



2018

New York Harbor Water Quality Report

NYC
Environmental
Protection

Bill de Blasio
Mayor

Vincent Sapienza, P.E.
Commissioner



Vincent Sapienza, P.E.
Commissioner



Dear Friends,

New York City has invested more than \$12 billion over the last decade to improve the health of New York Harbor and no one in our lifetime has seen it as clean and healthy. Our strategic investments in the critical infrastructure that supports our great city, has resulted in many ecological successes, ushering in the return of a variety of plant and animal species to our waters and improving quality of life for millions of New Yorkers.

This historic achievement is a direct result of our efforts to utilize innovative new technologies, and cultivate partnerships with elected officials, environmental advocates, and New Yorkers who share our commitment to the natural world. But our work is not done. 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 installing green infrastructure and optimizing sewers, to recovering resources from our wastewater and reconstructing miles of natural wetlands.

I am pleased to share the 2018 Harbor Water Quality Report and I encourage you to read this in conjunction with the NYC Stormwater Management Plan, NYC Green Infrastructure Annual Report and State of the Sewers Annual Report to gain a more complete view of the City's coordinated efforts to restore our vital waterways.

Sincerely,

A handwritten signature in black ink, appearing to read 'Vincent Sapienza'.

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 first carried out by the Metropolitan Sewerage Commission in 1909 in response to public outcry over degraded water quality affecting quality of life 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 subsequent high levels of pollution and bacteria, had lost the ability to support wildlife and recreation.

The City would eventually construct 7,500 miles of sewers and 14 wastewater resource recovery facilities citywide 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, the New York City Department of Environmental Protection (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. Water quality in New York Harbor has improved to the point that many waterways are now utilized for recreation and commerce throughout the year.



North River Wastewater Resource Recovery Facility

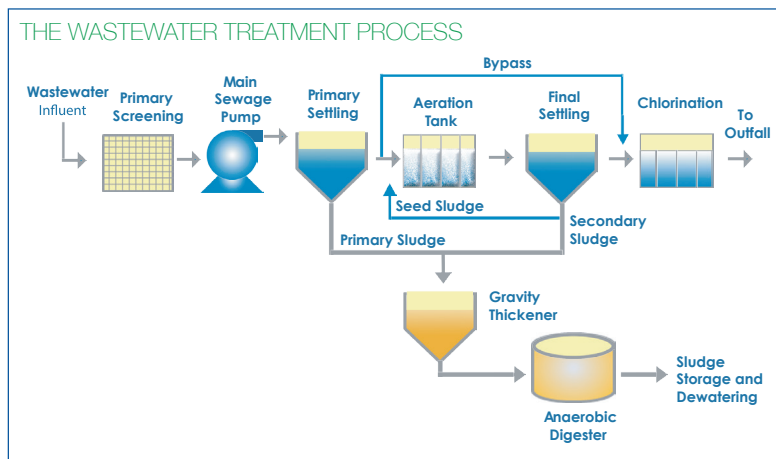
DEP's North River WRRF sits below the 28-acre Riverbank State Park, provides wastewater treatment to hundreds of thousands of people who work, live and visit the west side of Manhattan, and is designed to handle up to 340 million gallons of wastewater on a wet weather day. Managing a plant of this size – and its 100 employees, is no small feat, but it is expertly lead by Plant Chief Kiah Miller.

After more than 25 years in the industry, he says, "It's an exciting time to be in the field. Things are changing and it's a powerful indicator. People are really invested in this place. They want to be here, and it's a great opportunity."

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 Resource Recovery Facilities (WRRF).

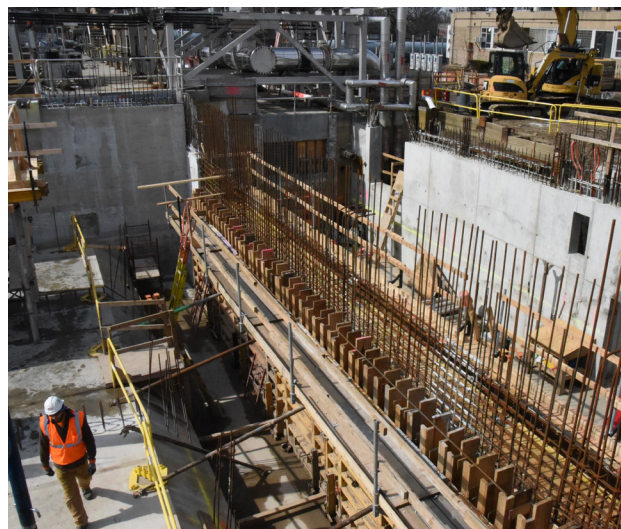
At WRRFs, physical and biological processes closely duplicate how wetlands, rivers, streams, and lakes naturally purify water. While the natural treatment of wastewater can take weeks, treatment at a plant is comparatively quick, taking only seven hours to remove most pollutants.



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 wastewater resource recovery facilities 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.

According to the National Weather Service's annual measurements, 65.66 inches of precipitation soaked Central Park in 2018, well above the normal level of 49.94 inches, making 2018 the fourth wettest year on record for New York City. The City's Department of Environmental Protection (DEP) implements three distinct strategies aimed at creating additional capacity in our wastewater system in order to reduce the number of CSO's during wet weather events. 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 in the future. This commitment is likely to increase as DEP develops the final "Citywide/Open Waters Long Term Control Plan" which is due in March 2020.



\$150 Million Project Will Protect Health of Jamaica Bay

The 26th Ward WRRF is currently being upgraded as part of a \$150 million project which includes the construction of a fifth treatment tank to ensure the plant operates at full capacity during wet weather, thus helping to protect the health of Jamaica Bay by reducing the risk of CSOs.



Coney Island Facility Gets an Upgrade

Work began in 2018 on a \$57 million upgrade at the Coney Island WRRF which will reduce the amount of nitrogen released into Jamaica Bay and help to improve the overall ecology of the waterway. The project complements the \$460 million in upgrades that have already been completed to reduce nitrogen discharges from the Jamaica and 26th Ward WRRF's, which similarly drain to Jamaica Bay.



\$95 Million Project to Reduce CSOs by 98 Percent

Construction on a mile-long parallel sewer project has begun in the Bronx which will direct more wastewater to the Hunts Point WRRF and reduce CSOs into Pugsley Creek by 98 percent.

SEWER OPTIMIZATION

Construction of storm sewers to increase the capacity of our sewers has been an effective strategy in reducing both local street flooding and CSOs. To improve the health of Flushing Bay, subsurface sewer upgrades took place at five key junction points within the sewer system between LaGuardia Airport and the Long Island Expressway. The work focused on raising and lengthening the weirs that direct the wastewater to the Bowery Bay WRRF. By directing additional wastewater to the treatment facility, this project has reduced sewer overflows into Flushing Bay by 225 million gallons annually. The work began in the spring of 2016 and was completed in the spring of 2018.

The City also completed a \$42 million project in 2018 to build four subsurface litter capture devices that include fixed baffles and bending weirs to capture floating litter and direct it to a wastewater resource recovery facility to be removed, helping to improve the health of Newtown Creek. Similar litter capture technology is already benefitting the Bronx River and Gowanus Canal.

MANAGING STORMWATER

As traditional “grey” infrastructure upgrades became increasingly expensive, New York City launched the NYC Green Infrastructure Program and now boasts the largest and most ambitious green infrastructure program in the nation. 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 through 2030 to build new green infrastructure.

To date, more than 4,000 rain gardens have been constructed across the city, with 5,000 more going into construction this year. In addition to installing green infrastructure along streets and sidewalks, 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. DEP has committed more than \$50 million to NYC Parks’ Community Parks Initiative (CPI) and has transformed more than a dozen asphalt schoolyards into green playgrounds through The Trust for Public Land’s Playground Program, while also working with the Department of Education and School Construction Authority to transform additional playgrounds citywide.



New Green Playground Opens

DEP and NYC Parks cut the ribbon on Playground 52 in the Bronx after a \$9.5 million transformation. The park is one of hundreds of parks to be renovated through CPI and now includes new rain gardens which will absorb more than 780,000 gallons of stormwater each year, helping to improve the health of the East River.

Some parts of the City are serviced by a separate sewer system that carries stormwater directly to local waterways. As stormwater flows over streets and other impervious surfaces it sweeps up pollutants such as oils, pathogens, and sediments that can have a negative impact on water quality and recreational uses.

In 2018, DEP, on behalf of the City released the NYC Stormwater Management Program Plan (SWMP Plan) The SWMP Plan describes the various programs the City will implement to reduce pollution in stormwater runoff. Programs cover a wide range of topics including illicit discharge detection and elimination, and requirements for new construction and industrial/commercial facilities.”

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. Much of this work focuses on Jamaica Bay and Flushing Bay, diverse ecological resources that support multiple habitats. DEP protects and restores these areas through a variety of programs, including those to improve harbor water quality, promote and protect wildlife, and restore eroded marshlands.

Wetlands are among the most productive natural areas on earth and are particularly important in urban waters. They are extremely valuable in helping to absorb storm surge, filter impurities from the water, increase dissolved oxygen levels, reduce coastal erosion, and capture greenhouse gases.

DEP also oversees an award-winning Bluebelt Program through which we have constructed ecologically rich and cost-effective drainage systems that naturally handle the runoff precipitation that fall on our streets and sidewalks.

In an effort to return some of these natural functions to Flushing Bay, DEP completed the planting of 110,000 plugs of aquatic grasses in 2018 as part of a \$19.2 million project to construct more than three acres of new wetlands along the bay’s southern shore.

