Draft for Public Comment, February 2025
Publication AS-509

One Draft Total Maximum Daily Load for Indicator Bacteria in Poenisch Park

Assessment Unit 2481CB_06

Water Quality Planning Division, Office of Water

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Distributed by the
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The preparation of this report was financed in part through grants from
the United States Environmental Protection Agency.

This total maximum daily load report is based in large part on the report titled:
“Technical Support Document for One Total Maximum Daily Load for Indicator
Bacteria in Poenisch Park,” TCEQ AS-496
by Dr. Philippe Tissot of Texas A&M University – Corpus Christi.

The maps in this report were created by the Total Maximum Daily Load Program of the Texas Commission on Environmental Quality. These maps are for informational purposes only and are not suitable for legal, engineering, or surveying purposes. They do not represent on-the-ground surveys; they represent only approximate locations. For more information concerning these maps, contact the Water Quality Planning Division at 512-239-6682 or email tmdl@tceq.texas.gov.

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Abbreviations

AU	assessment unit
BMP	best management practice
CFR	Code of Federal Regulations
cfu	colony forming units
cfs	cubic feet per second
EPA	Environmental Protection Agency (United States)
FDC	flow duration curve
FG	future growth
I-Plan	implementation plan
LA	load allocation
LDC	load duration curve
MCM	minimum control measure
mL	milliliter
MOS	margin of safety
MS4	municipal separate storm sewer system
NAS-CC	Naval Air Station-Corpus Christi
NLCD	National Land Cover Database
NRCS	Natural Resources Conservation Service
OSSF	on-site sewage facility
SSO	sanitary sewer overflow
SWMP	Stormwater Management Program
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TGLO	Texas General Land Office
TMDL	total maximum daily load
TPDES	Texas Pollutant Discharge Elimination System
TWDB	Texas Water Development Board
U.S.	United States
USCB	United States Census Bureau
WLA	wasteload allocation
WQBELs	water quality-based effluent limits
WQMP	Water Quality Management Plan
WWTF	wastewater treatment facility

Executive Summary

This report describes one total maximum daily load (TMDL) for Poenisch Park where concentrations of indicator bacteria exceed the criterion used to evaluate attainment of the primary contact recreation 1 use. Beginning in 2010, the Texas Commission on Environmental Quality (TCEQ) began assessing recreational beaches along Corpus Christi Bay (2481CB) based on Texas General Land Office (TGLO) Beach Watch data, resulting in the listing of Cole Park and Ropes Park, (assessment units (AUs) 2481CB_03 and 2481CB_04 respectively) in the *2010 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Texas Integrated Report) as impaired for elevated indicator bacteria (TCEQ, 2010). In the 2014 Texas Integrated Report, Poenisch Park (AU 2481CB_06) was added to the list of Corpus Christi Bay (Recreational Beaches) impaired for bacteria (TCEQ, 2014). TMDLs addressing indicator bacteria impairments at Cole and Ropes parks, *Two Total Maximum Daily Loads for Indicator Bacteria at Corpus Christi Beaches, Cole Park and Ropes Park,* were adopted in 2021.

The Poenisch Park (AU 2481CB_06) watershed is located along Corpus Christi Bay in the City of Corpus Christi. The watershed is small (64.5 acres) and is dominated by stormwater runoff, which is discharged out of a stormwater outfall at the Poenisch Park beach.

Enterococci are widely used as indicator bacteria to determine attainment of the contact recreation use in saltwater. The criterion for determining attainment of the contact recreation use is expressed as the number of bacteria, typically given as colony forming units (cfu) in 100 milliliters (mL) of water. Recreational beaches are not assessed using a geometric mean, as is common for non-beach water bodies, and are instead assessed using the total number of days a beach was under advisory (when Enterococci concentrations exceed 104 cfu/100 ml). Recreational beaches are listed as not supporting primary contact recreation 1 use when more than 25% of sampled days are under advisory.

Enterococci data were collected at TGLO water quality monitoring station (NUE026) in the impaired AU (2481CB_06) over a seven-year period from Dec. 1, 2013 through Nov. 30, 2020. These data were used in assessing attainment of the primary contact recreation 1 use and reported in the 2022 Texas Integrated Report (TCEQ, 2022a). The assessed data indicate nonattainment of the contact recreation standard in AU 2481CB_06.

Within the Poenisch Park watershed, probable sources of bacteria include regulated stormwater runoff, sanitary sewer overflows (SSOs), illicit discharges, and domesticated animals.

A review of the TCEQ Central Registry in December 2023 found two active municipal separate storm sewer system (MS4) permits that encompass the watershed (TCEQ 2022c).

A simplified step model was used to model flow and water quality in the Poenisch Park watershed. Using the results of the simplified step model, a load duration curve (LDC) analysis was done for the TMDL watershed to quantify allowable pollutant loads, as well as allocations for point and nonpoint sources of bacteria. Wasteload allocations (WLAs) were established for permitted stormwater discharging to the AU. Because there are no wastewater treatment facilities (WWTFs) that discharge within the Poenisch Park watershed and there is no possibility that one will be constructed in the future due to the watershed's small size and existing residential development, the future growth (FG) component for this TMDL is zero.

Introduction

Section 303(d) of the federal Clean Water Act requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. States must develop a TMDL for each pollutant that contributes to the impairment of a water body included on a state's 303(d) list of impaired waters. TCEQ is responsible for ensuring that TMDLs are developed for impaired surface waters in Texas.

A TMDL is like a budget—it determines the amount of a particular pollutant that a water body can receive and still meet applicable water quality standards. TMDLs are the best possible estimates of the assimilative capacity of the water body for a pollutant under consideration. A TMDL is commonly expressed as a load with units of mass per period of time but may be expressed in other ways.

The TMDL Program is a major component of Texas' overall process for managing the quality of its surface waters. The program addresses impaired or threatened streams, reservoirs, lakes, bays, and estuaries (water bodies) in, or bordering on, the state of Texas. The program's primary objective is to restore and maintain water quality uses—such as drinking water supply, recreation, support of aquatic life, or fishing—of impaired or threatened water bodies.

This TMDL report addresses impairments to the primary contact recreation 1 use due to elevated levels of indicator bacteria in Corpus Christi Bay, 2481CB. This TMDL takes a watershed approach to addressing indicator bacteria impairment. While TMDL allocations were developed only for the impaired AUs identified in this report, the entire project watershed (Figure 1) and all discharges within it are included within the scope of this TMDL. Information in this TMDL report was derived from the *Technical Support Document for One Total Maximum Daily Load for Indicator Bacteria in Poenisch Park* (TCEQ, 2024).[1]

Section 303(d) of the Clean Water Act and the implementing regulations of the United States (U.S.) Environmental Protection Agency (EPA) in Title 40 of the Code of Federal Regulations (CFR), Chapter 1, Part 130 (40 CFR 130) describe the statutory and regulatory requirements for acceptable TMDLs. EPA provides further direction in its *Guidance for Water Quality-Based Decisions: The TMDL Process* (EPA, 1991). This TMDL report has been prepared in accordance with those regulations and guidelines.

TCEQ must consider certain elements in developing a TMDL. They are described in the following sections of this report:

- Problem Definition
- Endpoint Identification
- Source Analysis

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[1] www.tceq.texas.gov/downloads/water-quality/tmdl/corpus-christi-beaches-recreational-97/as-496-poenisch-park-draft-tsd.pdf

- Linkage Analysis
- Margin of Safety
- Pollutant Load Allocation
- Seasonal Variation
- Public Participation
- Implementation and Reasonable Assurance

Upon adoption of the TMDL report by the commission and subsequent EPA approval, these TMDLs will become an update to the state's Water Quality Management Plan (WQMP).

Problem Definition

In accordance with the federal Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act), TGLO issues beach advisories as part of the Texas Beach Watch Program when indicator bacteria Enterococci concentrations exceed 104 cfu/100 mL. The target of 104 cfu/100 mL of Enterococci has been accepted by EPA as a Beach Action Value (BAV) to issue beach advisories in the Texas Beach Watch Program in accordance with the BEACH Act. TCEQ uses beach advisories issued by TGLO to identify impairments as part of the Texas Integrated Report.

