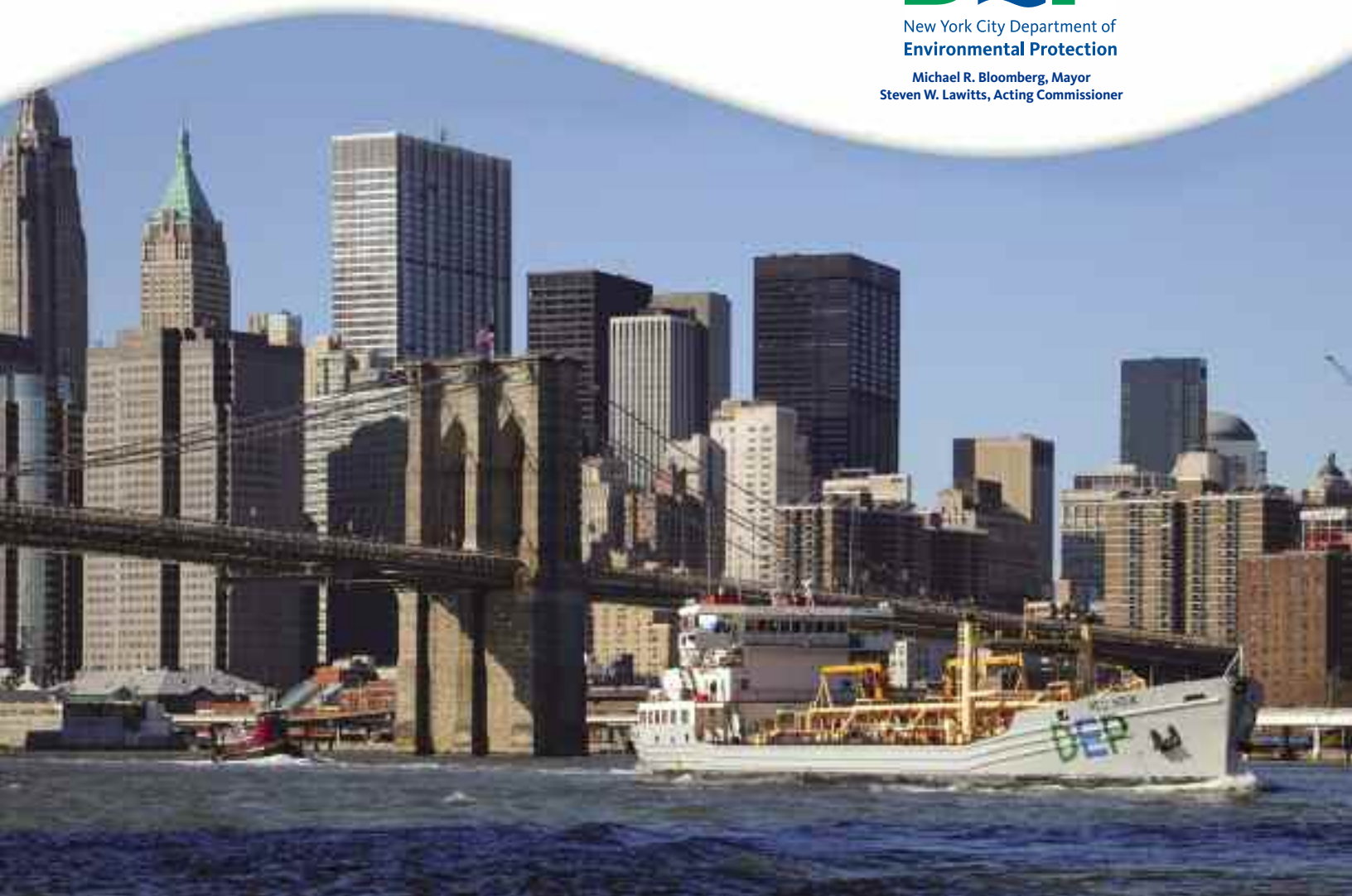
2008

New York Harbor Water Quality Report

New York City Department of
Environmental Protection

Michael R. Bloomberg, Mayor
Steven W. Lawitts, Acting Commissioner



2008

New York Harbor Water Quality Report

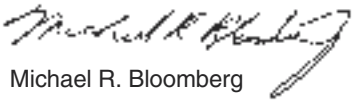
The *2008 New York Harbor Water Quality Report* marks the 99th year of comprehensive water quality monitoring of New York Harbor. The findings of this year's report show that overall aquatic health and essential Harbor ecosystems are continuing to thrive. Key indicators reveal that the current water quality of the Harbor is at its cleanest level in over a century.

Despite this tremendous achievement, further improvements are necessary to ensure that the Harbor and its many tributaries remain in good health as integral components of the City's remarkable landscape.

For this reason, I have made water quality improvement a key goal of PlaNYC. As part of this sustainable vision for New York City's future, we will work to improve aquatic health, so that 90% of City waterways will be viable for recreation by 2030. This way New York's many residents and visitors can enjoy the iconic natural features that have defined the City's history and growth for centuries.

I encourage all New Yorkers to review this comprehensive account of New York Harbor's biological health in order to appreciate the significant improvements in water quality made in recent decades and to learn more about the many initiatives that will guide the City toward a green and sustainable future.

Sincerely,



Michael R. Bloomberg
Mayor

The New York City Department of Environmental Protection is pleased to present this year's Harbor Water Quality Report, which documents the continued enhancement of the health and vitality of New York's waterways. These notable achievements reflect the ongoing success of DEP's extensive pollution control programs and robust upgrades to our wastewater treatment infrastructure.

Though these accomplishments are significant, combined sewer overflows (CSOs) continue to impact the Harbor's aquatic health. DEP's Ten-Year Capital Investment Strategy calls for continued upgrades to key wastewater treatment facilities, storm sewer expansions and the construction of several, large CSO retention tanks to further mitigate this chronic source of pollution. Existing infrastructure developments have increased DEP's standardized CSO capture rate from about 30% in 1980 to about 77%. Recent increases can be attributed to the implementation of additional CSO control measures such as the Spring Creek and Flushing Bay CSO Retention Facilities that came online in 2007. Ongoing work continues at the Paerdegat Basin and Alley Creek CSO Retention Facilities, which are expected to go online by 2011.

To supplement this extensive infrastructure and further enhance CSO capture rates, DEP is beginning to identify new, comprehensive engineering solutions and develop innovative and sustainable storm water management techniques, known as best management practices. These techniques will allow DEP to meet the water quality goals set by Mayor Bloomberg as part of his PlaNYC initiative and open 90% of New York's waterways to recreation by the year 2030.

I hope you will find this report useful and informative. DEP is proud of the consistent improvements to aquatic health in the Harbor, and appreciates your interest in our continuing efforts to further enhance the health of New York's waterways and meet the Mayor's ambitious, but achievable goal for 2030.

