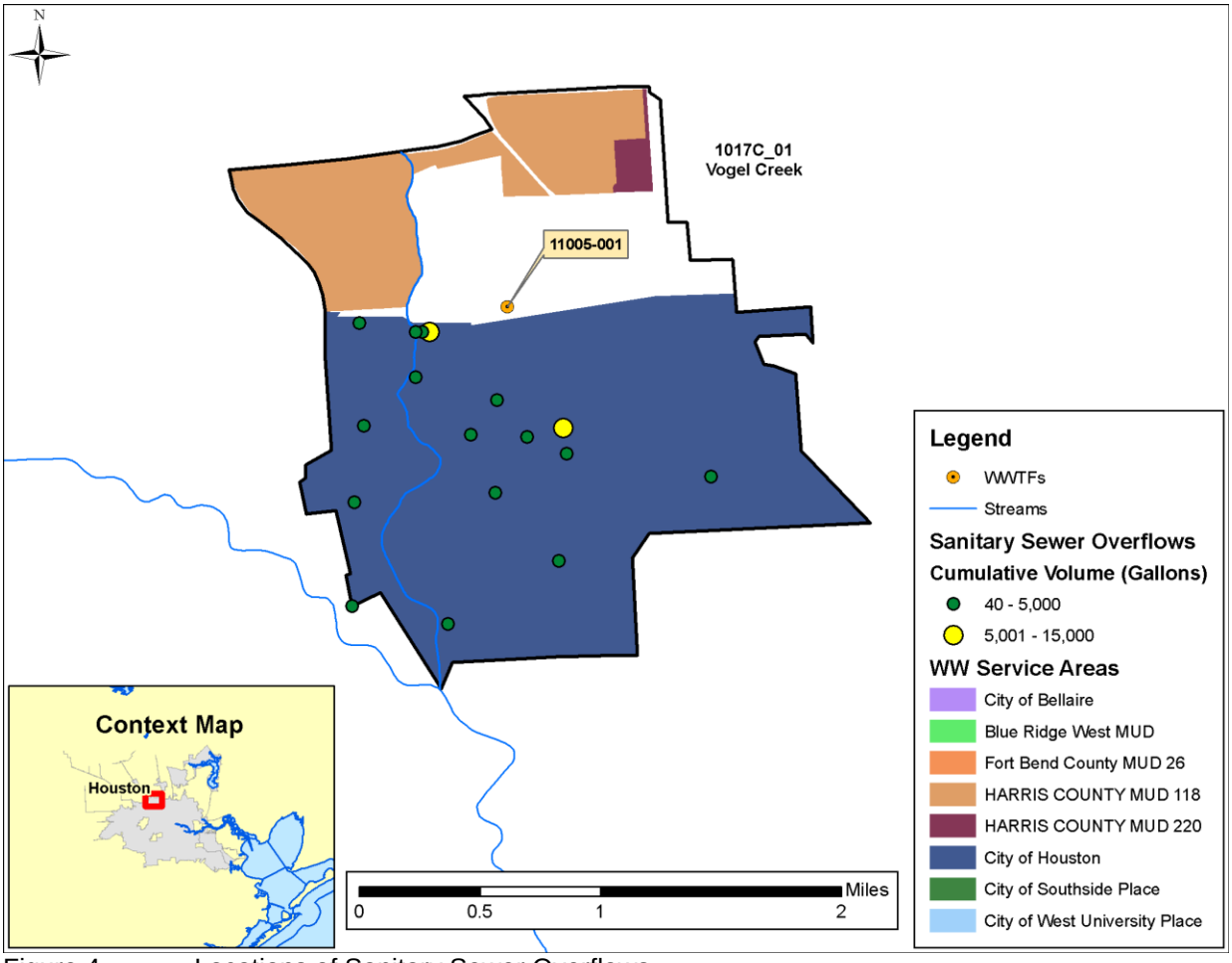


Figure 4. Locations of Sanitary Sewer Overflows

Unregulated Sources

Pollutants from unregulated sources enter the impaired AU through distributed, nonspecific locations, which may include urban runoff not covered by a permit, wildlife, various agricultural activities and animals, land application fields, failing onsite sewage facilities (OSSFs), and domestic pets.

Wildlife and Unmanaged Animal Contributions

Currently there are insufficient data available to estimate populations and spatial distribution of wildlife and avian species by subwatershed. Consequently, it is difficult to assess the magnitude of bacteria contributions from wildlife species as a general category.

Unregulated Agricultural Activities and Domesticated Animals

A number of agricultural activities that do not require permits can also be sources of fecal bacteria loading. Given the fact that the TMDL Study Area is highly urbanized, livestock and other domesticated animals are either not found in the watershed or exist in small numbers. Therefore, livestock and other domesticated animals are not considered as a contributor of bacteria loads.

Failing On-site Sewage Facilities

To estimate the potential magnitude of fecal bacteria loading from OSSFs, the number of OSSFs was estimated for each subwatershed. The estimate of OSSFs was derived by using data from the 1990 U.S. Census (U.S. Census Bureau 2000) and a GIS shape file obtained from Houston-Galveston Area Council (H-GAC) showing all areas where wastewater service currently exists. Figure 5 displays unsewered areas that did not fall under the wastewater service areas. OSSFs were calculated using spatial GIS queries for areas not covered by wastewater service areas. OSSFs were assigned proportionally based on the percentage of the area falling outside a wastewater service area within the project subwatershed. Finally, the OSSFs for each unsewered area were then totaled for the TMDL subwatershed. This approach gives an estimate of OSSFs in the subwatershed. Table 7 shows the estimated number of OSSFs calculated using this GIS method. The estimated OSSF numbers and loads were accounted for in the original TMDL document. They are being assigned to the specific project subwatershed in this addendum.

For the purpose of estimating fecal coliform loading in subwatersheds, the OSSF failure rate of 12 percent from the Reed, Stowe & Yanke, LLC (2001) report for Texas Region 4 was used. Using this 12 percent failure rate, calculations were made to characterize fecal coliform loads in the project subwatershed.

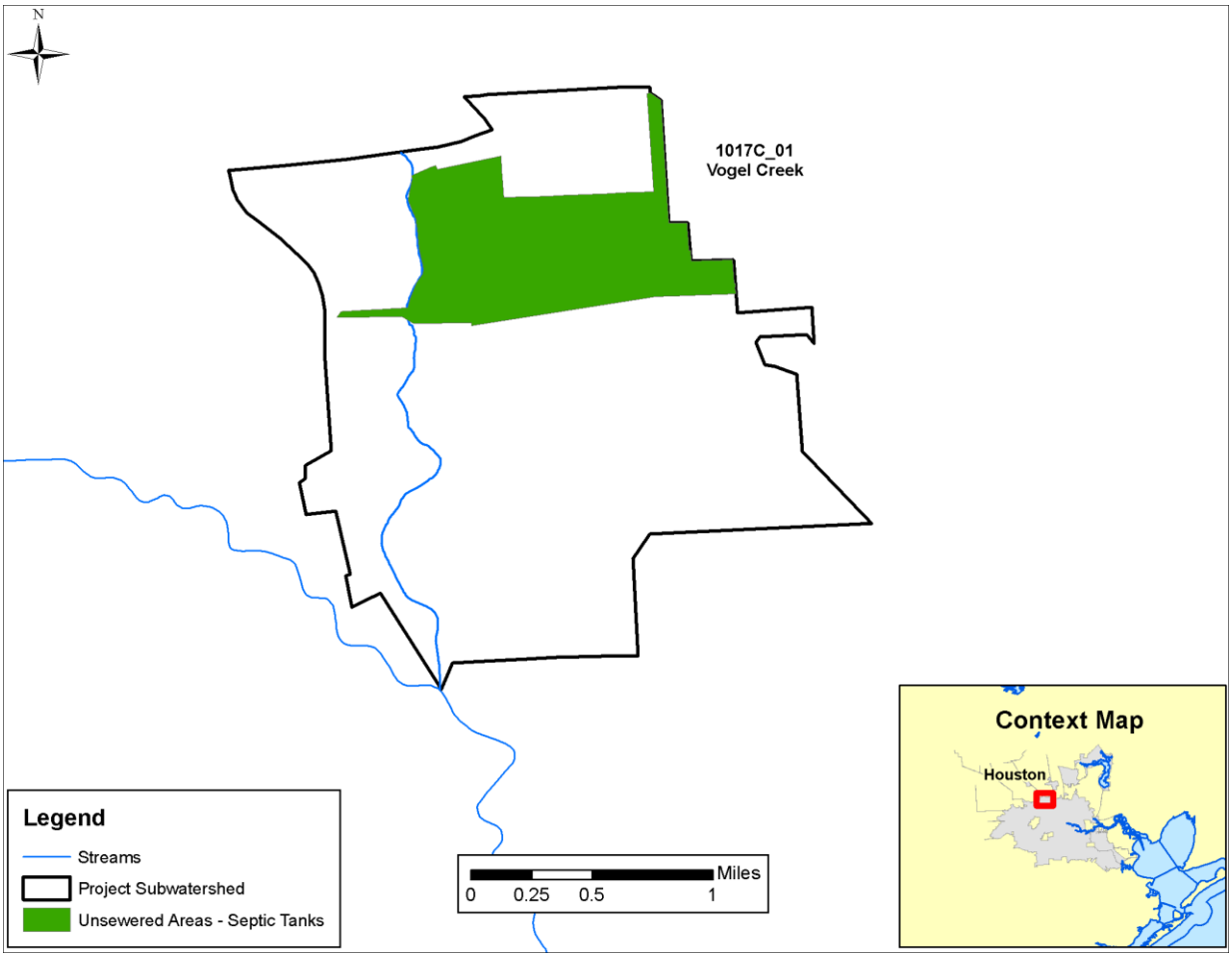


Figure 5. Unsewered Areas

Fecal coliform loads were estimated using the following equation (EPA 2001):

$$\#\frac{counts}{day} = \left(\#\,Failing\_systems\right) \times \left(\frac{10^6\,counts}{100ml}\right) \times \left(\frac{70gal}{personday}\right) \times \left(\#\frac{person}{household}\right) \times \left(3785.2\frac{ml}{gal}\right)$$

The average of number of people per household was calculated to be 2.78 for counties in the Study Area (U.S. Census Bureau 2000). Approximately 70 gallons of wastewater were estimated to be produced on average per person per day (Metcalf and Eddy 1991). The fecal coliform concentration in septic tank effluent was estimated to be 10^6 per dL of effluent based on reported concentrations from a number of published reports (Metcalf and Eddy 1991; Canter and Knox 1985; Cogger and Carlile 1984). Using this information, the estimated load from failing septic systems within the subwatershed was summarized below in Table 7. Based on this data, it was determined that the estimated fecal coliform loading from OSSFs in the Study Area was found to be negligible.

Table 7. Estimated Number of OSSFs per Subwatershed, and Their Fecal Coliform Loads

Segment	Stream Name	OSSF Estimate using 1990 Census method	OSSF data from HGAC	# of Failing OSSFs	Estimated Loads from OSSFs (Billion MPN/day)
1017C_01	Vogel Creek	39	0	4.72	35

Domestic Pets

Fecal matter from dogs and cats is transported to streams by runoff from urban and suburban areas and can be a potential source of bacteria loading. On average nationally, there are 0.58 dogs per household and 0.66 cats per household (American Veterinary Medical Association 2007). Using the U.S. Census data at the block level (U.S. Census Bureau 2010), dog and cat populations can be estimated for each subwatershed. Table 8 summarizes the estimated number of dogs and cats for the subwatershed of the Study Area. Only a small portion of the bacteria load from pets is expected to reach water bodies, through wash-off of land surfaces and conveyance in runoff. The pet number estimates were accounted for in the original TMDL document. They are being assigned to the specific subwatershed in this addendum.

Table 8. Estimated Numbers of Pets

Segment	Stream Name	Dogs	Cats
1017C_01	Vogel Creek	3,796	4,282

Linkage Analysis

Load duration curve (LDC) analysis (including flow duration curve (FDC) analysis) was used for analyzing indicator bacteria load and instream water quality for the segment in this project. The Technical Support Document has details about this analysis.

Margin of Safety

The TMDL covered by this report incorporates an explicit margin of safety (MOS) by setting a target for indicator bacteria loads that is 5 percent lower than the single sample criterion. The MOS was used because of the limited amount of data available for the sampling locations. For contact recreation, this equates to a single sample target of 379 MPN/100mL for *E. coli* and a geometric mean target of 120 MPN/100mL. The net effect of the TMDL with MOS is that the assimilative capacity or allowable pollutant loading of the water body is slightly reduced. The TMDL covered by this report incorporates an explicit MOS in each LDC by using 95 percent of the single sample criterion.

Pollutant Load Allocation

Pollutant load allocations were developed using analysis of the FDC and the LDC method. To establish the subwatershed targets, TMDL calculations and associated allocations are established for the most-downstream sampling location in the subwatershed. This establishes a distinct TMDL for the 303(d) listed water body.

To calculate the bacteria load at the criterion for the segment, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*24,465,755 dL/ft3 * seconds/day*) and the *E. coli* criterion. This calculation produces the maximum bacteria load in the stream without exceeding the instantaneous standard over the range of flow conditions. *E. coli* loads are plotted versus flow exceedance percentiles as an LDC. The x-axis indicates the flow exceedance percentile, while the y-axis is expressed in terms of a bacteria load.

To estimate existing loading in Vogel Creek, bacteria observations from 1999 to 2011 are paired with the flows measured or estimated in that segment on the same date. Pollutant loads are then calculated by multiplying the measured bacteria concentration by the flow rate and a unit conversion factor of *24,465,755 dL/ft3 * seconds/day*. The associated flow exceedance percentile is then matched with the measured flow. The observed bacteria loads are added to the LDC plot as points. These points represent individual ambient water quality samples of bacteria. Points above the LDC indicate the bacteria instantaneous standard was exceeded at the time of sampling. Conversely, points under the LDC indicate the sample met the criterion.

The LDC approach recognizes that the assimilative capacity of a water body depends on the flow, and that maximum allowable loading varies with flow condition. Existing loading and loads that meet the TMDL water quality target can also be calculated under different flow conditions.

The load allocation goal for Vogel Creek is based on data analysis using the geometric mean criterion since it is anticipated that achieving the geometric mean over an extended period of time will likely ensure that the single sample criterion will also be achieved.

Figure 6 represents the LDC for Vogel Creek and is based on *E. coli* bacteria measurements at sampling location 11155 (Vogel Creek at Little York Road). The LDC indicates that *E. coli* levels exceed the instantaneous and geometric mean water quality criteria under high and mid-range flow conditions. Wet weather influenced *E. coli* observations are found under all flow conditions. The allocation goal for the segment used in the final TMDL equation was based on the flow regime with the highest bacteria load (0–20th percentile).