TCEQ assesses TGLO information as part of the Texas Integrated Report to protect human health by identifying beaches with persistent advisories. Beginning in 2010, TCEQ began assessing recreational beaches along Corpus Christi Bay (2481CB) based on GLO Beach Watch data, resulting in the listing of Cole Park and Ropes Park (AUs 2481CB_03 and 2481CB_04, respectively) in the 2010 Texas Integrated Report (TCEQ, 2010) as impaired for indicator bacteria. In the 2014 Texas Integrated Report (TCEQ, 2014), Poenisch Park (AU 2481CB_06) was added to the list of Corpus Christi Bay recreational beaches impaired for elevated indicator bacteria. TMDLs addressing the indicator bacteria impairments at Cole and Ropes parks, *Two Total Maximum Daily Loads for Indicator Bacteria at Corpus Christi Beaches, Cole Park and Ropes Park,* were adopted in 2021.

The bacteria impairment of Corpus Christi Bay recreational beaches has been identified in each subsequent integrated report, including the most recent EPA-approved 2022 Texas Integrated Report. AU 2481CB_06 is listed in Subcategory 5a in the 2022 Texas Integrated Report, making it a high priority for TMDL development.

Recent surface water Enterococci monitoring within the TMDL watershed has occurred at one TGLO surface water quality monitoring station (station NEU026; Table 1 and Figure 1). Enterococci data, collected at this station from 2013 through 2020, were used to determine attainment of primary contact recreation use 1 as reported in the 2022 Texas Integrated Report (TCEQ, 2022a). Recreational beaches are not assessed using a geometric mean, as is common for non-beach water bodies. Recreational beaches are instead assessed using the total number of days a beach was under advisory (when Enterococci concentrations exceed 104 cfu/100 ml). TCEQ then categorizes the beach segments using the following scale:

Beach advisories <25% of the time—Fully Supporting

Beach advisories 20-25% of the time—Concern and Fully Supporting

Beach advisories < 20% of the time—Delisted and Fully Supporting

Beach advisories ≥ 25% of the time—Not Supporting

The 2014 Texas Integrated Report found that BAV exceedances at Poenisch Park were greater than 25% of the time and it was listed as not supporting primary contact recreation 1 use. However, the 2022 Texas Integrated Report found exceedances only 21% of the time. Based on the above scale, a water body is only delisted when beach advisories fall below 20% of the time, and therefore Poenisch Park is still listed as not supporting primary contact recreation 1 use.

Because recreational beaches do not use a geometric mean for assessment, the 2022 Texas Integrated Report does not provide a geometric mean for Enterococci as measured at station NEU026. Based on sampling data provided by TGLO for station NUE026 between Dec. 1, 2013, and Nov. 30, 2020, a geometric mean of 29.3 cfu/100 ml was calculated. The 2022 Texas Integrated Report summary for the Poenisch Park watershed is provided in Table 1.

Table 1. 2022 Texas Integrated Report Summary for the impaired AUs

Water Body	AU	Parameter	TGLO Station	Number of Samples	Data Range	Percent Days BAV Exceeded
Poenisch Park	2481CB_06	Enterococcus	NUE026	330	2013-2020	21%

Watershed Overview

Poenisch Park is a small (64.5 acres) watershed located in Nueces County in the City of Corpus Christi. Corpus Christi is a large city of over 300,000 inhabitants (USCB, 2020) along the Texas Gulf Coast. The Poenisch Park watershed, which contributes flow to the stormwater outfall in the impaired AU, is part of the City of Corpus Christi's stormwater drainage system. The city surrounds the southern end of Corpus Christi Bay and extends to North Padre Island and Mustang Island. On the western side of Corpus Christi Bay, there are a series of recreational parks within the City of Corpus Christi which are also typical locations for stormwater runoff outfalls. Such is the case for the impaired AU, as illustrated in Figure 1.

The Poenisch Park watershed is the largest in a series of small watersheds bordering the southern shoreline of Corpus Christi Bay. The Poenisch Park watershed consists of urban land that discharges to Corpus Christi Bay through an outfall located within the impaired AU.

Figure 1. Map of the project watershed.

Climate and Hydrology

Temperature

Observations at Naval Air Station-Corpus Christi (NAS-CC – ID 12926) from 1991 through 2020 were used to calculate 30-year normal monthly average temperatures, as shown in Figure 2 (Arguez et al. 2012).

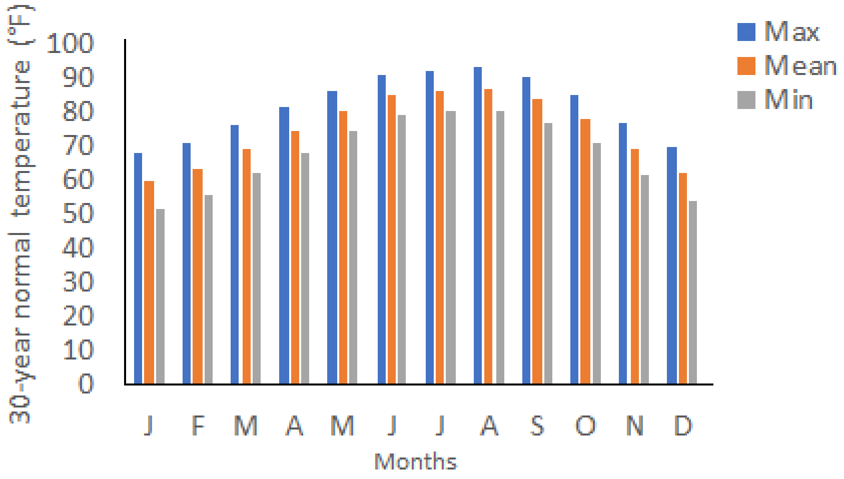

Figure 2. 30-year normal maximum, minimum and mean monthly temperature (˚F) at NAS-CC – ID 12926 between 1991 and 2020.

Precipitation

Given that AU2481CB_06 is not a perennial stream and pollutant loading is entirely runoff driven, precipitation is a key driver for Enterococcus concentration in the study area. To estimate precipitation in the Poenisch Park watershed, observed rainfall data from rain gauges and rainfall estimates derived from weather radar were analyzed.

A rain gauge located at NAS-CC was used for this analysis of precipitation at Poenisch Park. NAS-CC is part of the National Weather Service meteorological network and the Texas Automated Surface Observing Systems and provides observed precipitation data. Because precipitation can be highly localized, precipitation information for the study watershed was also extracted from the National Weather Service Multi-Sensor Precipitation Estimates (MPE) (National Weather Service, 2024) database. These weather radar-derived time series of estimated precipitation cover areas of about 4 km by 4 km.

A comparison of MPE precipitation and observed precipitation at the NAS-CC gauge between 2004 and 2018 and for select large rain events (Figure 3) indicated that the timing of the precipitation aligns between MPE and observed measurements. Further comparisons between the MPE estimates for the NAS-CC area and the Poenisch Park watershed (Figure 4) indicate that timing and intensity of precipitation is very similar for the two neighboring MPE cells.

Overall, the comparison between the NAS-CC rain gauge data and the corresponding MPE estimates give confidence in the use of MPE estimates as the precipitation input for the study models.