Sincerely,

Steven W. Lawitts
Acting Commissioner

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Introduction

The City of New York's Harbor Survey Program has been in existence since 1909 — an amazing accomplishment for a water quality monitoring program of a major municipality. Later this year, a special detailed history and documentation of this program's centennial will be produced. This annual Harbor Water Quality Report consists of water quality monitoring data collected by the New York City Department of Environmental Protection's (DEP) 99th Harbor Survey during the 2008 summer sampling season.

The Harbor Survey has evolved from the initial efforts carried out by the Metropolitan Sewerage Commission during 1909 in response to public complaints of degraded water quality affecting their quality of life. This initial effort has grown into a Survey Program that consists of 47 stations: 35 stations located throughout the open waters of the harbor, and 12 stations located in smaller tributaries within the City. The number of water quality parameters measured has also increased from five in 1909 to over 20 at present.

Harbor water quality has improved dramatically since the early surveys. Infrastructure improvements and the capture and treatment of virtually all dry-weather sewage that was discharged into the harbor are the primary reasons for this improvement. During the last decade, water quality in New York Harbor has improved to the point that the many waterways are now utilized for recreation and commerce throughout the year. While some impairments still exist, the City is working with regulators to further improve water quality throughout New York Harbor.

The New York City DEP's Long Term Control Plan (LTCP) has begun to focus on those areas within the harbor that remain impaired. These plans will be evaluating all waterbodies and their drainage basins, and will develop a comprehensive plan for each waterbody to attain its "best use" classification.

The water quality data collected by the NYC DEP during the summer of 2008 will be presented in four sections, each delineating a geographic region within the harbor. Four water quality parameters will be used as indicators of water quality for this report: fecal coliform bacteria, dissolved oxygen, chlorophyll 'a' and Secchi transparency. These parameters and their relevance are explained in the synopsis that follows.

The New York Harbor Survey has modified its sampling program over the last several years. The number of open water stations sampled has been reduced from fifty-three to thirty-five. The statistics presented in this report reflect comparisons with only the current Harbor Survey stations. Future Surveys will begin to incorporate additional stations as a part of the LTCP. When the Harbor Survey has been expanded to include the entire LTCP area, adjustments will be made to the maps and trends to better reflect the water quality throughout the entire harbor.

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 phyto-plankton 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 eutro-phication. Chlorophyll 'a' levels above 20 ug/L are considered indicative of enriched, 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 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)
SA	Shellfishing and all other recreational use	No standard	5.0 mg/L
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
I	Fishing or boating	Monthly geometric mean less than or equal to 2,000 cells/100 mL from 5 or more samples	4.0 mg/L
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

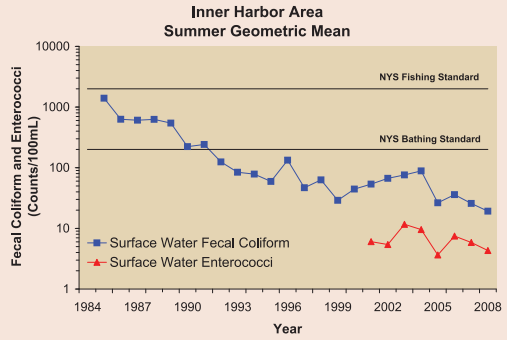
Water quality as estimated by fecal coliform (FC) concentrations was superior for the Inner Harbor in the summer of 2008. The regional summer mean was 19 cells/100 mL, decreasing slightly from 26 cells/100 mL in 2007. All Inner Harbor Area monitoring sites complied with the monthly FC standard of 200 cells/100 mL. All sites had geometric means less than 100 cells/100 mL.

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). Under these conditions, all sites exceeded the SB standard 200 cells/100 mL. Note: Wet Weather advisories for the New York City beaches may still be issued by NYC DOH under certain conditions.

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 '70s to below 100 cells/100 mL since early 1990. This improvement has allowed for the opening of Inner Harbor waters for most recreational activities. This improvement has been attributed to the cessation of raw sewage dumping through the full build-out of New York City's Wastewater Treatment Plants (WTPs), 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 to levels below standards.

Fecal Coliform and Enterococci

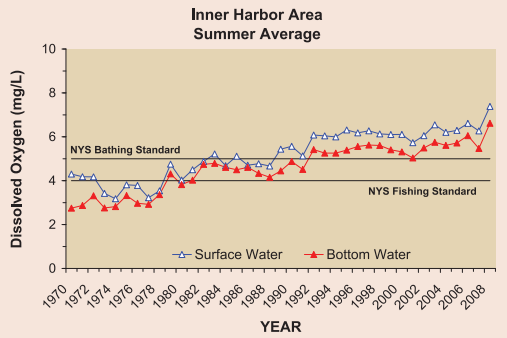


DISSOLVED OXYGEN

Average Dissolved Oxygen (DO) values reached a record high in the Inner Harbor area in 2008. The values also had the most significant increase around the harbor. Summer DO values averaged 7.4 mg/L for surface waters and 6.6 mg/L for bottom waters, both increased more than 1.1 mg/L from 2007 values of 6.3 mg/L and 5.5 mg/L.

DO measurements complied with NYSDEC standards throughout the Inner Harbor area except once at Mt. St. Vincent (N1) and three times for bottom samples taken at Tottenville (K5). There was a total of 15 to 17 samples taken for each location during the summer (June – September) 2008. Again, this is one of the best records in this area.

Dissolved Oxygen



TRENDS

Average summer surface DO values in the Inner Harbor have risen to levels above NYSDEC standards for primary contact recreation and commercial fisheries since the late 1980s. Bottom water values have risen from approximately 3.0 mg/L in 1970 to 6.6 mg/L at present. There is an increase between 0.4 – 1.3 mg/L for each decade.

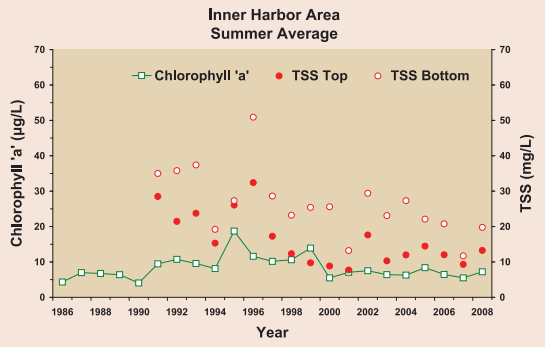
Inner Harbor Area

CHLOROPHYLL 'a'

The average chlorophyll 'a' in the Inner Harbor in 2008 was 7.2 ug/L. Furthermore, all the stations located here averaged less than 15 ug/L. In this region, most of the Hudson River and Arthur Kill areas remain under 10 ug/L chlorophyll 'a' for much of the summer. As you progress south toward Raritan Bay, there is usually more phytoplankton present in the water (K5 averaged 10.1 ug/L).

The Gowanus Canal remains an area of concern in the Inner Harbor. Monthly averages in July and August during 2008 peaked at around 20 ug/L, while individual samples were as high as 48.3 ug/L. This was likely a result of nutrient-rich waters in the canal which received non-point-source runoff and minimal tidal flushing.

