

# Upper Texas Coast TMDLs: Bacteria in Oyster Waters

- [Six TMDLs Adopted August 2008](#), Approved by EPA February 2009
- **Two TMDLs Added by Addendum January 2012**, Approved by EPA April 2012 (scroll to view or print this publication)



Prepared by the:

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

# Addendum Two to Six Total Maximum Daily Loads for Bacteria in Waters of the Upper Gulf Coast

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## Two TMDLs for Bacteria in Drum Bay

For Segment 2435OW

Assessment Units 2435OW\_01 and 2435OW\_02

### Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted the total maximum daily loads (TMDLs) Six Total Maximum Daily Loads for Bacteria in Waters of the Upper Gulf Coast: Segments 2421, 2422, 2423, 2424, 2432, and 2439 (TCEQ 2008) on 8/20/2008. The TMDLs were approved by the United States Environmental Protection Agency (EPA) on 2/4/2009. This is an addendum to that original TMDL document.

Drum Bay (Segment 2435OW) was inadvertently not included in the Draft 2010 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d) (TCEQ 2010a; the Integrated Report), and the TCEQ and EPA reached an agreement to allow it to be addressed through an update to the Water Quality Management Plan (WQMP).

This addendum includes information specific to Drum Bay that has been added to the adopted TMDL. Figure 1 shows Drum Bay's location in relation to the original TMDL segments.

### Background Information

This TMDL addresses an impairment to the oyster waters use identified as a "Restricted Harvest Zone" (RHZ) by the Texas Department of State Health Services (DSHS). The RHZ pertinent to this TMDL is described and illustrated by a map in the DSHS publication *Classification of Shellfish Harvesting Areas of West Galveston Bay* (DSHS 2010; Figure 2). The DSHS publication describes the RHZ for Drum Bay as: "All of Drum Bay following a line from Rattlesnake Point 162 degrees southeast to the marsh, then south and west to the Intracoastal Waterway."

This TMDL addresses elevated fecal coliform concentrations in the restricted area for:

- Drum Bay; Segment 2435OW; Assessment Units (AUs) 2435OW\_01 (area adjacent to Christmas Bay) and 2435OW\_02 (remainder of Drum Bay).

The criteria used for assessing attainment of the oyster waters use are expressed as the number of colony-forming units (cfu) of fecal coliform bacteria per hundred milliliters (100 mL) of water. Using the fecal coliform criteria in the 2010 Texas Surface Water Quality Standards (TCEQ 2010c), if the minimum sample requirement during the assessment period is met, the oyster waters use is not supported when:

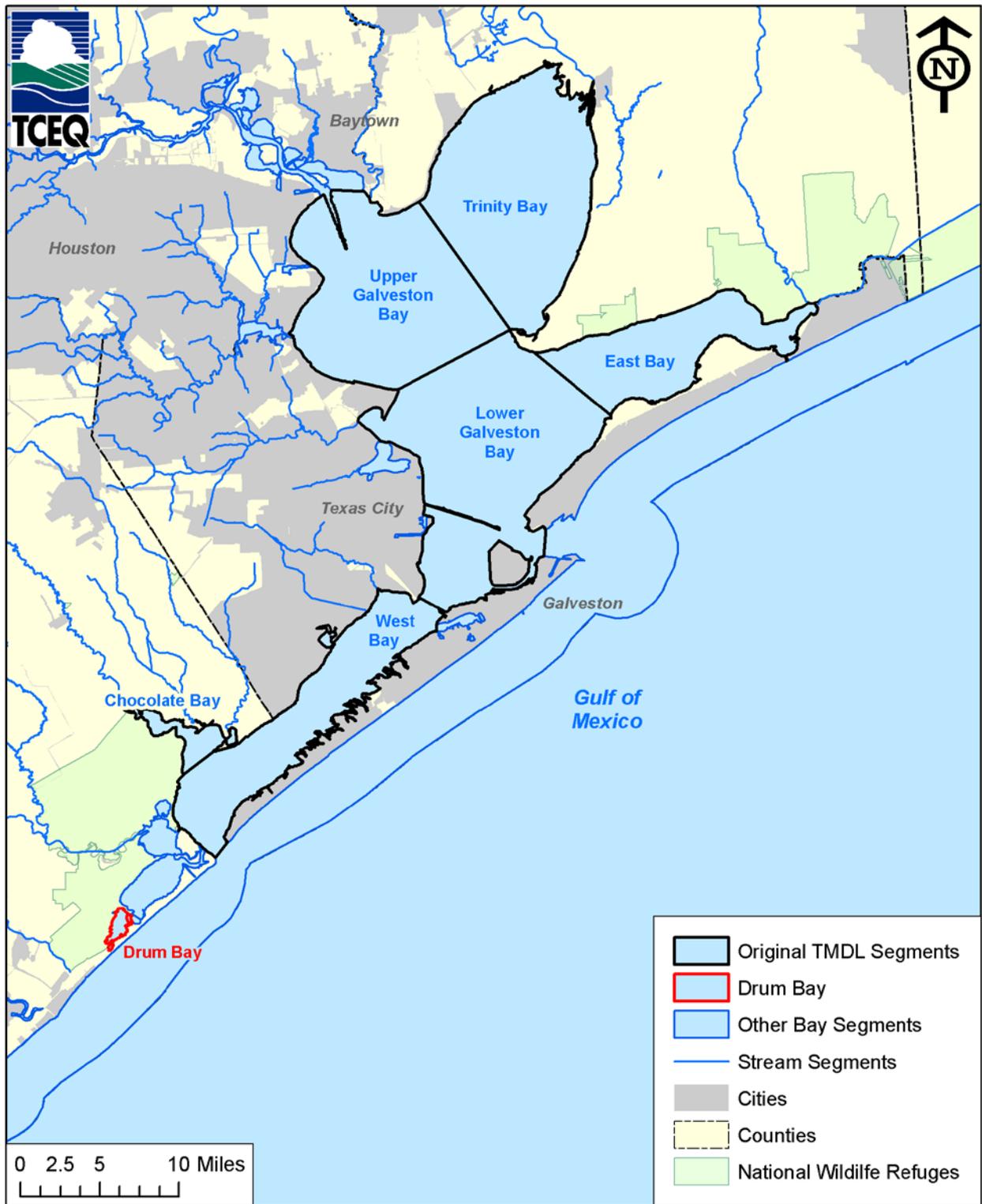


Figure 1. Galveston Bay System <sup>a</sup>

<sup>a</sup> This map was developed 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.