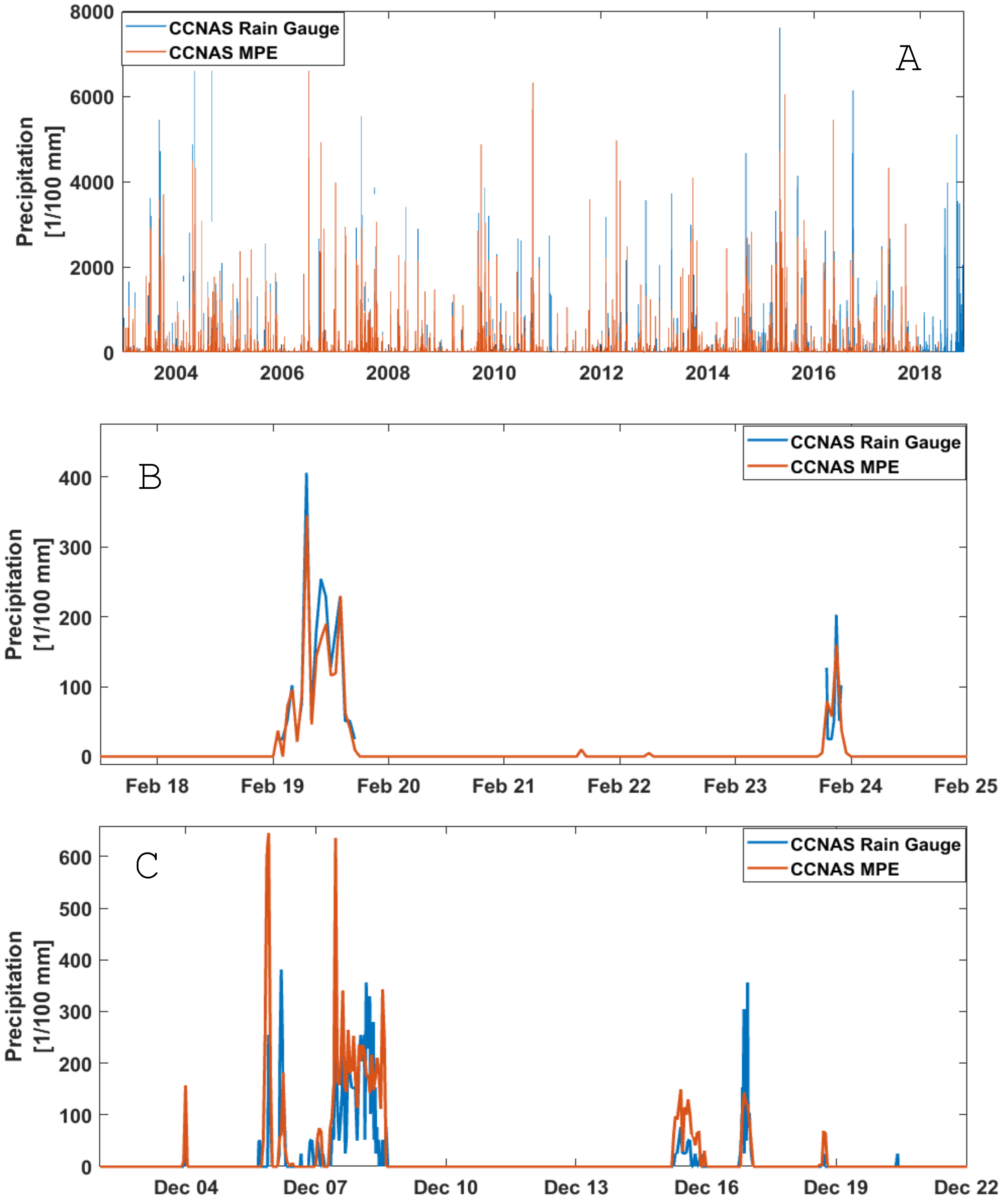

Figure 3. Comparisons of precipitation measurements at the NAS-CC Rain Gauge with the co-located MPE estimates between 2004 and 2018 (A) and select large rain events during February 2010 (B) and December 2017(C)

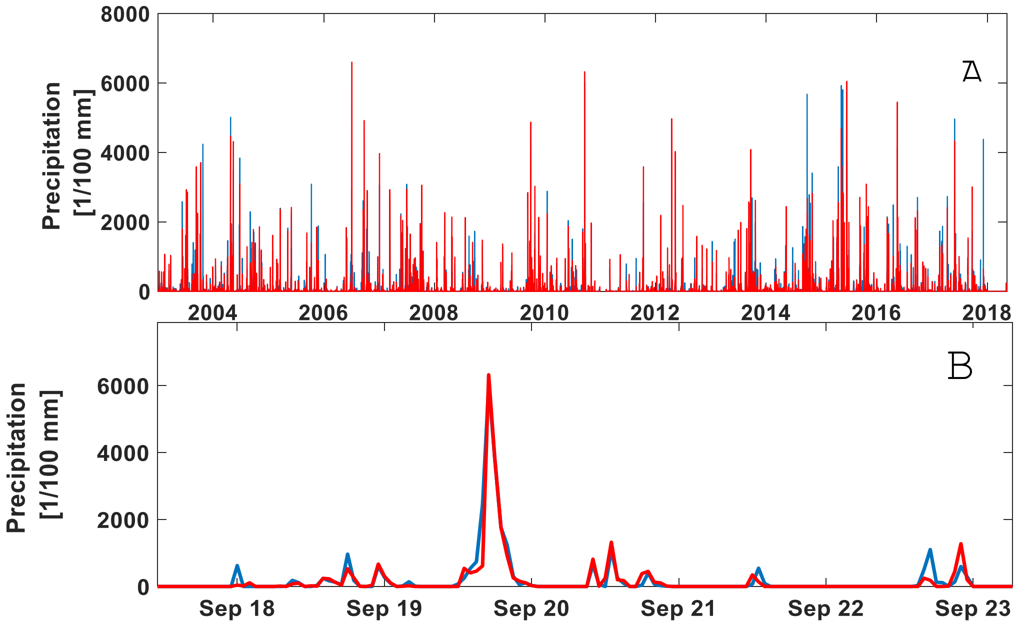

Figure 4. Comparisons of MPE at the NAS-CC rain gauge MPE at Poenisch Park 2004-2018 (A) and during a large rain event September 2010 (B).

Average annual precipitation for the Poenisch Park watershed was 29.81 inches for the period 2004 – 2018. Annual precipitation ranged from 6.37 inches in 2011 to 48.67 inches in 2015 for the watershed (Table 2).

Table 2. MPE annual totals for the Poenisch Park watershed

Year	Poenisch Park (MPE, inches)
2004	38.74
2005	20.63
2006	21.83
2007	32.71
2008	20.71
2009	16.84
2010	32.89
2011	6.37
2012	17.25
2013	28.60
2014	39.53
2015	48.67
2016	36.55
2017	37.20
2018	46.37

Wind Direction

Wind conditions recorded at the NAS-CC were used to determine dominant wind direction and compare wind conditions with water quality. Wind conditions could play a direct or indirect role in water quality. Wind-generated waves in Corpus Christi Bay drive wave runup on the beach and could lead to mixing of bay waters and stormwater runoff within the stormwater outlet.

Wind analysis for the Poenisch Park watershed was based on wind measurements at NAS-CC – ID 12926 from Jan. 1, 2003, through Dec. 31, 2017. Wind speeds above 100 mph were removed (<0.02%) prior to the analysis to ensure accuracy. Of the remaining 15 years of hourly measurements, less than 1% of the data was missing.

Southeasterly winds are dominant in the Poenisch Park watershed (Figure 5). The watershed is also influenced by less frequent northerly winds, associated with the passage of cold fronts during the period of October through April. Both wind directions generate slightly onshore but mostly longshore currents. Without other forces, the wind drives water along the coastline in the northwesterly direction during the usual southeasterly winds and in a southeasterly direction during frontal passages.

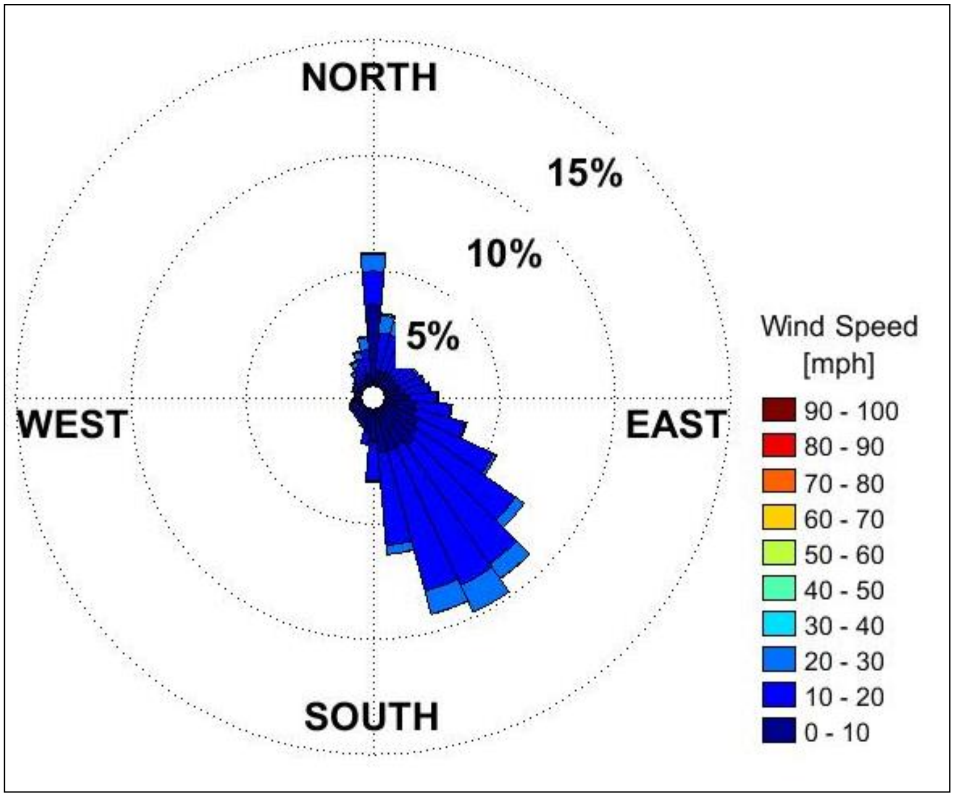

Figure 5. Dominant wind direction for the Poenisch Park Watershed, NAS-CC – ID 12926 (2003-2017)

Hydrogeomorphology

Strong winds also generate waves in Corpus Christi Bay, leading to sediment resuspension and transport along the beach front of Poenisch Park (Williams, 2005). Sediment resuspension will facilitate the transport of bacteria and materials stored in sediments to the water column. Sediment transport leads to the formation and movement of a berm along the impaired AU, between Corpus Christi Bay and the distal inland portion of Poenisch Park, parallel to the shoreline. The berm moves depending on the season, wind direction, and water level of the bay. At the Poenisch Park outfall, the berm is breached during strong precipitation events. During lighter rain events the berm, keeping its integrity, causes stormwater runoff to pool, slowing the rate of bacteria transport to the impaired AU through seepage of the berm materials.