Chlorophyll 'a' and Total Suspended Solids



TRENDS

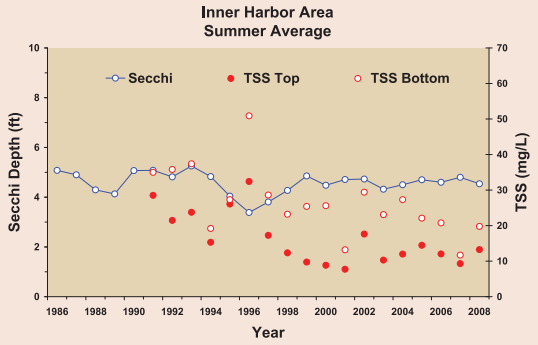
There is very little inter-annual chlorophyll 'a' variability in the Inner Harbor. The summer averages here have remained fairly constant and under 10.0 ug/L since 2000 (see figure). Massive water flow into the region from the Hudson River has been thought to be a stabilizing factor, keeping chlorophyll 'a' averages steady over the years.

SECCHI TRANSPARENCY

No water quality standards exist for the Secchi transparency. In general, high Secchi numbers (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) conditions. In summer 2008, the average Secchi reading was 4.5 feet in the Inner Harbor area.

The average values for the thirteen stations were between 2.8 – 6.0 feet. Out of a total of 212 samples, Secchi values ranged from 1.5 – 3.0 feet (52 times, most of them at N1, N3B and N4) to a high of 5.0 – 11.0 feet (94 times, highest at K4 on July 16, 2008).

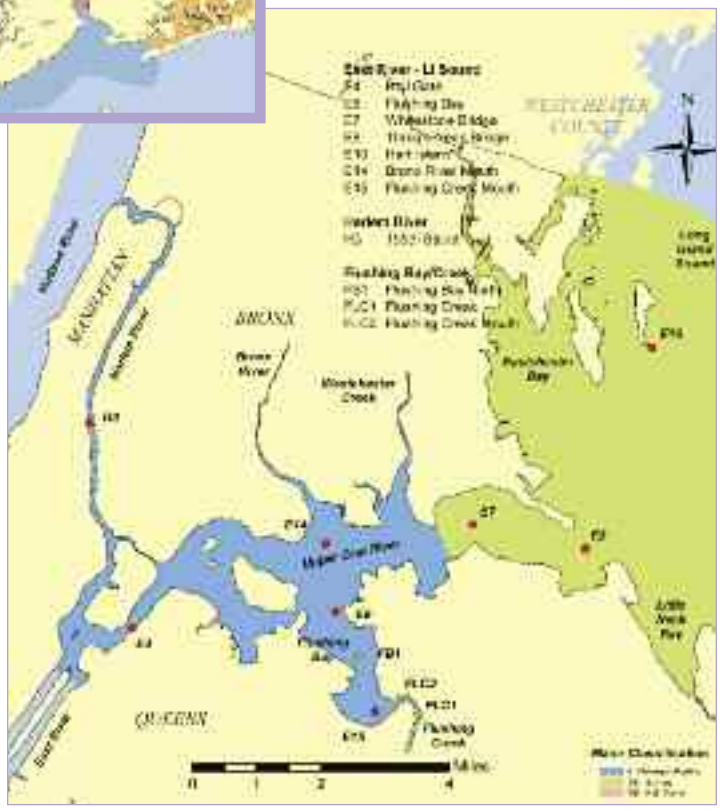
Secchi Depth and Total Suspended Solids



TRENDS

Average summer Secchi values have remained relatively constant (>4.0 feet) in the Inner Harbor area since measurements began in 1986, except for years 1996 and 1997. Compared with other city open waters, there have been the least variations (< 2.0 feet) over the past 22 years. This can most likely be attributed to the normal flow from the Hudson River.

Upper East River – Western Long Island Sound



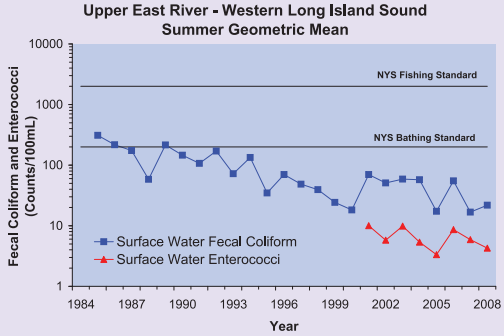
The Upper East River–Western Long Island Sound (UER-WLIS) represents the northeastern portion of NY Harbor, from Hell Gate in the East River, up into the Western Long Island Sound (WLIS). ***The Harbor Survey Program*** *provides coverage of this area, including the Harlem River and the East River, from Roosevelt Island to Hart Island at the NYC–Westchester County boundary. This area contains eight 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 2008, water quality continued to be superior for the Upper East River–Western Long Island Sound. Fecal coliform (FC) concentrations for all monitoring sites were in compliance with their specified "best use" classifications for bathing and fishing. The summer geometric mean for this region was 22 cells/100 mL, up from 17 cells/100 mL in 2007. Seven of eight sites had summer geometric means less than 40 cells/100 mL.

Fecal Coliform and Enterococci



TRENDS

Fecal coliform concentrations have shown a downward trend for more than twenty years in the Upper East River–Western Long Island Sound (UER-WLIS) region. This improvement, measuring one order of magnitude, indicates FC concentrations met standards suitable for bathing 100% of the time over the past 15 years. The ongoing upgrade of wastewater treatment facilities and capture of combined sewer overflows (CSOs) will continue to have a major impact on the reduction of fecal coliform loads.

DISSOLVED OXYGEN

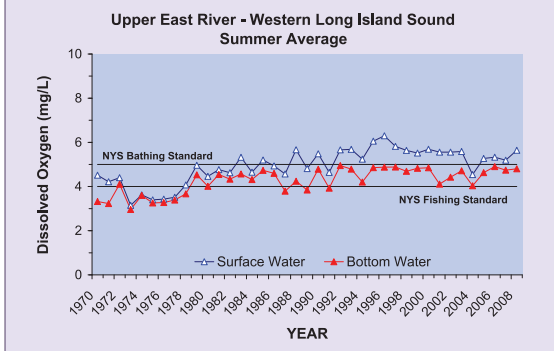
Average summer DO values for the Upper East River and Western Long Island Sound (UER-WLIS) vicinity met and exceeded 5.0 mg/L (conditions suitable for SB-bathing) in surface waters at all sites. Average values for bottom waters at the three stations designated as SB (stations E7, E8, and E10) were below the 5.0 mg/L NYSDEC standard for bathing, and the average DOs were 0.7 mg/L less than last year at E8 and E10.

