2017
New York Harbor Water Quality Report

NYC Environmental Protection

Bill de Blasio, Mayor
Vincent Sapienza, Commissioner

NYC Environmental Protection

Vincent Sapienza, P.E.
Commissioner

Dear Friends,

With 522 miles of shoreline, New York City's waterways are one of our greatest assets. Over the past decade, the City has invested more than $12 billion to upgrade the sewer system and wastewater treatment plants to improve the health of these critical ecosystems. This investment, over time, has produced many ecological successes, ushering in the return of a variety of plant and animal species to our waters – including whales! It has also allowed for the redevelopment of vast swaths of our waterfront and numerous recreational opportunities for residents and visitors.

These encouraging signs further illustrate that New York Harbor is healthier than it has been in more than a century. This historic achievement is a direct result of substantial investment in our infrastructure, utilization of innovative new technologies, and partnerships with elected officials, environmental advocates, and New Yorkers who share our commitment to the natural world. As a protector of public health and the environment, the New York City Department of Environmental Protection (DEP) is leading efforts to restore the Harbor's natural ecology, from building Green Infrastructure and separating sewers, to significantly reducing nitrogen discharges and reconstructing acres of natural wetlands.

I am pleased to share the 2017 Harbor Water Quality Report and I encourage you to read this in conjunction with the NYC Stormwater Management Plan, the NYC Green Infrastructure Annual Report and the State of the Sewers Annual Report to gain a more complete view of the City's coordinated efforts to restore our vital waterways.

Sincerely,

Vincent Sapienza, P.E.
Commissioner

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INTRODUCTION

New York City has monitored the waterways of New York Harbor for more than a century through its Harbor Survey Program. The Survey was initiated in 1909 in response to public outcry over water pollution, and sought to study the relationship between wastewater and harbor water quality. By this time, New York Harbor had long-served as a global hub for commerce and industry and, due to high levels of pollution and bacteria, had lost the ability to support wildlife and recreation.

The City would eventually construct 14 wastewater treatment plants to accommodate a growing population. The Harbor Survey Program has also since expanded to include 89 monitoring stations, with 40 located in open waters and another 49 located in tributaries. The number of water quality parameters measured has also increased from just five in 1909, to 27 at present.

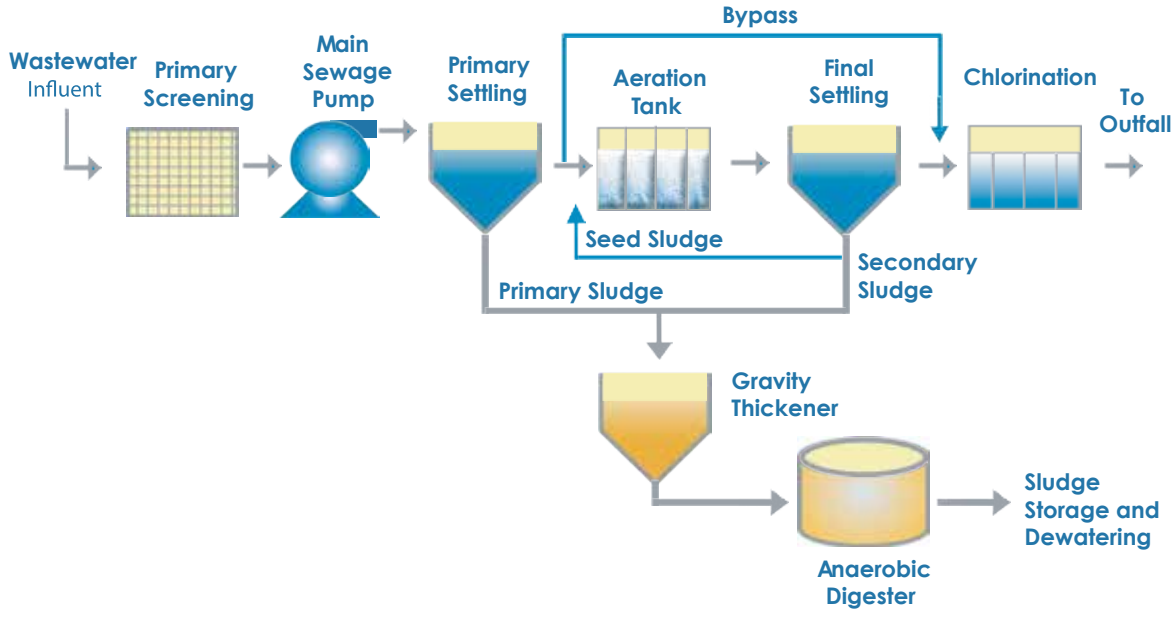
As the largest municipal water and wastewater utility in the country, DEP carries out an expansive environmental mission to protect waterbodies both in and around New York, investing billions of dollars in new infrastructure, while pioneering advancements in wastewater treatment and resource recovery. Over the last decade, water quality in New York Harbor has improved to the point that many waterways are now utilized for recreation and commerce throughout the year.

Newtown Creek Wastewater Treatment Plant

Located in Brooklyn's Greenpoint neighborhood, the Newtown Creek Wastewater Treatment Plant is the largest of New York City's 14 wastewater treatment facilities, situated on 53 acres and serving more than 1 million people in parts of Brooklyn, Queens, and Manhattan. On average, the facility treats about 18% of New York City's wastewater, or 310 million gallons each dry day, with double the capacity when it rains.

WASTEWATER TREATMENT PROCESS

THE WASTEWATER TREATMENT PROCESS



Every day more than 8.6 million New Yorkers send more than a billion gallons of wastewater down toilets and drains into New York City's 7,500 miles of sewer lines and then to one of DEP's 14 Wastewater Treatment Plants (WWTP).

At WWTPs, physical and biological processes closely duplicate how wetlands, rivers, streams, and lakes naturally purify water. While the natural treatment of wastewater can take weeks, treatment at a plant is comparatively quick, taking only seven hours to remove most pollutants.

INVESTING IN OUR INFRASTRUCTURE

New York City, like other older urban communities, is largely serviced by a combined sewer system where stormwater that falls on roofs, streets, and sidewalks, and wastewater from homes and businesses, are carried through a single sewer line to treatment plants. The City's 14 treatment plants can manage and treat to federal Clean Water Act standards all the wastewater created in New York City on a dry weather day, or about 1.3 billion gallons on average. On a rainy day they have the capacity to clean more than twice the dry weather flows. However, during intense precipitation events, the stormwater that falls on the City's impervious surfaces exceeds that capacity and overflows can be discharged into local waterways, otherwise known as a Combined Sewer Overflow (CSO). If the overflows were not discharged, the City's treatment plants would be flooded and severely damaged and wastewater could backup into homes and businesses.

To reduce CSO's, DEP has upgraded key wastewater treatment facilities, expanded and separated storm sewers, constructed large CSO retention tanks, and has incorporated the nation's largest green infrastructure program to further mitigate this source of pollution. The city's standardized CSO capture rate has risen from about 30% in 1980, to over 80% today. DEP has committed $4.1 billion to these projects and has completed a series of Long Term Control Plans which commit an additional $4.4 billion to further mitigate the water quality impact of CSO events.

The remaining part of the City is serviced by the Municipal Separate Storm Sewer System or MS4. In MS4 areas, stormwater flows over streets and other impervious surfaces sweeping up pollutants such as oils, chemicals, pathogens, and sediments

26th Ward Wastewater Treatment Plant Earns ASCE Award

The American Society of Civil Engineers (ASCE) recently named DEP's 26th Ward Wastewater Treatment Plant in Brooklyn an "Infrastructure Game Changer." The treatment plant is currently undergoing a $150 million upgrade.

New Curbside Rain Gardens Beautify The Bronx

Each rain garden has been specially designed to collect and absorb up to 2,500 gallons of stormwater each time it rains, or 12 million gallons each year. This project will ease pressure on the combined sewer system during heavy rain storms and reduce overflows into the Hutchinson River.

Sewer Infrastructure Upgrades

DEP oversees a robust capital plan and is committed to separating sewers where feasible. This helps to reduce street flooding and CSO's, contributing to a healthier, more resilient New York Harbor.

New Green Playground Opens in Flushing

The Trust for Public Land and New York City unveiled a state-of-the art "green" playground on a formerly cracked asphalt lot at the Edward Bleeker School, JHS 185, in the Flushing neighborhood of Queens.

and discharging it directly into local waterways. DEP recently released the NYC Stormwater Management Plan which describes several programs to reduce pollution in stormwater runoff in these areas and further improve water quality

SEPARATING SEWERS

A $132 million project in the College Point neighborhood of Queens to separate the existing Combined Sewer System will reduce CSO's into the Upper East River and Flushing Bay. The work includes the construction of more than 400 new catch basins and nearly 12 miles of new sewers, allowing for the decommissioning of three existing combined sewer outfalls. It is estimated that CSO's will be reduced by nearly 50 million gallons annually.

Work is also underway on a $56.5 million project in the Canarsie neighborhood of Brooklyn that will include the construction of more than 7 miles of new, high-level storm sewers to collect stormwater runoff, thereby diverting it from the existing combined sewer system and improving the health of Fresh Creek and Jamaica Bay.

Additionally, the Gowanus neighborhood in Brooklyn is receiving nearly three miles of high level storm sewers which will create additional capacity in the neighborhood's drainage system. The $52 million project will help to reduce street flooding and the amount of CSO that may be discharged into the Gowanus Canal during heavy rain storms.

CAPTURING STORMWATER

As traditional "grey" infrastructure upgrades have become increasingly more expensive, DEP has launched the NYC Green Infrastructure Plan.

An alternative approach to improving harbor water quality, the plan combines traditional infrastructure upgrades and the integration of green infrastructure to capture and retain stormwater runoff before it can ever enter the sewer system and contribute to CSOs. DEP will invest $1.5 billion to build green infrastructure by 2030.

To date, more than 4,000 rain gardens have been constructed across the city. In addition to installing green infrastructure in the public right-of-way, DEP is also partnering with NYC Parks

and The Trust for Public Land to add stormwater-capturing green elements such as retention basins, permeable pavement and trees, to playgrounds in schoolyards and parks citywide. DEP has committed more than $50 million to NYC Parks' Community Parks Initiative and has transformed more than a dozen asphalt schoolyards into green playgrounds through The Trust for Public Land's Playground Program.

ECOLOGICAL RESTORATION

In addition to improving water quality through investments in more advanced wastewater treatment and stormwater management, DEP has committed to protecting and restoring marine ecosystems.

In 2016 DEP completed the final phase of a $455 million upgrade of the Paerdegat Basin area which has already led to significant improvements in water quality and aesthetics, including restoration of over 50 acres of native grasslands and wetlands and the construction of a 5-acre Ecology Park. Earlier, DEP built and activated a 50-million gallon CSO retention facility and dredged approximately 23,000 cubic yards of sediment from the bottom of the Basin.

In the larger Jamaica Bay area, DEP has worked with partners to restore 142 acres of marsh islands and over 400 acres of maritime grassland and forests. Similar wetland restorations have taken place in Alley Creek, Flushing Bay and even Newtown Creek.

NITROGEN REDUCTION

Nitrogen is the most common element in the Earth's atmosphere. It is a major building block of plant and animal proteins, as well as a key nutrient for all types of life. Although it is not a pathogen and poses no threat to human health, excess nitrogen can promote the growth of harmful algae and reduce levels of dissolved oxygen in waterbodies, limiting the ability of a waterbody to sustain a healthy ecosystem.

NYC is a regional leader in reducing nitrogen discharges and following a $1 billion investment in upgrades at four wastewater treatment plants, the amount of nitrogen being discharged into the Upper East River has been reduced by more than 60 percent. These significant upgrades are already

Using Oysters as Natural Filters

DEP joined the Billion Oyster Project in 2016 to install 50,000 oysters in Jamaica Bay – the largest single installation of breeding oysters in New York City.