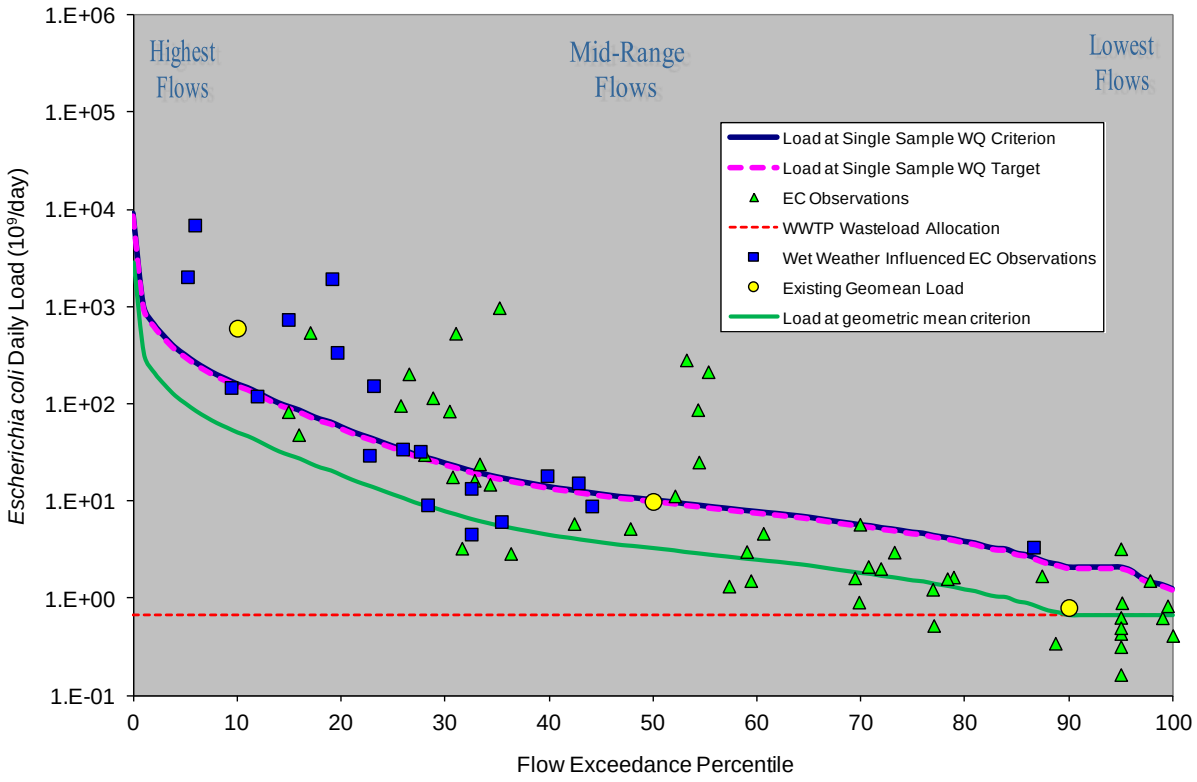


Figure 6. Load Duration Curve for Vogel Creek (1017C_01)

Wasteload Allocation

The wasteload allocation (WLA) is the sum of loads from regulated sources.

WWTFs

TPDES-permitted WWTFs are allocated a daily wasteload (WLA_{WWTF}) calculated as their permitted discharge flow rate multiplied by one-half the instream geometric mean water quality criterion. One-half of the water quality criterion is used as the target to provide instream and downstream load capacity, and to provide consistency with other TMDLs developed in the Houston area.

Table 9 summarizes the WLA for the TPDES-permitted facility within the Study Area. WLAs were established for the facilities throughout the Buffalo and Whiteoak Bayous watersheds in the original TMDL document and its subsequent Water Quality Management Plan (WQMP) updates. This facility is being assigned to a specific subwatershed in this addendum.

Table 9. Wasteload Allocations for TPDES-Permitted Facilities

Assessment Unit	Stream Name	TPDES Number	NPDES Number	Facility Name	Final Permitted Flow (MGD)	*E. coli* WLA_{WWTF} (Billion MPN/day)
1017C_01	Vogel Creek	11005-001	TX0020095	Champ's Water Company, W. Montgomery Subdivision-WWTP	0.28	0.668

Stormwater

Stormwater discharges from MS4, industrial, and construction areas are considered permitted or regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). A simplified approach for estimating the WLA for these areas was used in the development of the TMDL due to the limited amount of data available, the complexities associated with simulating rainfall runoff, and the variability of stormwater loading.

The percentage of the subwatershed that is under the jurisdiction of stormwater permits (i.e., defined as the area designated as urbanized area in the 2000 US Census) is used to estimate the amount of the overall runoff load to be allocated as the regulated stormwater contribution in the WLA_{SW} component of the TMDL. The load allocation (LA) component of the TMDL corresponds to direct nonpoint source runoff and is the difference between the total load from stormwater runoff and the portion allocated to WLA_{SW}. For the subwatershed addressed in this TMDL, 100 percent of the area is within the urbanized area.

Load Allocation

The LA is the sum of loads from unregulated sources. Since the entirety of the subwatershed is within the urbanized area, there is no LA for this TMDL.

Allowance for Future Growth

As described in the original TMDL document, future growth of existing or new point sources is not limited by this TMDL as long as the sources do not cause indicator bacteria to exceed the limits. The assimilative capacity of streams increases as the amount of flow increases. Consequently, increases in flow allow for additional indicator bacteria loads if the concentrations are at or below the contact recreation standard. New or amended permits for wastewater discharge facilities will be evaluated case by case.

To account for the probability that increased or additional flows from WWTFs may occur in Vogel Creek, a provision for future growth was included in the TMDL calculations by estimating permitted flows to year 2035 using population projections completed by H-GAC.

The three-tiered antidegradation policy in the SWQSs prohibits an increase in loading that would cause or contribute to degradation of an existing use. The antidegradation policy applies to both point and nonpoint source pollutant discharges. In general, antidegradation procedures establish a process for reviewing individual proposed actions to determine if the activity will degrade water quality. The TMDLs in this document will result in protection of existing beneficial uses and conform to Texas's antidegradation policy.

TMDL Calculations

Table 10 summarizes the estimated maximum allowable load of *E. coli* for the AU included in this project.

The final TMDL allocation required to comply with the requirements of 40 CFR 130.7 is summarized in Table 11. In this table, the future capacity for WWTF has been added to the WLA_{WWTF}.

TMDL values and allocations in Table 11 are derived from calculations using the existing water quality criteria for *E. coli*. However, designated uses and water quality criteria for these water bodies are subject to change through the TCEQ SWQS revision process. Figure 7 was developed to demonstrate how assimilative capacity, TMDL calculations, and pollutant load allocations change in relation to a number of hypothetical water quality criteria. The equations provided along with Figure 7 allow the calculation of new TMDLs and pollutant load allocations based on any potential new water quality criteria for *E. coli*.

Table 10. *E. coli* TMDL Summary Calculations for Vogel Creek (1017C_01)

All loads expressed as Billion MPN/day

TMDL[a]	WLA_{WWTF}[b]	$WLA_{STORMWATER}$[c]	LA[d]	MOS[e]	Future Growth[f]
51.4	0.668	48.1	0	2.57	0.0534

[a] *Maximum allowable load for the highest flow range (0 to 20th percentile flows)*

[b] *Sum of loads from the WWTF discharging upstream of the TMDL station. Individual loads are calculated as permitted flow * 126/2 (*E. coli*) MPN/100mL*conversion factor*

[c] $WLA_{STORMWATER}$ *= (TMDL – MOS –*WLA_{WWTF}*)*(percent of drainage area covered by stormwater permits)*

[d] *LA = TMDL – MOS –*WLA_{WWTF} *–*$WLA_{STORMWATER}$*-Future growth*

[e] *MOS = TMDL x 0.05*

[f] *Projected increase in WWTF permitted flows*126/2*conversion factor*

Table 11. Final TMDL Allocations

All loads expressed as Billion MPN/day

Assessment Unit	TMDL[a]	WLA_{WWTF}[b]	$WLA_{STORMWATER}$	LA	MOS
1017C_01	51.4	0.721	48.1	0	2.57

[a] $TMDL = WLA_{WWTF} + WLA_{STORMWATER} + LA + MOS$

[b] $WLA_{WWTF} = WLA_{WWTF}$ *+ Future Growth*

Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. Seasonal variation was accounted for in the TMDL by using more than five years of water quality data and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing historical bacteria concentrations collected in the warmer months against those collected during the cooler months. Analysis of available *E. coli* data showed no significant difference.

Public Participation

A presentation on this addendum was given at the annual meeting of the Bacteria Implementation Group (BIG) in Houston on May 22, 2012. The public will have an opportunity to comment on this document during a 30-day WQMP comment period. Notice of the public comment period will be sent to the BIG group and posted at <http://www.tceq.texas.gov/permitting/wqmp/WQmanagement _comment.html>, and the document will be posted at <http:// www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html>. The technical support document for this project is posted on the TMDL project page at <http://www.tceq.texas.gov/waterquality/tmdl/nav/42-houstonbacteria/42-houstonareabacteria-library>.

Implementation and Reasonable Assurance

The segment covered by this addendum is within the existing Buffalo and Whiteoak Bayous bacteria TMDL project watershed. This watershed is within the area covered by the I-Plan developed

by the BIG for bacteria TMDLs throughout the greater Houston area. Please refer to the original TMDL document for additional information regarding implementation and reasonable assurance.

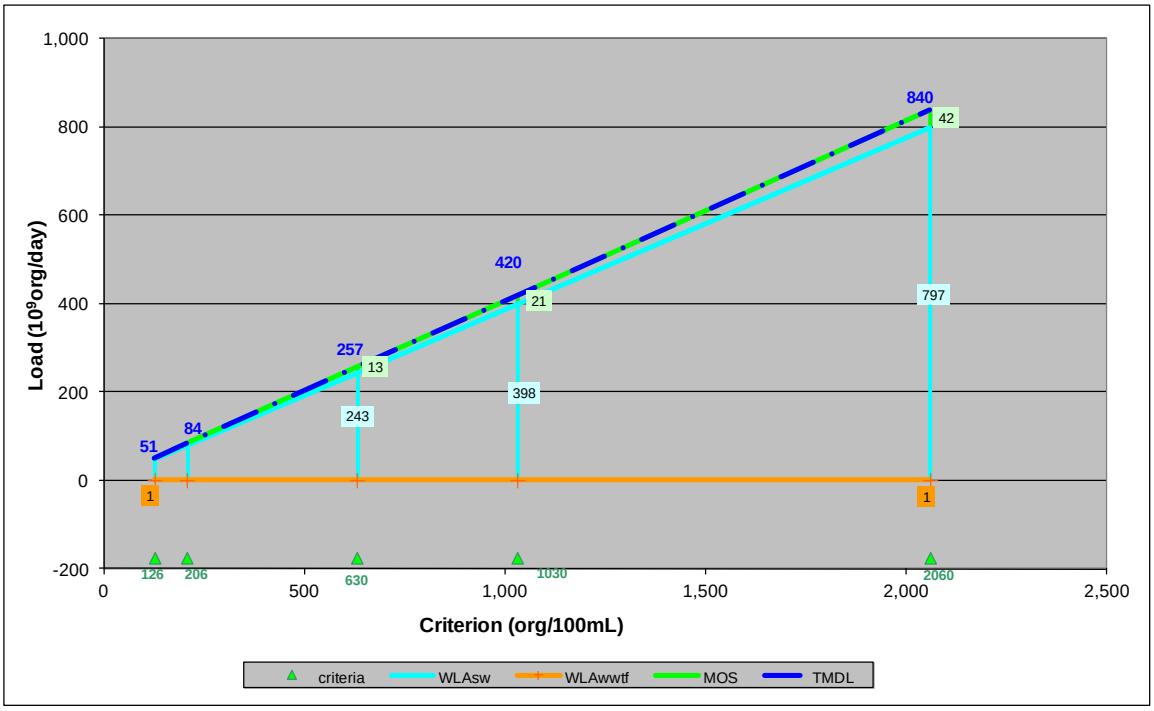


Figure 7. Allocation Loads for AU 1017C_01 as a Function of Water Quality Criteria

Equations for Calculating New TMDL and Allocations

TMDL = 0.4079*Std
LA = 0
WLA_{WWTF} = 63*0.011 = 1
$WLA_{STORM\ WATER}$ = 0.3875*Std-0.7212
MOS = 0.05*TMDL

Where:

WLA_{WWTF} = waste load allocation (permitted WWTF)
$WLA_{STORM\ WATER}$ = waste load allocation (permitted storm water)
LA = load allocation (non-permitted source contributions)
Std = Revised Contact Recreation Standard
MOS = Margin of Safety

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Appendix V. Addendum One to Thirteen Total Maximum Daily Loads for Indicator Bacteria in Eastern Houston Watersheds

One Total Maximum Daily Load for Indicator Bacteria in Unnamed Tributary of Hunting Bayou

For Segment 1007V
Assessment Unit 1007V_01

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted the total maximum daily loads (TMDLs) *Thirteen Total Maximum Daily Loads for Indicator Bacteria in Eastern Houston Watersheds: Segments 1006F, 1006H, 1007F, 1007G, 1007H, 1007I, 1007K, 1007M, 1007O, and 1007R* (TCEQ 2010a) on 9/15/2010. The TMDLs were approved by the United States Environmental Protection Agency (EPA) on 9/27/2010. This document represents an addendum to the original TMDL document.

This addendum includes information specific to one additional segment located within the watershed of the approved TMDL project for bacteria in eastern Houston watersheds. Concentrations of indicator bacteria in this segment exceed the criteria used to evaluate attainment of the contact recreation standard. This addendum presents the new information associated with the additional segment. For background or other explanatory information for this segment, please refer to *Technical Support Document: Bacteria Total Maximum Daily Loads for New/Additional Listings in the Houston Metro Area, Houston, Texas (1007T_01, 1007U_01, 1007S_01, 1007V_01, 1017C_01, and 1007A_01)* (University of Houston and Parsons 2012), which has additional details related to all aspects of this addendum.

Refer to the original, approved TMDL document for details related to the overall project watershed as well as the methods and assumptions used in developing this TMDL. This addendum focuses on the subwatershed of the additional segment. This subwatershed was addressed in the original TMDL. This addendum provides the details related to developing the TMDL allocation for the additional segment, which was not addressed individually in the original document. This segment is also covered by an implementation plan (I-Plan) that has been drafted by stakeholders in the greater Houston area. The I-Plan addresses multiple watersheds, including Eastern Houston's.