UER-WLIS showed least improvement compared with other regions during summer 2008; however, long-term trends remained positive. Average DO levels stayed fairly consistent for the past four years. Discrete DO measurements of surface and bottom waters complied with the NYSDEC standards 79% and 64% of the time, respectively. It was 75% and 63% in 2007.

2008 DO levels in the area are still the lowest throughout the harbor. Summer DO averaged 5.6 mg/L and 4.8 mg/L for surface and bottom waters; higher than the 5.2 mg/L and 4.7 mg/L in 2007.

Although average summer bottom DO was similar to last year, more incidents of hypoxia (DO<3.0 mg/L) were measured at stations E7 (one time), E8 (eight times) and E10 (eight times) from July 14th to September 15th. Minimum DO levels (0.30 mg/L at E10 and 1.36 mg/L at E8) were recorded on August 11th; the same month had the lowest bottom DO for the past couple of years. Hypoxia events were extended one month longer in 2008, compared with the previous two years.

Dissolved Oxygen



TRENDS

Since 1970, trend analysis for the UER-WLIS area has shown an increase in DO of about 1.5 mg/L for surface waters and 2.0 mg/L for bottom waters. Most notable are improvements in bottom waters that have risen from below fishable (4.0 mg/L) to close to the bathing standard (5.0 mg/L). Trends, however, 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

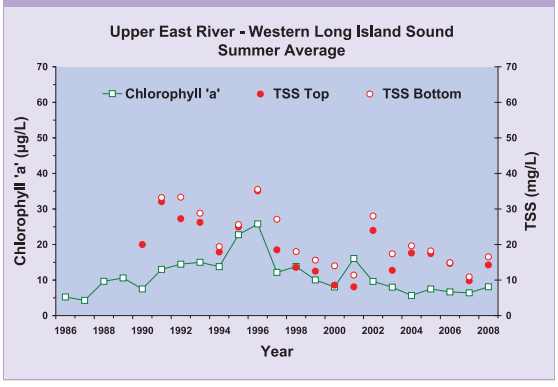
CHLOROPHYLL 'a'

The stations in the Upper East River–Western Long Island Sound (UER-WLIS) generally have low chlorophyll 'a' averages (< 10 ug/L), with only E15 at the head of Flushing Bay and E10 (Hart Island) averaging 15.2 and 12.7 ug/L, respectively. The head of Flushing Bay, being adjacent to the mouth of Flushing Creek, receives nutrient rich water due to non-point-source runoff in the creek. The overall average for the entire region was 8.1 ug/L in 2008.

TRENDS

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

Chlorophyll 'a' and Total Suspended Solids

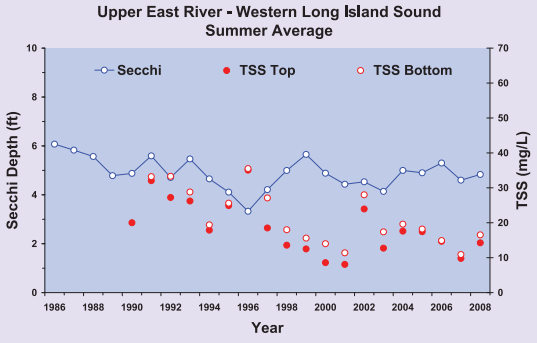


DEP is now constructing nitrogen removal processes in each of the four Upper East River Wastewater Treatment Plants to reduce nutrient discharges.

SECCHI TRANSPARENCY

In summer 2008, the average Secchi transparency for Upper East River–Western Long Island Sound (UER-WLIS) was 4.8 feet. For five out of eight stations the average Secchi readings were higher than 5.0 feet (at E6, E7, E8, E10 and E14). A total of 60 out of 135 readings were in the range 5.0 – 12.0 feet, with E7 having the highest value of 12.0 feet on September 8th. Lower readings (2.0 – 3.0 feet) were observed 25 times, mostly in Flushing Creek (E15, 8 times) and Harlem River at East 155 St. (H3, 8 times). The lowest value of 2.0 feet was found three out of five times at H3.

Secchi Depth and Total Suspended Solids



TRENDS

For UER-WLIS stations as a group, the Secchi transparency has varied between about 4.0 and 6.0 feet since 1986. The transparency once dropped to 3.3 feet in 1996, but has climbed back; the highest average chlorophyll ‘a’ and TSS were also recorded in the same year. Since 1996 for the same waters, improved Secchi transparency depths may coincide with a significant decrease in chlorophyll ‘a’.

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 nine 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 2008, sanitary water quality was superior for Jamaica Bay, with summer fecal coliform (FC) concentrations below 200 cells/100 mL, the SB standard for all stations.

Seven of nine sites had geometric means below 50 cells/100 mL. Three stations' geometric means were less than 20 cells/100 mL (an order of magnitude below State Standards).

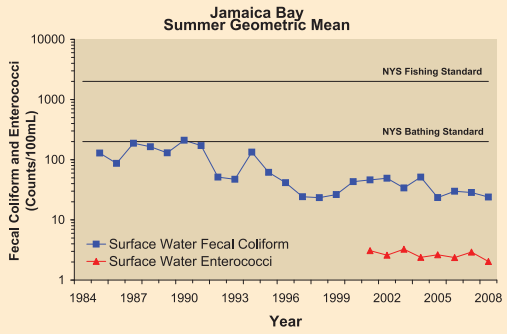
Under wet weather conditions, the Bay experiences localized degradation. At these times, spikes in FC may temporarily exceed the SB standard of 200 cells/100mL for the entire northern portion of the Bay (from Mill Basin to Bergen Basin). This decrease in water quality is limited to the Bay proper, as Lower New York Bay waters (immediately outside the mouth of Jamaica Bay) are not typically affected by wet weather events.

TRENDS

Mean FC levels in Jamaica Bay as a whole have been at or below the 200 cells/100 mL New York State Standard for bathing over the past 20 years. FC levels peaked at 200 cells/100 mL in 1990; they reached lows of 23 cells/100 mL in 1998 and 2008.

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

Fecal Coliform and Enterococci

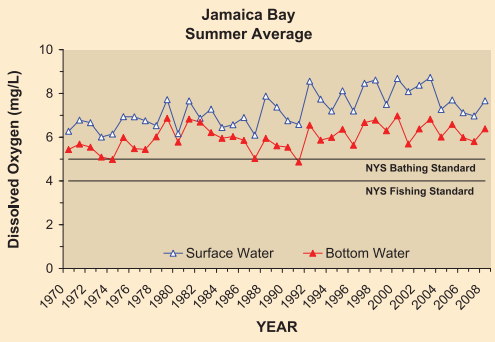


DISSOLVED OXYGEN

The 2008 summer averages for dissolved oxygen (DO) for surface and bottom waters surpassed the New York State Standard of never less than 5.0 mg/L for bathing (SB) at all stations except for bottom waters at station J12 (Grassy Bay).