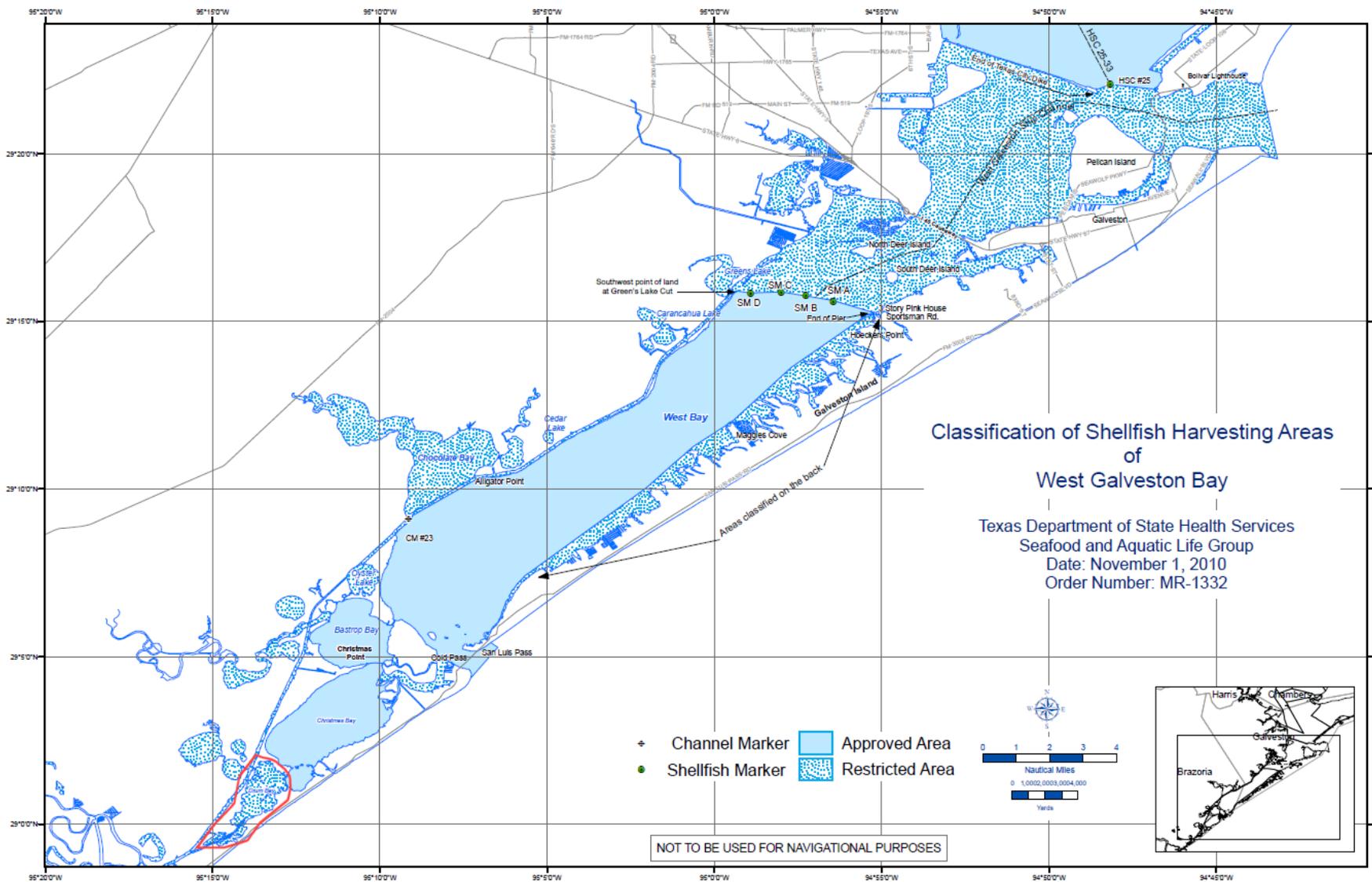


Figure 2. Classification of Shellfish Harvesting Areas of West Galveston Bay (Drum Bay circled in red)

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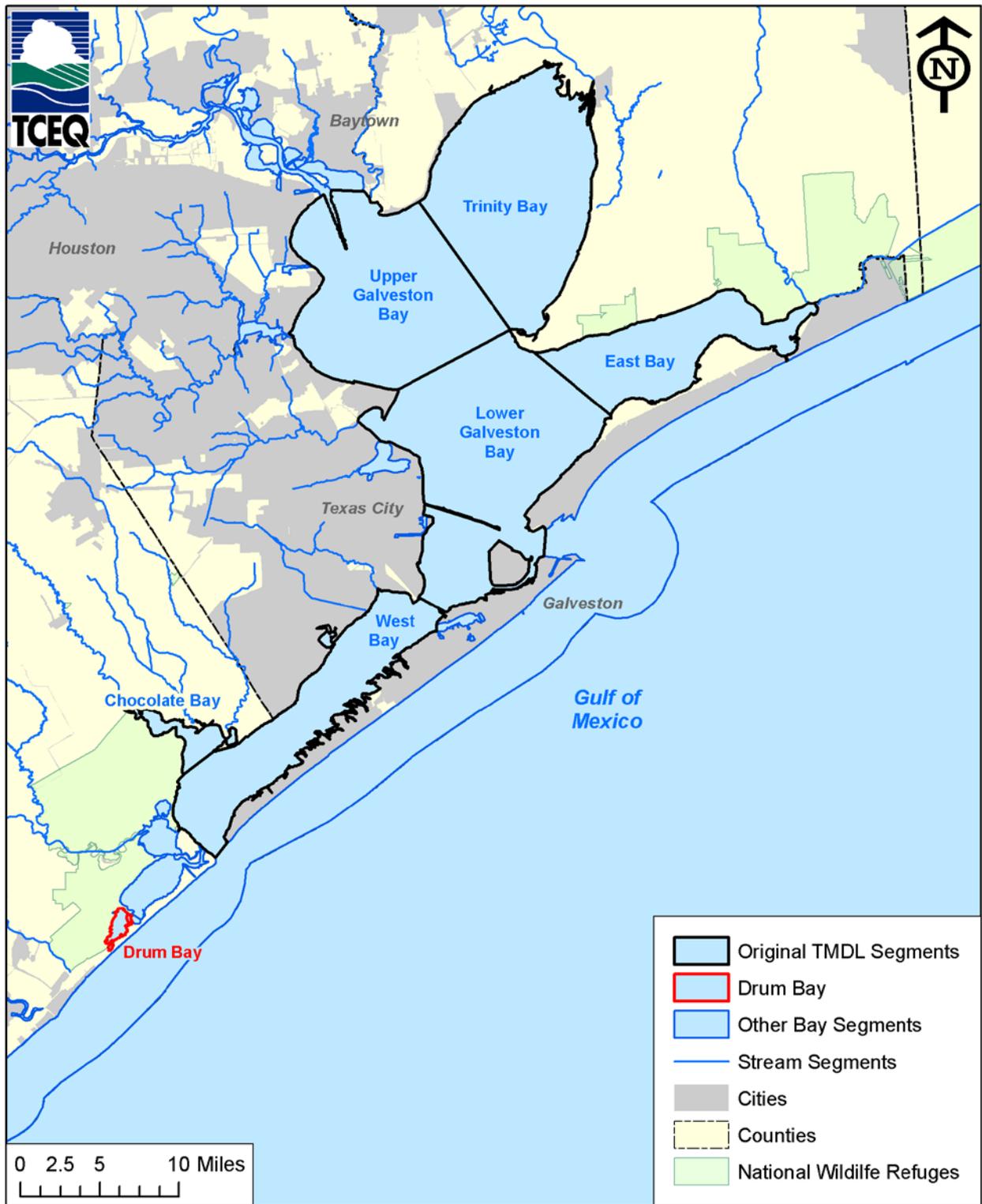


