2010

New York Harbor Water Quality Report

Environmental Protection

Michael R. Bloomberg, Mayor
Carter H. Strickland, Jr., Commissioner

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Dear Friends;

The New York City Department of Environmental Protection (DEP) is proud to release the 2010 Harbor Water Quality Report. Since 1909, DEP has routinely collected samples from dozens of harbor water sampling stations throughout the year that measure four basic parameters: fecal coliform, dissolved oxygen, chlorophyll 'a', and secchi transparency. Taken together, these four metrics give a clear indication that the overall health of the city's surrounding waterways continues to improve to levels not witnessed in more than a century.

Under Mayor Bloomberg's leadership, the city has invested nearly $8 billion improving the quality of our harbor waters. Just this past year, we announced a number of new initiatives to guide our investments in the coming decades. The city reached a historic agreement with the state, the Natural Resources Defense Council and other environmental stakeholders to cut nitrogen discharges into Jamaica Bay by 50% over the next decade. As part of that effort, we added seven new sampling locations to our Harbor Survey throughout Jamaica Bay, giving us an unprecedented level of detail about the health of the harbor. And we began to implement a comprehensive green infrastructure plan that will cut combined sewer overflows by 40% over the next 20 years by capturing stormwater through green elements, like bioswales, blue roofs, and streetside tree pits. Combined sewer overflows, a challenge that many cities in the Northeast and Midwest face during periods of heavy rain, are perhaps the single greatest remaining challenge to harbor water quality that we must address.

Keeping our harbor waters as pristine as possible is not just a matter of aesthetics; it directly impacts New Yorkers' quality of life, and is a key factor in the continued growth and prosperity of the City. A clean, healthy harbor is a place where people want to work, play, and raise a family. A waterfront that is safe and inviting will attract the new investments that have been made possible by Mayor Bloomberg's visionary re-zonings of large parts of the city, including Greenpoint/Williamsburg in Brooklyn and Hunters Point South in Queens. That's why we will continue to make the investments necessary to sustain and extend this progress, and why improving the quality of New York Harbor is a major component of Strategy 2011-2014, our far-reaching strategic plan to make DEP the safest, most effective, cost-efficient and transparent water utility in the nation.

I hope you will take the time to learn more about what we do by visiting www.nyc.gov/dep, or follow us at www.faceboook.com/nycwater.

All the best,

Carter H. Strickland, Jr.

Carter H. Strickland, Jr.
Commissioner

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Introduction

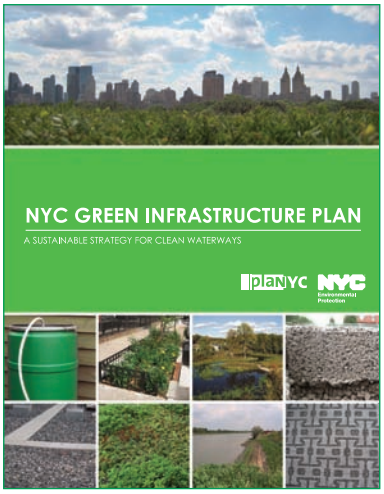
The Harbor Survey Program has now entered its second century of data collection in New York Harbor. As the Harbor Survey embarks on its next hundred years of operations, the water quality in New York Harbor is on average the best it has been since the monitoring program began in 1909. The data collected by the Harbor Survey over the previous 100 years has been used in innumerable ways by regulatory agencies, academic institutions, and the general public.

Throughout the past century, harbor water quality has improved dramatically. Within the last generation, many New Yorkers have again begun to use local waterways for recreation. These improvements in water quality have been directly associated with infrastructure investments, including major construction and upgrades at all 14 in-city wastewater treatment plants (WWTPs) and increased capture of storm runoff. Since 2002, the city has invested nearly $8 billion as part of this effort. Today, all sewage generated in the city on a dry-weather day is treated to full Clean Water Act standards.

To further improve and protect New York City's ambient waterways, DEP has been investing in sustainable practices to address flooding, conducting programs to remove floatables and debris from the waterways, and organizing beach clean-up and protection programs. These include the Floatable Action and Boom and Skim programs, Shoreline Survey/Sentinel Monitoring, and Enhanced Beach Protection.

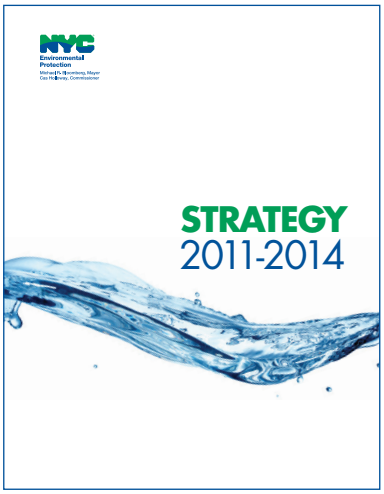
The Harbor Survey has evolved from the initial monitoring efforts conducted by the Metropolitan Sewerage Commission during 1909, which were done in response to public outcry about fouled waterways impacting quality of life. At that time, a handful of locations around Manhattan were assessed. The survey grew over the years to encompass the entire city. During 2010, the number of sampling locations grew from 55 to 65. Forty of these stations are located throughout the open waters of the harbor, and 25 stations are located in smaller tributaries. During 2011, the number of sampling sites will be 72, as DEP further assesses the benefits of its Combined Sewer Overflow reduction initiatives. The number of water quality parameters measured has also increased from five in 1909 to more than 20 today.

This annual New York Harbor Water Quality Report includes data collected by DEP during 2010. It is presented in four sections, each delineating a geographic region within the harbor. Four water quality parameters, used as key indicators, are evaluated: fecal coliform bacteria, dissolved oxygen, chlorophyll 'a' and Secchi transparency. A discussion of enterococci bacteria, which the US EPA is now using as a sewage indicator, is also included in this year's report.



New York Harbor is the cleaner than it has been in more than 100 years of testing. In September 2010, Mayor Bloomberg unveiled the NYC Green Infrastructure Plan, which will improve harbor water quality even further by capturing and retaining stormwater runoff before it enters the sewer system. New York City, like other older urban centers, is largely serviced by a combined sewer system where stormwater and wastewater are carried through a single pipe. During heavy storms, the system often reaches capacity and must discharge a mix of stormwater and wastewater—called a combined sewer overflow, or CSO—into New York Harbor. The plan, which includes $2.4 billion in green infrastructure, will reduce these sewer overflows by 40% by 2030. This approach will also save $2.4 billion over the next 20 years because it will reduce more costly investments in traditional sewage retention projects, like tanks and tunnels. Green infrastructure uses vegetation, soils, and other structural elements to absorb and evaporate water and to mimic natural areas and hydrologic cycles. These types of projects are a key component of PlaNYC's sustainability effort because they also shade and cool the city, improve air quality, and increase property values. These characteristics, the minimal energy and manpower required for operation, and the relatively quick installation mean that green infrastructure can be cost-effective and provide immediate benefits.

DEP Launches Ambitious and Forward-Thinking Strategic Plan



Mayor Michael R. Bloomberg and Environmental Protection Commissioner Cas Holloway recently unveiled *Strategy 2011-2014*, a far-reaching strategic plan that lays out 100 distinct initiatives to make DEP the safest, most efficient, cost-effective, and transparent water utility in the nation. Each initiative directly advances one of DEP's core functions: serving nine million water customers; supplying and treating more than one billion gallons of water every day; making cost-effective infrastructure investments; and achieving a sustainable quality of life for all New Yorkers. The new plan, the product of nearly one year of analysis and outreach, builds on PlaNYC, Mayor Bloomberg's sustainability blueprint for New York City. From improving harbor water quality to harnessing clean renewable energy, *Strategy 2011-2014* includes bold and achievable initiatives that will improve New Yorkers' quality of life—at a price they can afford. The plan will guide DEP's investments and operations over the next four years, and DEP will publish an annual report card on the progress of each initiative. For more information or to download the Strategy, visit www.nyc.gov/dep.

> ***"Building on the successes of the past eight years, DEP has developed this exciting strategic plan that lays out the next generation of improvements to our water system, as well as ambitious strategies such as a Green Infrastructure Plan to reduce combined sewer overflows that will transform the City and improve water quality."***
>
> ***— Mayor Michael R. Bloomberg***

Synopsis of Four Major Indicators of Environmental Change

Fecal Coliform (FC) Bacteria - Fecal coliform concentrations are measured in NY Harbor as human health-related indicators of sewage-related pollution. Fecal coliform are a group of bacteria primarily found in human and animal intestines and are associated with sewage waste. These bacteria are widely used as indicator organisms to show the presence of such wastes in water and the possible presence of pathogenic (disease-producing) bacteria.