HARBOR WATER SURVEY PROGRAM

Water quality data collected by DEP scientists in summer 2018 will be presented in four sections delineating each geographic region within the harbor. The water quality parameters used as indicators of water quality for this report are bacteria (fecal coliform and enterococcus), dissolved oxygen, chlorophyll ‘a’, Secchi transparency and nitrogen.



Staten Island Gets a New Bluebelt

DEP completed the first phase of the New Creek Bluebelt in 2018 which saw the removal 475 cubic yards of trash and debris, the removal of phragmites to reduce the risk of brushfires, and the installation of more than 21,000 diverse native plants that will attract more fish and wildlife to the area. The \$25 million project created 4.7 acres of new freshwater wetlands.



Tidal Wetlands Take Shape in Newtown Creek

DEP joined elected officials and community members to celebrate the installation of tidal wetlands in Newtown Creek at Dutch Kills. The wetlands will help to improve water quality, provide habitat for wildlife and a more natural aesthetic area for the community. This is the first time Newtown Creek has had substantial wetlands in more than 100 years.

SYNOPSIS OF 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, and 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. Fecal coliform bacteria are found in human and animal intestines and are associated with wastewater. Enterococci are a subgroup within the fecal streptococcus group and are distinguished by their ability to survive in salt water. DEP scientists measure concentrations of the two groups of bacteria.

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 ft) indicates 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 vital for photosynthesis, which allows plants and algae to obtain energy from light. It can be used as an indicator of the health of an aquatic ecosystem's primary producers whose overgrowth can indicate eutrophication. This condition, caused by excess nutrients, 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.

Nitrogen - Nitrogen is a major building block of plant and animal proteins, as well as a key nutrient for all types of life and commonly used in fertilizers. Excess nitrogen can promote the growth of harmful algae and reduce levels of dissolved oxygen. Nitrogen is not a pathogen and poses no threat to human health. In 2002 the City began upgrading wastewater resource recovery facilities to remove nitrogen from plant effluent and continues to construct additional nitrogen control facilities.

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. DEC has publicly noticed revised rulemaking. Anticipated updates in summer 2019 include: 30-day Enterococci, criteria for coastal recreational waters, Fecal coliform criteria applicable for recreational season, and Reclassification of the Upper and part of Lower Bay to Class SB.

COMMON WATER USE AND NYSDEC STANDARDS FOR SALINE WATERS

Class	Total Coliform	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

NEW JERSEY

WESTCHESTER COUNTY

Long Island Sound

BRONX

MANHATTAN

QUEENS

BROOKLYN

STATEN ISLAND

ATLANTIC OCEAN

Sandy Hook

Upper New York Bay

Lower New York Bay

Jamaica Bay

Rockaway

Arthur Kill

Kill Van Kull

Harlem River

East River

Upper East River

Newark Bay

Raritan Bay

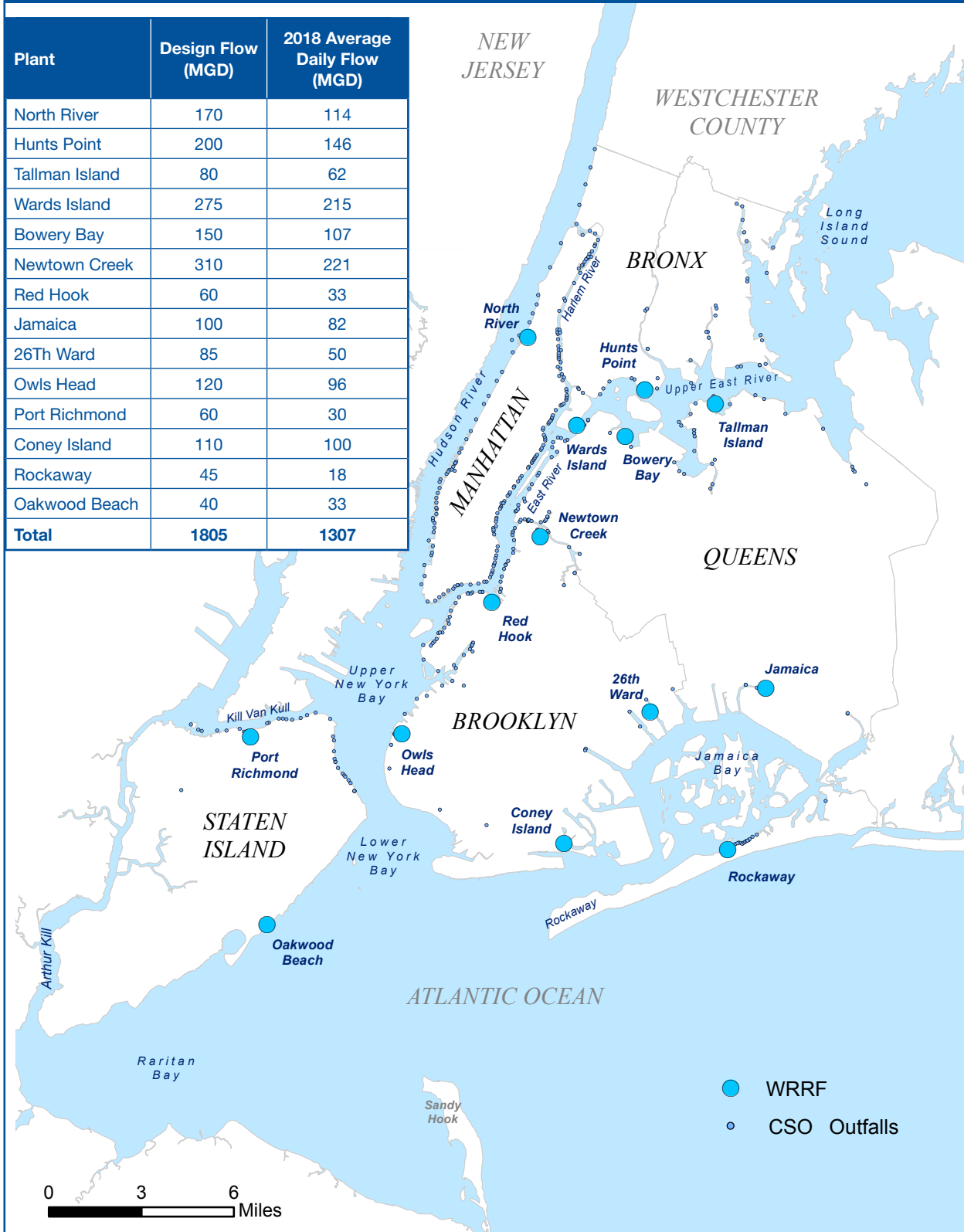
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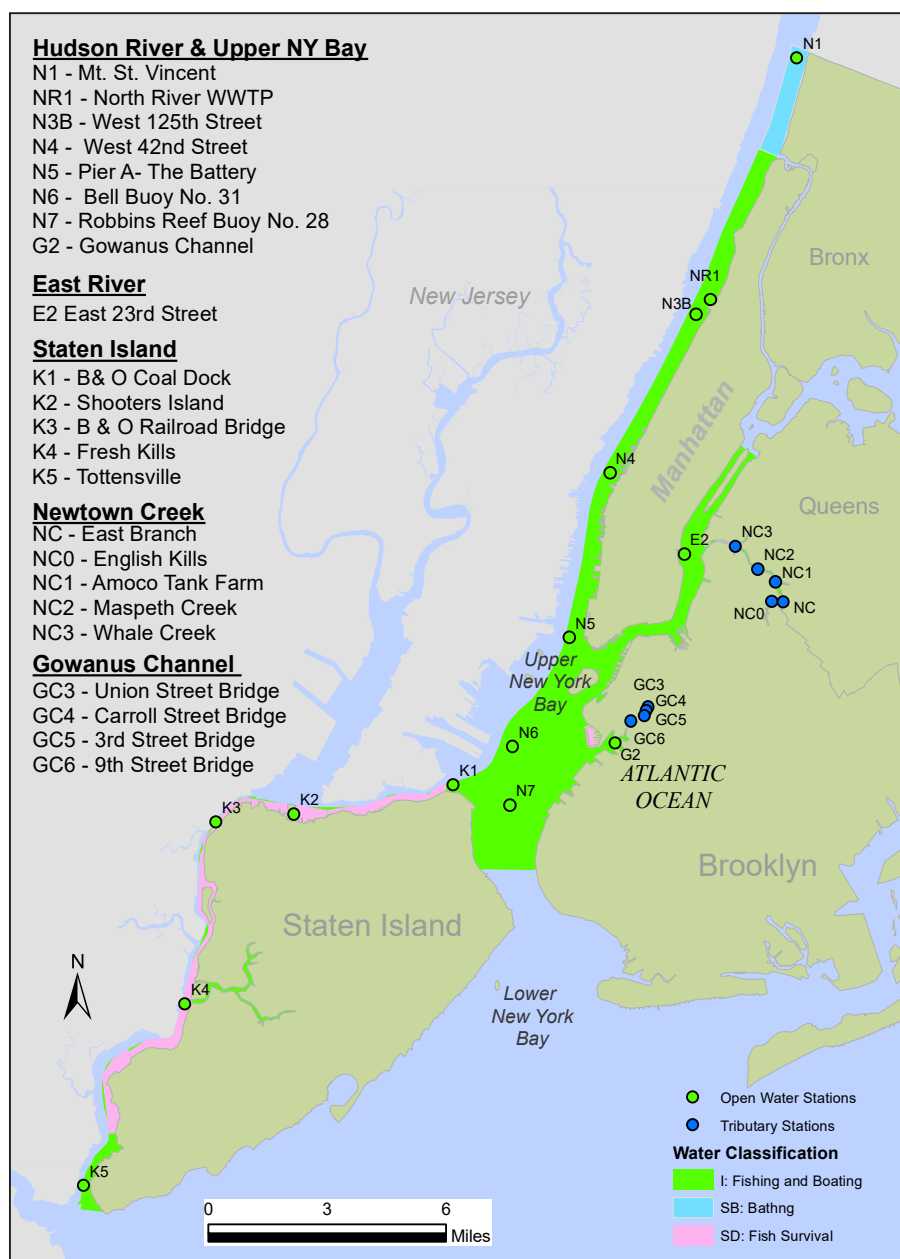
- Open Water (Red dot)
- Triathlon (Black dot)
- Tributary (Green dot)
- Upper East River WLIS (Light green shaded area)
- Inner Harbor (Pink shaded area)
- Lower NY Bay (Light green shaded area)
- Jamaica Bay (Orange shaded area)

