1998 New York Harbor Water Quality

Regional Report

Inner Harbor Area

The Hudson River from the city line to Verrazano Narrows; the Harlem River & lower East River to Battery and the Kills. Represented by 26 monitoring stations.

Upper East River–Western Long Island Sound

Northeastern portion of the Harbor from Hell Gate to Steppingstones, Western Long Island Sound. Represented by 12 monitoring stations.

Lower New York Bay–Raritan Bay

Most oceanic portion of the Harbor, composed of open shallow waters, bordering the NY Bight. Represented by 5 monitoring stations.

Jamaica Bay

An urban estuarine embayment, covering approximately 25 sq. miles and represented by 10 monitoring stations.

New York City Department of Environmental Protection

Rudolph W. Giuliani, Mayor

Joel A. Miele Sr., P.E., Commissioner

April, 1999

The following **1998 New York Harbor Water Quality Regional Report** represents the 89th year of comprehensive monitoring of water quality in New York Harbor, and demonstrates the continued improvement of the City's waterways and the regeneration of their aquatic ecosystems. In fact, the Harbor is in better shape today than it has been in more than thirty years.

Under the management of the Department of Environmental Protection (DEP), the City's advanced wastewater treatment and pollution prevention programs are clearly producing positive results. Largely because of these efforts, our bathing waters are cleaner and our aquatic environment is flourishing. What's more, we are committed to doing even better next year. With further enhancements to our treatment plants and other infrastructure upgrades already underway, the quality of the Harbor, and of City life, will surely continue to improve.

I encourage all New Yorkers to review this report to gain an appreciation for the extensive efforts the City has undertaken to reduce pollution in the Harbor and to protect our wonderful natural resources.

Sincerely,

Rudolph W. Giuliani
Mayor

April, 1999

The New York City Department of Environmental Protection (DEP) performs an intensive, annual survey of water quality in New York Harbor. The purpose of the Harbor Survey Program is to assess the effectiveness of the City's various water pollution control programs, and their combined impact on water quality.

The following **1998 Regional Report** includes discussion of our monitoring results in this the 89th year of the program and trend data, in some cases dating back to 1970. A more comprehensive presentation of this material is available in the full Harbor Survey Report to be released later this month.

We are continually striving to improve our programs and to enhance the usefulness of these reports. To that end, this regional report provides data summaries for four significant regions of the Harbor. Your comments on these regional summaries, and on other information in the Report, are encouraged. Questions or suggestions may be directed to Alan I. Stubin or Naji Yao of DEP's Marine Sciences Section at 212/860-9378.

We are proud of the results of our efforts to improve the quality of New York City's waterways. Your interest in the success of our programs is greatly appreciated.

Sincerely,

Joel A. Miele Sr., P.E.
Commissioner

Introduction

The New York City Harbor Survey, a near century long documentation of human impacts on the City's water environment, monitors the quality of Harbor waters and identifies the impacts of pollution control programs on these waters. By measuring a number of water quality parameters and human-health related indicators during the summer months, this survey: identifies changes in the environmental health and ecosystem quality of New York Harbor; describes long-term water quality trends; and provides a unique data base for regional scientists, educators, and private citizens.

The current monitoring program developed from an effort begun by the Metropolitan Sewerage Commission in 1909 in response to public concerns about gross pollution in the Harbor. The program has continued to expand since the early 1900s when only twelve stations were used to record the impacts of sewage pollution. At present, the New York City Department of Environmental Protection's (NYC DEP) Marine Sciences Section monitors both surface and bottom waters at 53 stations throughout the Harbor. At these stations more than one dozen water quality parameters are measured as frequently as four times per summer month.

This regional report of the Harbor Survey's 89th year of monitoring, provides a comprehensive overview of findings in a new format (to which the entire report will be moving in future issues), that allows for an individualized focus on four regional waterways. Waters within a geographical region share common uses and pollutant loadings and represent a unique combination of land and water use within the Harbor Estuary.[1]

[1] **Estuary** - a semi-enclosed coastal body of water where fresh water and salt water mix.

This brief synopsis examines trends of four major indicators of environmental change in the Harbor Estuary. A more expanded discussion on each of these parameters is included in the full Harbor Survey Report. These four indicators are:

- **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 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 plant pigment, the concentration of which in water is used as an estimate of productivity or phytoplankton abundance.

  Phytoplankton, minute free-floating aquatic plants, form the basis of the food web. Since these organisms respond quickly to environmental changes, their abundance may serve as a measure of water quality and an indicator of greater ecosystem change.

  The Harbor Survey measures chlorophyll 'a' (as a surrogate for phytoplankton) to provide an assessment of ecosystem health. Levels above 20 ug/L are considered indicative of enriched or eutrophic[2] conditions, indicating a decline in water quality.