Problem Definition

The TCEQ first identified the bacteria impairment to the segment and assessment unit (AU) included in this addendum in the year 2010 Texas Water Quality Inventory and 303(d) List (Table 1). The impaired AU is Unnamed Tributary of Hunting Bayou (1007V_01). See Figure 1 for a map of the watershed.

The Texas surface water quality standards (SWQSs; TCEQ 2010b) provide numeric and narrative criteria to evaluate attainment of designated uses. The basis for water quality targets for the TMDL developed in this report will be the numeric criteria for bacterial indicators from the 2010 Texas SWQS. *E. coli* is the preferred indicator bacteria for assessing contact recreation use in freshwater.

Table 2 summarizes the ambient water quality data for the TCEQ water quality monitoring (WQM) station on the impaired water body.

Unnamed Tributary of Hunting Bayou (Segment 1007V_01): The single sample criterion for *E. coli* was exceeded in 56 percent of the samples at the only WQM station location within this subwatershed. The geometric mean criterion for *E. coli* was also exceeded.

Watershed Overview

The Eastern Houston watersheds encompasses approximately 63 square miles of land located in parts of the cities of Houston, South Houston, Pasadena and Jacinto City as well as incorporated areas of Harris County.

The Eastern Houston watersheds are part of the San Jacinto River Basin. The entire watersheds' rainfall average is approximately 53 inches per year. The average value for the subwatershed is summarized in Table 3.

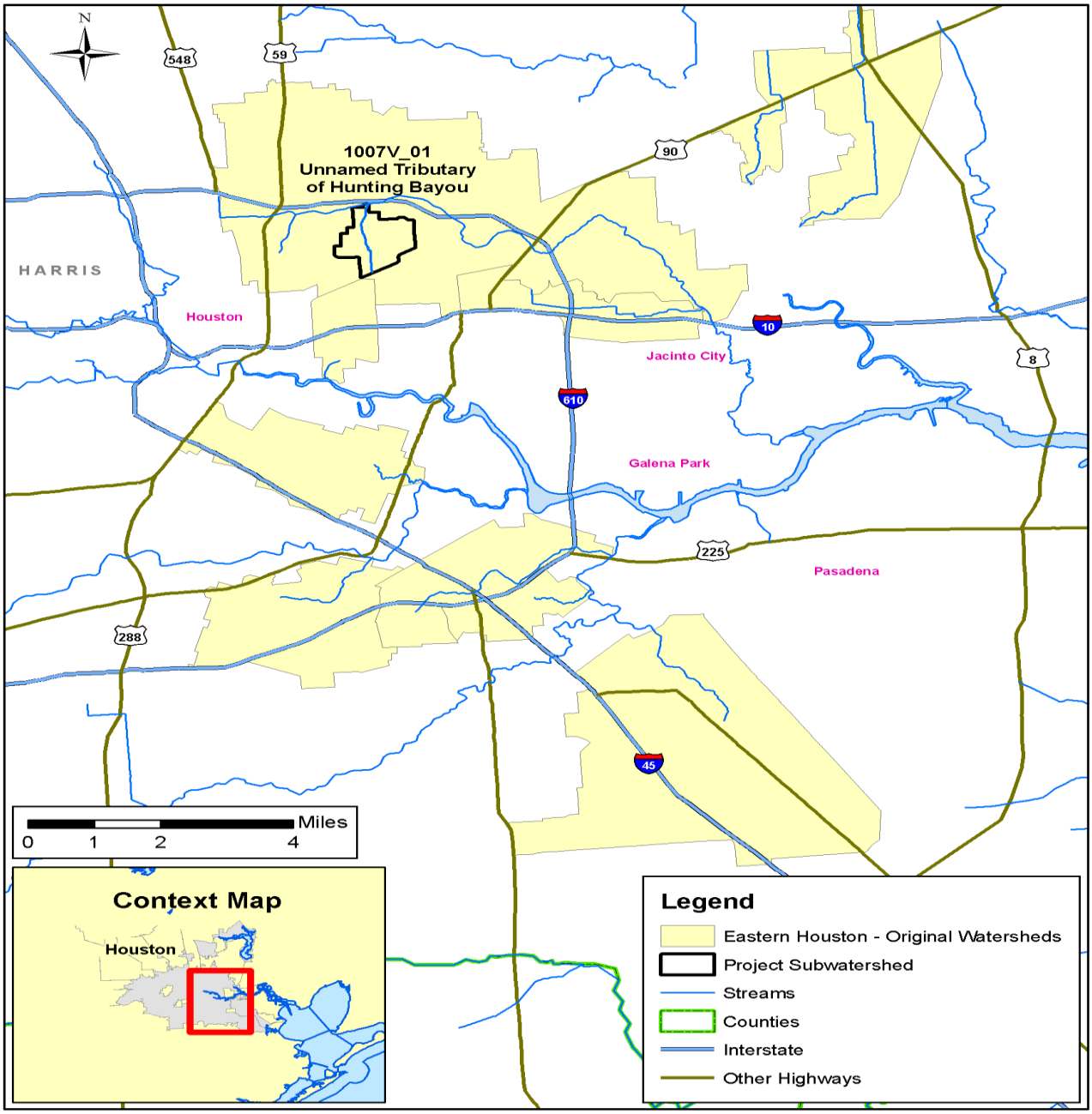


Figure 1. Eastern Houston Watersheds [a]

[a] *All maps in this document were developed by the University of Houston and modified by the TMDL Program of the TCEQ. No claims are made to the accuracy or completeness of the data or to its suitability for a particular use. "TSARP" refers to the Tropical Storm Allison Recovery Project, for which some map delineations used in this project were originally created.*

Table 1. Synopsis of Texas Integrated Report for Water Bodies in the Eastern Houston Watersheds

Segment ID	Segment Name	Parameter	Contact Recreation Use	Year Impaired	Category	Stream Length (miles)
1007V_01	Unnamed Tributary of Hunting Bayou	*E. coli*	Nonsupport	2010	5a	1.1

Table 2. Water Quality Data for TCEQ Stations from 1999 to 2011

Segment	Station ID	Indicator Bacteria	Geometric Mean Concentration (MPN/100ml)	Number of Samples	Number of Samples Exceeding Single Sample Criterion	% of Samples Exceeding
1007V_01	18689	*E. coli*	375	57	32	56%

MPN: Most Probable Number

Geometric Mean Criterion: 126 MPN/100 m.

Single Sample Criterion: 399 MPN/100 ml.

Table 3. Average Annual Precipitation in Study Area Subwatershed, 1988-2007 (in inches)

Segment Name	Segment ID	Average Annual (Inches)
Unnamed Tributary of Hunting Bayou	1007V_01	50.85

Table 4 summarizes the acreages and the corresponding percentages of the land use categories associated with the project subwatershed in the Eastern Houston watersheds. The land use/land cover data were retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Coastal Services Center. The specific land use/land cover data files were derived from the Coastal Change Analysis Program (C-CAP), Texas 2005 Land Cover Data (NOAA 2007). The total acreage of the segment in Table 4 corresponds to the watershed delineation in Figure 2. Based on the data sources that were used, the predominant land use category in this subwatershed is developed land (99%).

Population estimates and future population projections were examined for counties and cities in the project area. These are discussed in the original TMDL document as well as the technical support document for this addendum.

Endpoint Identification

The water quality target for the TMDL for this freshwater segment is to maintain concentrations below the geometric mean criterion of 126 MPN/100 mL for *E. coli*. Maintaining the geometric mean criterion for indicator bacteria is expected to be protective of the single sample criterion also and therefore will ultimately result in the attainment of the contact recreation use. The TMDL will be based on bacteria allocations required to meet the geometric mean criterion.

Source Analysis

Regulated Sources

There are no National Pollutant Discharge Elimination System (NPDES)/Texas Pollutant Discharge Elimination System (TPDES)-permitted facilities within the project's subwatershed. The entire Study Area is regulated under the TPDES municipal separate storm sewer system (MS4) discharge permit jointly held by Harris County, Harris County Flood Control District (HCFCD), City of Houston, and Texas Department of Transportation. There are no NPDES-permitted Concentrated Animal Feeding Operations

(CAFOs) within the Study Area. Figure 3 shows the MS4 coverage area and water quality monitoring (WQM) station.

Table 4. Aggregated Land Use Summaries by Segment

Aggregated Land Use Category	1007V_01
Acres of Developed	632
Acres Cultivated Land	0
Acres Pasture/Hay	0
Acres Grassland/Herbaceous	0
Acres of Woody Land	7.1
Acres of Open Water	0
Acres of Wetland	0
Acres of Bare/Transitional	0
Watershed Area (acres)	**639**
Percent Developed	98.9%
Percent Cultivated Land	0%
Percent Pasture/Hay	0%
Percent Grassland/Herbaceous	0%
Percent Woody Land	1.1%
Percent Open Water	0%
Percent Wetland	0%
Percent Bare/Transitional	0%

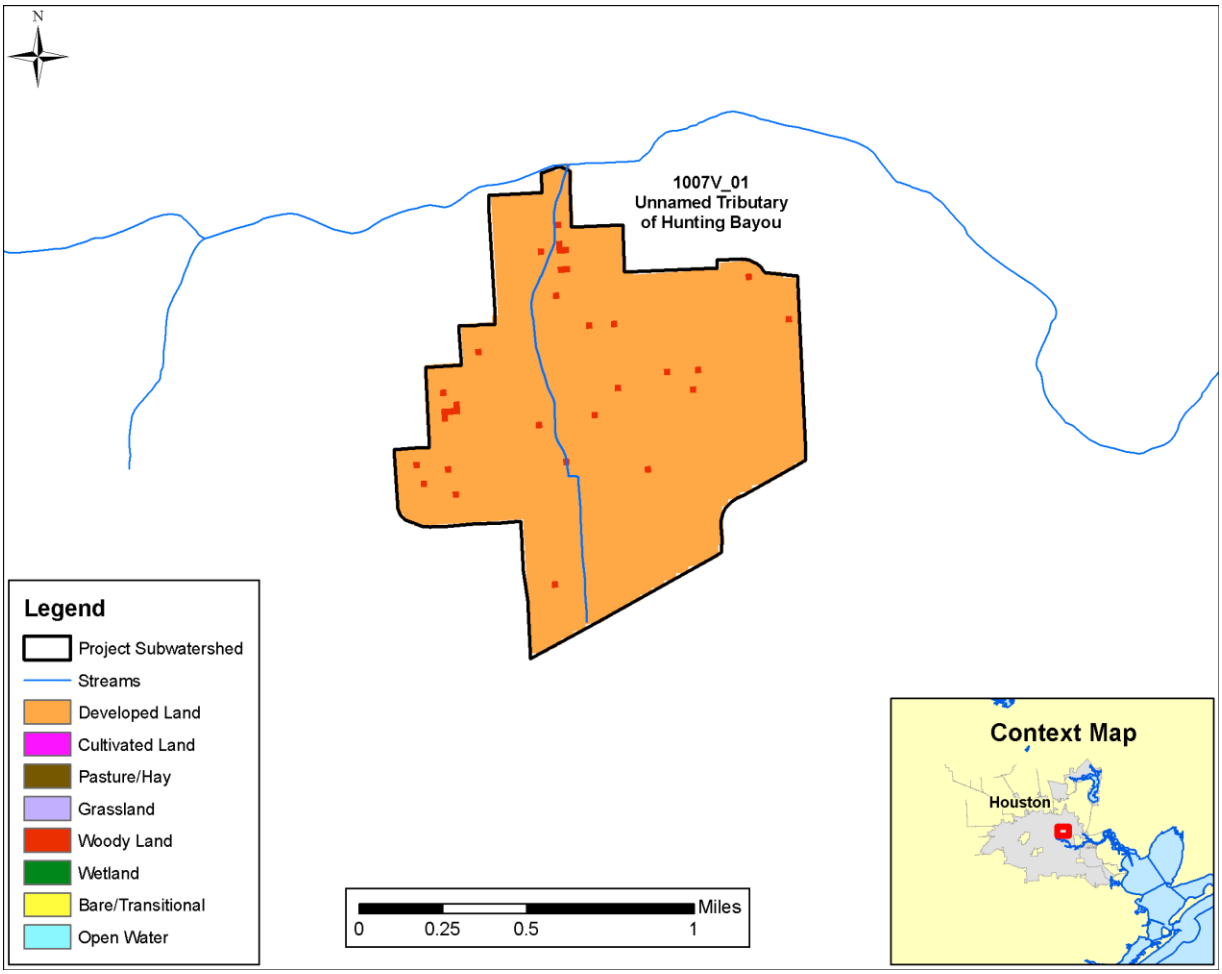
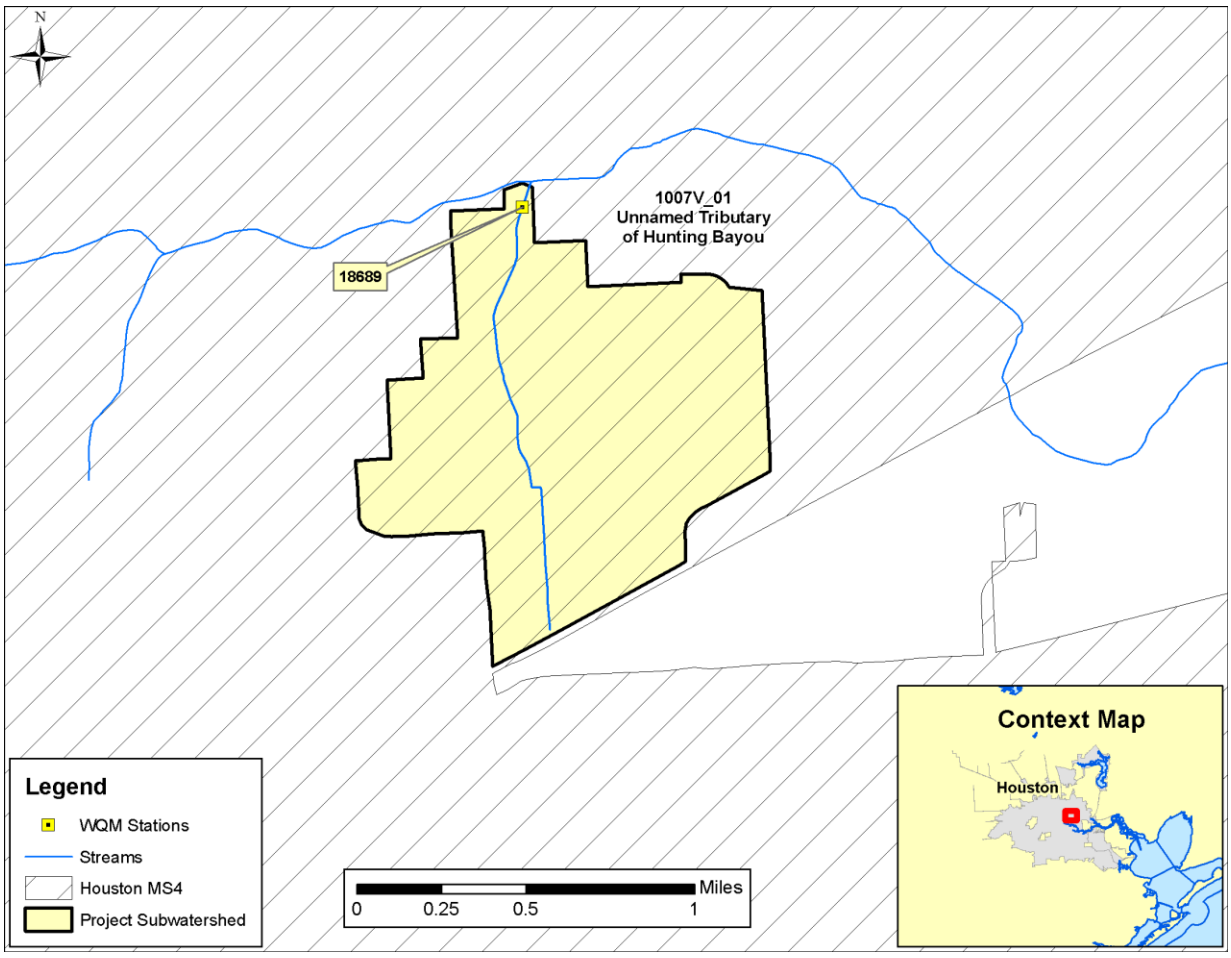


Figure 2. Land Use for Project Subwatersheds



Source: The jurisdictional boundary of the Houston MS4 permit is derived from Urbanized Area Map Results for Texas which can be found at the USEPA website <cfpub.epa.gov/npdes/stormwater/urbanmapresult.cfm?state=TX>.

