Characterizing Water Quality in the Nueces River Tidal Segment

Final Report

CBBEP Project No. 2436
June 2025

Prepared by:

Sam Sugarek, Principal Investigator
Brenna Edwards, ESCI M.S. Student
Center for Coastal Studies
Texas A&M University – Corpus Christi
6300 Ocean Drive, NRC Suite 3200
Corpus Christi, Texas 78412
Phone: 361-850-0240
Email: samuel.sugarek@tamucc.edu

Submitted to:

Coastal Bend Bays and Estuaries Program
1305 N. Shoreline Blvd., Suite 205
Corpus Christi, Texas 78401

The views expressed herein are those of the authors and do not necessarily reflect the views of CBBEP or other organizations that may have provided funding for this project.

PREPARED IN COOPERATION WITH THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY AND U.S. ENVIRONMENTAL PROTECTION AGENCY.

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement C6-48000060-0 to Texas Commission on Environmental Quality. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Table of Contents

Executive Summary

The tidal segment of the Nueces River, located near the City of Corpus Christi in South Texas is listed in the Texas Commission on Environmental Quality's (TCEQ) 2022 Texas Integrated Report (IR) as having a screening level concern for chlorophyll-*a*, a proxy for algal biomass, and a Use Concern for Fish Kills in Water. Excessive chlorophyll-*a* concentrations in the segment have been attributed to elevated nutrients loadings combined with long residence time of the waterbody. Research to investigate fish kills linked mortality events in the segment to low dissolved oxygen related to algal blooms, which had been triggered by high nutrient loadings (unpubl. Texas Parks and Wildlife Spills & Kills Team reports). Potential sources of elevated nutrient loadings include contributions from the above tidal segment during flow events, non-point source runoff, agricultural runoff, on-site sewage facilities (OSSFs) within the segment, and point sources including a wastewater treatment facility that discharges into the segment. Additional stressors may include water management and engineered structures impeding flow and prolonging residence time of nutrients in the segment. To quantify nutrient loadings, monthly surface water data collection occurred at 5 sampling locations throughout the segment. Bacteriological parameters were added to determine if recreational use standards were in attainment. Data collection occurred during drought conditions in March and April 2024 and severe drought conditions from October 2024 through March 2025. Algal blooms were noted in January and February 2025. Results from the monthly monitoring events confirmed excessive concentrations of chlorophyll-*a* throughout the segment, with the highest concentrations occurring in the middle and downstream portions. Ammonia-nitrogen and nitrite-nitrogen concentrations were typically low. Nitrate-nitrogen results acquired from commercial labs were problematic due to sample dilution requirements, but limited results did not indicate excessive concentrations. Concentrations of organic nitrogen as Total Kjeldahl Nitrogen and Dissolved Total Kjeldahl Nitrogen were typically elevated throughout the segment with the highest concentrations occurring in November and December 2024, at the downstream-most stations. Total phosphorus concentrations were below TCEQ screening levels at the upper-most stations, at or near screening levels in the middle portion of the study area, and consistently above screening levels at the downstream-most stations. Enterococcus bacteria concentrations were variable throughout the study area with the highest concentrations occurring in the upstream-most stations. The downstream stations had consistently low bacteria concentrations with one minor exceedance of 41 CFU/100mL at each station. Additional data collection is recommended

to determine the seasonal variability of nutrients, and bacteriological parameters, which will help decision makers determine which parameters to target for load reductions.

Acknowledgments

CTCS staff would sincerely like to thank the CBBEP and staff for their support for the study. CTCS would also like to thank the laboratories that ran the analysis on water samples including the City of Corpus Water Utilities Laboratory (CCW) and the Lower Colorado River Authority – Environmental Services Laboratory (LCRA-ELS).

List of Figures

List of Tables

Introduction

Water quality is an important factor affecting the health and productivity of estuarine ecosystems. Estuaries, dependent on freshwater inflows, function as aquatic nursery grounds, playing a significant role in the life cycle of marine species, and supporting marine food webs. The construction of reservoirs, engineered structures, population growth, and drought have impacts on the amount, timing, and quality of freshwater entering estuaries. The Nueces River tidal segment is one example that is experiencing the effects of these impacts. The construction of two reservoirs, paired with infrequent flushing events, has often resulted in extended periods of hypersaline conditions (Alexander & Dunton, 2002) and increased residence time of the waterbody. Increases in nutrient loading sourced from point and non-point sources, can result in symptoms including harmful algal blooms and hypoxic/anoxic conditions (Nixon, 1995).

The Nueces River Tidal Segment, monitored on a quarterly basis at one station by the Texas Commission of Environmental Quality (TCEQ) has had state-identified water quality concerns for excessive chlorophyll-*a*, a proxy for phytoplankton biomass, since the 2008 TCEQ Integrated Report (IR) assessment. In 2022, the TCEQ IR assessments included an impairment for Fish Kills in Water. Investigations of fish kills linked fish mortality to low dissolved oxygen events related to algal blooms, which had been triggered by high nutrient loadings (unpubl. Texas Parks and Wildlife Spills & Kills Team reports).

The purpose of this study is to characterize water quality at a finer temporal and spatial resolution than is presently done to inform management strategies aimed at improving water quality in the Nueces River Tidal Segment. Results from this work will aid managers in determining which nutrient(s) to target for load reductions.

Description of Watershed – The Nueces River Watershed is comprised of three sub-watersheds: the Nueces, Frio, and Atascosa rivers. The Nueces River arises from its headwater springs located in Edwards and Real counties in the Texas hill country. The more ephemeral West Nueces River joins the Nueces in Uvalde County. The river descends from the Edwards Plateau carving through the Balcones Escarpment to the South Texas Plains. During periods of low or moderate flows, surface water from these streams is absorbed into the Edwards Aquifer to become water supply for more than 2.5 million people in San Antonio/Austin. During periods of sufficient flow, a portion of surface water flows downstream through the South Texas Plains/Texas-Tamaulipan thornscrub, an area known as the Wildhorse Desert. It traverses

through are area of low slope and crisscrossing stream channels known as the “braided reach” in southern La Salle and McMullen counties. The Nueces River is joined by the Frio and Atascosa rivers in Live Oak County continuing its 315-mile/507-km journey to its mouth in Nueces Bay near the City of Corpus Christi (pop. 316,105). The total drainage area is 16,800 square miles/43,500square kilometers.

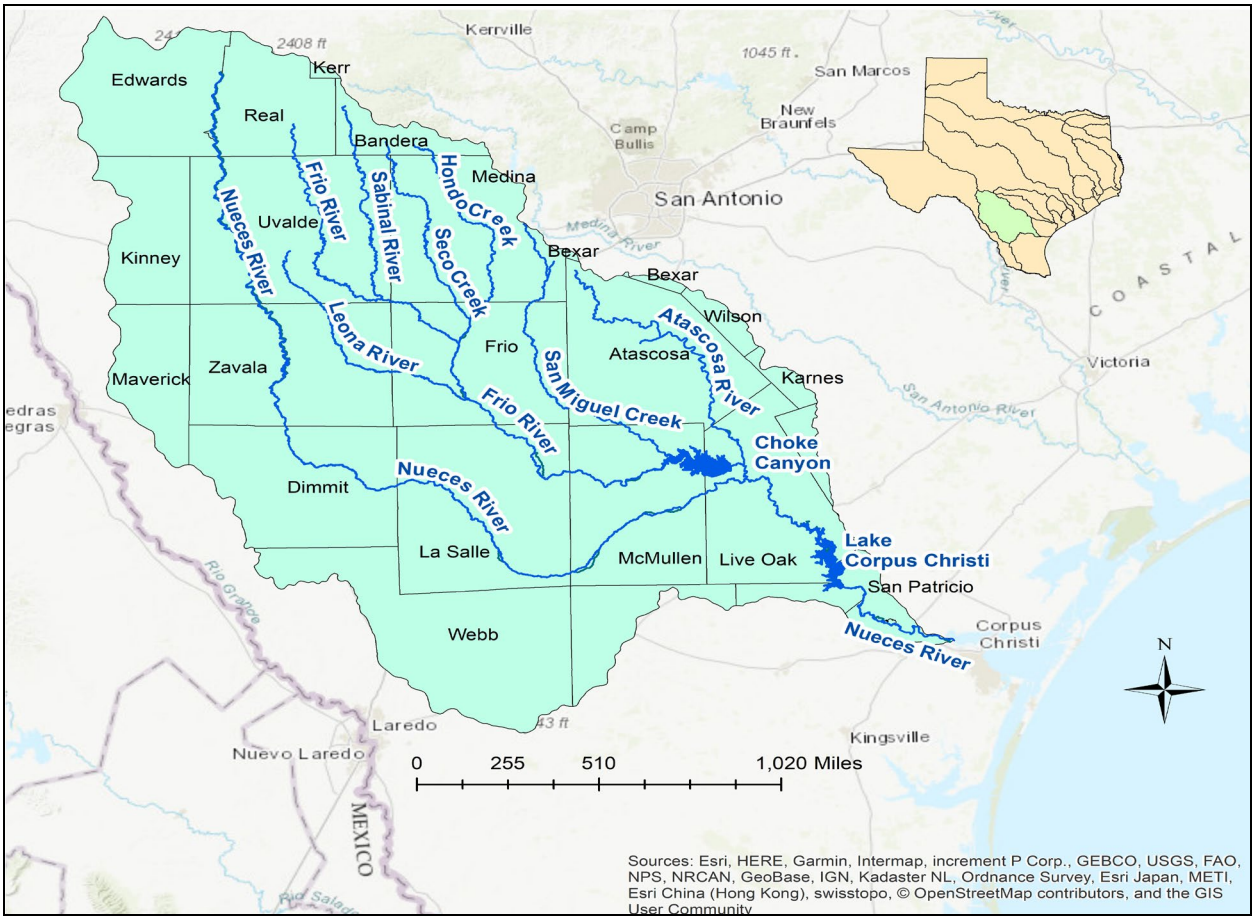


Figure 1. Map of the Nueces River Basin

Streamflow - Historic estuary inflows average 587,000 acre-feet per year (TWDB). Streamflow in the Nueces Tidal Segment was reduced substantially by the construction of two reservoirs upstream in the watershed that impound water. Wesley Seale Dam, completed in 1958, located at the intersection of Live Oak, San Patricio, and Jim Wells counties near Mathis (pop. 4,282), impounds a maximum of 256,339 acre-feet from the Nueces, Atascosa, and Frio rivers. Choke Canyon Reservoir, located in McMullen and Live Oak counties, completed in 1982, impounds a maximum of 662,821 acre-feet from the Frio River watershed. Both reservoirs, referred to collectively as the Reservoir System, provide water supply for more than half a million people

across the Coastal Bend. The Nueces River below Lake Corpus Christi (Segment 2102) flows 39 miles/63 kilometers to the tidal boundary at the "saltwater barrier" at Labonte Park (Figure 2) and has a watershed area of 116,863 acres/473 square kilometers. Inflows to the Nueces River tidal segment are largely based on amounts dictated by the pass-thru requirements of the Reservoir System and flows originating from the watershed downstream from Lake Corpus Christi (Figure 3) *www.twdb.texas.gov/surfacewater/bays/major_estuaries/nueces/index.asp*

Figure 2. Nueces River "Saltwater Barrier" Dam at Labonte Park

Permitted Sources in the Segment – Nueces River Tidal Segment has one permitted source that drains treated effluent directly in the segment. The Allison Wastewater Treatment Plant (WQ10401-006.001) is permitted to discharge up to five million gallons/19 million liters of treated domestic effluent per day. The treatment plant serves a large portion of the City of Corpus Christi's Northwest side.

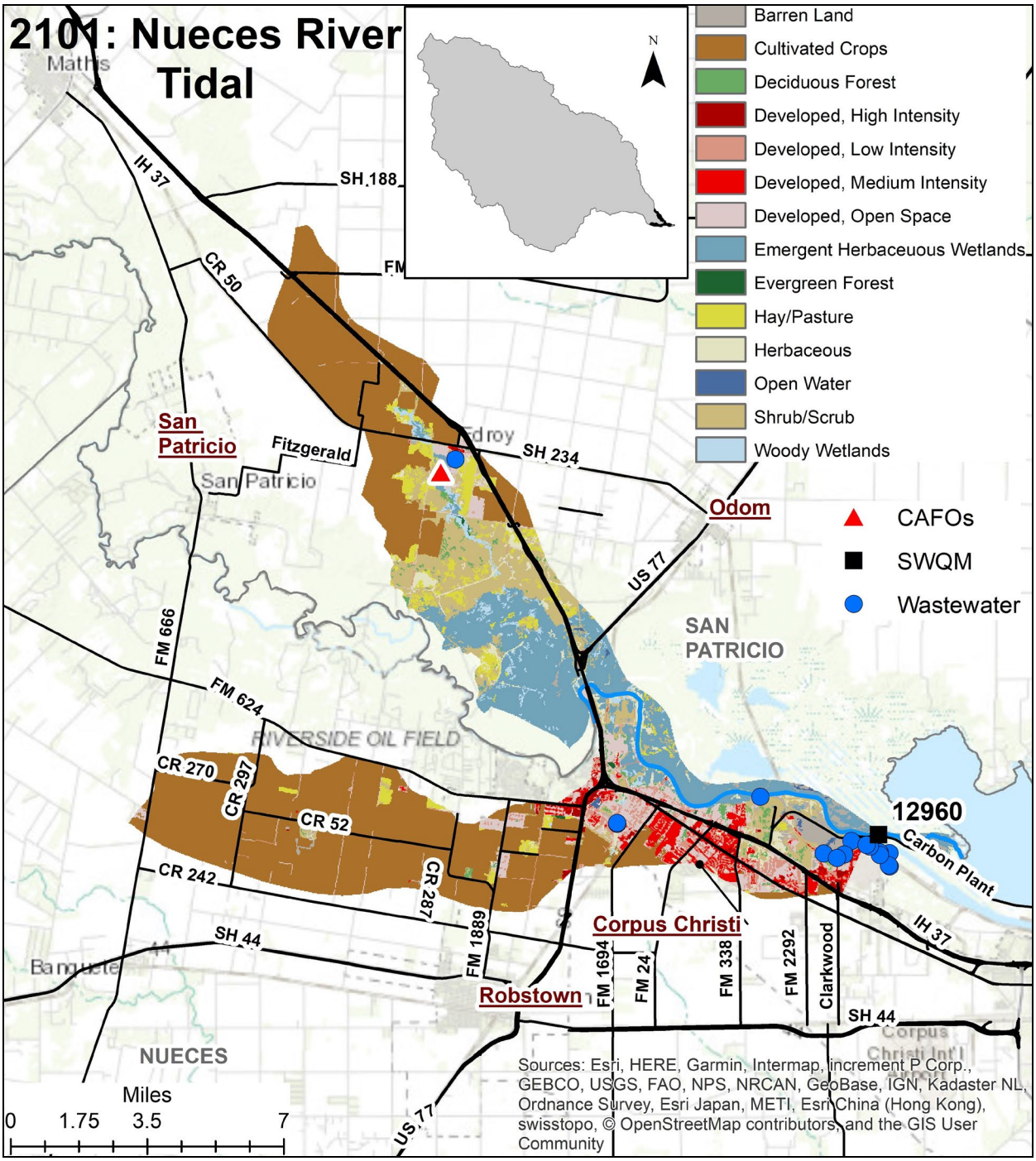


Figure 3. Land Use Land Cover and permitted dischargers to Nueces River Tidal Segment

Climate – The climate in the Nueces River Tidal Segment is characterized as subtropical, humid, with hard winter freezes that are uncommon but sufficiently frequent to exclude tropical plant species. Rainfall is sparse throughout the year with average precipitation of 31.7 inches/805 millimeters per year.

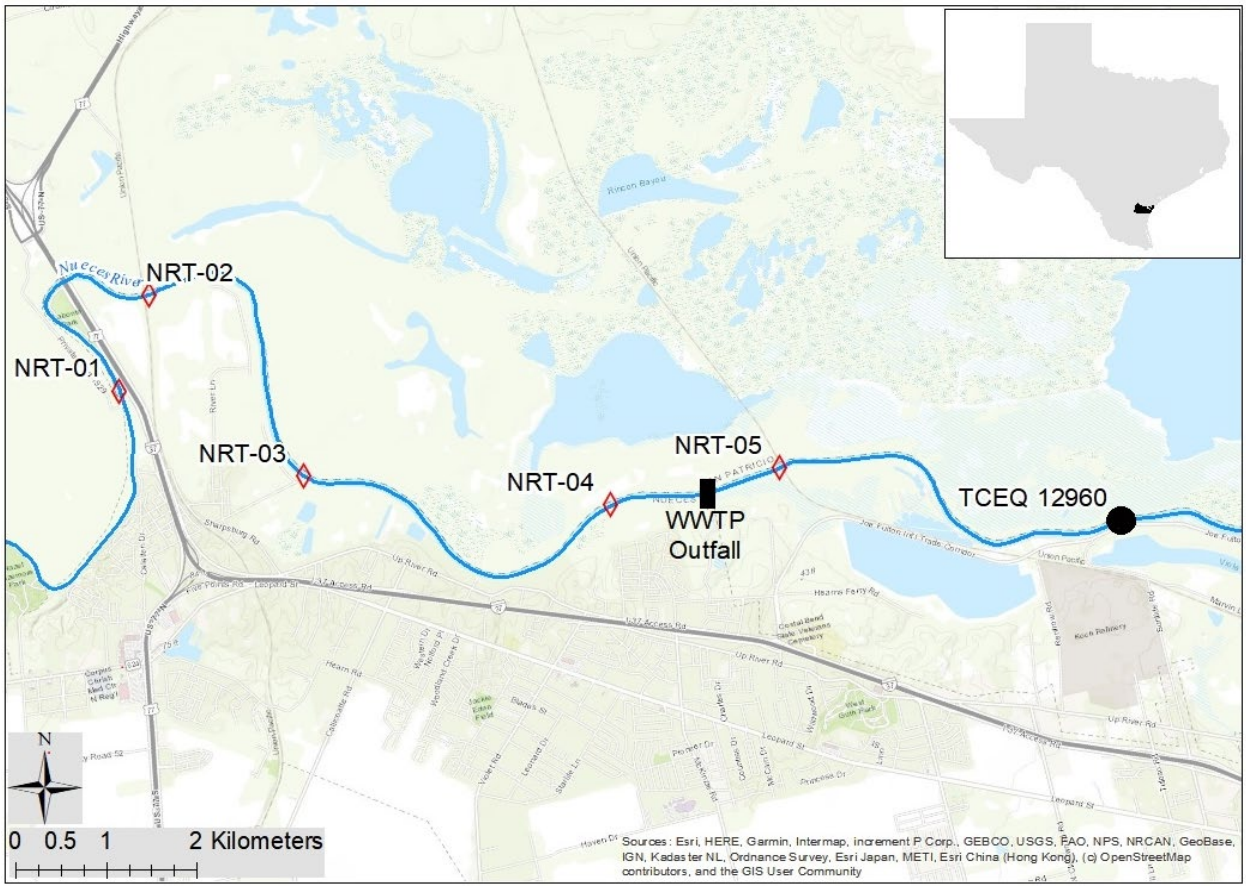


Figure 4. Map of sampling stations in Nueces River Tidal Segment

Hydrological – Streamflow in the Nueces Tidal Segment was measured by the USGS stream gauge located just upstream from NRT-01 (Figure 4) and the saltwater barrier in Calallen (Station # 08211500). This gauge measures the amount of water that is flowing over the saltwater barrier from upstream sources.