- **Dissolved Oxygen (DO)** – The levels of oxygen dissolved in the water column is 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 feet) is indicative of clear water, with declines in transparency typically due to high suspended solid concentrations or plankton blooms. Low Secchi readings (less than 3 feet) are typically associated with degraded waters. These conditions are indicative of light limiting conditions, which in turn affect primary productivity and nutrient cycling.

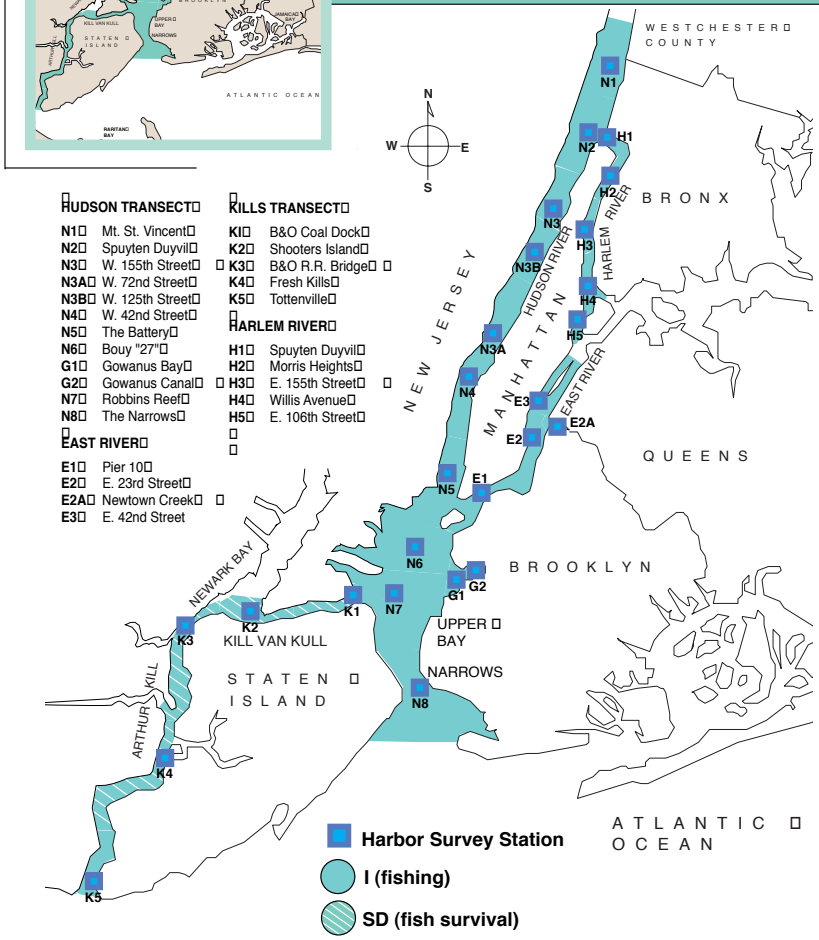
Coliform and dissolved oxygen indicators are used in New York State Department of Environmental Conservation (NYS DEC) standards, to quantify ecosystem health or degradation. NYS DEC standards reflect a range of acceptable water quality conditions corresponding to the State-designated "best usage" of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

Common Water Use And NYS DEC 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/100mL from 5 or more samples	5.0 mg/L
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
SD	Fish survival	No standard	3.0 mg/L

[2] **Eutrophic conditions** –a condition in which nutrient-rich waters allow for excessive growth of algae, often leading to reduced water clarity and DO levels.

Inner Harbor Area



HUDSON TRANSECT
- N1 Mt. St. Vincent
- N2 Spuyten Duyvil
- N3 W. 155th Street
- N3A W. 72nd Street
- N3B W. 125th Street
- N4 W. 42nd Street
- N5 The Battery
- N6 Bouy "27"
- G1 Gowanus Bay
- G2 Gowanus Canal
- N7 Robbins Reef
- N8 The Narrows

EAST RIVER
- E1 Pier 10
- E2 E. 23rd Street
- E2A Newtown Creek
- E3 E. 42nd Street

KILLS TRANSECT
- KI B&O Coal Dock
- K2 Shooters Island
- K3 B&O R.R. Bridge
- K4 Fresh Kills
- K5 Tottenville

HARLEM RIVER
- H1 Spuyten Duyvil
- H2 Morris Heights
- H3 E. 155th Street
- H4 Willis Avenue
- H5 E. 106th Street

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 Harlem River including the Lower East River to the Battery; and the Kill Van Kull-Arthur Kill system. This area contains 26 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.

All of the Inner Harbor Area, excluding the Kills, is classified by NYCDEC as I, for uses such as fishing or boating. The area in the Kills is classified for fish survival only (SD).

