Northeast Ohio Regional Sewer District

2024 Lake Erie Beach Monitoring




Water Quality and Industrial Surveillance

Environmental Assessment Group

May 2025

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May 1, 2025

Introduction

Since 1992, the Northeast Ohio Regional Sewer District (NEORSD) has conducted 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 2024, 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 *2024 Lake Erie Beach Monitoring*, which was approved by Ohio EPA on April 24, 2024. 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 beach, in line with the brick stack on the South side of the highway	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	

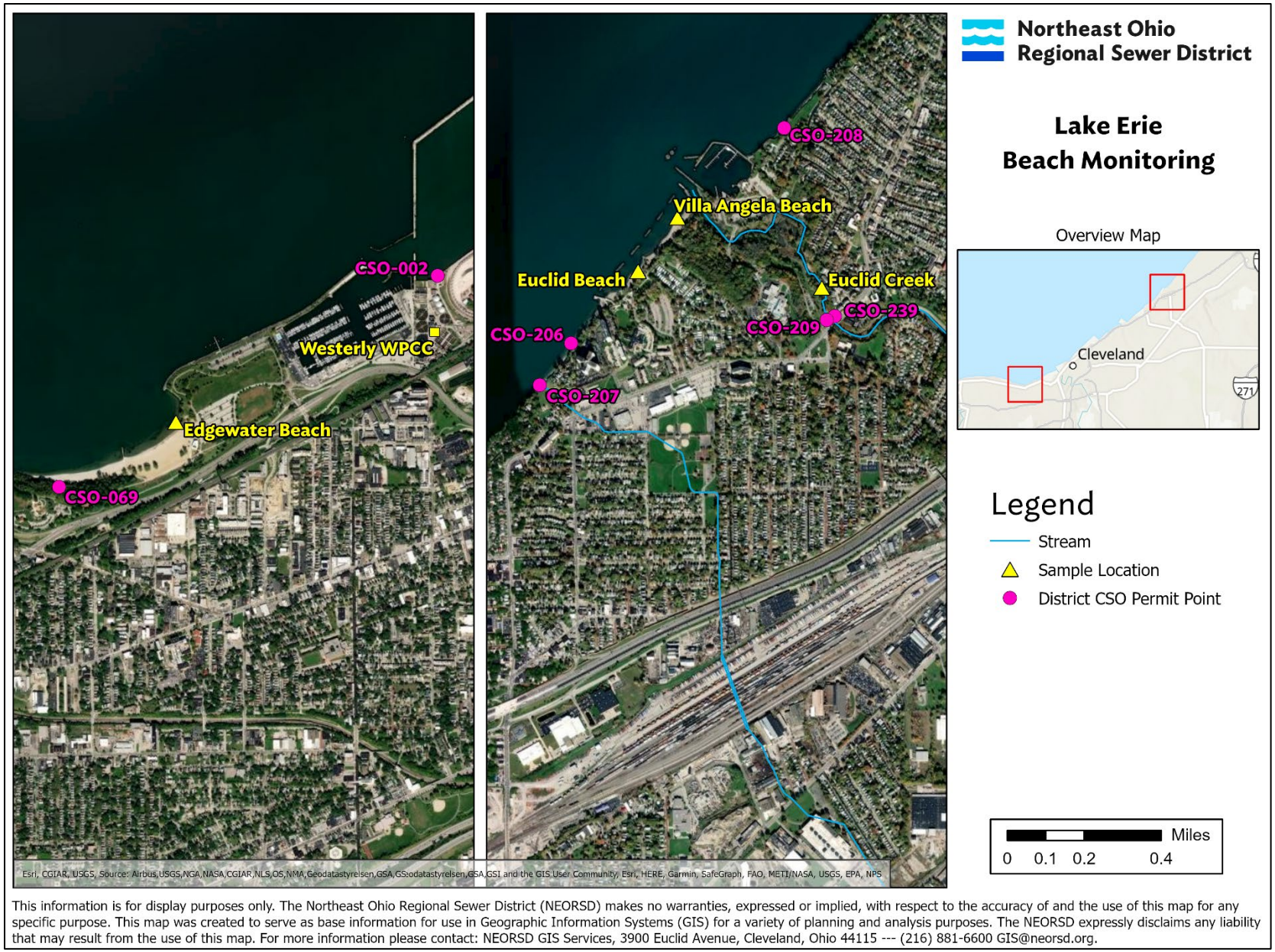

Figure 1. Map of Sampling Sites

Methods

Bacteriological sampling was conducted from May 6, 2024, to September 26, 2024. From May 6 through May 16, 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 20, and lasting through September 1, samples were collected at each beach and Euclid Creek seven days a week. From September 2 through September 26, sampling at all sites returned to four days a week (Monday through Thursday). One hundred twenty-nine samples were collected at each site. Overall, a total of 546 samples including 30 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, dissolved oxygen, temperature, and turbidity. The data sonde was primarily used as a real-time predictive tool for harmful algal bloom (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: $$\text{RPD} = \left| \frac{x-y}{\left[\frac{(x-y)}{2}\right]} \right| \times 100$$

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 2013-2024 was obtained from the United States Geological Survey (USGS) gauge station on Euclid Creek located at Lakeshore Boulevard, Cleveland (gauge 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 2013-2024 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, 2024). 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 30 replicate samples were collected for a final replicate frequency of 5.5%. No replicate samples collected at any of the four sites were outside of the acceptable RPD during the 2024 season.