Meteorological data – During monthly site visits at each station, field staff recorded meteorological information including air temperature, wind direction, wind velocity and precipitation data including days since last precipitation, amount of precipitation in the past day and past seven days. Monthly precipitation data was provided by the National Weather Service (NWS) and National Oceanic and Atmospheric Administration (NOAA) using the link provided: https://www.weather.gov/crp/monthlyrainfall

Surface Water Quality Assessments - Surface water quality monitoring in Texas is routinely conducted by the TCEQ to assess the status of water quality in streams, rivers, lakes, and bays

throughout the state. The Texas Surface Water Quality Standards establish criteria to protect the designated uses of waterbodies, including aquatic life, water supply, and recreation, against water quality degradation. The criteria for evaluating support of the designated uses include dissolved oxygen, temperature, pH, dissolved minerals, toxic substances, and bacteria. However, TCEQ does not have numerical criteria for nutrients in their surface water quality standards. In Texas, nutrient controls have taken the form of narrative criteria, watershed rules, and anti-degradation considerations in permitting actions. TCEQ screens ammonia, nitrate nitrogen, total phosphorus, and chlorophyll-*a* monitoring data as a preliminary indication of areas of possible concern. The following tables explain the potential causes and impacts when water quality screening levels for certain water quality parameters are not met (TCEQ website).

Table 1. TCEQ screening levels for nutrient parameters

Parameter	**Nutrient Screening Levels for Nueces River Tidal - Segment 2101**	**Calculation Used for Concern**
Ammonia-Nitrogen	0.46 mg/l	20% of samples are above the criteria
Nitrate	1.1 mg/l	
Total phosphorus	0.66 mg/l	
Chlorophyll-*a*	21.0 µg/l	

Table 2. Causes and impacts of excess nutrient parameters

Parameter	**Cause**	**Impact**
Ammonia	Ammonia is excreted by animals and is produced during the decomposition of plants and animals. It is an ingredient in many fertilizers and is also present in sewage, storm water runoff, certain industrial wastewaters, and runoff from animal feedlots.	Elevated levels of ammonia in the environment can adversely affect fish and invertebrate reproductive capacity and reduced growth of the young.
Nitrates & Total Phosphorus	Nutrients are found in effluent released from wastewater treatment plants (WWTP)s, fertilizers, and agricultural runoff carrying animal waste from farms and ranches. Soil erosion and runoff from farms, lawns, and gardens can add nutrients to the water.	These nutrients increase plant and algae growth. When plants and algae die, the bacteria that decompose them consume dissolved oxygen leaving less available for fish and other living aquatic life. High levels of nitrate and nitrites can produce Nitrite Toxicity, or “brown blood disease,” in fish. This disease reduces the ability of blood to transport oxygen throughout the body.

Chlorophyll-*a*	Modifications to the riparian zone, human activity that causes increases in organic matter, nutrients, bacteria, and over abundant algae in water.	Chlorophyll-*a* is the photosynthetic pigment found in all green plants, algae, and cyanobacteria. Elevated levels indicate abundant plant growth which could lead to reduced DO levels.

Nueces River Above Tidal (Segment 2102) –The quality of source water to the Nueces Tidal segment is of great importance when determining nutrient and bacterial inputs in the receiving waterbody. The Nueces River above tidal (Segment 2102) is listed in TCEQs 2022 Texas Integrated Report (IR) for surface water quality as having exceedances to the screening level for **chlorophyll-*a*** (14.1 µg/l).

Nueces River Tidal (Segment 2101) - The designated uses for Nueces River Tidal include aquatic life use, general use, and recreational use. Segment 2101 is listed in TCEQs 2022 Texas IR for Surface Water Quality as having an aquatic life use concern for **Fish Kills in Water.** Previous research to investigate the fish kills linked mortality to low dissolved oxygen events related to algal blooms, which had been triggered by high nutrient loadings. Surface water quality monitoring by TCEQ has identified an exceedance to the screening level for **chlorophyll-*a*** *(*21.0 µg/l). Possible sources of excess nutrient loadings include permitted point source discharges, runoff from urban and rural non-point sources, On-Site Sewage Facilities (OSSF), groundwater discharges, and others.

Nueces Bay (Segment 2482) - For the receiving water body, Nueces Bay (TCEQ Segment 2482), surface water quality monitoring by TCEQ has identified an exceedance to the criterion for dissolved copper in water, a legacy pollutant. No other concerns or impairments were listed for the waterbody.

Methods

Sample collection – Surface water quality data, including field and laboratory data, were collected monthly from March 2024 through April 2025 at five sampling stations. No water quality sampling occurred from May 2024 through September 2024 due to delays associated with a change in the laboratory that ran the nutrient samples. At each sampling location, field

data including water depth, water temperature, pH, dissolved oxygen, specific conductance, and salinity were obtained using a Hydrolab MS5 datasonde following sampling guidelines found in TCEQs Surface Water Quality Manual Procedures, Volume 2 (RG-416). The datasonde was calibrated before each sampling event and post calibrated immediately after returning from the field. Water samples were taken from the centroid of flow (point of maximum flow) at each station. Surface water quality samples were collected and placed on ice. Bacteria samples were delivered to the Corpus Christi Water (CCW) Utilities Laboratory Nutrient parameter samples were shipped to the Lower Colorado River Authority – Environmental Laboratory Services (LCRA-ELS). Chlorophyll-*a* and pheophytin samples were analyzed at Texas A&M University-Corpus Christi's Center for Coastal Studies Laboratory (CTCSL).

Sample Analysis – Surface water samples were collected and analyzed for nutrient components by three laboratories. Nutrient samples including ammonia, nitrate, nitrite, Total Kjeldahl Nitrogen (TKN), dissolved TKN (DTKN), and total phosphorus were analyzed by the (LCRA-ELS) in Austin, Texas. Bacteriological samples were analyzed by Corpus Christi Water (CC-Water). Nutrient samples were analyzed by LCRA-ELS. Chlorophyll-*a* and pheophytin samples were analyzed at the Texas A&M University-Corpus Christi's Center for Coastal Studies Laboratory (CTCSL).

Results

Data Collection – Data collection for the project occurred in March and April 2024, and from October 2024 through March 2025. The results presented from October 2024 through March 2025 also had laboratory issues at the alternative laboratory due to sample dilutions due to elevated salinities in the segment. Results for nitrate-nitrogen, and nitrite nitrogen are presented with the caveat that most of the results are at the Limit of Qualification (LOQ) due to dilutions.

Hydrological/Precipitation – Streamflow from upstream sources in the Nueces River Above Tidal (Segment 2102), measured by USGS Gauge Station 0821150 at the "saltwater barrier" dam at Labonte Park in Calallen was absent during much of the data collection period in March and April 2024 and from October 2024 through March 2025 (Figure 5). Rain events in July and August 2024 resulted in multiple minor flow events with the greatest value approaching 375 ft^3/s in late July 2024. Data results from these flow events were not captured due to sampling delays

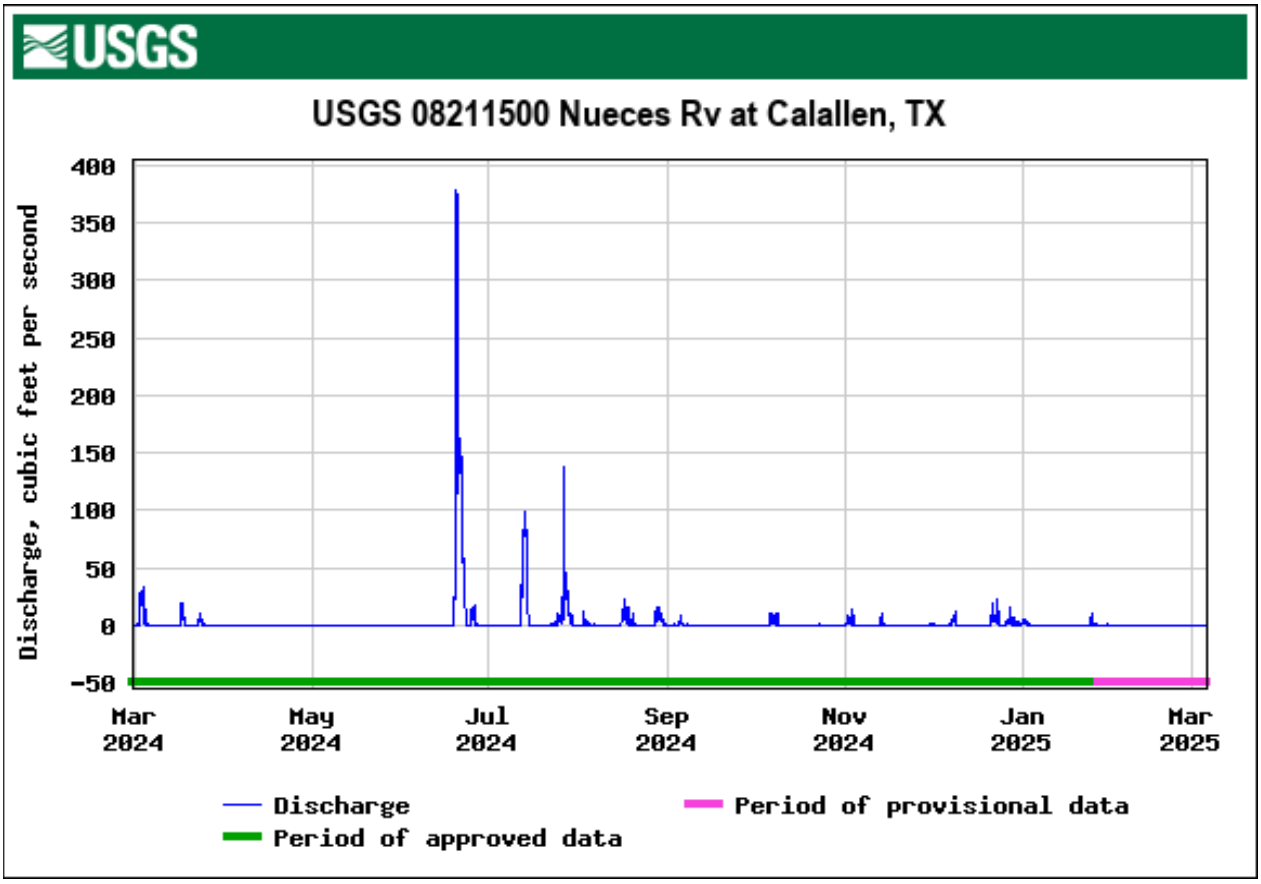


Figure 5. Streamflow at Nueces River at Calallen

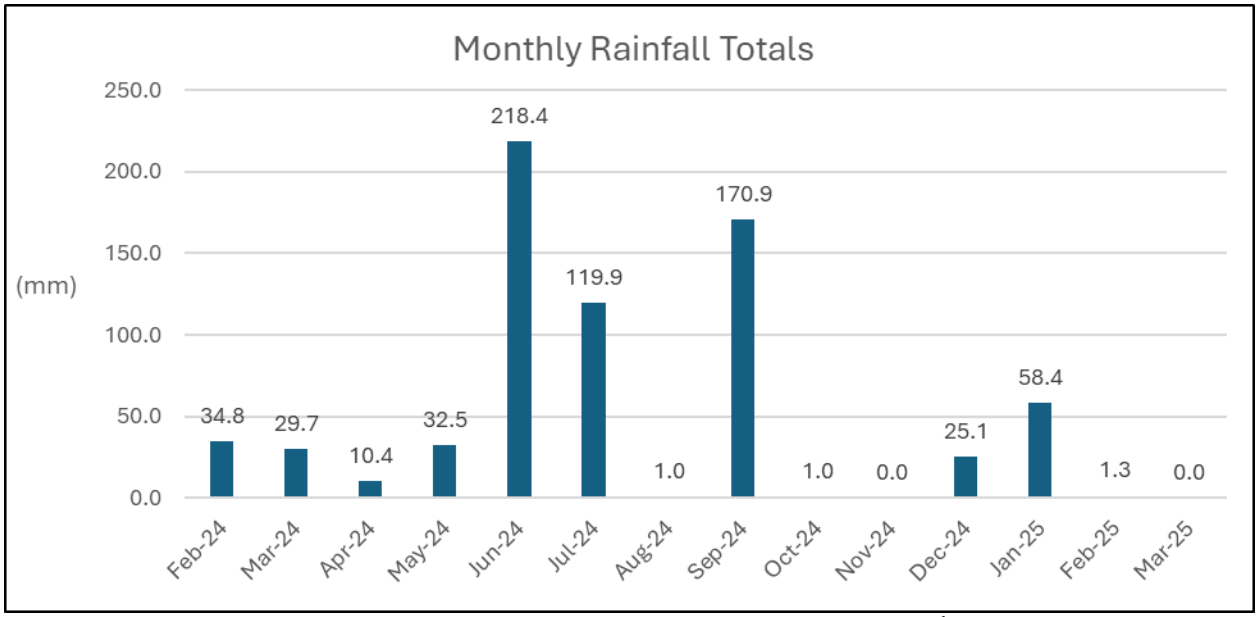


Figure 6. Monthly rainfall totals from March 1st, 2024, through March 5th, 2025

due to contractor lab changes. Only one sampling event occurred with water flowing over the Saltwater Barrier Dam, albeit low with a flow rate of 0.5 ft^3/s/0.014 m^3/s in October 2024. All

other monitoring events were conducted without contributions of water from upstream sources or runoff from rain events. Precipitation totals from March 1st, 2024 through March 6th, 2025 totalled approximately 703.6 mm/27.7 inches (Figure 6) according to National Oceanic Atmospheric Administration's (NOAA's) Climate Data Online website.

River Segment Characteristics – Surface salinity measurements taken at a depth of 0.3 meters ranged from 6.8 ppt at NRT-01 in March 2024 to 27.9 ppt in December 2024. Surface salinities were typically uniform from NRT-01 to NRT-05 during site visits, likely due to freshwater input from the Allison Wastewater Treatment Plant effluent source located between NRT-04 and NRT-05. Significant salinity and dissolved oxygen stratification (i.e., higher salinity/lower dissolved oxygen in bottom waters than surface) of the water column was observed at stations with depths greater than 1 meter, likely attributed to saline groundwater seeps. NRT-01 and NRT-02 had the deepest water column depths of 2.8 m and 5.0 m, respectively. Dissolved oxygen below 2.0 m at NRT-01 and NRT-02 was typically absent, approaching 0.0 mg/L during all sampling events. Salinities at 0.3 m off the bottom at NRT-01 and NRT-02 ranged from 37.2 ppt in March 2024 to 47.4 ppt in December 2024, significantly higher than the surface salinities. Above 1.0 m, supersaturation (i.e., higher than 100% saturation) of dissolved oxygen were documented from NRT-02 to NRT-05 with a maximum value of 21.9 mg/L and 292.0% oxygen saturation at NRT-04 in December 2024. Further downstream, water depths at NRT-03 and NRT-04 were approximately 1.3 m, and 0.7 m at NRT-05 with little dissolved oxygen or salinity stratification observed.

Water appearance in the segment typically indicated increasing turbidity, likely from algal components, from NRT-01 downstream to NRT-05 (Figure 7). Significant increases in turbidity were commonly observed in an area between NRT-02 and NRT-03 progressing to a maximum near NRT-04. Water color ranged from bright green to orange/brown. Two algal blooms were reported by Texas Parks & Wildlife Department (TPWD) in January and February 2025 during the study period. A few dead fish were observed during the separate events, but no major fish kills were reported by TPWD Spills and Kills responders.

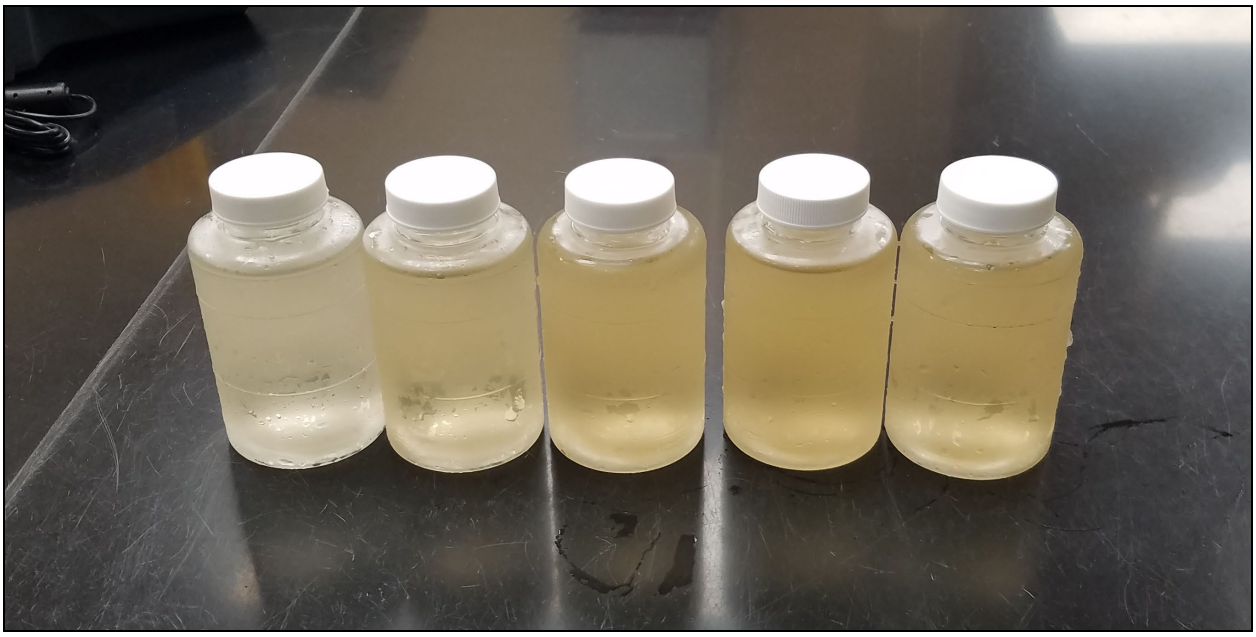


Figure 7. Water Appearance of Water Samples from NRT-01 to NRT-05 (right to left)

Ammonia-Nitrogen – Ammonia-nitrogen concentrations were typically very low in the segment ranging from <0.1 to 0.89 mg/L. The highest concentrations were from NRT-04 and NRT-05. Ammonia-nitrogen concentrations at NRT-01 through NRT-03 were all at the limit of quantification (LOQ) (i.e., the lowest concentration of an analyte that can be determined with a given analytical assay with the required precision and accuracy) of 0.1 mg/L except for one sample from NRT-01 in November 2024 with a value of 0.217 mg/L.