Fecal Coliform

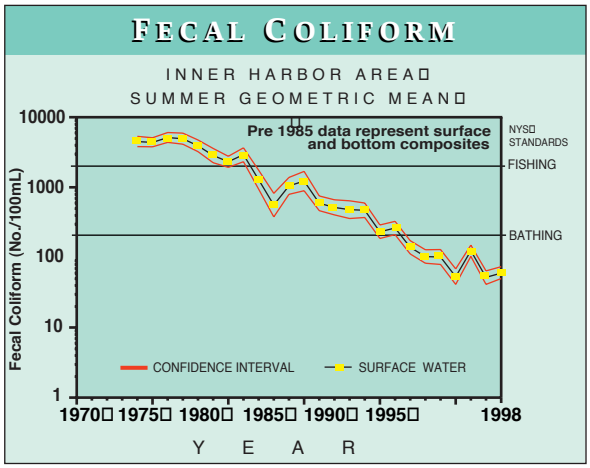
Sanitary water quality as estimated by fecal coliform (FC) concentrations was superior for the Inner Harbor Area in summer 1998. All Inner Harbor Area monitoring sites complied with monthly FC standards of 2,000 cells/ 100 mL by at least one order of magnitude. Only three sites had geometric means greater than 100 cells/100 mL.

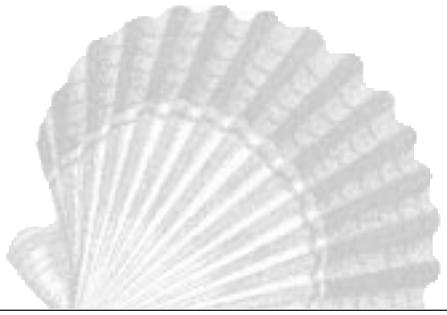
The average (or more specifically, the geometric mean[3] of) FC concentrations mask short-term fluctuations in water quality. Wet weather data shows that the Inner Harbor Areas are prone to short-lived degradation due to an increase in FC loadings following rain storms. Under these conditions, the Upper Hudson River (from its junction with the Harlem River to W. 125th street), a portion of the Lower East River, and the Upper NY Bay, increase from below 100 to 100–200 cells/ 100 mL. The remaining Inner Harbor Area reaches FC levels of 201–2,000 cells/100 mL. This degraded water quality still meets designated standards.

[3] **Geometric mean** - a calculation of central tendency for a set of data often employed when a high degree of variation is present.

TRENDS

Fecal coliform concentrations for the Inner Harbor Area show a dramatic decline (nearly two orders of magnitude) from the early 1970s to the present time. During this period, FC concentrations went from levels well above 2,000 cell/ 100 mL to levels well below 200 cells/ 100 mL, and most recently below 100 cells/ 100 mL. As a result, today's water quality has improved to the degree that it surpasses conditions deemed appropriate for most recreational activities, whereas 1970's water quality did not meet fishing standards. This improvement is noteworthy in view of the multitude of point sources that discharge into these waters and the magnitude of increased loading known to occur in these waters during rain events. This improvement is largely attributable to abatement of raw sewage discharges through construction, expansion, and upgrading of Water Pollution Control Plants (WPCPs), elimination of illegal discharges, and the reduction of combined sewer overflows (CSO).[4]



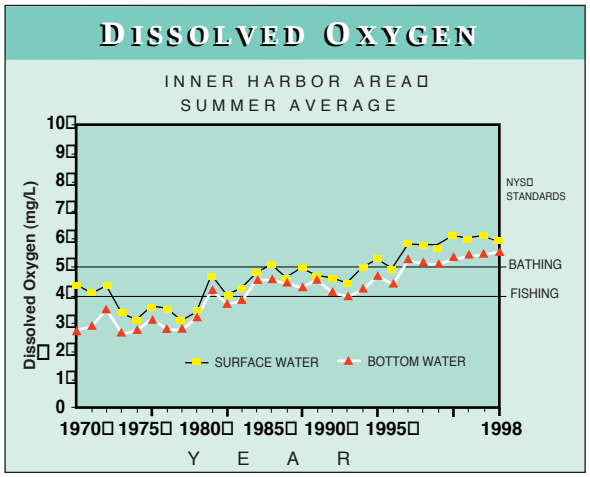


DISSOLVED OXYGEN

Dissolved oxygen (DO) values observed in the Inner Harbor Area for the summer of 1998 were quite favorable. Average DO values were above the I standard of 4 mg/L deemed appropriate for fishing for both surface and bottom waters. Individual DO measurements failed to comply with applicable DO standards for the Inner Harbor Area only 38 times out of 767 measurements. Finally, only one location, on the Southern Arthur Kill (K5), had a minimum DO value below 3 mg/L (the NYS-DEC standard for fish survival and the threshold regionally defined as hypoxia).[5]

TRENDS

Dissolved oxygen (DO) has shown a consistent increase in the Inner Harbor Area over the past 29 years. The average DO values have increased from below 3 mg/L in 1970 to above 5 mg/L in 1998.