Wetland Restoration in Flushing Bay

Following a sewer upgrade to reduce CSOs and dredging to eliminate odors, DEP restored more than three acres of wetlands to improve the ecological health of Flushing Bay.

contributing to the improvement of the health and ecology of the East River, Long Island Sound and New York Harbor.

Work is also underway on a $23 million upgrade to the Rockaway Wastewater Treatment Plant that will reduce the amount of nitrogen released into Jamaica Bay and help to improve the overall ecology of the waterway. The project is anticipated to be completed in 2020. This project complements the $460 million in upgrades that have already been completed to reduce nitrogen discharges from the Jamaica and 26th Ward Wastewater Treatment Plants, which similarly drain to Jamaica Bay.

HARBOR WATER QUALITY SURVEY PROGRAM AND REPORT

In addition to the Harbor Survey Program, the City has several other water quality monitoring programs including the Sentinel Monitoring Program, Shoreline Survey, the Field Sampling and Analysis Program, and DEP reviews data collected by citizen scientists.

Water quality data collected by DEP scientists in Summer 2017 will be presented in five sections, with four delineating each geographic region within the harbor, and one discussing nitrogen. The water quality parameters used as indicators of water quality for this report are bacteria (fecal coliform and enterococcus), dissolved oxygen, chlorophyll ‘a’ and Secchi transparency. These parameters and their relevance are explained in the synopsis that follows.

SYNOPSIS OF FOUR MAJOR INDICATORS OF ENVIRONMENTAL CHANGE

Dissolved Oxygen **-** The oxygen dissolved in the water column is critical to respiration in most aquatic life forms, including fish and invertebrates such as crabs, clams, and zooplankton. Because oxygen is essential for much ocean life, dissolved oxygen is one of the important indicators of overall water quality. Where geography allows, DEP scientists measure the amount of oxygen dissolved in water at both the surface and the bottom of the water column.

Bacteria **-** Concentrations of certain bacteria are measured as human health-related indicators of harbor water quality. DEP scientists measure concentrations of two groups of bacteria. Fecal coliform bacteria are found in human and animal intestines and are associated with wastewater. These bacteria are widely used to indicate the possible presence of pathogenic (disease-producing) bacteria. Enterococci are a subgroup within the fecal streptococcus group and are distinguished by their ability to survive in salt water. The US Environmental Protection Agency recommends enterococci as the best indicator of health risk in salt water used for recreation. Bacteria counts are calculated as summer geographic means for May to October.

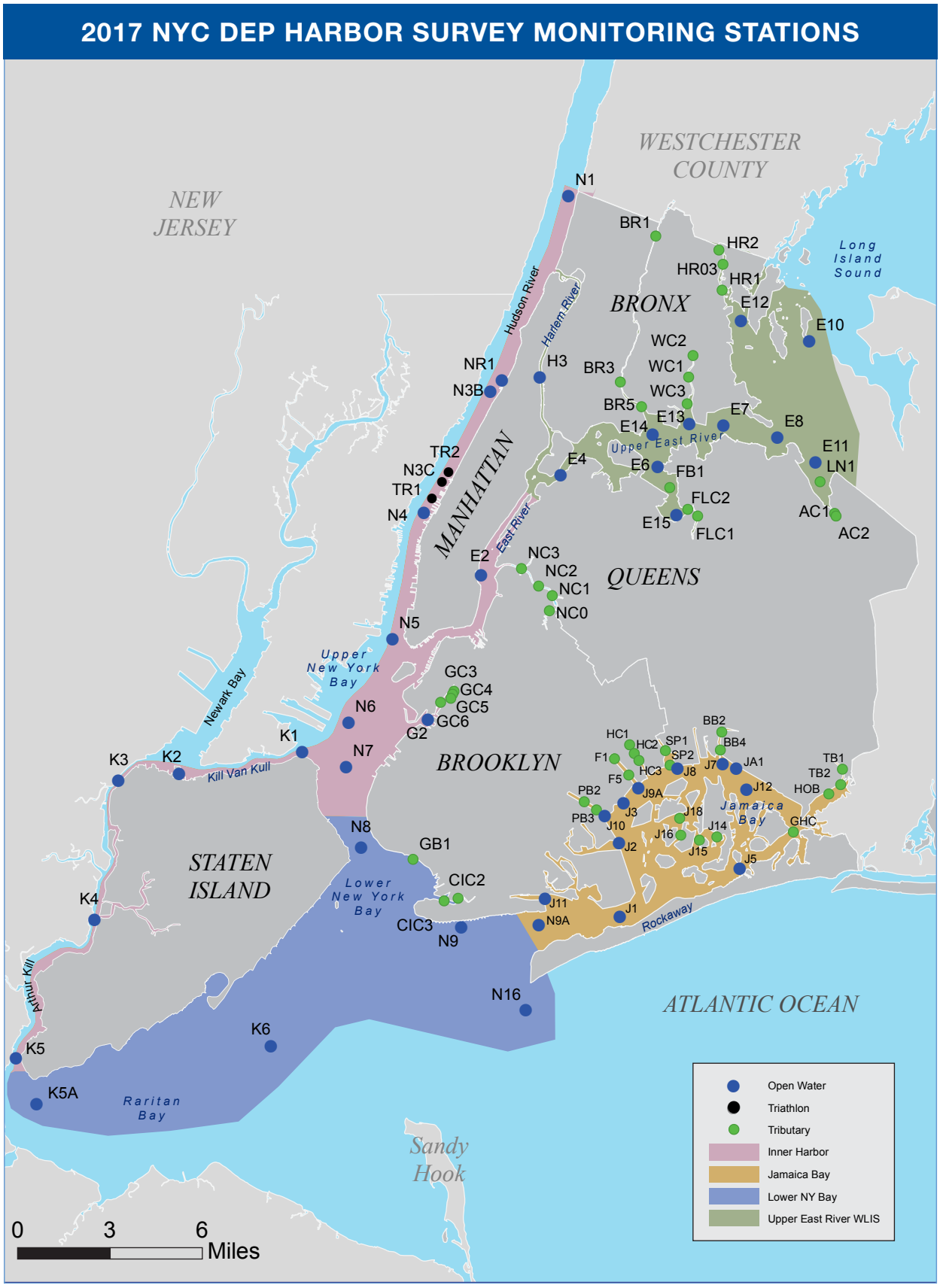
Secchi Transparency **-** To estimate the clarity of surface waters, DEP scientists record the visibility of Secchi disks lowered into the water. High Secchi transparency (greater than 5.0 feet) indicates of clear water, and reduced transparency is typically due to high suspended solids concentrations or plankton blooms. These conditions lead to light-limiting conditions, which affect primary productivity and nutrient cycling.

Chlorophyll 'a' **-** Chlorophyll 'a' is a green pigment found in most plants, algae, and phytoplankton. It is vital for photosynthesis, which allows plants to obtain energy from light. It can be used as an indicator of the health of an aquatic ecosystem's primary producers, which are the base of the food chain. Overgrowth of primary producers can indicate eutrophication, a high concentration of nutrients like nitrogen and phosphorus in a body of water. Excess nutrients can cause high growth rates of phytoplankton and algae, which can lead to negative secondary impacts like reduced light penetration, low dissolved oxygen, and the formation of hypoxic or "dead" zones. In coastal ecosystems, nitrogen is the limiting nutrient, so sources of nitrogen discharge are important to understanding eutrophication in salt water.

Coliform and dissolved oxygen indicators are used in New York State Department of Environmental Conservation (NYSDEC) standards to quantify ecosystem health or degradation. NYSDEC standards reflect a range of acceptable water quality conditions corresponding to the State-designated "best usage" of the water body. Common uses and NYSDEC standards for fecal coliform, enterococcus and dissolved oxygen are noted in the following chart.

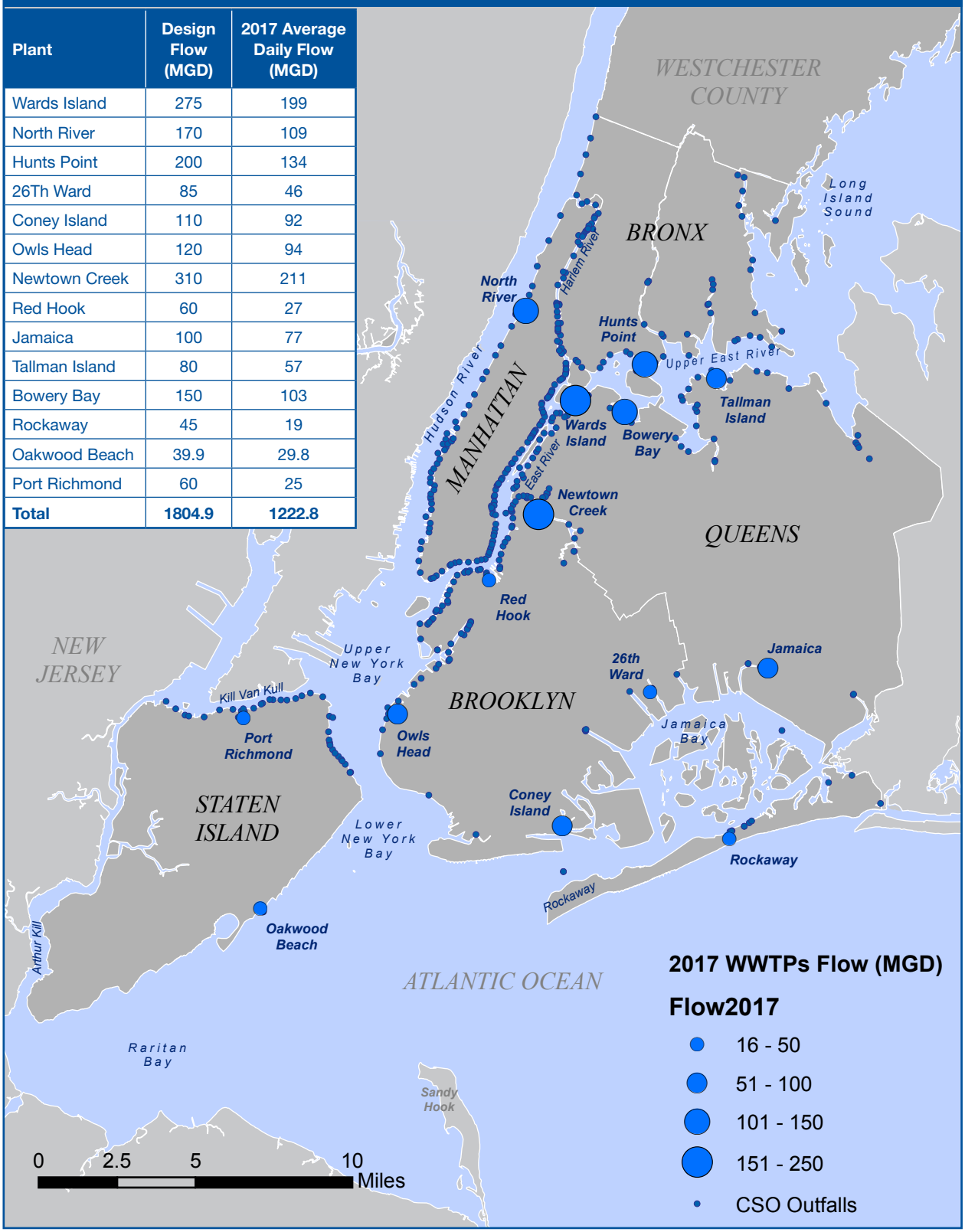
COMMON WATER USE AND NYSDEC STANDARDS FOR SALINE WATERS

Class	Best Usage of Waters	Fecal Coliform	Dissolved Oxygen (never-less-than)	Enterococcus
SA	Shellfishing and all other recreational use	No standard	5.0 mg/L	N/A
SB	Bathing and other recreational use	Monthly geometric mean less than or equal to 200 cells/100 mL from 5 or more samples	5.0 mg/L	(monthly geometric mean) - < 35 Cells / 100mL (single sample) - Max 104 Cells / 100mL
I	Fishing and Boating	Monthly geometric mean less than or equal to 2,000 cells/100 mL from 5 or more samples	4.0 mg/L	N/A
SD	Fish survival	No standard	3.0 mg/L	N/A