Table 3. Ammonia-nitrogen concentrations from NRT-01 to NRT-05

Ammonia-nitrogen	**[Minimum]**	**[Maximum]**	**[Mean]**
NRT-01	<0.1 mg/L	0.22 mg/L	0.14 mg/L
NRT-02	<0.1 mg/L	0.20 mg/L	0.13 mg/L
NRT-03	<0.1 mg/L	0.20 mg/L	0.13 mg/L
NRT-04	<0.1 mg/L	0.43 mg/L	0.18 mg/L
NRT-05	<0.1 mg/L	0.89 mg/L	0.22 mg/L

Nitrate-nitrogen – Nitrate-nitrogen was a nutrient parameter that was problematic for the National Environmental Laboratories Accreditation Program (NELAP) accredited laboratories contracted to run the analysis. Elevated salinities in the segment required laboratories to dilute water samples for this specific parameter, which resulted in LOQs that were elevated, and in many cases, above screening levels set by TCEQ for nitrate-nitrogen (1.1 mg/L). Nitrate-nitrogen laboratory results were reported at the LOQ, ranging from 0.2 mg/L to as high as 5.0 mg/L at NRT-01, NRT-02, and NRT-03. The LOQ listed in the project QAPP for nitrate-

nitrogen was listed as 0.025 mg/L. One sample from NRT-02 was above the LOQ with a value of 0.65 mg/L but did not exceed the TCEQ screening limit of 1.1 mg/L. Three samples from NRT-04 were above the LOQ with all results exceeding the TCEQ screening limit with values of 1.86 mg/L, 2.64 mg/L, and 3.56 mg/L in January, February, and March, respectively. At NRT-05, five samples out of eight were above the LOQ. Three samples exceeded the TCEQ screening limit with values of 2.61 mg/L, 1.61 mg/L, and 3.7 mg/L, in December, January, and March, respectively.

Table 4. Nitrate-nitrogen concentrations from NRT-01 to NRT-05

Nitrate-nitrogen	**[Minimum]**	**[Maximum]**
NRT-01	<0.25 mg/L	<5 mg/L
NRT-02	<0.25 mg/L	<5 mg/L
NRT-03	<0.25 mg/L	<5 mg/L
NRT-04	<0.25 mg/L	<5 mg/L
NRT-05	<0.25 mg/L	<5 mg/L

Nitrite-nitrogen – Nitrite-nitrogen was another parameter that was problematic for the laboratories running the analysis due to dilution requirements of saline waters. All nitrite-nitrogen laboratory results from NRT-01 and NRT-03 were reported at the LOQ, that ranged from 0.25 mg/L to as high as 5.0 mg/L. Seven out of eight samples were <1.0 mg/L. The LOQ listed in the project QAPP for nitrate-nitrogen was listed as 0.02 mg/L.

Table 5. Nitrite-nitrogen concentrations from NRT-01 to NRT-05

Nitrite-nitrogen	**[Minimum]**	**[Maximum]**
NRT-01	<0.25 mg/L	<5 mg/L
NRT-02	<0.25 mg/L	<5 mg/L
NRT-03	<0.25 mg/L	<5 mg/L
NRT-04	<0.25 mg/L	<5 mg/L
NRT-05	<0.25 mg/L	<5 mg/L

Dissolved Total Kjeldahl Nitrogen (DTKN) – DTKN concentrations ranged from 0.51 mg/L at NRT-03 to 7.75 mg/L at NRT-04. The lowest values of the study were in March and April 2024. Samples analyzed from October 2024 through March 2025 had higher concentrations of DTKN after switching contractor labs. The segment also experienced extreme drought from October 2024 through March 2025 which may have played a role in concentrating nutrients. No TCEQ screening limits exist for DTKN.

Table 6. DTKN concentrations from NRT-01 to NRT-05

DTKN	[Minimum]	[Maximum]	[Mean]
NRT-01	0.66 mg/L	4.94 mg/L	3.02 mg/L
NRT-02	0.57 mg/L	5.68 mg/L	2.85 mg/L
NRT-03	0.51 mg/L	6.42 mg/L	2.63 mg/L
NRT-04	0.90 mg/L	6.95 mg/L	3.08 mg/L
NRT-05	1.20 mg/L	7.75 mg/L	3.77 mg/L

Total Kjeldahl Nitrogen (TKN) – TKN concentrations ranged from 0.78 mg/L at NRT-02 to 10.7 mg/L at NRT-04. The lowest values of the study were in March and April 2024 and increased from October 2024 through March 2025. No TCEQ screening limits exist for TKN.

Table 7. TKN Concentrations from NRT-01 to NRT-05

TKN	[Minimum]	[Maximum]	[Mean]
NRT-01	0.80 mg/L	6.43 mg/L	3.37 mg/L
NRT-02	0.78 mg/L	7.07 mg/L	3.77 mg/L
NRT-03	1.02 mg/L	10.70 mg/L	5.88 mg/L
NRT-04	1.57 mg/L	8.49 mg/L	5.89 mg/L
NRT-05	2.01 mg/L	9.28 mg/L	5.82 mg/L

Total Phosphorus (TP) – Total phosphorus concentrations ranged from 0.19 mg/L at NRT-01 and NRT-02 to 1.31 mg/L at NRT-04. The TCEQ screening limit for total phosphorus is 0.66 mg/L. All total phosphorus concentrations from NRT-01 and NRT-02 were below screening limit. NRT-03 had two minor exceedances (0.687 mg/L and 0.875 mg/L), and two results that were very close to the screening limit with results 0.627 mg/L and 0.653 mg/L. NRT-04 and NRT-05 had elevated concentrations above the screening limit at seven out of eight sampling events.

Table 8. Total Phosphorus concentrations from NRT-01 to NRT-05

Total Phosphorus	[Minimum]	[Maximum]	[Mean]
NRT-01	0.19 mg/L	0.447 mg/L	0.32 mg/L
NRT-02	0.19 mg/L	0.519 mg/L	0.29 mg/L
NRT-03	0.24 mg/L	0.875 mg/L	0.55 mg/L
NRT-04	0.35 mg/L	1.31 mg/L	0.92 mg/L
NRT-05	0.62 mg/L	1.25 mg/L	0.98 mg/L

Chlorophyll-a – Chlorophyll-*a* concentrations were typically highly elevated during the study. The TCEQ screening limit for this parameter in the Nueces River Tidal is 21.0 µg/L. Chlorophyll-*a* concentrations ranged from 11.1 µg/L at NRT-01 to 515 µg/L at NRT-03. The lowest concentrations were at NRT-01 and NRT-02 with only two sample results under the TCEQ screening limit. Mean concentrations at NRT-01 and NRT-02 were 51.3 µg/L and 50.4 µg/L, respectively. Concentrations quickly increased moving downstream to NRT-03 with mean values of 162 µg/L. NRT-04 and NRT-05 had mean concentrations of 194 µg/L and 159 µg/L, respectively

Table 9. Cholorphyll-*a* concentrations from NRT-01 to NRT-05

Chlorophyll-*a*	**[Minimum]**	**[Maximum]**	**[Mean]**
NRT-01	11.1 µg/L	126.4 µg/L	51.3 µg/L
NRT-02	17.5 µg/L	108.5 µg/L	50.4 µg/L
NRT-03	21.0 µg/L	515.3 µg/L	161.7 µg/L
NRT-04	25.8 µg/L	509.5 µg/L	194.3 µg/L
NRT-05	27.9 µg/L	334.5 µg/L	158.7 µg/L

Pheophytin - Pheophytin concentrations were very similar to chlorophyll-*a* concentrations, highly elevated with the lowest values at NRT-01 and NRT-02 and the highest values.

Table 10. Pheophytin concentrations from NRT-01 to NRT-05

Pheophytin	**[Minimum]**	**[Maximum]**	**[Mean]**
NRT-01	13.2 µg/L	59.6 µg/L	27.8 µg/L
NRT-02	11.1 µg/L	56.1 µg/L	24.2 µg/L
NRT-03	20.8 µg/L	321.7 µg/L	84.2 µg/L
NRT-04	27.2 µg/L	150.4 µg/L	96.9 µg/L
NRT-05	22.7 µg/L	139.5 µg/L	68.7 µg/L

Bacteria – Enterococcus indicator bacteria concentrations in the segment ranged from <10 colony forming units (CFU)/100 mL to a maximum of 870 CFU/100 mL at NRT-01. Elevated bacteria concentrations of 134 CFU/100 mL and 226 CFU/100 mL occurred at NRT-03 in March and April 2024, respectively. NRT-04 and NRT-05 concentrations were between <10 and 41 CFU/100 mL.

Table 11. Enterococcus concentrations from NRT-01 to NRT-05

Enterococcus	[Minimum]	[Maximum]	[Mean]
NRT-01	<10 CFU/100 mL	870 CFU/100 mL	150 CFU/100 mL
NRT-02	<10 CFU/100 mL	250 CFU/100 mL	46 CFU/100 mL
NRT-03	<10 CFU/100 mL	226 CFU/100 mL	58 CFU/100 mL
NRT-04	<10 CFU/100 mL	41 CFU/100 mL	16 CFU/100 mL
NRT-05	<10 CFU/100 mL	41 CFU/100 mL	22 CFU/100 mL

A second large spike in bacteria concentrations occurred at NRT-01 and NRT-02 on November 14th, 2024, following a rain event in the area that resulted in a trickle of flow from the above tidal portion. The maximum concentrations during the study occurred during this sampling event. Bacteria concentrations were low at NRT-04 and NRT-05 during both of the very minor flow events.

Discussion

Results from this study provide evidence that screening level concerns for excessive chlorophyll-*a* in water and an impairment for Fish Kills in Water by state-led monitoring programs are appropriate for the tidal segment of the Nueces River. Surface water samples analyzed during drought conditions indicate ammonia-nitrogen concentrations at all stations were in attainment of the TCEQ screening levels of 0.46 mg/L. Nitrate-nitrogen and nitrite-nitrogen, despite the laboratory issues associated with dilutions due to elevated salinity, did not have excessive concentrations above the TCEQ screening level of 1.1 mg/L. Low concentrations of nitrate-nitrogen provides some evidence that this parameter could be being used by algal species, converting nitrate-nitrogen to chlorophyll-a/algal biomass. More precise data for nitrate and nitrite-nitrogen concentrations are needed. DTKN and TKN concentrations were highly variable. No screening limits are available for DTKN and TKN parameters, but concentrations were typically elevated at all stations, increasing toward downstream stations NRT-03 through NRT-05. Total phosphorus concentrations were in attainment of TCEQ screening level of 0.66 mg/L from NRT-01 to NRT-03, and over the screening level at NRT-04 and NRT-05. Chlorophyll-*a* concentrations, were highly elevated throughout the segment, showed an increasing trend from upstream to downstream stations. Water appearance during the monitoring events identified an area between NRT-02 and NRT-03 where visible changes in turbidity and water color were noted. Bacteria concentrations were typically higher at upstream stations NRT-

01 through NRT-03. This is an area that receives rainfall-runoff from multiple small tributary creeks and drainages from residential neighborhoods and riverfront homes that use septic systems for effluent treatment. Bacteria concentrations between NRT-04 and NRT-05 were the lowest in the segment, providing evidence that the one permitted source of effluent in the segment was working properly during the sampling events.

Recommendations

Recommendations include the continuation of monthly monitoring for the project to build a robust dataset that will allow the determination of seasonal trends. Surface water quality data compiled from wet years would be beneficial to determine the contributions from upstream sources including the effects of freshwater pass-throughs on the segment.

Literature Cited

Alexander, H. D., & Dunton, K. H. 2002. Freshwater inundation effects on emergent vegetation in a hypersaline salt marsh. *Estuaries*, *25*(6), 1426–1435. https://doi.org/10.1007/BF02804834

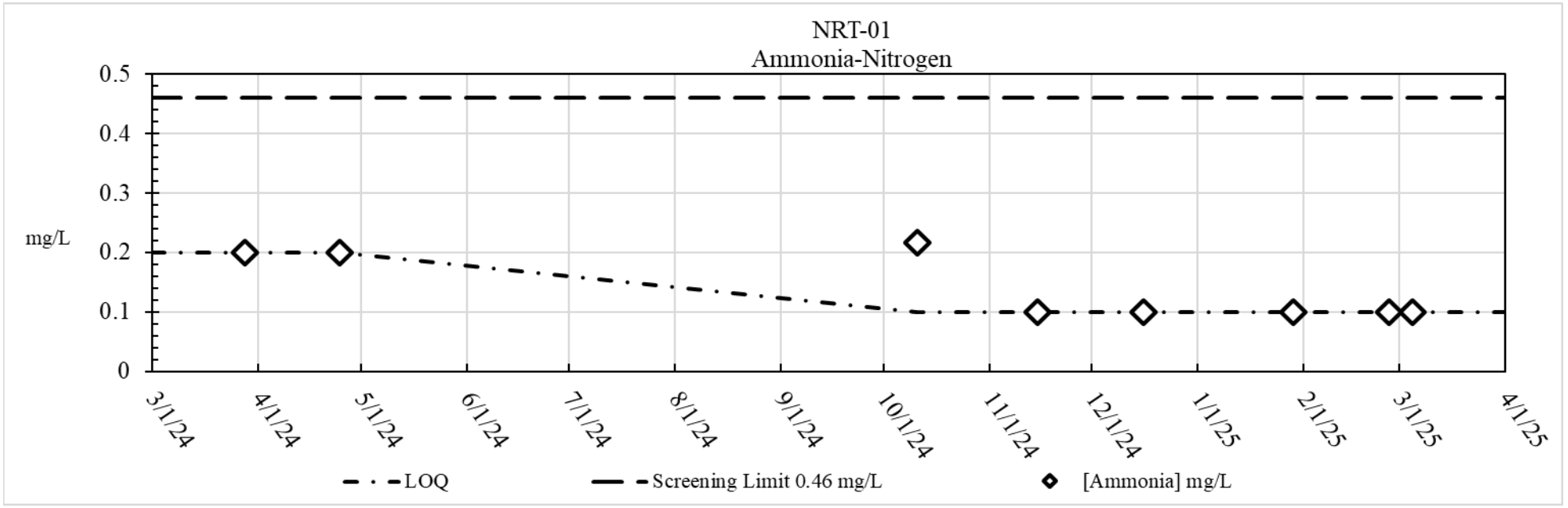
Nixon SW. 1995. Coastal marine eutrophication – a definition, social causes, and future concerns. Ophelia 41: 199-219

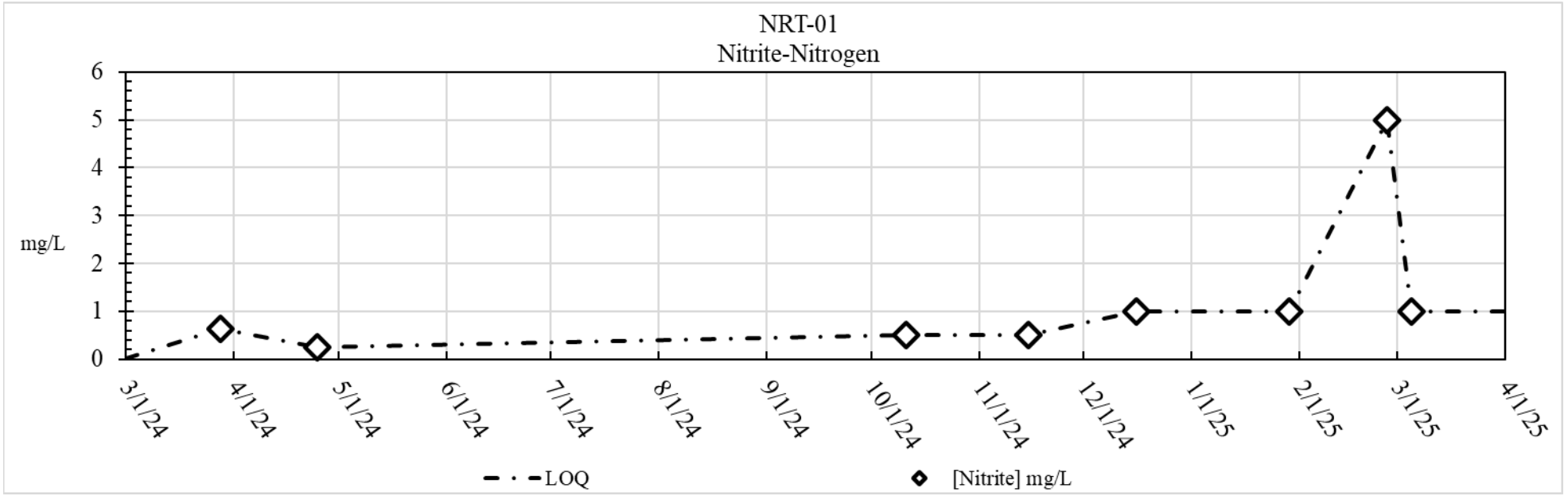
Texas Commission on Environmental Quality. 2022). 2022 Texas IR index of impairments report. Retrieved from https://www.tceq.texas.gov/downloads/water-quality/assessment/integrated-report-2022/2022-imp-index.pdf