This change is substantial in that values rose from levels that were not adequate for fish survival to levels fully supportive of ecological productivity. This improvement is evident in the heavy re-infestation of Harbor wood pilings by marine organisms, and partially responsible for recovery of the shortnose sturgeon to record numbers in the Hudson River.

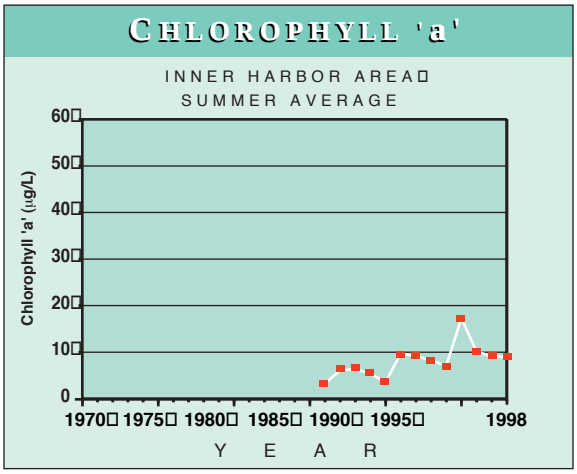
[4]**Combined sewer overflows (CSO)** - the discharge of rain runoff and untreated domestic sewage through special sewers. Overflow to the Harbor occurs when WPCP hydraulic capacity is exceeded.

[5]**Hypoxia** - a condition of low dissolved oxygen, considered stressful to many aquatic organisms.

INNER HARBOR AREA

CHLOROPHYLL 'a'

While water quality standards do not exist for chlorophyll 'a', concentrations in excess of 20 μg/L are considered indicative of eutrophic conditions. For the Inner Harbor Area, only Tottenville (K5) had an average chlorophyll 'a' concentration above 20 μg/L. Concentrations at the remaining 25 stations were much lower, with only four sites having averages above 10 μg/L.



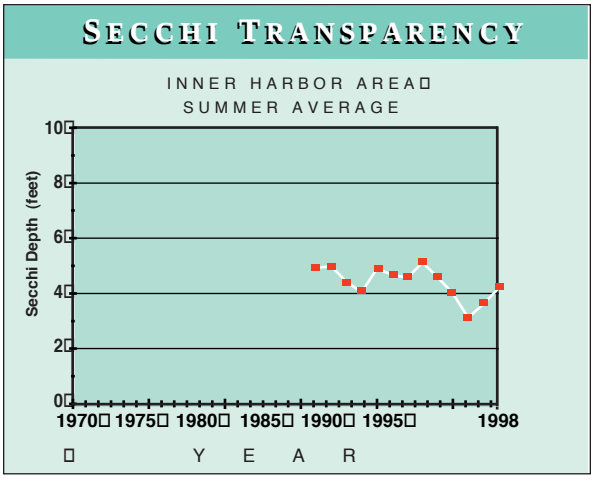
TRENDS

Of the four geographical Harbor Survey regions, the Inner Harbor Area shows the least year to year chlorophyll 'a' variation and the lowest summertime averages. In this vicinity, high flushing rates are likely responsible for limiting the development of standing phytoplankton communities. Trends show a slight increase in chlorophyll 'a' concentrations in the 1990s relative to the values of the 1980s. The average summer concentration for the area since 1991 remains at about 10 μg/L, despite a short-lived peak in 1995 to 17 μg/L.

SECCHI TRANSPARENCY

No water quality standards exist for Secchi transparency. In general, high Secchi numbers (depths 5 feet or better) are associated with clearer water, while low Secchi transparencies (depths 3 feet or less) are indicative of turbid (or light limiting) conditions. Of the 26 Inner Harbor Area stations, 7 sites had average Secchi transparency values of 5 feet or better, including lower East River sites in the vicinity of Newtown Creek; the Gowanus Canal; and the Upper New York Bay area through the Narrows.