Individual measurements failed to comply with NYSDEC Standards in 63 of 297 measurements. Most of them occurred at the northeastern part of Jamaica Bay. At Bergen Basin (J7) and Spring Creek (J8), with depths less than 30 feet, lower DO readings were found in both surface and bottom waters during August and September. At Grassy Bay (J12), out of 16 bottom samples measured during the summer of 2008, 14 of them did not attain the Standard; the bottom DO average was 2.9 mg/L. There were fourteen (14) hypoxia events (DO <3.0 mg/L) recorded at six of a total of nine stations in the Bay, eight of the fourteen events were found at Grassy Bay (J12). Lack of water circulation is the main issue at this 40 feet area.

Dissolved Oxygen



TRENDS

Average DO levels were well above the 5.0 mg/L Bathing Standard as early as 1970. DO variability is high within and between years. The big gap (1.8 mg/L) between surface and bottom waters was recorded for 16 years (1988–2003). High surface DO levels are often due to supersaturated conditions, attributable to algae blooms and eutrophic waters. Also, pH average readings of 7.9 and 7.8 in surface and bottom waters were the highest within the harbor area. Individual pH readings reached 8.44 in surface water and 8.57 in bottom water.

Jamaica Bay

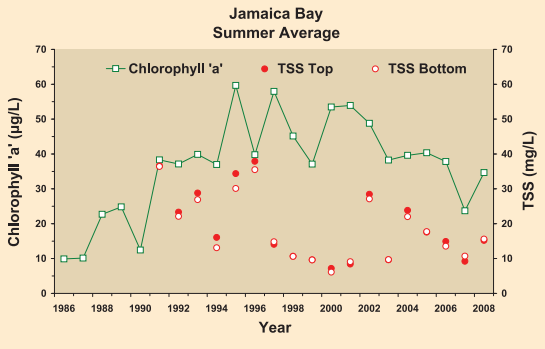
CHLOROPHYLL 'a'

Jamaica Bay typically has the highest chlorophyll 'a' averages in all of the city's marine waters. This year was no exception, with an average of 34.7 ug/L. All stations in the bay average over 20 ug/L, with the higher areas being in the northern half (stations J3, J9A, J7, J12 and J8 all average > 37 ug/L). One discrete sample at J7 contained 141.0 ug/L of chlorophyll 'a'. 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 development of large standing phytoplankton populations.

In the summer of 2008, every station in Jamaica Bay exhibited its highest monthly average chlorophyll 'a' in July. This is consistent with past years since 2005, when monthly averages were highest in June and July, then settled down in the final two months of summer. It appears that the phytoplankton blooms that are prevalent in the early summer minimize as the season progresses.

Capital work at the 26th Ward Wastewater Treatment Plant is ongoing to install process equipment that will reduce nutrient discharges.

Chlorophyll 'a' and Total Suspended Solids



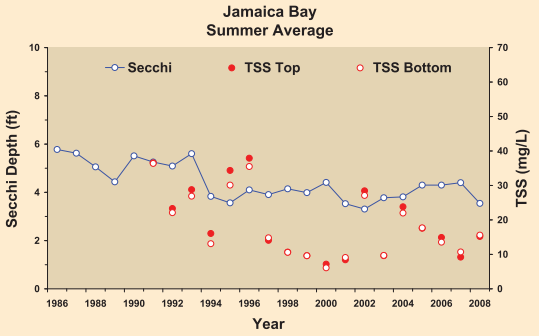
TRENDS

Although last year there was a substantial decrease in the chlorophyll 'a' average (23.7 ug/L for 2007), it seems to be an outlier. This year's average of 34.65 ug/L is more consistent with the values seen since 2003 (see figure). Over the past 23 years chlorophyll 'a' concentrations have fluctuated rather wildly, particularly in the mid 90s. The other three regions showed some spikes during this period also (see their chlorophyll 'a' figures).

SECCHI TRANSPARENCY

The Secchi transparencies range from 1.5 to 10.5 feet in the Jamaica Bay area; the average of all 9 sites was 3.5 feet in 2008. Two of the sample sites (J1 and J11) are located outside the bay proper and experience greater water exchange than sites within the bay. As a matter of fact, a low value of 2.0 feet was observed at J1 on August 5th, and a highest value of 10.5 feet was measured at the same location on June 10th. The average for those two sites ranged from 4.1 to 4.6 feet. Average Secchi values for interior bay survey sites ranged from 3.0 to 3.6 feet. Inside Jamaica Bay, the lowest Secchi readings (1.5 feet) were recorded on July 15th (J3), July 22nd (J9A) and July 29th (J12), associated with higher chlorophyll 'a' and pH measurements. The highest readings of 5.0 feet were recorded on July 3rd (J5) and July 8th (J9A).

Secchi Depth and Total Suspended Solids



TRENDS

The Secchi transparency depth decreases as chlorophyll 'a' levels increase. Secchi average depths greater than 5.0 feet were typical before 1993. After that year the average depths stayed between 3.3 to 4.4 feet. For the last three years, average Secchi transparency depths were between 3.5 to 4.4 feet.

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.*

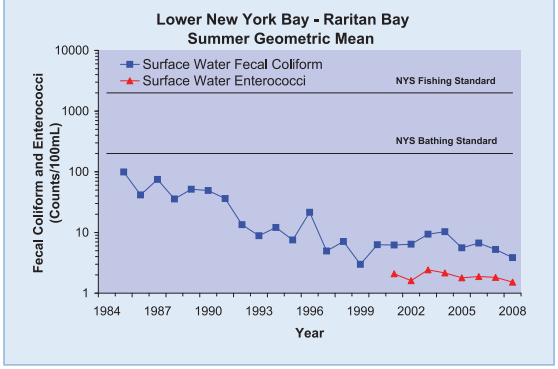
This area of the harbor is classified for bathing and other recreational use (SB). Portions of those waters are also designated for the permitted use of shellfishing (for relay to cleaner waters, but not direct consumption), having a stricter use classification of SA.

FECAL COLIFORM

In 2008, 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. All five stations had geometric means less than 20 cells/100 mL (an order of magnitude below State Standards).

Fecal Coliform and Enterococci



TRENDS

Fecal coliform (FC) concentrations for LNYB-RB show significant decline (more than an order of magnitude) from the mid-1980s to the present time. While FC concentrations for surface waters were always below 200 cells/100 mL, recent average FC levels reached a low of 3 cells/100 mL in 1999. The levels have remained at or below 10 cells/100 mL since then.

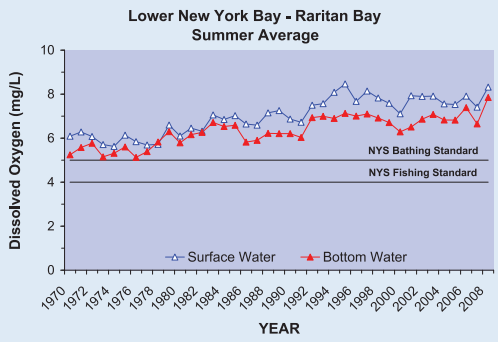
These improvements have allowed for the opening of all NYC public beaches since 1992 and the lifting of wet weather swimming advisories.