Recreational Use Attainment Status

Edgewater Beach

Edgewater Beach was in attainment of the recreational use criteria for all of 2024. Water Quality Standards attainment status of Edgewater Beach for Bathing Water recreational use criteria is shown in Figures 2 and 3. There were no exceedances of either the geomean criterion or the STV criterion for any of the 90-day periods. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 10 of the 129 sampling events, a frequency of 7.8%. Eight of the 10 exceedances of the Beach Action Value (80%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

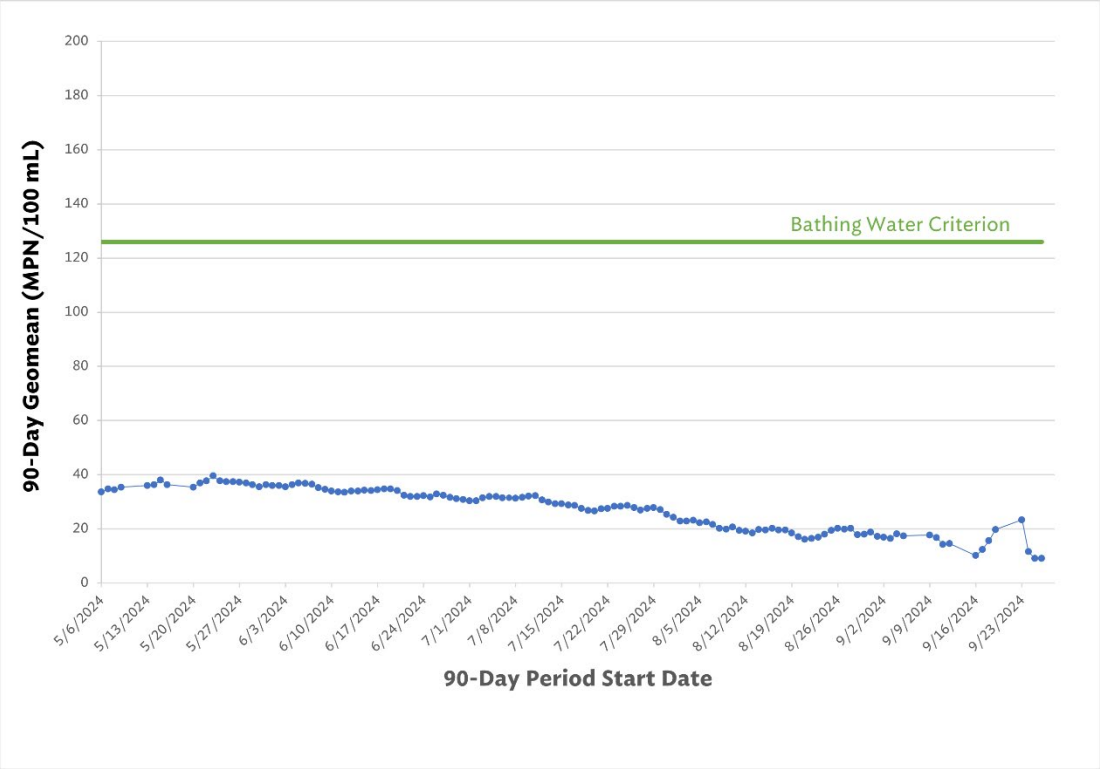

Figure 2. 2024 Edgewater Beach - Attainment of Bathing Water 90-Day Geomean Criterion

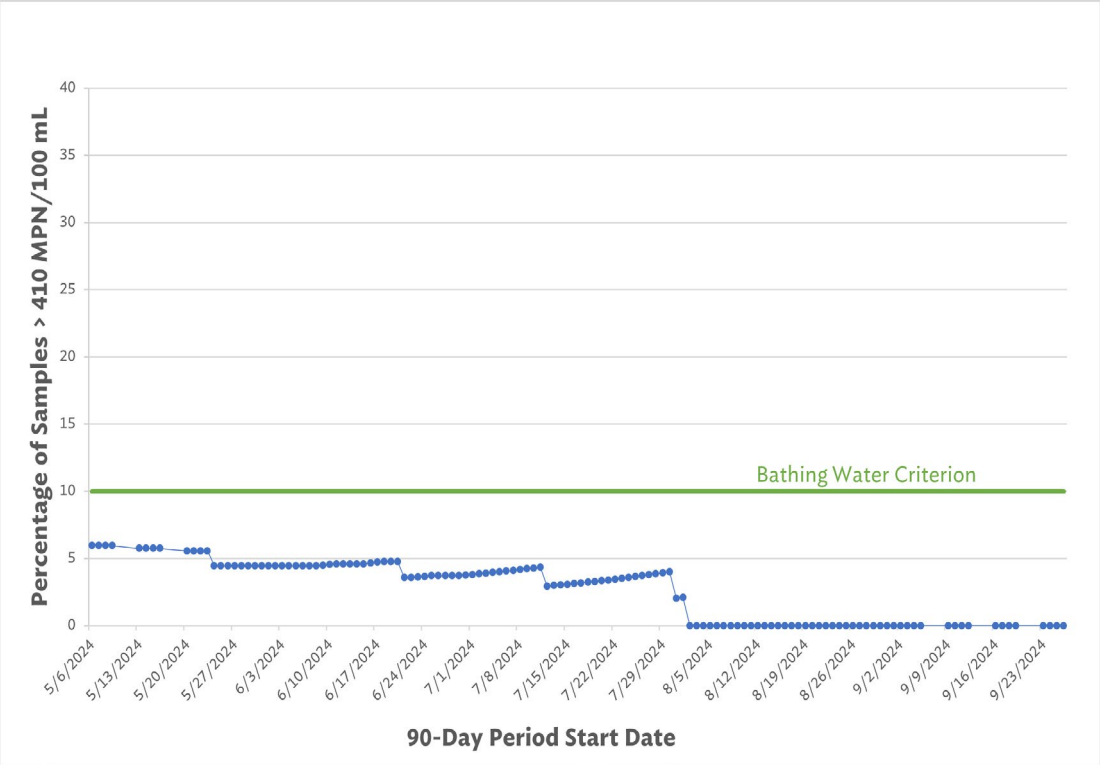

Figure 3. 2024 Edgewater Beach - Attainment of Bathing Water STV Criterion

Euclid Beach

Water Quality Standards attainment status of Euclid Beach for Bathing Water recreational use criteria is 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 90.7% of the 90-day periods. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 32 of the 129 sampling events, a frequency of 24.8%. Twenty-three of these 32 exceedances (71.9%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