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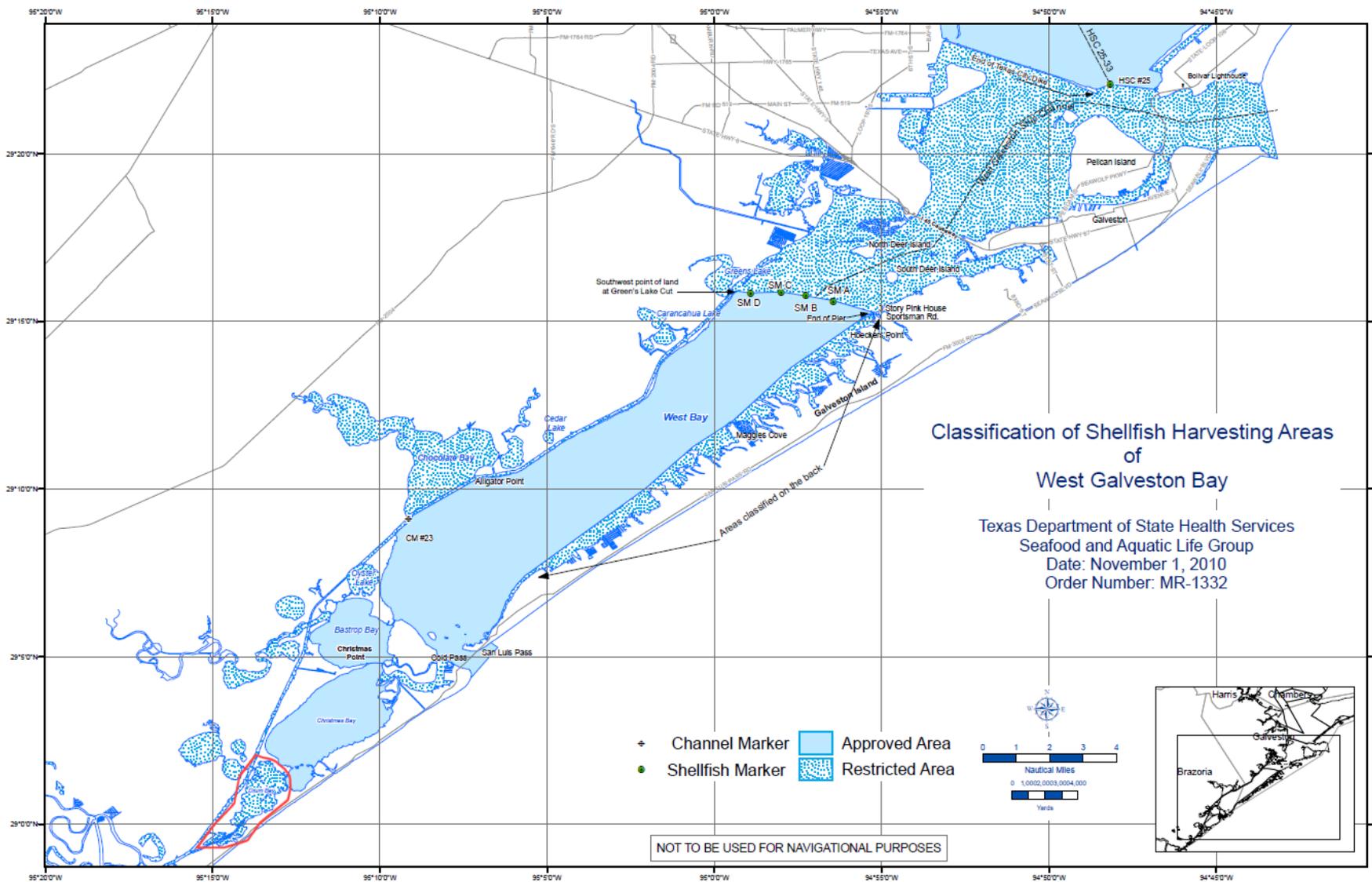


Figure 2. Classification of Shellfish Harvesting Areas of West Galveston Bay (Drum Bay circled in red)

- the median fecal coliform concentration in bay and gulf waters, exclusive of 1,000-foot shoreline buffer zones, exceeds 14 cfu per 100 mL; AND/OR
- more than 10 percent of all samples exceed 43 cfu per 100 mL.

However, DSHS may use other factors in addition to a simple application of the Water Quality Standards to determine the classification of oyster harvest zones. Additionally, the TCEQ bases its list of impaired oyster waters on the DSHS classifications rather than on its own assessments of the fecal coliform data for these water bodies (TCEQ 2010b).

## Drum Bay Information

Drum Bay has an area of about 1.97 square miles (5.10 square kilometers), based on the TCEQ’s definition of the segment (Figure 3). As shown in Figure 3, the DSHS designation of the RHZ for Drum Bay does not perfectly coincide with the TCEQ’s designation of the Drum Bay impaired AUs, extending slightly farther to the southwest on the DSHS map.

Drum Bay is located at the southwestern end of the Galveston Bay system. It is bordered by Christmas Bay to the northeast, Follets Island to the southeast, and Brazoria National Wildlife Refuge to the west. The Gulf Intracoastal Waterway is just inland from Drum Bay along its western edge. Drum Bay has an average depth of 1.1 feet (GBNEP 1991).

In the original TMDL, the 90th percentile criterion was found to be the most critical condition for examining the fecal coliform data, and that applies to the Drum Bay data as well. This percentile represents the most stringent conditions that are likely to result in attainment of the water quality standard. Table 1 updates Table 3 in the original TMDL, and is based on fecal coliform data provided by DSHS. The date range for the data is 12/01/2001 – 11/30/2008. This matches the dates for data used in the 2010 Integrated Report.