Figure 6. Morphologies along Poenisch Park beach, dependent on wind and precipitation patterns

Population and Population Projections

Watershed population estimates were developed using the 2020 United States Census Bureau (USCB) census block geographic units and population data (USCB, 2020). The TMDL watershed boundary was intersected with census blocks to determine the proportion of the watershed within each census block. Census blocks are the smallest geographic units used by USCB to tabulate population data. This analysis found an estimated population of 329 people within the Poenisch Park watershed.

Population projections in Table 3 were estimated based on population projections for the City of Corpus Christi using data from the Texas Water Development Board (TWDB) 2021 Regional Water Plan Population and Water Demand Projection data (TWDB, 2019). The rate of change between each decade between 2020 and 2070 was calculated for the City of Corpus Christi. The rate of change was multiplied by, and then added to, the 2020 population estimate for the Poenisch Park watershed.

Table 3. Population estimates and projections

AU	2020 U.S. Census	2070 Population Projection	Projected Increase (2020-2070)	Percentage Increase (2020-2070)
2481CB_06	329	392	63	19.14%

Land Cover

The land cover data for the TMDL watershed was obtained from the U.S. Geological Survey 2022 National Land Cover Database (NLCD) (Dewitz, 2023) and is displayed in Figure 7.

The following land cover categories and definitions in the NLCD are found in the TMDL watershed:

- **Developed, Open Space** – Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
- **Developed, Low Intensity** – Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49 % of total cover. These areas most commonly include single-family housing units.
- **Developed, Medium Intensity** – Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
- **Developed, High Intensity** – Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

A summary of the land cover data is provided in Table 4. As depicted in Table 4 and Figure 7, the watershed is a developed neighborhood, mostly comprised of medium-intensity developed land cover.

Table 4. Land cover percentages

2022 NLCD Classification	Area (acres)	Percentage Total
Developed, Open Space	6.56	10.17%
Developed, Low Intensity	12.24	18.98%
Developed, Medium Intensity	40.67	63.05%
Developed, High Intensity	5.03	7.80%

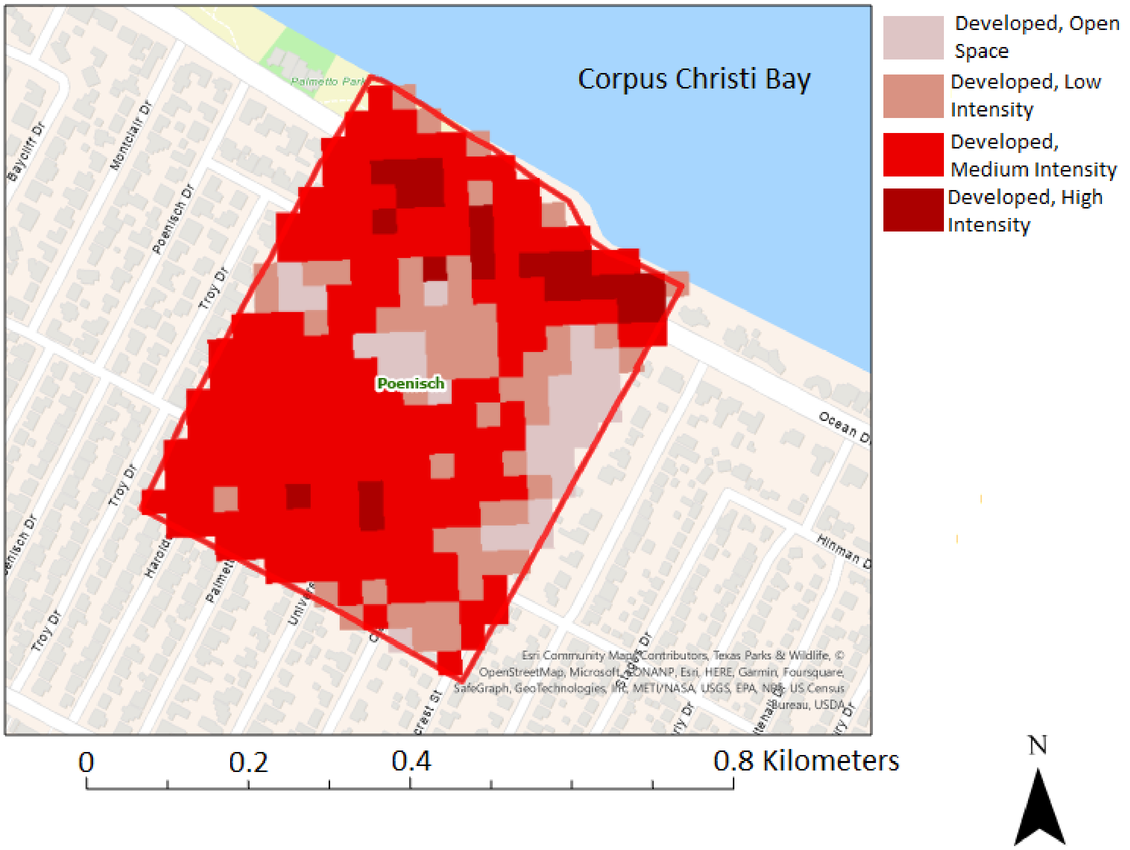

Figure 7. 2022 NLCD land cover map

Soils

Soils within the TMDL watershed are characterized by hydrologic groups that describe infiltration and runoff potential. These data are provided by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Soil Survey Geographic database (SSURGO) (NRCS, 2018). The SSURGO data assigns different soils to one of seven possible runoff potential classifications or hydrologic groups. These classifications are based on the estimated rate of water infiltration when soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The four main groups are A, B, C, and D, with three dual classes (A/D, B/D, C/D). The SSURGO database defines the following classifications.

- **Group A** – Soils having high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well-drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
- **Group B** – Soils having a moderate infiltration rate when thoroughly wet. These consist of moderately deep or deep, moderately well-drained or well-drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

- **Group C** – Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- **Group D** – Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Soils with dual hydrologic groupings indicate that drained areas are assigned the first letter, and the second letter is assigned to undrained areas. Only soils that are in group D in their natural condition are assigned to dual classes.

The predominant soil type for Nueces County is the Victoria Series. It can be characterized as a rich clayey loam with some sandy areas. The Victoria Series has strong shrink/swell characteristics. During lengthy dry periods, the soil will present large, wide cracks. During wet periods, the soil can absorb large quantities of water (NRCS, 2005). The Victoria Series of soils is part of the Hydrologic Soil Group C. As seen in Figure 8, the Poenisch Park Watershed is completely comprised of Hydrologic Soil Group C (NRCS, 2020).

Figure 8. Hydrologic soil groups

Water Rights Review

Surface water rights in Texas are administered and overseen by TCEQ. A search of TCEQ's Texas Water Rights Viewer, (TCEQ, 2022b) indicated there are zero water rights in the Poenisch Park watershed.

Endpoint Identification

All TMDLs must identify a quantifiable water quality target that indicates the desired water quality condition and provides a measurable goal for the TMDL. The TMDL endpoint also serves to focus the technical work to be accomplished and as a criterion against which to evaluate future conditions.

While the single sample bacteria criterion adopted by TCEQ for coastal recreation waters in saltwater is 130 cfu/100 ml of Enterococci, TGLO uses a BAV of 104 cfu/100 ml of Enterococci to issue beach advisories. When the BAV is exceeded, TGLO will issue a Beach Advisory until the Enterococci concentrations fall below 104 cfu/100 ml. TCEQ includes this information in the Texas Integrated Report in order to protect human health by identifying beaches with persistent advisories. TCEQ assessment consists of identifying the percentage of days each beach has an advisory. If more than 25% of the days sampled have an advisory, the beach is listed as impaired in the Texas Integrated Report. The endpoint for the TMDL in this report is to not exceed the BAV for Enterococci, 104 cfu/100 ml, more than 25% of the days sampled.