NYC DEP WASTEWATER RESOURCE RECOVERY FACILITIES AND COMBINED SEWER OVERFLOW OUTFALLS

Plant	Design Flow (MGD)	2018 Average Daily Flow (MGD)
North River	170	114
Hunts Point	200	146
Tallman Island	80	62
Wards Island	275	215
Bowery Bay	150	107
Newtown Creek	310	221
Red Hook	60	33
Jamaica	100	82
26Th Ward	85	50
Owls Head	120	96
Port Richmond	60	30
Coney Island	110	100
Rockaway	45	18
Oakwood Beach	40	33
Total	1805	1307



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 2018. The regional summer geometric mean was 66 cells/100mL for fecal coliform. Thirteen out of fourteen historical/ open-water monitoring sites were in compliance with their monthly FC Fishing Standard of 2000 cells/mL, and 90% complied with the stricter 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 2018. The regional summer geometric mean was 6 cells/100mL; all 14 historical/open-water monitoring sites had averages ≤ 15 cells/100mL, which complied with the Bathing Standard of 35 cells/100mL for *Enterococcus*.

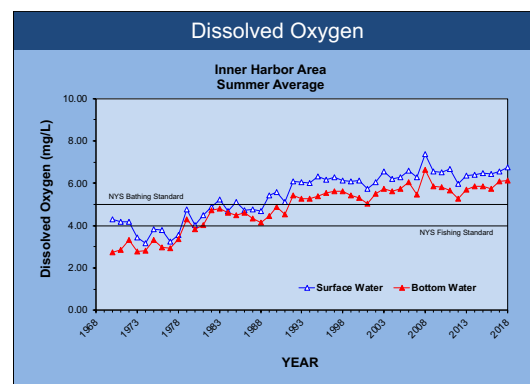
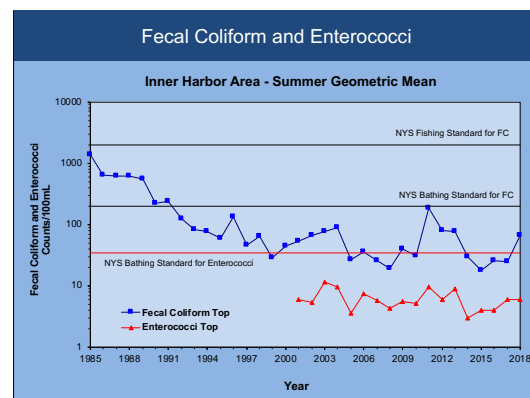
Fecal coliform levels in the Inner Harbor have dramatically declined over the last three decades, with levels well below the Bathing Standards since 1992. The averaged FC counts have declined from levels in the mid-80s that were well in excess of the standards to the current levels well below the Bathing 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 Resource Recovery Facilities (WRRFs), 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 17 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 6.74 mg/L at the surface and 6.14 mg/L in bottom waters. Every sample in this region is above the state bathing standard except for three summer samples that fell below the standard. Sites such as E2, K5 and N1 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 18.3 ug/L of chlorophyll 'a' during the summer. At the opposite edge of the region N1, a brackish water station, chlorophyll 'a' averaged 6.8 ug/L. In Gowanus Bay (G2) the summer average was 7.9 ug/L. There is also great variability during the course of the summer as phytoplankton blooms intensify and diminish.

The 2018 summer chlorophyll 'a' average of 6.5 ug/L was fairly consistent with the past seven 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 34.3 mg/L total suspended solids (TSS).

SECCHI TRANSPARENCY

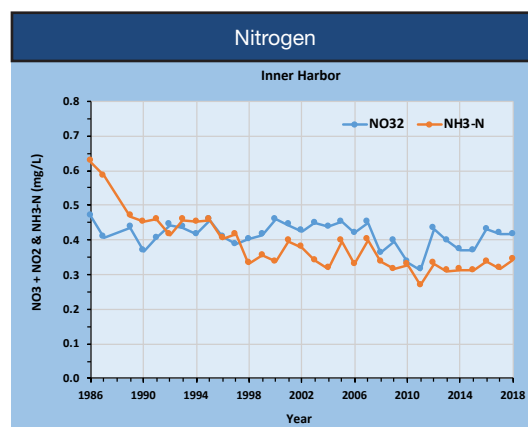
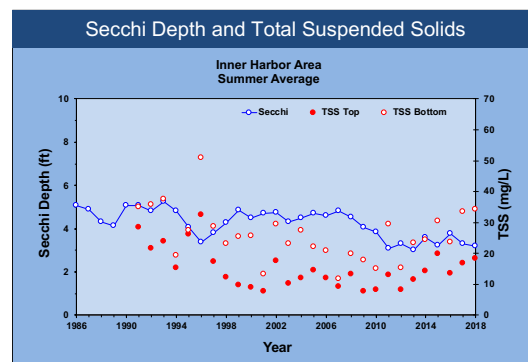
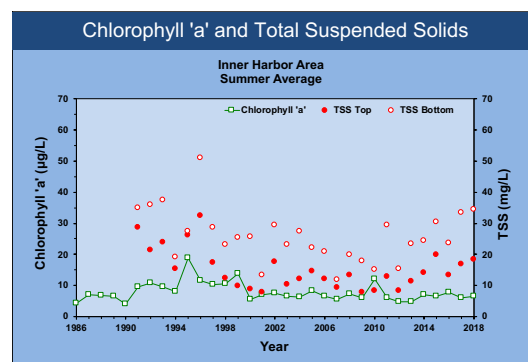
No official water quality standards exist for the Secchi transparency. In general, high Secchi readings (depths of five feet or greater) are associated with clearer water, while low Secchi numbers (depths of three feet or less) are indicative of turbid (or light limiting) waters. In the summer of 2018, the average Secchi reading was 3.2 ft. in the Inner Harbor area. The marine conditions vary substantially in this region. N1 in the turbid Hudson River averaged 2.0 ft. Secchi depth while further down the estuary in Gowanus Bay (G2) the average was 3.7 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.

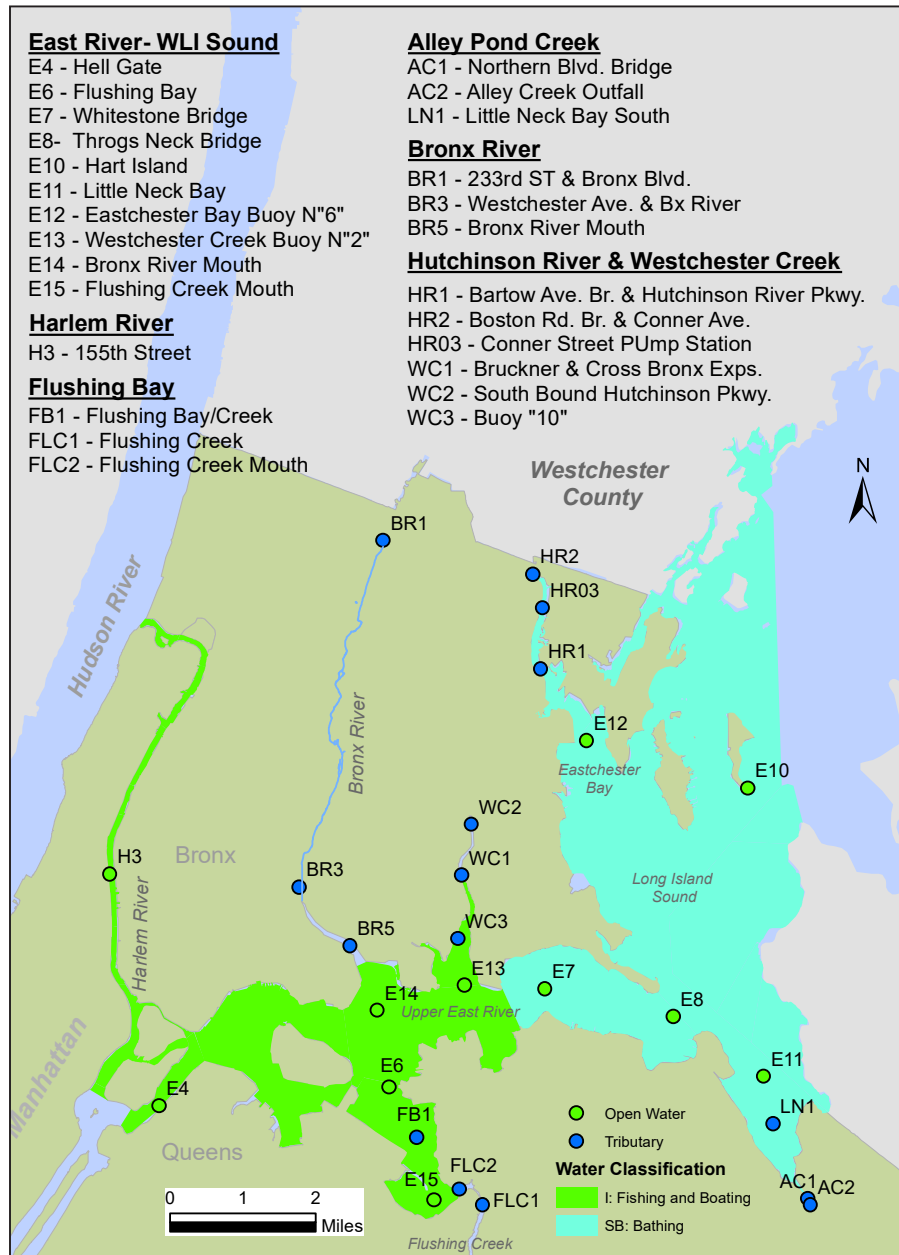
NITROGEN

The inner harbor currently has the highest nitrogen levels of the four regions. Looking at the region via individual sampling sites, it becomes apparent that higher concentrations of inorganic nitrogen (NO_2 & NO_3) and ammonia ($\text{NH}_3\text{-N}$) are highest in the Staten Island Kills (K3 and K4) and lowest in the Battery area (N4 and N5).

