Northeast Ohio
Regional Sewer District

2023 Lake Erie Beach Monitoring




Water Quality and Industrial Surveillance

Environmental Assessment Group

May 2024

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May 30, 2024

Introduction

Since 1992, the Northeast Ohio Regional Sewer District (NEORSD) has conducted bacteriological sampling on Lake Erie at Edgewater Beach, Villa Angela Beach, and Euclid Beach to monitor bacteriological densities at the beaches. In 2005, sampling at Euclid Creek was added to determine the impact the creek may have on the water quality at Villa Angela and Euclid Beaches.

In 2023, the NEORSD continued these sampling efforts by monitoring the *Escherichia coli* (*E. coli*) densities at Edgewater, Villa Angela, and Euclid Beaches and Euclid Creek. The purpose of this sampling was to communicate beach conditions to the public and evaluate the attainment of water quality standards. This report evaluates the attainment of water quality standards using the results from each sample site.

Sampling was completed by either NEORSD Level 3 Qualified Data Collectors (QDCs) certified by the Ohio Environmental Protection Agency (Ohio EPA) in Chemical Water Quality Assessment or other individuals in the Water Quality and Industrial Surveillance (WQIS) Division trained by Level 3 QDCs as explained in the NEORSD study plan *2023 Lake Erie Beach Monitoring*, which was approved by Ohio EPA on April 10, 2023. Sample analyses were conducted by NEORSD's Analytical Services division, which is accredited by the National Environmental Laboratory Accreditation Program.

Table 1 indicates the sampling sites with respect to location, site or river mile (RM), latitude/longitude and description. Figure 1 is a map of the sampling locations at Edgewater, Euclid and Villa Angela Beaches and Euclid Creek.

Table 1. List of Lake Erie and Euclid Creek Sampling Sites

Location	Site	Latitude	Longitude	Description	Quadrangle	Purpose
Edgewater Beach	East	41.4893	-81.7392	Eastern half of the beach. In line with the brick stack on the other side of the freeway	Cleveland South	• Public notification of water quality conditions at bathing beaches • Determination of water quality standards attainment • Evaluation of the impact of point and non-point sources
Villa Angela Beach	East	41.5851	-81.5677	Eastern half of beach, mid-distance between the 3rd and 4th break walls	East Cleveland	
Euclid Beach	East	41.5843	-81.5686	Eastern half of beach in line with the East side of the pile of stones on the beach	East Cleveland	
Euclid Creek	RM 0.55	41.5831	-81.5594	Downstream of Lakeshore Boulevard	East Cleveland	

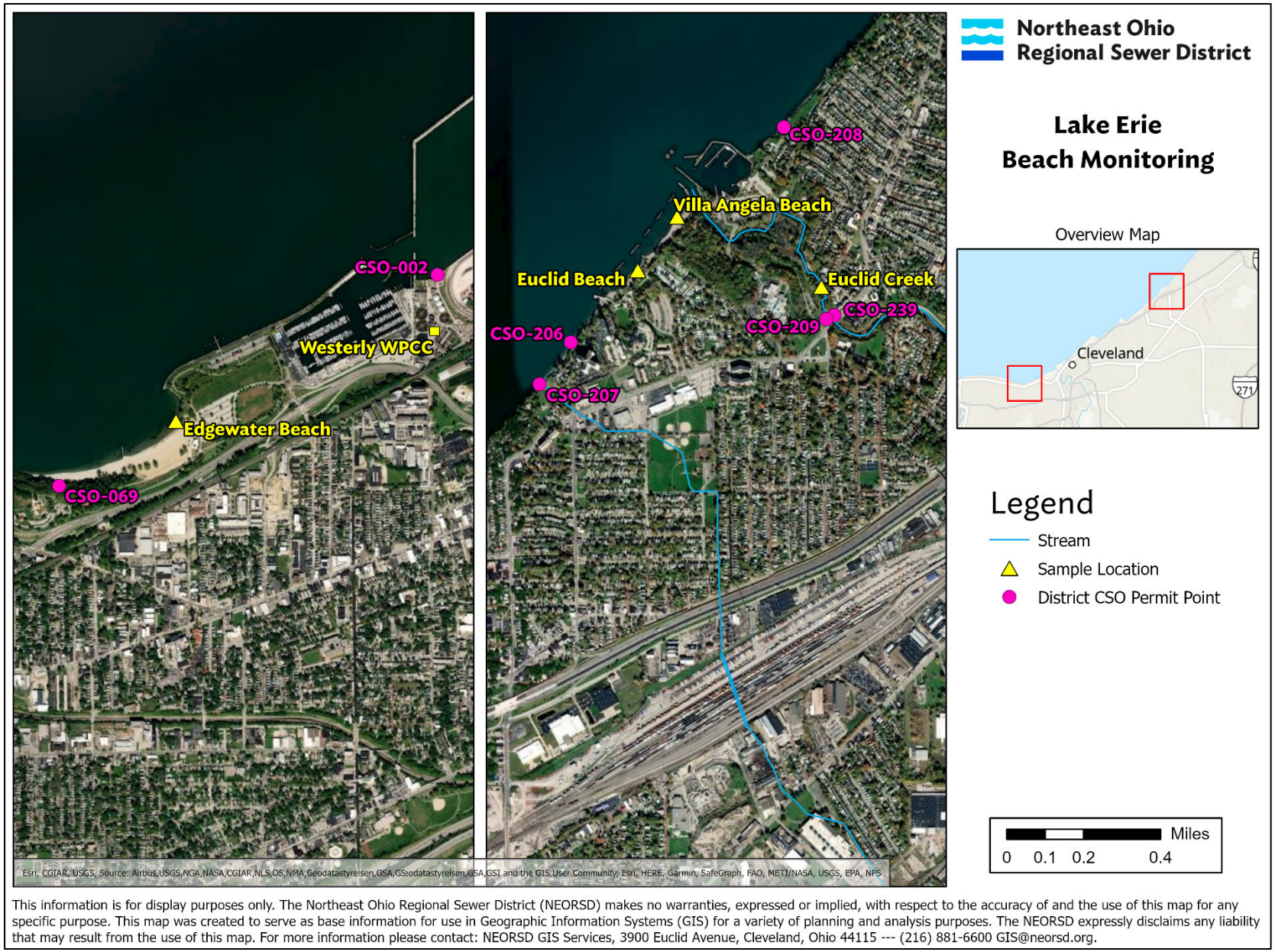

Figure 1. Map of Sampling Sites

Methods

Bacteriological sampling was conducted from May 1, 2023, to September 28, 2023. From May 1 through May 18, water samples were collected from each beach and Euclid Creek RM 0.55 (further referred to simply as Euclid Creek) four days a week (Monday through Thursday). Beginning May 22, and lasting through September 3, samples were collected at each beach and Euclid Creek seven days a week. From September 4 through September 28, sampling at all sites returned to four days a week (Monday through Thursday). One hundred thirty-two samples were collected at each site. Overall, a total of 561 samples including 33 replicates were collected throughout the course of this study.

Field analysis included the use of a Hanna HI 98129 meter to measure pH, water temperature, and specific conductance. The Hach 2100Q Portable Turbidimeter was additionally used to obtain field turbidity measurements. An in-situ YSI EXO2 sonde installed along the eastern break wall of Edgewater Beach collected field measurements of chlorophyll *a* and phycocyanin pigments, pH, turbidity, temperature, and turbidity. The data sonde was primarily used as a real-time predictive tool for HAB monitoring by utilizing the ratio of chlorophyll *a* vs phycocyanin pigments measured by the EXO Total Algae PC Sensor. All water samples, field parameters and analyses were collected as specified in the most current NEORSD Beach Sampling Standard Operating Procedure (*SOP-EA016-19*) and Ohio EPA's *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2023a).