Chlorophyll 'a' - Chlorophyll 'a' is a green pigment found in most macro-algae and phytoplankton. It is vital for photosynthesis, which allows plants to obtain energy from light. Chlorophyll 'a' found in phytoplankton can be used as an indicator of primary productivity, which is the necessary base of the food chain in the water. These organisms respond quickly to environmental changes, and their abundance may serve as a measure of water and ecosystem quality. Overgrowth of primary producers can cause eutrophication. High concentrations of nutrients in water that promote algae growth, Chlorophyll 'a' levels above 20 µg/L are considered indicative of eutrophic conditions.

Eutrophication is a common phenomenon in marine coastal waters. In contrast to freshwater systems, nitrogen is more commonly the key limiting nutrient of marine waters; thus, nitrogen levels have greater importance to understanding eutrophication problems in salt water.

Dissolved Oxygen (DO) - The levels of oxygen dissolved in the water column are critical for the respiration of most aquatic life forms, including fish and invertebrates such as crabs, clams, zooplankton, etc. Dissolved oxygen concentration is, therefore, one of the most universal indicators of overall water quality and a means of determining habitat and ecosystem conditions.

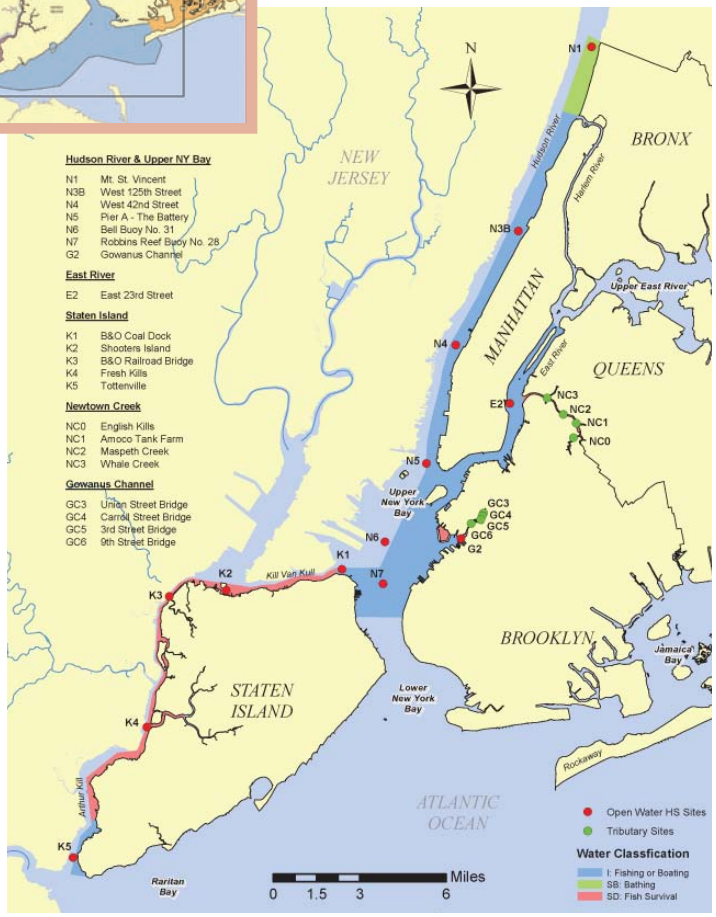
Secchi Transparency - A Secchi disk is used to estimate the clarity of surface waters. High Secchi transparency (greater than 5.0 feet) is indicative of clear water, with declines in transparency typically due to high suspended solids concentrations or plankton blooms. Low Secchi readings (less than 3.0 feet) are typically associated with degraded waters. These conditions are indicative of light-limiting conditions, which in turn affect primary productivity and nutrient cycling.

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 and dissolved oxygen are noted in the following chart.

Common Water Use And NYSDEC Standards For Fresh And 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	For Class SB / Bathing
SB	Bathing and other recreational use	Monthly geometric mean less than or equal to 200 cells/100mL from 5 or more samples	5.0 mg/l	(Monthly geometric mean) <35 cells/100mL
I	Fishing or boating	Monthly geometric mean less than or equal to 2,000 cells/100mL from 5 or more samples	4.0 mg/L	(Single sample) Max 10+ cells/100mL
SD	Fish survival	No standard	3.0 mg/L	

Inner Harbor Area



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 13 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).

FECAL COLIFORM

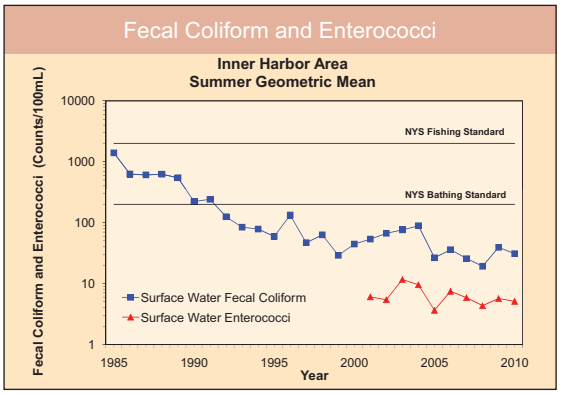
Water quality as estimated by fecal coliform (FC) concentrations was superior for the Inner Harbor in the summer of 2010. The regional average was 35 cells/100 mL, slightly decreasing from 39 cells/100 mL in 2009. All monitoring sites in the area complied with the monthly FC standard of 200 cells/100 mL.

Discharges from storm drains and combined sewer overflows (CSO) can increase fecal coliform concentrations immediately after a heavy rainfall. Under these conditions, 5 of 13 sites exceeded the daily Bathing Standard, and wet weather advisories were issued by NYC DOHMH.

Water quality as estimated by Enterococcus concentrations was also superior for the Inner Harbor in 2010. The regional summer geometric mean was 5 cells/100 mL; all monitoring sites had averages <15 cells/100 mL, which complied with the Bathing Standard of 35 cells/100 mL for Enterococcus.

TRENDS

Fecal coliform levels in the Inner Harbor have dramatically declined over the last three decades, with levels since 1997 well below the Bathing Standard. The averaged FC counts have declined from 2000 cells/100 mL in the early 1970s to below 100 cells/100 mL since early 1990. 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 waterbody, and the reduction of CSOs. Year-to-year variations have become more apparent with the reduction of FC levels.

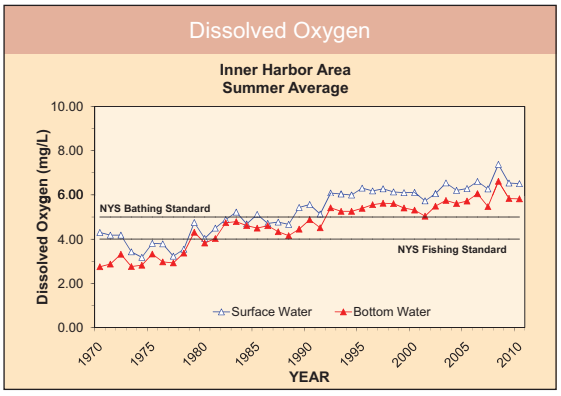


Enterococcus levels in the Inner Harbor have been monitored since 2001. The averages for the past ten years have been consistently well below the Bathing Standard of 35 cells/100mL.

DISSOLVED OXYGEN

The Inner Harbor area had summer average Dissolved Oxygen (DO) values of 6.5 mg/L for surface waters and 5.8 mg/L for bottom waters in 2010. They were similar as in 2009 for both surface and bottom waters.

During the summer (June—September), out of a total 196 samples taken from the surface and 196 samples taken from bottom waters in the area, 98% and 95% of the time DO values complied with NYSDEC standards.



TRENDS

Since late 1980, average summer surface DO values in the Inner Harbor have risen to levels above NYSDEC standards for bathing and other recreational use (5.0 mg/L). Bottom water average DO values reached this level in early 1990. The average DO levels for surface and bottom waters have risen from approximately 2.8 and 4.3 mg/L in 1970 to 6.5 and 5.8 mg/L at present, respectively.

Inner Harbor Area

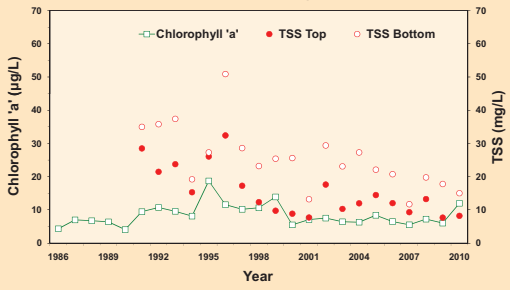
CHLOROPHYLL ‘a’

During 2010, the average chlorophyll ‘a’ in the Inner Harbor was the highest summer mean (12.0 µg/L) in 11 years. July 2010 was the hottest on record. The stations in the Staten Island Kills, East River, and Hudson River all averaged under 16 µg/L, with the exception of K5. Raritan Bay typically has high chlorophyll ‘a’ averages, thus the proximity of K5 to the bay contributed to a rather high summer average of 25.3 µg/L.