Figure 3. WQM Station and MS4 Coverage Area in the Eastern Houston Subwatershed

Sanitary Sewer Overflows

TCEQ Region 12-Houston provided two database queries for sanitary sewer overflow (SSO) data – one is collected by the City of Houston and the other is compiled from the remainder of the wastewater dischargers in the Study Area (Rice 2005).

These data are included in Table 5. The locations and magnitudes of the reported SSOs are displayed in Figure 4. The WWTF service area boundaries are also shown in Figure 4. The loads from these SSOs were accounted for in the original TMDL document. They are being assigned to the specific subwatershed in this addendum.

Table 5. Sanitary Sewer Overflow (SSO) Summary

Facility Name	NPDES Permit No.	TPDES Permit No.	# of Occurrences	Date Range – From	Date Range – To	Gallons (Min)	Gallons (Max)	Gallons (Avg.)	Segment
City of Houston - 69th Street	TX0096172	10495-090	13	04/12/01	07/14/03	53	4654	1558	1007V_01

TPDES-Regulated Stormwater

The entirety of the subwatershed in the Study Area is covered under the City of Houston County MS4 permit (TPDES Permit No. WQ0004685000). Under the City of Houston/Harris County discharge permit, Harris County, HCFCD, City of Houston, and Texas Department of Transportation are designated as co-permittees.

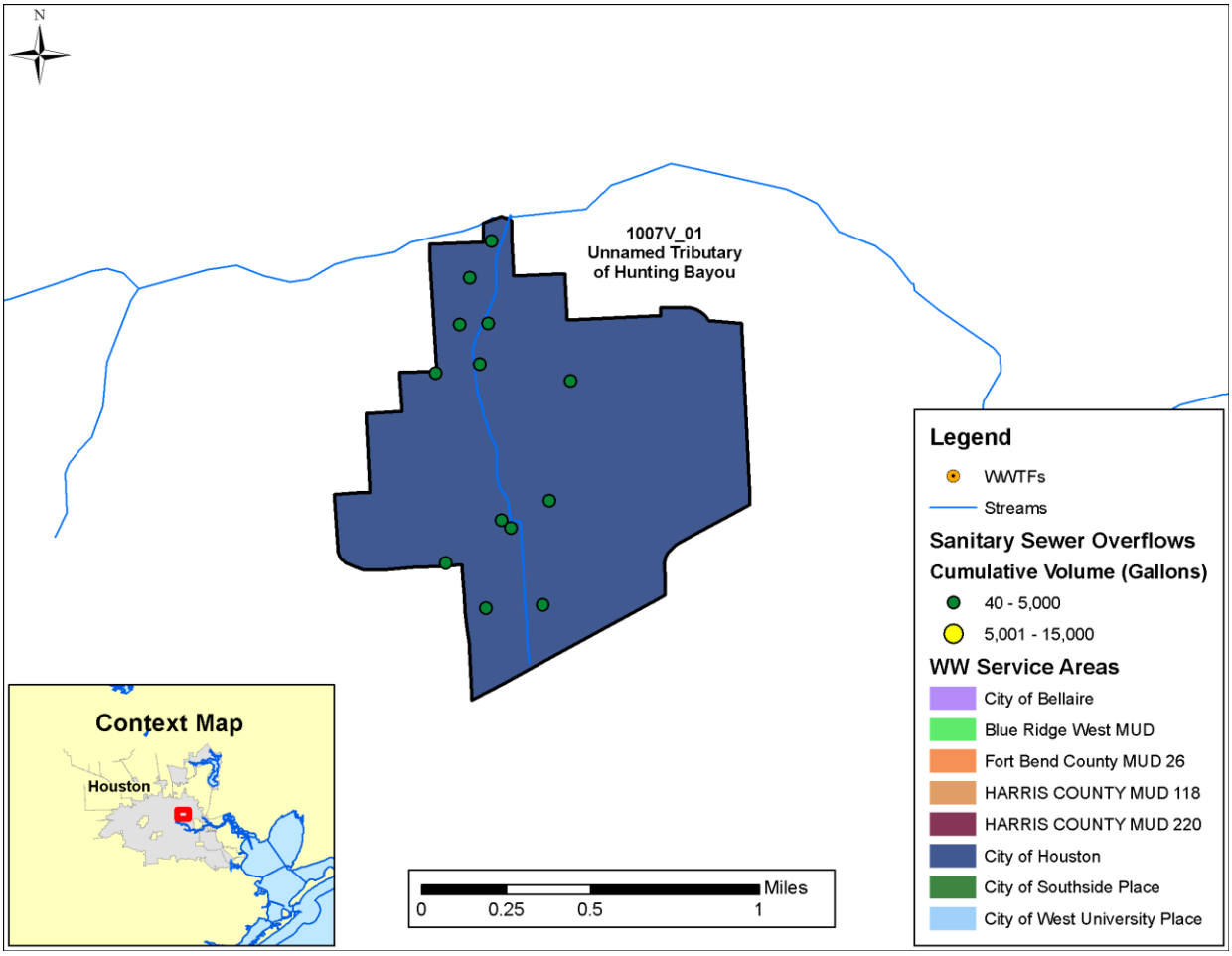


Figure 4. Locations of Sanitary Sewer Overflows

Unregulated Sources

Pollutants from unregulated sources enter the impaired AU through distributed, nonspecific locations, which may include urban runoff not covered by a permit, wildlife, various agricultural activities and animals, land application fields, failing onsite sewage facilities (OSSFs), and domestic pets.

Wildlife and Unmanaged Animal Contributions

Currently there are insufficient data available to estimate populations and spatial distribution of wildlife and avian species by subwatershed. Consequently, it is difficult to assess the magnitude of bacteria contributions from wildlife species as a general category.

Unregulated Agricultural Activities and Domesticated Animals

A number of agricultural activities that do not require permits can also be sources of fecal bacteria loading. Given the fact that the TMDL Study Area is highly urbanized, livestock and other domesticated animals are either not found in the watershed or exist in small numbers. Therefore, livestock and other domesticated animals are not considered as a contributor of bacteria loads.

Failing On-site Sewage Facilities

To estimate the potential magnitude of fecal bacteria loading from OSSFs, the number of OSSFs was estimated for each subwatershed. The estimate of OSSFs was derived by using data from the 1990 U.S. Census (U.S. Census Bureau 2000) and a GIS shape file obtained from Houston-Galveston Area Council (H-GAC) showing all areas where wastewater service currently exists. This analysis indicated that there are no unsewered areas with OSSFs in the project's subwatershed. Therefore, OSSFs are not considered as a contributor of bacteria loads.

Domestic Pets

Fecal matter from dogs and cats is transported to streams by runoff from urban and suburban areas and can be a potential source of bacteria loading. On average nationally, there are 0.58 dogs per household and 0.66 cats per household (American Veterinary Medical Association 2007). Using the U.S. Census data at the block level (U.S. Census Bureau 2010), dog and cat populations can be estimated for each subwatershed. Table 6 summarizes the estimated number of dogs and cats for the subwatershed of the Study Area. Only a small portion of the bacteria load from pets is expected to reach water bodies, through wash-off of land surfaces and conveyance in runoff. The pet number estimates were accounted for in the original TMDL document. They are being assigned to the specific subwatershed in this addendum.

Table 6. Estimated Numbers of Pets

Segment	Stream Name	Dogs	Cats
1007V_01	Unnamed Tributary of Hunting Bayou	903	1,018

Linkage Analysis

Load duration curve (LDC) analysis (including flow duration curve (FDC) analysis) was used for analyzing indicator bacteria load and instream water quality for the segment in this project. The Technical Support Document has details about this analysis.

Margin of Safety

The TMDL covered by this report incorporates an explicit margin of safety (MOS) by setting a target for indicator bacteria loads that is 5 percent lower than the single sample criterion. The MOS was used because of the limited amount of data available for the sampling location. For contact recreation, this equates to a single sample target of 379 MPN/100mL for *E. coli* and a geometric mean target of 120 MPN/100mL. The net effect of the TMDL with MOS is that the as-

similative capacity or allowable pollutant loading of the water body is slightly reduced. The TMDL covered by this report incorporates an explicit MOS in each LDC by using 95 percent of the single sample criterion.

Pollutant Load Allocation

Pollutant load allocations were developed using analysis of the FDC and the LDC method. To establish the subwatershed targets, TMDL calculations and associated allocations are established for the most-downstream sampling location in the subwatershed. This establishes a distinct TMDL for the 303(d) listed water body.

To calculate the bacteria load at the criterion for the segment, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*24,465,755 dL/ft3 * seconds/day*) and the *E. coli* criterion. This calculation produces the maximum bacteria load in the stream without exceeding the instantaneous standard over the range of flow conditions. *E. coli* loads are plotted versus flow exceedance percentiles as an LDC. The x-axis indicates the flow exceedance percentile, while the y-axis is expressed in terms of a bacteria load.

To estimate existing loading in the Unnamed Tributary of Hunting Bayou, bacteria observations from 1999 to 2011 are paired with the flows measured or estimated in that segment on the same date. Pollutant loads are then calculated by multiplying the measured bacteria concentration by the flow rate and a unit conversion factor of *24,465,755 dL/ft3 * seconds/day*. The associated flow exceedance percentile is then matched with the measured flow. The observed bacteria loads are added to the LDC plot as points. These points represent individual ambient water quality samples of bacteria. Points above the LDC indicate the bacteria instantaneous standard was exceeded at the time of sampling. Conversely, points under the LDC indicate the sample met the criterion.

The LDC approach recognizes that the assimilative capacity of a water body depends on the flow, and that maximum allowable loading varies with flow condition. Existing loading and loads that meet the TMDL water quality target can also be calculated under different flow conditions.

The load allocation goal for the Unnamed Tributary of Hunting Bayou is based on data analysis using the geometric mean criterion since it is anticipated that achieving the geometric mean over an extended period of time will likely ensure that the single sample criterion will also be achieved.

Figure 5 represents the LDC for the Unnamed Tributary of Hunting Bayou and is based on *E. coli* bacteria measurements at sampling location 18689 (Tributary Hunting Bayou at Minden). The LDC indicates that *E. coli* levels exceed the instantaneous and geometric mean water quality criteria under all flow conditions. Wet weather influenced *E. coli* observations are found under high and mid-range flow conditions. The allocation goal for the segment used in the final TMDL equation was based on the flow regime with the highest bacteria load (0–20th percentile).

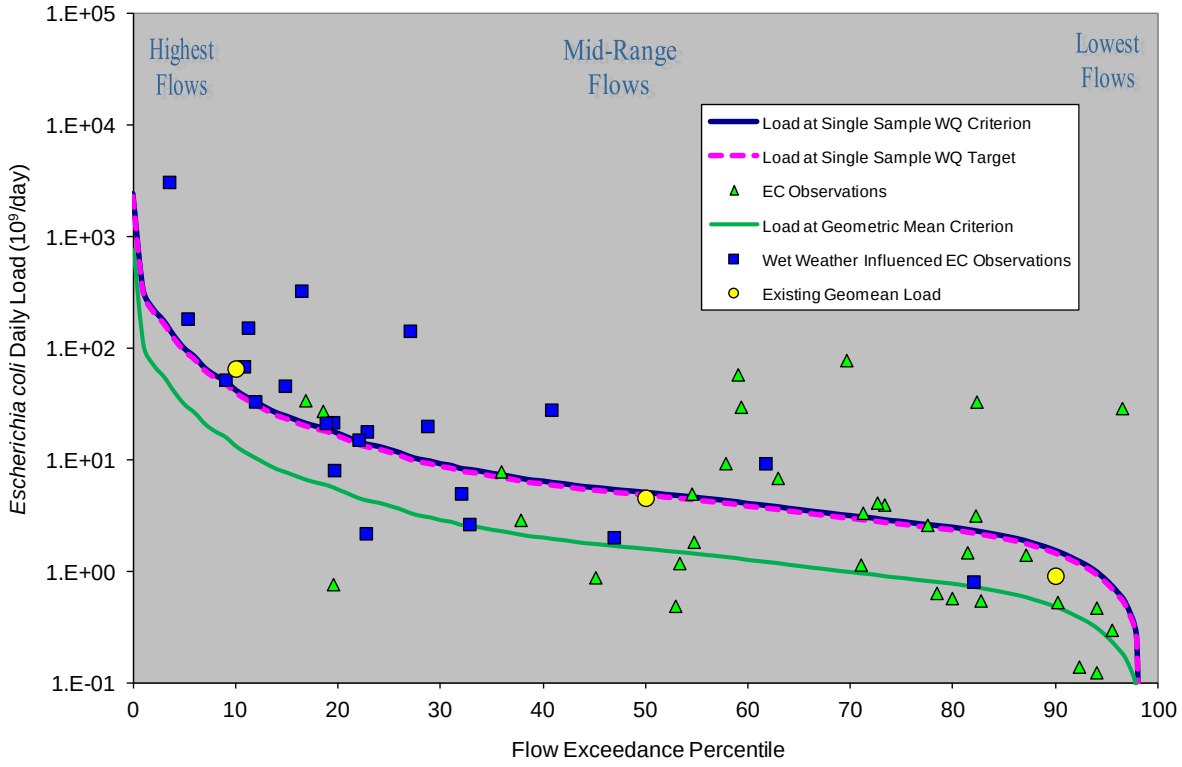


Figure 5. Load Duration Curve for Unnamed Tributary of Hunting Bayou (1007V_01)

Wasteload Allocation

The wasteload allocation (WLA) is the sum of loads from regulated sources.