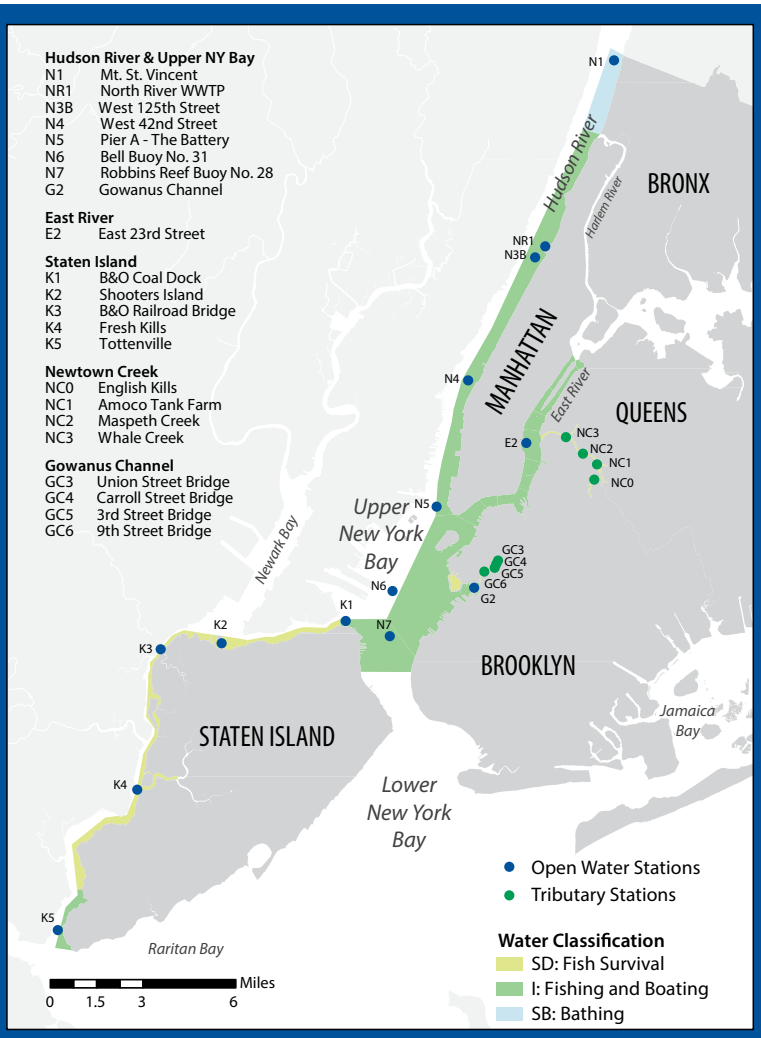

2017 NYC DEP HARBOR SURVEY MONITORING STATIONS
NEW JERSEY
WESTCHESTER COUNTY
Long Island Sound
BRONX
MANHATTAN
QUEENS
BROOKLYN
STATEN ISLAND
ATLANTIC OCEAN
Sandy Hook
Hudson River
Harlem River
East River
Upper East River
Upper New York Bay
Lower New York Bay
Newark Bay
Kill Van Kull
Arthur Kill
Raritan Bay
Jamaica Bay
Rockaway
N1
BR1
HR2
HR03
HR1
E12
E10
WC2
WC1
WC3
BR3
BR5
E13
E7
E8
E14
E11
LN1
E4
E6
FB1
FLC2
AC1
AC2
E15
FLC1
NR1
N3B
H3
TR2
N3C
TR1
N4
E2
NC3
NC2
NC1
NC0
N5
GC3
GC4
GC5
GC6
G2
N6
K1
N7
K3
K2
HC1
HC2
SP1
SP2
BB2
BB4
F1
F5
HC3
J8
J7
JA1
TB1
TB2
HOB
PB2
J9A
J12
PB3
J3
J18
J10
J14
GHC
J16
J15
J2
J5
N8
GB1
CIC2
K4
J11
N9A
J1
CIC3
N9
N16
K6
K5
K5A
0
3
6
Miles
Open Water
Triathlon
Tributary
Inner Harbor
Jamaica Bay
Lower NY Bay
Upper East River WLIS

NYC DEP WASTEWATER TREATMENT PLANTS AND CSOs

Plant	Design Flow (MGD)	2017 Average Daily Flow (MGD)
Wards Island	275	199
North River	170	109
Hunts Point	200	134
26Th Ward	85	46
Coney Island	110	92
Owls Head	120	94
Newtown Creek	310	211
Red Hook	60	27
Jamaica	100	77
Tallman Island	80	57
Bowery Bay	150	103
Rockaway	45	19
Oakwood Beach	39.9	29.8
Port Richmond	60	25
Total	**1804.9**	**1222.8**



INNER HARBOR WATER QUALITY



The Inner Harbor is defined as the area including: the Hudson River from the NYC-Westchester line, through the Battery to the Verrazano Narrows; the Lower East River to the Battery; and the Kill Van Kull-Arthur Kill system.

This area contains 22 Harbor Survey monitoring stations that have been grouped together due to common water uses and functions as well as similarities in point-source loadings. Waters of the Inner Harbor are often continuous, through connecting branches or straits, and cover a large and diverse geographic expanse.

Most of the Inner Harbor Area, excluding the Kills, is classified by NYSDEC as I, for uses such as fishing or boating. Most of the area in the Kills is classified for fish survival only (SD), with the exception of the far southern reach of Arthur Kill, which is designated as Class I. The Hudson River, from North of Spuyten Duyvil to Westchester County, is designated for bathing (SB).

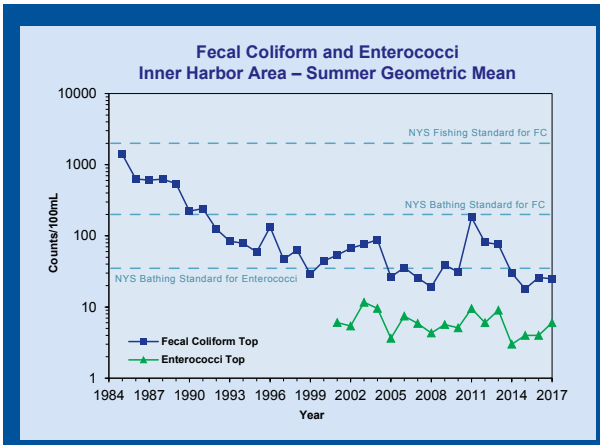
BACTERIA

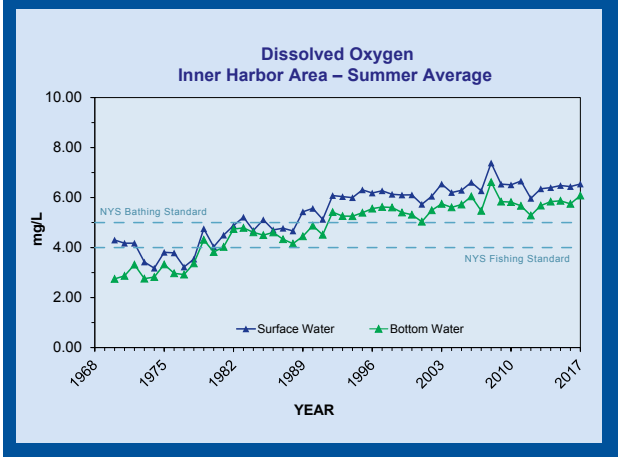
Water quality as estimated by fecal coliform (FC) concentrations was superior for the Inner Harbor in the summer of 2017. The regional summer geometric mean was 25 cells/100mL for fecal coliform. All 14 historical/open-water monitoring sites complied with the monthly FC Bathing Standard of 200 cells/100mL.

Past data has indicated that the Inner Harbor is prone to episodic degradation following rain events due to additional FC loadings from storm drains and combined sewer overflows (CSOs). Water quality as estimated by Enterococcus concentrations was also superior for the Inner Harbor in 2017. The regional summer geometric means was 6 cells/100mL; all 14 historical/open-water monitoring sites had averages < 10 cells/100mL, which complied with the Bathing Standard of 35 cells/100mL for Enterococcus.

Fecal coliform levels in the Inner Harbor have dramatically declined over the last three decades, with levels since 1992 well below the Bathing Standards. The averaged FC counts have declined from levels in the mid-80s that were well in excess of the standards to the current levels well below Bathing Standard of 200 cells/100mL. This improvement has allowed for the opening of Inner Harbor Waters to most recreational activities. The progress has been attributed to the cessation of raw sewage dumping through the full build-out of New York City's Wastewater Treatment Plants (WWTPs), the elimination of illegal discharges into the water body and the reduction of CSOs.

Enterococcus levels in the Inner Harbor have been monitored since 2001. The averages for the past 16 years have consistently been well below the Bathing Standard of 35 cells/100mL.





DISSOLVED OXYGEN

Average summer dissolved oxygen (DO) values in the Inner Harbor were 6.54 mg/L at the surface and 6.08 mg/L in bottom waters. Every sampling station in this region except K3 had at least one summer sample that fell below the state DO bathing standard. Sites such as E2, G2, K5 and N3B had several sub-standard samples. These sites range from the Hudson River to Arthur Kill and include the East River and Gowanus Bay. The waters in this large lower estuary region are generally well mixed.

One hundred years ago sanitary engineer Kenneth Allen of the city's Board of Estimate and Apportionment published his findings* based on DO sampling by the Metropolitan Sewerage Commission which began in 1909. It was known even then the "value of dissolved oxygen determinations as a measure of the digestive capacity of the water and, inversely, of their pollution...". Since that time, the implementation of municipal wastewater treatment facilities beginning early in the 20th century and the subsequent upgrading of those facilities to incorporate secondary treatment have led to notable improvements in water quality. The gradual increase since 1970 in average DO levels is a result of the important steps taken in New York City after the Clean Water Act in 1972. Since 1992, no average summer DO value has fallen below the state's bathing standard of 5.0 mg/L.

*Allen, Kenneth. 1918. Dissolved Oxygen as an Index of the Pollution of New York Harbor. American Journal of Public Health: November 1918, Vol. 8, No. 11, pp. 838-842.