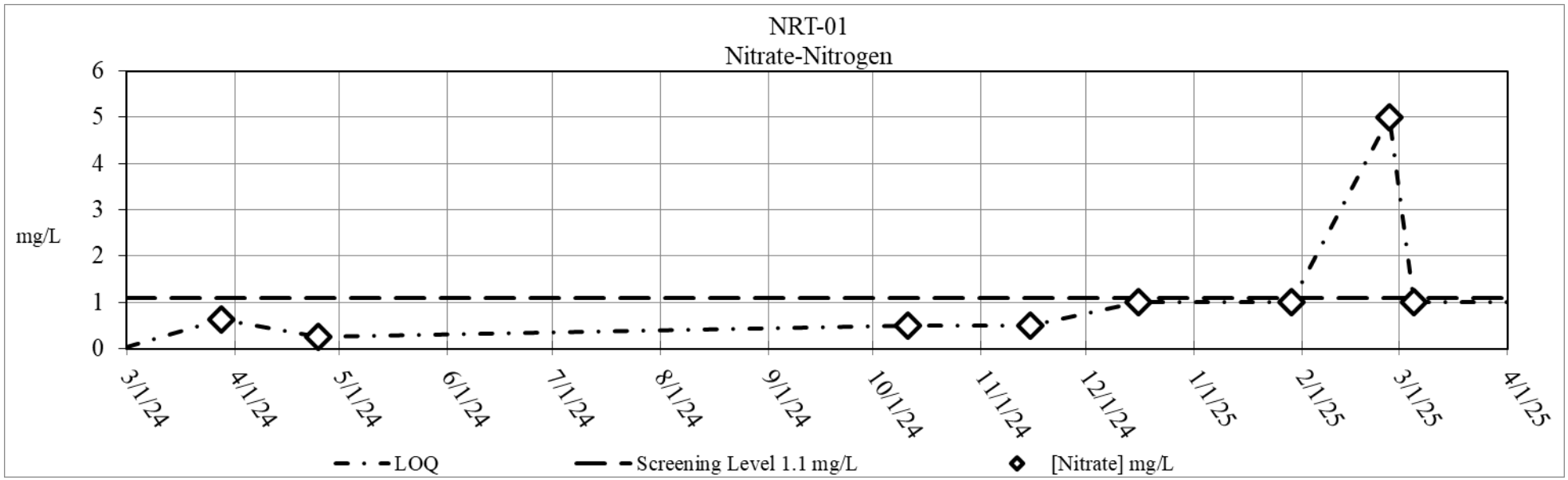
Texas Water Development Board. Nueces Estuary (Corpus Christi Bay). Retrieved from https://www.twdb.texas.gov/surfacewater/bays/major_estuaries/nueces/index.asp

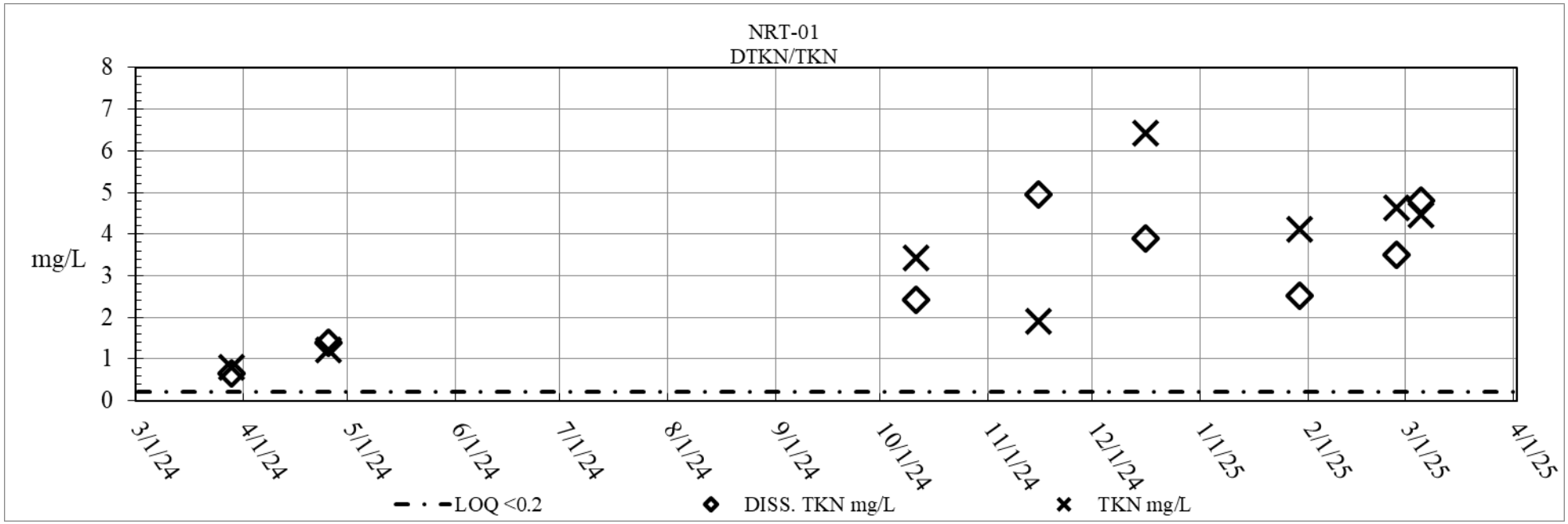
Appendix A

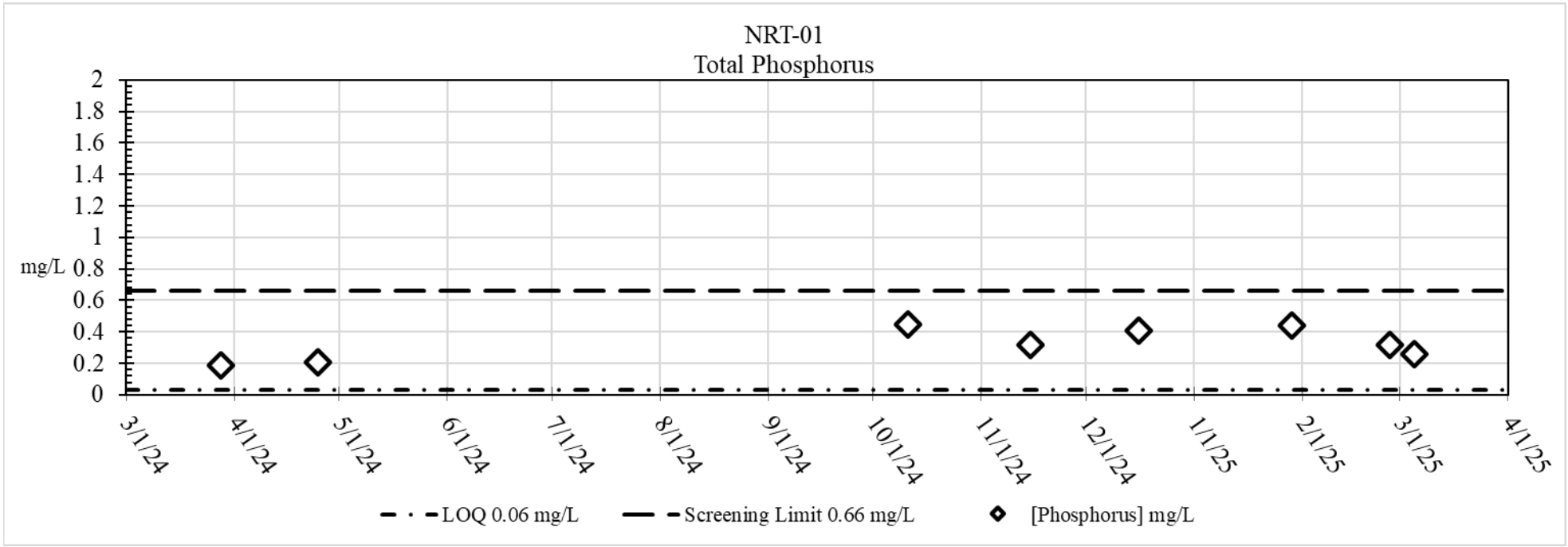
Laboratory Results

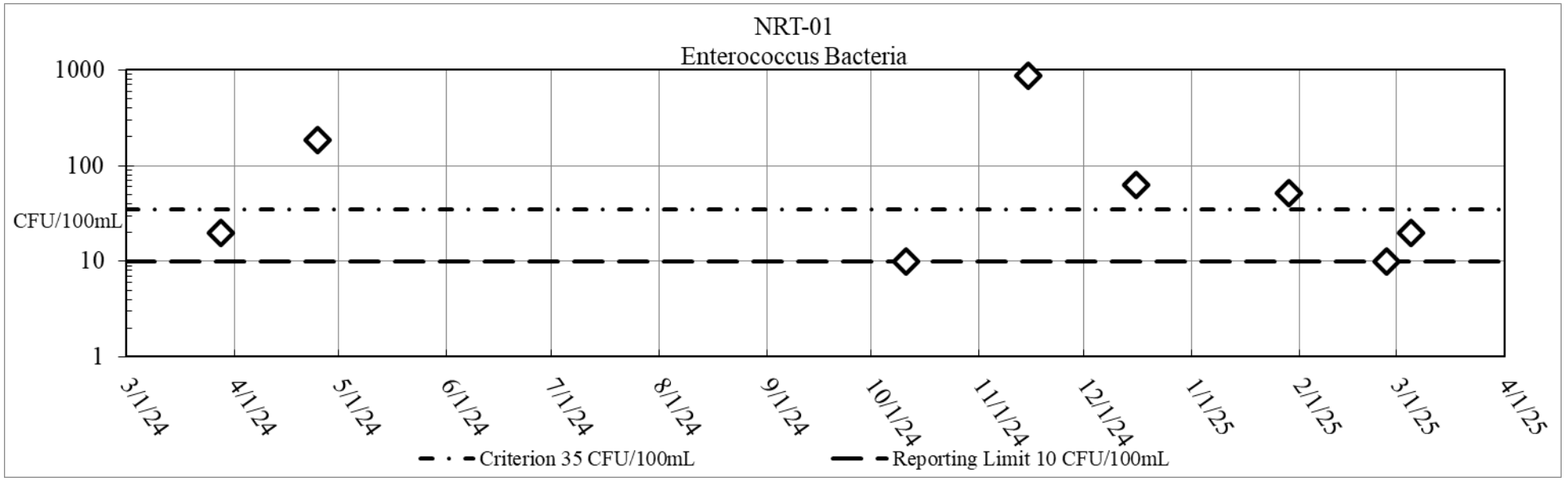

NRT-01
Ammonia-Nitrogen
mg/L
0.5
0.4
0.3
0.2
0.1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Limit 0.46 mg/L
[Ammonia] mg/L

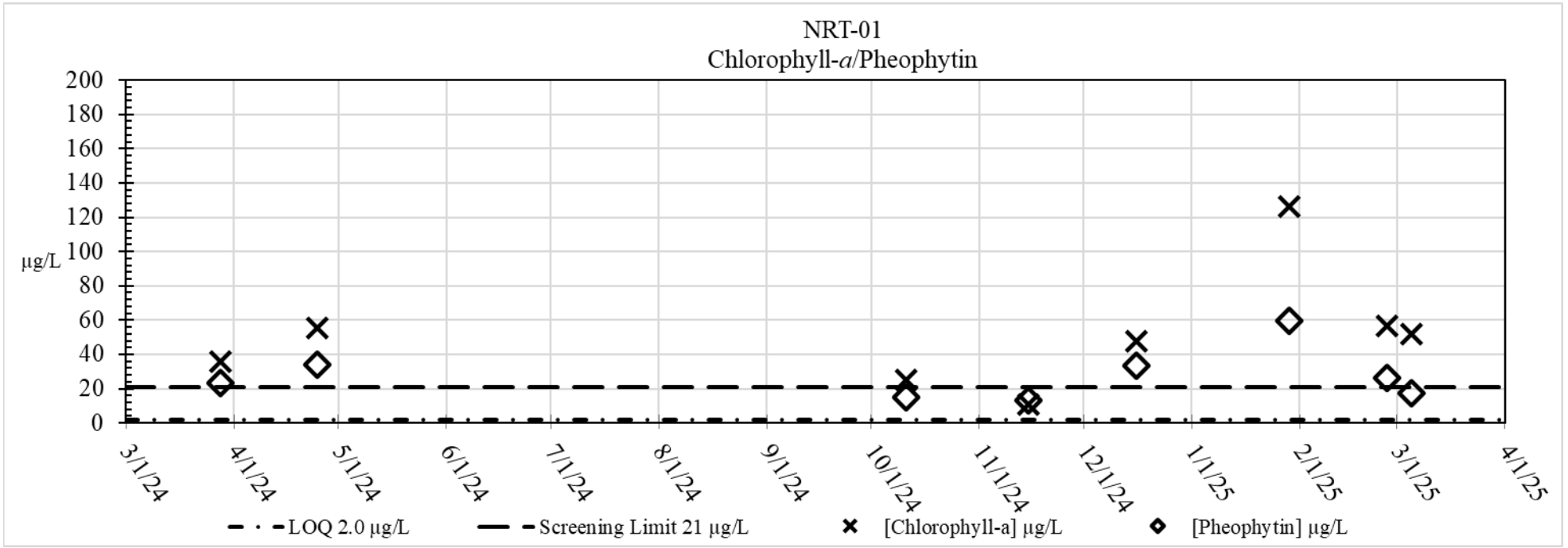

NRT-01
Nitrite-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
[Nitrite] mg/L

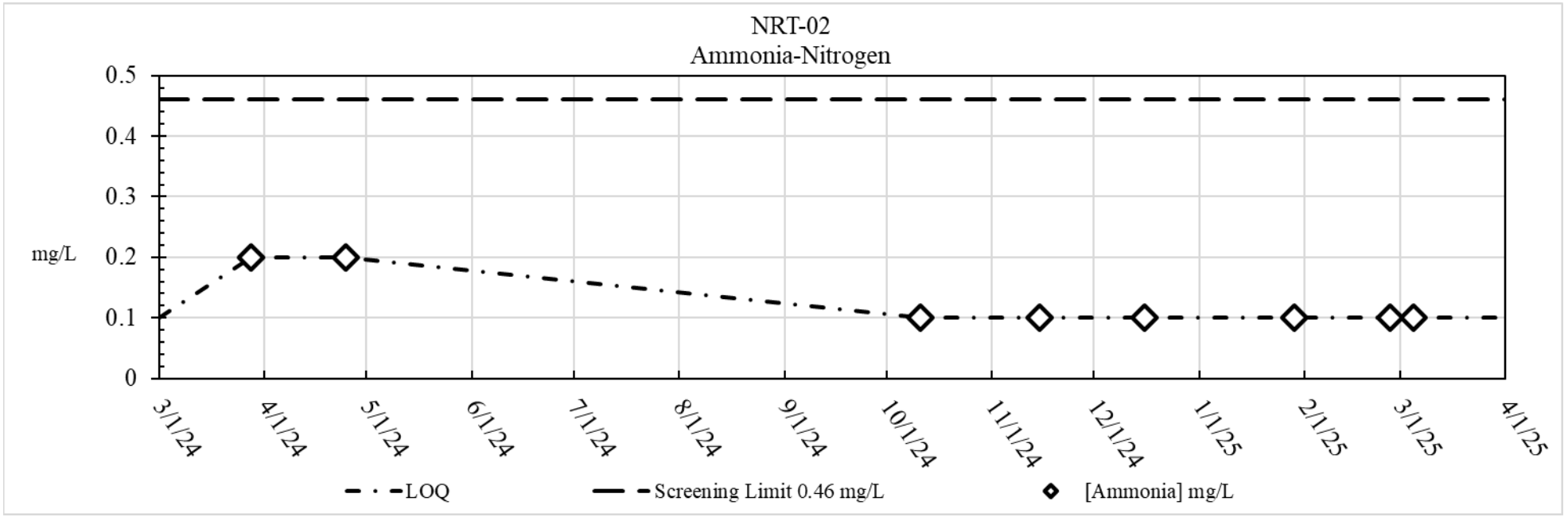

NRT-01
Nitrate-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Level 1.1 mg/L
[Nitrate] mg/L

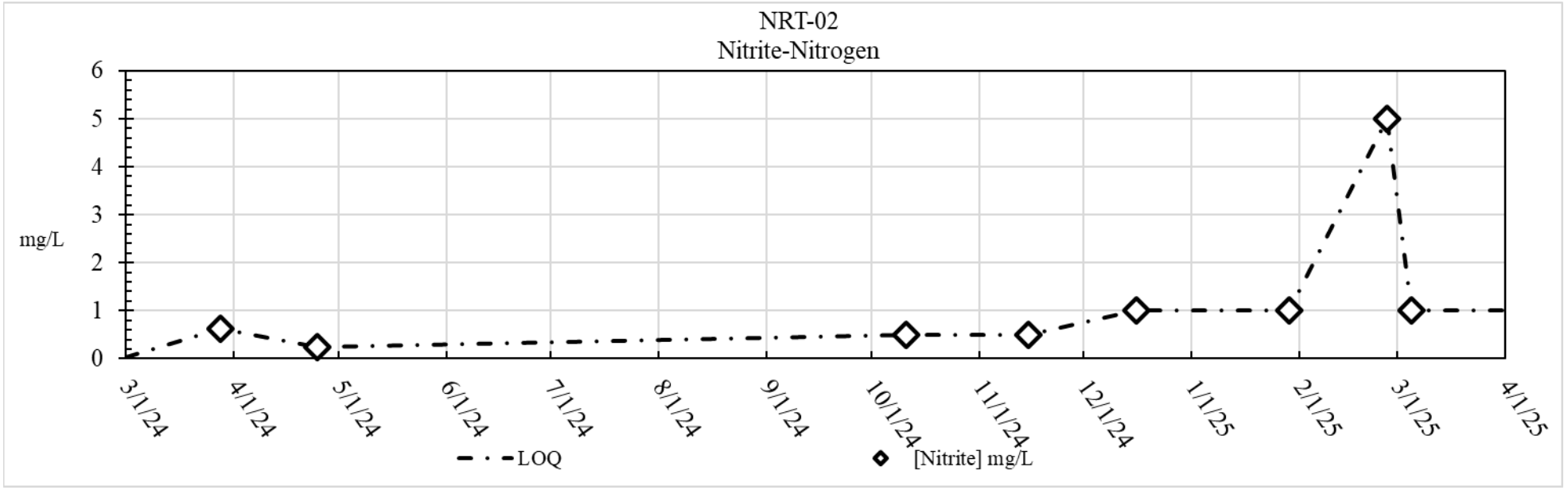

NRT-01
DTKN/TKN
mg/L
8
7
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ <0.2
DISS. TKN mg/L
TKN mg/L