WWTFs

TPDES-permitted WWTFs are allocated a daily wasteload (WLA_{WWTF}) calculated as their permitted discharge flow rate multiplied by one-half the instream geometric mean water quality criterion. One-half of the water quality criterion is used as the target to provide instream and downstream load capacity, and to provide consistency with other TMDLs developed in the Houston area.

There are no TPDES-permitted facilities within the subwatershed covered by this project. WLAs were established for facilities throughout the Eastern Houston watersheds in the original TMDL document and its subsequent Water Quality Management Plan (WQMP) updates.

Stormwater

Stormwater discharges from MS4, industrial, and construction areas are considered permitted or regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). A simplified approach for estimating the WLA for these areas was used in the development of the TMDL due to the limited amount of data available, the complexities associated with simulating rainfall runoff, and the variability of stormwater loading.

The percentage of the subwatershed that is under the jurisdiction of stormwater permits (i.e., defined as the area designated as urbanized area in the 2000 US Census) is used to estimate the amount of the overall runoff load to be allocated as the regulated stormwater contribution in the WLA_{SW} component of the TMDL. The load allocation (LA) component of the TMDL corre-

sponds to direct nonpoint source runoff and is the difference between the total load from stormwater runoff and the portion allocated to WLA_{SW}. For the subwatershed addressed in this TMDL, 100 percent of the area is within the urbanized area.

Load Allocation

The LA is the sum of loads from unregulated sources. Since the entirety of the subwatershed is within the urbanized area, there is no LA for this TMDL.

Allowance for Future Growth

As described in the original TMDL document, future growth of existing or new point sources is not limited by this TMDL as long as the sources do not cause indicator bacteria to exceed the limits. The assimilative capacity of streams increases as the amount of flow increases. Consequently, increases in flow allow for additional indicator bacteria loads if the concentrations are at or below the contact recreation standard. New or amended permits for wastewater discharge facilities will be evaluated case by case.

To account for the probability that increased or additional flows from WWTFs may occur in water bodies with WWTFs, a provision for future growth is typically included in the TMDL calculations by estimating permitted flows to year 2035 using population projections completed by H-GAC. The subwatershed for the Unnamed Tributary of Hunting Bayou has no WWTF, so no future growth allocation was assigned in its TMDL equation.

The three-tiered antidegradation policy in the SWQSs prohibits an increase in loading that would cause or contribute to degradation of an existing use. The antidegradation policy applies to both point and nonpoint source pollutant discharges. In general, antidegradation procedures establish a process for reviewing individual proposed actions to determine if the activity will degrade water quality. The TMDLs in this document will result in protection of existing beneficial uses and conform to Texas's antidegradation policy.

TMDL Calculations

Table 7 summarizes the estimated maximum allowable load of *E. coli* for the AU included in this project.

The final TMDL allocation required to comply with the requirements of 40 CFR 130.7 is summarized in Table 8. In this table, the future capacity for WWTF has been added to the WLA_{WWTF}.

TMDL values and allocations in Table 8 are derived from calculations using the existing water quality criteria for *E. coli*. However, designated uses and water quality criteria for these water bodies are subject to change through the TCEQ SWQS revision process. Figure 6 was developed to demonstrate how assimilative capacity, TMDL calculations, and pollutant load allocations change in relation to a number of hypothetical water quality criteria. The equations provided along with Figure 6 allow the calculation of new TMDLs and pollutant load allocations based on any potential new water quality criteria for *E. coli*.

Table 7. *E. coli* TMDL Summary Calculations for Unnamed Tributary of Hunting Bayou (1007V_01)

All loads expressed as Billion MPN/day

TMDL[a]	WLA_{WWTF}[b]	$WLA_{STORMWATER}$[c]	LA[d]	MOS[e]	Future Growth[f]
13.3	0	12.6	0	0.664	0

[a] *Maximum allowable load for the highest flow range (0 to 20th percentile flows)*

[b] *Sum of loads from the WWTF discharging upstream of the TMDL station. Individual loads are calculated as permitted flow * 126/2 (*E. coli*) MPN/100mL*conversion factor*

[c] $WLA_{STORMWATER}$ *= (TMDL – MOS –*WLA_{WWTF}*)*(percent of drainage area covered by stormwater permits)*

[d] *LA = TMDL – MOS –*WLA_{WWTF} *–*$WLA_{STORMWATER}$*-Future growth*

[e] *MOS = TMDL x 0.05*

[f] *Projected increase in WWTF permitted flows*126/2*conversion factor*

Table 8. Final TMDL Allocations

All loads expressed as Billion MPN/day

Assessment Unit	TMDL[a]	WLA_{WWTF}[b]	$WLA_{STORMWATER}$	LA	MOS
1007V_01	13.3	0[c]	12.6	0	0.664

[a] *TMDL=* WLA_{WWTF} *+* $WLA_{STORMWATER}$ *+ LA + MOS*

[b] WLA_{WWTF}*=* WLA_{WWTF} *+ Future Growth*

[c] WLA_{WWTF} *of zero for this AU does not preclude the inclusion of future WWTFs in this watershed. Any new permitted discharges will be held to the same bacteria criteria used in this allocation process. Additional discharges would lead to additional flow in the affected segment. The assimilative capacity of streams increases as the amount of flow increases. Consequently, increases in flow allow for additional indicator bacteria loads if the concentrations are at or below the contact recreation standard.*

Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. Seasonal variation was accounted for in the TMDL by using more than five years of water quality data and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing historical bacteria concentrations collected in the warmer months against those collected during the cooler months. Analysis of available *E. coli* data showed no significant difference.

Public Participation

A presentation on this addendum was given at the annual meeting of the Bacteria Implementation Group (BIG) in Houston on May 22, 2012. The public will have an opportunity to comment on this document during a 30-day WQMP comment period. Notice of the public comment period will be sent to the BIG group and posted at <http://www.tceq.texas.gov/permitting/wqmp/WQmanagement _comment.html>, and the document will be posted at <http://www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html>. The technical support document for this project is posted on the TMDL project page at <http://www.tceq.texas.gov/waterquality/tmdl/nav/42-houstonbacteria/42-houstonareabacteria-library>.

Implementation and Reasonable Assurance

The segment covered by this addendum is within the existing Eastern Houston Watersheds bacteria TMDL project area. These watersheds are within the area covered by the I-Plan developed by the BIG for bacteria TMDLs throughout the greater Houston area. Please refer to the original TMDL document for additional information regarding implementation and reasonable assurance.

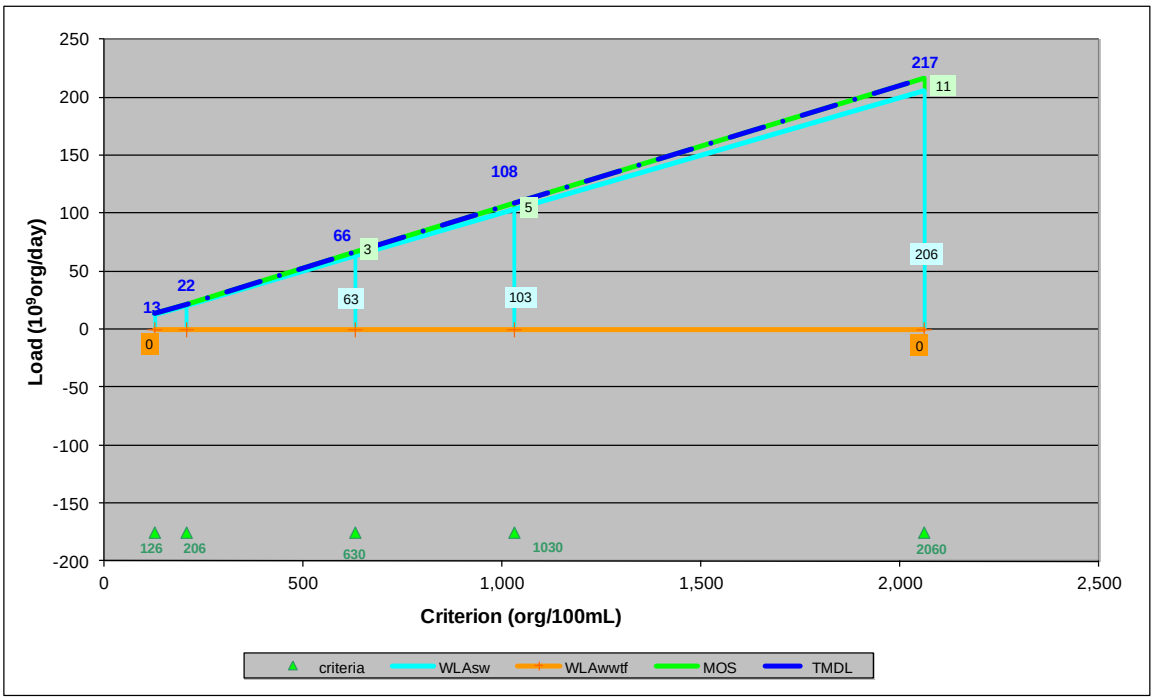


Figure 6. Allocation Loads for AU 1007V_01 as a Function of Water Quality Criteria

Equations for Calculating New TMDL and Allocations

TMDL = 0.1053*Std
LA = 0
WLA_{WWTF} = 0
$WLA_{STORM\ WATER}$ = 0.1001*Std
MOS = 0.05*TMDL

Where:

WLA_{WWTF} = waste load allocation (permitted WWTF)
$WLA_{STORM\ WATER}$ = waste load allocation (permitted storm water)
LA = load allocation (non-permitted source contributions)
Std = Revised Contact Recreation Standard
MOS = Margin of Safety

References

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Appendix VI. Addendum One to Four Total Maximum Daily Loads for Indicator Bacteria in Sims Bayou Above Tidal and Tributary

One Total Maximum Daily Load for Indicator Bacteria in Canal C-147

For Segment 1007A
Assessment Unit 1007A_01

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted the total maximum daily loads (TMDLs) *Four Total Maximum Daily Loads for Indicator Bacteria in Sims Bayou Above Tidal and Tributary: Segments 1007D and 1007N* (TCEQ 2010a) on 9/15/2010. The TMDLs were approved by the United States Environmental Protection Agency (EPA) on 9/27/2010. This document represents an addendum to the original TMDL document.

This addendum includes information specific to one additional segment located within the watershed of the approved TMDL project for bacteria in the Sims Bayou watershed. Concentrations of indicator bacteria in this segment exceed the criteria used to evaluate attainment of the contact recreation standard. This addendum presents the new information associated with the additional segment. For background or other explanatory information for this segment, please refer to *Technical Support Document: Bacteria Total Maximum Daily Loads for New/Additional Listings in the Houston Metro Area, Houston, Texas (1007T_01, 1007U_01, 1007S_01, 1007V_01, 1017C_01, and 1007A_01)* (University of Houston and Parsons 2012), which has additional details related to all aspects of this addendum.

Refer to the original, approved TMDL document for details related to the overall project watershed as well as the methods and assumptions used in developing this TMDL. This addendum focuses on the subwatershed of the additional segment. This subwatershed, including permitted facilities within it, was addressed in the original TMDL. This addendum provides the details related to developing the TMDL allocation for the additional segment, which was not addressed individually in the original document. This segment is also covered by an implementation plan (I-Plan) that has been drafted by stakeholders in the greater Houston area. The I-Plan addresses multiple watersheds, including Sims Bayou's.

Problem Definition

The TCEQ first identified the bacteria impairment to the segment and assessment unit (AU) included in this addendum in the year 2006 Texas Water Quality Inventory and 303(d) List (Table 1). The impaired AU is Canal C-147 (1007A_01). See Figure 1 for a map of the watershed.

The Texas surface water quality standards (SWQSs; TCEQ 2010b) provide numeric and narrative criteria to evaluate attainment of designated uses. The basis for water quality targets for the TMDL developed in this report will be the numeric criteria for bacterial indicators from the 2010 Texas SWQS. *E. coli* is the preferred indicator bacteria for assessing contact recreation use in freshwater.

Table 2 summarizes the ambient water quality data for the TCEQ water quality monitoring (WQM) stations on the impaired water body.

Canal C-147 (Segment 1007A_01): The single sample criterion for *E. coli* was exceeded at both WQM station locations within this subwatershed (42 percent of samples at one station and 67 % at the other). The geometric mean criterion for *E. coli* was also exceeded at both stations.

Watershed Overview

The Sims Bayou Above Tidal watershed encompasses approximately 64 square miles of land located southwest of the City of Houston, Texas. The Sims Bayou Above Tidal watershed is part of the San Jacinto River Basin. The entire watershed's rainfall average is approximately 46 inches per year. The average value for the subwatershed is summarized in Table 3.