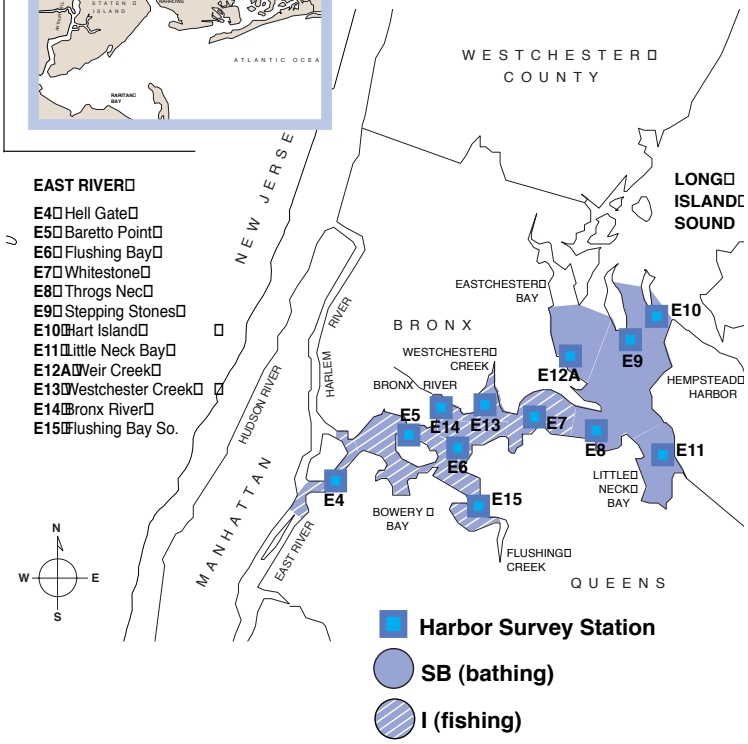
Eight sites had average Secchi values below 3 feet. These sites included the northern portions of the Harlem River and the Hudson River from its junction with the Harlem River down to W. 72nd Street. Decreased water clarity in the Hudson is associated with higher quantities of suspended solids due to erosion and tidal scouring of bottom sediments.



TRENDS

Annual averages show Inner Harbor Area Secchi transparency depths have remained at about 5 feet (from 1986-1994) with some temporal downward trending. Following 1994, transparency dropped notably to a low of 3.1 feet in 1996. A gradual increase of Secchi transparencies is evident over the past two years.

UPPER EAST RIVER–WESTERN LONG ISLAND SOUND



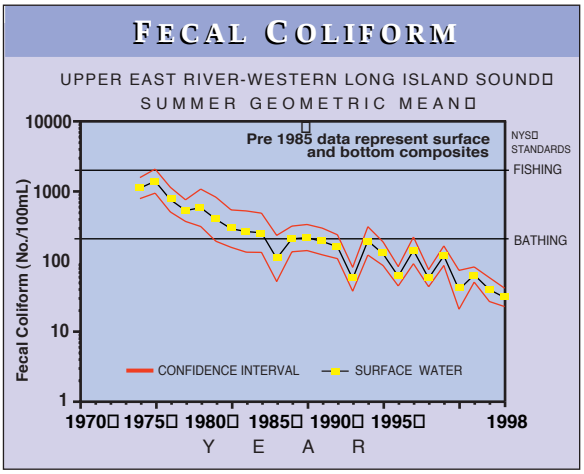
The Upper East River-Western Long Island Sound (UER-WLIS) represents the northeastern portion of NY Harbor, from Hells Gate in the East River, up into the Western Long Island Sound (WLIS). **The Harbor Survey Program** provides coverage of this area, including the East River from Roosevelt Island to Hart Island at the NYC-Westchester County boundary, through 12 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 Study 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 1998, sanitary water quality continued to be superior for this area. 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 all but two sites were below 100 cells/100 mL. Higher concentrations (although still in compliance with NYS standards) were recorded at the two Flushing Bay stations, E6 and E15.

During wet weather conditions a decline in this area's water quality was discernable, with increased FC levels in the Upper East River, from Hell Gate to Throgs Neck. Even under these conditions, FC levels deemed appropriate for fishing are maintained throughout the vicinity, with the exception of Flushing Bay waters.



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 more than an order of magnitude, indicates FC concentrations met standards suitable for bathing 90% of the time over the past decade. The ongoing upgrade of wastewater treatment facilities and improved control of flow regulators and combined sewer overflow events have had, and will continue to have, a major impact on the reduction of fecal coliform loads. While Flushing Bay waters have been compromised, due to low flushing capabilities and high wet weather loads, this area is targeted for CSO abatement (including construction of wet-weather storage facilities) and is the focus of a joint NYCDEP- Army Corps of Engineers Ecosystem Restoration Project.