The Newtown Creek stations, which are not included in the regional data, average between 25.4 µg/L at the mouth of the creek and 37.9 µg/L near the head. This is typical of the creek and is likely a result of nutrient-enriched waters from runoff and minimal tidal flushing.

The Gowanus Canal station (G2) average chlorophyll ‘a’ increased markedly from last year (7.9 µg/L) with an average of 22.9 µg/L this summer. Some individual samples were as high as 91.6 µg/L indicating possible eutrophic conditions in mid-summer. A Gowanus tributary station (GC6) adjacent to G2 had a mean of 25.5 µg/L.

Chlorophyll ‘a’ and Total Suspended Solids



TRENDS

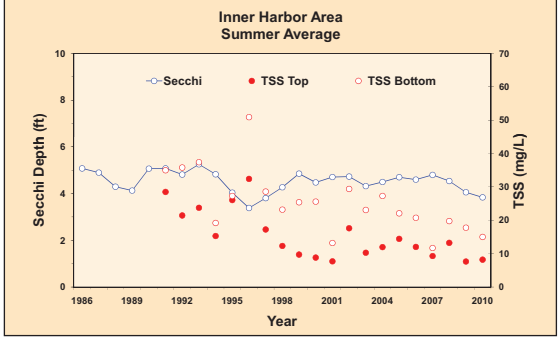
The regional mean seems to be affected by the higher than usual averages at G2 as well as higher averages in the Hudson River. This area includes the stations N1, N5, N6, and N7, which were all greater than 10 µg/L in 2010. Some of the increase was likely due to the hot weather.

SECCHI TRANSPARENCY

The Inner Harbor region encompasses many distinct sub-regions: an estuary, a near fresh water river, a narrow marine channel known to New Yorkers as the “East River,” and an even narrower marine channel separating New Jersey and Staten Island that is fed into by several smaller rivers and tributaries. It is beneficial to consider these sub-regions separately.

In summer 2010, the average Secchi reading was 3.8 ft in the entire Inner Harbor area. Stations in the Staten Island Kills and East River all averaged at least 3.8 ft Secchi depth, while the Hudson River stations were all less than 3.8 ft, with lower values typical as one travels north up the river. The Hudson-Estuary area can be very turbid from freshwater influx, and Secchi depths of 1.5 ft are quite common. Newtown Creek also has low averages (all stations <3.2 ft). A contributing factor seems to be the high algal content and non-point-source runoff in these waters.

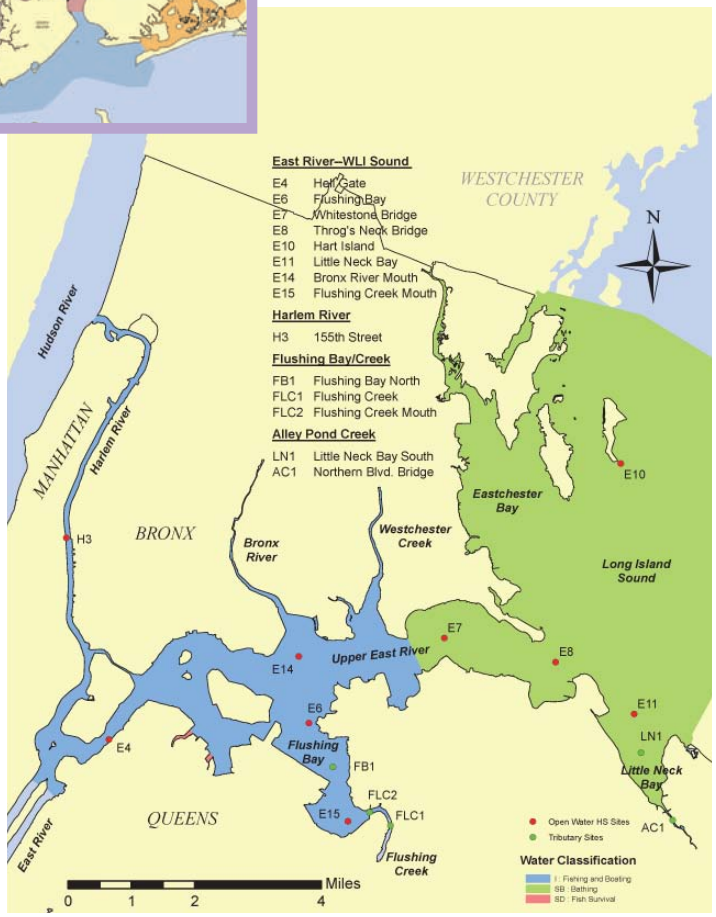
Secchi Depth and Total Suspended Solids



TRENDS

Average summer Secchi values have remained relatively constant (>4.0 ft) in the Inner Harbor area since measurements began in 1986. However, three years marked Secchi depth averages of less than 4 ft: 1996, 1997, and now 2010. The slight decrease may be attributed to the large increase in chlorophyll ‘a’ discussed in the previous section. Generally there is little variation in this region over the years (see figure). This can most likely be attributed to the normal flow from the Hudson River.

Upper East River–Western Long Island Sound



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 nine Harbor Survey monitoring stations. Waters of this vicinity, though divergent in salinity and depth, share similarities in pollutant loadings and are targeted for intensive management efforts as part of the Long Island Sound National Estuary Program.

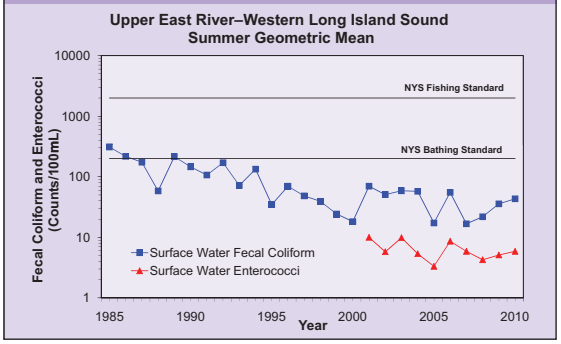
The majority of the Upper East River–Western Long Island Sound complex is classified as I, for uses such as fishing or boating, with the area east of the Bronx-Whitestone Bridge designated for Bathing (SB).

FECAL COLIFORM

In 2010, water quality continued to be superior for the Upper East River–Western Long Island Sound (UER-WLIS). Fecal Coliform (FC) concentrations for all monitoring sites except one at Flushing Creek (E15) were in compliance with their specified "best use" classifications for bathing and fishing. The summer geometric mean for this region was 43 cells/100 mL, up from 36 cells/100 mL in 2009. Eight of nine sites had averages <100 cells/100 mL.

Enterococcus concentrations were also superior for the area in 2010. The regional summer geometric mean was 6 cells/100 mL. All monitoring sites in the area complied with the Bathing Standard of 35 cells/100 mL.

Fecal Coliform and Enterococci



TRENDS

Fecal coliform (FC) concentrations have shown a downward trend for more than twenty years in the UER-WLIS region. The ongoing upgrade of wastewater treatment facilities and capture of combined sewer overflows (CSOs) were responsible for this FC reduction and will continue to have a major impact on the reduction of FC loads.

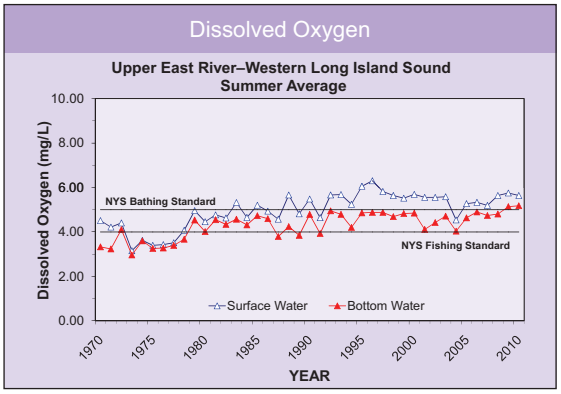
Enterococcus levels in the UER-WLIS have been monitored since 2001. The averages for the past ten years have been consistently well below the Bathing Standard.

DISSOLVED OXYGEN

This is the second year that average summer Dissolved Oxygen (DO) values for both surface and bottom waters in the Upper East River and Western Long Island Sound (UER-WLIS) vicinity have met and exceeded 5.0 mg/L (conditions suitable for SB-Bathing) since harbor survey sampling began. They were 5.6 mg/L and 5.2 mg/L for surface and bottom waters, similar to 5.8 mg/L and 5.1 mg/L in 2009.

During summer 2010, average DO values for surface waters at all 9 sites and for bottom waters at 5 out of 8 sites met and exceeded their designated 'best usage' classifications. Discrete DO measurements of surface and bottom waters complied with the NYSDEC standards (DO never-less-than) 77% and 72% of the time, respectively. It was 74% and 66% in 2009.

There were incidents of hypoxia (DO <3.0 mg/L) detected at stations E7 (once) and E10 (four times) from July 12 to August 9; one of the four events was defined as a 'wet' day. A sampling event was considered 'wet' if a significant rainfall was recorded in the preceding 48 hours, with a significant rainfall defined as 0.4 inches within 24 hours or 0.2 inches within 2 hours. Consistent with the past couple of years, most of minimum DO levels were recorded in August.