Bacteriological grab samples were collected in a 250-mililiter sterilized polypropylene container. Samples at each location were collected approximately 6-12 inches below the surface, in water that was approximately three feet deep. At the time of sample collection, field parameters were measured, and field observations and water conditions were documented at each beach site. The data was recorded on a NEORSD Beach Sampling Field Data Form. All samples were placed in a cooler with ice and stored in a locked NEORSD vehicle until the samples were transferred to NEORSD's Analytical Services sample receiving with a Chain of Custody (COC). All Beach Sampling Field Data Forms, COCs and Certificates of Analysis are available upon request from the WQIS Division, and the Analytical Services Division.

The quality assurance and quality control of bacteriological water sample collections included field replicates that were collected at a frequency not less than 5% of the total samples collected. Since field blanks are not required by method SM 9223 or by the National Environmental Laboratory Accreditation Conference (NELAC) for bacteria analysis, no bacteriological field blanks were collected during the study. Analytical Services has procedures in place which are required by NELAC to demonstrate that the sample containers are clean and sterile.

Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and replicate sample (Formula 1).

Formula 1: $$\mathbf{RPD} = \left| \frac{x-y}{\left[\frac{(x-y)}{2}\right]} \right| \times 100$$

x = is the concentration of the parameter in the primary sample
y = is the concentration of the parameter in the replicate sample

For bacteriological samples, the acceptable RPD is 133.3%. Those RPDs that are higher than acceptable may indicate potential problems with sample collection and, as a result, the data would not be used for comparison to the water quality standards.

Euclid Creek flow data from 2013-2023 was obtained from the United States Geological Survey (USGS) gage station on Euclid Creek located at Lakeshore Boulevard, Cleveland (gage number 04208700). Euclid Creek bacteriological data was taken from historical sampling on Euclid Creek at RM 0.55 by the NEORSD from Level 3 Credible Data studies from 2013-2023 during the recreational season.

Results and Discussion

The *E. coli* results from each beach site were compared to the Ohio Water Quality Standards to determine recreational use attainment. From May 1st to October 31st, the three beaches are designated as Bathing Waters for the Protection of Recreational Use, while Euclid Creek is designated as a Primary Contact Recreation stream (Ohio EPA, 2023b). Both the Bathing Waters and Primary Contact Recreation criteria for *E. coli* include a statistical threshold value (STV) criterion not to exceed 410 colony counts units per 100 milliliters (colony counts/100mL) in more than ten percent of the samples collected during any 90-day period and a 90-day geometric mean criterion of 126 colony counts/100mL. The Bathing Waters criteria also maintain the use of the previous single sample maximum limit of 235 colony counts/100mL as the Beach Action Value for the purpose of posting daily water quality advisories.

Throughout the study, a total of 33 replicate samples were collected for a final replicate frequency of 6%. No replicate samples collected at any of the four sites were outside of the acceptable RPD during the 2023 season.

Recreational Use Attainment Status

Edgewater Beach

Edgewater Beach was in attainment of the recreational use criteria for most of 2023. Water Quality Standards attainment status of Edgewater Beach for Bathing Water recreational use criteria are shown in Figures 2 and 3. There were no exceedances of the geomean criterion for any of the 90-day periods. Edgewater Beach was in non-attainment of the STV criterion for 27 of the 90-day periods, an exceedance frequency of 20.3%. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 23 of the 133 sampling events, a frequency of 17.3%. Twenty of the 23 exceedances of the Beach Action Value (87%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

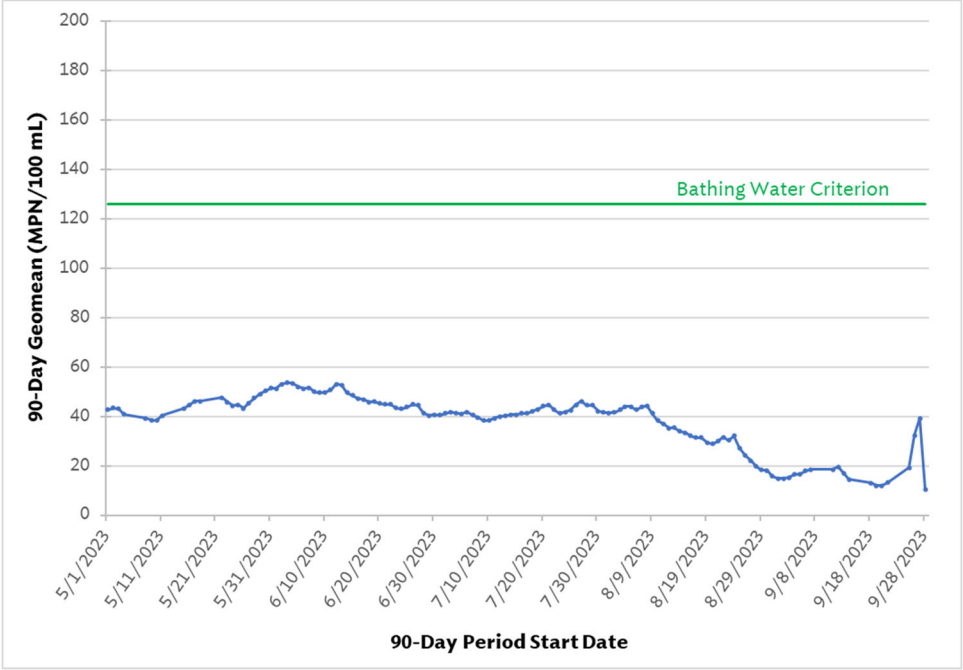

Figure 2. 2023 Edgewater Beach - Attainment of Bathing Water 90-Day Geomean Criterion

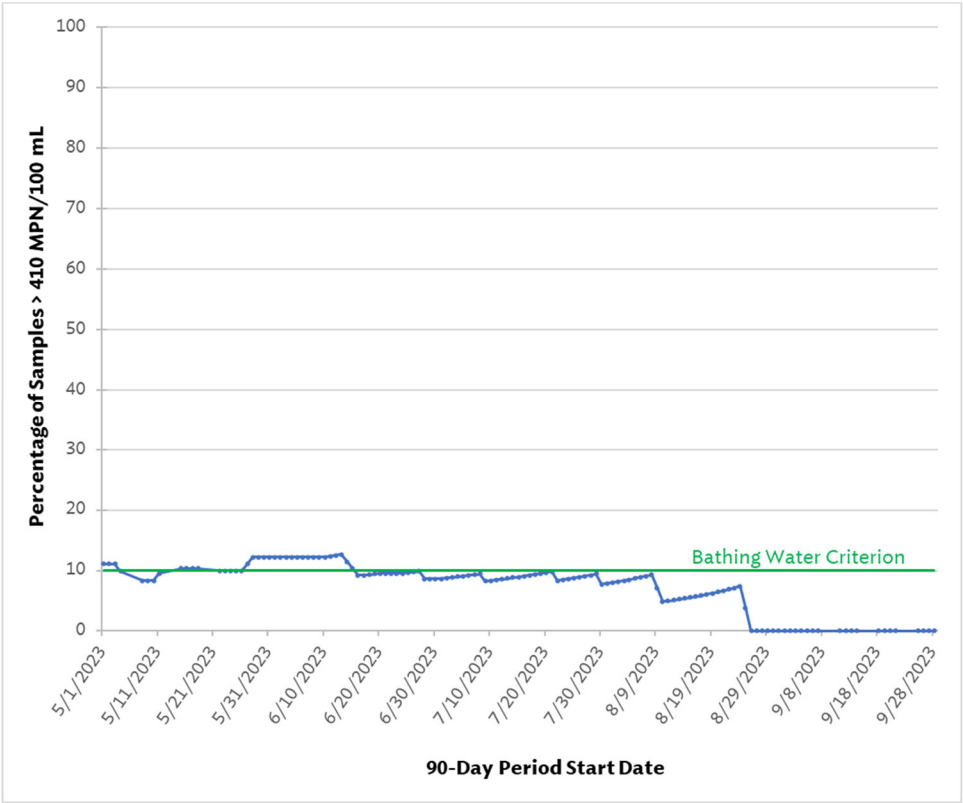

Figure 3. 2023 Edgewater Beach - Attainment of Bathing Water STV Criterion

Euclid Beach

Water Quality Standards attainment status of Euclid Beach for Bathing Water recreational use criteria are shown in Figures 4 and 5. There were no exceedances of the geomean criterion for any of the 90-day periods. Euclid Beach was in non-attainment of the STV criterion for 62.9% of the 90-day periods. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 23 of the 132 sampling events, a frequency of 17.4%. Eighteen of these 23 exceedances (78.2%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