Table 1. Bacteria Concentration in Drum Bay

| Segment Number | Segment Name | Number of Samples in RHZ | RHZ Median (cfu/100 mL of Fecal Coliform) | RHZ 90th Percentile (cfu/100 mL of Fecal Coliform) | Exceedances at Sampling Locations within RHZ |
|----------------|--------------|--------------------------|---|--|--|
| 2435OW         | Drum Bay     | 245                      | 8   | 79   | Yes  |

Table 2 updates Table 5 in the original TMDL, and is based on the same DSHS data used in Table 1. The 90th percentile criterion was used to determine the percent reduction goals. Since all stations are below the median criterion, the load reductions based on attainment of the 90th percentile criterion are also protective of the median criteria. DSHS provided data for five stations associated with Drum Bay. Four of these stations fall within the 1,000-foot shoreline buffer. This area is subject to the contact recreation standard, and the oyster waters standard would normally not apply. However, due to the very small size of this bay, all stations are included in the table.

During previous WQMP updates related to the original TMDL report, a method was developed to consistently determine when regulated dischargers should be given individual wasteload allocations (WLAs). Specifically, facilities discharging within one stream mile of the listed segments should be given individual WLAs. There are no permitted discharges to Drum Bay. Therefore, there are no WLAs to add or revise in Table 6 or Appendix A in the original TMDL document. Should permits be issued to wastewater dischargers in the future, the permits should include individual WLAs determined through the regular WQMP update process.

Storm water flowing into Drum Bay is not regulated. There are no marinas on Drum Bay. These were identified as potential sources of bacteria in certain areas covered by the original TMDL, but are not pertinent here.

Table 2. Endpoint Target Reductions at Sampling Stations

| Sampling Station    | Number of Samples <sup>a</sup> | Median <sup>b</sup> | 90th Percentile <sup>b</sup> | Exceedance Identified | Median Reduction to Meet End-point | 90th Percentile Reduction to Meet End-point |
|---------------------|--------------------------------|---------------------|------------------------------|-----------------------|------------------------------------|---|
| FRE-11 <sup>c</sup> | 49                             | 10                  | 55                           | Yes                   | N/A                                | 22%   |
| FRE-24              | 49                             | 11                  | 79                           | Yes                   | N/A                                | 46%   |
| FRE-25              | 49                             | 7                   | 47                           | Yes                   | N/A                                | 8%  |
| FRE-26              | 49                             | 11                  | 49                           | Yes                   | N/A                                | 12%   |
| FRE-31              | 49                             | 8                   | 616                          | Yes                   | N/A                                | 93%   |

a. Samples used in assessing bacteria concentrations were collected during the 2010 assessment period (12/01/2001 – 11/30/2008).

b. All concentrations are reported in cfu/100 mL.

c. Station FRE-11 is the only station outside the 1,000-foot shoreline buffer area.

The original TMDL report established concentration-based TMDLs and load allocations expressed in terms of bacteria concentrations. Table 3 below updates Table 11 in the original document.

Table 3. TMDL Indicator Bacteria for Drum Bay

| Water Body                       | TMDL Indicator Parameter                       |
|----------------------------------|--|
| Drum Bay (2435OW_01 & 2435OW_02) | Fecal coliform 90th percentile < 43 cfu/100 mL |

Table 4 presents concentration-based limits (load allocations) for indicator bacteria in the source categories associated with the Upper Gulf Coast project, including Drum Bay. These load allocations will apply year-round to each source category of pollution in the watershed (e.g., urban runoff, on-site sewage facilities (OSSFs), wastewater treatment facilities (WWTFs), boat discharges). Compliance with these load allocations will ensure protection of the water quality and benefi-

cial uses of the bay. Table 4 in this addendum is a reproduction of Table 12 from the original TMDL document.



Figure 3. Drum Bay<sup>a</sup>

<sup>a</sup> This map was developed 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.

Table 4. Concentration-Based Pollutant Wasteload and Load Allocations for Upper Gulf Coast Segments<sup>a</sup>

| Discharge Type   | Fecal coliform densities for Discharges to the RHZ  | For Discharges to Adjacent Watersheds and the 1,000 foot Buffer Zone <sup>b</sup>  |
|--|---|--|
| <b>Wasteload Allocations</b>                               |   |  |
| Mechanical WWTFs <sup>c</sup>                              | Discharges directly to the RHZ are not possible <sup>d</sup>  | Fecal Coliform 200 per 100 mL OR<br><i>E. coli</i> 126 per 100 mL OR<br>Enterococcus 35 per 100 mL   |
| Wetland WWTFs  | Discharges directly to the RHZ are not possible <sup>d</sup>  | Wetland systems are measured based on detention time. Human waste must be detained for at least 21 days in sun light before reaching the bay system, unless individual permit requires additional time.  |
| Municipal Separate Storm Sewer Systems (MS4s) <sup>c</sup> | Discharges directly to the RHZ are not possible <sup>e</sup>  | Numerical concentrations requirements are unreasonable for storm water runoff. This TMDL will require MS4s to follow implementation of bacteria reduction efforts and best management practices.   |
| <b>Load Allocations</b>                                    |   |  |
| OSSFs  | Discharges directly to the RHZ are not possible <sup>e</sup>  | 0 per 100 mL   |
| Recreational Boat and Ship Discharges                      | 0 per 100 mL  | 0 per 100 mL   |
| Marina   | Discharges directly to the RHZ are not possible <sup>d</sup>  | 0 per 100 mL   |
| Non-Regulated Municipal Runoff                             | Discharges directly to the RHZ are not possible <sup>e</sup>  | Numerical concentrations requirements are unreasonable for storm water runoff. Incentive based options will be developed for municipalities with non-regulated runoff. Bacteria reductions will be achieved through the implementation of the resulting implementation plan. |
| Direct Deposition into Segment <sup>f</sup>                | The reduction of wildlife or changing natural background conditions is not the intended goal of a TMDL. | The reduction of wildlife or changing natural background conditions is not the intended goal of a TMDL.  |

- a. Allocations are applicable year-round. WLAs apply to any sources (existing or future) subject to regulation by a Texas Pollutant Discharge Elimination System (TPDES) permit.
- b. All concentrations limits within the 1,000-foot buffer zone will be based on the geometric means of the applicable indicator bacteria.
- c. Regulated entities may use indicator bacteria other than fecal coliform, as listed in individual TPDES permits. Indicator bacteria concentrations for each permit must be consistent with the applicable water quality standard for the receiving water. Dischargers releasing effluent into a segment buffer zone shall meet those water quality standards.
- d. Discharges to RHZ are not possible for WWTFs and Marinas because DSHS implements safety perimeters known as Prohibited Harvest Zones around this source to protect against any unauthorized discharges of raw sewage.
- e. Discharges to RHZ are not possible because TCEQ implements a 1,000-foot buffer zone around this source designated as contact recreation.
- f. The listed segments contain wildlife and unmanaged animals and are therefore potential sources.