TRENDS

Average regional DOs have increased gradually for the past six years after the last drop in 2004. The bottom DO values stayed at a record high in the UER-WLIS area in summer 2010. For the second year, average bottom DO was >5.0 mg/L, which exceeded the NYSDEC Bathing Standard. The trend analysis has shown an increase in DO of about 1.0 mg/L for surface waters and 1.5 mg/L for bottom waters. Most notable are improvements in bottom waters that have risen from below fishable (4.0 mg/L) in most of the 1970s to above the Bathing Standard in 2009 and 2010. The trends also demonstrate stability, with a decreasing gap between surface and bottom waters, which occurred between the mid-1980s to early 2000s.

Upper East River–Western Long Island Sound

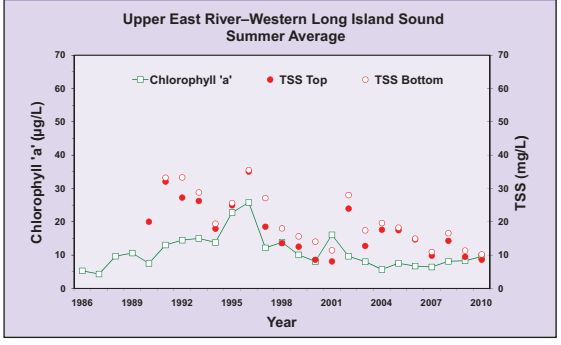
CHLOROPHYLL 'a'

The stations in the Upper East River–Western Long Island Sound (UER-WLIS) averaged between 2.6 µg/L (E4) and 31.0 µg/L (LN1) of chlorophyll 'a.' The highest averages tend to be in confined water bodies at the heads of Flushing Bay (E15, 22.8 µg/L), Flushing Creek (FLC2, 25.9 ug/L) and Little Neck Bay (LN1). High readings in Flushing Creek were as high as 147.8 µg/L in mid summer. The head of Flushing Bay, being adjacent to the mouth of Flushing Creek, receives nutrient-rich water from the creek. The overall average for the entire region was 9.5 µg/L in 2010. Other stations in the Upper East River and Harlem River are typically low in chlorophyll 'a' (E4, E6, E7, E8, E14, and H3 all <11.0 µg/L average).

TRENDS

Long-term trends for chlorophyll 'a' in this region show summer averages in the 6–16 µg/L range dating back to 1986 (see figure). The two exceptions are 1995 and 1996, when concentrations averaged 22.8 µg/L and 25.8 µg/L, respectively. Furthermore, for the past nine years, the summer average has been less than 10 µg/L.

Chlorophyll 'a' and Total Suspended Solids



DEP has been constructing nitrogen removal processes in each of the four Upper East River Wastewater Treatment Plants to reduce nutrient discharges. The Hunts Point Plant in the Bronx began nitrogen-removal operations in mid 2010.

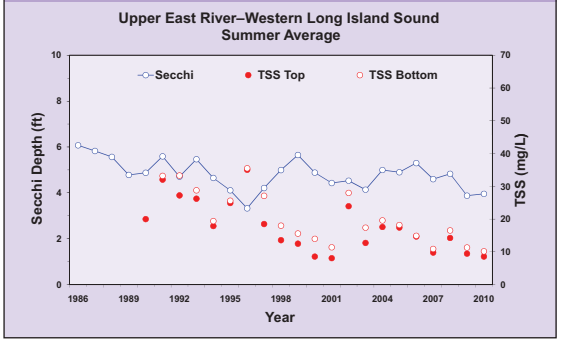
SECCHI TRANSPARENCY

In summer 2010, the average Secchi transparency for Upper East River–Western Long Island Sound (UER-WLIS) was 4.0 ft. Stations in more constricted waterways, such as Flushing Creek and H3 in the Harlem River, displayed low averages of 3.0 ft or less. Runoff after rainfall and freshwater influx from the Hudson to the Harlem River can contribute to turbid waters in these areas.

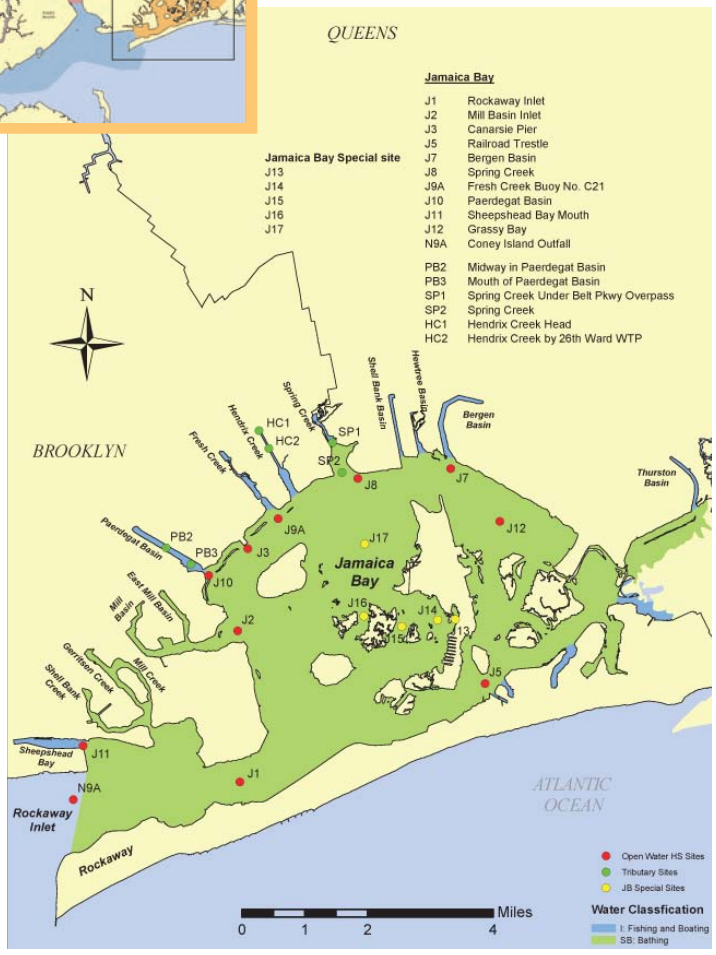
TRENDS

The UER-WLIS regional average has varied between 3.3 and 6.1 ft Secchi depth since 1986. The lowest average transparency of 3.3 feet in 1996 coincided with very high average chlorophyll 'a' and total suspended solids readings. Since 1996 for these waters, improved Secchi transparency depths may coincide with a decrease in chlorophyll 'a' or total suspended solids averages 1996.

Secchi Depth and Total Suspended Solids



Jamaica Bay



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 eleven 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.

FECAL COLIFORM

In 2010, water quality was superior for Jamaica Bay, with summer Fecal Coliform (FC) concentrations below 200 cells/100 mL, the Bathing Standard for all stations, except Bergen Basin (J7).

Under wet weather conditions, the Bay experiences localized degradation. At these times, spikes in FC may temporarily exceed the Bathing Standard of 200 cells/100 mL 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.

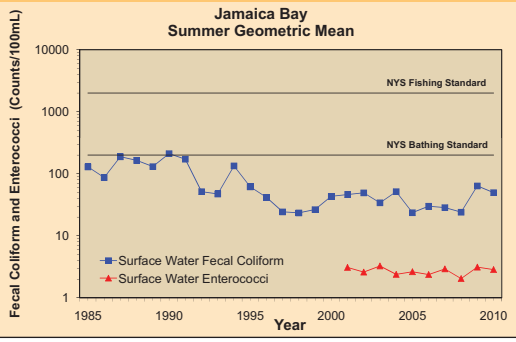
Enterococcus concentrations were also superior for Jamaica Bay in 2010. The regional summer geometric mean was 3 cells/100mL; all monitoring sites complied with the Bathing Standard of 35 cells/100 mL.

TRENDS

Average Fecal Coliform (FC) levels in Jamaica Bay have been below the 200 cells/100 mL New York State Standard for Bathing since 1985 (except in 1990 when it peaked at 210 cells/100 mL). The regional geometric mean FC was 50 cells/100 mL in summer 2010.

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

Fecal Coliform and Enterococci



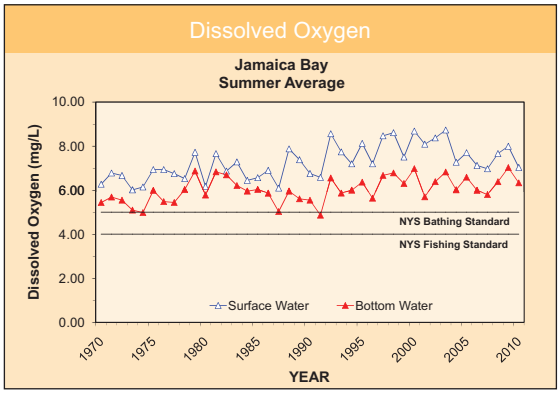
Enterococcus levels in Jamaica Bay have consistently met the Bathing Standard since 2001.