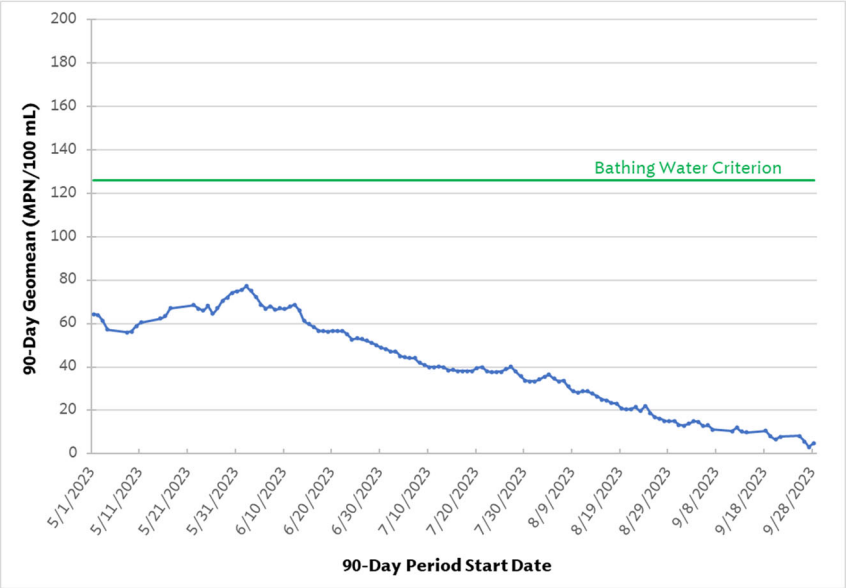

Figure 4. 2023 Euclid Beach - Attainment of Bathing Water 90-Day Geomean Criterion

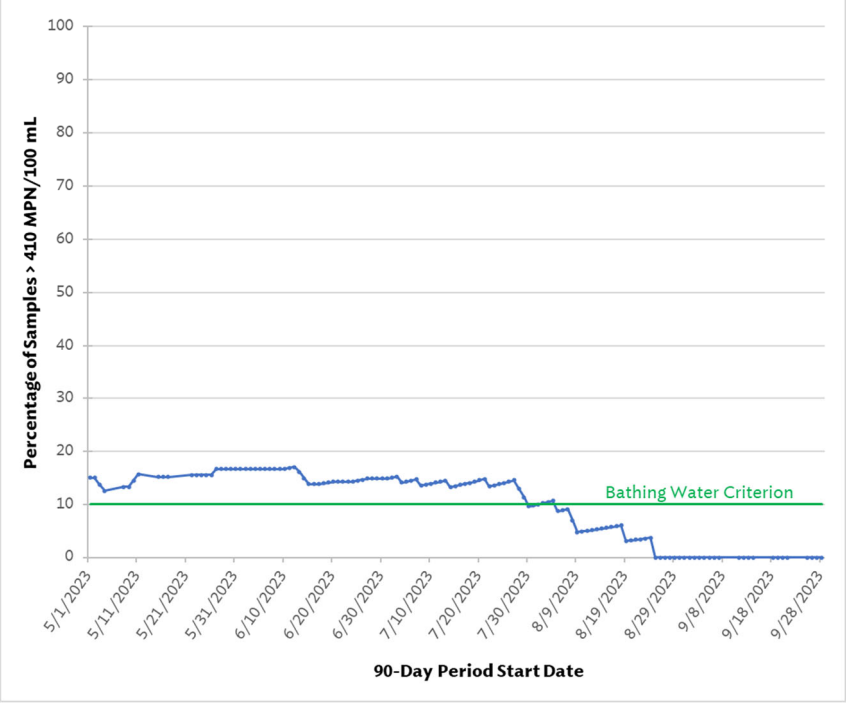

Figure 5. 2023 Euclid Beach - Attainment of Bathing Water STV Criterion

Villa Angela Beach

Water Quality Standards attainment status of Villa Angela Beach for Bathing Water recreational use criteria are shown in Figures 6 and 7. Villa Angela exceeded the geomean criterion for one of the 90-day periods in 2023 and exceeded the STV criterion for 81.1% of the 90-day periods. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 29 of the 132 sampling events, a frequency of 22%. Twenty-three of the 29 exceedances (79.3%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

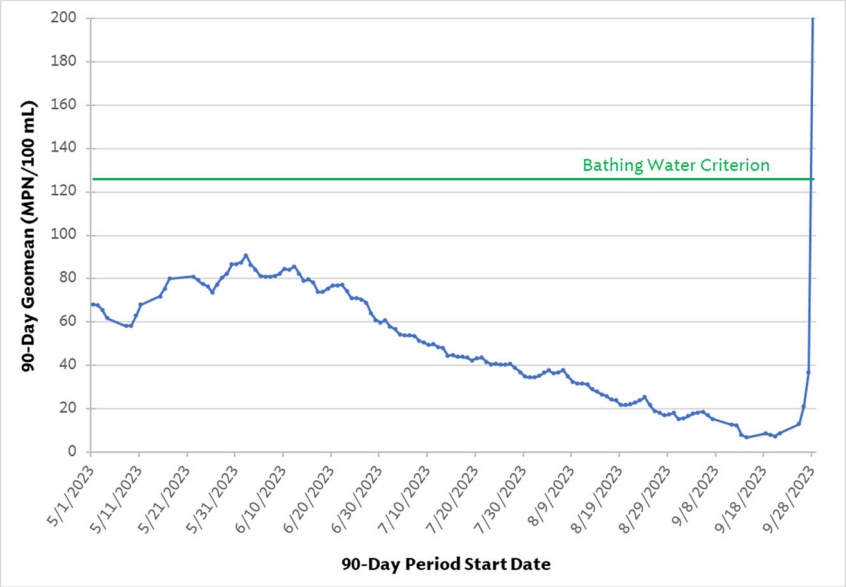

Figure 6. 2023 Villa Angela Beach - Attainment of Bathing Water 90-Day Geomean Criterion

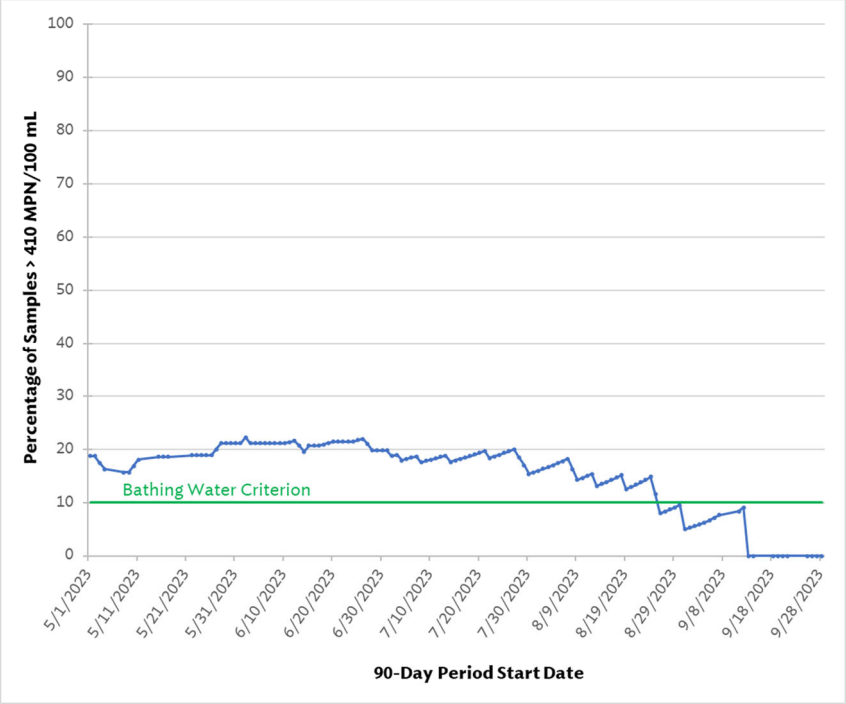

Figure 7. 2023 Villa Angela Beach - Attainment of Bathing Water STV Criterion

Euclid Creek RM 0.55

Euclid Creek was in non-attainment of both Primary Contact recreational criteria in 2023 (Figures 8 and 9). Euclid Creek exceeded both the geomean and STV criterion for 100% of the 90-day periods. As further discussed below, Euclid Creek RM 0.55 has displayed this degree of exceedance for as long as monitoring has been performed by the NEORSD.