## Median Fecal Coliform Capacity of Restricted Harvest Zone Assessment Units

Table 5 updates the table in the first addendum to the original TMDL that gave the capacity of the restricted oyster water assessment units based on the oyster waters criterion for fecal coliform (14 cfu/100mL; the median concentration).

Table 5. Median RHZ Capacity in Drum Bay

| Segment Name | RHZ Assessment Unit | Area (Sq. Mi.) | Average Depth (Ft.) | Volume (Cu. Ft) | Median RHZ Capacity (cfu) |
|--------------|---------------------|----------------|---------------------|-----------------|---------------------------|
| Drum Bay     | 2435OW_01           | 0.15           | 1.1                 | 4,569,270       | 1.81E+10                  |
| Drum Bay     | 2435OW_02           | 1.82           | 1.1                 | 55,689,892      | 2.21E+11                  |

## References

- DSHS 2010. Classification of Shellfish Harvesting Areas of West Galveston Bay. Texas Department of State Health Services. <[www.dshs.state.tx.us/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=8589935647](http://www.dshs.state.tx.us/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=8589935647)>.
- GBNEP 1991. An Environmental Inventory of the Christmas Bay Coastal Preserve. Publication GBNEP-7. Galveston Bay National Estuary Program. <<http://gbic.tamug.edu/gbepubs/7/gbnep-7.html>>.
- TCEQ 2006. 2006 Texas Water Quality Inventory and 303(d) list. <[www.tceq.texas.gov/assets/public/compliance/monops/water/06twqi/2006\\_303d.pdf](http://www.tceq.texas.gov/assets/public/compliance/monops/water/06twqi/2006_303d.pdf)>.
- TCEQ 2008. Six Total Maximum Daily Loads for Bacteria in Waters of the Upper Gulf Coast: Segments 2421, 2422, 2423, 2424, 2432, and 2439. Texas Commission on Environmental Quality. <[www.tceq.state.tx.us/assets/public/implementation/water/tmdl/74uppercoast/74-uppercoast\\_tmdlapproved.pdf](http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/74uppercoast/74-uppercoast_tmdlapproved.pdf)>.
- TCEQ 2010a. Draft 2010 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d). Texas Commission on Environmental Quality. <[www.tceq.texas.gov/waterquality/assessment/10twqi/10twqi](http://www.tceq.texas.gov/waterquality/assessment/10twqi/10twqi)>.
- TCEQ 2010b. Guidance for Assessing and Reporting Surface Water Quality in Texas. Texas Commission on Environmental Quality. <[www.tceq.texas.gov/assets/public/compliance/monops/water/10twqi/2010\\_guidance.pdf](http://www.tceq.texas.gov/assets/public/compliance/monops/water/10twqi/2010_guidance.pdf)>.
- TCEQ 2010c. Texas Surface Water Quality Standards. Texas Commission on Environmental Quality. <[www.tceq.texas.gov/waterquality/standards/2010standards.html](http://www.tceq.texas.gov/waterquality/standards/2010standards.html)>.

## Revised Tables

Tables and table numbers from the original TMDL report, revised based on the information in this addendum

Revised Table 1. Characteristics of Impaired Segments of Galveston Bay

| Segment Name          | Segment Number | Year Listed | Area (square kilometers) | Percent Area in the RHZ |
|-----------------------|----------------|-------------|--------------------------|-------------------------|
| Upper Galveston Bay   | 2421           | 1996        | 299.1                    | 47%                     |
| Trinity Bay           | 2422           | 2000        | 317.5                    | 48%                     |
| East Bay              | 2423           | 1998        | 148.9                    | 25%                     |
| West Bay              | 2424           | 1996        | 195.3                    | 37%                     |
| Chocolate Bay         | 2432           | 1996        | 21.1                     | 100%                    |
| Drum Bay <sup>1</sup> | 2435OW         | 2010        | 5.1                      | 100%                    |
| Lower Galveston Bay   | 2439           | 1996        | 362.4                    | 27%                     |

<sup>1</sup> Inadvertently not included in the first published 2010 Integrated Report

Revised Table 3. Bacteria Concentrations in Impaired Segments of Galveston Bay

| Segment Number | Segment Name        | Number of Samples in RHZ | RHZ Median (cfu/100 mL of Fecal Coliform) | RHZ 90th Percentile (cfu/100 mL of Fecal Coliform) | Exceedances at Sampling Locations within RHZ |
|----------------|---------------------|--------------------------|---|--|--|
| 2421           | Upper Galveston Bay | 947                      | 8.0                                       | 130.0  | Yes  |
| 2422           | Trinity Bay         | 376                      | 2.0                                       | 33.0   | Yes  |
| 2423           | East Bay            | 199                      | 2.0                                       | 36.2   | Yes  |
| 2424           | West Bay            | 515                      | 5.0                                       | 49.0   | Yes  |
| 2432           | Chocolate Bay       | 37                       | 5.0                                       | 61.0   | Yes  |
| 2435OW         | Drum Bay            | 245                      | 8   | 79   | Yes  |
| 2439           | Lower Galveston Bay | 707                      | 2.0                                       | 49.0   | Yes  |

Revised Table 4. Use Attainment of Segments of Galveston Bay

| Segment Number | Segment Name        | Recreational Use | Oyster Use                       | Parameter |
|----------------|---------------------|------------------|----------------------------------|-----------|
| 2421           | Upper Galveston Bay | Fully Supporting | Dependent upon specific location | Bacteria  |
| 2422           | Trinity Bay         | Fully Supporting | Dependent upon specific location | Bacteria  |
| 2423           | East Bay            | Fully Supporting | Dependent upon specific location | Bacteria  |
| 2424           | West Bay            | Fully Supporting | Dependent upon specific location | Bacteria  |
| 2432           | Chocolate Bay       | Fully Supporting | Non-Supporting                   | Bacteria  |
| 2435OW         | Drum Bay            | Fully Supporting | Non-Supporting                   | Bacteria  |
| 2439           | Lower Galveston Bay | Fully Supporting | Dependent upon specific location | Bacteria  |