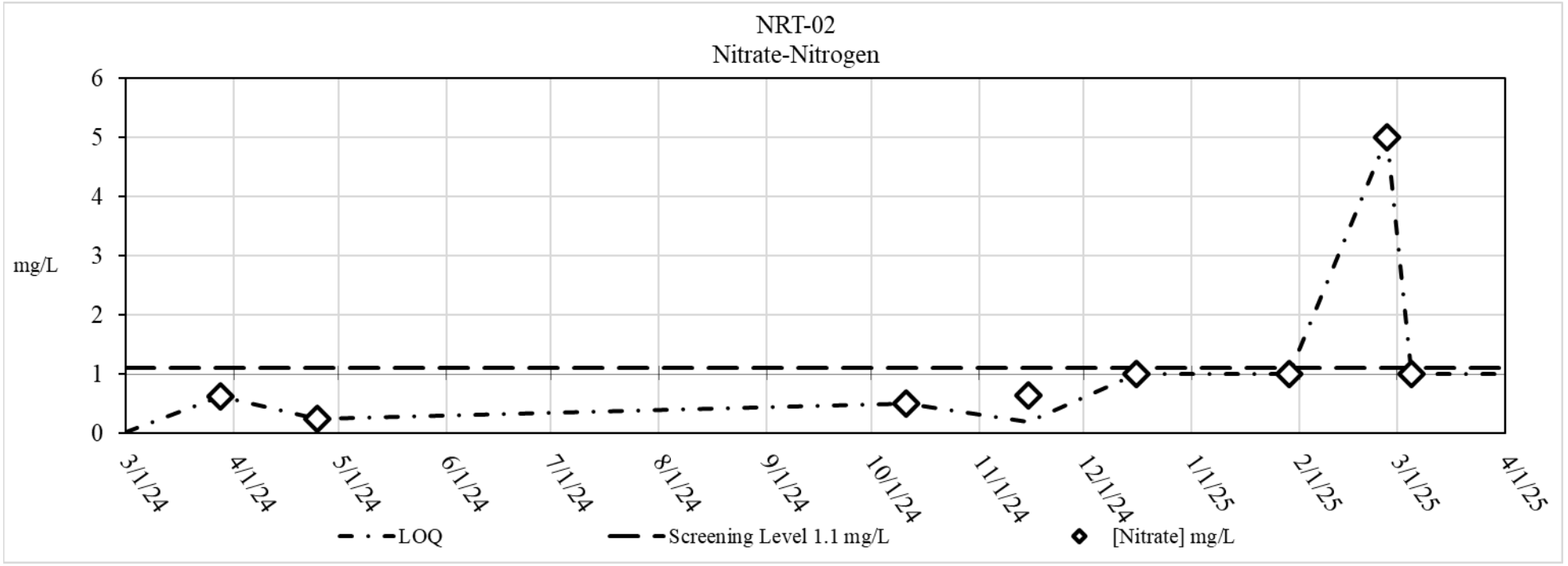

NRT-01
Total Phosphorus
mg/L
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 0.06 mg/L
Screening Limit 0.66 mg/L
[Phosphorus] mg/L

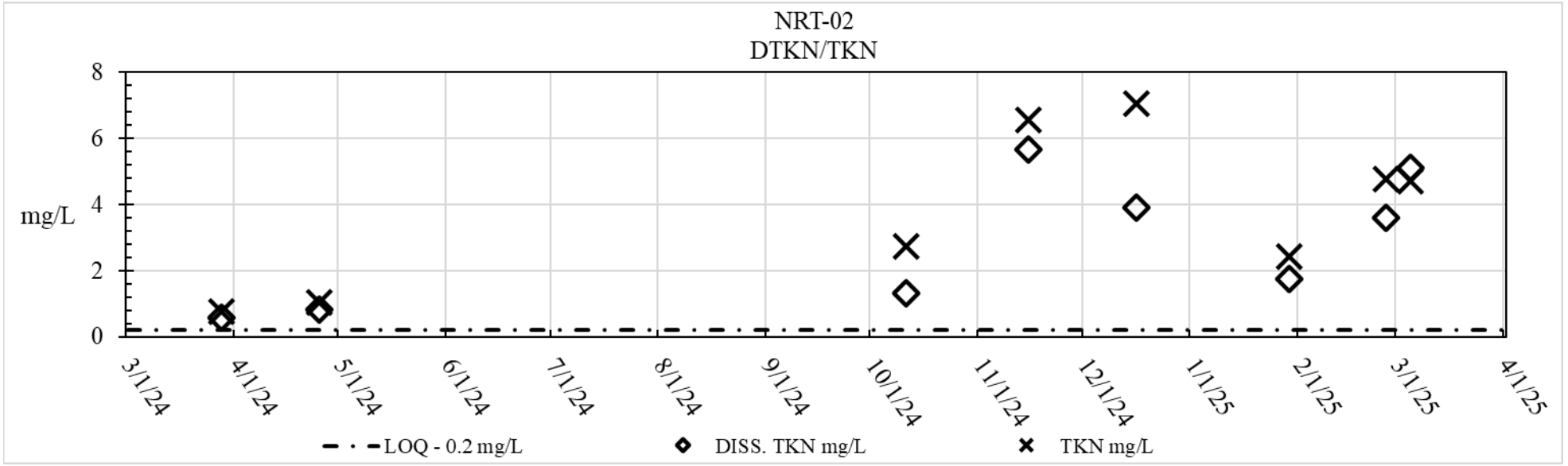

NRT-01
Enterococcus Bacteria
1000
100
CFU/100mL
10
1
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
Criterion 35 CFU/100mL
Reporting Limit 10 CFU/100mL

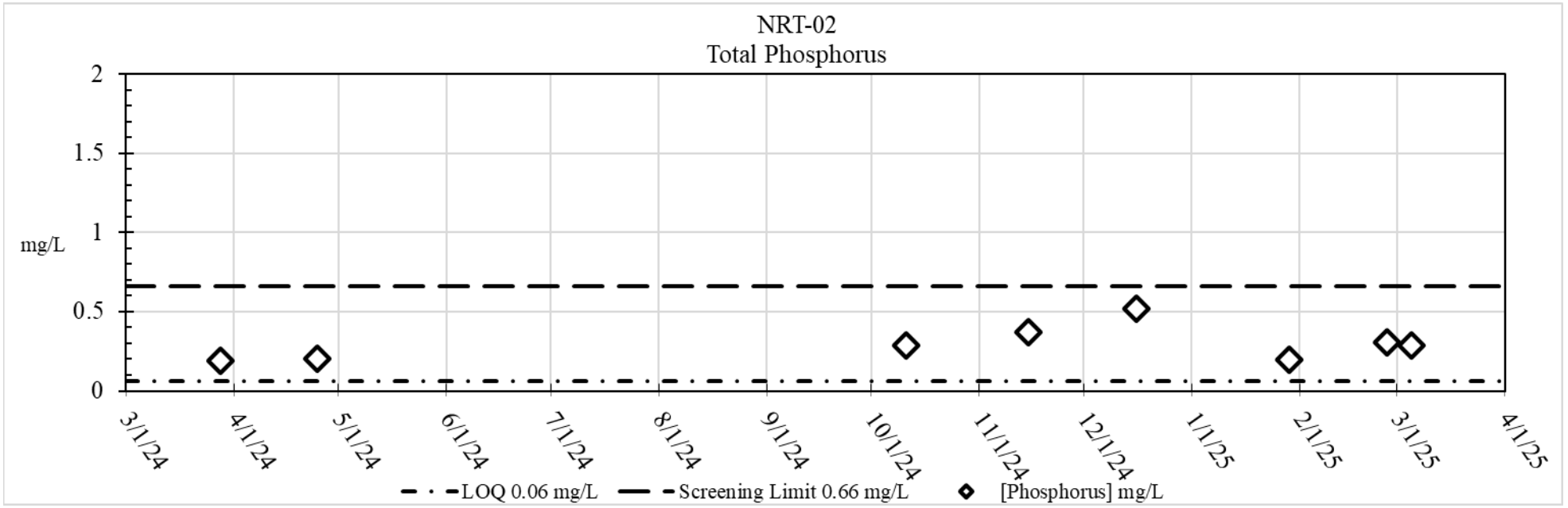

NRT-01
Chlorophyll-a/Pheophytin
200
180
160
140
120
µg/L
100
80
60
40
20
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 2.0 µg/L
Screening Limit 21 µg/L
[Chlorophyll-a] µg/L
[Pheophytin] µg/L

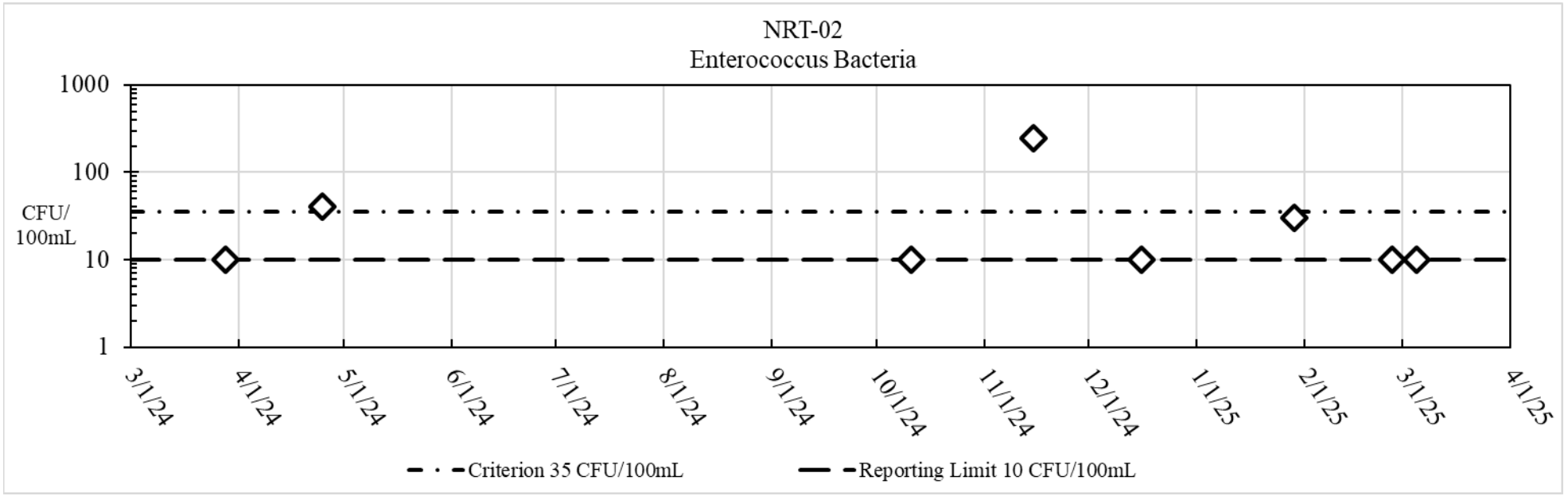

NRT-02
Ammonia-Nitrogen
mg/L
0.5
0.4
0.3
0.2
0.1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Limit 0.46 mg/L
[Ammonia] mg/L

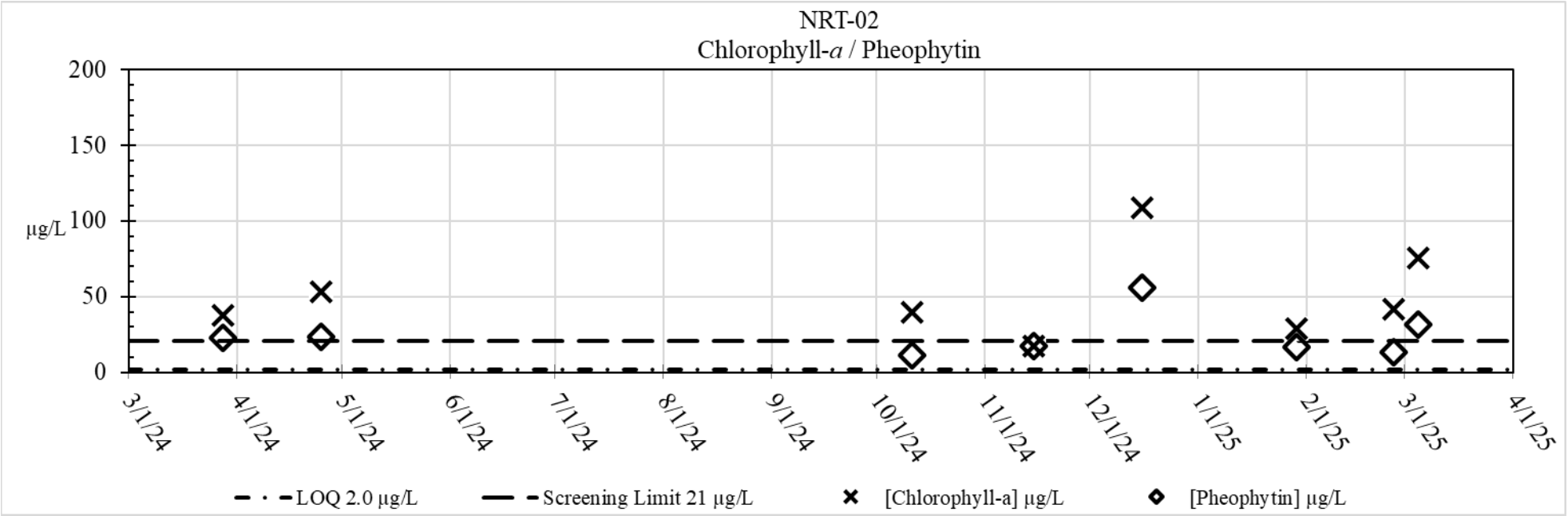

NRT-02
Nitrite-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
[Nitrite] mg/L

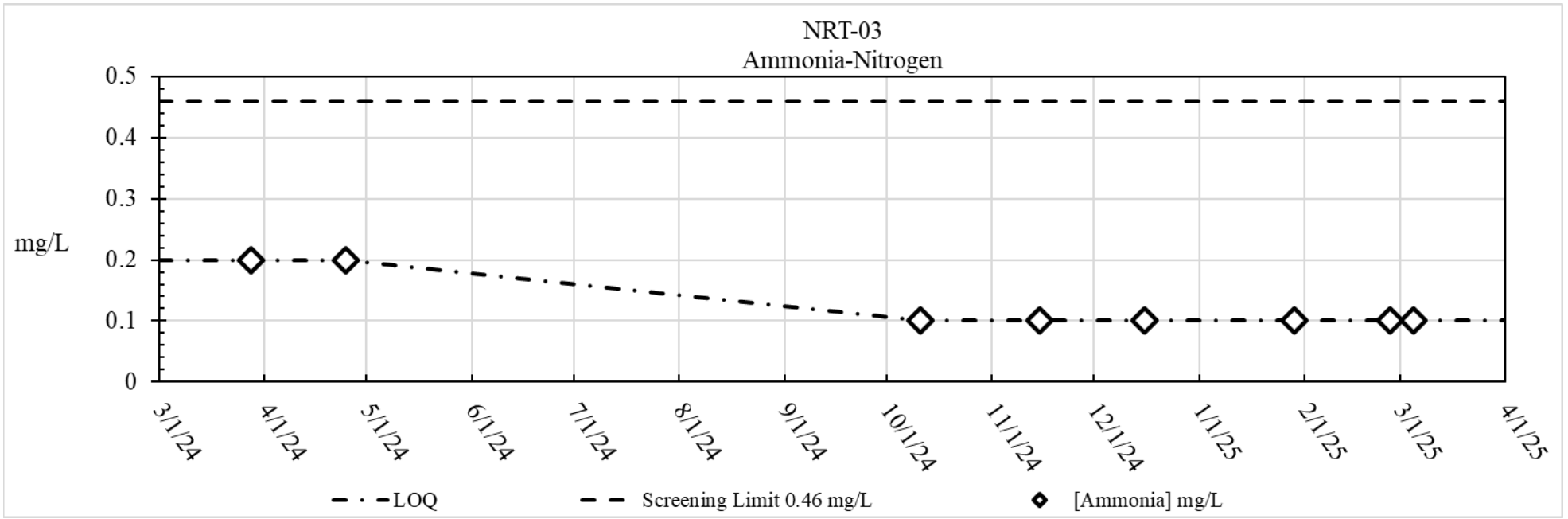

NRT-02
Nitrate-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Level 1.1 mg/L
[Nitrate] mg/L

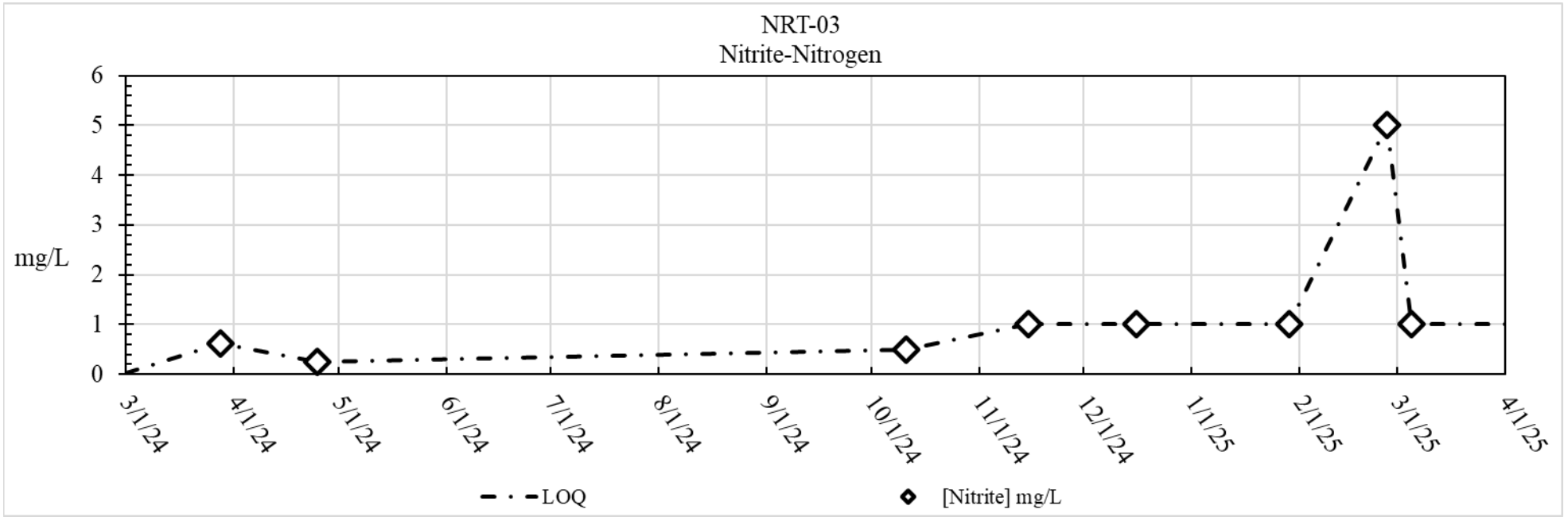

NRT-02
DTKN/TKN
mg/L
8
6
4
2
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ - 0.2 mg/L
DISS. TKN mg/L
TKN mg/L