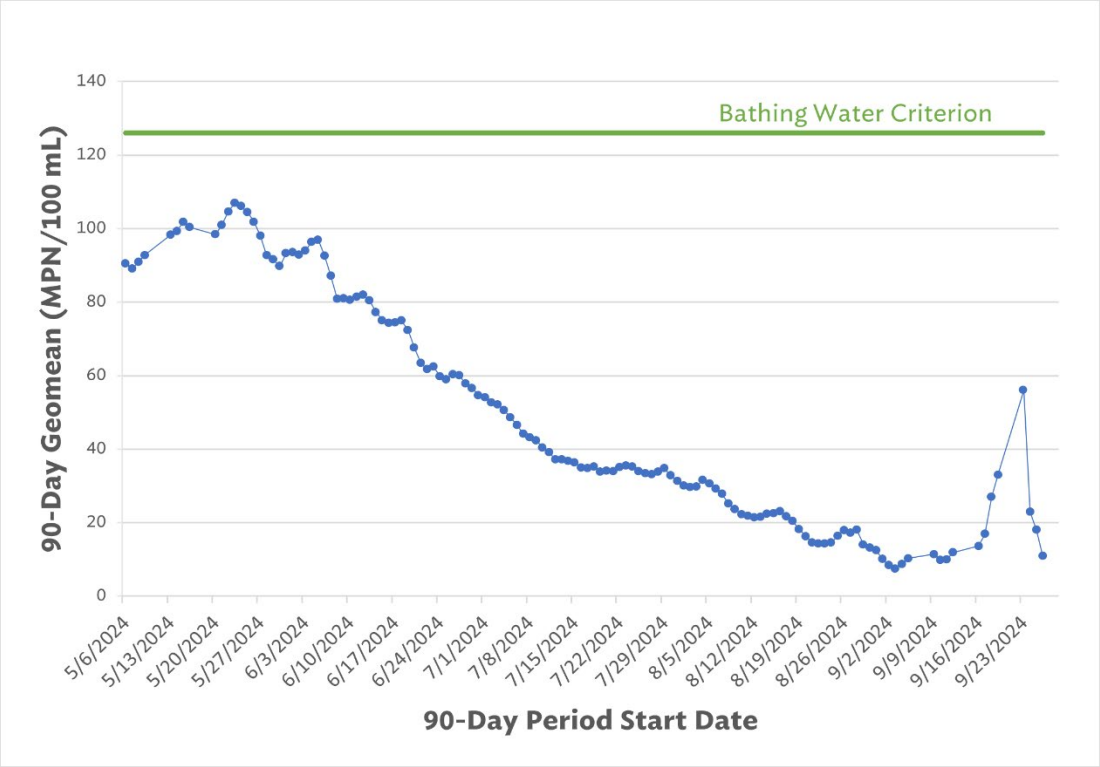

Figure 4. 2024 Euclid Beach - Attainment of Bathing Water 90-Day Geomean Criterion

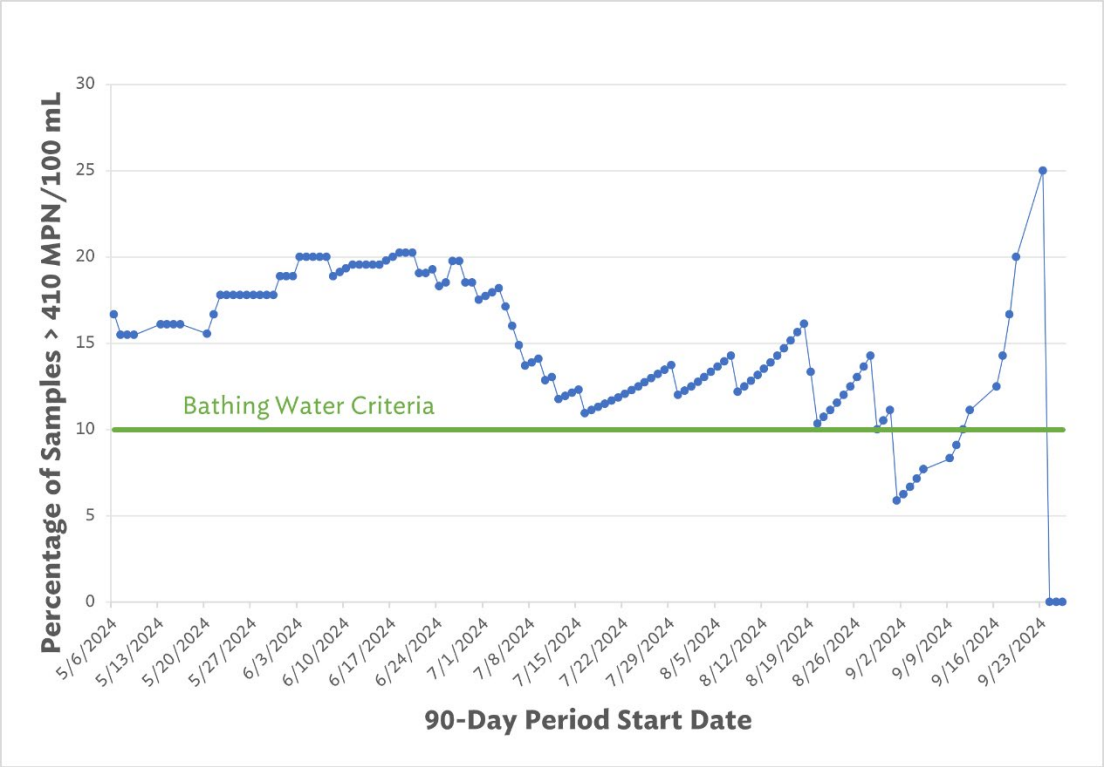

Figure 5. 2024 Euclid Beach - Attainment of Bathing Water STV Criterion

Villa Angela Beach

Water Quality Standards attainment status of Villa Angela Beach for Bathing Water recreational use criteria is shown in Figures 6 and 7. Villa Angela Beach exceeded the geomean criterion for 20 of the 90-day periods in 2024 and exceeded the STV criterion for 81.4% of the 90-day periods. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 37 of the 129 sampling events, a frequency of 28.7%. Sixteen of the 37 exceedances (43.2%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