CHLOROPHYLL 'A'

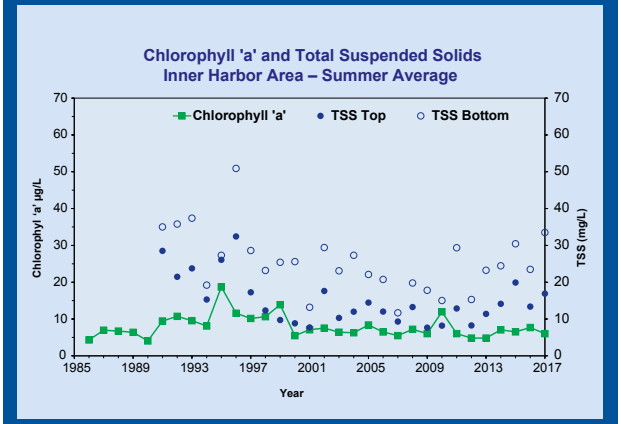
The Inner Harbor region encompasses the lower Hudson River Estuary, the Staten Island Kills as well as the upper portion of New York Bay. As a result of this spatial diversity, the physical and chemical oceanographic conditions which affect chlorophyll 'a' in the area also vary widely. A station such as K5 located at the edge of Raritan Bay averaged 17.3 µg/L of chlorophyll 'a' during the summer. At the opposite edge of the region N1, a brackish water station, averaged 5.9 µg/L of chlorophyll 'a'. There is also great variability during the course of the summer as phytoplankton blooms intensify and diminish

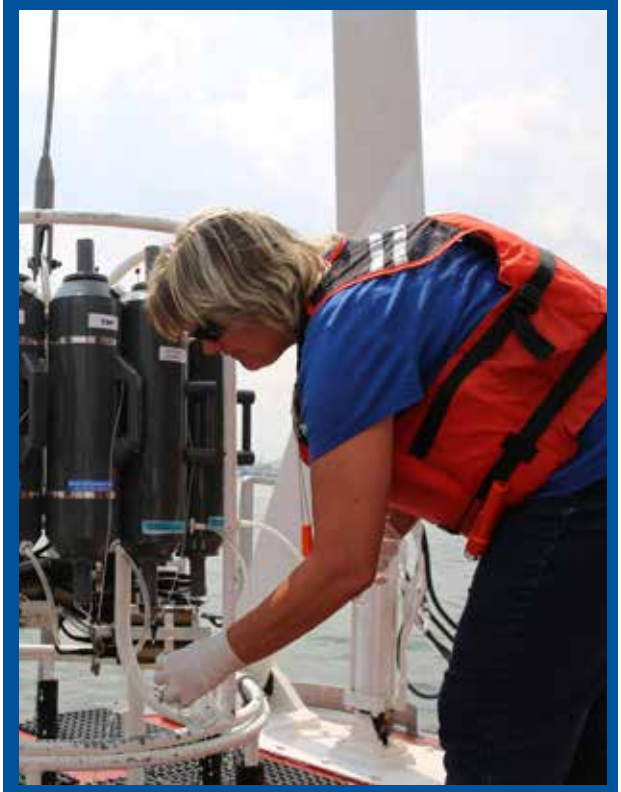
The 2017 summer chlorophyll 'a' average of 6.02 µg/L was fairly consistent with the past six years' average. In fact, since 1986 there are few instances of great yearly variation in chlorophyll 'a'. Massive water flow into the region from the Hudson River has been thought to be a stabilizing factor. This influx of turbulent river water also results in a high bottom water average of 33.52 mg/L total suspended solids (TSS).

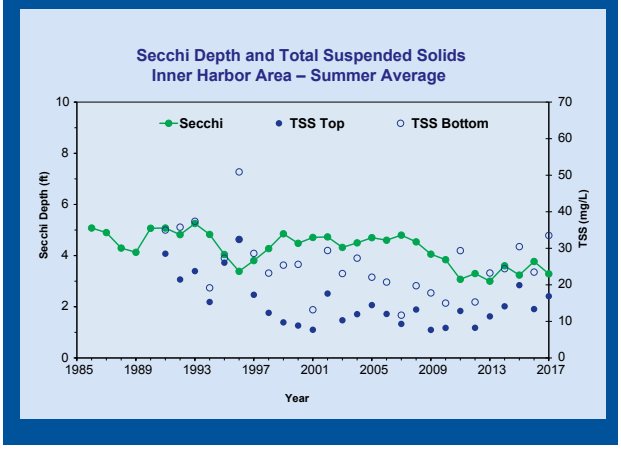
SECCHI TRANSPARENCY

No official water quality standards exist for the Secchi transparency. In general, high Secchi readings (depths of five feet or greater) are associated with clearer water, while low Secchi numbers (depths of three feet or less) are indicative of turbid (or light limiting) waters. In the summer of 2017, the average Secchi reading was 3.3 feet in the Inner Harbor area. The marine conditions vary substantially in this region. N1 in the turbid Hudson River averaged 2.2 ft. Secchi depth while further down the estuary in Gowanus Bay (G2) the average was 4.8 ft.

Since 2010 there have been consistently lower Secchi averages in this region. One instance of a particularly high TSS average in 1996 correlated with a marked decrease In average Secchi depth. Over the long term however, there has been little variation in the Secchi depth averages. This is likely due to the regular, normal flow from the Hudson River.







UPPER EAST RIVER – WESTERN LONG ISLAND SOUND WATER QUALITY

The Upper East River–Western Long Island Sound (UER-WLIS) represents the northeastern portion of NY Harbor, from Hell Gate in the East River, up into the Western Long Island Sound (WLIS). The Harbor Survey Program provides coverage of this area, including the Harlem River and the East River, from Roosevelt Island to Hart Island at the NYC–Westchester County boundary. This area contains 26 Harbor Survey monitoring stations. Waters of this vicinity, though divergent in salinity and depth, share similarities in pollutant loadings and are targeted for management efforts as part of the Long Island Sound National Estuary Program.

About half of the Upper East River–Western Long Island Sound area is classified as I, for uses such as fishing or boating, with the area east of the Bronx-Whitestone Bridge designated for bathing (SB).

BACTERIA

In 2017, water quality continued to be superior for the Upper East River-Western Long Island Sound (UER-WLIS). Fecal Coliform (FC) concentrations for all 11 historical/open-water monitoring sites were in compliance with their specified 'best use' classifications for bathing and fishing. The summer geometric mean for this region was 24 cells/100mL. Ten out of eleven historical/open-water sites had averages < 100 cells/100mL.

Enterococcus concentrations were also superior for the area in 2017. The regional summer geometric mean was 4 cells/100mL. All 11 monitoring sites in the area complied with the Bathing Standard of 35 cells/100mL.

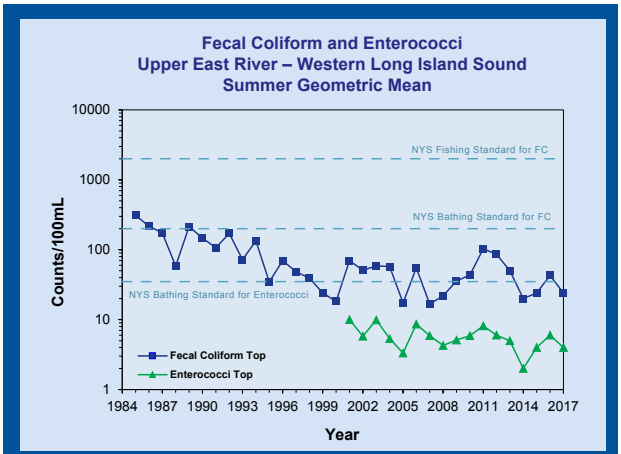
Bacteria concentrations have shown a downward trend for more than 20 years in the UER-WLIS region. The recent slight upward tick in the bacteria levels seems to have more to do with how superior the waters were the previous seasons than any systematic change.

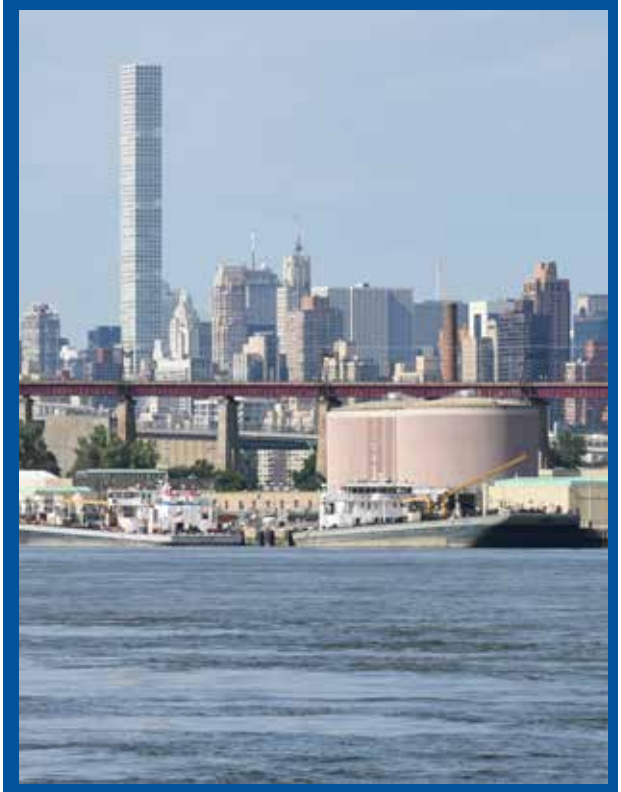
Enterococcus levels in the UER-WLIS have been monitored since 2001. The averages for the past 16 years have been consistently well below the Bathing Standard.

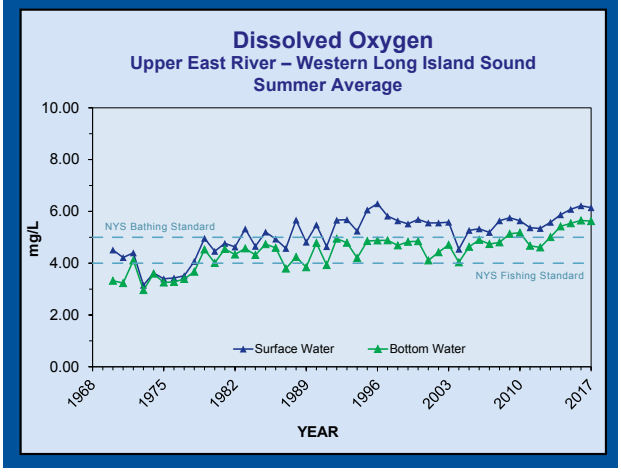
DISSOLVED OXYGEN

Average summer surface and bottom water DO values for the UER-WLIS region exceeded the state bathing standard. However, the 2017 average here is the lowest of any of the four city regions (6.15 mg/L and 5.63 mg/L for surface and bottom waters respectively). Most of the sites included in this region had one or more samples that were below the NY state fishing standard of 4.0 mg/L. H3 in the Harlem River and E12 in western Long Island Sound had samples that fell below the bathing standard. Deep water sites such as E10 will commonly yield bottom DO values as low as 2.57 mg/L in the mid and late summer.

The most important trend in this region is the improvement of bottom waters that hovered near or below the bathing standard for over 40 years. Though there was a slight decrease in values this year, there has been a consistent increase in average DO values since 2012. Surface water averages have not been below the bathing standard since 2004.







CHLOROPHYLL ‘A’

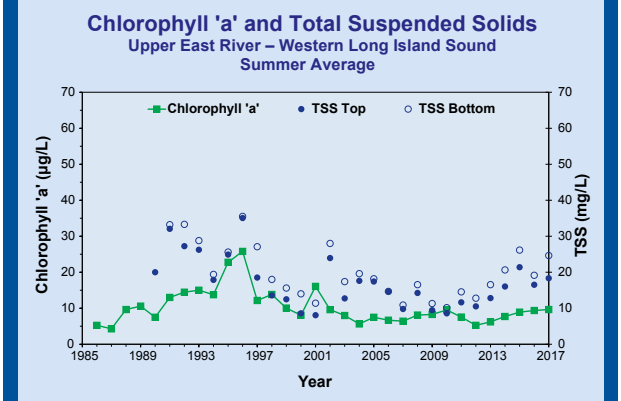
The stations in the UER-WLIS generally have low chlorophyll ‘a’ averages (<10 µg/L). Some stations located in the Long Island Sound bays can average as high as 26.79 µg/L (E12 Eastchester Bay) with single samples as high as 92.8 µg/L. E11 in Littleneck Bay had the next highest average of 17.82 µg/L with samples as high as 53.4 µg/L. The regional average in this area was a more modest 9.66 µg/L.