DISSOLVED OXYGEN

The 2010 summer dissolved oxygen (DO) averages for both surface and bottom waters surpassed the New York State Standard of never less than 5.0 mg/L for bathing (SB) at all 11 stations except for Grassy Bay (J12).

Summer individual measurements comply with NYSDEC Standards (DO never-less-than 5 mg/L) in 287 of 364 measurements. Most of the lower DO levels (DO <3.0 mg/L, hypoxia) occurred at the northeastern part of Jamaica Bay. At Bergen Basin (J7), with depths less than 25 ft, lower DO readings (2.72–2.85 mg/L) were found in bottom waters three times during July and August. At Grassy Bay (J12), 6 out of 16 bottom samples measured showed hypoxia conditions during late June through the end of August; the bottom DO varied between 0.68–7.10 mg/L. Lack of bottom water circulation is the main issue at this 40–ft area.

Dissolved Oxygen



TRENDS

The regional summer average DO levels were well above the 5.0 mg/L Bathing Standard as early as 1970, except 1991. Average DO levels were also among the highest around New York Harbor. In Jamaica Bay, average DO variability is high within and between years. The big gap (1.8 mg/L) between surface and bottom waters has been reduced since 2004. High surface DO levels are often due to supersaturated conditions, attributable to algae blooms and eutrophic waters. Also, pH average readings of 7.8 in both surface and bottom waters were the highest in the harbor area. Individual pH readings reached 8.40 in surface water and 8.33 in bottom water.

Jamaica Bay

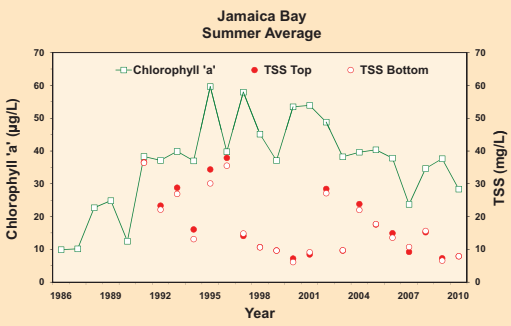
CHLOROPHYLL 'a'

Jamaica Bay typically has the highest chlorophyll 'a' averages in all of the city's marine waters, though the trend continues downward. The 2010 average was no exception, with an average of 28.4 µg/L. Most stations in the region average fairly high (>20 µg/L) with the highest occurring in the eastern half of the bay (J7; 38.0 µg/L and J12; 41.2 µg/L). J12 in Grassy Bay recorded a season high concentration of 107.3 µg/L on August 3rd. Several new shallow water stations in the center of the bay all averaged over 35 µg/L. It should be noted that this area was sampled in situ with a flourometer as opposed to an extraction method. Slow turnover of water within the bay allows for development of large standing phytoplankton populations virtually any time of the year.

Concentrations at the western end of the bay are lower due to better mixing with ocean waters. J1 averaged 21.2 µg/L and J11 averaged 19.8 µg/L.

Nitrogen removal processes began in May 2010 at the 26th Ward Wastewater Treatment Plant. This will help to reduce nutrient levels in the Bay. DEP also began upgrading the Jamaica plant to remove nitrogen. Upgrades to the plants at Rockaway and Coney Island will follow.

Chlorophyll 'a' and Total Suspended Solids



In 2010, New York City, the New York State Department of Environmental Conservation, the Natural Resources Defense Council and other environmental stakeholders announced a historic agreement to invest $115 million to improve the overall water quality and mitigate marshland loss in Jamaica Bay. The investments include $100

million to install new nitrogen control technologies at wastewater treatment plants located on Jamaica Bay. The investments, made in concert with $95 million the city has already committed for nitrogen control upgrades, will reduce the nitrogen levels discharged into Jamaica Bay by nearly 50% over the next ten years. The city will also invest $15 million for marshland restoration projects around the bay.

TRENDS

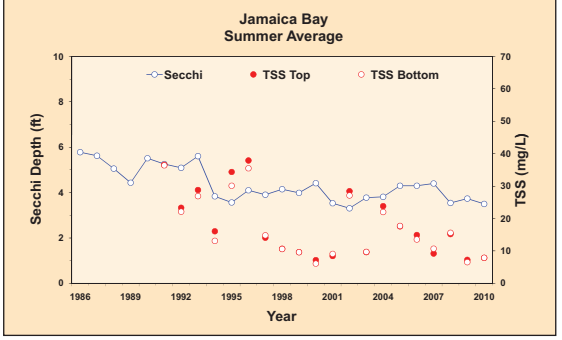
In recent years, the inter-annual trend usually shows higher chlorophyll 'a' readings toward the end of summer. Many stations in the region had maximum chlorophyll 'a' levels on August 3. J12 recorded 107.3 µg/L on this day. Highs were reached at J2, J3, J7, J8, and J9A on the same day as well.

Conversely, the lowest values occur in November and December after water temperatures cool down. Most of the stations in the region had minimum values less than 3.0 µg/L during these two months. The annual average trend is heading down.

SECCHI TRANSPARENCY

The average Secchi depth in Jamaica Bay was 3.5 ft in 2010. Most of the stations in the bay proper average between 3 and 4 ft Secchi depth except for J1 at the entrance of the bay (4.1 ft). Areas in the tributaries (Spring Creek and Paerdegat Basin) average 3 ft or less due to turbid conditions from runoff and algal content. The stations with the lowest chlorophyll 'a' averages (J1 and J11) also had the highest Secchi depths. Conversely, the highest chlorophyll 'a' average in the bay at J12 (41.2 µg/L) was associated with the lowest Secchi average (3.0 ft).

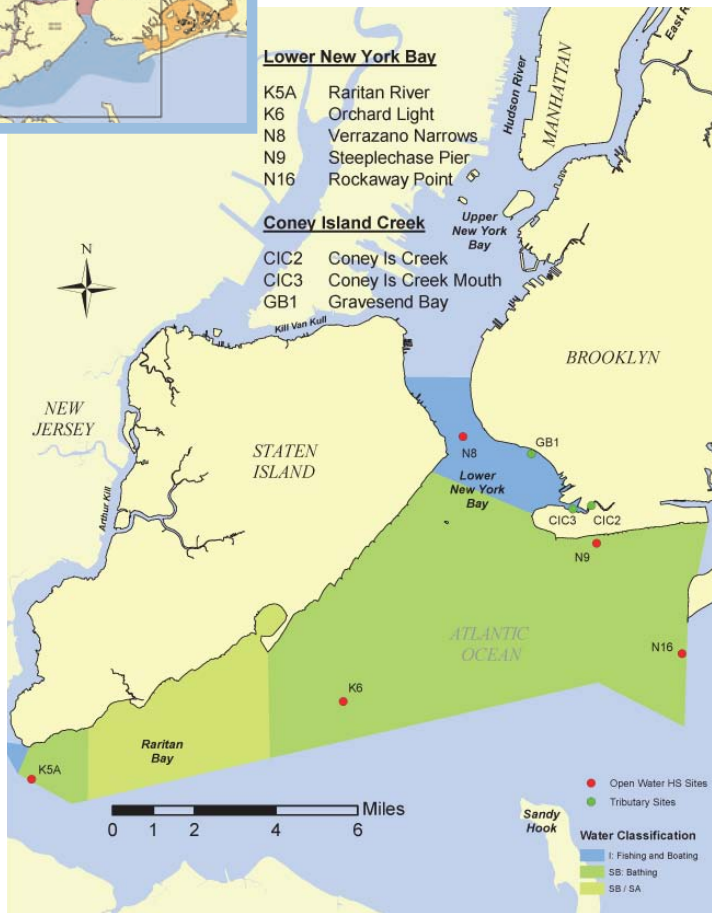
Secchi Depth and Total Suspended Solids



TRENDS

In Jamaica Bay there is a loose correlation between chlorophyll 'a' averages and water column transparency. Average Secchi depths greater than 5.0 ft were typical before 1993, when chlorophyll 'a' averages where relatively low (see figure). However, this year's substantial drop in the chlorophyll 'a' average did not result in a higher Secchi depth average.

Lower New York Bay–Raritan Bay



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 five 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 the harbor is classified for bathing and other recreational use (SB). Portions of those waters are also designated for the permitted use of shellfishing (for relay to cleaner waters, but not direct consumption), having a stricter use classification of SA.