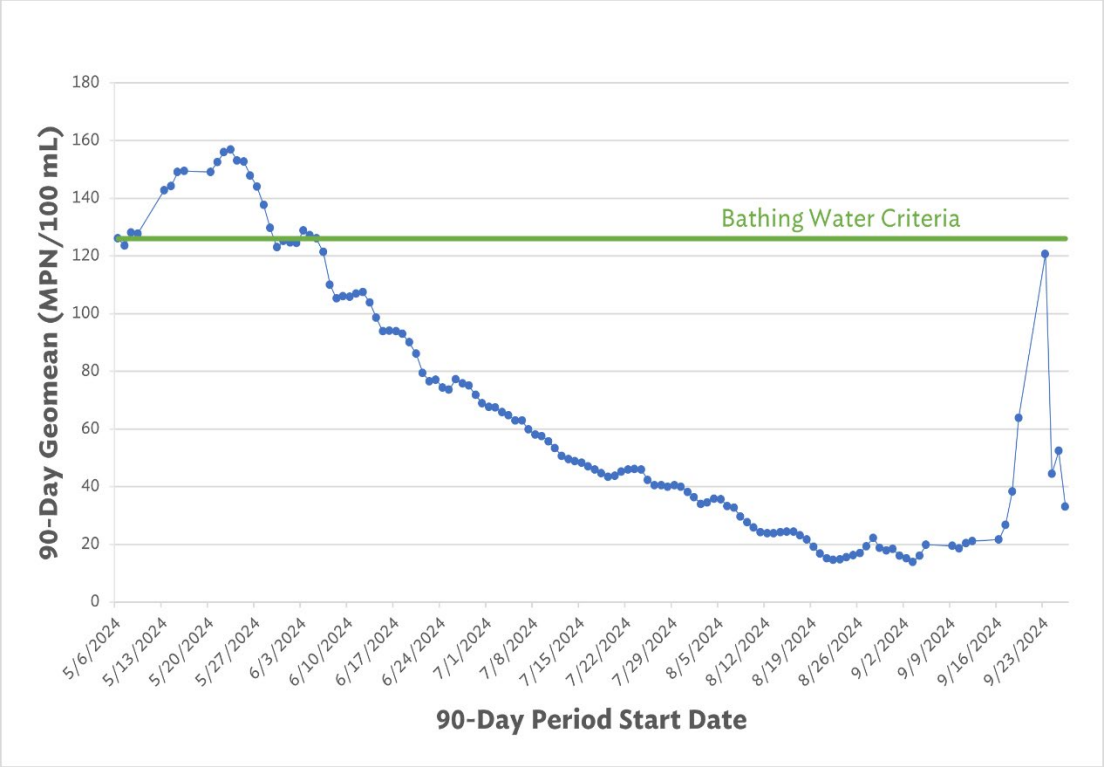

Figure 6. 2024 Villa Angela Beach - Attainment of Bathing Water 90-Day Geomean Criterion

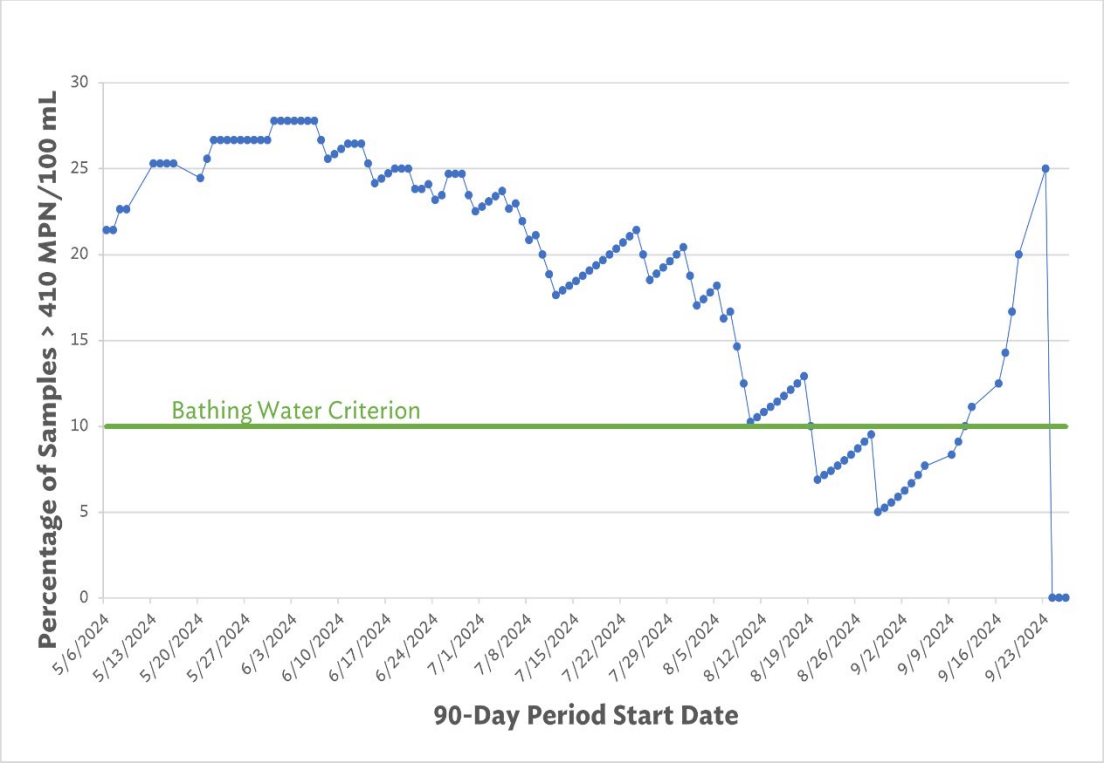

Figure 7. 2024 Villa Angela Beach - Attainment of Bathing Water STV Criterion

Euclid Creek RM 0.55

Euclid Creek was in non-attainment of both Primary Contact recreational criteria in 2024 (Figures 8 and 9). Euclid Creek exceeded both the geomean and STV criteria 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 NEORSD.