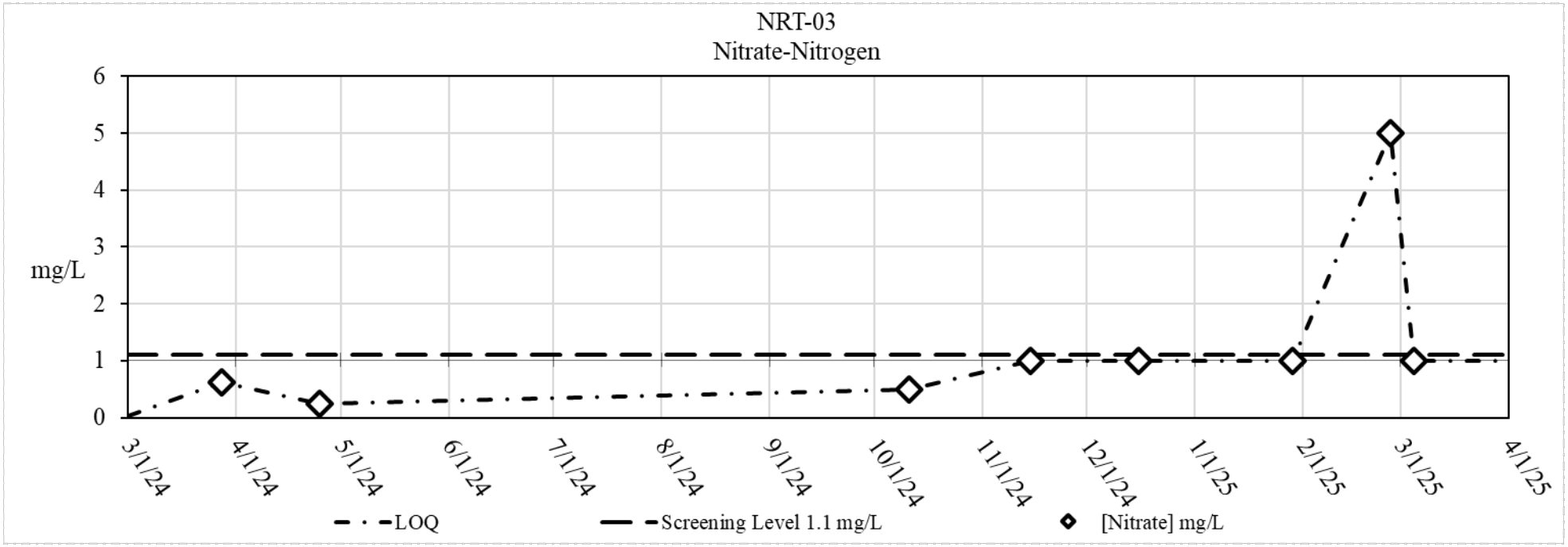

NRT-02
Total Phosphorus
mg/L
2
1.5
1
0.5
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 0.06 mg/L
Screening Limit 0.66 mg/L
[Phosphorus] mg/L

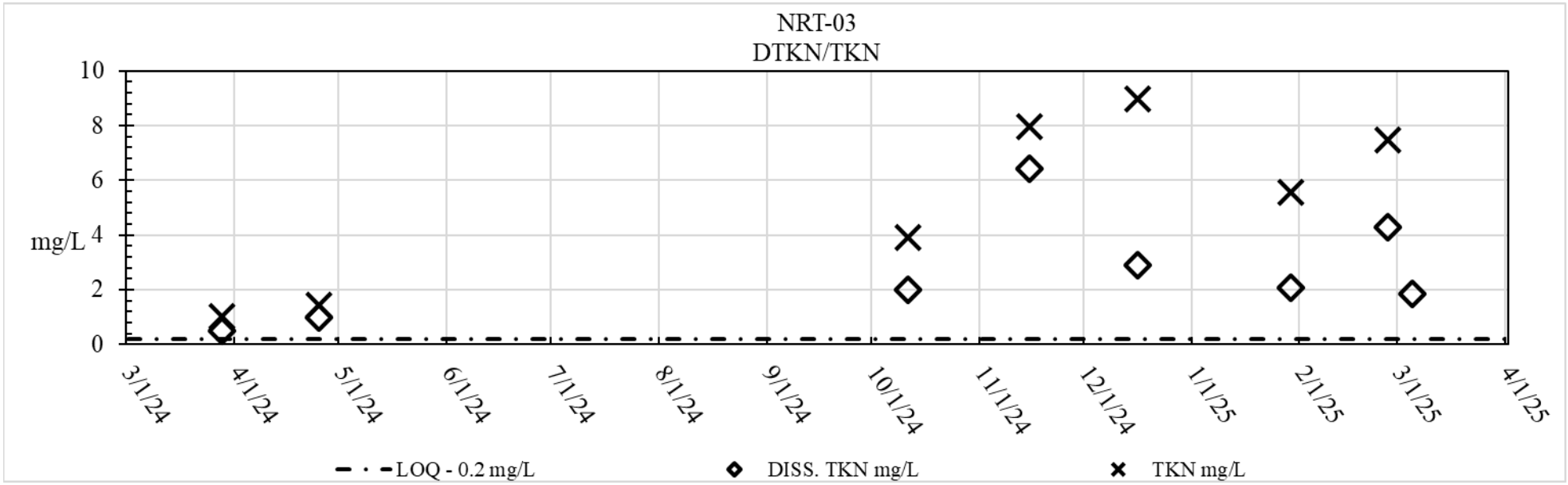

NRT-02
Enterococcus Bacteria
CFU/
100mL
1000
100
10
1
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
Criterion 35 CFU/100mL
Reporting Limit 10 CFU/100mL

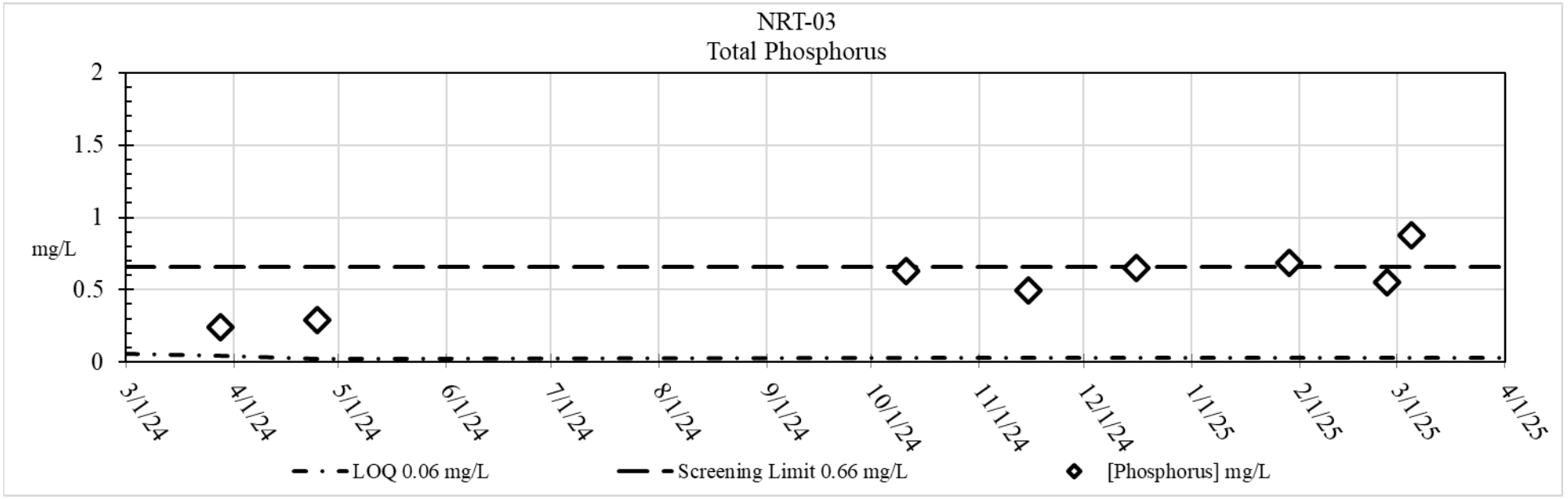

NRT-02
Chlorophyll-a / Pheophytin
200
150
µg/L 100
50
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 2.0 µg/L
Screening Limit 21 µg/L
[Chlorophyll-a] µg/L
[Pheophytin] µg/L

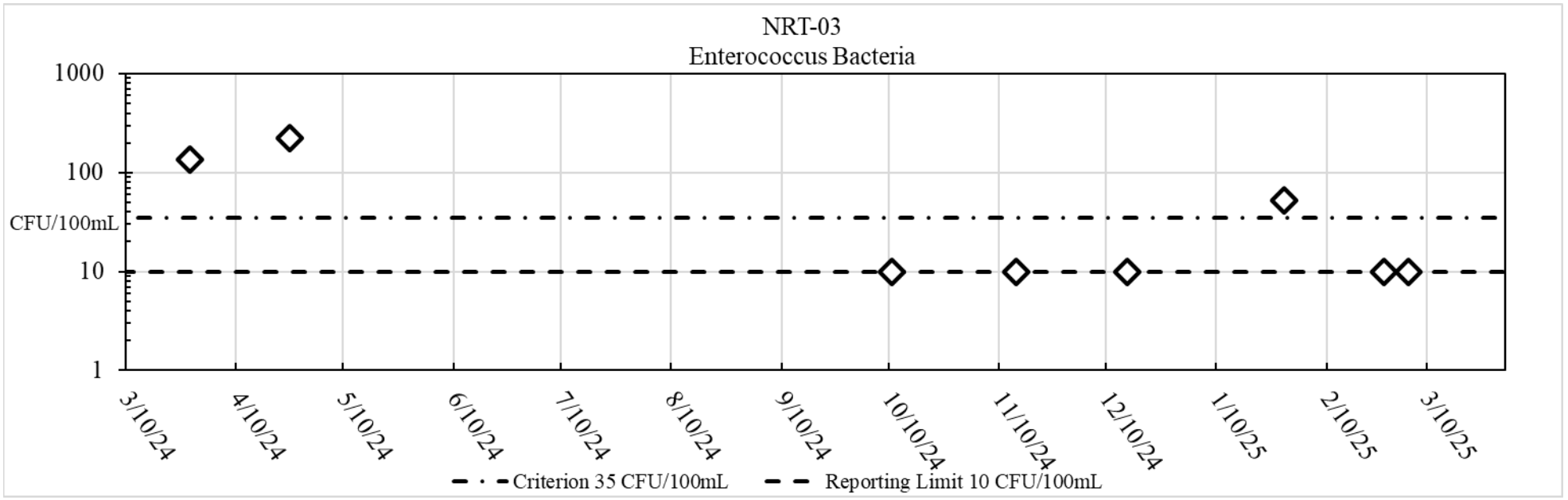

NRT-03
Ammonia-Nitrogen
mg/L
0.5
0.4
0.3
0.2
0.1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Limit 0.46 mg/L
[Ammonia] mg/L

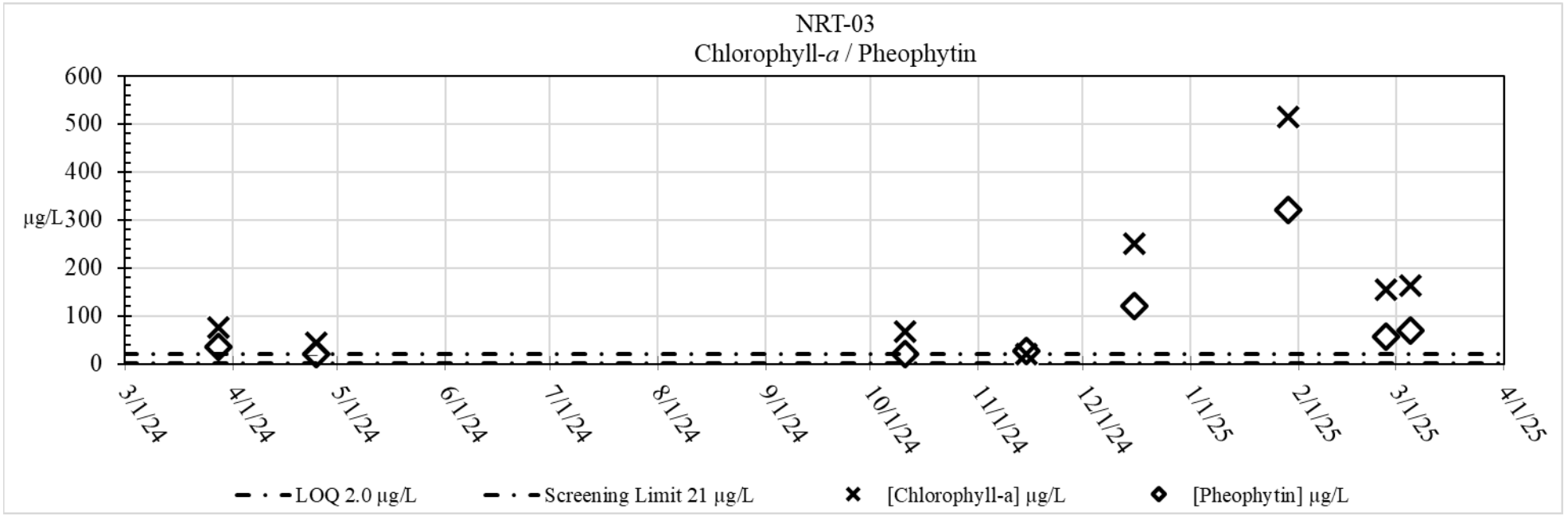

NRT-03
Nitrite-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
[Nitrite] mg/L

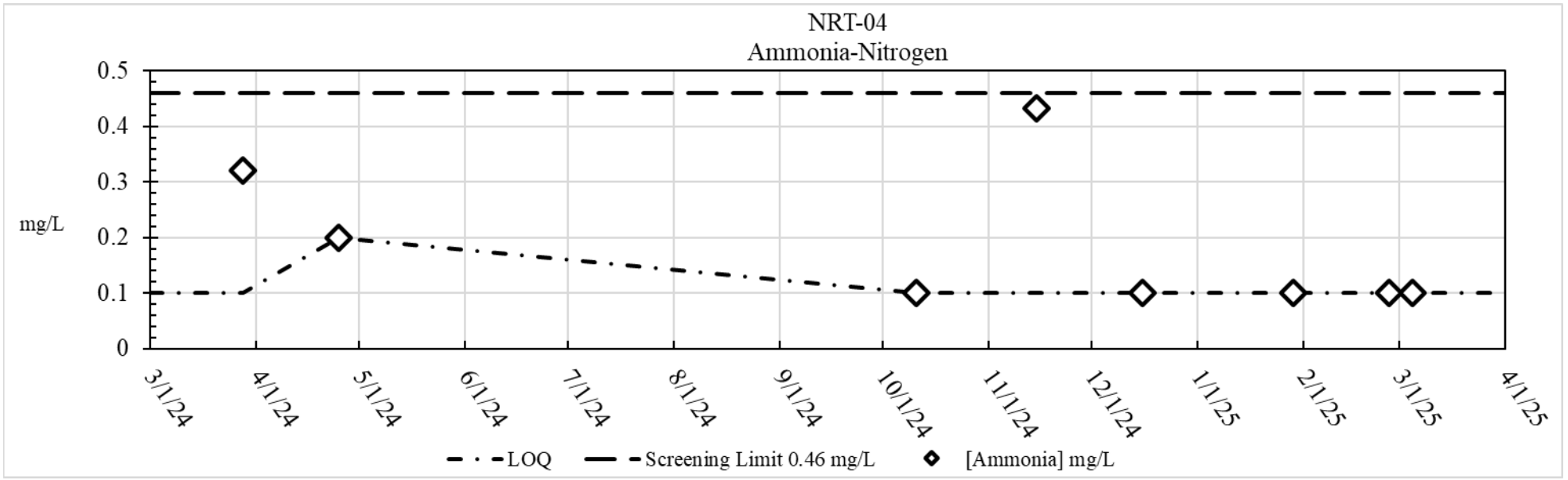

NRT-03
Nitrate-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Level 1.1 mg/L
[Nitrate] mg/L