With one exception in 2011, summer means of ammonia and nitrate/nitrite have remained greater than 0.30 mg/L. In 2018 ammonia remained stable compared to 2017 while the nitrate/nitrite concentrations showed a small but notable increase.



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 2018, water quality continued to be superior for the Upper East River-Western Long Island Sound (UERWLIS). 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 45 cells/100mL. Nine out of eleven historical/open-water sites had averages <100 cells/100mL.

Enterococcus concentrations were also superior for the area in 2018. The regional summer geometric mean was 5 cells/100mL. All 11 monitoring sites in the area complied with the Bathing Standard of 35 cells/100mL.

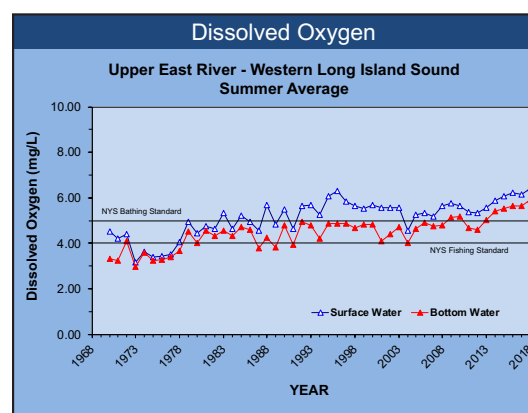
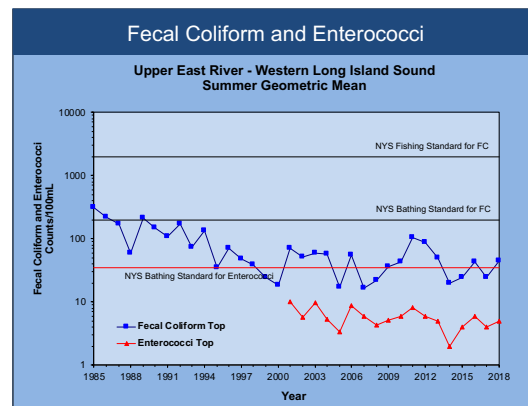
Bacteria concentrations have shown a downward trend for more than 20 years in the UER-WLIS region. The recent slight upward tick in the bacteria levels seems to have more to do with how superior the waters were the previous seasons than any systematic change.

Enterococcus levels in the UER-WLIS have been monitored since 2001. The averages for the past 17 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 2018 average here is the lowest of any of the four city regions (6.43 mg/L and 5.91 mg/L for surface and bottom waters, respectively). DO levels at sites H3, E15 and E11 remained above their classified standard all summer. The remaining sites in this region had one or more samples that were below the NY state fishing standard of 4.0 mg/L. Deep water sites such as E10 and E8 will commonly yield bottom DO values as low as 2.45 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. The average bottom DOs have been consistently above the standard since 2013. Surface water average DOs have increased to and stayed above the bathing standard since 1992, with one year exception (2003).



CHLOROPHYLL 'a'

The UER-WLIS region generally has a low chlorophyll 'a' average (<10 ug/L). Some stations located in the Long Island Sound bays can average as high as 20.8 ug/L (E11 Little Neck Bay) with single samples as high as 52.6 ug/L. E12 in Eastchester Bay had the next highest average of 16.4 ug/L with samples as high as 44.2 ug/L. Stations to the west in the upper East River (E4, E6, E14) have lower chlorophyll 'a' averages (<6 ug/L). The regional average in this area was 9.8 ug/L.

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

SECCHI TRANSPARENCY

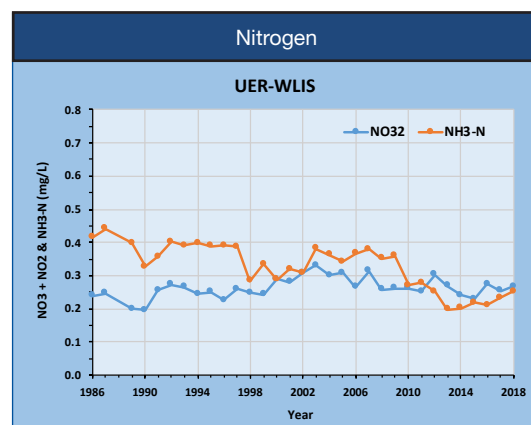
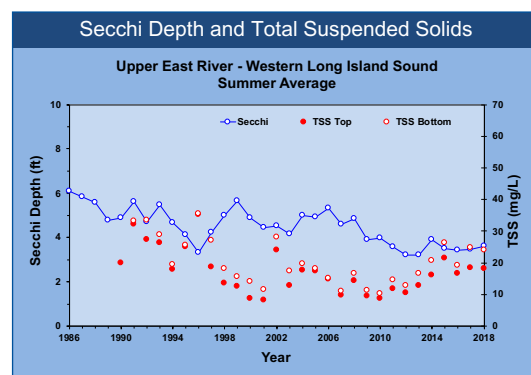
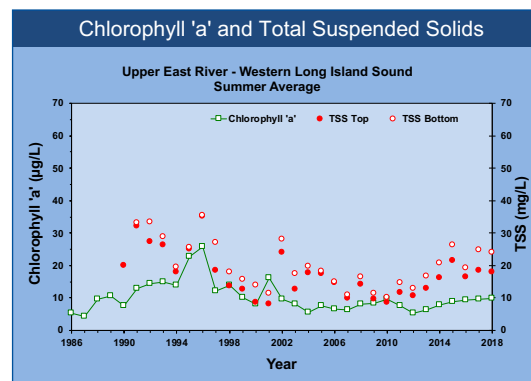
In the summer of 2018, the average Secchi transparency in the UER-WLIS was 3.6 ft. All of the open water historical sites in this region averaged between 3 and 4 ft. except E10 (average Secchi of 4.4 ft.) and H3 (2.5 ft.). H3 is located in the Harlem River and depending on tide receives flow from the turbid Hudson River.

Average Secchi depths have not varied substantially since 2009. Surface water suspended solids and secchi depth have not varied the past three years. 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.