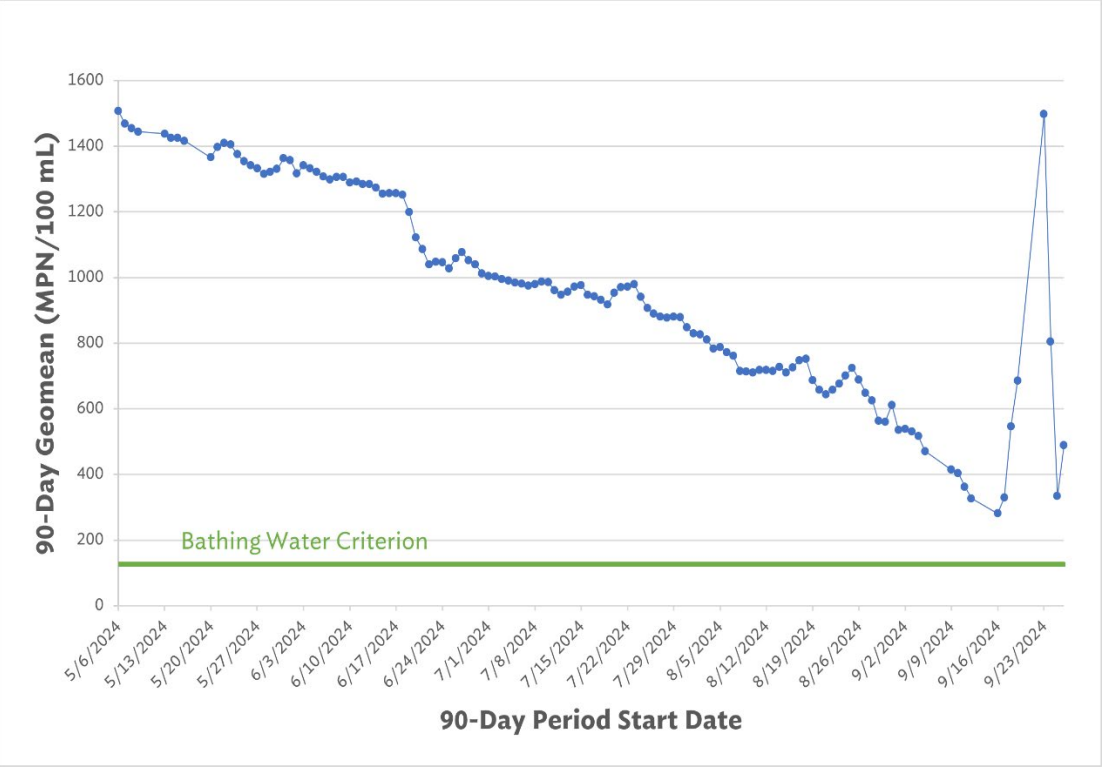

Figure 8. 2024 Euclid Creek RM 0.55 - Attainment of Primary Contact 90-Day Geomean Criterion

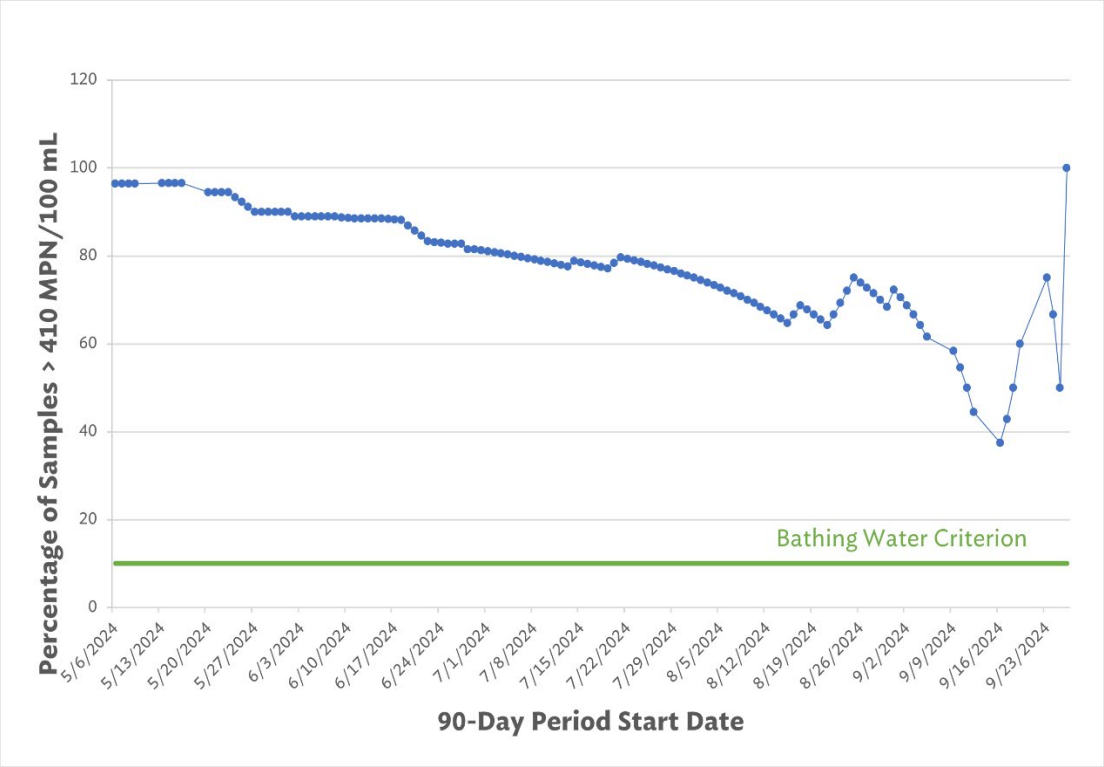

Figure 9. 2024 Euclid Creek RM 0.55 - Attainment of Primary Contact STV Criterion

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, 2024). 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 2015-2024, 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.

Edgewater Beach had zero exceedances of both the SSM/STV and geometric mean in 2024 (Table 2). This was the first year with zero exceedances of both criteria since 2020. At Euclid Beach, the SSM/STV value increased from 2023, but the geometric mean percent exceedance remained at zero from 2023 to 2024 (Table 3). At Villa Angela Beach, there was only

a very slight increase in the SSM/STV percent exceedance from 81.1 in 2023 to 81.4 in 2024. The geometric mean value at Villa Angela Beach was found to be higher in 2024 compared to 2023 (Table 4). Additionally, the beach action value percent exceedance was found to be lower at Edgewater Beach but higher at Villa Angela and Euclid beaches in 2024 compared to 2023.

Table 2. Edgewater Beach Historical Recreational Use Criteria Exceedances

Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
2024	0.0	0.0	7.8	29.5*
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	18.0	*0.7*	11.8	*39.9*
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
2024	90.7	0.0	24.8	62.7*
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	*85.9*	*7.3*	*25.3*	*76.8*
2014	98.0	N/A	32.2	126
2013	97.0	N/A	41.1	**144**
2012	99.3	N/A	36.9	118

Table 3. Euclid Beach Historical Recreational Use Criteria Exceedances				
Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
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
2024	81.4	15.5	28.7	81.2*
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	*88.2*	*12.3*	*29.5*	*93.7*
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
2024	100	100	N/A	**1,199***
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***

Table 5. Euclid Creek Historical Recreational Use Criteria Exceedances				
Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
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***
Average	99.9	99.9	N/A	**1,161**
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*	*N/A*	*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.