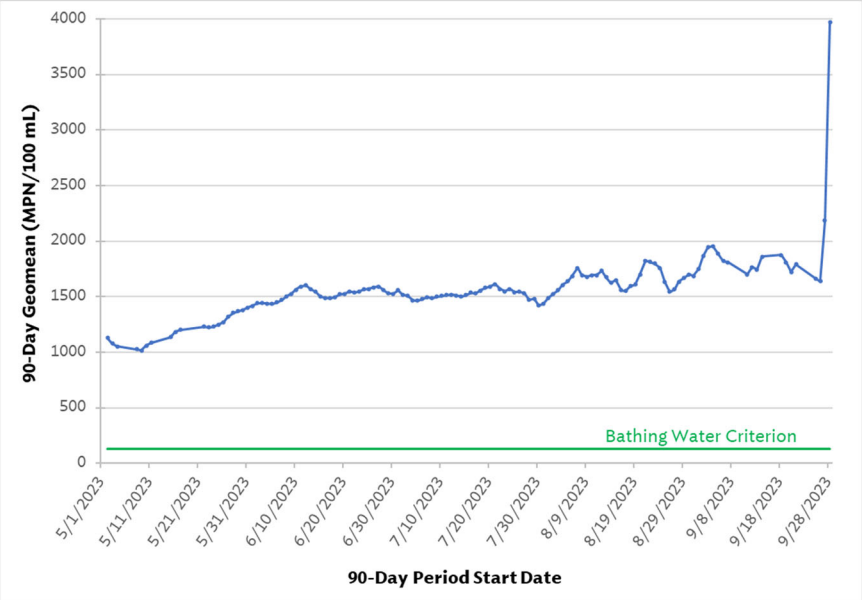

Figure 8. 2023 Euclid Creek RM 0.55 - Attainment of Primary Contact 90-Day Geomean Criterion

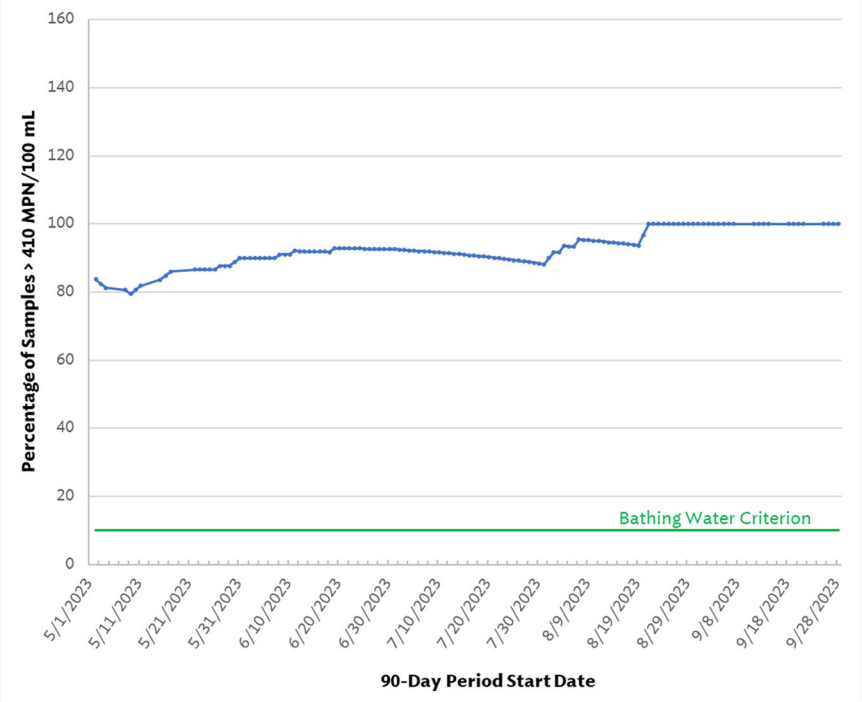

Figure 9. 2023 Euclid Creek RM 0.55 - Attainment of Primary Contact STV Criterion

Comparison with Historical Data, Rainfall, and CSO Occurrence

Tables 2-5 present historical data on the recreational use criteria exceedances for all the sites included in this study. The NEORSD began submitting beach monitoring data to the Ohio EPA Credible Data Program in 2009. Therefore, prior data is not included in this comparison. It should be noted that the recreational use criteria have been modified within the presented timeline. From 2009 to 2014, the applicable Bathing Waters recreational use criteria included an *E. coli* criterion not to exceed a single sample maximum (SSM) of 235 colony counts/100mL in more than ten percent of the samples collected during any 30-day period, and a seasonal geometric mean (SGM) criterion of 126 colony counts/100mL. The current 90-day STV criterion of 410 colony counts/100mL took effect in 2015 (Ohio EPA, 2023b). The data presented below represent exceedances of the criteria that were applicable at the time of sample collection. For comparative purposes only, the SGM *E. coli* density was also calculated from data collected from 2015-2023, even though it does not apply to data collected from these years. Additionally, the Beach Action Value of 235 colony counts/100mL used to post public advisories has remained constant for the entire period of record. The seasonal percent exceedance of the Beach Action Value for each beach site is also presented in the tables below for historical comparison.

The SSM/STV value and geometric mean percentages at all three beaches were found to be lower in 2023 compared to the previous year. Additionally, the beach action percentage was found to be higher at Edgewater Beach while at Euclid and Villa Angela Beaches the percentages were lower than the previous year.

Table 2. Edgewater Beach Historical Recreational Use Criteria Exceedances

Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
2023	20.3	0.0	17.3	43*
2022	26.1	5.2	11.9	34*
2021	3.8	0.0	7.5	33*
2020	0.0	0.0	12.6	30*
2019	3.8	0.0	13.7	52*
2018	91.4	1.6	13.6	35*
2017	0.0	0.0	6.9	30*
2016	0.0	0.0	8.3	35*
2015	34.8	0.0	18.8	77*
Average	***20.0***	***0.8***	***12.3***	***41.0***
2014	93.0	N/A	20.0	60
2013	66.0	N/A	13.9	53
2012	58.6	N/A	11.6	41
2011	92.2	N/A	26.6	98
2010	73.0	N/A	13.3	56
2009	90.6	N/A	28.1	107
Average	***78.9***	***N/A***	***18.9***	***69.2***

The SSM/STV criterion switched from 235 to 410 colony counts/100mL in 2015
Exceedances of historical SGM criterion in **Bold (>126 colony counts per 100mL)**
*SGM does not apply. Calculated for comparative purposes only.

Table 3. Euclid Beach Historical Recreational Use Criteria Exceedances

Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
2023	62.9	0.0	17.4	50*
2022	89.6	7.5	23.9	65*
2021	94.7	9.0	25.6	89*
2020	79.3	3.7	17.1	68*
2019	89.4	15.2	26.5	63*
2018	98.6	2.0	29.8	84*
2017	66.1	1.5	25.4	79*
2016	89.5	0.0	24.8	71*
2015	97.8	33.8	37.7	**136***
Average	***85.3***	***8.1***	***25.4***	***78.3***
2014	98.0	N/A	32.2	126
2013	97.0	N/A	41.1	**144**
2012	99.3	N/A	36.9	118
2011	100	N/A	43.6	**149**
2010	90.0	N/A	36.3	110
2009	100	N/A	36.6	112
Average	***97.4***	***N/A***	***37.8***	***126.5***

The SSM/STV criterion switched from 235 to 410 colony counts/100mL in 2015
Exceedances of historical SGM criterion in **Bold (>126 colony counts per 100mL)**
*SGM does not apply. Calculated for comparative purposes only.