Source Analysis

Pollutants may come from several sources, both regulated and unregulated. Regulated pollutants, referred to as “point sources,” come from a single definable point, such as a pipe, and are regulated by permit under the Texas Pollutant Discharge Elimination System (TPDES) program. WWTFs and stormwater discharges from industries, construction activities, and the separate storm sewer systems of cities are considered point sources of pollution.

Unregulated sources are typically nonpoint source in origin, meaning the pollutants originate from multiple locations and rainfall runoff washes them into surface waters. Nonpoint sources are not regulated by permits.

Except for WWTFs, which receive individual wasteload allocations (WLAs) (see the “WLA” section), the regulated and unregulated sources in this section are presented to give a general account of the different sources of bacteria expected in the watershed. These are not meant to be used for allocating bacteria loads or interpreted as precise inventories and loadings.

Regulated Sources

Regulated sources are controlled by permit under the TPDES program. Regulated sources can include WWTF outfalls, SSOs, stormwater discharges from industrial and regulated construction sites, MS4s, and other miscellaneous sources.

Domestic and Industrial Wastewater Treatment Facilities

The Poenisch Park watershed is serviced by a municipal sanitary sewer system. All sanitary wastewater is conveyed out of the watershed and the treated effluent is not discharged within the watershed, nor in the vicinity of the impaired AU. Based on the City of Corpus Christi's future land use geographic information system viewer, maintained by the city's Department of Development Services, the City of Corpus Christi has no plans to change this system. The limited space within the watershed precludes the possibility that a WWTF will be constructed within, or near, the watershed and that sanitary wastewater will be discharged in the watershed (City of Corpus Christi, 2018).

TCEQ/TPDES Water Quality General Permits

Certain types of activities must be covered by one of several TCEQ/TPDES general permits:

- TXG110000 – concrete production facilities
- TXG130000 – aquaculture production
- TXG340000 – petroleum bulk stations and terminals
- TXG640000 – conventional water treatment plants
- TXG670000 – hydrostatic test water discharges
- TXG830000 – water contaminated by petroleum fuel or petroleum substances
- TXG870000 – pesticides (application only)
- TXG920000 – concentrated animal feeding operations
- WQG100000 – wastewater evaporation
- WQG200000 – livestock manure compost operations (irrigation only)

The following general permit authorizations are not considered to affect the bacteria loading in the TMDL watershed and were excluded from this investigation:

- TXG640000 – conventional water treatment plants
- TXG670000 – hydrostatic test water discharges
- TXG830000 – water contaminated by petroleum fuel or petroleum substances
- TXG870000 – pesticides (application only)
- WQG100000 – wastewater evaporation

A review of active general permit coverage, as of December 2023, showed that there were no active general wastewater permit authorizations in the Poenisch Park watershed (TCEQ, 2022c).

Sanitary Sewer Overflows

Sanitary sewer overflows are unauthorized discharges that must be addressed by the responsible party, either the TPDES permittee or the owner of the collection system that is connected to a permitted system. These overflows in dry weather most often result from blockages in the sewer collection pipes caused by tree roots, grease, and other debris. Inflow and infiltration (I&I) are typical causes of overflows under conditions of high flow in the WWTF system. Blockages in the line may worsen the I&I problem. Other causes, such as a collapsed sewer line, may occur under any condition. There were no reported SSOs within the Poenisch Park watershed between January 2019 and April 2024.

TPDES-Regulated Stormwater

When evaluating stormwater for a TMDL allocation, a distinction must be made between stormwater originating from an area under a TPDES-regulated discharge permit and stormwater originating from areas not under a TPDES-regulated discharge permit. Stormwater discharges fall into two categories:

1) Stormwater subject to regulation, which is any stormwater originating from TPDES-regulated MS4 entities, stormwater discharges associated with regulated industrial activities, and construction activities.
2) Stormwater runoff not subject to regulation.

TPDES MS4 Phase I and II rules require municipalities and certain other entities to obtain permit coverage for their stormwater systems. A regulated MS4 is a publicly owned system of conveyances and includes ditches, curbs, gutters, and storm sewers that do not connect to a sanitary wastewater collection system or treatment facility. Phase I permits are individual permits for large and medium-sized MS4s with populations of 100,000 or more based on the 1990 U. S. Census, whereas the Phase II General Permit regulates other MS4s within an urban area with a population of at least 50,000 people.

The purpose of an MS4 permit is to reduce discharges of pollutants in stormwater to the “maximum extent practicable” by developing and implementing a stormwater management program (SWMP). The SWMP describes the stormwater control practices that the regulated entity will implement, consistent with permit requirements, to minimize the discharge of pollutants. The MS4 permits require that SWMPs specify the best management practices (BMPs) to meet several minimum control measures (MCMs) that, when implemented in concert, are expected to result in significant reductions of pollutants discharged into receiving water bodies. Phase II MS4 MCMs include:

- Public education, outreach, and involvement.
- Illicit discharge detection and elimination.
- Construction site stormwater runoff control.

- Post-construction stormwater management in new development and redevelopment.
- Pollution prevention and good housekeeping for municipal operations.
- Industrial stormwater sources (only required for MS4s serving a population of 100,000 people or more in the urban area).
- Authorization for construction activities where the small MS4 is the site operator (*optional*)[2].

Phase I MS4 individual permits have their own set of MCMs that are similar to the Phase II MCMs, but Phase I permits have additional requirements to perform water quality monitoring and implement a floatables program. The Phase I MCMs include all of these activities:

- MS4 maintenance activities.
- Post-construction stormwater control measures.
- Detection and elimination of illicit discharges.
- Pollution prevention and good housekeeping for municipal operations.
- Limiting pollutants in industrial and high-risk stormwater runoff.
- Limiting pollutants in stormwater runoff from construction sites.
- Public education, outreach, involvement, and participation.
- Monitoring, evaluating, and reporting.

Discharges of stormwater from a Phase II MS4 area, regulated industrial facility, construction area, or other facility involved in certain activities must be covered under the following TCEQ/TPDES general permits:

- TXR040000 – Phase II MS4 General Permit for MS4s located in UAs
- TXR050000 – Multi-Sector General Permit for industrial facilities
- TXR150000 – Construction General Permit (CGP) for construction activities disturbing more than one acre or are part of a common plan of development disturbing more than one acre

The entire Poenisch Park watershed is covered under the City of Corpus Christi Phase I MS4 permit (TPDES Permit No. WQ0004200000). The jurisdictional boundary of the Corpus Christi Phase I MS4 permit is dictated by the corporate boundary of the City of Corpus Christi. Under the City of Corpus Christi MS4 permit, the City of Corpus Christi, Del Mar College East Campus, Port of Corpus Christi Authority of Nueces County, and Texas A&M University-Corpus Christi are designated as co-permittees. The Texas Department of Transportation (TPDES Permit No. WQ0005011000) maintains a state-wide MS4 permit for rights-of-ways in Phase I MS4 areas, including Corpus Christi.

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[2] MCM only applies to Phase II MS4s which serve a population of 100,000 or more

Poenisch Park and adjacent watershed land contains one stormwater outfall which discharges directly to Corpus Christi Bay. The entire watershed is covered under the City of Corpus Christi Phase I MS4 permit and is described in Table 5.

Table 5. MS4 permits

Regulated Entity	Authorization Type	TPDES Permit No./ [a]NPDES ID	Location
City of Corpus Christi, Del Mar College East Campus, Port of Corpus Christi Authority of Nueces County, and Texas A&M University - Corpus Christi	Phase I	WQ0004200000/TXS000601	Area within the boundary of the City of Corpus Christi served by MS4
Texas Department of Transportation	Combined Phase I and Phase II MS4	WQ0005011000/TXS002101	TXDOT [b] rights-of way located within Phase I MS4s and Phase II UAs [c]

[a] National Pollution Discharge Elimination System

[b] Texas Department of Transportation

[c] Urbanized Area

Illicit Discharges

Pollutant loads can enter water bodies from MS4 outfalls that carry authorized sources, as well as illicit discharges under both dry- and wet-weather conditions. The term "illicit discharge" is defined in TPDES General Permit TXR040000 for Phase II MS4s as "Any discharge to a municipal separate storm sewer system that is not entirely composed of stormwater, except discharges pursuant to this general permit or a separate authorization and discharges resulting from emergency firefighting activities." Illicit discharges can be categorized as either direct or indirect contributions. Examples of illicit discharges identified in the *Illicit Discharge Detection and Elimination Manual: A Handbook for Municipalities* (NEIWPCC, 2003) include:

Direct Illicit Discharges

- Sanitary wastewater piping that is directly connected from a home to the storm sewer.
- Materials that have been dumped illegally into a storm drain catch basin.
- A shop floor drain that is connected to the storm sewer.
- A cross-connection between the sanitary sewer and storm sewer systems.