DISSOLVED OXYGEN

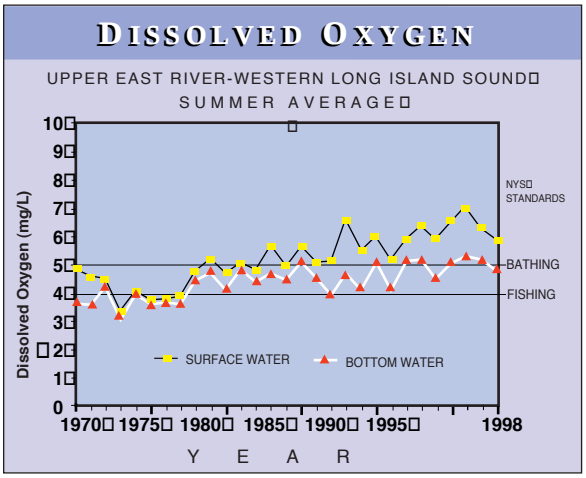
Average summer DO values for the UER-WLIS vicinity met and exceeded 4 mg/L (conditions suitable for fishing). However, bottom water values at three of the five stations designated as SB, were below the applicable 5 mg/L standard for bathing waters. The latter stations, from Throgs Neck to Western Long Island Sound (WLIS), were responsible for 42% of the DO readings that failed to comply with NYS standards. With regard to individual DO readings, UER-WLIS stations failed to comply with NYS standards 113 times out of 376 DO readings, with 42% of these failures occurring at sites E8, E9, and E10. Dissolved oxygen values of less than 3 mg/L (defined as hypoxic) were observed at least once at half of the UER-WLIS monitoring sites, and WLIS had minimum DO levels of less than 1 mg/L.

These observations highlight the need for continued ecological concern for the vicinity of the WLIS, which is the major focus of the Long Island Sound Study initiated in 1985. Together with the states of New York and Connecticut, and Westchester County, DEP is committed to efforts to reduce nitrogen loadings into in the Long Island Sound.

TRENDS

Trend analysis for the UER-WLIS area shows an increase in DO of over 1 mg/L for both top and bottom waters since 1970. Most notable, are improvements in bottom waters that have risen from below fishable (4 mg/L) to above bathing standards (5 mg/L). Trends however also demonstrate high DO variability, with an increasing gap between surface and bottom water improvements since the mid-1980s (This suggests the formation of two separate water masses or pronounced stratification[6]).

In the WLIS in particular, conditions symptomatic of eutrophic waters have been observed since the late 1980s. These conditions include extremely high surface water DO (often associated with algae blooms) and sporadic, but extremely low, bottom DO. This decline in water quality is being addressed by the Long Island Sound Study.



[6]**Pronounced stratification**- the development of separate water masses within the water column, most often due to distinct differences in salinity and/or temperature.

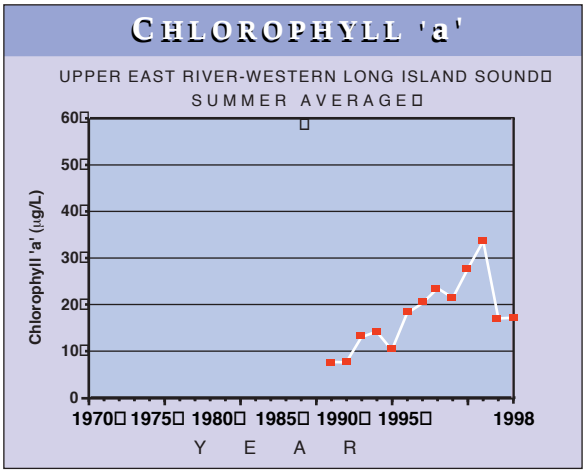
UPPER EAST RIVER– WESTERN LONG ISLAND SOUND

CHLOROPHYLL 'a'

Chlorophyll 'a' concentrations for the Upper East River-Western Long island Sound (UER-WLIS) remained close to (or only slightly above) that of the previous years, with the average summer concentration measuring 17.2 μg/L for 1998. Overall, waters in this area tend towards eutrophic, with half of the HS stations in this vicinity having average concentrations above 20 μg/L. The highest concentrations, as in past years, were again apparent in WLIS. Steps now being taken, as part of the Long Island Sound Study, to reduce nitrogen discharges into the East River, are expected to reduce enrichment of these waters. This in turn, will limit algal growth and mitigate other water quality concerns symptomatic of eutrophic conditions.

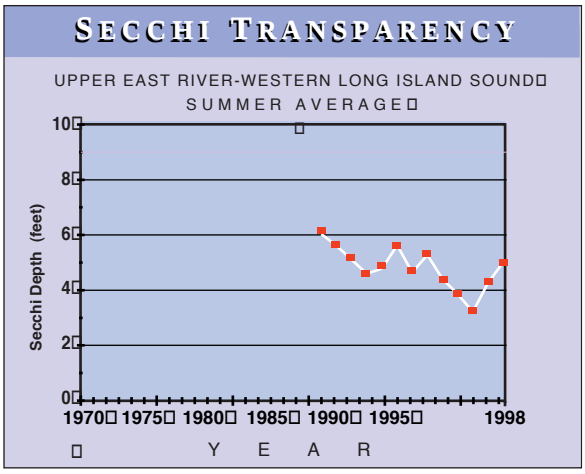
TRENDS

Until experiencing a sharp decrease of greater than 16 μg/L in 1997, chlorophyll 'a' in the UER-WLIS showed a strong and fairly consistent rate of increase, close to 10 μg/L every four years. The slight increase in 1998 measurements over 1997 values are within sampling variability and demonstrate the previous years' decline to be real; marking only the second consecutive year since 1991 in which average group values remained below 20 μg/L.