Table 4. Villa Angela Beach Historical Recreational Use Criteria Exceedances

Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
2023	81.1	0.8	21.0	52*
2022	99.3	9.7	26.1	78*
2021	94.0	6.8	30.7	87*
2020	74.8	3.7	20.0	77*
2019	84.1	20.5	28.8	100*
2018	98.6	0.0	30.5	93*
2017	79.2	8.4	29.2	89*
2016	91.7	5.3	33.1	99*
2015	97.8	51.8	46.4	**181***
Average	***88.9***	***11.9***	***29.5***	***95.1***
2014	96.0	N/A	34.4	**147**
2013	91.0	N/A	41.7	**141**
2012	100	N/A	41.5	110
2011	100	N/A	46.0	**174**
2010	100	N/A	34.9	**128**
2009	100	N/A	43.8	**172**
Average	***97.8***	***N/A***	***40.4***	***145.3***

The SSM/STV criterion switched from 235 to 410 colony counts/100mL in 2015
Exceedances of historical SGM criterion in **Bold (>126 colony counts per 100mL)**
*SGM does not apply. Calculated for comparative purposes only.

The geometric mean and SSM/STV value percentages at Euclid Creek RM 0.55 remain unchanged throughout the historical period of record (Table 5).

Table 5. Euclid Creek Historical Recreational Use Criteria Exceedances

Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
2023	100	100	N/A	**1,240***
2022	100	100	N/A	**909***
2021	100	100	N/A	**1,185***
2020	100	100	N/A	**1,168***
2019	98.5	99	N/A	**1,241***
2018	100	100	N/A	**1,006***
2017	100	100	N/A	**1,510***
2016	100	100	N/A	**907***
2015	100	100	N/A	**1,246***
2014	100	N/A	N/A	**1,617**
2013	100	N/A	N/A	**1,092**
2012	100	N/A	N/A	**973**
2011	100	N/A	N/A	**1,351**
2010	100	N/A	N/A	**1,047**
2009	99.3	N/A	N/A	**852**
Average	***99.9***	***99.9***	***N/A***	***1,155***

Exceedances of historical SGM criterion in **Bold (>126 colony counts per 100mL)**
*SGM does not apply. Calculated for comparative purposes only.

The number of exceedances at Edgewater Beach was slightly higher than average likely due to higher-than-average rainfall events on the west side of the NEORSD service area during 2023. Table 6 presents total rainfall in inches during the past twelve years of recreational seasons (May 1st to October 31st) as measured at the Division Avenue (located near Edgewater Beach) and Easterly WWTP rain gauges (located near Euclid and Villa Angela Beaches and Euclid Creek). Total rainfall in 2023 was measured nearly 1.75 inches higher at Division Avenue during the recreational season as compared to 2022, while the rainfall was over a half inch lower at the Easterly WWTP rain gauge.

Across the District Service area there were 24 days where precipitation exceeded 0.5 inches in 24 hours during the recreation season in 2022, and in 2023 there were 19 days where precipitation exceeded 0.5 inches in 24 hours. Although there were overall less high-intensity events in 2023, there was an increase in the number of rainfall events leading to an increase in the total accumulation throughout the year. Table 7 below presents the monthly rainfall accumulation for the past nine years across the entire NEORSD service area using the 30 rain gauges in our precipitation monitoring network. July and August of 2023 were significantly wetter than any of the previous years. During these months there were significant high-intensity events within a short duration that caused CSOs that do not typically activate in a typical storm to be triggered.

Significant wet-weather[1] events and runoff are often associated with elevated microbial densities along Great Lakes Beaches. Point and non-point source contaminants are flushed into surface water from inflow and infiltration in common trench sanitary/storm sewer systems, combined sewer overflows (CSOs), urban stormwater including sediment, nutrients, pet and wildlife waste, sanitary sewer overflows, and illicit cross connections (Chaganti et. al, 2022).

Table 6. Total Rainfall (Inches) from May 1st to October 31st

Year	Division Ave Rain Gage (West Side)	Easterly Rain Gage (East Side)
2023	27.78	24.84
2022	26.01	25.43
2021	24.00	24.60
2020	29.50	26.30
2019	31.80	27.70
2018	27.56	25.32
2017	16.56	20.30
2016	13.87	16.23
2015	23.40	23.41
2014	24.50	25.12
2013	21.35	28.31
2012	26.46	24.80
Average	***24.40***	***24.36***

Table 7. Monthly Rainfall (Inches) Accumulation across the NEORSD Service Area

Year	May	June	July	August	September	October
2023	73.87	114.38	215.98	204.80	23.28	152.31
2022	137.95	77.46	171.28	145.55	140.70	116.65
2021	98.33	102.94	191.61	148.57	79.17	153.53
2020	176.87	80.58	117.62	167.82	168.83	197.69
2019	128.78	245.27	118.01	99.22	60.48	102.59
2018	138.52	103.58	118.79	124.89	134.27	119.96
2017	178.46	120.89	87.75	60.77	30.74	100.93
2016	83.27	43.72	66.93	90.18	125.05	100.28
2015	134.51	227.27	76.17	64.97	110.11	70.51
Average	***127.84***	***124.01***	***129.35***	***122.97***	***96.96***	***123.83***

Contributions of CSO discharges may have influenced criteria exceedances at Edgewater, Euclid, and Villa Angela Beaches in 2023. Figures 10 and 11 show the proximity of nearby CSO outfalls to the three beaches in this study. The number of overflow events and the total volume of discharge from each of the listed CSOs from May 1 to October 31 is presented in Table 8. CSO

[1] Wet-weather sampling events: greater than 0.10 inches of rain but less than 0.25 inches, samples collected that day and the follow day are considered wet-weather samples; greater than 0.25 inches, the samples collected that day and the following two days are considered wet-weather samples.

discharge and capture volumes were provided by the NEORSD Engineering and Construction department and include both modeled and direct flow measurements. The annual CSO Public Notification requirements began in November 2018. Prior to this, the District did not compile daily overflow data from CSO sites that are currently modeled.

Thirty-four overflow events occurred during the 2023 recreational season near Edgewater Beach. Twenty-eight of these events occurred from CSO-002, the Westerly Wastewater Treatment Center Overflow, three from CSO-069, and three from CSO-071. Six additional events potentially occurred at CSO-071 based on District level monitoring equipment within the collection system, but the CSO model did not calculate any overflow volumes for these events. Twenty-eight overflow events occurred in the proximity of Euclid and Villa Angela Beaches in 2023, with eighteen activations occurring at CSO-001, the Easterly Wastewater Treatment Plant Overflow, one event from CSO-206, and three events from each CSO-207, three from CSO-209, and three from CSO-242. There were no dry weather overflows reported at any of the CSO regulators in the vicinity of the three beaches. CSO overflow events, among other contributing factors, most likely influenced the elevated *E. coli* densities observed at these beaches.