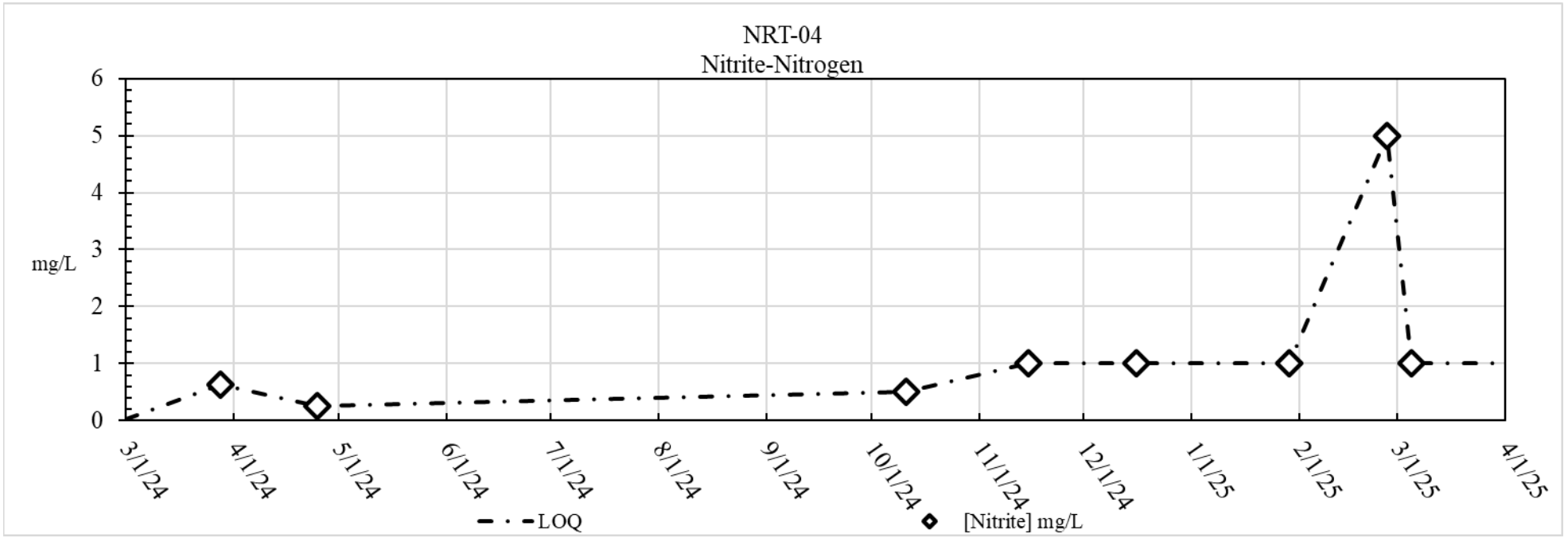

NRT-03
DTKN/TKN
mg/L
10
8
6
4
2
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ - 0.2 mg/L
DISS. TKN mg/L
TKN mg/L

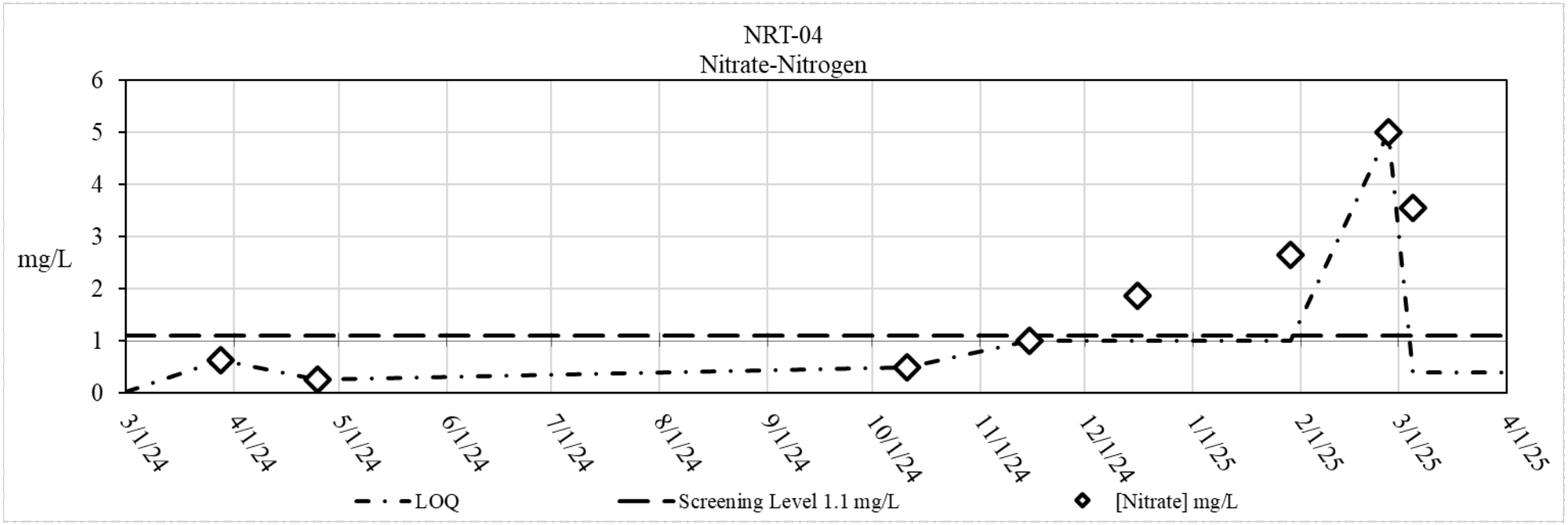

NRT-03
Total Phosphorus
2
1.5
1
0.5
0
mg/L
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 0.06 mg/L
Screening Limit 0.66 mg/L
[Phosphorus] mg/L

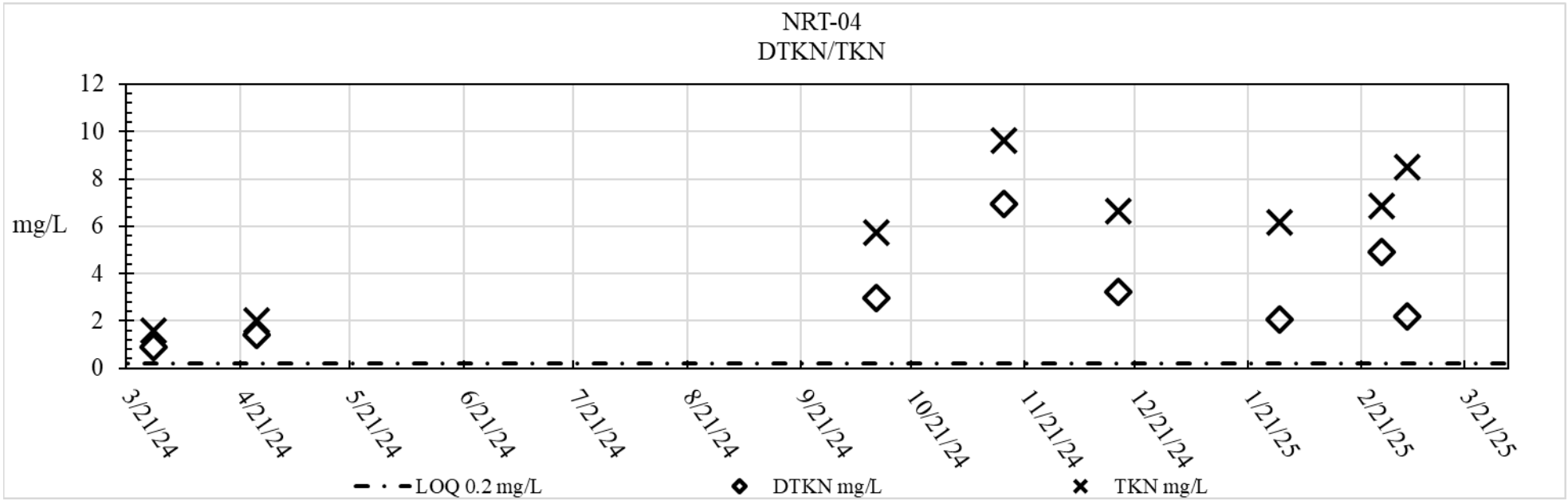

NRT-03
Enterococcus Bacteria
1000
100
10
1
CFU/100mL
3/10/24
4/10/24
5/10/24
6/10/24
7/10/24
8/10/24
9/10/24
10/10/24
11/10/24
12/10/24
1/10/25
2/10/25
3/10/25
Criterion 35 CFU/100mL
Reporting Limit 10 CFU/100mL

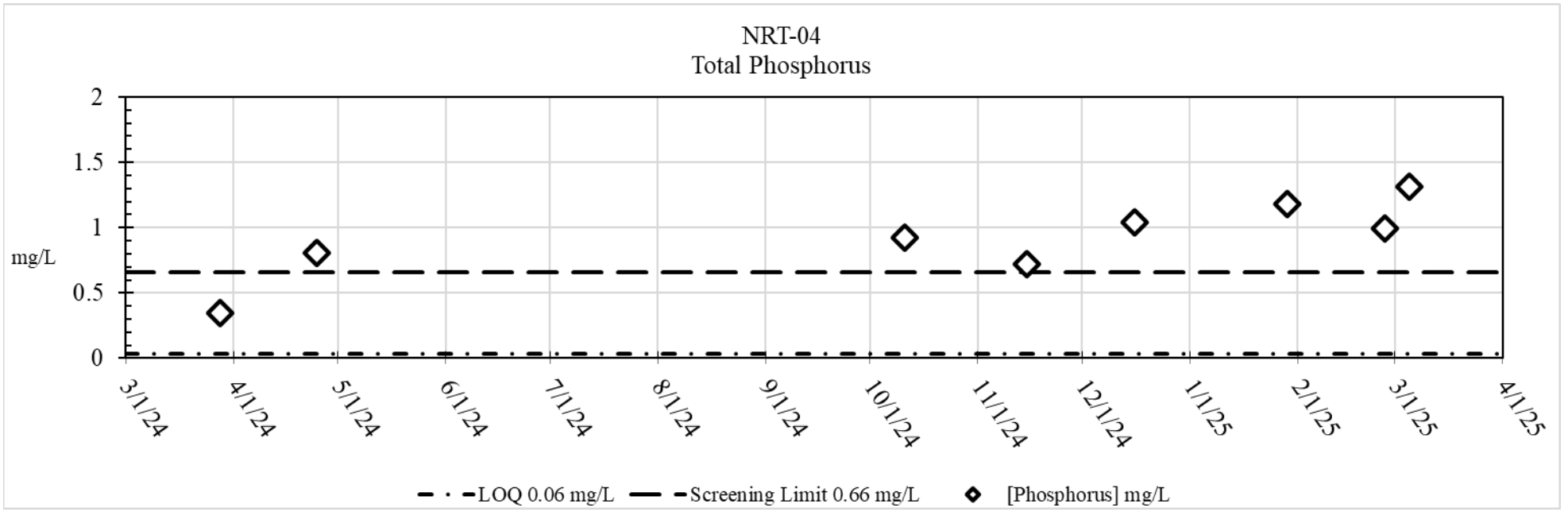

NRT-03
Chlorophyll-a / Pheophytin
600
500
400
µg/L 300
200
100
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 2.0 µg/L
Screening Limit 21 µg/L
[Chlorophyll-a] µg/L
[Pheophytin] µg/L

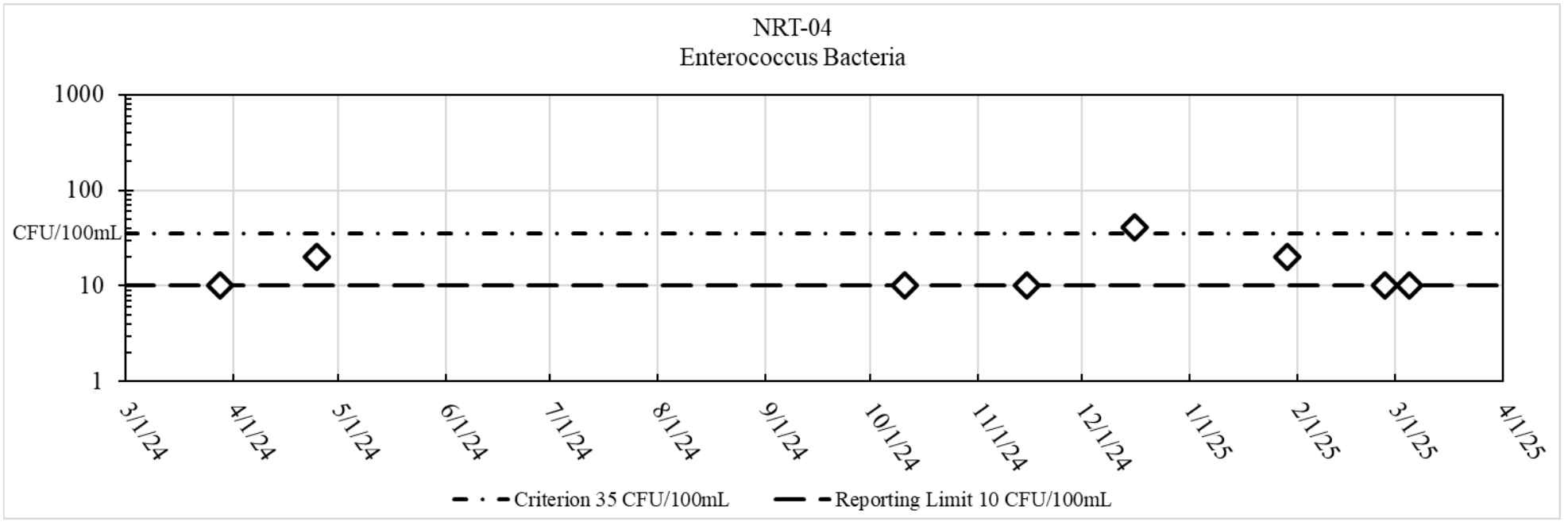

NRT-04
Ammonia-Nitrogen
mg/L
0.5
0.4
0.3
0.2
0.1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Limit 0.46 mg/L
[Ammonia] mg/L

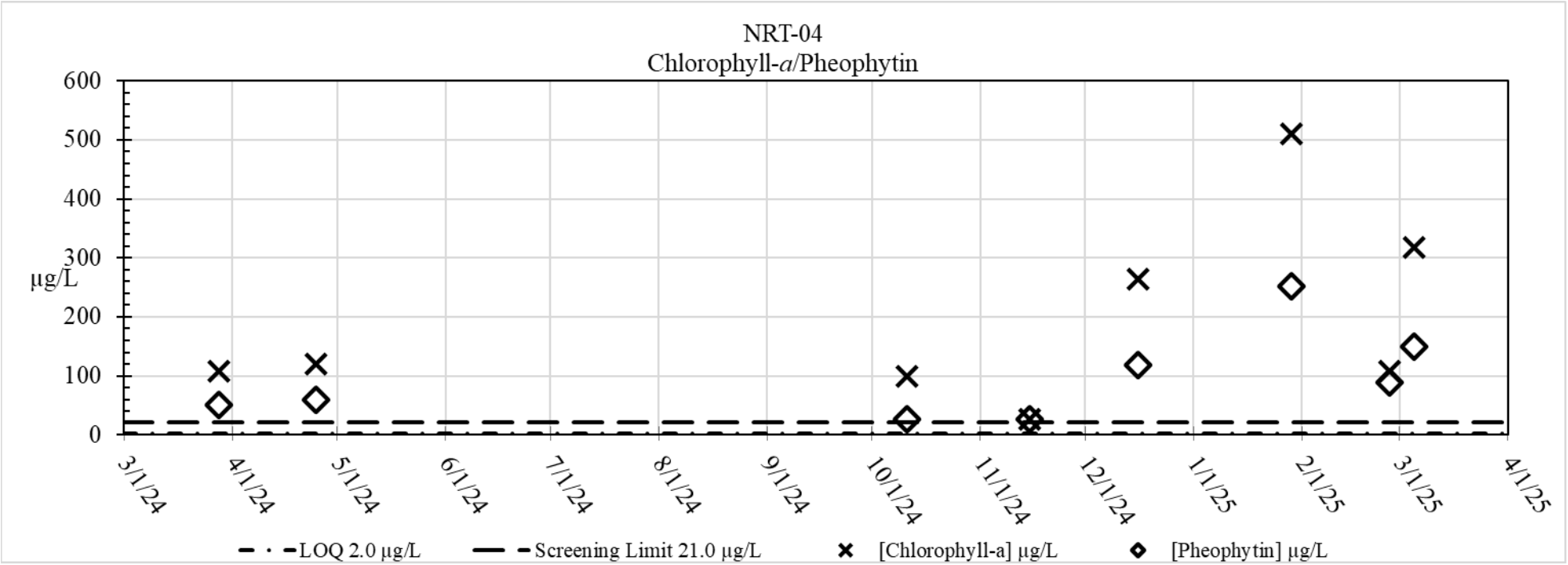

NRT-04
Nitrite-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
[Nitrite] mg/L

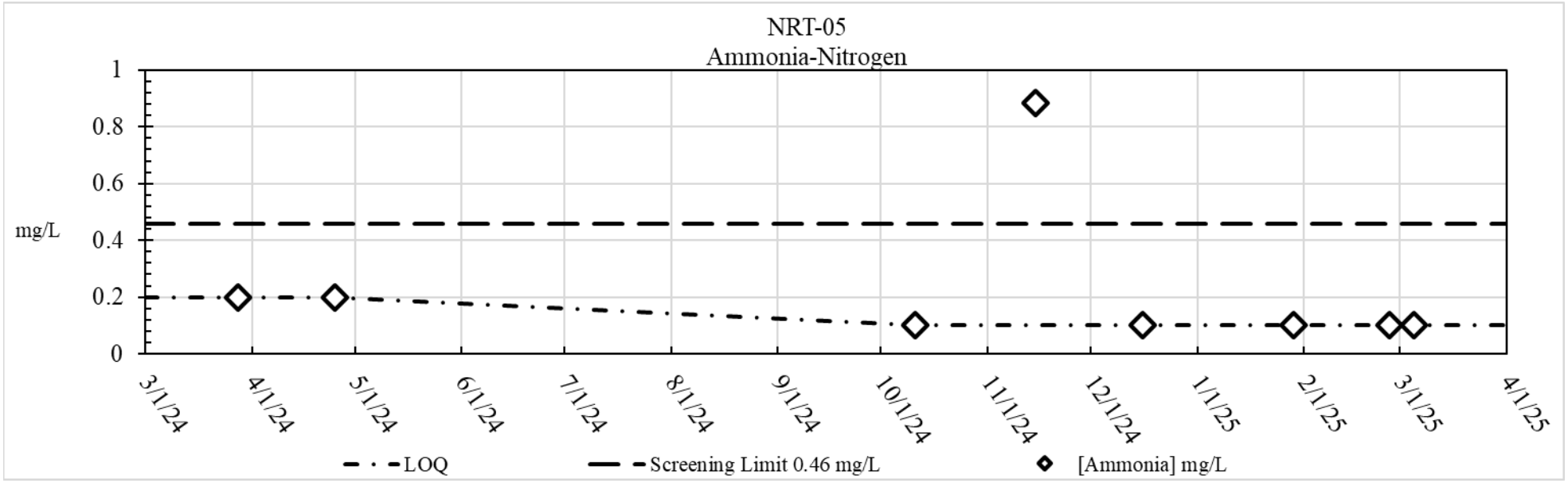

NRT-04
Nitrate-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Level 1.1 mg/L
[Nitrate] mg/L