Table 6 presents total rainfall in inches during the past thirteen 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 2024 was measured approximately 11 inches lower at the Division Avenue rain gauge and approximately 7.6 inches lower at the Easterly WWTP rain gauge compared to 2023. Total rainfall in 2024 was the lowest it has been at both rain gauges since 2017.

As measured by the Division Avenue rain gauge, there were 11 days where the precipitation was equal to or exceeded 0.5 inches in 24 hours during the recreation season in 2024. As measured by the Easterly WWTP rain gauge, there were 12 days where the precipitation was equal to or exceeded 0.5 inches in 24 hours during the recreation season in 2024. This was less than in 2023, with 21 days at the Division Avenue gauge and 18 days at the Easterly WWTP gauge. Overall in 2024, there was less total precipitation accumulation as well as less high-intensity rain events compared to the last several years.

Table 7 below presents the monthly rainfall accumulation for the past ten years across the entire NEORSD service area using the 30 rain gauges in our precipitation monitoring network. Total rainfall for the entire recreation season in 2024 was the lowest it has been since 2016. June, July, August, and October were significantly dryer than the previous several years. Even though rainfall during the 2024 recreation season was lower than recent years, several high-intensity events still occurred during this time triggering combined sewer overflow (CSO) discharges. 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, CSOs, urban stormwater

[1] Wet-weather sampling events: greater than 0.10 inches of rain but less than 0.25 inches, samples collected that day and the following 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.

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 Gauge (West Side)	Easterly Rain Gauge (East Side)
2024	16.74	17.27
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	***23.81***	***23.82***

Table 7. Monthly Rainfall (Inches) Accumulation across the NEORSD Service Area						
Year	May	June	July	August	September	October
2024	77.31	71.32	78.18	110.62	93.32	80.63
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	***122.79***	***118.74***	***124.23***	***121.74***	***96.60***	***119.51***

Contributions of CSO discharges may have influenced criteria exceedances at Edgewater, Euclid, and Villa Angela Beaches in 2024. 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 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-three overflow events occurred during the 2024 recreational season near Edgewater Beach. Thirty-two of these events occurred from CSO-002, the Westerly Wastewater Treatment Center Overflow, and one from CSO-069. Fourteen overflow events occurred in the proximity of Euclid and Villa Angela Beaches in 2024. This included ten activations occurring at CSO-001, the Easterly Wastewater Treatment Plant Overflow, one event from CSO-207, one event from CSO-209, and two events 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)									
		2024	2023	2022	2021	2020	2019	2018	2017	2016	2015
CSO-002	Edgewater	32 (226.2)	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	1 (0.9)	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	0 (0.0)	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	10 (319.5)	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	0 (0.0)	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	1 (0.1)	3 (0.4)	1 (0.1)	1 (0.1)	0 (0.0)	0 (0.0)	NA	NA	NA	NA
CSO-209	Euclid/Villa Angela	1 (0.1)	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)	0 (0.0)	27 (033.5)	31 (18.0)	39 (26.7)	46 (60.0)
CSO-242	Euclid/Villa Angela	2 (2.0)	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 2024 sampling season.

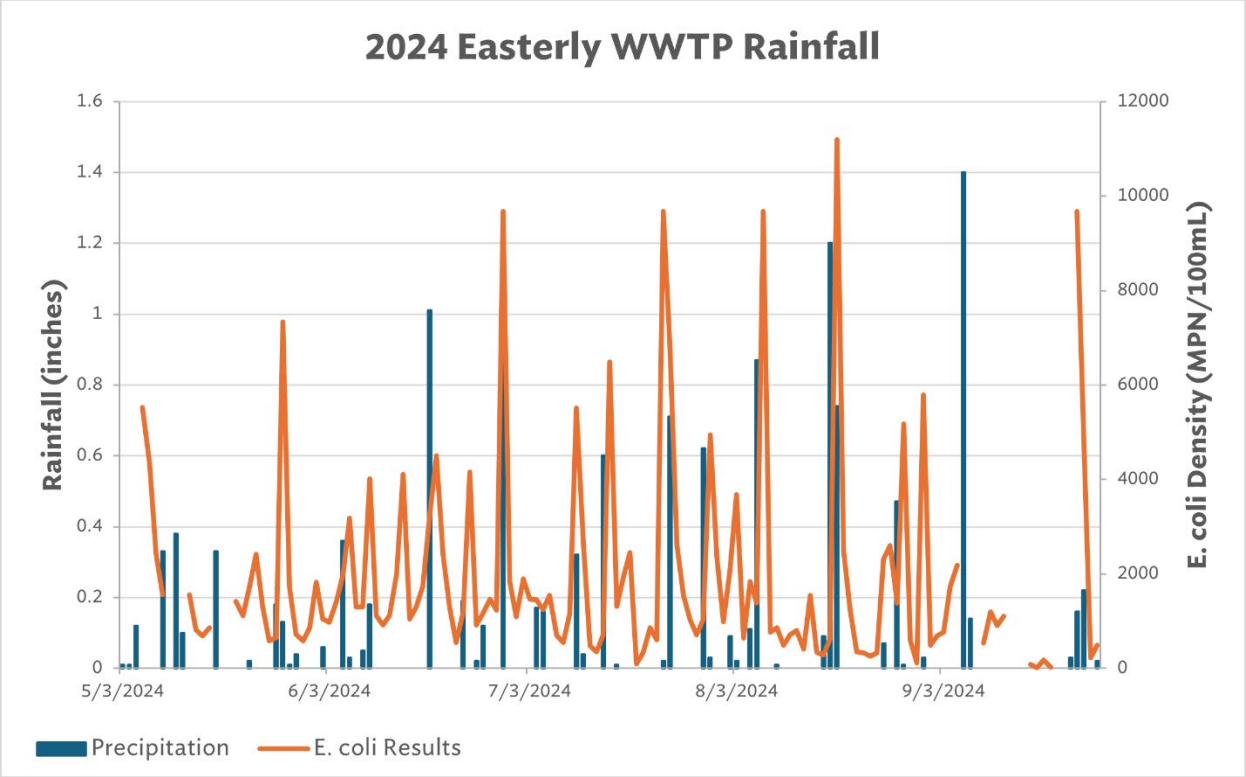

Figure 12. Comparison of Euclid Creek *E. coli* Densities from 2024 with Rainfall Data from Easterly Wastewater Treatment Plant. Precipitation gauge is owned and maintained by NEORSD.