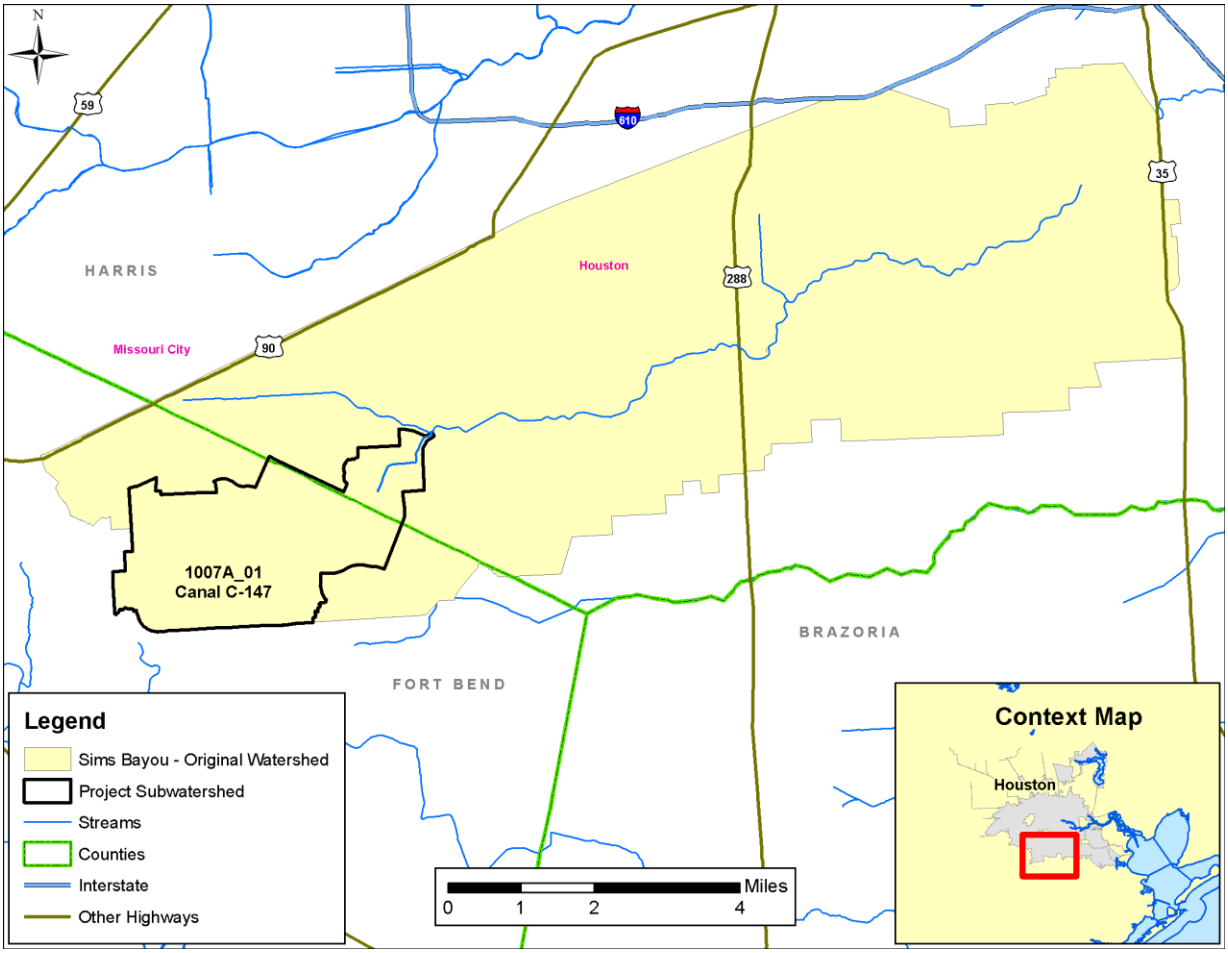


Figure 1. Sims Bayou Watershed [a]

[a] All maps in this document were developed by the University of Houston and modified by the TMDL Program of the TCEQ. No claims are made to the accuracy or completeness of the data or to its suitability for a particular use. "TSARP" refers to the Tropical Storm Allison Recovery Project, for which some map delineations used in this project were originally created.

Table 1. Synopsis of Texas Integrated Report for Water Bodies in the Sims Bayou Watershed

Segment ID	Segment Name	Parameter	Contact Recreation Use	Year Impaired	Category	Stream Length (miles)
1007A_01	Canal C-147	*E. coli*	Nonsupport	2006	5a	0.44

Table 2. Water Quality Data for TCEQ Stations from 1999 to 2011

Segment	Station ID	Indicator Bacteria	Geometric Mean Concentration (MPN/100ml)	Number of Samples	Number of Samples Exceeding Single Sample Criterion	% of Samples Exceeding
1007A_01	17971	*E. coli*	356	98	41	42%
	13589	*E. coli*	698	46	31	67%

MPN: Most Probable Number

Geometric Mean Criterion: 126 MPN/100 m.

Single Sample Criterion: 399 MPN/100 ml.

Table 3. Average Annual Precipitation in Study Area Subwatershed, 1988-2007 (in inches)

Segment Name	Segment ID	Average Annual (Inches)
Canal C-147	1007A_01	46.39

Table 4 summarizes the acreages and the corresponding percentages of the land use categories associated with the project subwatershed in the Sims Bayou Above Tidal watershed. The land use/land cover data were retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Coastal Services Center. The specific land use/land cover data files were derived from the Coastal Change Analysis Program (C-CAP), Texas 2005 Land Cover Data (NOAA 2007). The total acreage of the segment in Table 4 corresponds to the watershed delineation in Figure 2. Based on the data sources that were used, the predominant land use category in this subwatershed is developed land (79%), followed by pasture/hay (11 %).

Population estimates and future population projections were examined for counties and cities in the project area. These are discussed in the original TMDL document as well as the technical support document for this addendum.

Endpoint Identification

The water quality target for the TMDL for this freshwater segment is to maintain concentrations below the geometric mean criterion of 126 MPN/100 mL for *E. coli*. Maintaining the geometric mean criterion for indicator bacteria is expected to be protective of the single sample criterion also and therefore will ultimately result in the attainment of the contact recreation use. The TMDL will be based on bacteria allocations required to meet the geometric mean criterion.

Source Analysis
Regulated Sources

There are three National Pollutant Discharge Elimination System (NPDES)/Texas Pollutant Discharge Elimination System (TPDES)-permitted facilities within the project's subwatershed. In addition, the entire Study Area is regulated under the TPDES municipal separate storm sewer system (MS4) discharge permit jointly held by Harris County, Harris County Flood Control District (HCFCD), City of Houston, and Texas Department of Transportation. There are no NPDES-permitted Concentrated Animal Feeding Operations (CAFOs) within the Study Area.

The three TPDES-permitted facilities that continuously discharge wastewater to surface waters addressed in this TMDL are listed in Table 5 and shown in Figure 3. Figure 3 also shows water quality monitoring (WQM) stations and the MS4 coverage area.

Table 4. Aggregated Land Use Summaries by Segment

Aggregated Land Use Category	1007A_01
Acres of Developed	3,611
Acres Cultivated Land	0.2
Acres Pasture/Hay	518
Acres Grassland/Herbaceous	161
Acres of Woody Land	237
Acres of Open Water	2.4
Acres of Wetland	58
Acres of Bare/Transitional	4.2
Watershed Area (acres)	**4,592**
Percent Developed	78.6%
Percent Cultivated Land	0.005%
Percent Pasture/Hay	11%
Percent Grassland/Herbaceous	3.5%
Percent Woody Land	5.2%
Percent Open Water	0.05%
Percent Wetland	1.3%
Percent Bare/Transitional	0.09%

Table 5. TPDES-Permitted Facilities in the Study Area

Segment	Receiving Water	TPDES Number	NPDES NUMBER	Facility Name	Facility Type	Permitted Flow (MGD)
1007A_01	Canal C-147	11553-001	TX0053643	Blue Ridge West MUD-WWTP	Sewerage Systems	1.3
1007A_01	Canal C-147	10495-110	TX0026433	City of Houston (Greenridge)	Sewerage Systems	7.05
1007A_01	Canal C-147	12073-001	TX0078891	Fort Bend County MUD No.26	Sewerage Systems	0.8

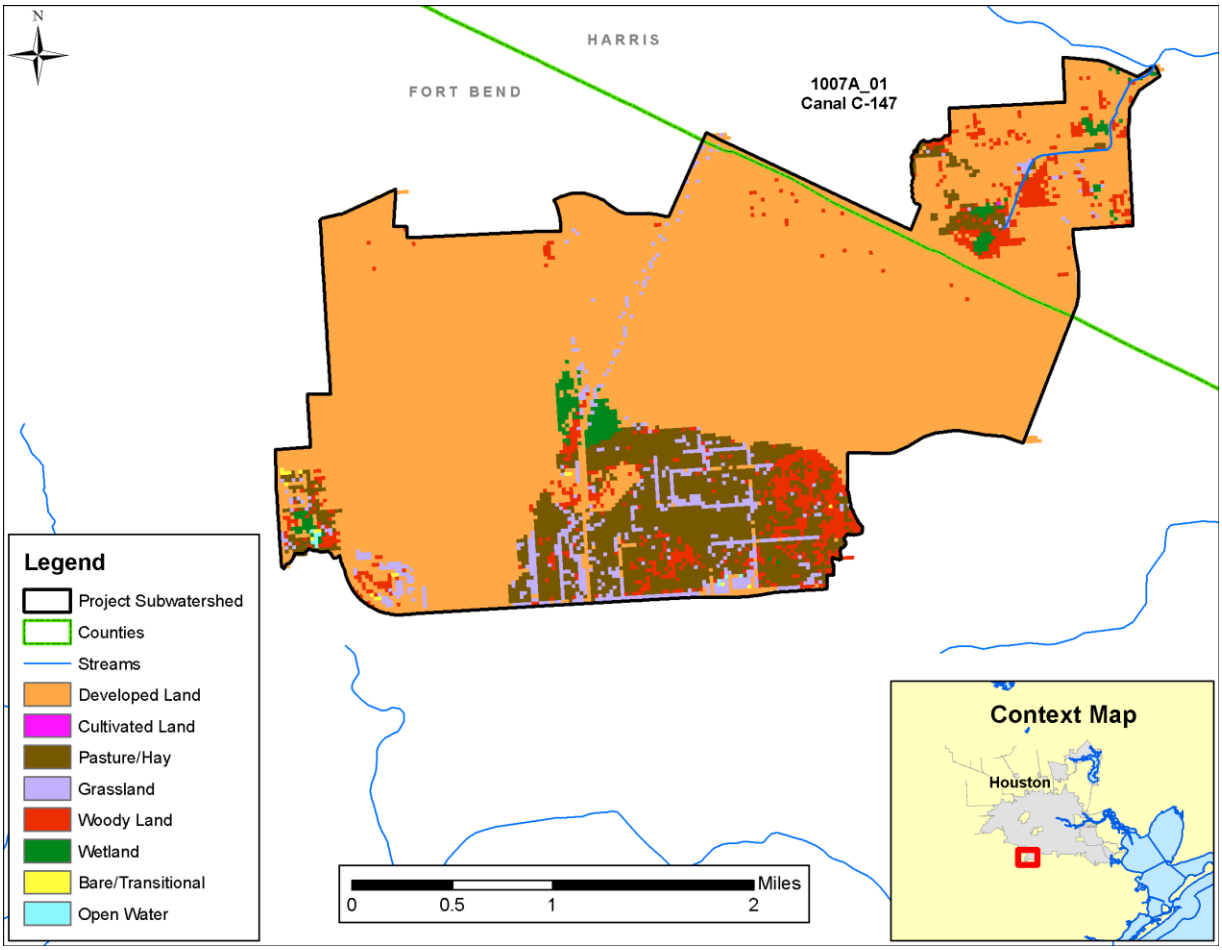
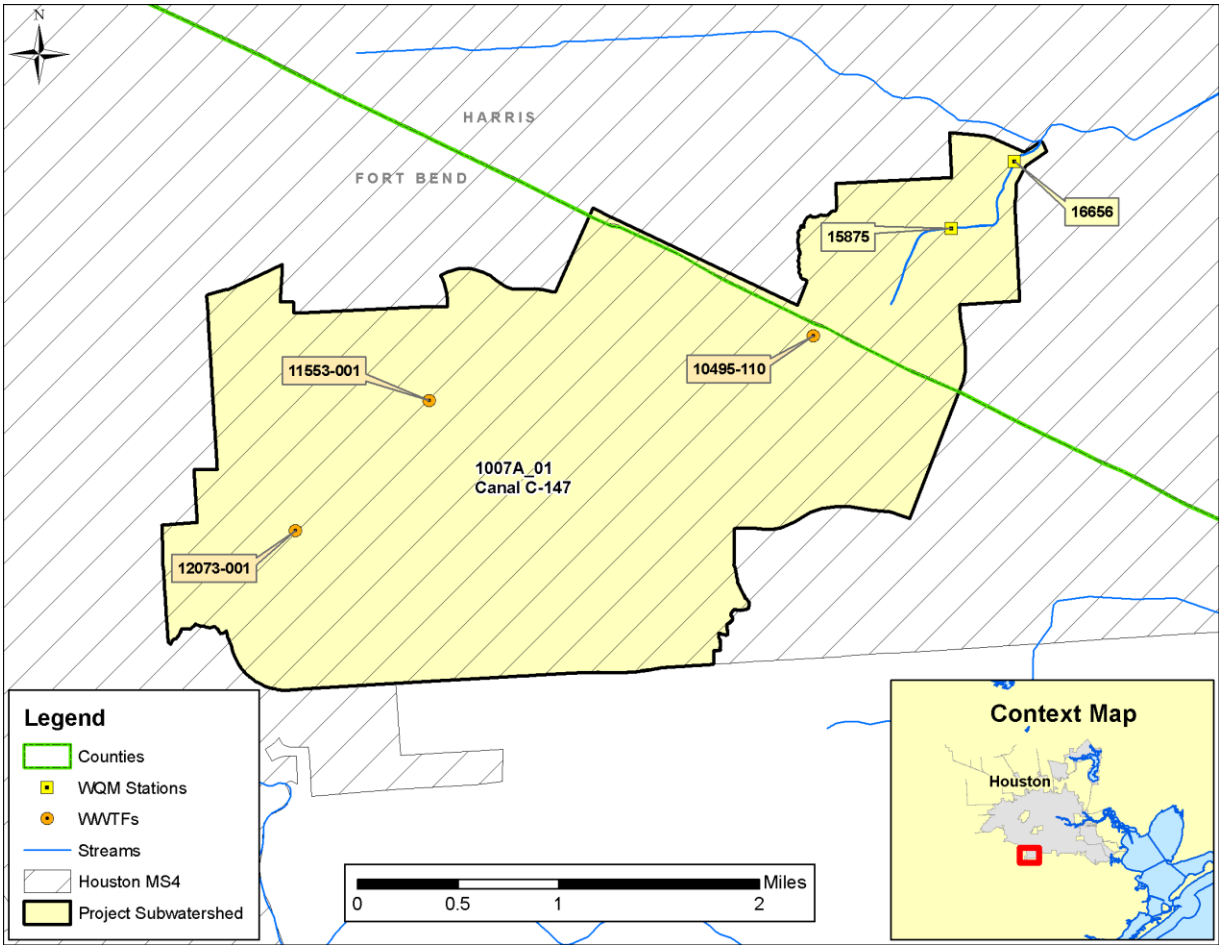


Figure 2. Land Use for Project Subwatersheds



Source: The jurisdictional boundary of the Houston MS4 permit is derived from Urbanized Area Map Results for Texas which can be found at the USEPA website <cfpub.epa.gov/npdes/stormwater/urbanmapresult.cfm?state=TX>.