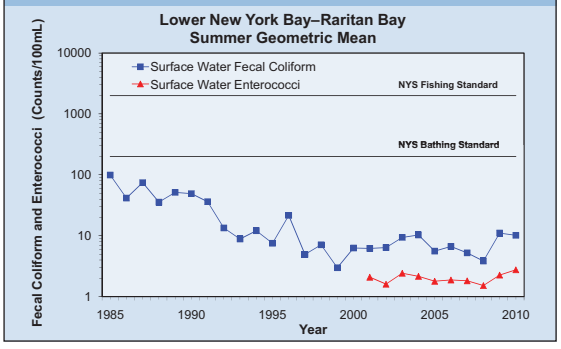
FECAL COLIFORM

In 2010, sanitary 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 averages for FC numbers show waters of the LNYB-RB meet and surpass NYS Standards for this area. Three of five stations had geometric means less than 20 cells/100 mL (an order of magnitude below State Standards).

In 2010, Enterococcus concentrations were the lowest in the LNYB-RB compared to other waterbodies around New York City. All stations' averages were <3 cells/100mL.

Fecal Coliform and Enterococci



TRENDS

Fecal coliform (FC) concentrations for LNYB-RB show significant decline from the mid-1980s to the present time. While FC concentrations for surface waters were always below 200 cells/100 mL, average FC levels reached a low of 3 cells/100 mL in 1999. The levels have remained at or below 11 cells/100 mL since then.

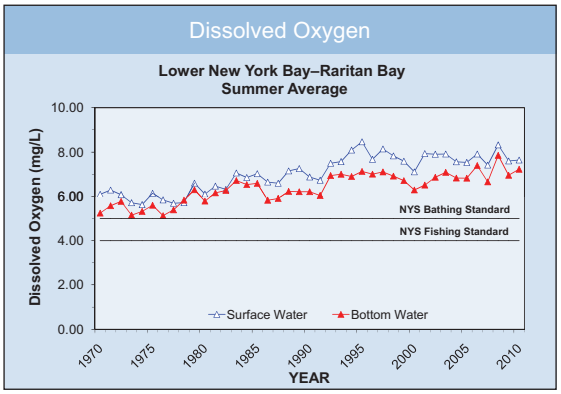
These improvements have allowed for the opening of all NYC public beaches since 1992 and the lifting of wet weather swimming advisories.

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

DISSOLVED OXYGEN

Most of dissolved oxygen (DO) values for surface and bottom waters in Lower New York Bay–Raritan Bay (LNYB-RB) complied with the NYS DO Standard of 5.0 mg/L for bathing waters during the summer of 2010. At total 75 samples measured for surface and bottom waters, four out of 75 samples and six out of 75 samples did not achieve their designated DO standards, respectively. All ten readings, with the lowest bottom DO at 3.78 mg/L, were found at Raritan Bay (K5A).

Summer average DO values in LNYB-RB have been one of the highest among the harbor area since 1970. The average DO measurements in summer 2010 were 7.6 mg/L in surface waters and 7.2 mg/L in bottom waters, similar to 7.6 mg/L and 7.0 mg/L in summer 2009.



TRENDS

Average summer DO concentrations have increased from 6.1 to 7.2 mg/L for surface waters, and from 5.2 to 7.0 mg/L for bottom waters from 1970 to 2010. Most of the improvement in the LNYB-RB area is attributed to improved water quality at station K5A. This improvement reflects loading decreases of sanitary waste over the years into Arthur Kill and the Raritan River.

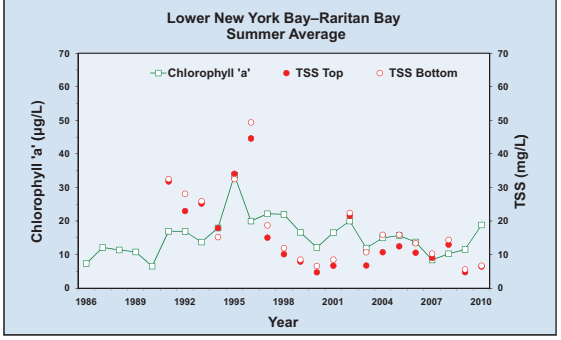
Lower New York Bay–Raritan Bay

CHLOROPHYLL 'a'

The Lower Bay varies in chlorophyll 'a' concentrations however the regional average rose to 18.8 µg/L in 2010. Stations near Raritan Bay and in Coney Island Creek tend to have high concentrations, whereas the Verrazano Narrows (N8), Coney Island Beach (N9), and Rockaway Inlet (N16) are among the clearest waters in the city (all less than 13 µg/L average). K5A and K6 near Raritan Bay averaged 27.2 and 37.7 µg/L, respectively.

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. For example, K6 recorded a chlorophyll 'a' concentration of 75.2 µg/L in early March. The relatively shallow area's main source of fresh water is the polluted Raritan River. It also receives waters from Arthur Kill and some smaller tributaries in New Jersey. Stations K5 and K4 in Arthur Kill had averages of 25.3 and 11.6 µg/L, respectively. 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.

Chlorophyll 'a' and Total Suspended Solids

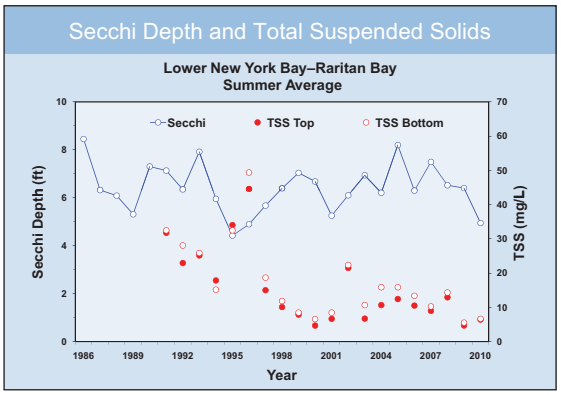


TRENDS

This year's average of 18.3 µg/L was the highest since 2002. Higher than usual averages at K5A and K6 caused the regional spike in 2010 (see figure). Annual averages at these stations are more variable then at N16 and N9, which typically remain below 20 µg/L. Only in 1995 were there very high averages in the region. N16 averaged 29.7 µg/L that year; unusually high for ocean waters.

SECCHI TRANSPARENCY

Lower Bay waters are generally very clear. An average of 5.0 ft this year reflects good transparency at open water stations such as N16 at Rockaway Point (average of 7.3 ft) and N9 at Coney Island (5.4 ft). Levels above 5.0 ft indicate clean conditions and superior water clarity. Stations in Raritan Bay averaged lower (<5 ft). as there are often phytoplankton blooms in the area and turbid conditions on windy days due to the shallow waters outside the main shipping channel.



TRENDS

Average Secchi transparencies in the Lower Bay–Raritan Bay region have remained at or above 5.0 ft since 1986, with the exceptions of 1995 and 1996. The drop coincided with a large increase in chlorophyll 'a' in 1995 (see figure). Also within this time frame, the annual Secchi averages fluctuate greatly, ranging from 4.4 ft to almost 8 ft in just 2 years. It appears the region is sensitive to annual variations that affect water clarity. The highest Secchi depth average recorded in 1986 (8.5 ft) coincided with the second-lowest chlorophyll 'a' average of 7.3 µg/L.

Harbor-Wide Improvements

The water quality conditions in summer 2010 varied slightly. Harbor-wide average Dissolved Oxygen (DO) values for both surface and bottom waters remained at record highs, 6.5 mg/L and 6.0 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 historical/open waters of the harbor have remained stable with slight fluctuations.

This is the second consecutive year on record that both surface and bottom DO values at all four regions exceeded 5.0 mg/L. It was the first time average bottom DO in the UER-WLIS region reached a record high (5.2 mg/L).

Harbor-wide summer geometric mean for FC count remained stable at levels in compliance with the Bathing Standard, <=200 cells/100mL. Short-term spikes do occur after rain events due to combined sewer overflow (CSO) discharges.

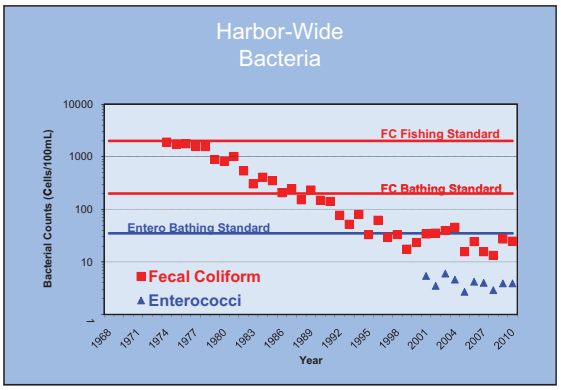
Enterococci sampling over the last ten years has shown relatively stable, with spikes similar in size and frequency to the fecal coliform levels. The enterococci summer geometric mean for the historical/open water sampling locations remains well below the Bathing Standard (35 cells/100mL).