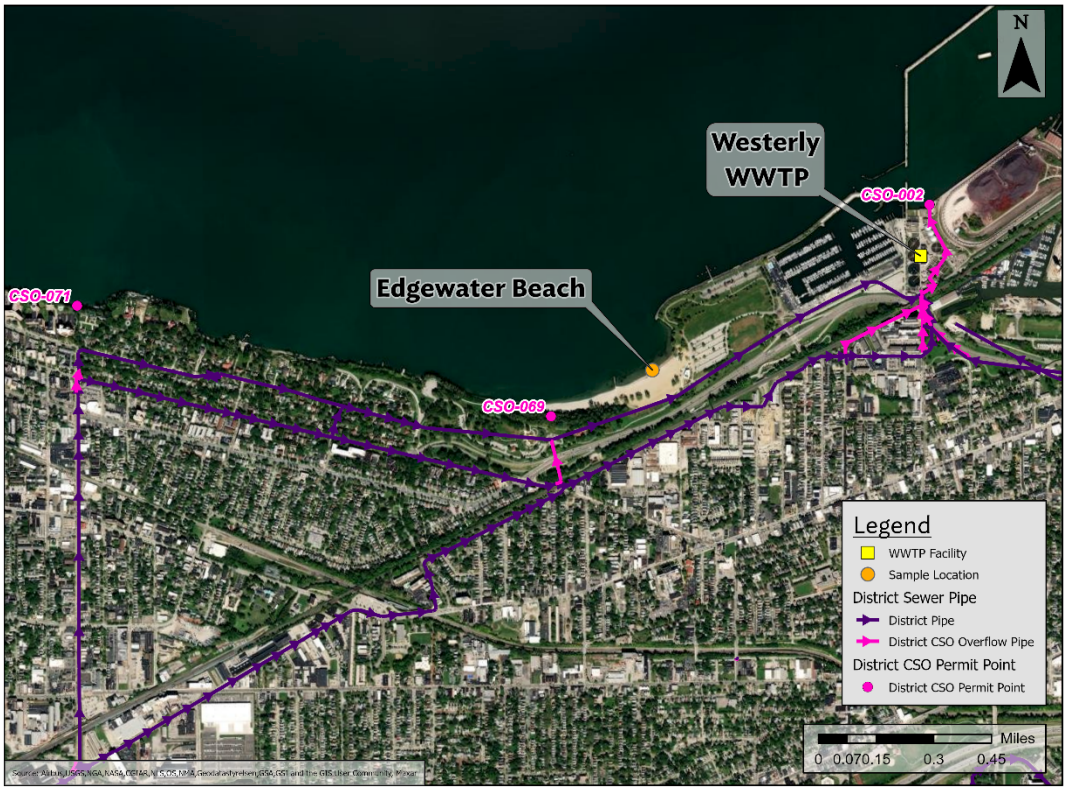

Figure 10. Proximity of CSO Outfalls to Edgewater Beach

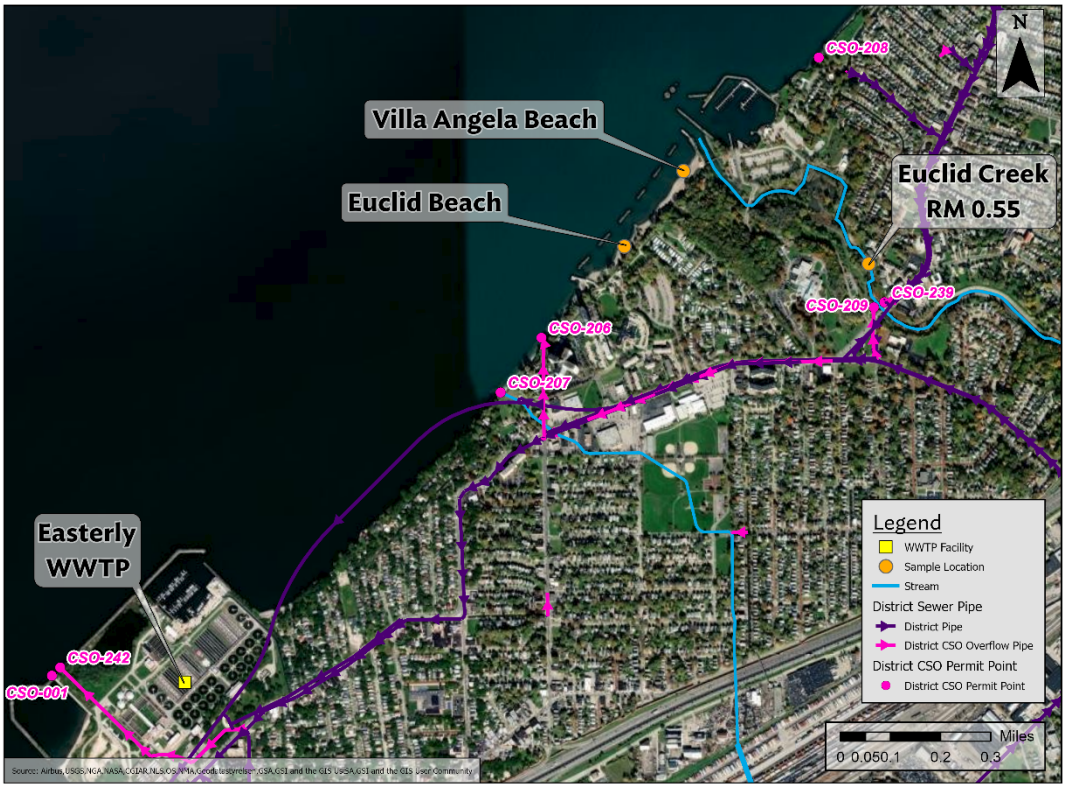

Figure 11. Proximity of CSO Outfalls to Euclid and Villa Angela Beaches

Table 8. CSO Events from May 1 to October 31										
Outfall ID	Nearest Beach	Number of Overflow Events (Total Overflow Volume -Million Gallons)								
		2023	**2022**	**2021**	**2020**	**2019**	**2018**	**2017**	**2016**	**2015**
CSO-002	Edgewater	28 (470.2)	13 (278.3)	16 (250.2)	14 (466.1)	15 (155.8)	19 (277.7)	8 (180.3)	9 (125.3)	16 (235.2)
CSO-069	Edgewater	3 (3.0)	2 (0.1)	1 (0.3)	3 (1.7)	2 (0.2)	2 (0.1)	0 (0.0)	0 (0.0)	3 (6.5)
CSO-071	Edgewater	3 (11.3)	5 (NA)	2 (NA)	3 (NA)	0 (0.0)	3 (NA)	0 (NA)	0 (NA)	5 (NA)
CSO-001	Euclid/Villa Angela	18 (1,222.1)	22 (992.3)	19 (394.3)	21 (637.9)	19 (294.8)	23 (670.5)	17 (614.6)	28 (1,346.7)	31 (2,301.9)
CSO-206	Euclid/Villa Angela	1 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	49 (21.0)	18 (65.3)	22 (37.4)	13 (18.3)	13 (50.7)
CSO-207	Euclid/Villa Angela	3 (0.4)	1 (0.1)	1 (0.1)	0 (0.0)	0 (0.0)	NA	NA	NA	NA
CSO-209	Euclid/Villa Angela	3 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)	29 (31.0)	NA	NA	NA	NA
CSO-239	Euclid/Villa Angela	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	27 (033.5)	31 (18.0)	39 (26.7)	46 (60.0)
CSO-242	Euclid/Villa Angela	3 (8.4)	3 (0.9)	1 (2.5)	3 (1.2)	12 (21.8)	6 (10.5)	5 (4.5)	7 (9.0)	17 (20.7)

Rainfall and its associated stormwater runoff have been associated with the transport of many pollutants into surface water. Rainfall is generally accepted as one of the most important factors associated with an increased level of *E. coli* in waterways (U.S. EPA, 2010). Increased rainfall causes elevated loadings of *E. coli* from the catchment surface and sewer infrastructure leading to higher densities of bacteria in recreational waters, increasing the risk of human exposure (Ackerman and Weisberg, 2003). The discharge from Euclid Creek has been found to impact nearby recreational swimming areas at Euclid and Villa Angela Beaches, resulting in exceedances of recreational water quality criteria during periods of rainfall and elevated stream flow. Figure 12 below shows the relationship between rainfall across the Euclid Creek drainage basin and the *E. coli* densities recorded at RM 0.55 during the 2023 sampling season.