Figure 3. TPDES-Permitted Facilities, WQM Stations, and MS4 Coverage Area in the Sims Bayou Above Tidal Subwatershed

Sanitary Sewer Overflows

TCEQ Region 12-Houston provided two database queries for sanitary sewer overflow (SSO) data – one is collected by the City of Houston and the other is compiled from the remainder of the wastewater dischargers in the Study Area (Rice 2005).

These data are included in Table 6. The locations and magnitudes of the reported SSOs are displayed in Figure 4. The WWTF service area boundaries are also shown in Figure 4. The loads from these SSOs were accounted for in the original TMDL document. They are being assigned to the specific subwatershed in this addendum.

Table 6. Sanitary Sewer Overflow (SSO) Summary

Facility Name	NPDES Permit No.	TPDES Permit No.	# of Occurrences	Date Range – From	Date Range – To	Gallons (Min)	Gallons (Max)	Gallons (Avg.)	Segment
City of Houston - Green Ridge	TX0026433	10495-110	19	03/01/01	05/03/03	41	10775	1342	1007A_01
City of Houston - Almeda Sims	TX0034924	10495-003	3	09/24/01	04/19/02	209	2374	957	1007A_01

TPDES-Regulated Stormwater

The entirety of the subwatershed in the Study Area is covered under the City of Houston County MS4 permit (TPDES Permit No. WQ0004685000). Under the City of Houston/Harris County discharge permit, Harris County, HCFCD, City of Houston, and Texas Department of Transportation are designated as co-permittees.

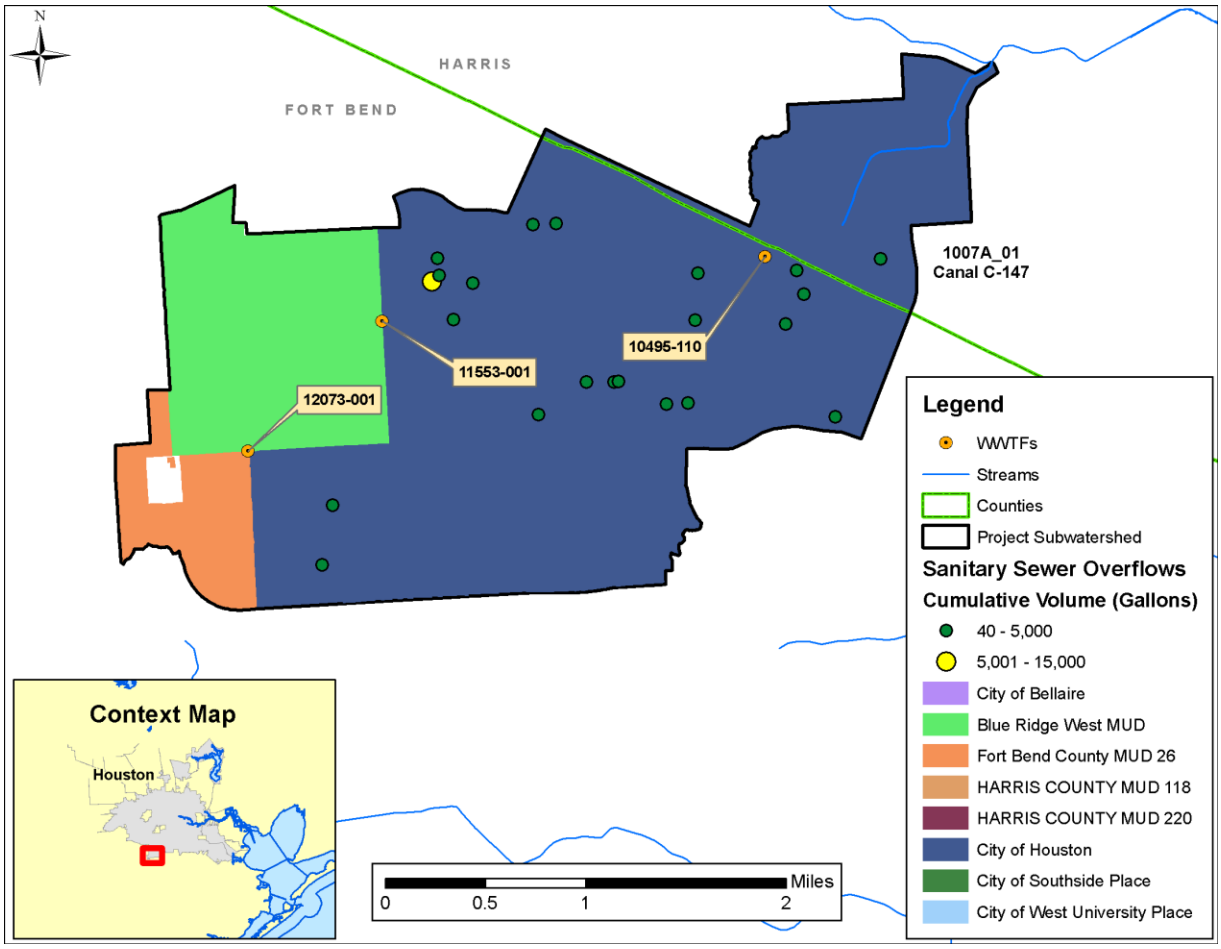


Figure 4. Locations of Sanitary Sewer Overflows

Unregulated Sources

Pollutants from unregulated sources enter the impaired AU through distributed, nonspecific locations, which may include urban runoff not covered by a permit, wildlife, various agricultural activities and animals, land application fields, failing onsite sewage facilities (OSSFs), and domestic pets.

Wildlife and Unmanaged Animal Contributions

Currently there are insufficient data available to estimate populations and spatial distribution of wildlife and avian species by subwatershed. Consequently, it is difficult to assess the magnitude of bacteria contributions from wildlife species as a general category.

Unregulated Agricultural Activities and Domesticated Animals

A number of agricultural activities that do not require permits can also be sources of fecal bacteria loading. Given the fact that the TMDL Study Area is highly urbanized, livestock and other domesticated animals are either not found in the watershed or exist in small numbers. Therefore, livestock and other domesticated animals are not considered as a contributor of bacteria loads.

Failing On-site Sewage Facilities

To estimate the potential magnitude of fecal bacteria loading from OSSFs, the number of OSSFs was estimated for each subwatershed. The estimate of OSSFs was derived by using data from the 1990 U.S. Census (U.S. Census Bureau 2000) and a GIS shape file obtained from Houston-Galveston Area Council (H-GAC) showing all areas where wastewater service currently exists. Figure 5 displays unsewered areas that did not fall under the wastewater service areas. OSSFs were calculated using spatial GIS queries for areas not covered by wastewater service areas. OSSFs were assigned proportionally based on the percentage of the area falling outside a wastewater service area within the project subwatershed. Finally, the OSSFs for each unsewered area were then totaled for the TMDL subwatershed. This approach gives an estimate of OSSFs in the subwatershed. Table 7 shows the estimated number of OSSFs calculated using this GIS method. The estimated OSSF numbers and loads were accounted for in the original TMDL document. They are being assigned to the specific project subwatershed in this addendum. H-GAC provided additional OSSF data for select portions of the Study Area (H-GAC 2005).

For the purpose of estimating fecal coliform loading in subwatersheds, the OSSF failure rate of 12 percent from the Reed, Stowe & Yanke, LLC (2001) report for Texas Region 4 was used. Using this 12 percent failure rate, calculations were made to characterize fecal coliform loads in the project subwatershed.

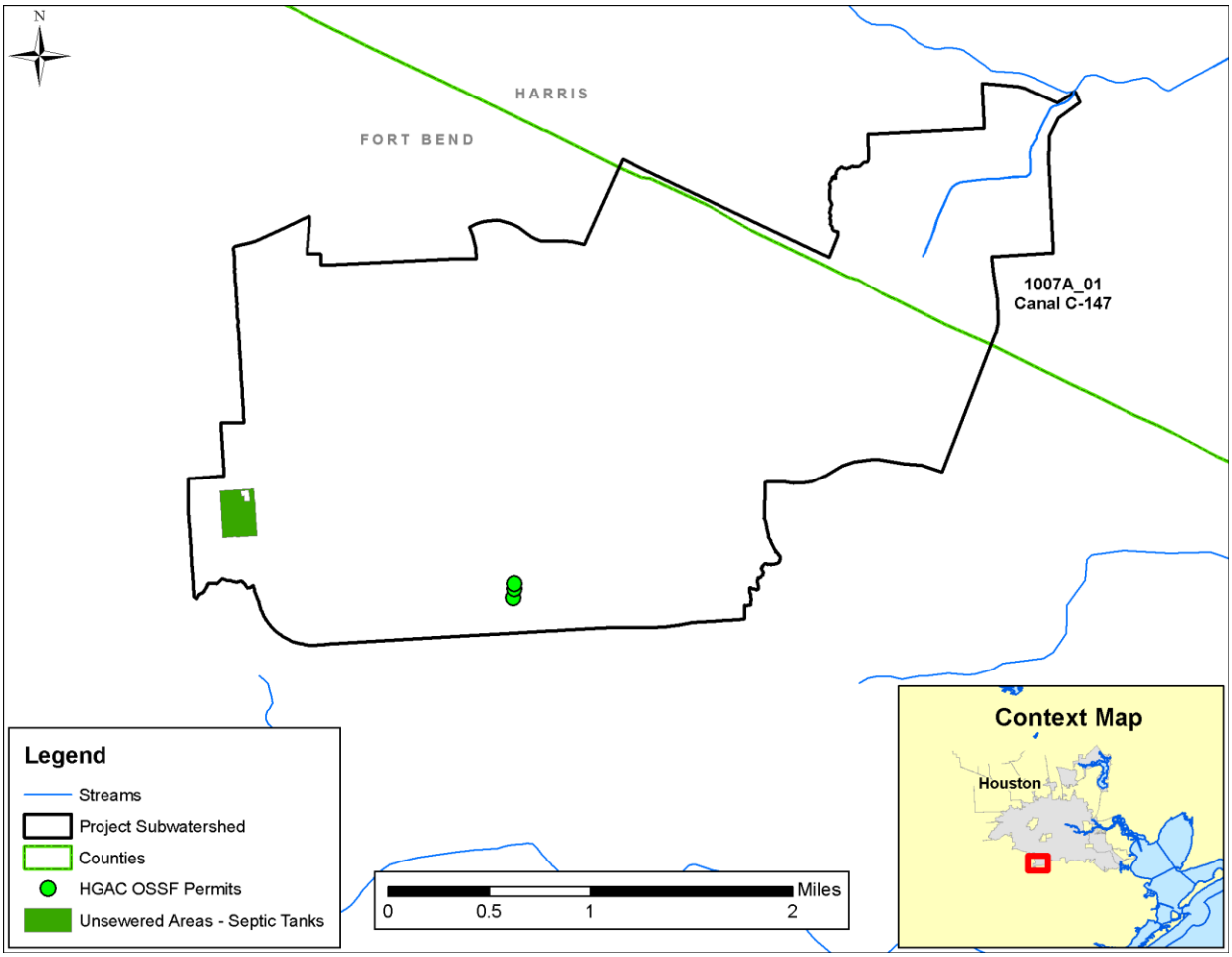


Figure 5. Unsewered Areas and Subdivisions with OSSFs

Fecal coliform loads were estimated using the following equation (EPA 2001):

$$\#\frac{counts}{day} = \left(\#\,Failing\_systems\right) \times \left(\frac{10^6\,counts}{100ml}\right) \times \left(\frac{70gal}{personday}\right) \times \left(\#\frac{person}{household}\right) \times \left(3785.2\frac{ml}{gal}\right)$$

The average of number of people per household was calculated to be 2.78 for counties in the Study Area (U.S. Census Bureau 2000). Approximately 70 gallons of wastewater were estimated to be produced on average per person per day (Metcalf and Eddy 1991). The fecal coliform concentration in septic tank effluent was estimated to be 10^6 per dL of effluent based on reported concentrations from a number of published reports (Metcalf and Eddy 1991; Canter and Knox 1985; Cogger and Carlile 1984). Using this information, the estimated load from failing septic systems within the subwatershed was summarized below in Table 7. Based on this data, it was determined that the estimated fecal coliform loading from OSSFs in the Study Area was found to be negligible.

Table 7. Estimated Number of OSSFs per Subwatershed, and Their Fecal Coliform Loads

Segment	Stream Name	OSSF Estimate using 1990 Census method	OSSF data from HGAC	# of Failing OSSFs	Estimated Loads from OSSFs (Billion MPN/day)
1007A_01	Canal C-147	18	4	2.62	19

Domestic Pets

Fecal matter from dogs and cats is transported to streams by runoff from urban and suburban areas and can be a potential source of bacteria loading. On average nationally, there are 0.58 dogs per household and 0.66 cats per household (American Veterinary Medical Association 2007). Using the U.S. Census data at the block level (U.S. Census Bureau 2010), dog and cat populations can be estimated for each subwatershed. Table 8 summarizes the estimated number of dogs and cats for the subwatershed of the Study Area. Only a small portion of the bacteria load from pets is expected to reach water bodies, through wash-off of land surfaces and conveyance in runoff. The pet number estimates were accounted for in the original TMDL document. They are being assigned to the specific subwatershed in this addendum.

Table 8. Estimated Numbers of Pets

Segment	Stream Name	Dogs	Cats
1007A_01	Canal C-147	5,551	6,263

Linkage Analysis

Load duration curve (LDC) analysis (including flow duration curve (FDC) analysis) was used for analyzing indicator bacteria load and instream water quality for the segment in this project. The Technical Support Document has details about this analysis.

Margin of Safety

The TMDL covered by this report incorporates an explicit margin of safety (MOS) by setting a target for indicator bacteria loads that is 5 percent lower than the single sample criterion. The MOS was used because of the limited amount of data available for the sampling locations. For contact recreation, this equates to a single sample target of 379 MPN/100mL for *E. coli* and a geometric mean target of 120 MPN/100mL. The net effect of the TMDL with MOS is that the as-

similative capacity or allowable pollutant loading of the water body is slightly reduced. The TMDL covered by this report incorporates an explicit MOS in each LDC by using 95 percent of the single sample criterion.

Pollutant Load Allocation

Pollutant load allocations were developed using analysis of the FDC and the LDC method. To establish the subwatershed targets, TMDL calculations and associated allocations are established for the most-downstream sampling location in the subwatershed. This establishes a distinct TMDL for the 303(d) listed water body.