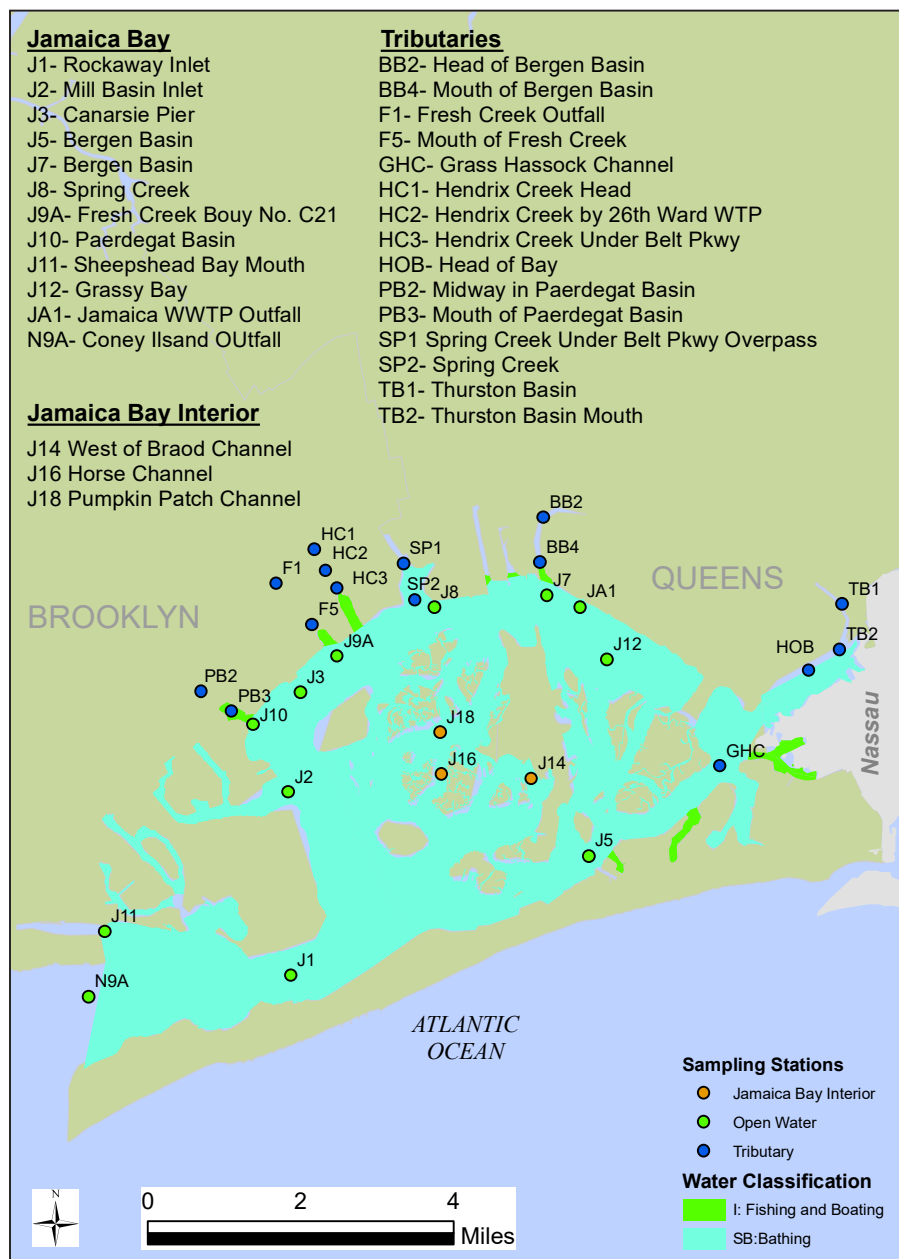
NITROGEN

This region encompasses several large treatment plants as well as tributaries. Nitrogen loading from a WRRF, 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 secondary treatment at a given plant. The Upper and Lower East River final combined total nitrogen limit is a 12-month rolling average limit of 44,325 lbs/day.

The region's nitrogen levels have slowly increased since 2014 after a decrease in ammonia levels from 2009 to 2013. Several nitrogen removal construction projects at plants in this region (including Hunt's Point and Ward's Island) were completed between 2010 and 2014. Additional upgrades were completed at Talman Island, Bowery Bay, and Ward's Island by early 2017.



JAMAICA BAY WATER QUALITY



Jamaica Bay is located at the south- western 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 2018, 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 19 cells/100mL.

Under wet weather conditions, the Bay experiences CSO events and 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 2018. The regional summer geometric mean was 2 cells/100mL; all 12 monitoring sites complied with the bathing standard of 35 cells/100mL.

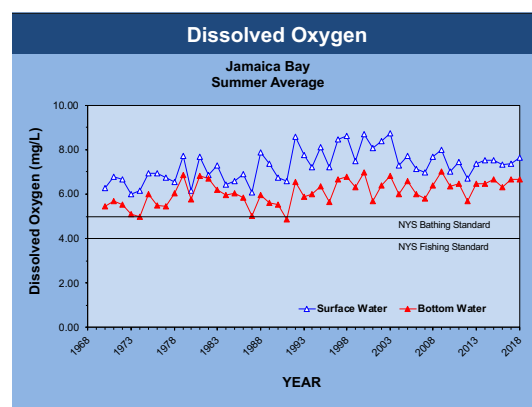
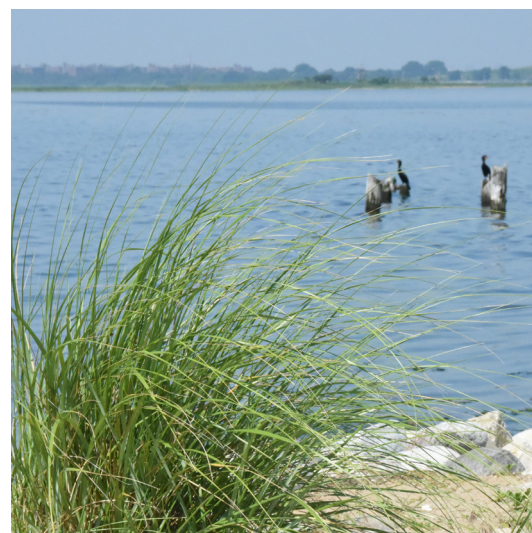
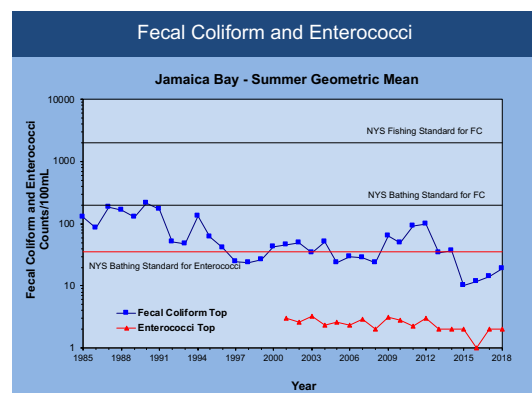
Summer geometric mean bacterial levels in Jamaica Bay as a whole have been below standards for more than 30 years.

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 summer DO average (7.64 mg/L). Both surface and bottom DO readings at J5 and J11 (two out of the twelve stations) meet the state bathing standard for DO (never less than 5.0 mg/L) throughout the summer; other stations had one or more DO readings less than the standard. In general, the stations near the mouth and southern side of the Bay tend to have higher DO readings than the ones in the northern and eastern sides. During the summer of 2018, the lowest DO readings (3.29 mg/L and 3.51 mg/L) were found in bottom waters outside of Fresh Creek (J9A) and at Grassy Bay (J12, near JFK airport runway).

Summer DO averages for both surface and bottom waters have remained above 5.0 mg/L for at least half a century with one exception (DO bottom = 4.86 mg/L in 1991). The long term trend shows a gradual and steady increase 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 21.35 ug/L. Only two open water historical stations in Jamaica Bay (N9A & J1) averaged less than 15 ug/L in 2018. Stations in the northeastern portion of the Bay (J5, J7, J8, J12 and JA1) all averaged over 22 ug/L with J7 at the mouth of Bergen Basin having the highest average of 34.65 ug/L. The stations located at the mouths of various tributaries in the bay are often eutrophic in summer months. Slow turnover of water within the bay and the nutrient-rich tributaries feeding it allow for the development of large standing phytoplankton populations and high chlorophyll 'a' levels.

Although declining modestly since 2014, average chlorophyll 'a' concentrations have fluctuated greatly over the past 30 years, particularly in the mid 90's. Since the summer average of 53.91 ug/L in 2001, the concentrations have been decreasing. The completed carbon addition facility (using glycerol in place of methanol) at the 26th Ward Wastewater Resource Recovery Facility (WRRF) 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 upgrades to 26th Ward, improvements are progressing at the Jamaica WRRF, Coney Island WRRF and Rockaway WRRF in Queens. All improvements are expected to be completed by 2020.

SECCHI TRANSPARENCY

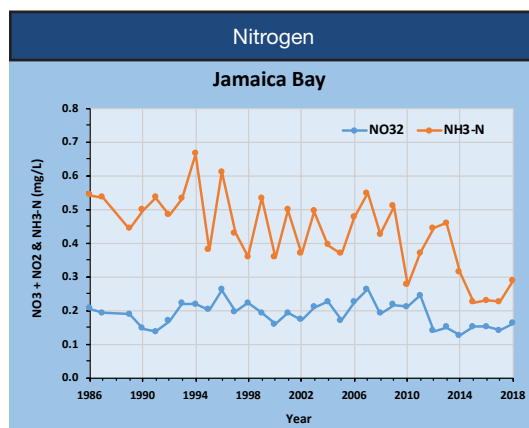
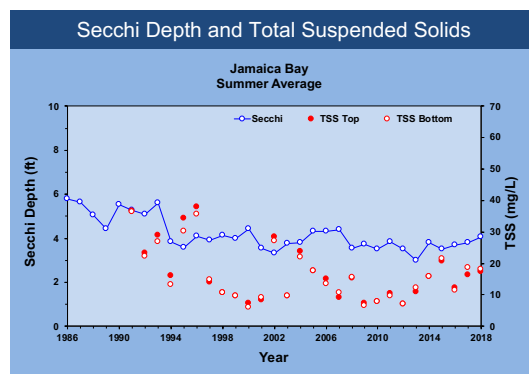
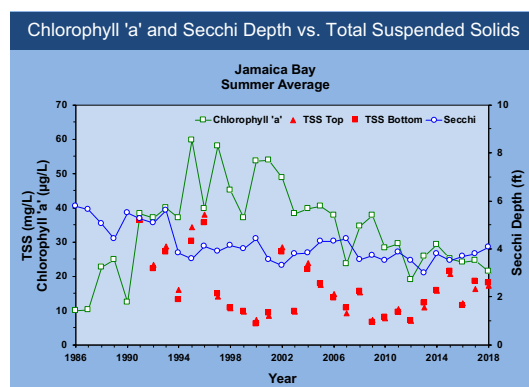
The 2018 average summer Secchi depth of 4.1 ft. represented a slight increase from the prior year. All of the open water historical sites in Jamaica Bay averaged between 3 and 4 ft. except J1 (Secchi depth of 5.0 ft.) and N9A (Secchi depth of 6.1 ft.). N9A is located near the outfall of the Coney Island WRRF. Often, low individual Secchi readings are paired with particularly high chlorophyll 'a' concentrations representative of a phytoplankton bloom. For example at J7 and J3, two instances of Secchi depths of 1.0 ft. and 1.5 ft. were measured when corresponding chlorophyll 'a' samples were 91.0 ug/L and 69.9 ug/L respectively.

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.