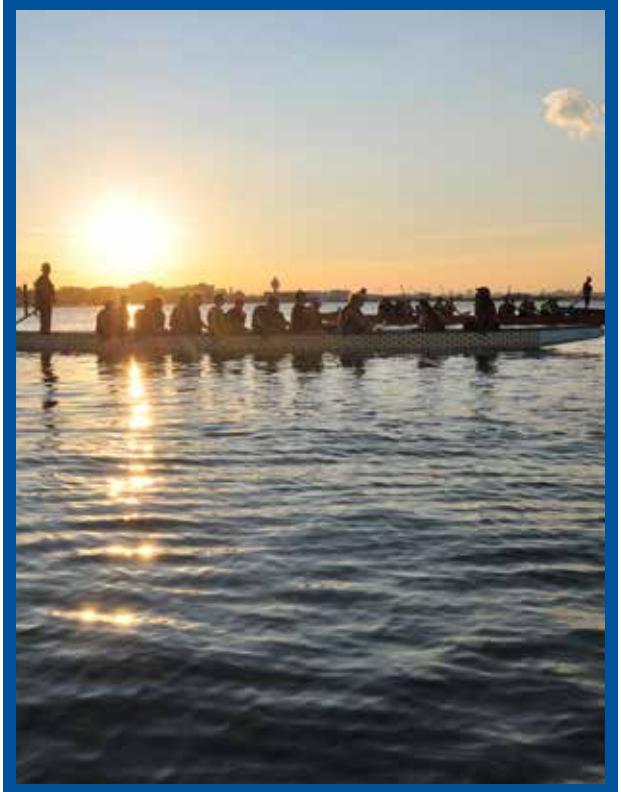
Since 2002, the summer regional chlorophyll ‘a’ average has been below 10 µg/L with little variation. Past and ongoing upgrades to nitrogen removal processes in each of the four Upper East River wastewater treatment plants have possibly resulted in lower chlorophyll ‘a’ averages.

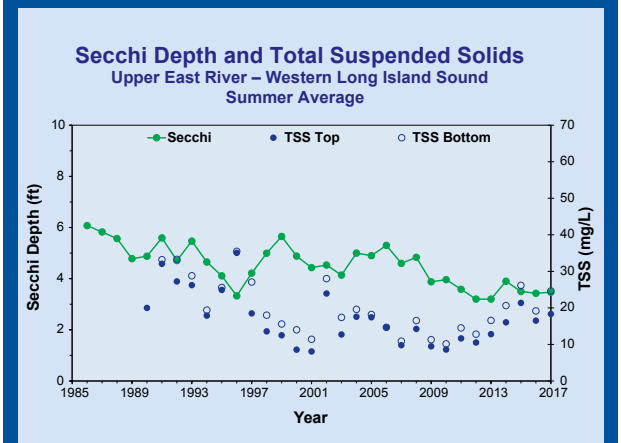
SECCHI TRANSPARENCY

In the summer of 2017, the average Secchi transparency in the UER-WLIS was 3.5 ft. All of the open water historical sites in this region averaged between 3 and 4 feet except H3 (average Secchi of 2.6 ft.). H3 is located in the Harlem River and depending on tide receives flow from the turbid Hudson River.

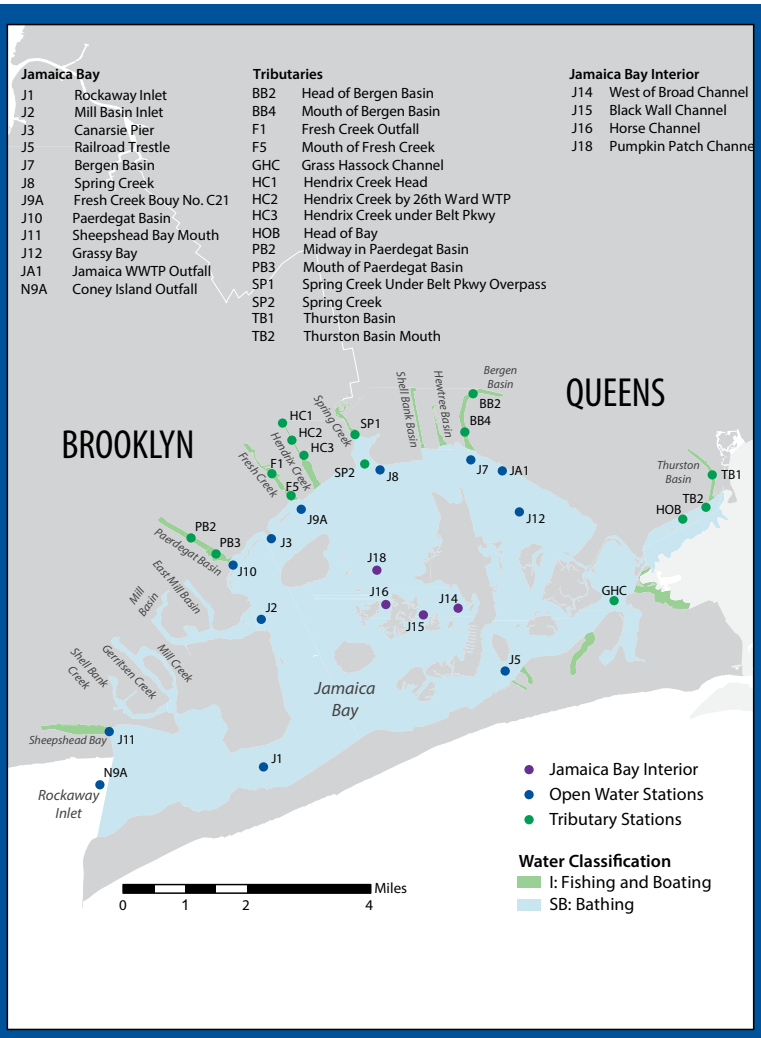
Average Secchi depths have not varied substantially since 2009. One noticeable dip in the average in 1996 coincided with a record high average in surface and bottom water total suspended solids and chlorophyll ‘a’ concentration (see figures).







JAMAICA BAY WATER QUALITY



Jamaica Bay is located at the southwestern end of Long Island. This urban, estuarine embayment and national park consists primarily of tidal wetlands, upland areas and open-waters. The Bay and its drainage area are almost entirely within the boroughs of Brooklyn and Queens, except for a small area at the eastern end that is in Nassau County. Jamaica Bay joins the New York Harbor to the west via the Rockaway Inlet at the tip of Breezy Point and includes the Rockaway Peninsula, which forms the southern limit of the Bay and separates it from the Atlantic Ocean. This estuarine water body, consisting of approximately 20 square miles of open-water, is covered by 31 Harbor Survey monitoring stations.

Open waters of Jamaica Bay are classified for bathing or other recreational use (SB). Areas within the Bay's tributaries and dead-end canals are prone to reduced water quality due to direct surface runoff and poor flushing. These areas are designated for secondary contact use (I), such as fishing or boating.

BACTERIA

In 2017, water quality was superior for Jamaica Bay with summer bacterial geometric means below 200 cells/100mL, the Bathing Standard for all 12 historical/open-water stations. The regional summer geometric mean for fecal coliform was 14 cells/100mL.

Under wet weather conditions, the Bay experiences localized degradation. At these times, spikes in FC may temporarily exceed the Bathing Standard of 200 cells/100mL for the entire northern portion of the Bay. This decrease in water quality is limited to the Bay proper, as Lower New York Bay waters are not typically affected by wet weather events.

Enterococcus concentrations were also superior for Jamaica Bay in 2017. The regional summer geometric mean was 2 cells/100mL; all 12 monitoring sites complied with the Bathing Standard of 35 cells/100mL.

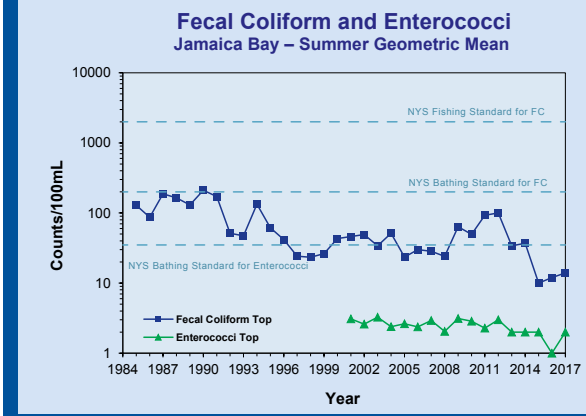
Summer geometric mean bacterial levels in Jamaica Bay as a whole have been below standards for more than 30 years.

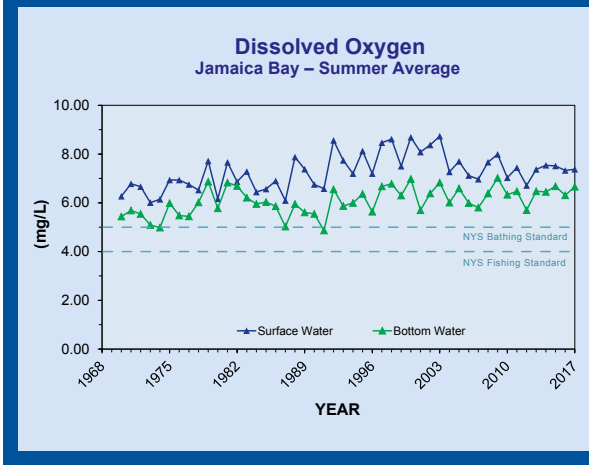
The DEP continues to improve its sewage system. The operation of CSO storage tanks continues in two Jamaica Bay tributaries. Additionally, DEP skimmer vessels work to control floatable debris in Jamaica Bay, as part of the "Boom and Skim" program.

DISSOLVED OXYGEN

Of all the city's regions, Jamaica Bay had the highest surface water DO summer average (7.37 mg/L). Stations J11, J2, J3, J5, J7, J8, J9A, J12 and JA1 all had several samples that were below the state bathing DO standard (5.0 mg/L). Stations J1 and N9A did not have any samples all summer below that standard. Several sites on the eastern side of the bay (J8, J12 and JA1) had several samples below 4.0 mg/L. The stations near the mouth of the bay generally tend to have better DO values and the stations in the northern and eastern sections of the bay have lower values.

After decades of year to year variations in average summer DO values, it appears there currently is a small period of stability. From 2013 to 2017, both surface and bottom water averages have varied very little. Longer term perspective generally shows a slight increase in DO averages over time since the early 1970's.





CHLOROPHYLL 'A'

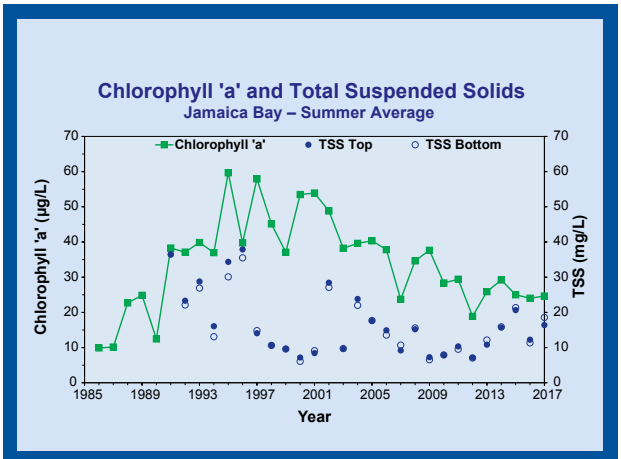
Jamaica Bay typically has the highest chlorophyll 'a' averages of all the city's marine waters. This year was no exception, with an average of 24.62 µg/L. Only one open water historical station in Jamaica Bay (N9A) averaged less than 15 µg/L in 2017. Stations in the northeastern portion of the Bay (J5, J7, J8, J12 and JA1) all averaged over 25 µg/L with J12 in Grassy Bay having the highest average of 41.92 µg/L. The stations located at the mouths of various tributaries in the bay are often eutrophic in summer months. For example, J7 at the mouth of Bergen Basin had a summer average of 37.61 µg/L. Slow turnover of water within the bay and the nutrient-rich tributaries feeding it allow for the development of large standing phytoplankton populations.