Indirect Illicit Discharges

- An old and damaged sanitary sewer line that is leaking fluids into a cracked storm sewer line.

- A failing septic system that is leaking into a cracked storm sewer line or causing surface discharge into the storm sewer.

Unregulated Sources

Unregulated sources of bacteria are generally nonpoint. Nonpoint source loading enters the impaired water body through distributed, nonspecific locations, which may include urban runoff not covered by a permit wildlife, and domestic pets.

Unregulated Agricultural Activities and Domesticated Animals

Several agricultural activities that do not require permits can be potential sources of fecal bacteria loading. However, there are no agricultural activities within the small Poenisch Park watershed, which is 100% developed land use (Figure 7).

Fecal bacteria from dogs and cats can be transported by runoff from urban and suburban areas and is a potential source of bacteria loading. Pet population estimates were calculated as the estimated number of dogs (0.614) and cats (0.457) per household according to data from the American Veterinary Medical Association 2017-2018 U.S. Pet Statistics (AVMA, 2018). Due to the Poenisch Park watershed being at a scale smaller than USCB census blocks, Google Map Pro was used to identify the number of households in the watershed, which was determined to be 151 households. The number of cats and dogs per household was then used to compute the number of dogs and cats for the Poenisch Park watershed, shown in Table 6. The actual contribution and significance of bacteria loads from pets reaching the water bodies of the watershed is unknown.

Table 6. Estimated households and pet populations

AU	Estimated Households	Estimated Dog Population	Estimated Cat Population
2481CB_06	151	93	69

Wildlife and Unmanaged Animals

Fecal bacteria are common inhabitants of the intestines of all warm-blooded animals, including wildlife such as mammals and birds. In developing bacteria TMDLs, it is important to identify, by watershed, the potential for bacteria contributions from wildlife. Wildlife are naturally attracted to riparian corridors of water bodies. With direct access to the stream channel, the direct deposition of wildlife waste can be a concentrated source of bacteria loading to a water body. Fecal bacteria from wildlife are also deposited onto land surfaces, where they may be washed into nearby water bodies by rainfall runoff.

The bacteria contribution from wildlife and unmanaged animals in the Poenisch Park watershed cannot be determined based on existing information. However, due to the urbanized nature of the watershed, it is assumed that the contribution is minimal.

On-Site Sewage Facilities

Private residential on-site sewage facilities (OSSFs), commonly referred to as septic systems, consist of various designs based on physical conditions of the local soils. Typical designs consist of 1) one or more septic tanks and a drainage or distribution field (anaerobic system) and 2) aerobic systems that have an aerated holding tank and often an above ground sprinkler system for distributing the liquid. In simplest terms, household waste flows into the septic tank or aerated tank, where solids settle out. The liquid portion of the water flows to the distribution system, which may consist of buried perforated pipes or an above ground sprinkler system.

Several pathways of the liquid waste in OSSFs afford opportunities for bacteria to enter ground and surface waters if the systems are not properly operating. However, properly designed and operated OSSFs contribute virtually no fecal bacteria to surface waters. For example, less than 0.01% of fecal coliforms originating in household wastes move further than 6.5 feet down gradient of the drainfield of a septic system (Weiskel et al., 1996). Reed, Stowe, and Yanke LLC (2001) provide estimated failure rates of OSSFs for different regions of Texas. The TMDL watershed is located within the Region IV area, which has a reported failure rate of about 12%, providing insight into expected failure rates for the area.

Due to the watershed being entirely within city boundaries and within the City of Corpus Christi, there are no reported OSSFs within the TMDL watershed, and a municipal sanitary sewer system has been available since the 1940s.

Bacteria Survival and Die-off

Bacteria are living organisms that survive and die. Certain enteric bacteria can survive and replicate in organic materials if appropriate conditions prevail (e.g., warm temperature). Fecal organisms can survive and replicate from improperly treated effluent during their transport in pipe networks, and they can survive and replicate in organic-rich materials such as improperly treated compost and sewage sludge (or biosolids). While die-off of bacteria has been demonstrated in natural water systems due to the presence of sunlight and predators, the potential for their regrowth is less understood. Both replication and die-off are instream processes and are not considered in the bacteria source loading estimates in the TMDL watershed.

Linkage Analysis

Establishing the relationship between outfall water quality and the source of loadings is an important component in developing a TMDL. It allows for the evaluation of management options that will achieve the desired endpoint. The relationship may be established through a variety of techniques.

Bacteria load contributions from regulated and unregulated stormwater sources are greatest during runoff events. Rainfall runoff, depending upon the severity of the storm, can carry bacteria from the land surface into the receiving water body. Generally, this loading follows a pattern of higher concentrations in the water body as the first flush of storm runoff enters the receiving water body. Over time, the concentrations decline as runoff washes fecal bacteria from the land surface and the volume of runoff decreases following the rain event. In the small, urbanized Poenisch Park watershed, all flow at the outfall is generated by rainfall runoff. Additionally, field observations found that rainfall runoff completely exits the watershed at the outfall three hours following the end of precipitation.

Load Duration Analysis

LDCs are graphs of the frequency distribution of loads of pollutants in a water body. LDC analyses are used to examine the relationship between water quality and the broad sources of indicator bacteria loads which are the basis of the TMDL allocations (Cleland, 2003). In the case of this TMDL, the loads shown are of Enterococci bacteria in cfu/day (Figure 9).

LDCs are derived from flow duration curves (FDCs). An FDC was developed for the Poenisch Park watershed based on flow estimates from a simplified step model due to the intermittent flow from the outfall in the watershed. For the FDC and LDC developed for this report, only estimates of nonzero flow were included. The simplified step model assumes that runoff from precipitation completely exits the watershed at the outfall after three hours following the end of precipitation. Because pollutant loading is a product of flow and pollutant concentration, loads cannot be estimated for periods when there is no flow. An important caveat is that pollutant concentrations in the Poenisch Park watershed could be influenced by other factors that the simplified step model is not able to account for and were therefore left out of this analysis.

Load Duration Curve Results

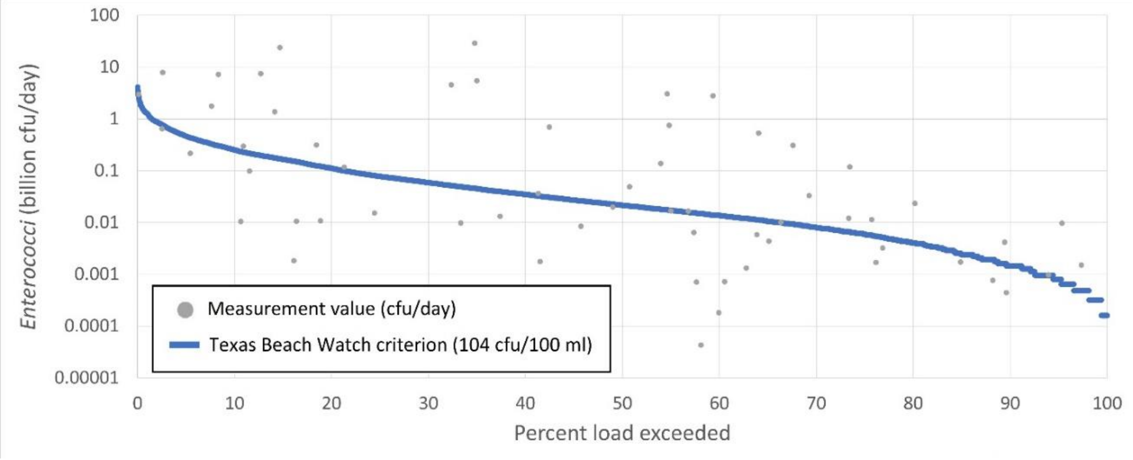

Figure 9. LDC for Poenisch Park watershed during wet conditions

Margin of Safety

The margin of safety (MOS) is used to account for uncertainty in the analysis used to develop the TMDL and thus provide a higher level of assurance that the goal of the TMDL will be met. It also accounts for any uncertainty that may arise in specifying water quality control strategies for the complex environmental processes that affect water quality. Quantification of this uncertainty, to the extent possible, is the basis for assigning an MOS.