Secchi Transparency

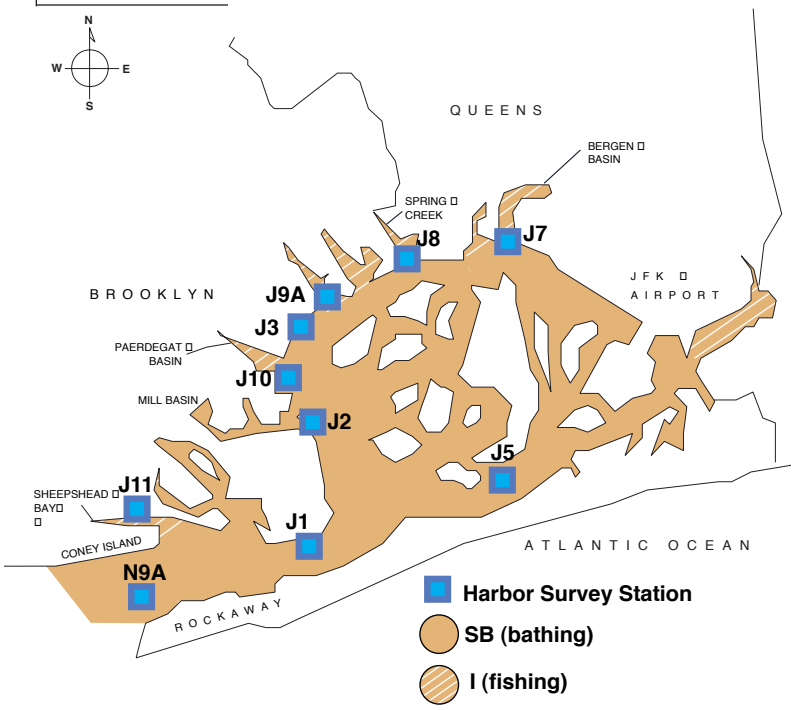
Average Secchi transparencies for the UER-WLIS were generally greater than 5 feet, with only three stations (E12A, E6, and E15) having values below this level. Of these sites, the lowest average value of 3.3 feet was observed at the southern end of Flushing Bay (E15).



Trends

Secchi transparency trends over the past decade have varied quite substantially in the UER- WLIS. During the late 1980s, the transparency dropped from above 6 feet to about 4.5 feet. Declines in transparencies were interrupted by several short-lived trend reversals in the early 1990s, before again dropping to a low of 3.3 feet in 1996. Improved transparencies over the past two years (to a recent high of over 5 feet) have arrested further declines and may coincide with a significant decrease in Chlorophyll 'a' (since 1996) for the same waters.

Jamaica Bay



Jamaica Bay is located at the southwestern end of Long Island. This urban, estuarine embayment and national park consists primarily of tidal wetlands, upland area, 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 10 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.

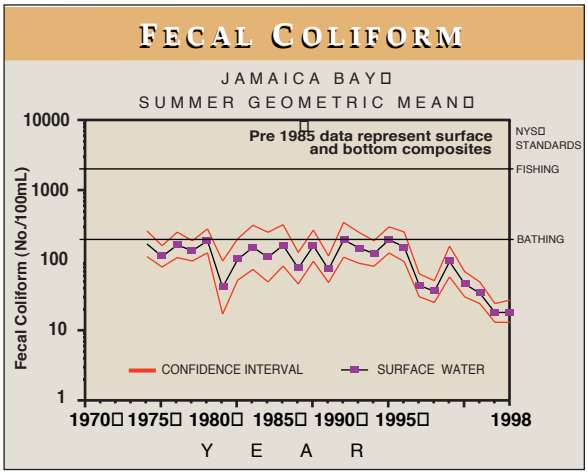
Fecal Coliform

In 1998, sanitary water quality was superior for Jamaica Bay, with summer fecal coliform (FC) concentrations well below standards for all stations, with exception of Sheepshead Bay (J11). The latter site had a geometric mean of 211 cells/100 mL and a highest single value of 500 cells/100 mL.

Under wet weather conditions, the Bay experiences localized degradation. At these times, spikes in FC may temporarily exceed the SB standard of 200 cells/100 mL 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 NY Bay waters (immediately outside of the mouth of Jamaica Bay) are not typically affected by wet weather events.