Revised Table 5. Endpoint Target Reductions at Sampling Stations in Project Segments

| Station  | Number of Samples <sup>a</sup> | Median <sup>b</sup> | 90th Percentile <sup>b</sup> | Exceedance Identified                                    | Median Reduction | 90th Percentile Reduction |
|--|--------------------------------|---------------------|------------------------------|--|------------------|---------------------------|
| <b>Segment 2421, Upper Galveston Bay: Station and Sampling Results</b> |                                |                     |                              | <b>Reductions Needed to Meet Endpoint Concentrations</b> |                  |                           |
| 13305  | 5                              | 10.0                | 18.0                         | No   |                  |                           |
| 14546  | 35                             | 23.0 <sup>c</sup>   | 130.0 <sup>d</sup>           | Yes  | 39%              | 67%                       |
| 14556  | 67                             | 11.0                | 73.6                         | Yes  |                  | 42%                       |
| 14560  | 107                            | 5.0                 | 110.0                        | Yes  |                  | 61%                       |
| 14562  | 105                            | 5.0                 | 97.6                         | Yes  |                  | 56%                       |
| 14570  | 116                            | 5.0                 | 79.0                         | Yes  |                  | 46%                       |
| 14571  | 107                            | 13.0                | 174.0                        | Yes  |                  | 75%                       |
| 14572  | 107                            | 10.0                | 110.0                        | Yes  |                  | 61%                       |
| 14580  | 58                             | 79.0                | 920.0                        | Yes  | 82%              | 95%                       |
| 14581  | 120                            | 7.5                 | 110.0                        | Yes  |                  | 61%                       |
| 14582  | 120                            | 2.0                 | 49.0                         | Yes  |                  | 12%                       |
| <b>Segment 2422, Trinity Bay: Stations and Sampling Results</b>        |                                |                     |                              | <b>Reductions Needed to Meet Endpoint Concentrations</b> |                  |                           |
| 13314  | 62                             | 2.0                 | 23.0                         | No   |                  |                           |
| 13315  | 66                             | 2.0                 | 15.0                         | No   |                  |                           |
| 14548  | 62                             | 6.0                 | 49.0                         | Yes  |                  | 12%                       |
| 14549  | 60                             | 5.0                 | 51.1                         | Yes  |                  | 16%                       |

| Station   | Number of Samples <sup>a</sup> | Median <sup>b</sup> | 90th Percentile <sup>b</sup> | Exceedance Identified | Median Reduction   | 90th Percentile Reduction |
|---|--------------------------------|---------------------|------------------------------|-----------------------|--|---------------------------|
| 16838   | 64                             | 2.0                 | 16.1                         | No                    |  |                           |
| 17092   | 62                             | 2.0                 | 22.4                         | No                    |  |                           |
| <b>Segment 2423, East Bay: Stations and Sampling Results</b>            |                                |                     |                              |                       | <b>Reductions Needed to Meet Endpoint Concentrations</b> |                           |
| 14527   | 56                             | 2.0                 | 24.5                         | No                    |  |                           |
| 14528   | 47                             | 2.0                 | 97.4                         | Yes                   |  | 56%                       |
| 14529   | 49                             | 2.0                 | 13.8                         | No                    |  |                           |
| 14530   | 47                             | 2.0                 | 63.8                         | Yes                   |  | 33%                       |
| <b>Segment 2424, West Bay: Stations and Sampling Results</b>            |                                |                     |                              |                       | <b>Reductions Needed to Meet Endpoint Concentrations</b> |                           |
| 13321   | 37                             | 13.0                | 33.0                         | No                    |  |                           |
| 14607   | 37                             | 2.0                 | 3.2                          | No                    |  |                           |
| 14608   | 37                             | 11.0                | 49.0                         | Yes                   |  | 12%                       |
| 14618   | 36                             | 2.0                 | 17.0                         | No                    |  |                           |
| 14620   | 37                             | 11.0                | 49.0                         | Yes                   |  | 12%                       |
| 14621   | 37                             | 5.0                 | 33.0                         | No                    |  |                           |
| 14622   | 36                             | 13.5                | 94.5                         | Yes                   |  | 54%                       |
| 14623   | 37                             | 11.0                | 73.6                         | Yes                   |  | 42%                       |
| 16839   | 37                             | 8.0                 | 99.4                         | Yes                   |  | 57%                       |
| 16840   | 37                             | 2.0                 | 9.2                          | No                    |  |                           |
| 16841   | 37                             | 2.0                 | 19.4                         | No                    |  |                           |
| 16842   | 37                             | 5.0                 | 73.6                         | Yes                   |  | 42%                       |
| 16844   | 37                             | 5.0                 | 33.0                         | No                    |  |                           |
| <b>Segment 2439, Lower Galveston Bay: Stations and Sampling Results</b> |                                |                     |                              |                       | <b>Reductions Needed to Meet Endpoint Concentrations</b> |                           |
| 14576   | 120                            | 4.0                 | 79.0                         | Yes                   |  | 46%                       |
| 14577   | 122                            | 8.0                 | 79.0                         | Yes                   |  | 46%                       |
| 14584   | 122                            | 2.0                 | 49.0                         | Yes                   |  | 12%                       |
| 14594   | 54                             | 4.0                 | 20.5                         | No                    |  |                           |
| 14595   | 53                             | 5.0                 | 49.0                         | Yes                   |  | 12%                       |
| 14597   | 57                             | 2.0                 | 10.0                         | No                    |  |                           |