According to EPA guidance (EPA, 1991), the MOS can be incorporated into the TMDL using either of the following two methods:

1) Implicitly incorporating the MOS using conservative model assumptions to develop allocations.
2) Explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

This TMDL incorporates an explicit MOS of 5% of the total TMDL allocation.

Pollutant Load Allocation

The TMDL represents the maximum amount of a pollutant that the water body can receive in a single day without exceeding water quality standards. The pollutant load allocations for the selected scenarios were calculated using the following equation:

TMDL = WLA + LA + FG + MOS

Where:

WLA = wasteload allocations, the amount of pollutant allowed by regulated dischargers

LA = load allocations, the amount of pollutant allowed by unregulated sources

FG = loadings associated with future growth from potential regulated facilities

MOS = margin of safety load

TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures [40 CFR 130.2(i)]. For Enterococci, TMDLs are expressed as cfu/day, and represent the maximum one-day load the water body can assimilate while still attaining the standards for surface water quality.

In non-beach TMDLs, the TMDL component for the impaired AU is derived using the median flow within the high-flow regime (or 5% flow) of the LDC developed for the TMDL watershed. For the Poenisch Park TMDL, 5% is used as the median value of the high-flow regime to be consistent with other TMDLS.

For the remainder of this report, each section will present an explanation of the TMDL component first, followed by the results of the calculation for that component. Also, please note that some calculations completed in the remainder of this report have been rounded and may not lead to the exact final amounts listed in the text, tables, or figures.

Assessment Unit-Level TMDL Calculations

The TMDL for the impaired AU was developed as pollutant load allocations based on information from the LDC developed for TGLO Station NUE026. The bacteria LDC was developed by multiplying the streamflow value along the FDC by the Texas Beach Watch criterion for Enterococci (104 cfu/100 ml) and by the conversion factor to convert to loading in cfu per day. This effectively displays the LDC as the TMDL curve of maximum allowable loading:

TMDL (billion cfu/day) = Criterion * Flow * Conversion Factor

Where:

Criterion = 104 cfu/100 ml Enterococci

Flow = 5% exceedance flow from FDC in cubic feet per second (cfs)

Conversion Factor (to billion cfu/day) = 28,316.8 ml/cubic foot (ft^3) * 86,400 seconds/day (s/d) ÷ 1,000,000,000

Table 7 shows the TMDL values at the 5% load duration exceedance.

Table 7. Summary of allowable loading calculation

AU	5% Exceedance Flow (cfs)	TMDL (Billion cfu/Day)
2481CB_06	4.365	11.107

Margin of Safety Formula

The MOS is applied only to the allowable loading for a watershed. Therefore, the MOS is expressed mathematically as the following:

$$MOS = 0.05 * TMDL$$

Where:

TMDL = total maximum daily load

The MOS calculations for each AU are shown in Table 8.

Table 8. MOS calculations

AU	TMDL	MOS
2481CB_06	11.107	0.555

Load units expressed as billion cfu/day Enterococci

Wasteload Allocation

The WLA is the sum of loads from regulated sources. The WLA consists of two parts – the wasteload that is allocated to TPDES-regulated WWTFs (WLA_{WWTF}) and the wasteload that is allocated to regulated stormwater dischargers (WLA_{SW}).

$$WLA = WLA_{WWTF} + WLA_{SW}$$

Wastewater Treatment Facilities

The daily allowable loading of Enterococci assigned to WLA_{WWTF} was determined to be zero in the Poenisch Park TMDL watershed because there are no WWTFs in the watershed; therefore, there are no regulated flows from any WWTFs and the WLA_{WWTF} is zero.

Regulated Stormwater

Stormwater discharges from MS4s, industrial facilities, concrete production and construction activities are considered 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_{sw} for these areas was used in the development of this 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 watershed that is under the jurisdiction of stormwater permits (i.e., defined as the area designated as urbanized area in the 2010 United States Census) was used to estimate the amount of the overall runoff load that should 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}.

WLA_{SW} is the sum of loads from regulated stormwater sources and is calculated as:

$$WLA_{SW} = (TMDL - WLA_{WWTF} - FG - MOS) * FDA_{SWP}$$

Where:

TMDL = total maximum daily load

WLA_{WWTF} = sum of all WWTF loads

FG = sum of future growth loads from potential regulated facilities

MOS = margin of safety load

FDA_{SWP} = fractional proportion of drainage area under jurisdiction of stormwater permits

The FDA_{SWP} must be calculated to arrive at the fractional proportion of the drainage area under jurisdiction of stormwater permits. FDA_{SWP} was calculated based on the area covered by regulated stormwater permits, and as discussed in "TPDES Regulated Stormwater" section, the entire Poenisch Park watershed is covered the City of Corpus Christi's Phase I MS4 permit. However, even in the urbanized Poenisch Park watershed there remain small portions of the watershed with potential for direct deposition of bacteria from unregulated sources such as wildlife. To account for possible unregulated direct deposition by wildlife, the area of the beach in the watershed was calculated. To arrive at the FDA_{SWP} proportion, the area under stormwater jurisdiction was divided by the total watershed area. The results were then used to compute an area of regulated stormwater contribution (Table 9).

Table 9. Regulated stormwater FDA_{SWP} calculations

AU	MS4 area of watershed (acres)	Poenisch Park Watershed area (acres)	Beach area (acres)	FDA_{SWP}
2481CB_06	64.371	64.500	0.130	0.998

A value for FG is necessary to complete the WLA_{SW}. The calculation for FG is presented in the later section “Allowance for Future Growth,” but the results will be included here for continuity. The WLA_{SW} calculations are presented in Table 10.

Table 10. Regulated stormwater load calculations

AU	TMDL	WLA_{WWTF}	FG	MOS	FDA_{SWP}	WLA_{SW}
2481CB_06	11.107	0.000	0.000	0.555	0.998	10.531

All loads are expressed in billion cfu/day. With the WLA_{SW} and WLA_{WWTF} terms, the total WLA term can be determined by adding the two parts (Table 11).

Table 11. WLA calculations

AU	WLA_{WWTF}	WLA_{SW}	WLA
2481CB_06	0.000	10.531	10.531

In areas currently regulated by an MS4 permit, development or redevelopment of land must include the implementation of the control measures/programs outlined in an MS4’s approved SWMP. Although additional flow may occur from development or redevelopment, loading of the pollutant of concern should be controlled or reduced through the implementation of BMPs as specified in both the TPDES permit and the approved SWMP.

An iterative, adaptive management approach will be used to address stormwater discharges. This approach encourages the implementation of structural or nonstructural controls, implementation of mechanisms to evaluate the performance of the controls, and finally, allowance to adjust (e.g., more stringent controls or specific BMPs) as necessary to protect water quality.

Implementation of Wasteload Allocations

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

As there are no permitted WWTFs discharging into the Poenisch Park watershed at this time, TCEQ will plan to implement individual WLAs for any future sources through the permitting process as monitoring requirements, effluent limitations, or both as required by the amendment of Title 30, Texas Administrative Code (TAC) Chapter 319, which became effective Nov. 26, 2009. Any future WWTFs discharging to the TMDL segments will be assigned an effluent limit based on the TMDL. Monitoring requirements will be based on permitted flow rates and are listed in 30 TAC Section 319.9.

Permit requirements are implemented during the routine permit renewal process. However, there may be a more economical or technically feasible means of achieving the goal of improved water quality, and circumstances may warrant changes in individual WLAs after this TMDL is adopted. Therefore, the individual WLAs, as well as the WLAs for stormwater, are nonbinding until implemented via a separate TPDES permitting action, which may involve preparation of an update to the state's WQMP. Regardless, all permitting actions will comply with the TMDL.

The executive director or commission may establish interim effluent limits, monitoring-only requirements, or both during amendment or renewal of a permit. These interim limits will allow a permittee time to modify effluent quality to attain the final effluent limits necessary to meet TCEQ- and EPA-approved TMDL allocations. The duration of any interim effluent limits may not be any longer than three years from the date of permit re-issuance. Compliance schedules are not allowed for new permits.

Where a TMDL has been approved, domestic WWTF TPDES permits will require conditions consistent with the requirements and assumptions of the WLAs. For TPDES-regulated municipal, construction stormwater, and industrial stormwater discharges, water quality-based effluent limits (WQBELs) that implement the WLA for stormwater may be expressed as BMPs or other similar requirements, rather than as numeric effluent limits.