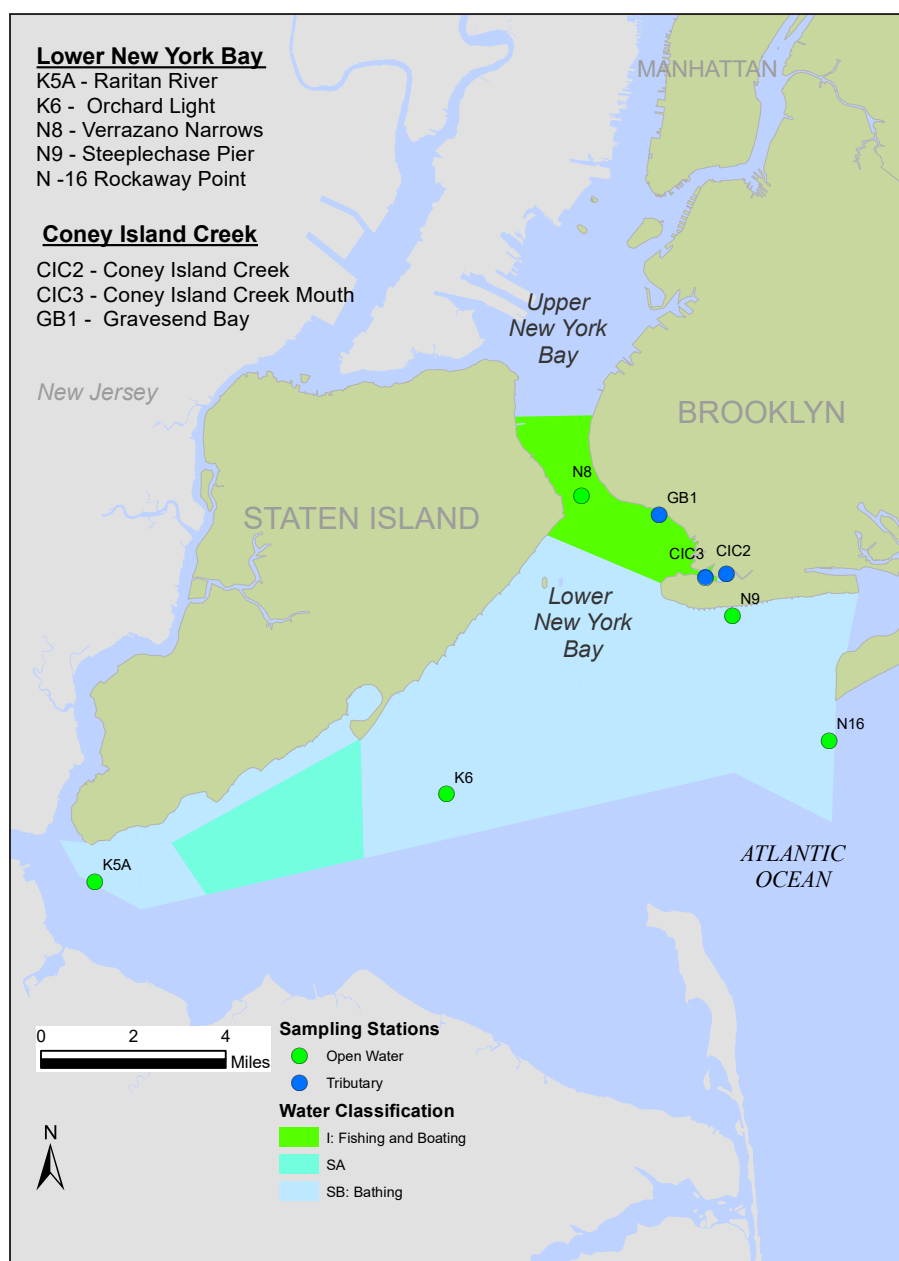
NITROGEN

In 2018, there was a slight increase in the mean ammonia concentration. The region has a history of year to year variations that reflect the increase. Stations in the bay located at the mouths of tributaries tend to show higher concentrations of nitrogen.

After almost 30 years of fluctuating ammonia levels in Jamaica Bay, there have been four consecutive years of values below 0.3 mg/L. Nitrate/nitrite levels here have also remained stable and below 0.20 mg/L since shortly after the commencement of the 26th Ward biological nitrogen reduction program in 2010. As of August 1 2017, the combined total nitrogen limit for Jamaica Bay is a 12-month rolling average of 31,118 lbs/day Total Nitrogen. DEP has been meeting this limit.



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 resource recovery facilities, 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 influences its water quality.

BACTERIA

In 2018, 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 the NYS Standard of 200 cells/100mL for this area. All five historical/open-water stations had summer geometric means ≤ 25 cells/100mL. Their monthly geometric mean met all standards.

Enterococcus concentrations were also superior for the Lower New York Bay-Raritan Bay in 2018. The regional summer geometric mean was 2 cells/100mL; all five monitoring sites complied with the bathing standard of 35 cells/100mL.

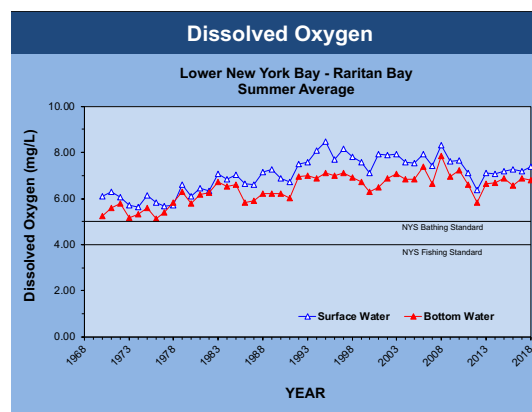
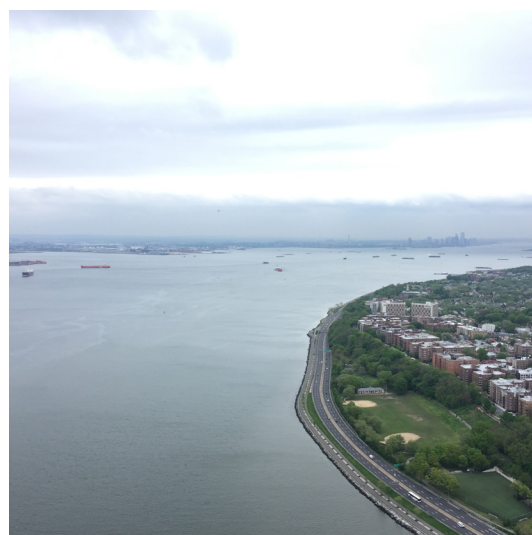
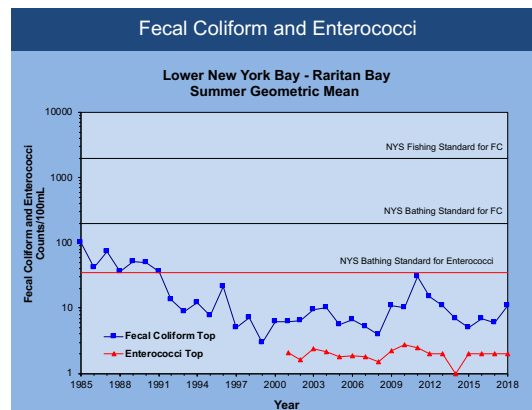
Fecal coliform (FC) concentrations for LNYB-RB show significant decline from the mid-1980s to the present time. These improvements have allowed for the opening of all NYC public beaches since 1992 and the lifting of wet weather swimming advisories.

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 (7.39 mg/L and 6.80 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 and bottom samples below the state's fishing standard (4.0 mg/L) 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 resource recovery facilities (including Oakwood Beach and Port Richmond) was completed. The Owls Head WRRF was upgraded later. These upgrades are reflected in the steady rise of 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 < 10 ug/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 17.40 ug/L (K5A) and 24.96 ug/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 ug/L (see figure). In 2018, the chlorophyll 'a' average was 13.47 ug/L.

SECCHI TRANSPARENCY

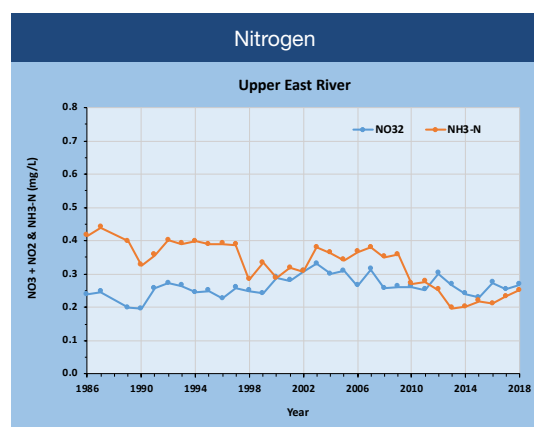
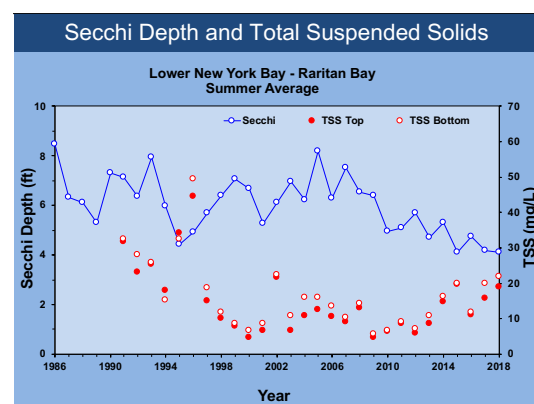
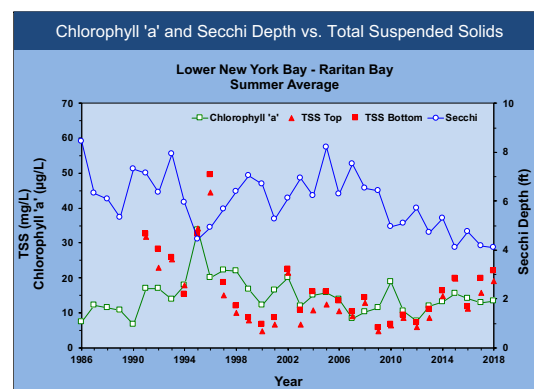
The 2018 average summer Secchi depth in the LNYB-RB region was 4.1 ft., a small decrease from last year's average of 4.2 ft. The five sites in this region mirror the layout described in the Chlorophyll 'a' section above. Sites on the eastern side of the region that have low chlorophyll 'a' concentrations also have high average Secchi depths (5.1 ft. for N9 and 6.1 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 3.1 and 3.7 ft., respectively. Higher Enterococcus readings were observed at the head of the Bronx River (BR1), mostly due to lack of water flow in the area during dry weather.