DISSOLVED OXYGEN

Dissolved oxygen (DO) values for top 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 2008, except for one violation in surface water and four in bottom waters. The five readings were within 4.1 – 4.9 mg/L, and all were found at Raritan Bay (K5A). This is true despite K5A's proximity to more degraded waters in this region.

Summer average DO values in LNYB-RB have been the highest among the harbor area since 2006. The average DO measurements were 8.3 mg/L in surface waters and 7.8 mg/L in bottom waters, which increased from 7.4 mg/L and 6.7 mg/L in 2007.

Dissolved Oxygen



TRENDS

Since 1970, average DO concentrations have increased from 6.1 to 8.3 mg/L for surface waters, and from 5.2 to 7.8 mg/L for bottom waters. 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 into Arthur Kill and the Raritan River.

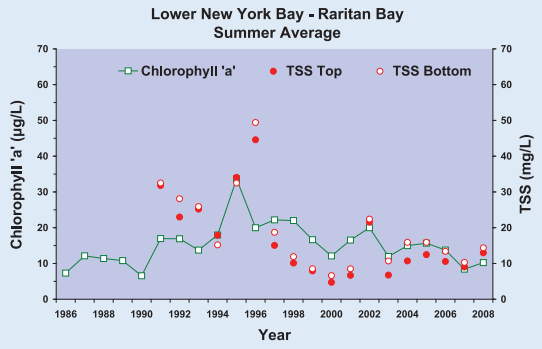
Lower New York Bay – Raritan Bay

CHLOROPHYLL 'a'

This large region is represented by five Harbor Survey stations. The three stations on the eastern side of this region (Lower Bay) typically have low average chlorophyll 'a' concentrations (all < 7.3 ug/L). These waters are among the clearest in the city and are represented by sampling stations at the Verrazano Narrows, Coney Island Beach and Rockaway Inlet. Conversely, the Raritan Bay stations on the south-east shore of Staten Island have averages of 13.4 ug/L (K5A) and 22.1 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 infamously polluted Raritan River. 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



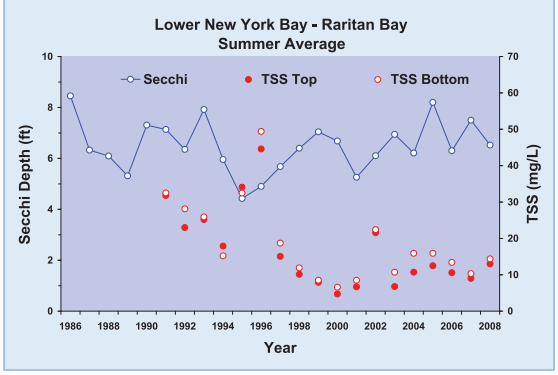
TRENDS

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 23 years, all but three years (1995, 1997, 1998) had averages below 20 ug/L (see figure). In 2008, the chlorophyll 'a' average was 10.2 ug/L.

SECCHI TRANSPARENCY

The average Secchi reading for LNYB-RB stations was 6.5 feet. As usual, a highest average value of 9.6 feet was located at Rockaway Point (N16). This site also reported the highest Secchi value of 14.0 feet (6/18, 8/19, 9/3). As the most oceanic of the Harbor Survey's 35 monitoring stations, N16 commonly experiences the widest range in Secchi values. In 2008, measurements at N16 ranged from 6.0 to 14.0 feet. Levels above 5.0 feet indicate clean conditions and superior water quality. In this region, 26 out of 80 Secchi readings were below 5.0 feet. The lowest readings of 3.0 feet were recorded on July 16 at stations K5A and K6.

Secchi Depth and Total Suspended Solids



TRENDS

While group average values for the LNYB-RB stations are typically 1.0 to 2.0 feet higher than those of Jamaica Bay, Secchi trends show similar patterns for both waterbodies.

Averages of Secchi transparency in LNYB-RB have remained above 5.0 feet since 1986, with the exceptions of 1995 and 1996. The drop coincided with the big jump of chlorophyll 'a' in 1995.

Harbor-Wide Improvements

2008 was a rewarding year. Harbor-wide average Dissolved Oxygen (DO) values for both surface and bottom waters reached record highs (7.2 mg/L and 6.4 mg/L). Chlorophyll 'a', Secchi Depth and Total Suspended Solids in the open waters of the harbor have remained stable with slight fluctuations.

Average DO values increased throughout New York Harbor, except bottom DO in parts of Upper East River, Western Long Island Sound and the North-Eastern part of the Jamaica Bay. The largest jump (1.0 – 1.7 mg/L) occurred in Upper and Lower New York Bay (N6 – N9), Gowanus Channel (G2) and Jamaica Bay Inlet (J1 and J11).

Harbor-wide average DO levels were all above the NYSDEC Bathing Standard of 5.0 mg/L, except for the average bottom DOs between Whitestone Bridge (E7) and Hart Island (E10) and Grassy Bay in Jamaica Bay, which were below the Bathing Standard.

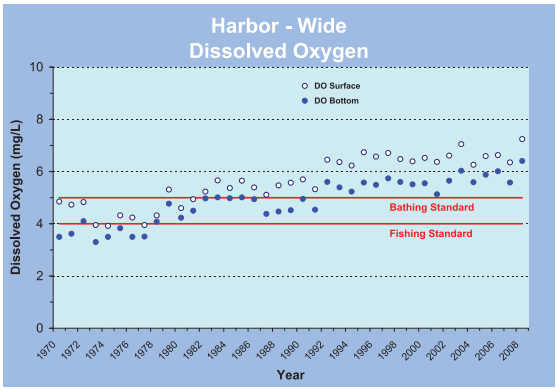
It should be noted that a technical problem with incubators resulted in some samples being removed from the compiled data.

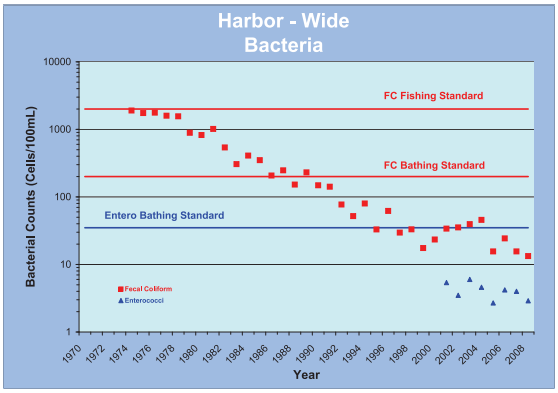
Fecal coliform trends throughout the harbor continued to decline. Open water stations all have average values well below the Bathing Standard. Short-term spikes do occur after rain events due to CSO discharges. Enterococci sampling over the last eight years has shown relatively stable average values, with spikes similar in size and frequency to the fecal levels. As with the fecal averages, the entero-cocci averages for open waters remain well below the Bathing Standard. The NYC DEP's Long Term Control Plan (LTCP) is an ongoing project which has begun addressing CSOs and stormwater runoff.