The Nov. 26, 2014 memorandum from EPA relating to establishing WLAs for stormwater sources states:

> Incorporating greater specificity and clarity echoes the approach first advanced by EPA in the 1996 Interim Permitting Policy, which anticipated that where necessary to address water quality concerns, permits would be modified in subsequent terms to include 'more specific conditions or limitations [which] may include an integrated suite of BMPs, performance objectives, narrative standards, monitoring triggers, numeric WQBELs, action levels, etc.'

Using this iterative, adaptive BMP approach to the maximum extent practicable is appropriate to address the stormwater component of this TMDL.

Updates to Wasteload Allocations

This TMDL is, by definition, the total of the sum of the WLA (including FG), the sum of the LA, and the MOS. Changes to individual WLAs may be necessary in the future to accommodate growth or other changing conditions. These changes to individual WLAs do not ordinarily require a revision of the TMDL report; instead, changes will be made through updates to the state's WQMP. Any future changes to effluent limitations will be addressed through the permitting process and by updating the WQMP.

Load Allocation

The LA is the sum of loads from unregulated sources, and is calculated as:

LA = TMDL – WLA – FG – MOS

Where:

TMDL = total maximum daily load

WLA_{WWTF} = sum of all WWTF loads

WLA_{SW} = sum of all regulated stormwater loads

FG = sum of future growth loads from potential regulated facilities

MOS = margin of safety load

Table 12 summarizes the LA.

Table 12. LA calculation

AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	FG	LA
2481CB_06	11.107	0.555	0.000	10.531	0.000	0.021

All loads are expressed in billion cfu/day.

Allowance for Future Growth

The FG component of the TMDL equation addresses the requirement to account for future loadings that may occur due to population growth, changes in community infrastructure, and development. Specifically, this TMDL component considers the probability that new flows from WWTF discharges may occur in the future. The assimilative capacity of water bodies increases as the amount of flow increases. Because there are no WWTFs that discharge within the Poenisch Park watershed and there is no possibility that one will be constructed in the future due to the watershed's small size and existing residential development, the FG component for this TMDL is zero.

Summary of TMDL Calculations

The TMDL was calculated based on the median flow in the 95-percentile range (5% exceedance) for flow exceedance based on the LDC developed for TGLO station NUE026.

Allocations are based on the current Texas Beach Watch criterion for Enterococci (104 cfu/100 ml) for each component of the TMDL. The TMDL allocation summary for the Poenisch Park TMDL watershed is summarized in Table 13.

Table 13. TMDL allocations

AU	TMDL	WLA_{WWTF}	WLA_{SW}	LA	FG	MOS
2481CB_06	11.107	0.000	10.531	0.021	0.000	0.555

All loads are expressed in billion cfu/day.

The final TMDL allocations (Table 14) needed to comply with the requirements of 40 CFR 130.7 include the FG component within the WLA_{WWTF}.

Table 14. Final TMDL allocations

AU	TMDL	WLA_{WWTF}	WLA_{SW}	LA	MOS
2481CB_06	11.107	0.000	10.531	0.021	0.555

All loads are expressed in billion cfu/day.

Seasonal Variation

Federal regulations require that TMDLs account for seasonal variation in watershed conditions and pollutant loading [40 CFR 130.7(c)(1)]. Federal regulations require that TMDLs account for seasonal variation in watershed conditions and pollutant loading [40 CFR Section 130.7(c)(1)].

Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing Enterococci concentrations obtained from 16 years (2003-2018) of routine monitoring data collected in the warmer months (May through September) against those collected during the cooler months (November through March). The months of April and October were considered transitional between warm and cool seasons and were excluded from the seasonal analysis.

Differences in Enterococci concentrations obtained in warmer versus cooler months were then evaluated by performing an Analysis of Variance (ANOVA) test. To meet the model assumptions of normality, data was log-transformed. This analysis of Enterococci data indicated that there was no difference in mean log-transformed concentrations during cool months or warm months ($p = 0.429$) in the Poenisch Park watershed when $\alpha = 0.05$.

The data were also evaluated based on wet and dry seasonality. November through April were classified as wet months, while May through September were classified as dry months. Mean log transformed concentrations were greater during wet months than during dry months ($p < 0.001$).

Similar to the LDC analysis and because runoff from the Poenisch watershed is primarily driven by rainfall, only estimates of nonzero flow were used for the seasonal analysis."

Public Participation

TCEQ maintains an inclusive public participation process. From the inception of the investigation, the project team sought to ensure that stakeholders were informed and involved. Communication and comments from the stakeholders in the watershed strengthen TMDL projects and their implementation.

Poenisch Park will be included in the Corpus Christi Regional Implementation Plan (I-Plan) and stakeholders within the Poenisch Park watershed have been engaged through the Cole and Ropes Parks Coordination Committee. Beginning in August 2022, discussion of Poenisch Park has been included at Coordination Committee meetings. Additionally, Texas A&M-Corpus Christi staff presented a summary of the Poenisch Park TMDL project at the Aug. 31, 2023 Corpus Christi Regional I-Plan Coordination Committee Meeting in Corpus Christi, TX. Going forward, public meetings for the Poenisch Park TMDL and the Corpus Christi Regional I-Plan will be held jointly.

Implementation and Reasonable Assurance

For MS4 entities, where numeric effluent limitations are infeasible, the permits require that the MS4 develop and implement BMPs under each MCM, which are a substitute for effluent limitations, as allowed by federal rules. How a regulated MS4 meets each MCM is not prescribed in detail in the MS4 permits but is included in the permittee's SWMP. During the permit renewal process, TCEQ revises its MS4 permits as needed to require the implementation of other specific revisions in accordance with an approved TMDL and I-Plan.

Strategies for achieving pollutant loads in TMDLs from both point and nonpoint sources are reasonably assured by the state's use of an I-Plan. TCEQ is committed to supporting implementation of all TMDLs adopted by the commission.

I-Plans for Texas TMDLs use an adaptive management approach that allows for refinement or addition of methods to achieve environmental goals. This adaptive approach reasonably assures that the necessary regulatory and voluntary activities to achieve pollutant reductions will be implemented. Periodic, repeated evaluations of the effectiveness of implementation methods ascertain whether progress is occurring and may show that the original distribution of loading among sources should be modified to increase efficiency. I-Plans will be adapted as necessary to reflect needs identified in evaluations of progress.

Key Elements of an I-Plan

An I-Plan includes a detailed description and schedule of the regulatory and voluntary management measures to implement the WLAs and LAs of particular TMDLs within a reasonable time. I-Plans also identify the organizations responsible for carrying out management measures, and a plan for periodic evaluation of progress.

Strategies to optimize compliance and oversight are identified in an I-Plan when necessary. Such strategies may include additional monitoring and reporting of effluent discharge quality to evaluate and verify loading trends, adjustment of an inspection frequency or a response protocol to public complaints, and escalation of an enforcement remedy to require corrective action of a regulated entity contributing to an impairment.

TCEQ works with stakeholders and interested governmental agencies to develop and support I-Plans and track their progress. Work on the I-Plan begins during development of TMDLs.

Ultimately, the I-Plan identifies the commitments and requirements to be implemented through specific permit actions and other means. For these reasons, the approved I-Plan may not approximate the predicted loadings identified category by category in the TMDL and its underlying assessment. The I-Plan is adaptive for this very reason; it allows for continuous update and improvement.

In most cases, it is not practical or feasible to approach all TMDL implementation as a one-time, short-term restoration effort. This is particularly true when a challenging wasteload reduction or load reduction is required by the TMDL, there is high uncertainty with the TMDL analysis, there is a need to reconsider or revise the established water quality standard, or the pollutant load reduction would require costly infrastructure and capital improvements.

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Appendix A.
Population and Population Projections

The following steps detail the method used to estimate the 2020 and projected 2070 populations in the TMDL watershed.

Estimate 2020 watershed population

1) Obtained census block level population and spatial data for Nueces County for the year 2020 from the USCB.
2) Intersected block-level census data with the watershed boundaries
3) Determined the proportion of the watershed within each census block
4) Multiplied this proportion by the census block population to determine the estimated 2020 census population for the watershed.

Estimate 2030-2070 watershed population

1) Obtained population projections for the City of Corpus Christi for 2070 from the TWDB 2021 Regional Water Plan Population and Water Demand Projection data (TWDB, 2019).

Calculated the projected population percentage increase from 2020 to 2070 from the TWDB Regional Water Plan Population and Water Demand Projections data (TWDB, 2019). The city-projected increase of 19.14% was multiplied by the 2020 watershed population to estimate the 2070 watershed population