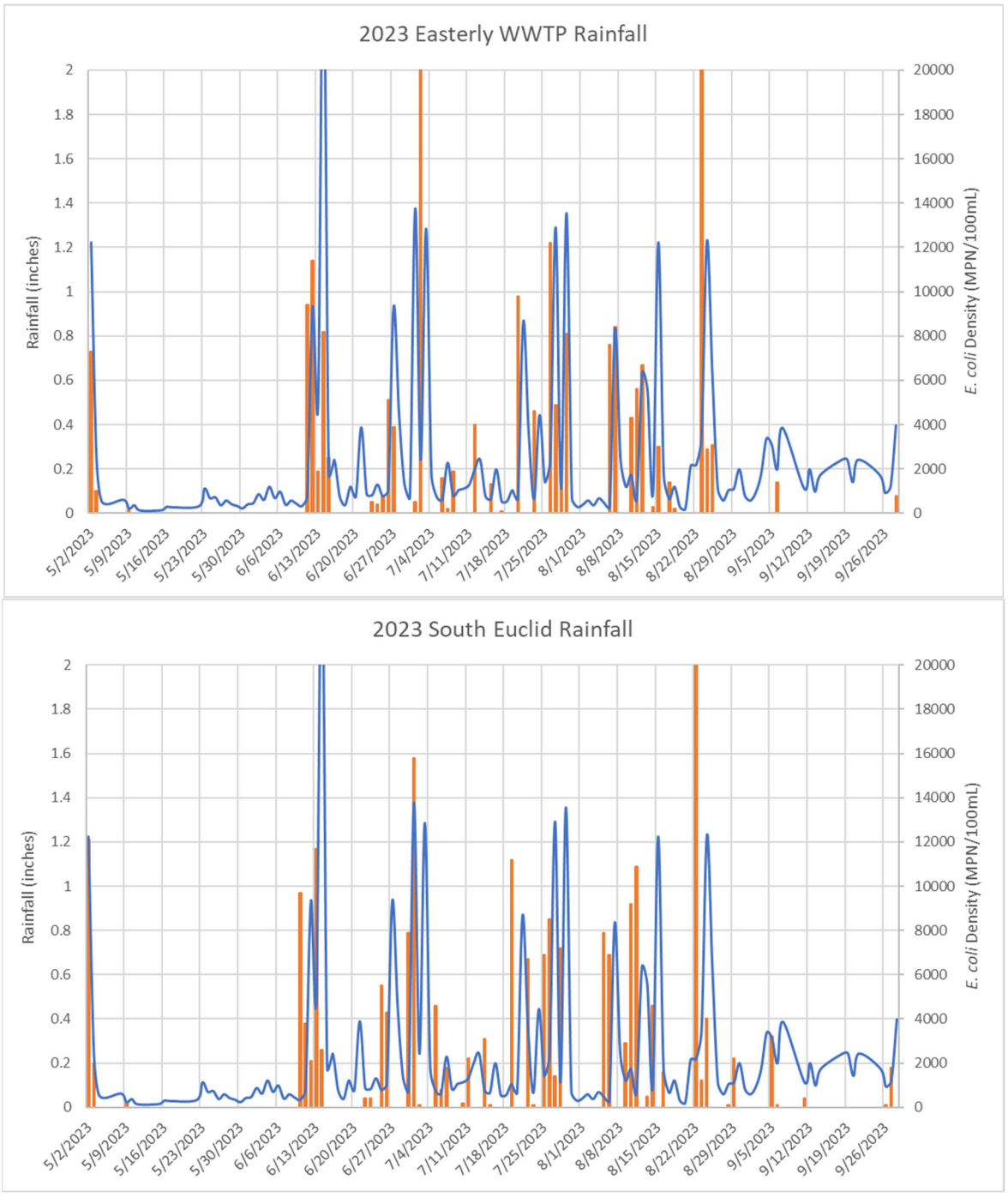

Figure 12. Comparison of Euclid Creek *E. coli* Densities from 2023 with Rainfall Data from Easterly Wastewater Treatment Plant (top) and the South Euclid precipitation gauge (bottom). Precipitation gauges are owned and maintained by NEORSD.

Euclid Creek was in 100% exceedance of the recreational water quality criteria for 14 of the past 15 years. A one-way ANOVA was conducted to compare the annual differences of *E. coli* densities at Euclid Creek. The analysis determined there was not a significant difference in annual *E. coli* densities from 2013 through 2023 ($F(10, 1420) = 0.993$, $p = 0.447$). *E. coli* densities did not vary significantly in 2023 from previous years, even with the Euclid Creek Storage Tunnel coming on-line in 2021 (Figure 13). The Euclid Creek Storage Tunnel (ECT), a CSO storage tunnel designed to capture CSO discharges, was brought partially online in July 2018, and has been fully operational since the 2021 recreational season. As a result of this, the ECT captured 816.3 million gallons of mixed sewage and stormwater between May 1 and October 31 from 2020-2023.

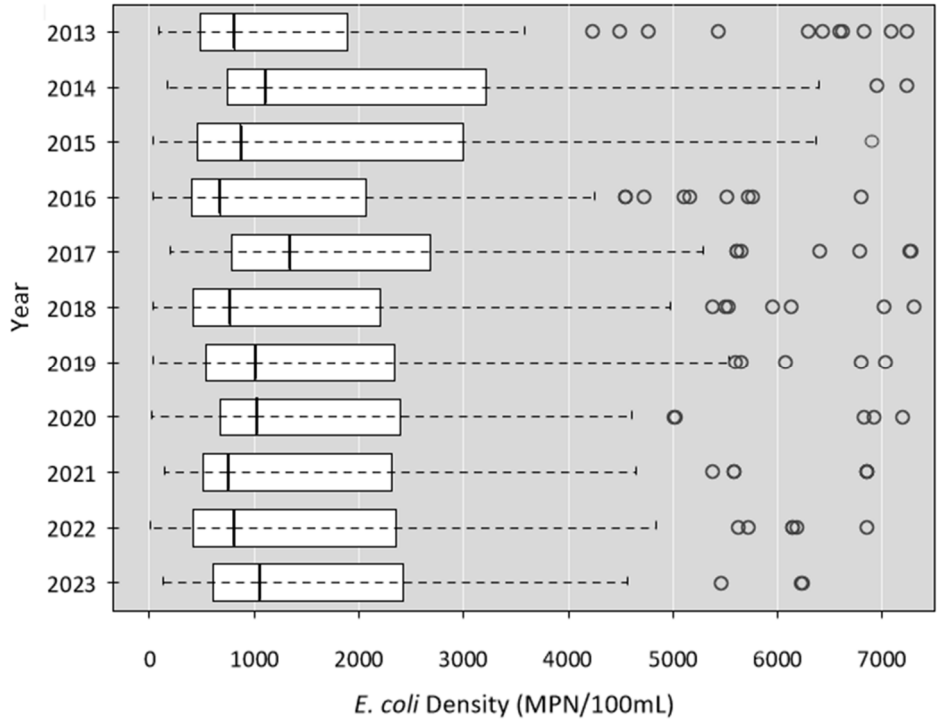

Figure 13. Comparison of Euclid Creek *E. coli* Densities from 2013-2023

Findings from the NEORSD and USGS nearshore water current and bacteriological transport studies (USGS, 2013 and 2022), and the *Euclid Creek Bacteriological Study 2019-2021* (NEORSD, 2022) have demonstrated that the discharge of Euclid Creek flows towards Euclid and Villa Angela Beaches and therefore directly impacting the beach water quality. The elevated *E. coli* densities present within Euclid Creek are most likely due to a combination of sanitary sewage contamination from illicit discharges and infiltration from common trench sewers (Zgnilec, 2016), as well as CSOs from points outside of the NEORSD service area and contamination from fecal matter from companion animals or wildlife from the surrounding urban community.