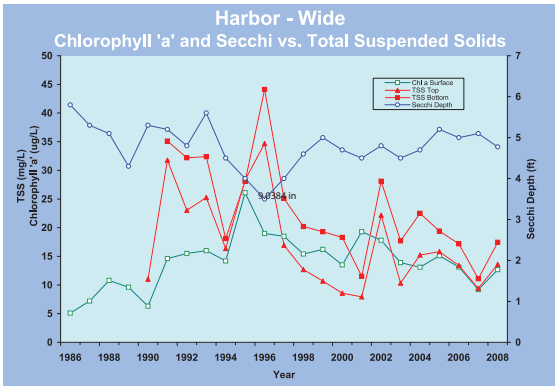
Data collected in 2008 showed levels of chlorophyll 'a' and both surface and bottom Total Suspended Solids returned to 2006 levels. The averaged summer values with Secchi depth were all relatively stable.

The Harbor Survey has begun a long-term analysis of linkages between wet weather and DEP's water quality measurements. The Survey has also begun its integration into the LTCP. Stations in the East River (Flushing Bay and Creek) and Jamaica Bay (Spring Creek) have already been added to our regular sampling rotation.

Overall water quality throughout the harbor exceeds Standards the vast majority of the time. Short-term spikes are present after some rain events. The City of New York through the LTCP is committed to addressing these spikes and is working toward a goal of having all open waters throughout the harbor meet fishing and bathing standards at all times.