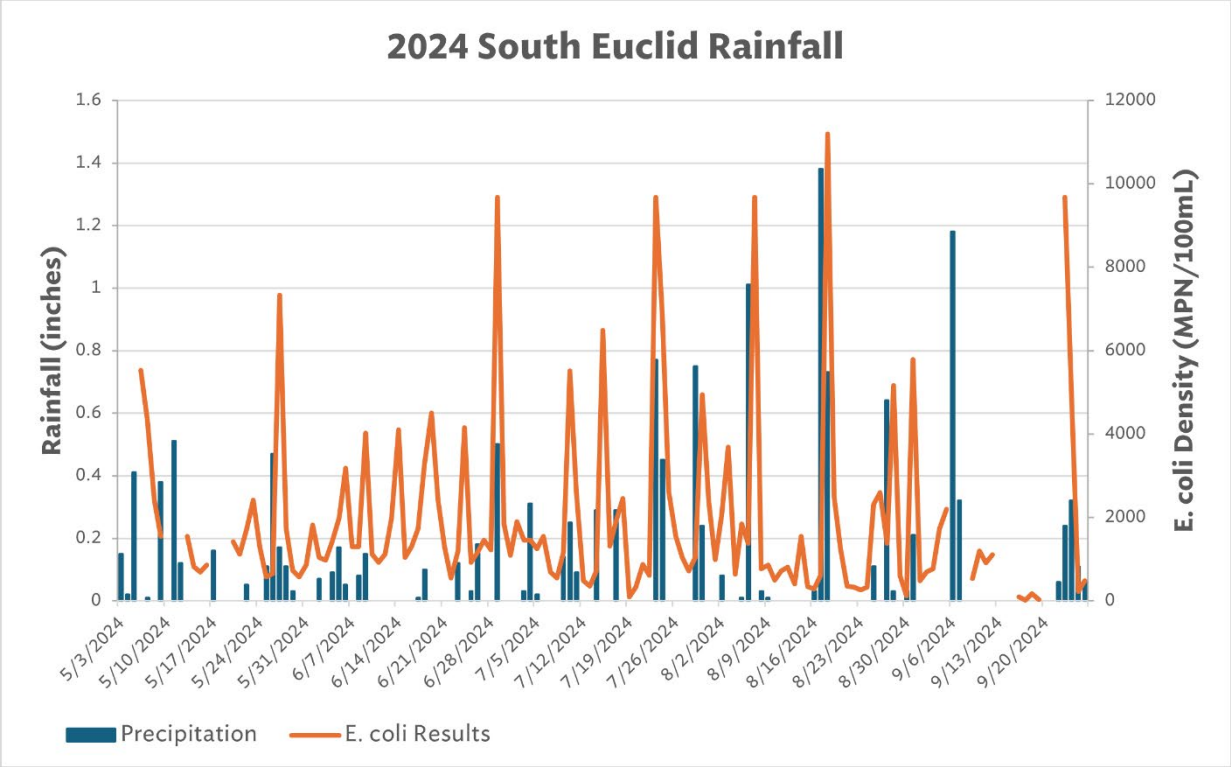

Figure 13. Comparison of Euclid Creek *E. coli* densities from 2024 with rainfall data from the South Euclid precipitation gauge. Precipitation gauge is owned and maintained by NEORSD.

Euclid Creek was in 100% exceedance of the recreational water quality criteria for 14 of the past 16 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 2024 ($F(11, 1548) = 1.195$, $p = 0.285$). *E. coli* densities did not vary significantly in 2024 from previous years, even with the Euclid Creek Storage Tunnel coming on-line in 2021 (Figure 14). 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 has captured approximately 956.3 million gallons of mixed sewage and stormwater between May 1 and October 31 from 2020-2024. While CSO control may have had some minor impact on *E. coli* densities during wet-weather conditions and high stream flow, the major causes of recreational use criteria impairment to Euclid Creek remain unaddressed.