The lack of water quality improvements at Euclid Creek is associated with *E. coli* being introduced upstream of CSO-239 and the NEORSD service area. Between 2019 and 2021, Field Biologist Eric Soehnlen conducted a study to evaluate the presence of *E. coli* in Euclid Creek. Samples were collected at several locations downstream and upstream of CSO-239 during wet- and dry-weather events. Results from the study showed that there was not a significant difference in *E. coli* densities downstream or upstream of CSO-239; elevated *E. coli* densities were ubiquitous throughout the watershed, likely due to aging common trench collection systems through local municipalities.

While capture of CSO discharges is a necessary step in the improvement in water quality in the region, the amount of upstream contamination in Euclid Creek remains the major hurdle for meeting the recreational criteria. Until these issues are addressed, the positive impact from the ECT may remain masked by upstream sources.

E. coli densities, an indicator of pathogens for the protection of human health, do not remain static in the environment. Densities fluctuate throughout the day at a given sample site. Beach monitoring samples from Euclid Creek are generally collected in the early morning whereas water quality monitoring during NEORSD's biological studies occurs later in the day. Figure 14 below illustrates *E. coli* data from 2013, 2014, and 2023 comparing beach sampling taken in the early morning to water quality samples taken later for select days where concurrent sampling was conducted. The afternoon water chemistry samples were generally lower than the morning samples.

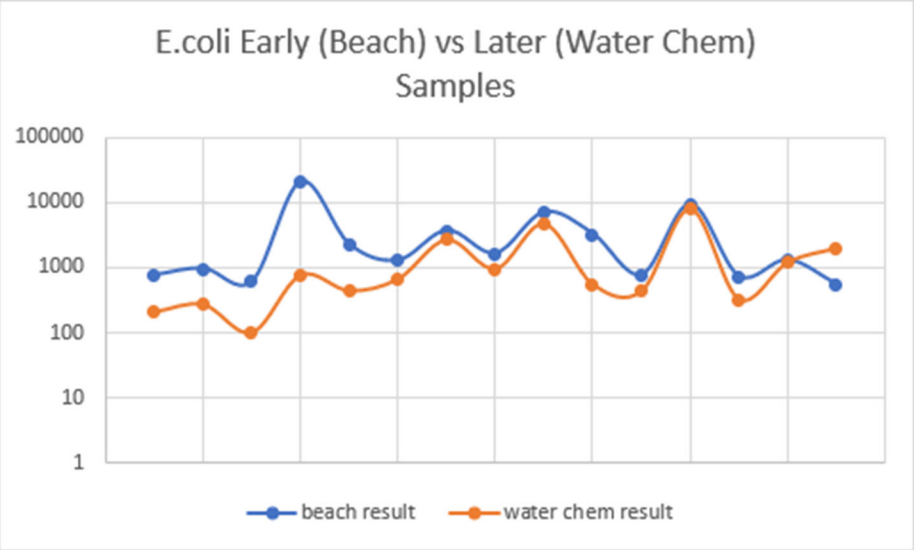

Figure 12. Comparison of Historical Early and Late Morning *E. coli* Sampling

Diurnal variations, partially resulting from environmental effects, may decrease the density of *E. coli*, resulting in lower densities in the afternoon. Exposure to solar UV radiation is a primary mechanism for *E. coli* decay and the time in which sampling is conducted can have a significant impact on *E. coli* counts (Whitman et al. 2004). Whitman et al. found that samples taken at 07:00

in the morning can be up to 70% higher than samples taken later in the day, due to the effects of solar radiation. Morning sampling yields more conservative results when *E. coli* is used as an indicator for relating water quality to human health (U.S. EPA, 2010). Therefore, NEORSD's standard practice of early morning sampling provides the most conservative estimates of *E. coli* for the protection of human health in recreational waters.

Harmful Algal Bloom Monitoring

The YSI EXO2 sonde deployed at Edgewater Beach detected no potential warning indicators of a HAB during the recreation season. No HABs were visually detected by or reported to WQIS personnel during the 2023 recreational season.

The National Oceanic and Atmospheric Administration (NOAA) conducted a bloom analysis and determined that the cyanobacteria bloom in the western basin of Lake Erie was considered moderately severe (Figure 15). The 2023 bloom in the western basin was less extensive and bloom concentrations were lower than in previous years. The 2023 bloom did start earlier than in 2022 and persisted late into the season through mid-September (NOAA, 2023). However, the 2023 bloom did not spread east into the central basin, so the beaches monitored during this study were not impacted.

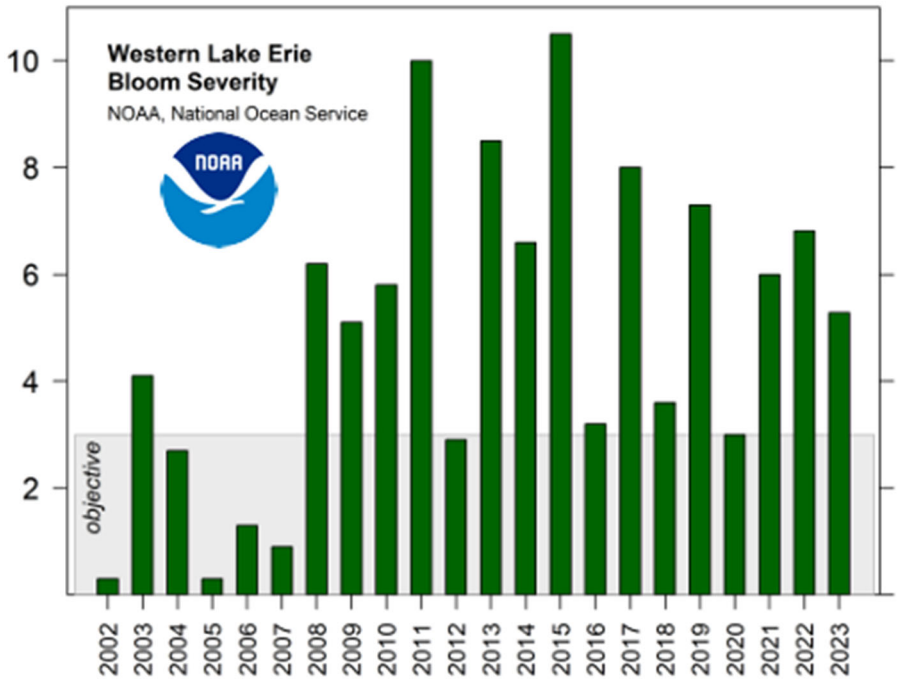

Figure 13. NOAA Forecasted Bloom Severity Index for 2023.

Conclusions

In 2023, Edgewater Beach was found to be in attainment of the bathing water recreational criteria for a majority of the season, attaining the geometric mean criterion for 100% of the sampling record and the STV criterion 80% of the time. Euclid and Villa Angela Beaches were in attainment of the geometric mean criterion for 100% and 99% of the season, respectively. However, Euclid and Villa Angela Beaches were in non-attainment of the STV criterion for 63% and 81% of the season, respectively.

Exceedances of the water quality criteria were often related to the occurrence of wet-weather events. Potential point and non-point sources of contamination from CSOs, urban stormwater including sediment, nutrients, pet and wildlife waste, sanitary sewer overflows, common trench sewer inflow and infiltration, and illicit connections can lead to elevated *E. coli* densities during wet weather. A decrease in the exceedance frequency of the STV criterion was observed at Euclid and Villa Angela Beaches in 2023 compared to previous years. It is unclear what caused the decrease *in E. coli* densities, though it is possible that this is related to lower intensity wet-weather events during the field season causing a decrease in runoff and CSO discharge into Lake Erie and Euclid Creek.

The Euclid Creek Tunnel system continued to capture CSO overflows in the vicinity of Villa Angela and Euclid Beaches during the recreation season and eliminated 254.43 million gallons of sewage and stormwater from being discharged between May 1 and October 31, 2023. Water quality may continue to improve at Euclid Creek and Euclid and Villa Angela Beaches because of infrastructure investment and upgrades but will likely continue to be limited by widespread bacteriological contamination in the Euclid Creek watershed upstream of the NEORSD service area. During the 2023 recreational season, no HABs at any of the beaches were observed.

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