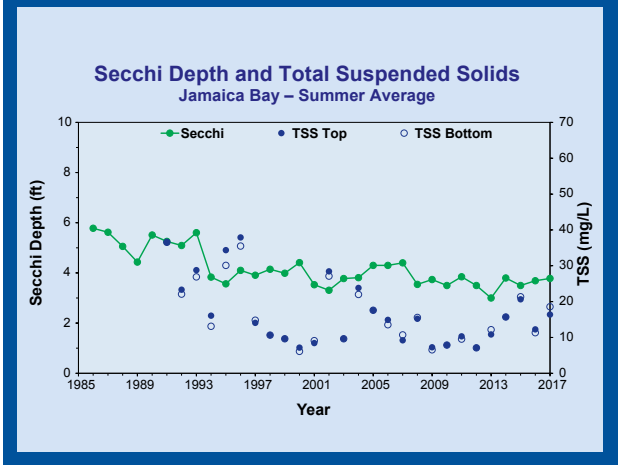
Average chlorophyll 'a' concentrations have fluctuated greatly over the past 30 years, particularly in the mid 90s. Since the summer average of 53.91 µg/L in 2001, the concentrations have decreased gradually. The completed carbon addition facility (using carbon for Biological Nitrogen Removal [BNR]) at the 26th Ward Wastewater Treatment Plant (WWTP) in 2012 was implemented in part to fulfill a commitment to reducing nitrogen discharges into Jamaica Bay by more than 50% over 10 years. In addition to BNR upgrades to 26th Ward, BNR improvements are progressing at the Jamaica WWTP, Coney Island WWTP and Rockaway WWTP in Queens. All BNR improvements are expected to be completed by 2020.

SECCHI TRANSPARENCY

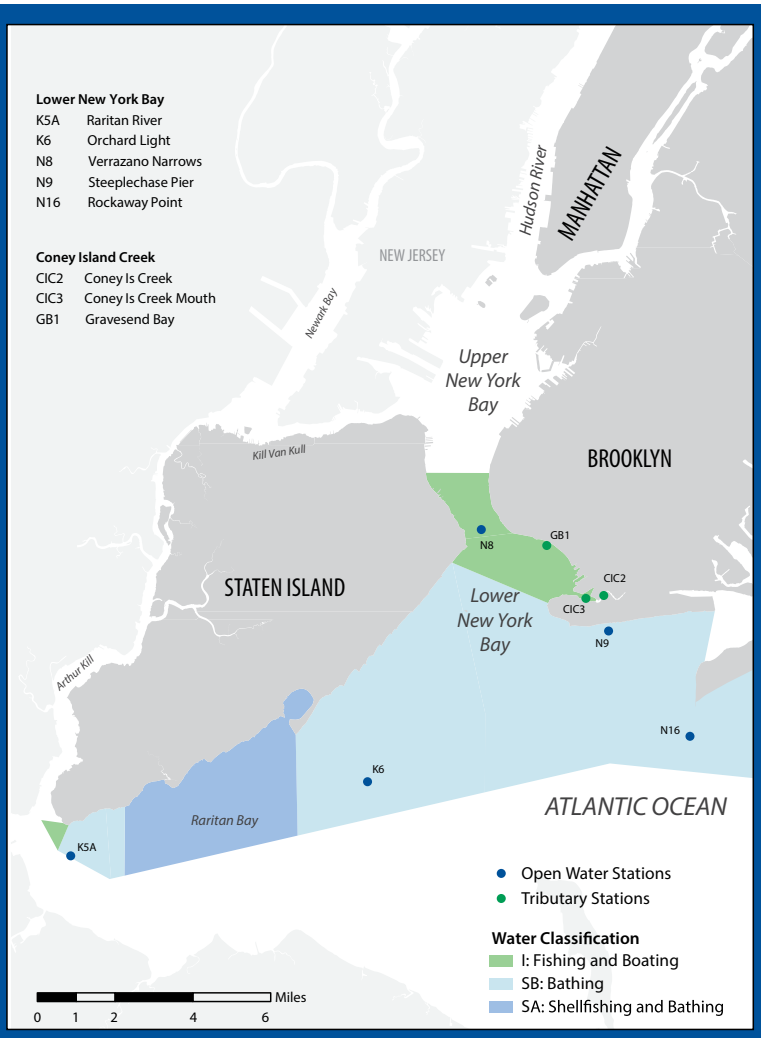
The 2017 average summer Secchi depth of 3.8 ft. represented a slight increase from the prior year. All of the open water historical sites in Jamaica Bay averaged between 3 and 4 feet except N9A (Secchi depth of 4.4 ft.). This site is located near the outfall of the Coney Island WWTP. Often, low individual Secchi readings are paired with particularly high chlorophyll 'a' concentrations representative of a phytoplankton bloom. For example at J7, two instances of Secchi depths of 1.0 ft. were measured when corresponding chlorophyll 'a' samples were 132 µg/L and 149 µg/L.

After 1993, average Secchi depths in Jamaica Bay have remained fairly stable. Throughout this relatively stable period, average chlorophyll 'a' concentrations and total suspended solids have varied substantially.





LOWER NEW YORK BAY – RARITAN BAY WATER QUALITY



The Lower NY Bay–Raritan Bay (LNYB-RB) vicinity represents the most oceanic portion of the Harbor Survey Program. This area of 100 square miles is represented by eight Harbor Survey monitoring stations and is composed mostly of open shallow waters, partially confined by Brooklyn's Coney Island to the north, Staten Island to the north- west, and New Jersey's Middlesex and Monmouth counties and Sandy Hook to the south. The remainder of its eastern boundary is open to Rockaway Inlet and the greater Atlantic Ocean.

This area of 100 square miles is represented by eight Harbor Survey monitoring stations and has mostly open shallow waters. Two wastewater treatment plants, Oakwood Beach and Owls Head, directly discharge into Lower New York Bay and Raritan Bay, but the region's interconnection with other parts of the harbor and to the open water of the Atlantic Ocean also influence its water quality.

BACTERIA

In 2017, water quality as estimated by fecal coliform (FC) had the lowest values in the Lower New York Bay-Raritan Bay (LNYB-RB) as compared to other waterbodies around New York City. Summer geometric mean for FC numbers show waters of the LNYB-RB meet and surpass NYS Standard of 200 cells/100mL for this area. All five historical/open-water stations had summer geometric means <= 13 cells/100mL. Their monthly geometric mean all met standards.

Enterococcus concentrations were also superior for the Lower New York Bay-Raritan Bay in 2017. The regional summer geometric mean was 2 cells/100mL; all five monitoring sites complied with the Bathing Standard of 35 cells/100mL.

Fecal coliform (FC) concentrations for LNYB-RB show significant decline from the mid-1980s to the present time.

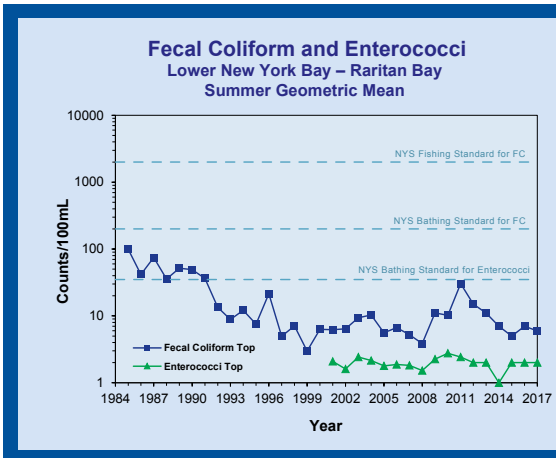
These improvements have allowed for the opening of all NYC public beaches since 1992 and the lifting of wet weather swimming advisories.

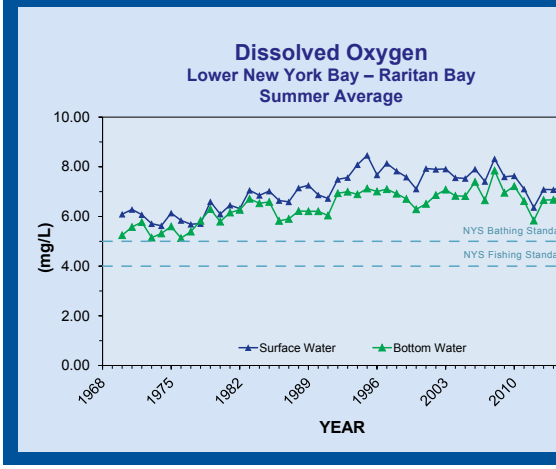
Enterococcus levels in the LNYB-RB have been consistently well below the Bathing Standard.

DISSOLVED OXYGEN

Average dissolved oxygen values in the LNYB-RB are relatively high when compared to other regions (7.17 mg/L and 6.88 mg/l for the surface and bottom water respectively), partly due to the open water sites here that are well mixed. The only site with surface samples below the state's bathing standard was K5A in Raritan Bay occurring, as is typical, in late summer when the water temperatures are high.

Since 1970, most of the improvement in the LNYB-RB area is attributed to decreased waste loading into the Arthur Kill and the Raritan River. It wasn't until 1979 when the upgrading of secondary treatment at most of the city's wastewater treatment plants (including Oakwood Beach and Port Richmond) was completed. The Owls Head Plant was upgraded later. These upgrades are reflected in the steady rise in average summer DO values after this time period.



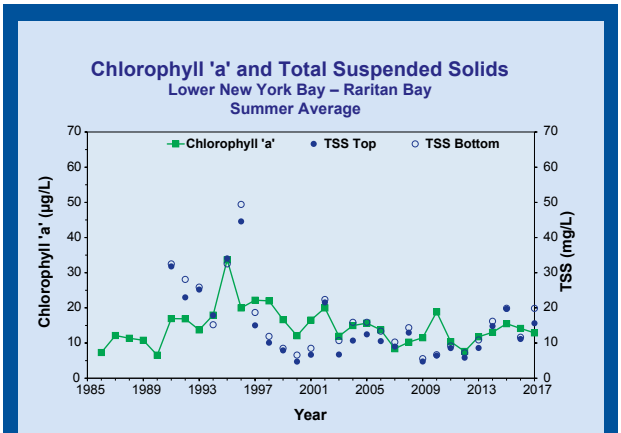


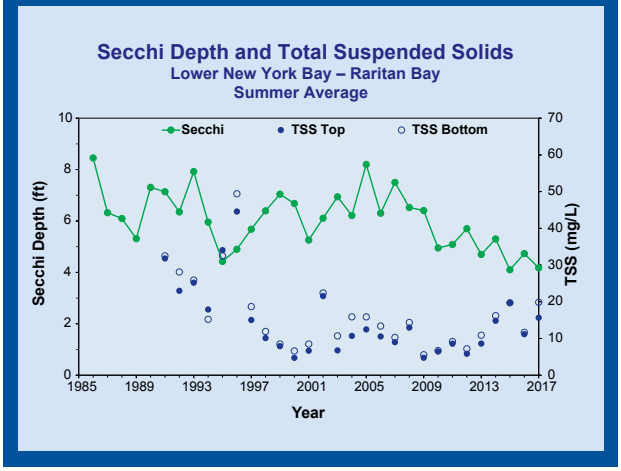
CHLOROPHYLL 'A'

This large region is represented by five open water historical survey stations. The three stations in the eastern side of the region (Lower Bay) typically have low average chlorophyll 'a' concentrations (all < 12 µg/L). These waters are among the clearest in the city and are represented by sampling stations at the Verrazano Narrows (N8), Coney Island Beach (N9) and Rockaway Inlet (N16). Conversely, the Raritan Bay stations on the southeast shore of Staten Island have higher averages of 16.10 µg/L (K5A) and 21.23 µg/L (K6)..

Raritan Bay appears to have a natural configuration ideal for the promotion of phytoplankton blooms not only in the summer, but in the winter as well. The relatively shallow area's main source of fresh water is the Raritan River, an endangered waterway. Flushing from the Hudson River is inhibited by surrounding shoals, such as Old Orchard Shoal. Tidal exchange with oceanic waters does occur, but is inhibited somewhat by Sandy Hook.

Given the propensity for algae blooms in Raritan Bay, this region as a whole still has a history of having fairly low summer chlorophyll 'a' averages. In fact, over the past 30 years, all but three years (1995, 1997 and 1998) had averages below 20 µg/L (see figure). In 2017, the chlorophyll 'a' average was 12.91 µg/L.