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 high TSS averages for both surface and bottom waters.

NITROGEN

This region had the lowest mean ammonia concentration in summer 2018 (0.24 mg/L). As one would suspect, the lowest mean nitrogen concentrations are found at open water sites such as Rockaway Point (N16) and Coney Island (N9) and higher concentrations in Raritan Bay (K5A & K6).

Lower NY Bay nitrogen levels have remained relatively low and stable over the past 32 years. Contributing factors likely include a large mixing area that limits stagnation at the sampling sites.



HARBOR-WIDE IMPROVEMENTS

In 2018, there were a total of 89 survey stations that covered most of the New York City's open water and tributaries. The harbor water quality conditions have remained good and stable compared to previous years. The harbor-wide summer (May-Oct) open water average Dissolved Oxygen (DO) for both surface and bottom waters, again, reached one of the highest records, 6.8 mg/L and 6.3 mg/L, respectively. Fecal Coliform (FC, for the past 29 years) and Enterococci (Entero, 18 years) 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/100mL 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 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 harbor-wide DO levels remained above the NYSDEC Bathing Standard of 5.0 mg/L for the past 27 years.

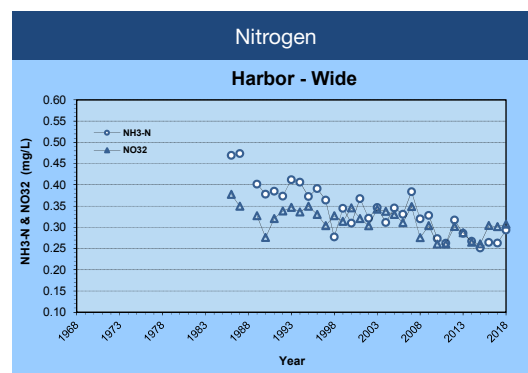
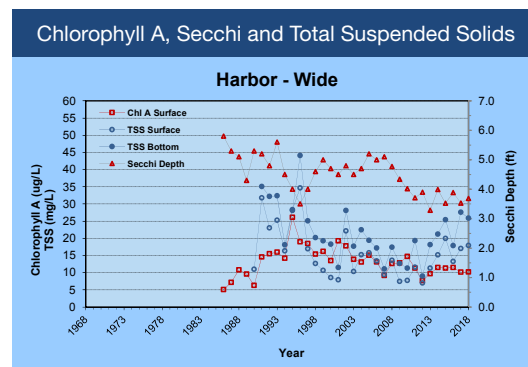
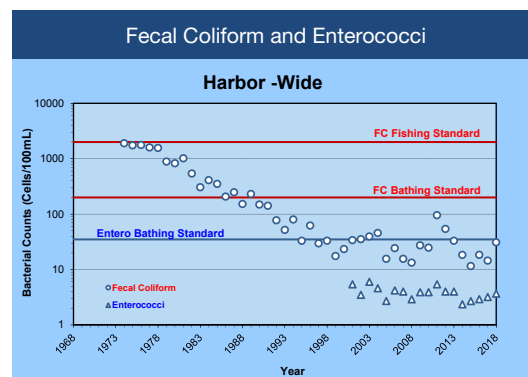
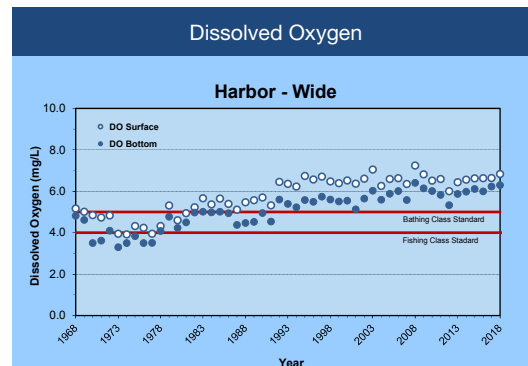
The harbor-wide summer geometric means for FC count have remained well below the levels and within compliance with the bathing standard for the past three decades, although it increased from 14 counts/100 mL to 31 counts/100 mL in summer 2018. High FC counts with high geometric means were found at A & K Railroad Bridge (K3), Staten Island and in tributaries located at Coney Island Creek (CIC2), Hutchinson River (HR2), Alley Creek CSO outfall (AC2) and Westchester Creek (WC2). Most short-term spikes occur after rain events due to combined sewer overflow (CSO) discharges.

Over the last 18 years, harbor-wide Enterococcus summer geometric means have been relatively stable, with spikes similar in size and frequency to the fecal coliform levels. However, higher than normal summer averages of FC and Enterococci were found in the same tributaries.

In the summer of 2018, the harbor-wide chlorophyll 'a' average (10.2 ug/L), Secchi depth (3.7 ft.) and surface and bottom Total Suspended Solids (17.9 and 25.9 mg/L) have had no big changes compared to 2017.

The Harbor Survey has begun its integration into DEP's Long Term Control Plans (LTCPs). In 2012 DEP kicked off the development of 11 water body-specific LTCPs to reduce CSOs and improve water quality in NYC's waterbodies and waterways. The goal of each LTCP is to identify appropriate combined sewer overflow (CSO) controls necessary to achieve waterbody-specific water quality standards, consistent with the Federal CSO Policy and the water quality goals of the Clean Water Act (CWA).

About half of the Harbor Survey sampling stations (49 out of 89 sties) that are distributed around New York City's tributaries are included in the plans. The Harbor Survey has been a part of DEP's Flotables Monitoring Program since 2007. It has also been a part of citywide ecological and water quality studies and the Post Construction Water Quality Monitoring Plan for Jamaica Bay since 2016.



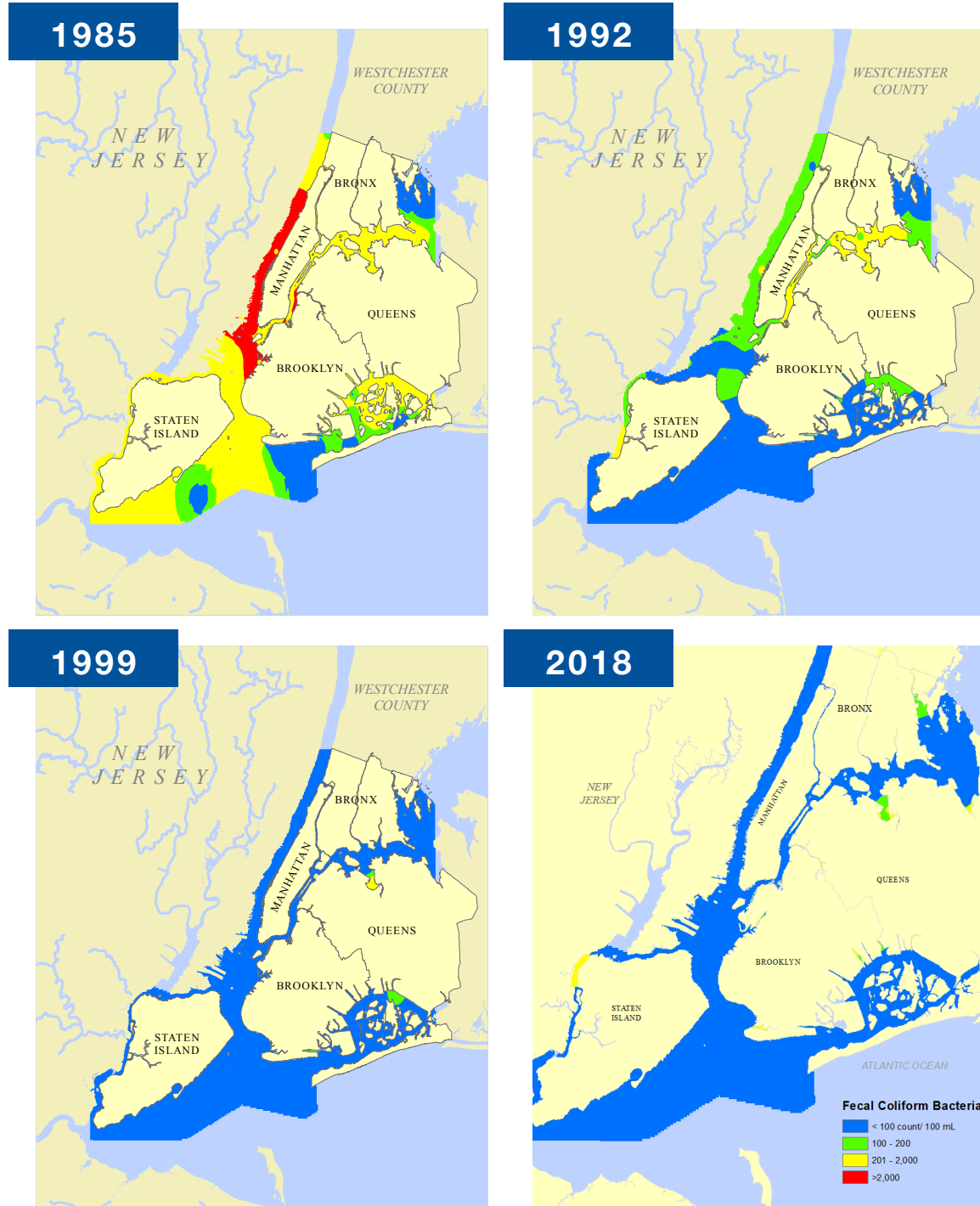
DEP regularly posts Harbor Survey Monitoring data on its website, including non-beach waterbody advisories. This year DEP launched an updated Waterbody Advisory System that improves upon earlier versions. This system can be used when planning recreational activities in locations other than beaches. For information on beaches, visit the NYC Beach Water Quality website. The Waterbody Advisory System is based on water quality models and real-time rainfall data. New Yorkers can visit the NYCDEP website for up-to-date information or register for daily alerts at NotifyNYC. The new Waterbody Advisory System:

- Expands the number of waterbodies that could receive an advisory from 28 to 45
- Utilizes and displays rainfall data from rain gauges at all 14 Wastewater Treatment Plants
- Provides more detailed advisory durations based on measured rainfall
- Uses primary contact recreation standards*

http://www.nyc.gov/html/dep/html/stormwater/combined_sewer_overflow.shtml

HARBOR-WIDE WATER QUALITY IMPROVEMENTS OVER FOUR TIME PERIODS

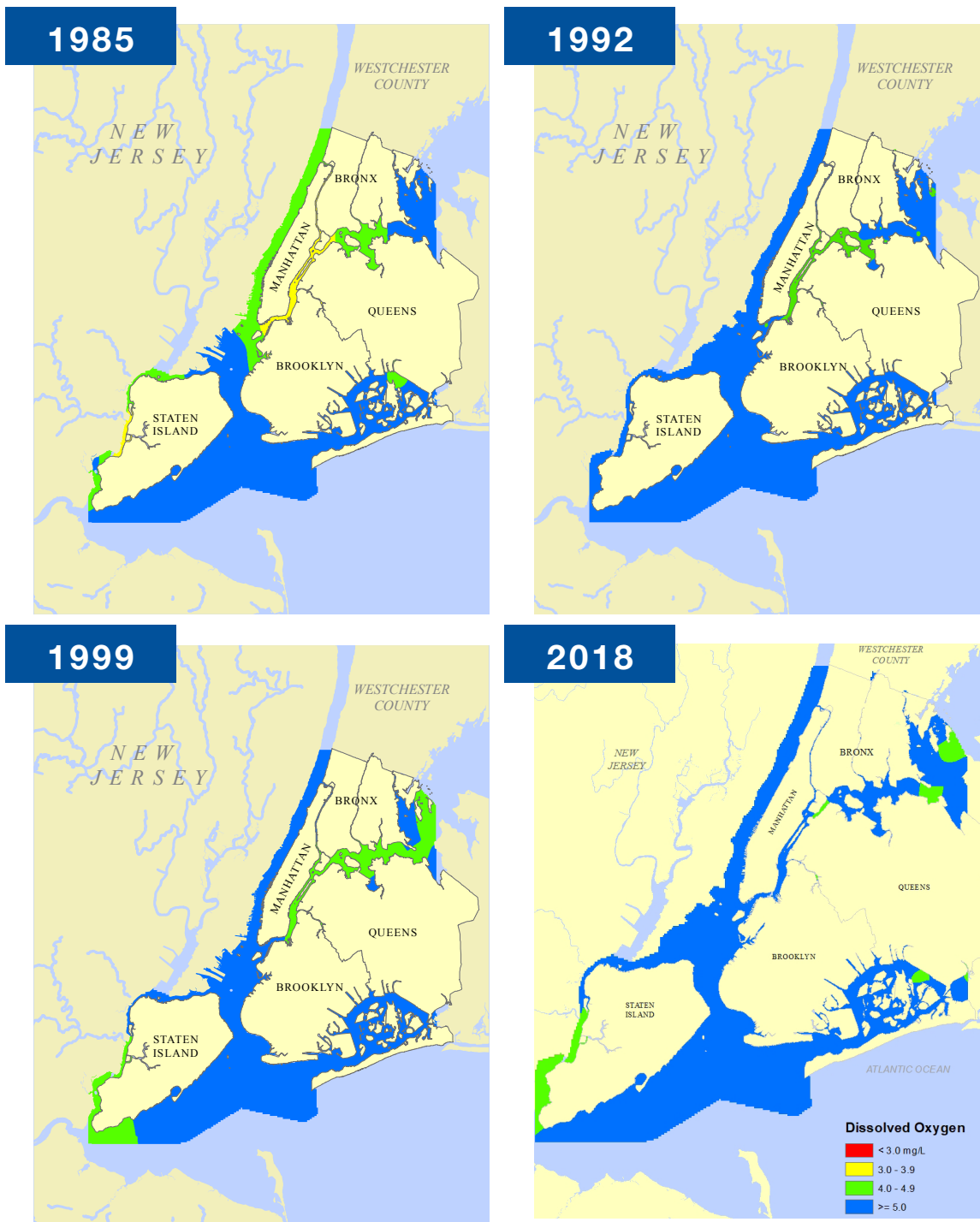
SUMMER GEOMETRIC MEANS FOR FECAL COLIFORM IN SURFACE WATERS



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

HARBOR-WIDE WATER QUALITY IMPROVEMENTS OVER FOUR TIME PERIODS

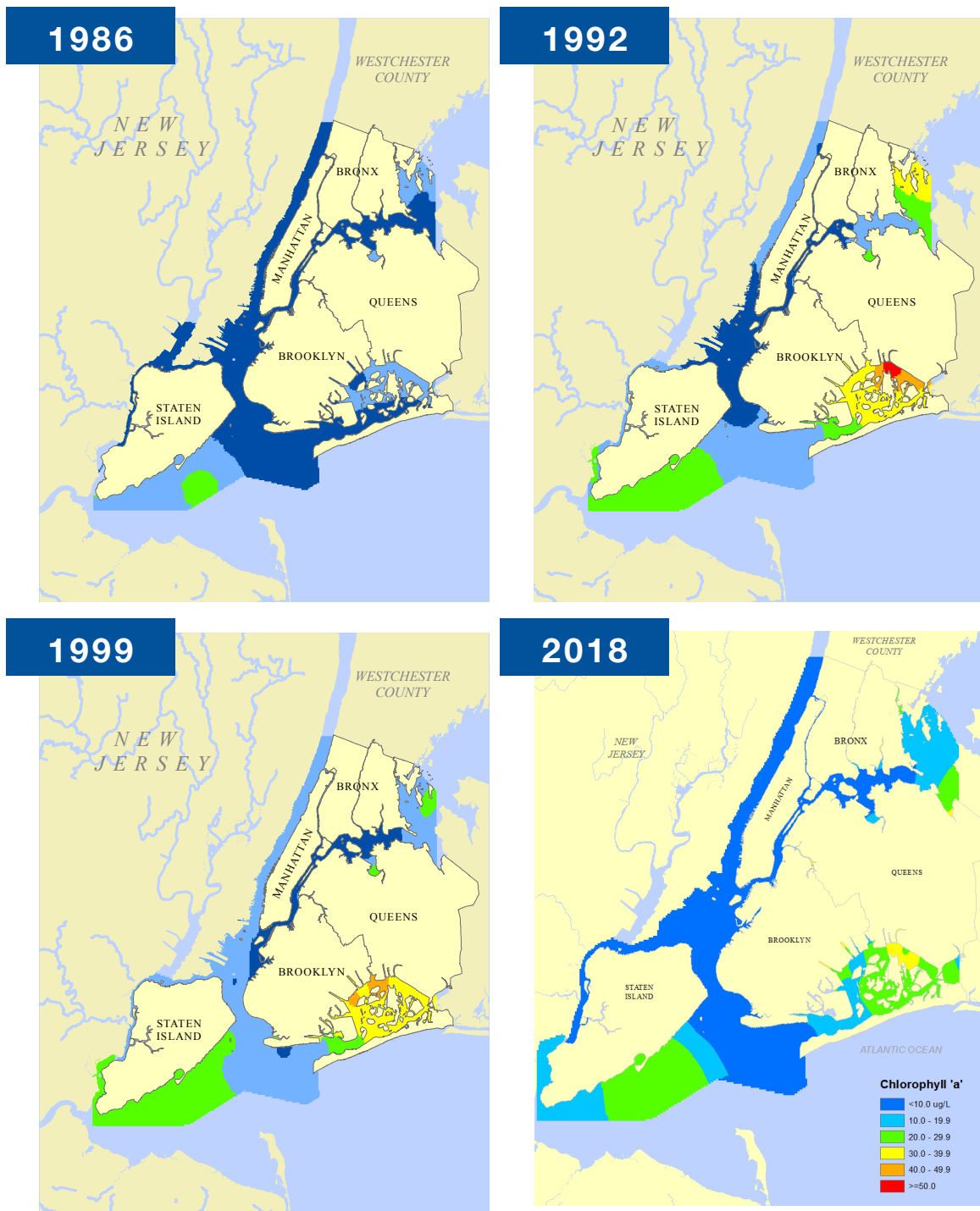
SUMMER AVERAGES FOR DISSOLVED OXYGEN IN BOTTOM WATERS



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



Visit DEP's website at nyc.gov/dep
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