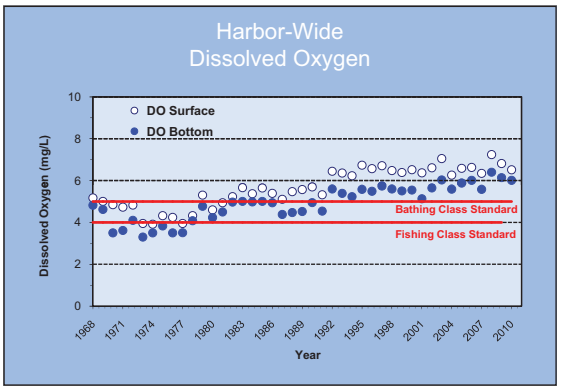
In summer 2010, the harbor-wide chlorophyll 'a' average in surface waters stayed at average level (15 µg/L) compared to the past 15 years. Average total suspended solids in both surface and bottom waters were the lowest since 1990. Secchi depth averaged 4.0 ft.

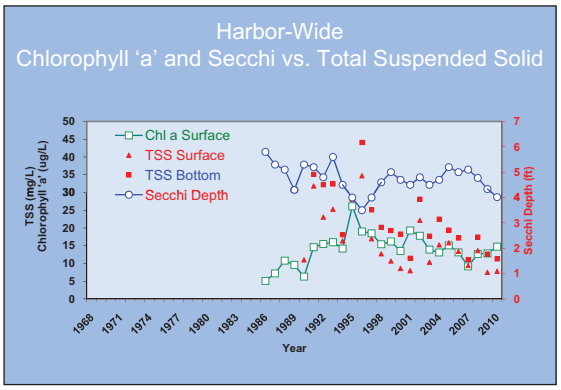
The apparent degradation in Jamaica Bay and Coney Island Creek on the following panels is likely a reflection of additional monitoring locations that were added to the Harbor Survey since 1999, not an actual decline in water quality.

Along with total 55 stations sampled in 2009, 10 additional sites were added; three in Coney Island Creek, two in Jamaica Bay open water and five in JB interior, during 2010.

An appendix with all parameters trend graphs for each sample location is available for this year's report.

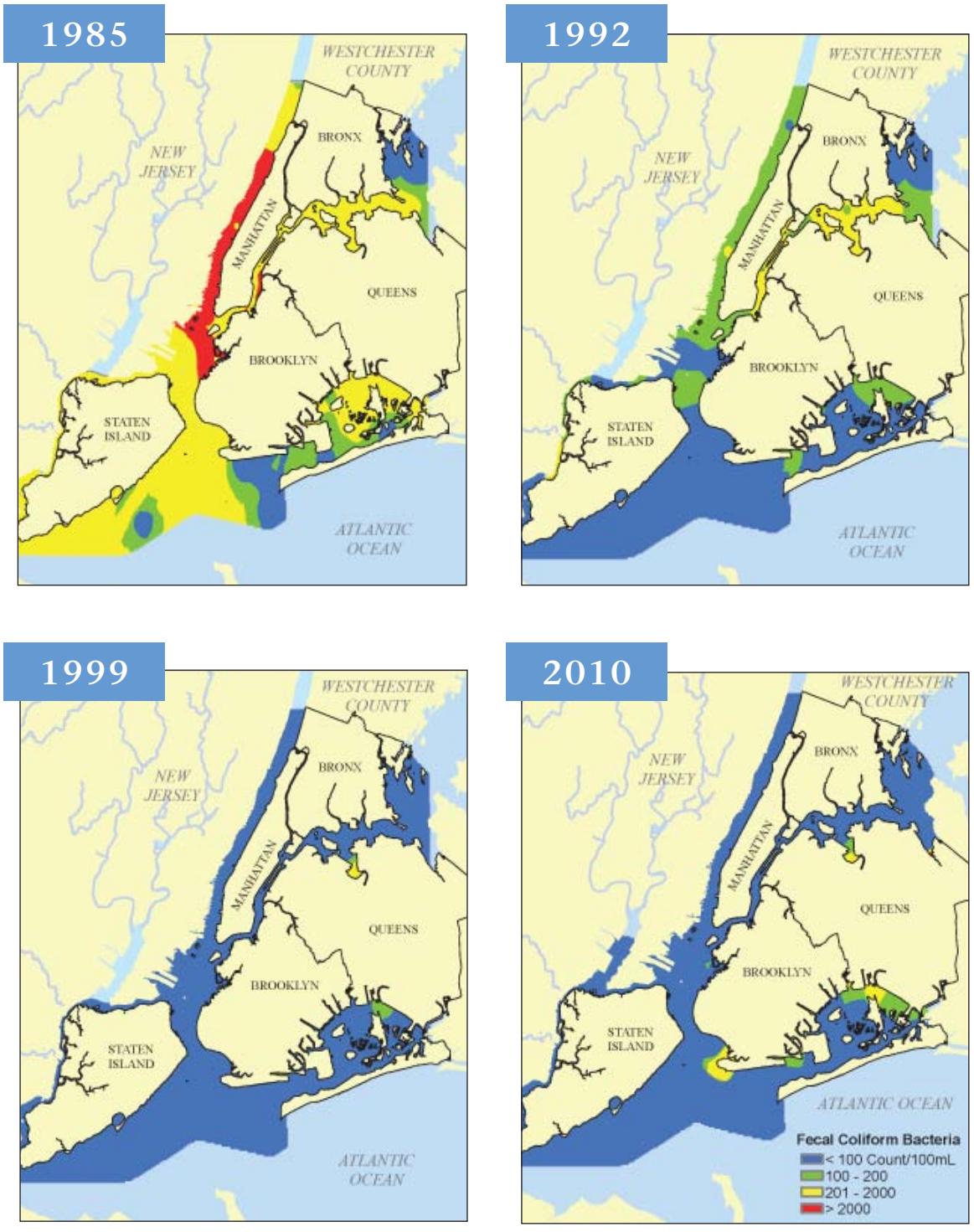






Harbor-Wide Water Quality Improvements Over Four Time Periods

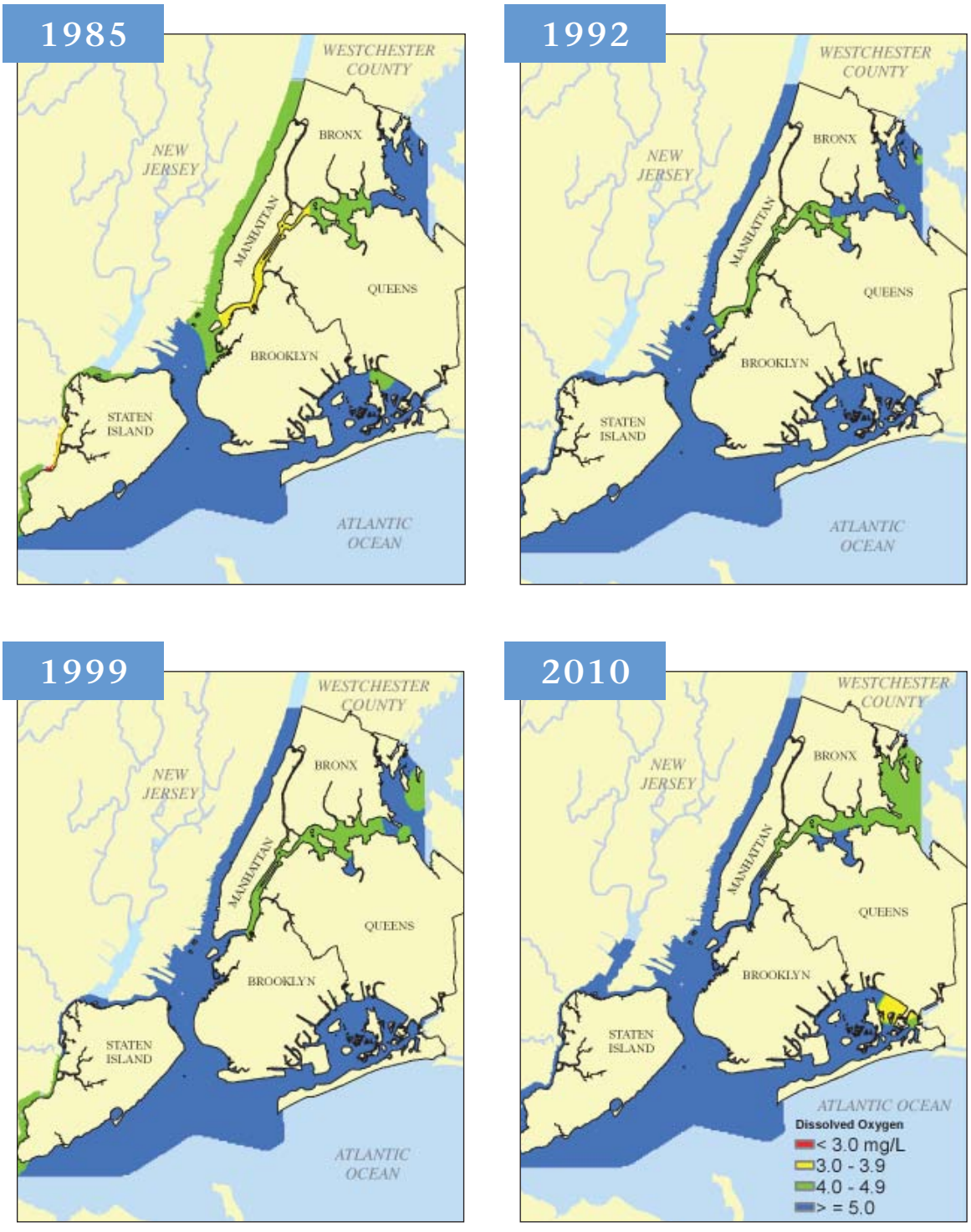
SUMMER GEOMETRIC MEANS FOR
FECAL COLIFORM IN SURFACE WATERS