SECCHI TRANSPARENCY

The 2017 average summer Secchi depth in the LNYB-RB region was 4.2 ft., a decrease from last year's average of 4.7 ft. The five sites in this region mirror the layout described in the Chlorophyll 'a' section above. Sites on the eastern side of the region that have low chlorophyll 'a' concentrations also have high average Secchi depths (4.6 ft. for N9 and 5.4 ft. for N16). N16 is an open water site with clear ocean water. Raritan Bay stations K6 and K5A on the other hand, had average Secchi depths of 3.7 and 3.6 ft. respectively.

Though variable on a year to year basis, this region historically has the highest Secchi depth averages in the city. One noticeable dip in the Secchi depth average occurred in the summer of 1995 and was associated with the region's highest chlorophyll 'a' average and a high TSS average.

NITROGEN

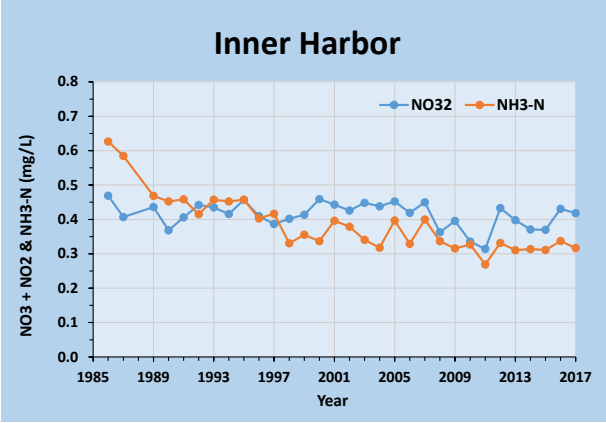
Nitrogen is the most common element in the Earth's atmosphere. It is a major building block of plant and animal proteins, as well as a key nutrient for all types of life. Because some nitrogen-based molecules have nutrient properties, they are commonly used as fertilizers. However, excess nitrogen in runoff and wastewater effluent can promote the growth of harmful algae and reduce levels of dissolved oxygen, limiting the ability of the waterbody to sustain a healthy ecosystem.

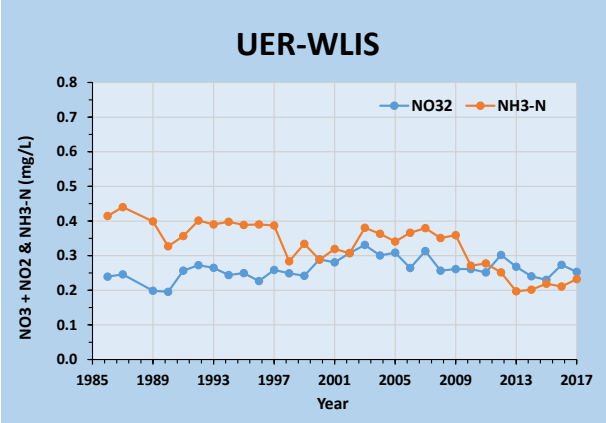
Nitrogen is not a pathogen and poses no threat to human health, so the wastewater treatment plants were not originally designed to remove it from effluent. In the 1980s, the City and environmental groups grew concerned about the impact of nitrogen on New York Harbor, especially as the total nitrogen discharged was expected to increase due to nationwide changes in sludge handling laws. In the early 1990s, the City developed a Nitrogen Control Action Plan to reduce the total nitrogen discharge into two ecologically sensitive waterbodies, the Upper East River and Jamaica Bay. Since 2002, the City has invested $1.2 billion in upgrades to wastewater treatment plants to remove nitrogen from plant effluent and has allocated $97 million over the next decade to construct additional nitrogen control facilities (estimates do not include costs for future chemical usage during operations).

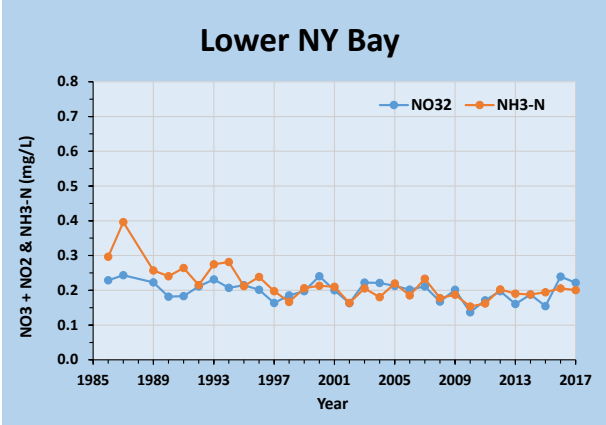
NYC DEP has initiated a comprehensive program to reduce nitrogen discharges to comply with maximum monthly and twelve month rolling average limits for Total Nitrogen, and to comply with the special conditions anticipated under the revised State Pollution Discharge Elimination System (SPDES) Permit. The ability to meet these goals is especially challenging at the WWTPs that perform centralized sludge dewatering operations. The nitrogen load, mostly in the form of ammonium, contributed from the centrate produced during sludge dewatering can account for as much as 30% of the total nitrogen load on the secondary treatment system at the WPCP. The Upper and Lower East River final combined total nitrogen limit is 12-month rolling average limit of 44,325 lbs/day. This became effective January 1, 2017. And the current limit for Jamaica Bay as of August 1, 2017 is a 12-month rolling average of 31,118 lbs/day Total Nitrogen. DEP is also meeting this limit.

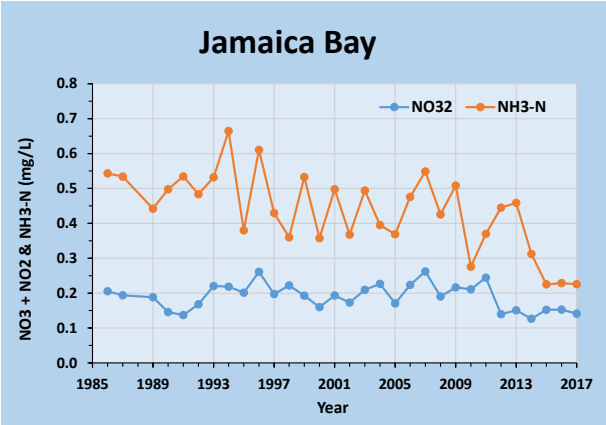
After almost 30 years of fluctuating ammonia levels in Jamaica Bay, there have been three consecutive years of values below 0.25 mg/L. Nitrate/nitrite levels

here have also remained stable and below 0.20 mg/L since the commencement of the 26th Ward biological nitrogen reduction program. The inner harbor currently has the highest nitrogen levels of the four regions. With one exception, summer means of ammonia and nitrate/nitrate have remained greater than 0.30 mg/L. Upper East River nitrogen levels have dipped slightly since 2012. Several nitrogen removal construction projects at plants in this region (including Hunt's Point and Ward's island) were completed between 2010 and 2014. Lower NY Bay nitrogen levels have remained relatively low and stable over the past 30 years. The region has the lowest mean ammonia concentration in 2017 (0.20 mg/L).









HARBOR-WIDE IMPROVEMENTS

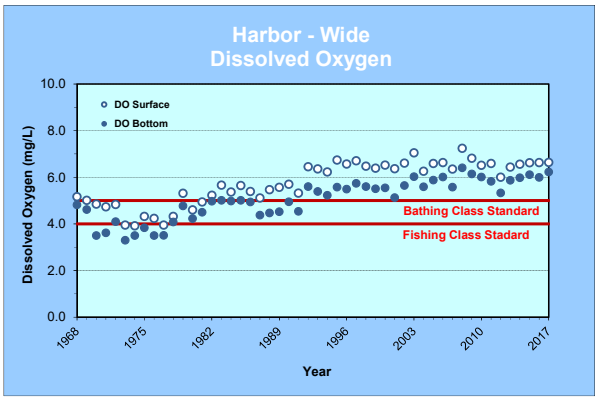
Water quality conditions in 2017 have remained stable or have improved slightly. Harbor-wide summer (May–Oct) average Dissolved Oxygen (DO) for both surface and bottom waters remained at record highs, 6.6 mg/L and 6.2 mg/L, respectively. Fecal Coliform (FC) and Enterococci summer geometric means were well below the New York State Department of Environmental Conservation Standards for bathing and all recreational use (200 cells/100mL for FC and 35 cells/100 mL for Entero). Chlorophyll 'a', Secchi Depth and Total Suspended Solids in the harbor have remained stable with slight fluctuations.

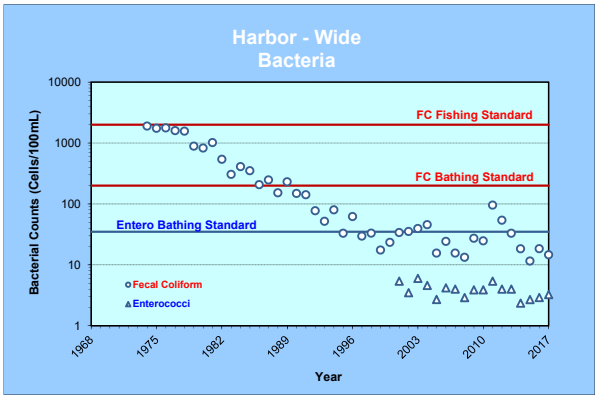
During the past half-century, summer average dissolved oxygen (DO) in the 40 historical/open-water sites of the New York City harbor have increased from less than 5.0 to greater than 6.5 mg/L for surface waters and from less than 4.0 to greater than 6.0 mg/L for bottom waters. Average DO levels remained above the NYSDEC Bathing Standard of 5.0 mg/L for the past 26 years.

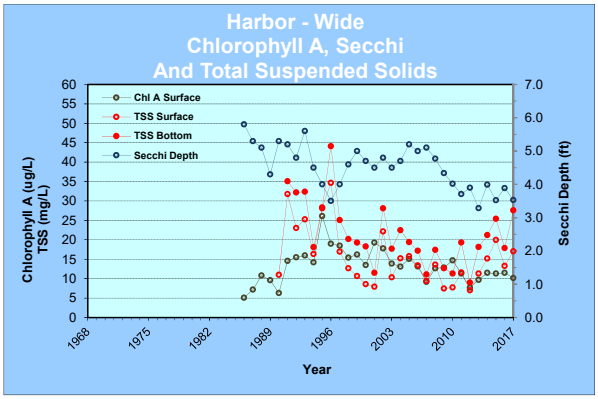
The harbor-wide summer geometric means for FC count has decreased and remained below the levels and within compliance with the NYSDEC Bathing Standard for the past three decades. All historical/open-water stations had average FC counts well below the Bathing Standard in 2017. Most high FC counts with high geometric means were found in tributaries located at Coney Island Creek (CIC2), Flushing Creek (FLC1) and Alley Creek CSO outfall (AC2). Short-term spikes do occur after rain events due to combined sewer overflow (CSO) discharges.

Over the last 17 years, harbor-wide Enterococcus summer geometric means have been relatively stable, with spikes similar in size and frequency to the fecal coliform levels. High summer average Enterotocci were found at Alley Creek CSO outfall (AC2), Alley Creek mouth (AC1), and Bronx River (BR1).

The NYC DEP's Long Term Control Plans (LTCP) are ongoing efforts to begin addressing the effects of CSOs and stormwater runoff. In the summer of 2017, the harbor-wide chlorophyll 'a' average drop down to 10.1 µg/L from 11.5 µg/L in the past three years; decreased Secchi depth correlated with both the surface and bottom Total Suspended Solids' increasing. The Harbor Survey has begun its integration with the LTCPs. There were a total of 86 sites included in the survey for 2017.