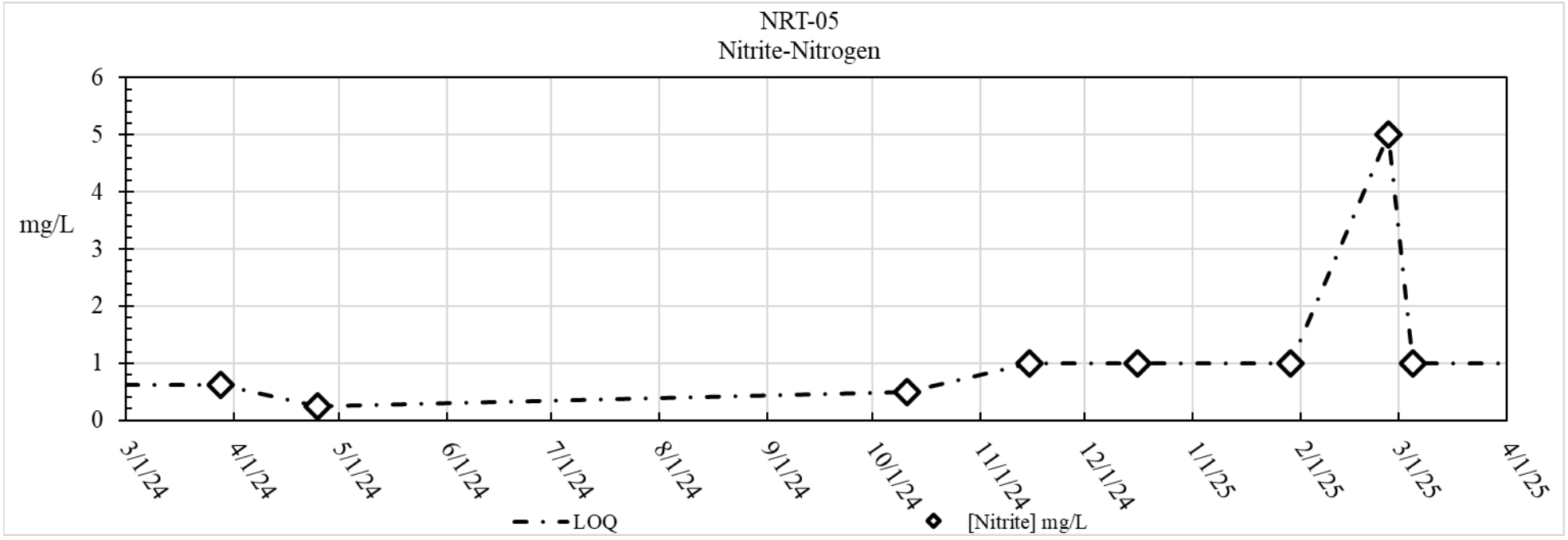

NRT-04
DTKN/TKN
mg/L
12
10
8
6
4
2
0
3/21/24
4/21/24
5/21/24
6/21/24
7/21/24
8/21/24
9/21/24
10/21/24
11/21/24
12/21/24
1/21/25
2/21/25
3/21/25
LOQ 0.2 mg/L
DTKN mg/L
TKN mg/L

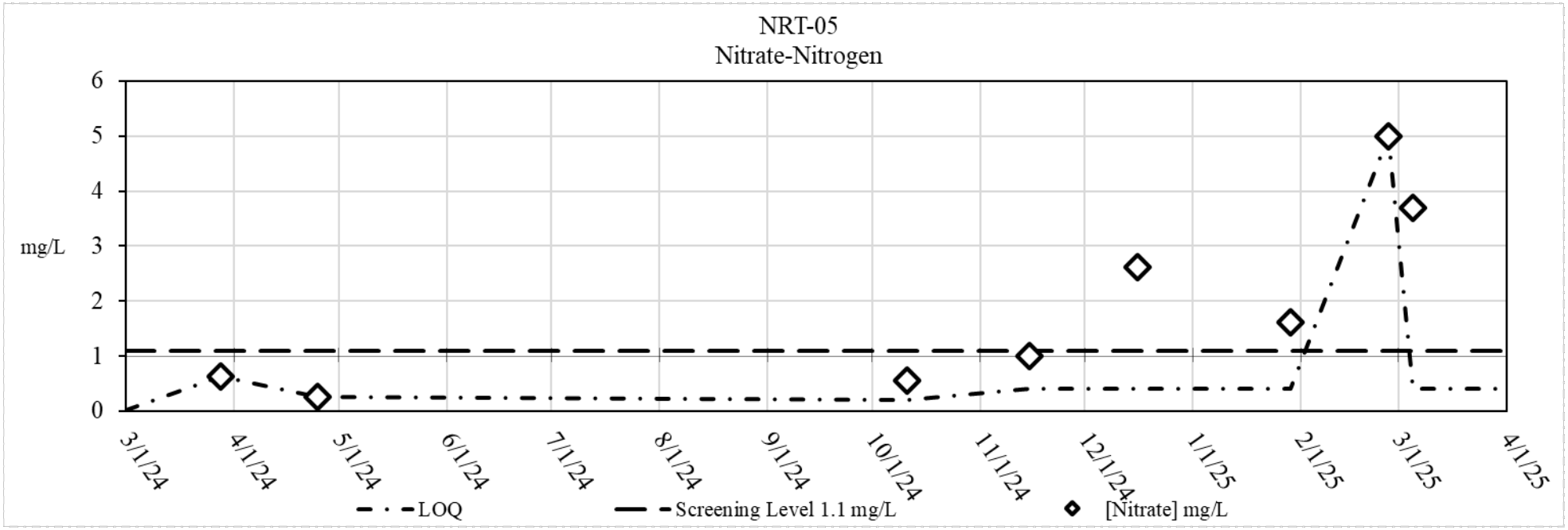

NRT-04
Total Phosphorus
2
1.5
1
0.5
0
mg/L
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 0.06 mg/L
Screening Limit 0.66 mg/L
[Phosphorus] mg/L

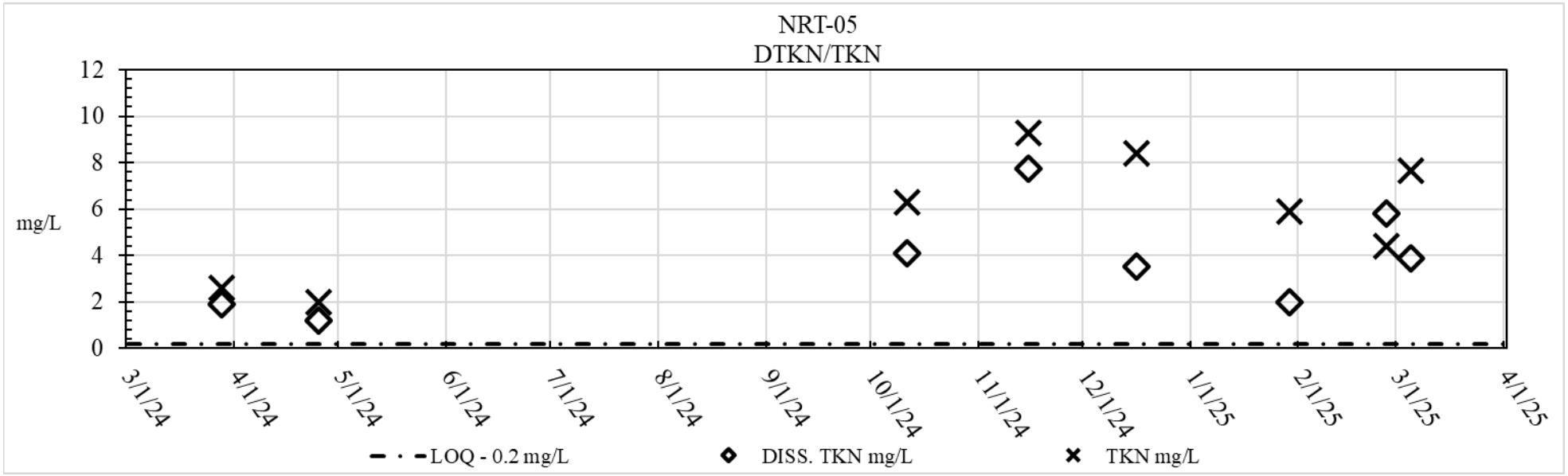

NRT-04
Enterococcus Bacteria
1000
100
10
1
CFU/100mL
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
Criterion 35 CFU/100mL
Reporting Limit 10 CFU/100mL

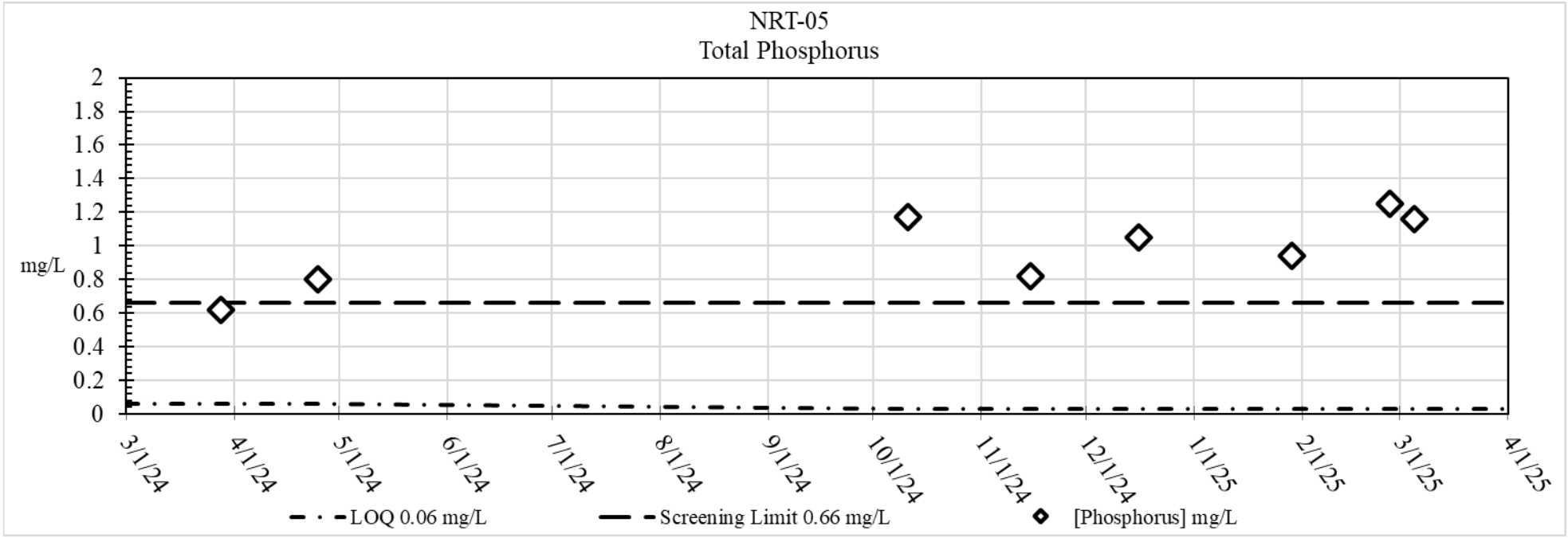

NRT-04
Chlorophyll-a/Pheophytin
600
500
400
300
200
100
0
µg/L
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 2.0 µg/L
Screening Limit 21.0 µg/L
[Chlorophyll-a] µg/L
[Pheophytin] µg/L

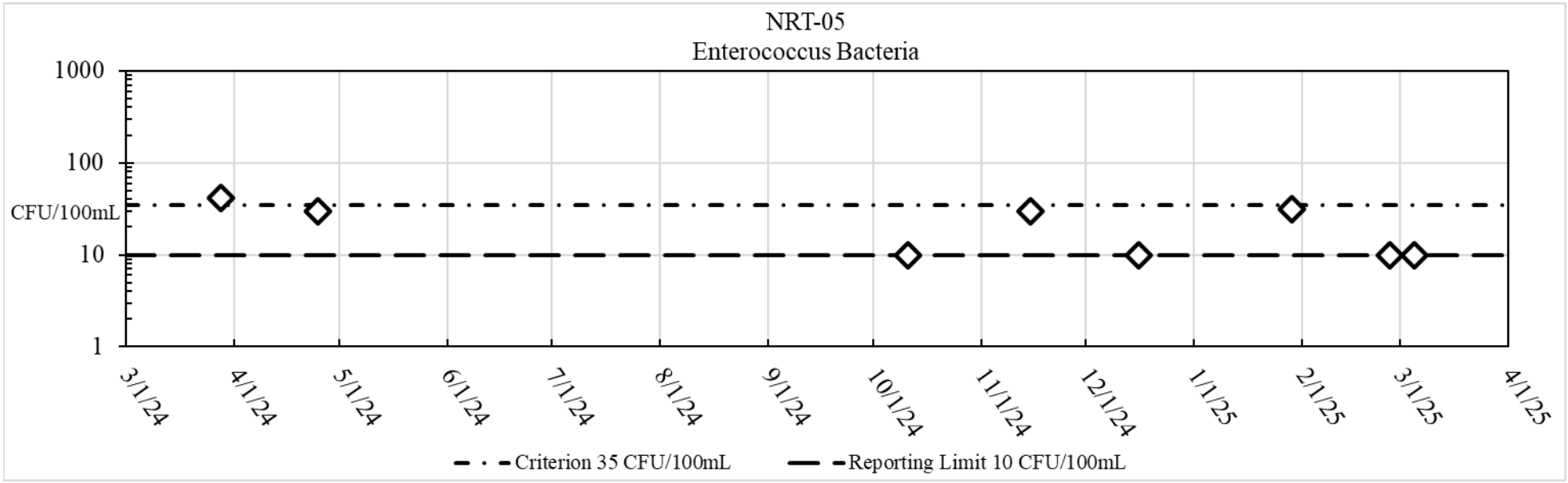

NRT-05
Ammonia-Nitrogen
mg/L
1
0.8
0.6
0.4
0.2
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Limit 0.46 mg/L
[Ammonia] mg/L

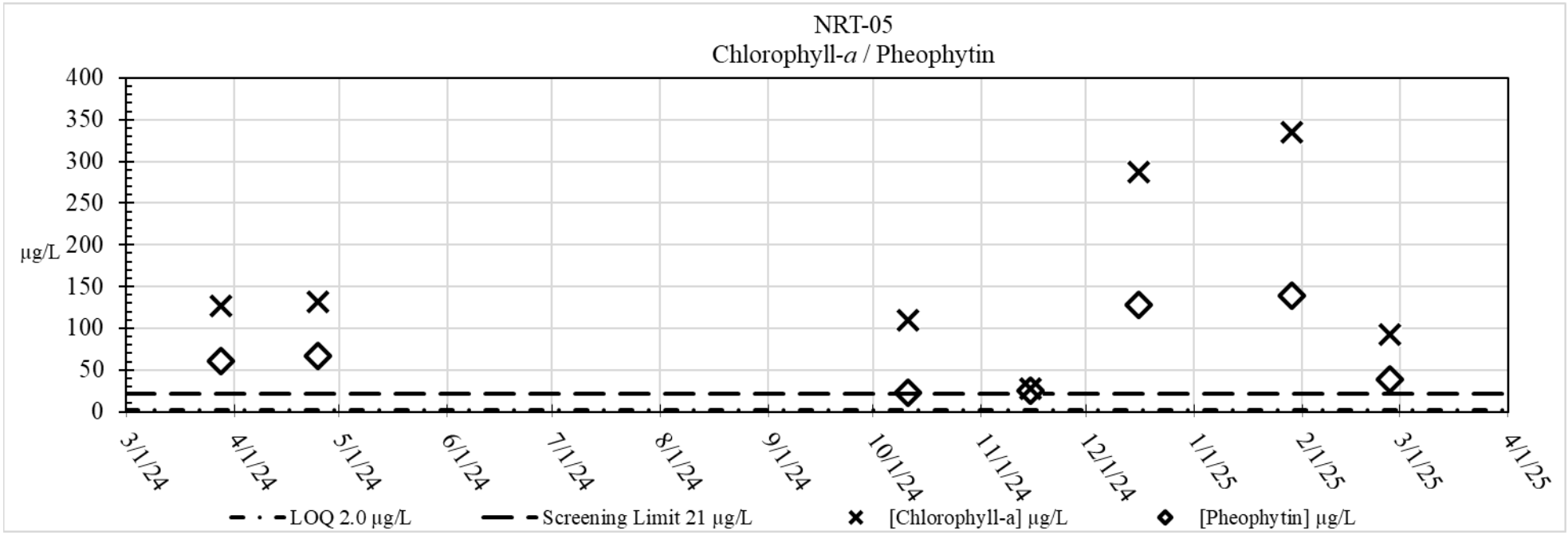

NRT-05
Nitrite-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
[Nitrite] mg/L


NRT-05
Nitrate-Nitrogen
mg/L
6
5
4
3
2
1
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ
Screening Level 1.1 mg/L
[Nitrate] mg/L


NRT-05
DTKN/TKN
mg/L
12
10
8
6
4
2
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ - 0.2 mg/L
DISS. TKN mg/L
TKN mg/L


NRT-05
Total Phosphorus
mg/L
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 0.06 mg/L
Screening Limit 0.66 mg/L
[Phosphorus] mg/L


NRT-05
Enterococcus Bacteria
CFU/100mL
1000
100
10
1
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
Criterion 35 CFU/100mL
Reporting Limit 10 CFU/100mL


NRT-05
Chlorophyll-a / Pheophytin
µg/L
400
350
300
250
200
150
100
50
0
3/1/24
4/1/24
5/1/24
6/1/24
7/1/24
8/1/24
9/1/24
10/1/24
11/1/24
12/1/24
1/1/25
2/1/25
3/1/25
4/1/25
LOQ 2.0 µg/L
Screening Limit 21 µg/L
[Chlorophyll-a] µg/L
[Pheophytin] µg/L

Appendix B

Photographs of Monitoring Stations

NRT-01 at Saltwater Barrier Dam in Calallen

NRT-02 at 30m Downstream from Union Pacific Railroad Bridge #1

NRT-03 at Figueroa Street Terminus

NRT-04 at 1.0 km Upstream of Allison Wastewater Treatment Plant

NRT-05 at 850m Downstream of Allison Wastewater Treatment Plant