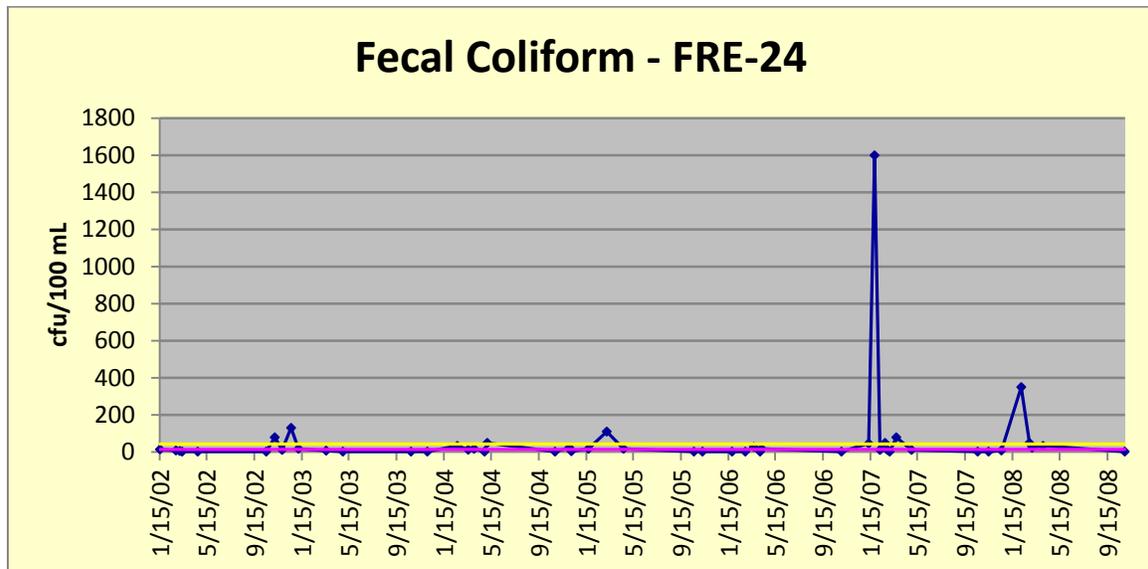
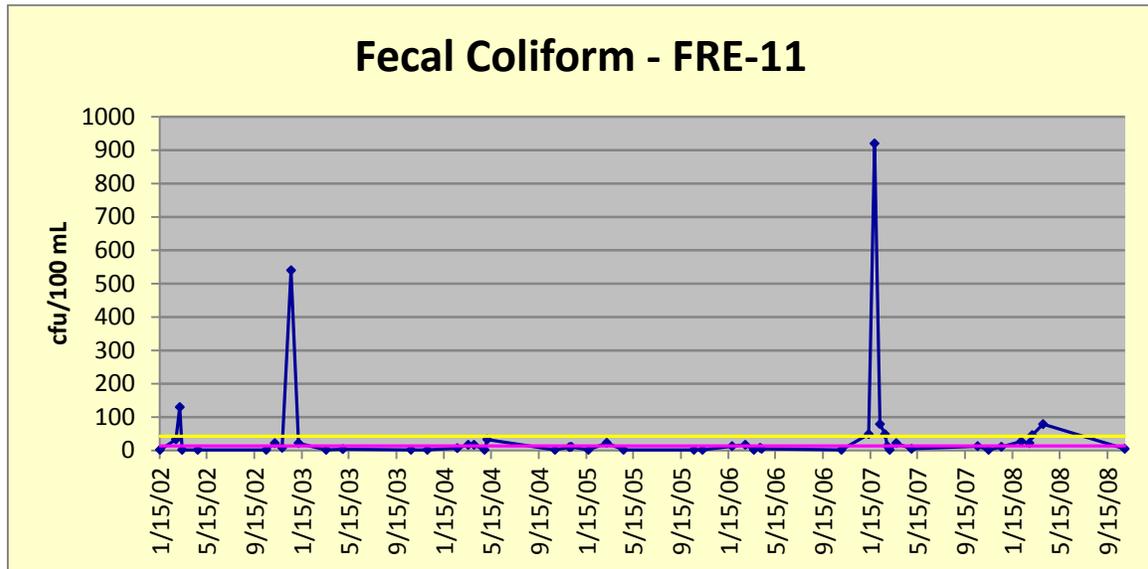
| Station  | Number of Samples <sup>a</sup> | Median <sup>b</sup> | 90th Percentile <sup>b</sup> | Exceedance Identified                                    | Median Reduction | 90th Percentile Reduction |
|--|--------------------------------|---------------------|------------------------------|--|------------------|---------------------------|
| <b>Segment 2432 Chocolate Bay: Stations and Sampling Results</b> |                                |                     |                              | <b>Reductions Needed to Meet Endpoint Concentrations</b> |                  |                           |
| 14610  | 37                             | 5.0                 | 61.0                         | Yes  |                  | 30%                       |
| <b>Segment 2435OW Drum Bay: Stations and Sampling Results</b>    |                                |                     |                              | <b>Reductions Needed to Meet Endpoint Concentrations</b> |                  |                           |
| FRE-11c  | 49                             | 10                  | 55                           | Yes  |                  | 22%                       |
| FRE-24   | 49                             | 11                  | 79                           | Yes  |                  | 46%                       |
| FRE-25   | 49                             | 7                   | 47                           | Yes  |                  | 8%                        |
| FRE-26   | 49                             | 11                  | 49                           | Yes  |                  | 12%                       |
| FRE-31   | 49                             | 8                   | 616                          | Yes  |                  | 93%                       |

- a. Samples used in assessing bacteria concentrations were collected during the years 2001 through 2008 (varies by station).
- b. All concentrations are reported in cfu/100 mL.
- c. Pink shading indicates concentrations exceed the median criterion.
- d. Gray shading indicates concentrations exceed the 90th percentile criterion.

Revised Table 11. Total Maximum Daily Loads of Indicator Bacteria for Galveston Bay System Segments

| Segment Name   | TMDL Indicator Parameter                       |
|--|--|
| Upper Galveston Bay<br>Trinity Bay<br>East Bay<br>West Bay<br>Chocolate Bay<br>Lower Galveston Bay<br>Drum Bay | Fecal coliform 90th Percentile < 43 cfu/100 mL |