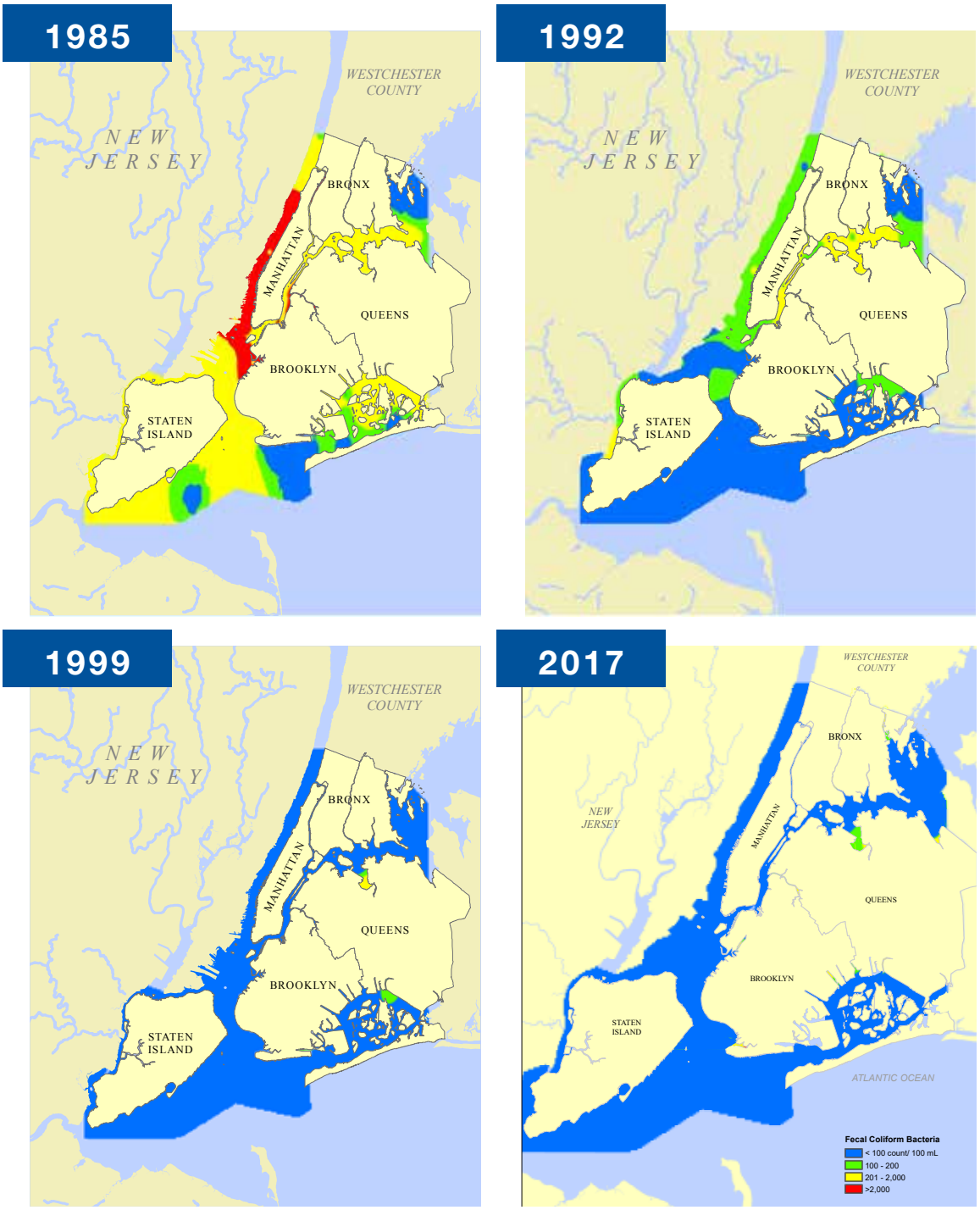






HARBOR-WIDE WATER QUALITY IMPROVEMENTS OVER FOUR TIME PERIODS

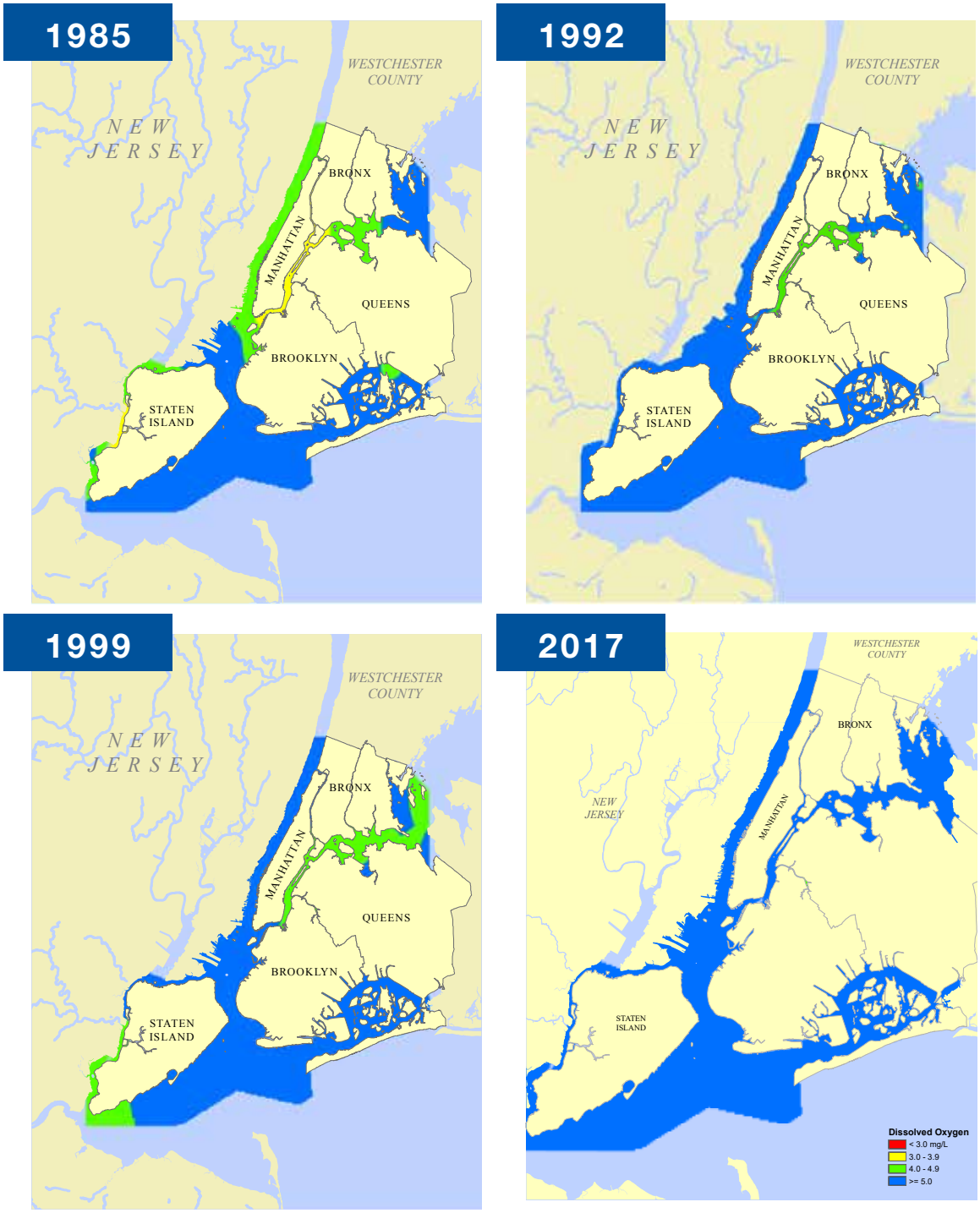
SUMMER GEOMETRIC MEANS FOR FECAL COLIFORM IN SURFACE WATERS



NYS Best-Use Classifications: 200 FC/100 mL=SB (Bathing); 2000 FC/100 mL=I (Fishing).
NYC DOH requirements preclude bathing near sewer outfalls and where rainfall may substantially increase coliform levels.

HARBOR-WIDE WATER QUALITY IMPROVEMENTS OVER FOUR TIME PERIODS

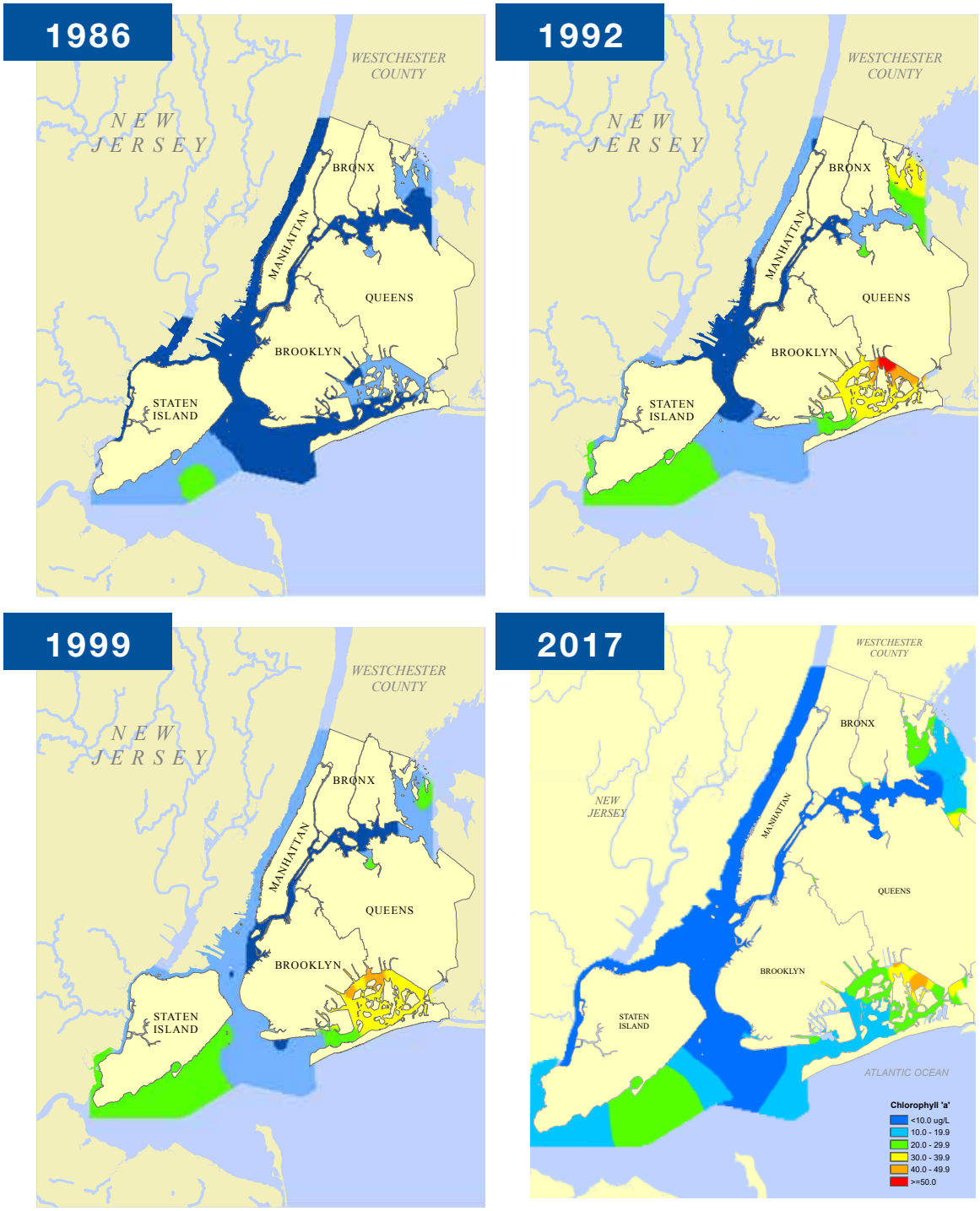
SUMMER AVERAGES FOR DISSOLVED OXYGEN IN BOTTOM WATERS



NYS Best-Use Classifications: DO > 5 mg/L=SB (Bathing); DO > 4 mg/L=I (Fishing); DO > 3 mg/L=SD (Fish Survival)

HARBOR-WIDE WATER QUALITY IMPROVEMENTS OVER FOUR TIME PERIODS

SUMMER AVERAGES FOR CHLOROPHYLL 'A' IN SURFACE WATERS



Chlorophyll 'a' > 20 µg/L = Eutrophic conditions

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