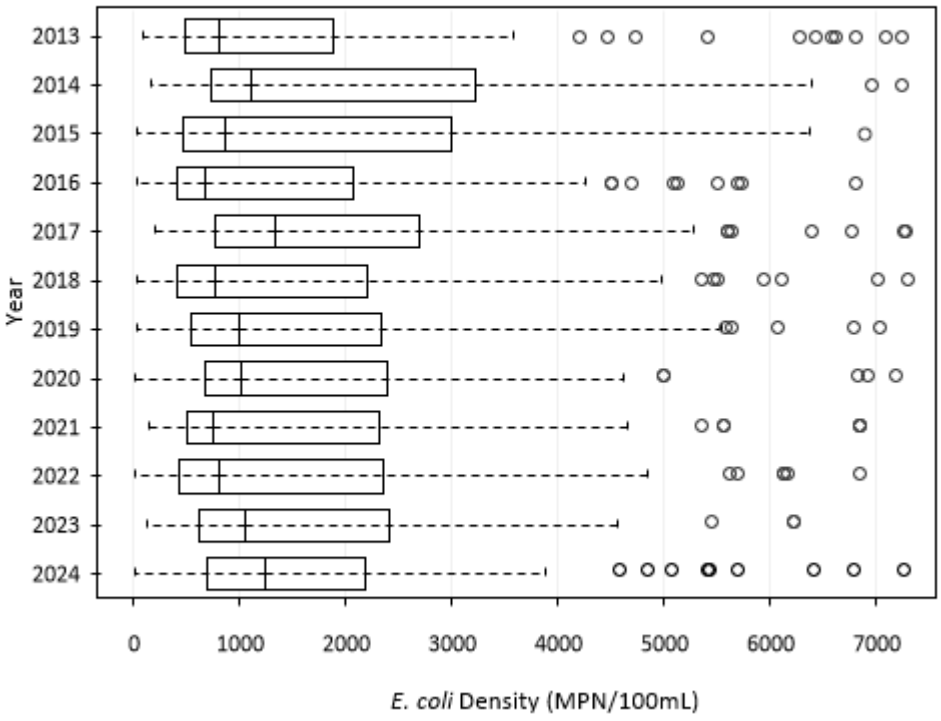

Figure 14. Comparison of Euclid Creek *E. coli* Densities from 2013-2024

Findings from the USGS study, *Circulation, Mixing, and Transport in Nearshore Lake Erie in the Vicinity of Villa Angela Beach and Euclid Creek* NEORSD (USGS, 2013 and 2022) and the *Euclid Creek Bacteriological Study 2019-2021* by NEORSD (NEORSD, 2022) have demonstrated that Euclid Creek discharge flows towards Euclid and Villa Angela Beaches and therefore directly impacts the water quality at the beaches. 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, a study was conducted to evaluate the presence of *E. coli* in Euclid Creek. The study utilized microbial source tracking to demonstrate that human sewage contamination was present throughout the entirety of the Euclid Creek watershed including reaches upstream of both NEORSD and City of Euclid CSOs (NEORSD, 2022). This human sewage contamination increased significantly during wet-weather events and was as elevated upstream of CSOs as it was downstream. *E. coli* loading calculations performed in the 2019-2021 study demonstrated that, while removal of CSO discharges eliminated a small volume (~3% of Euclid Creek's total discharge volume) of highly contaminated flow, the remaining 97% of the Euclid Creek flow was still highly contaminated from upstream sources. 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.

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.

Harmful Algal Bloom Monitoring

NEORSD maintained a YSI EXO2 water quality sonde at Edgewater Beach from July 11, 2024, through September 27, 2024. The sonde 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 2024 recreational season.

The National Oceanic and Atmospheric Administration (NOAA) conducts a bloom analysis in the western basin of Lake Erie each year. NOAA determined that the cyanobacteria bloom in the western basin of Lake Erie in 2024 was considered moderately severe with a severity index of 6.6 (Figure 15). The severity index is determined using satellite imagery to measure the amount of biomass observed over the peak 30-days of the bloom. The 2024 bloom in the western basin was the earliest bloom start on record; however, the peak occurred in mid-August which is similar to past years. The bloom peak only lasted for approximately a week before decreasing in intensity (NOAA, 2024). The 2024 bloom did not spread east into the central basin, so the beaches monitored during this study were not impacted.

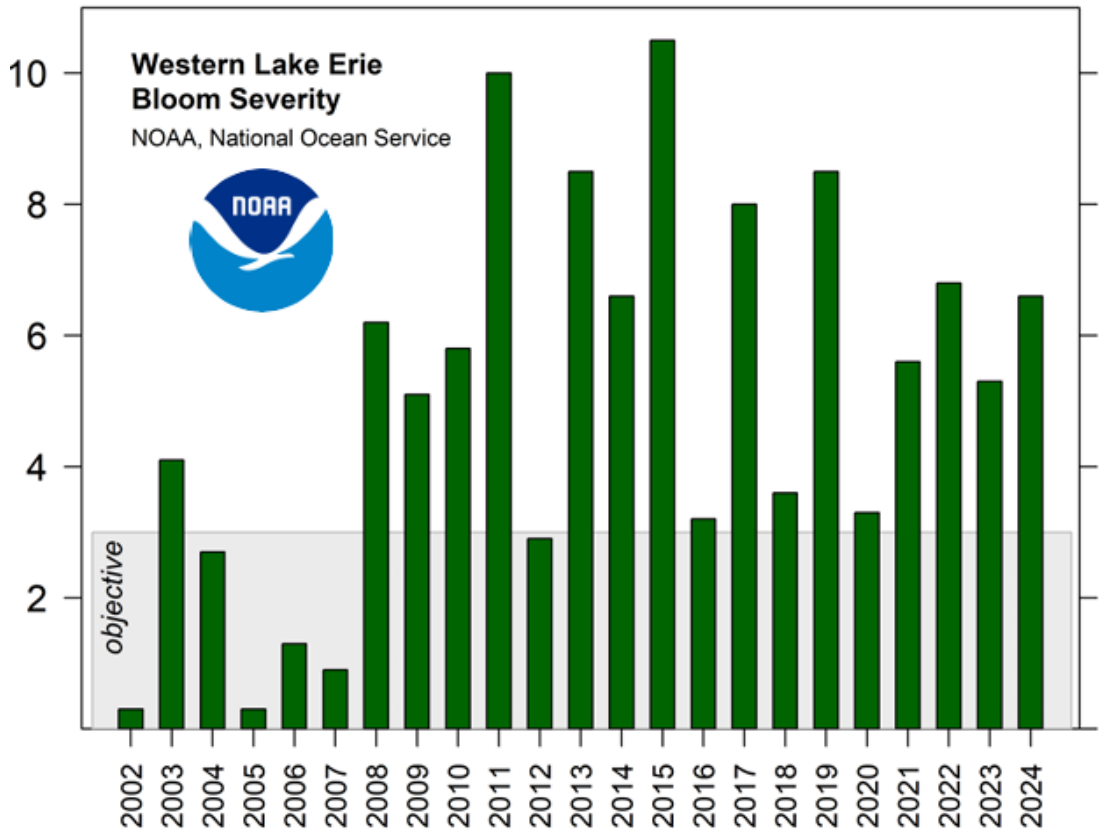

Figure 15. NOAA Bloom Severity Index for 2002 – 2024

Conclusions

In 2024, Edgewater Beach was in full attainment of the bathing water recreational criteria for the entire recreational season. Euclid Beach was in attainment of the geometric mean criterion for 100% of the season; however, it was in non-attainment of the STV criterion for 90.7% of the season. Villa Angela Beach was in attainment of the geometric mean criterion for 84.5% of the season but in non-attainment of the STV criterion for 81.4% of the season. Euclid Creek was in 100% exceedance of the recreational water quality criteria in 2024. This has been the case for Euclid Creek for 14 of the past 16 years.

Exceedances of the water quality criteria in 2024 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. Total rainfall for the entire recreation season in 2024 was the lowest it has been since 2016. June, July, August, and October were significantly dryer than the previous several years. Even though rainfall was lower in 2024 compared to 2023, an increase in the exceedance frequency of the STV criterion and the Beach Action Value was observed for both Euclid Beach and Villa Angela Beach.

The Euclid Creek Tunnel system continued to capture CSO overflows in the vicinity of Villa Angela and Euclid Beaches during the recreation season. Approximately 140 million gallons of sewage and stormwater were collected by the Euclid Creek Tunnel system between May 1 and October 31, 2024. 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 2024 recreational season, no HABs were observed at any of the beaches in this study.

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