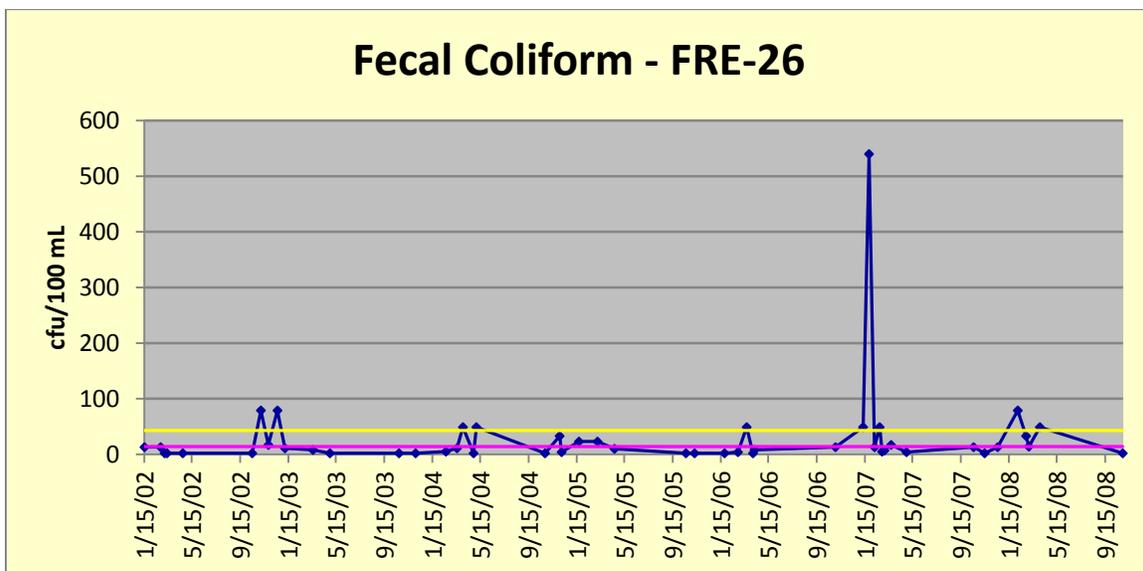
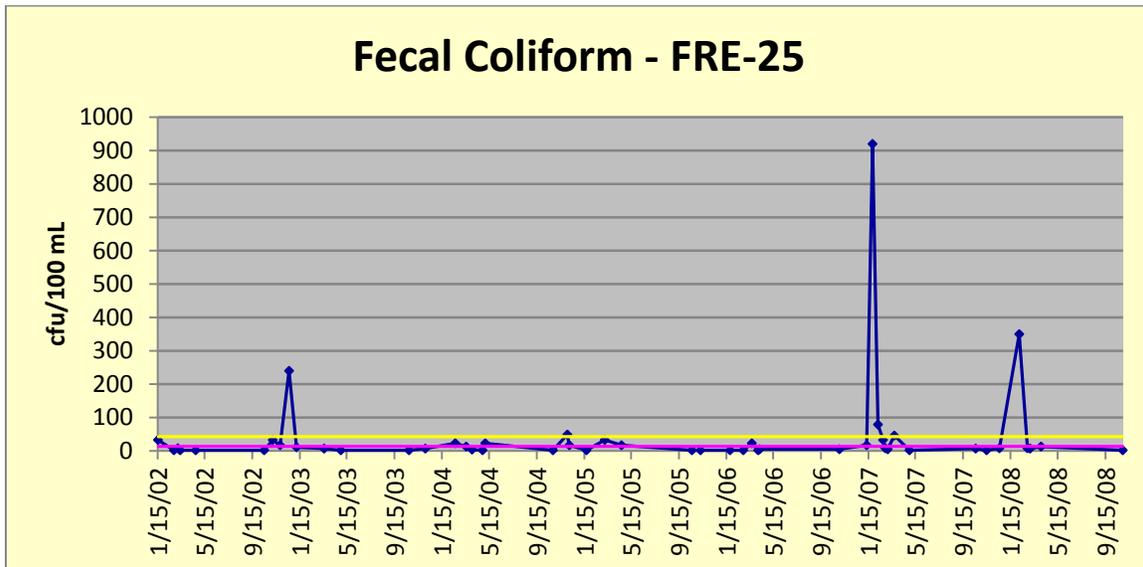
## Revisions to Appendix B: Temporal Trends in Bacteria Samples



Yellow Line = 90th percentile criterion (43 cfu/100mL)

Red Line = median criterion (14 cfu/100mL)

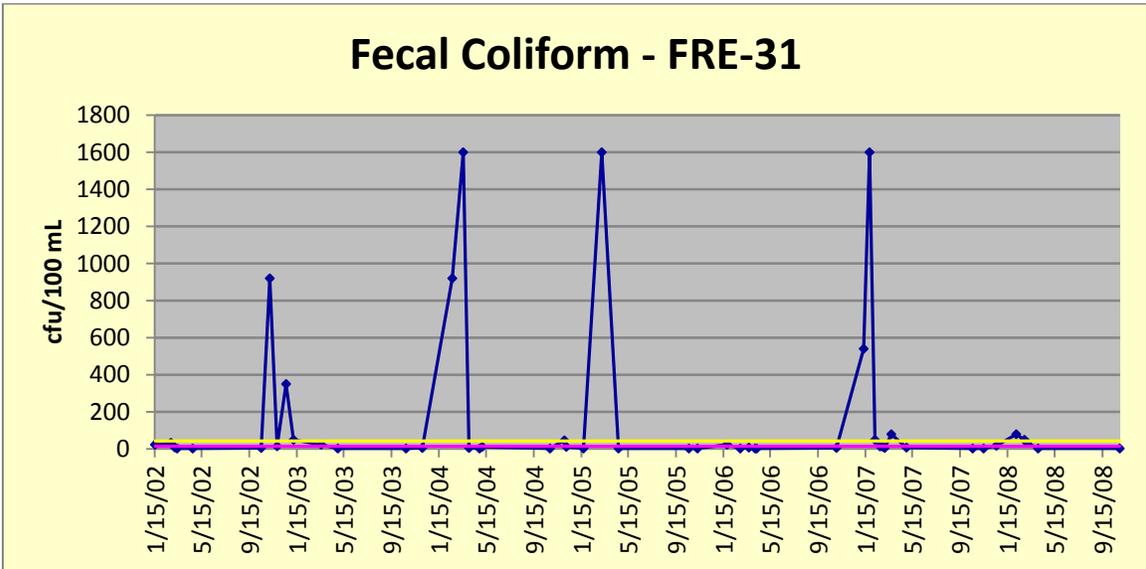
Yellow shaded border = concentrations at station exceeded 90th percentile criterion.



Yellow Line = 90th percentile criterion (43 cfu/100mL)

Red Line = median criterion (14 cfu/100mL)

Yellow shaded border = concentrations at station exceeded 90th percentile criterion.



Yellow Line = 90th percentile criterion (43 cfu/100mL)

Red Line = median criterion (14 cfu/100mL)

Yellow shaded border = concentrations at station exceeded 90th percentile criterion.

## Revised First Addendum: Median Fecal Coliform Capacity of Restricted Harvest Zone Assessment Units

Based on the Oyster Waters criterion of 14 cfu/100mL (the median concentration), the capacity of the restricted oyster water assessment units are listed below.

| Segment Name        | RHZ Assessment Unit | Area (Sq. Mi.) | Average Depth (Ft.) | Volume (Cu. Ft) | Median RHZ Capacity (cfu) |
|---------------------|---------------------|----------------|---------------------|-----------------|---------------------------|
| Upper Galveston Bay | 2421_01             | 16.8           | 9.5                 | 4,449,392,640   | 1.76E+13                  |
| Upper Galveston Bay | 2421_02             | 48.2           | 9.5                 | 12,765,519,360  | 5.06E+13                  |
| Trinity Bay         | 2422_01             | 64.4           | 7.5                 | 13,465,267,200  | 5.34E+13                  |
| East bay            | 2423_01             | 52.1           | 3.5                 | 5,083,626,240   | 2.02E+13                  |
| Chocolate Bay       | 2432_01             | 7.6            | 3.5                 | 741,565,440     | 2.94E+12                  |
| West Bay            | 2424_02             | 17.1           | 5                   | 2,383,603,200   | 9.45E+12                  |
| Drum Bay            | 2435OW_01           | 0.15           | 1.1                 | 4,569,270       | 1.81E+10                  |
| Drum Bay            | 2435OW_02           | 1.82           | 1.1                 | 55,689,892      | 2.21E+11                  |
| Lower Galveston Bay | 2439_01             | 38.4           | 3.5                 | 3,746,856,960   | 1.49E+13                  |