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

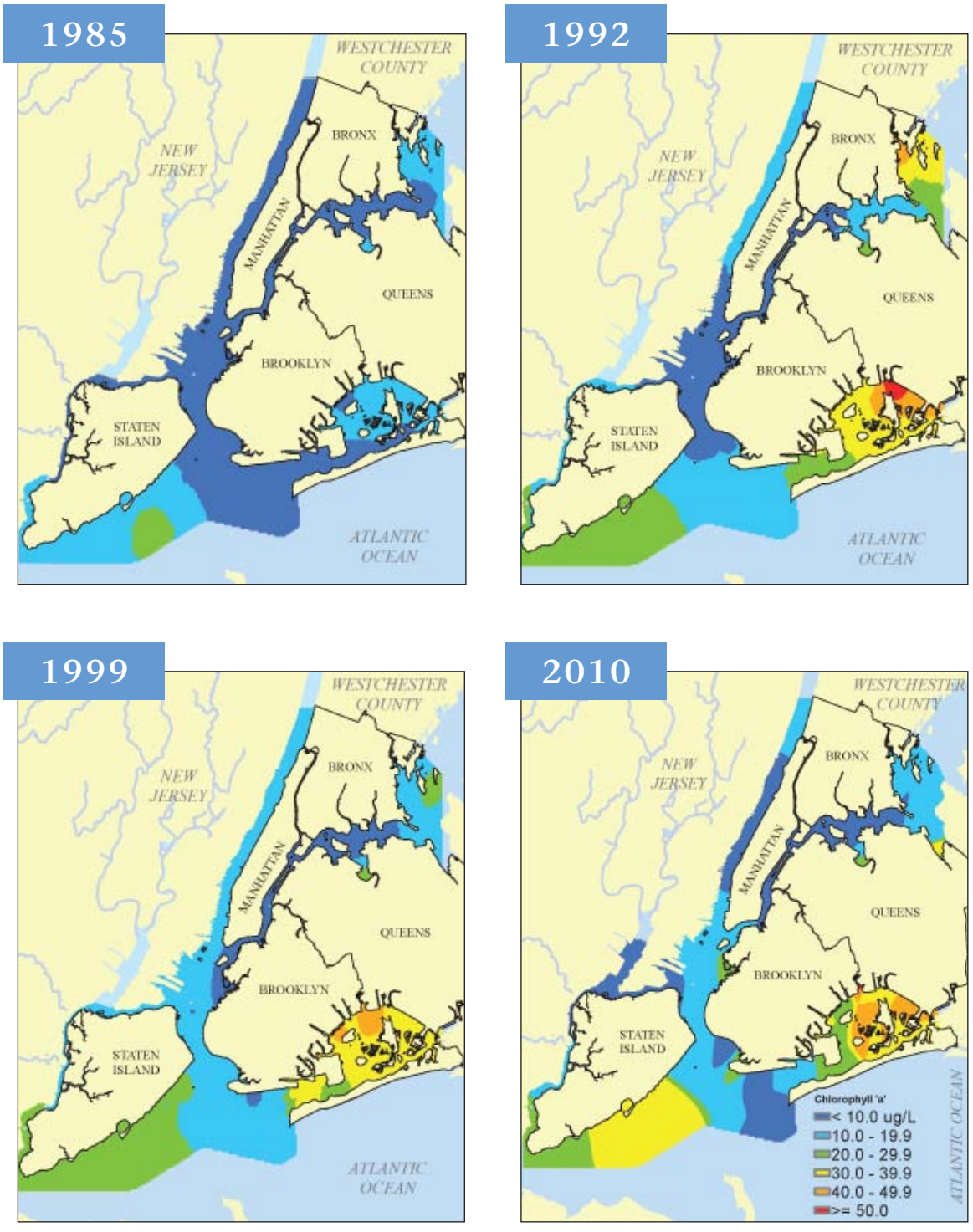
SUMMER AVERAGES FOR
DISSOLVED OXYGEN IN BOTTOM WATERS



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

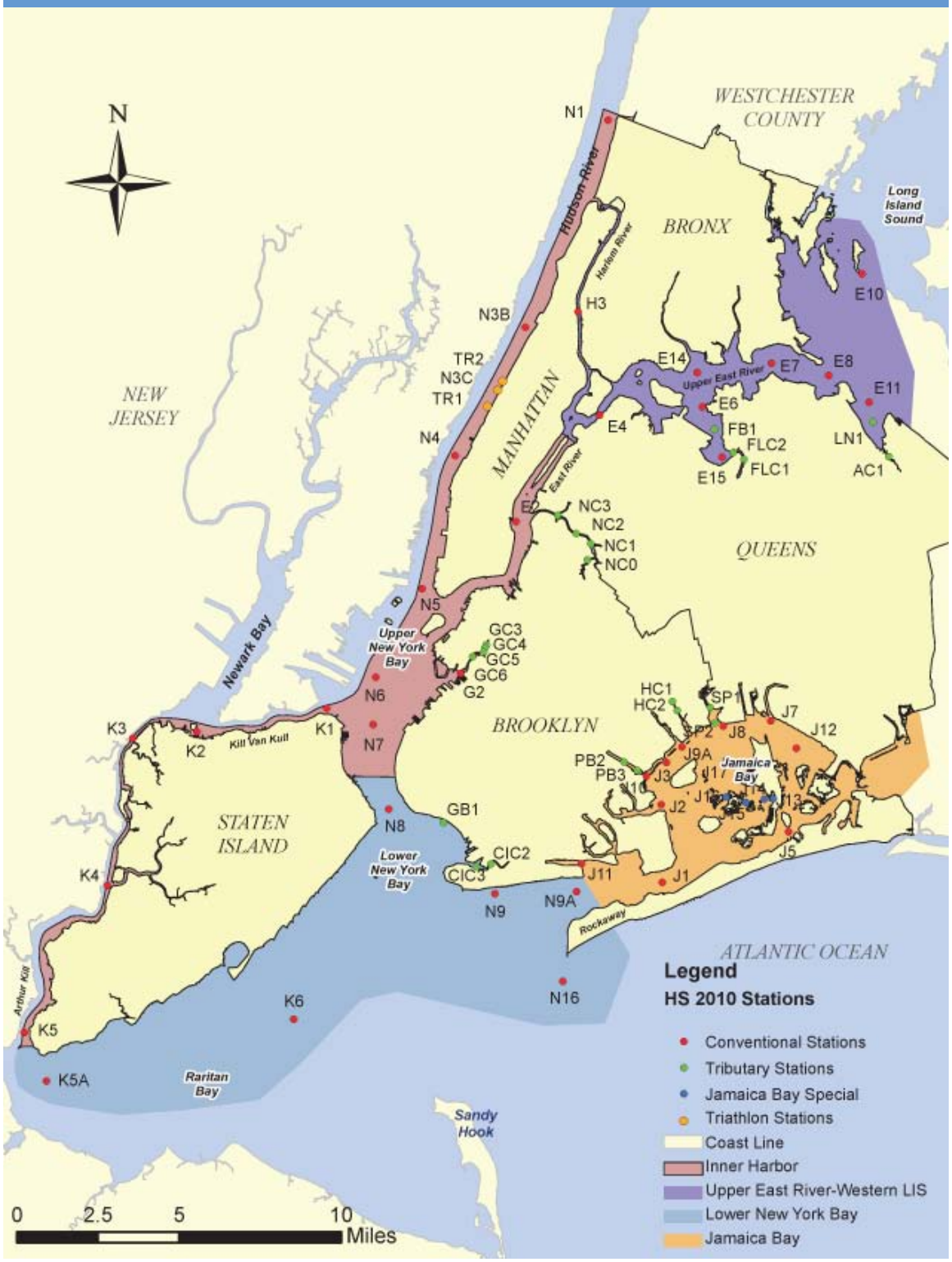
Harbor-Wide Water Quality Improvements Over Four Time Periods

SUMMER AVERAGES FOR
CHLOROPHYLL 'a' IN SURFACE WATERS



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

2010 NYC DEP HARBOR SURVEY STATIONS



NYC DEP WASTEWATER TREATMENT PLANTS AND CSO OUTFALLS

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