To calculate the bacteria load at the criterion for the segment, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*24,465,755 dL/ft3 * seconds/day*) and the *E. coli* criterion. This calculation produces the maximum bacteria load in the stream without exceeding the instantaneous standard over the range of flow conditions. *E. coli* loads are plotted versus flow exceedance percentiles as an LDC. The x-axis indicates the flow exceedance percentile, while the y-axis is expressed in terms of a bacteria load.

To estimate existing loading in Canal C-147, bacteria observations from 1999 to 2011 are paired with the flows measured or estimated in that segment on the same date. Pollutant loads are then calculated by multiplying the measured bacteria concentration by the flow rate and a unit conversion factor of *24,465,755 dL/ft3 * seconds/day*. The associated flow exceedance percentile is then matched with the measured flow. The observed bacteria loads are added to the LDC plot as points. These points represent individual ambient water quality samples of bacteria. Points above the LDC indicate the bacteria instantaneous standard was exceeded at the time of sampling. Conversely, points under the LDC indicate the sample met the criterion.

The LDC approach recognizes that the assimilative capacity of a water body depends on the flow, and that maximum allowable loading varies with flow condition. Existing loading and loads that meet the TMDL water quality target can also be calculated under different flow conditions.

The load allocation goal for Canal C-147 is based on data analysis using the geometric mean criterion since it is anticipated that achieving the geometric mean over an extended period of time will likely ensure that the single sample criterion will also be achieved.

Figure 6 represents the LDC for Canal C-147 and is based on *E. coli* bacteria measurements at sampling location 16656 (Sims Bayou South Branch at Tiffany Drive in South Houston). The LDC indicates that *E. coli* levels exceed the instantaneous and geometric mean water quality criteria under high and mid-range flow conditions. Wet weather influenced *E. coli* observations are found under all flow conditions. The allocation goal for the segment used in the final TMDL equation was based on the flow regime with the highest bacteria load (0–20th percentile).

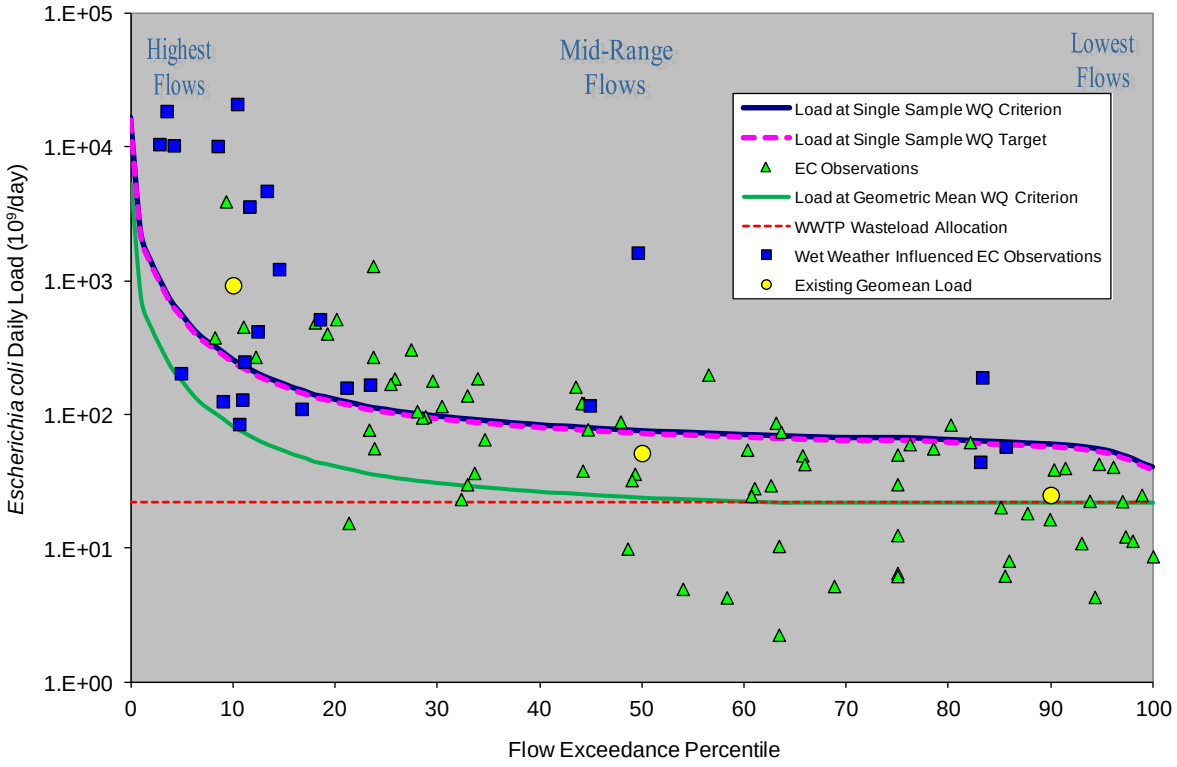


Figure 6. Load Duration Curve for Canal C-147 (1007A_01)

Wasteload Allocation

The wasteload allocation (WLA) is the sum of loads from regulated sources.

WWTFs

TPDES-permitted WWTFs are allocated a daily wasteload (WLA_{WWTF}) calculated as their permitted discharge flow rate multiplied by one-half the instream geometric mean water quality criterion. One-half of the water quality criterion is used as the target to provide instream and downstream load capacity, and to provide consistency with other TMDLs developed in the Houston area.

Table 9 summarizes the WLA for the TPDES-permitted facilities within the Study Area. WLAs were established for the facilities throughout the Sims Bayou Above Tidal watersheds in the original TMDL document and its subsequent Water Quality Management Plan (WQMP) updates. These facilities are being assigned to a specific subwatershed in this addendum.

Table 9. Wasteload Allocations for TPDES-Permitted Facilities

Assessment Unit	Stream Name	TPDES Number	NPDES Number	Facility Name	Final Permitted Flow (MGD)	*E. coli* WLA_{WWTF} (Billion MPN/day)
1007A_01	Canal C-147	11553-001	TX0053643	Blue Ridge West MUD-WWTP	1.3	3.1
1007A_01	Canal C-147	10495-110	TX0026433	City of Houston (Greenridge)	7.05	16.8
1007A_01	Canal C-147	12073-001	TX0078891	Fort Bend County MUD No.26	0.8	1.91

Stormwater

Stormwater discharges from MS4, industrial, and construction areas are considered permitted or regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). A simplified approach for estimating the WLA for these areas was used in the development of the TMDL due to the limited amount of data available, the complexities associated with simulating rainfall runoff, and the variability of stormwater loading.

The percentage of the subwatershed that is under the jurisdiction of stormwater permits (i.e., defined as the area designated as urbanized area in the 2000 US Census) is used to estimate the amount of the overall runoff load to be allocated as the regulated stormwater contribution in the WLA_{SW} component of the TMDL. The load allocation (LA) component of the TMDL corresponds to direct nonpoint source runoff and is the difference between the total load from stormwater runoff and the portion allocated to WLA_{SW}. For the subwatershed addressed in this TMDL, 100 percent of the area is within the urbanized area.

Load Allocation

The LA is the sum of loads from unregulated sources. Since the entirety of the subwatershed is within the urbanized area, there is no LA for this TMDL.

Allowance for Future Growth

As described in the original TMDL document, future growth of existing or new point sources is not limited by this TMDL as long as the sources do not cause indicator bacteria to exceed the limits. The assimilative capacity of streams increases as the amount of flow increases. Consequently, increases in flow allow for additional indicator bacteria loads if the concentrations are at or below the contact recreation standard. New or amended permits for wastewater discharge facilities will be evaluated case by case.

To account for the probability that increased or additional flows from WWTFs may occur in Canal C-147, a provision for future growth was included in the TMDL calculations by estimating permitted flows to year 2035 using population projections completed by H-GAC.

The three-tiered antidegradation policy in the SWQSs prohibits an increase in loading that would cause or contribute to degradation of an existing use. The antidegradation policy applies to both point and nonpoint source pollutant discharges. In general, antidegradation procedures establish a process for reviewing individual proposed actions to determine if the activity will degrade water quality. The TMDLs in this document will result in protection of existing beneficial uses and conform to Texas's antidegradation policy.

TMDL Calculations

Table 10 summarizes the estimated maximum allowable load of *E. coli* for the AU included in this project.

The final TMDL allocation required to comply with the requirements of 40 CFR 130.7 is summarized in Table 11. In this table, the future capacity for WWTF has been added to the WLA_{WWTF}.

TMDL values and allocations in Table 11 are derived from calculations using the existing water quality criteria for *E. coli*. However, designated uses and water quality criteria for these water bodies are subject to change through the TCEQ SWQS revision process. Figure 7 was developed to demonstrate how assimilative capacity, TMDL calculations, and pollutant load allocations change in relation to a number of hypothetical water quality criteria. The equations provided along with Figure 7 allow the calculation of new TMDLs and pollutant load allocations based on any potential new water quality criteria for *E. coli*.

Table 10. *E. coli* TMDL Summary Calculations for Canal C-147 (1007A_01)

All loads expressed as Billion MPN/day

TMDL[a]	WLA_{WWTF}[b]	$WLA_{STORMWATER}$[c]	LA[d]	MOS[e]	Future Growth[f]
109	21.8	78.8	0	5.44	2.84

[a] *Maximum allowable load for the highest flow range (0 to 20th percentile flows)*

[b] *Sum of loads from the WWTF discharging upstream of the TMDL station. Individual loads are calculated as permitted flow * 126/2 (*E. coli*) MPN/100mL*conversion factor*

[c] $WLA_{STORMWATER}$ *= (TMDL – MOS –*WLA_{WWTF}*)*(percent of drainage area covered by stormwater permits)*

[d] *LA = TMDL – MOS –*WLA_{WWTF} *–*$WLA_{STORMWATER}$*-Future growth*

[e] *MOS = TMDL x 0.05*

[f] *Projected increase in WWTF permitted flows*126/2*conversion factor*

Table 11. Final TMDL Allocations

All loads expressed as Billion MPN/day

Assessment Unit	TMDL[a]	WLA_{WWTF}[b]	$WLA_{STORMWATER}$	LA	MOS
1007A_01	109	24.6	78.8	0	5.44

[a] $TMDL = WLA_{WWTF} + WLA_{STORMWATER} + LA + MOS$

[b] $WLA_{WWTF} = WLA_{WWTF}$ *+ Future Growth*

Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. Seasonal variation was accounted for in the TMDL by using more than five years of water quality data and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing historical bacteria concentrations collected in the warmer months against those collected during the cooler months. Analysis of available *E. coli* data showed no significant difference.

Public Participation

A presentation on this addendum was given at the annual meeting of the Bacteria Implementation Group (BIG) in Houston on May 22, 2012. The public will have an opportunity to comment on this document during a 30-day WQMP comment period. Notice of the public comment period will be sent to the BIG group and posted at <http://www.tceq.texas.gov/permitting/wqmp/WQmanagement _comment.html>, and the document will be posted at <http://www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html>. The technical support document for this project is posted on the TMDL project page at <http://www.tceq.texas.gov/waterquality/tmdl/nav/42-houstonbacteria/42-houstonareabacteria-library>.

Implementation and Reasonable Assurance

The segment covered by this addendum is within the existing Sims Bayou Above Tidal bacteria TMDL project watershed. This watershed is within the area covered by the I-Plan developed by the BIG for bacteria TMDLs throughout the greater Houston area. Please refer to the original TMDL document for additional information regarding implementation and reasonable assurance.

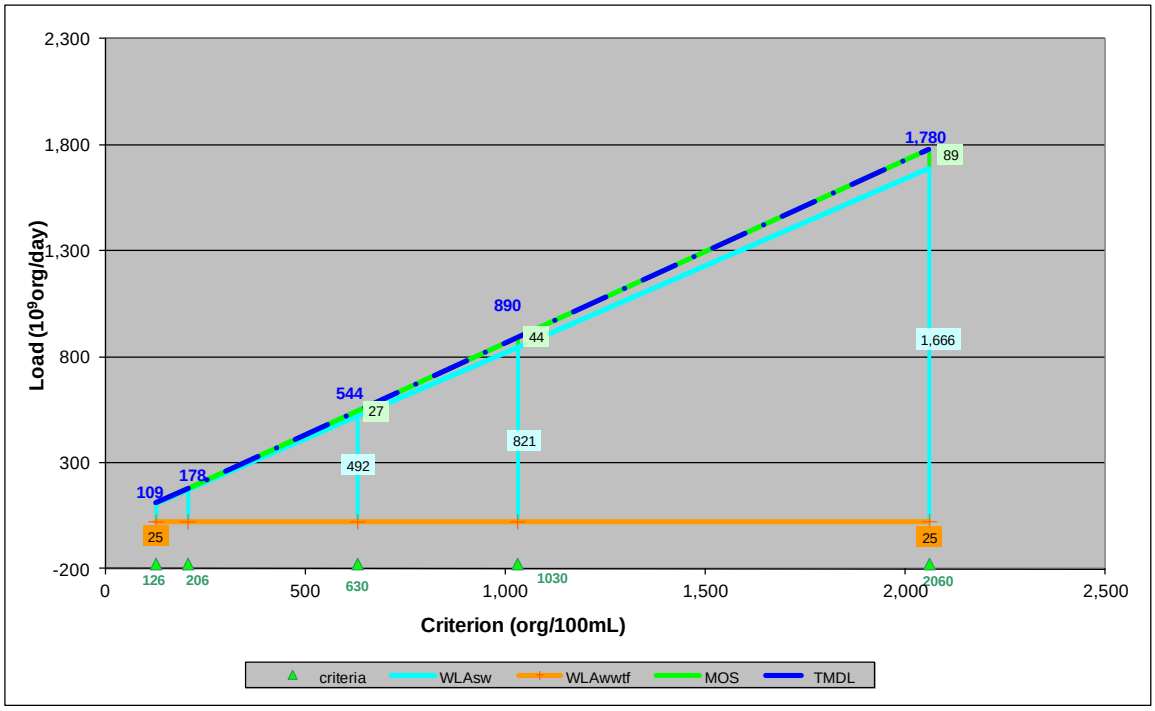


Figure 7. Allocation Loads for AU 1007A_01 as a Function of Water Quality Criteria

Equations for Calculating New TMDL and Allocations

TMDL = 0.8639*Std
LA = 0
WLA_{WWTF} = 63*0.391 = 25
$WLA_{STORM\ WATER}$ = 0.8207*Std-24.658
MOS = 0.05*TMDL

Where:

WLA_{WWTF} = waste load allocation (permitted WWTF)
$WLA_{STORM\ WATER}$ = waste load allocation (permitted storm water)
LA = load allocation (non-permitted source contributions)
Std = Revised Contact Recreation Standard
MOS = Margin of Safety

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