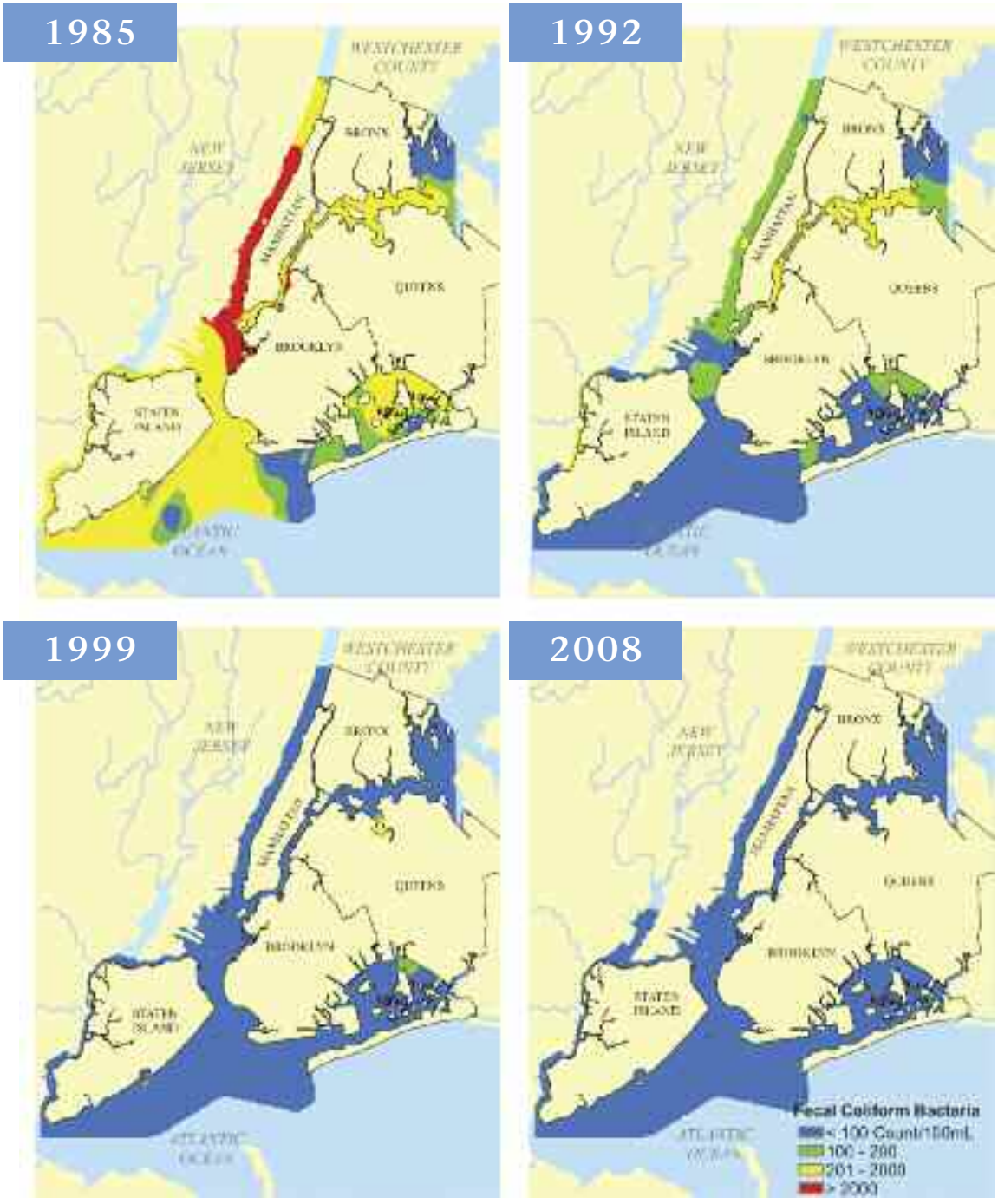






Harbor-Wide Water Quality Improvements Over Four Time Periods

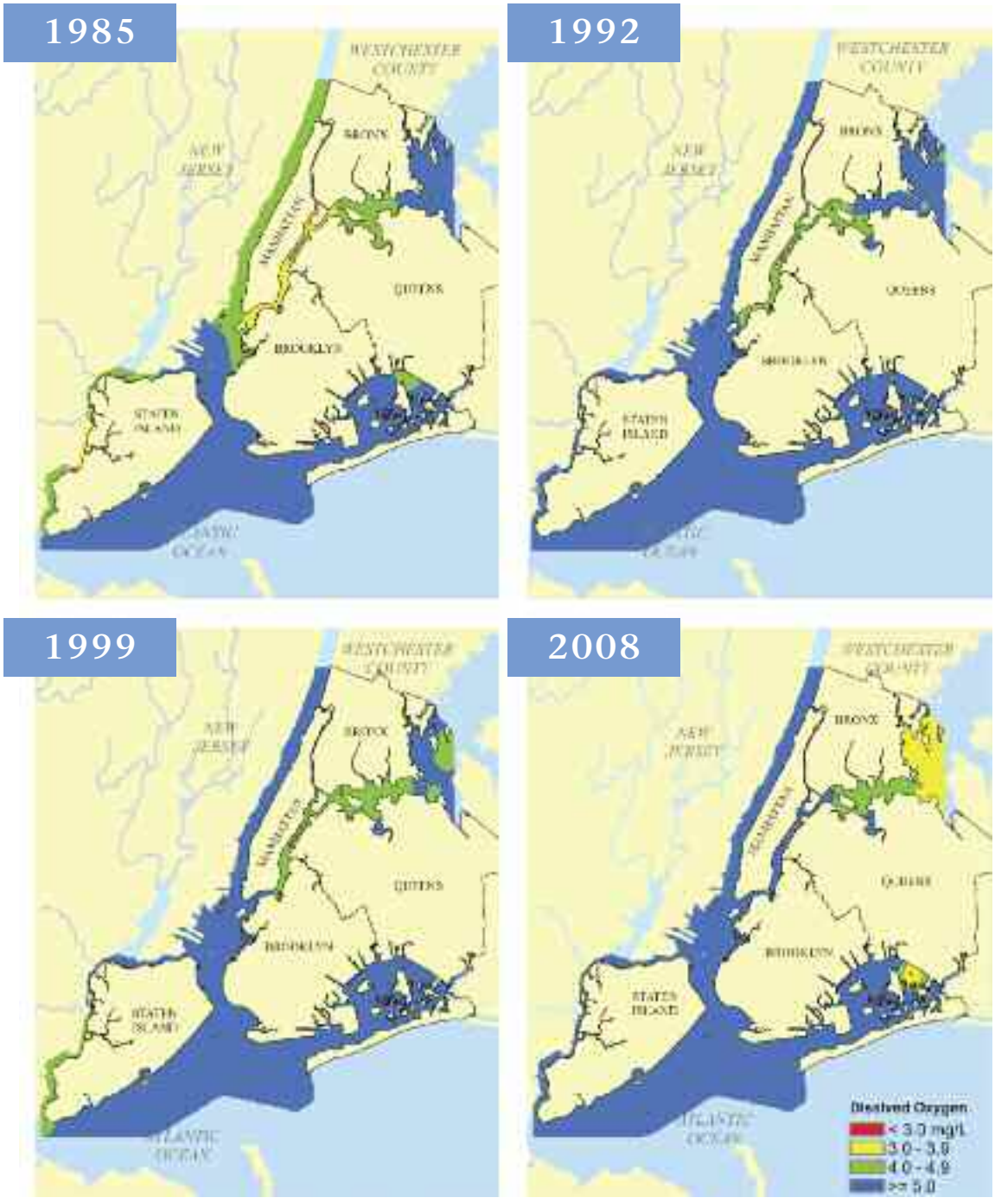
SUMMER GEOMETRIC MEANS FOR
FECAL COLIFORM IN SURFACE WATERS



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

Harbor-Wide Water Quality Improvements Over Four Time Periods

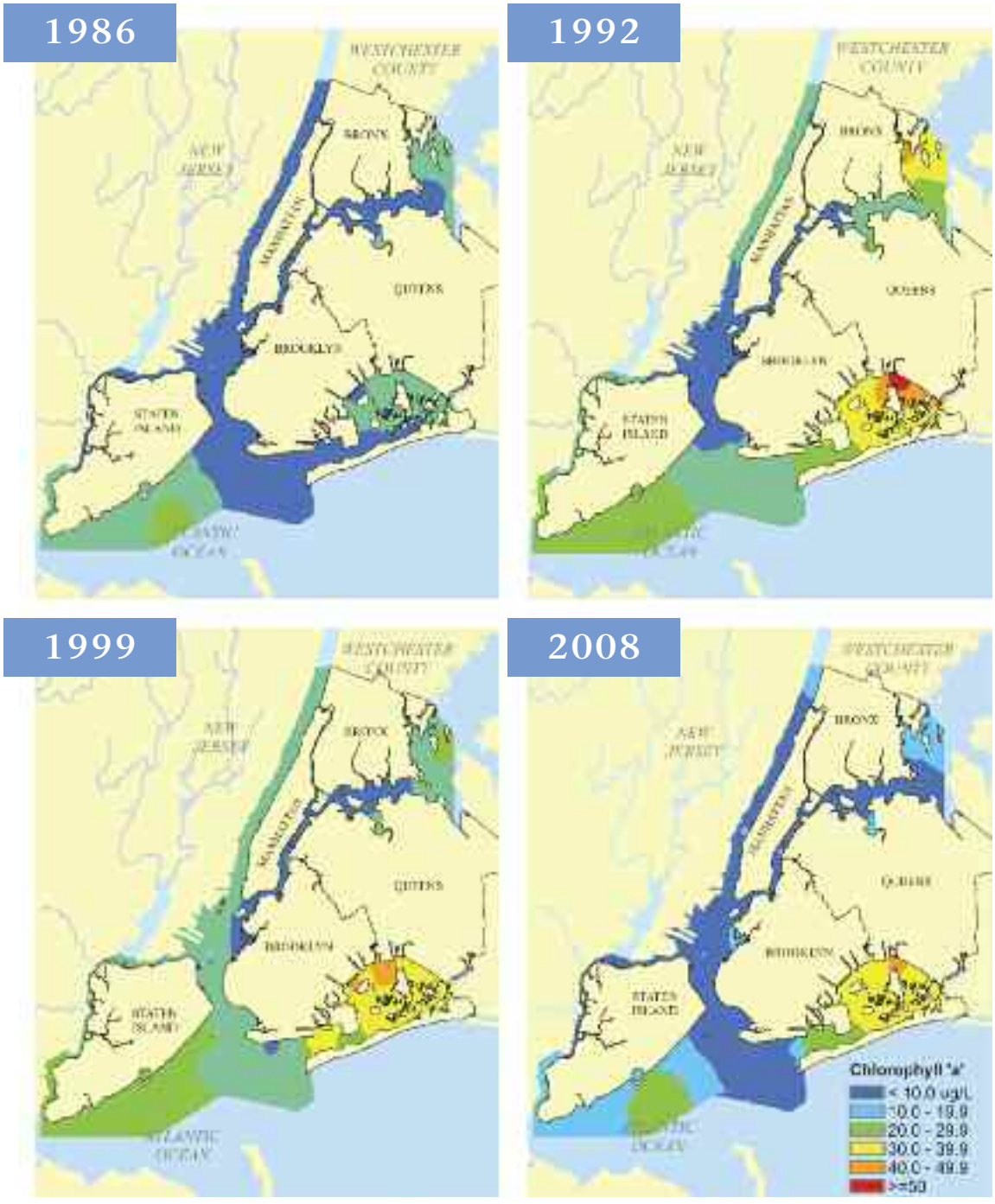
SUMMER AVERAGES FOR
DISSOLVED OXYGEN IN BOTTOM WATERS



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

Harbor-Wide Water Quality Improvements Over Four Time Periods

SUMMER AVERAGES FOR
CHLOROPHYLL 'a' IN SURFACE WATERS



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

2008 NYC DEP HARBOR SURVEY STATIONS

NYC DEP WASTEWATER TREATMENT PLANTS AND CSOS

Acknowledgments

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