TRENDS

Although trends for Jamaica Bay FC, from the early 1970s until 1990, show considerable variability above and below the standard, (with counts during this period ranging from well below 100 cells/100 mL to highs near 300 cells/100 mL) beginning in the 1990s, a significant improvement is apparent. From this point, and continuing through 1998, the geometric mean of the FC concentration decreases by an order of magnitude (from 200 to 20 cells/100 mL). This improvement is attributed to sewage system operational improvements and elimination of illegal discharges. Additional improvements are anticipated with the ongoing construction of CSO storage tanks and other treatment facilities in several Jamaica Bay Tributaries.

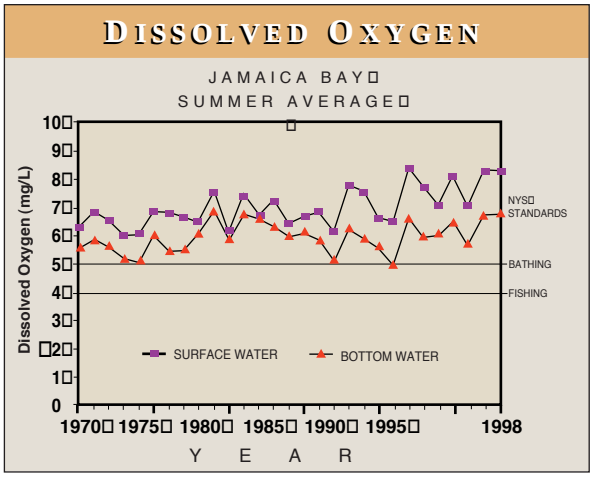


DISSOLVED OXYGEN

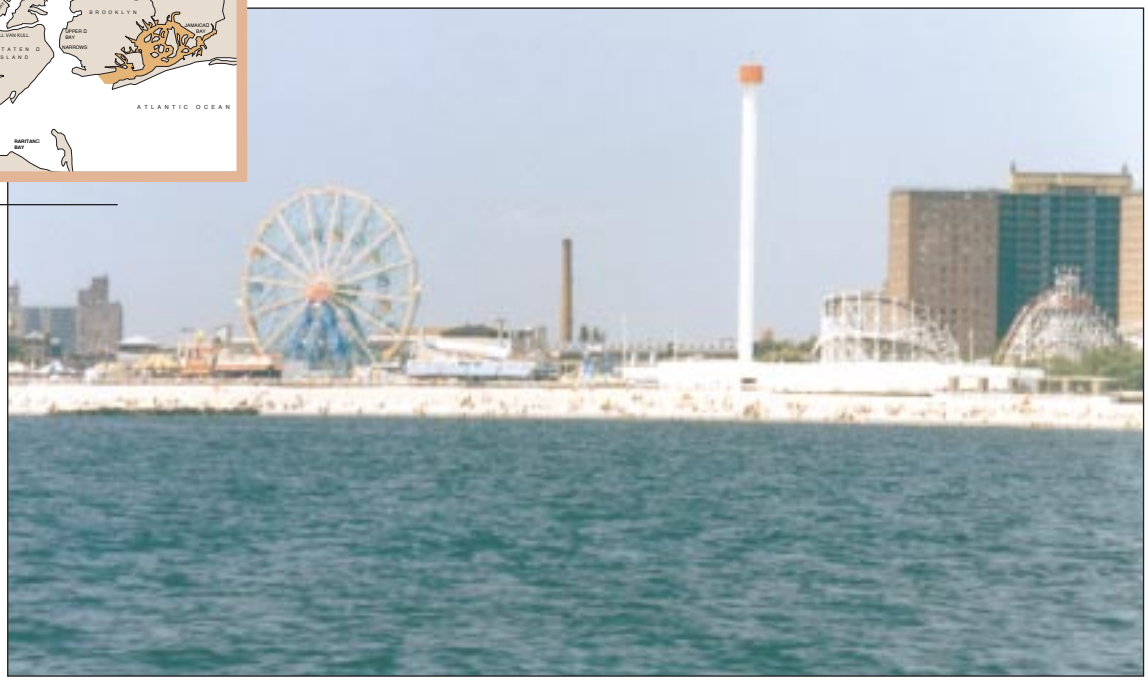
The 1998 summer averages for dissolved oxygen (DO) for surface and bottom waters surpassed the New York State standard of 5.0 mg/L for bathing (SB) at all 10 Jamaica Bay sites. Individual measurements failed to comply with the applicable standard only 22 times of 217 measurements. A minimal DO below 3.0 was observed at Beach Channel (J5) and Bergen Basin (J7).

TRENDS

Average DO concentrations in Jamaica Bay have shown improvement over the past 29 years, with top waters often reaching DO levels over 8 mg/L since the 1990s. This is notable in that average DO levels were well above bathing standards as early as 1970. Of concern, is high DO variability within and between years, and an increasing gap between surface and bottom waters since the mid-1980s. High surface DOs are often due to super-saturated conditions, attributable to algae blooms or eutrophic waters.



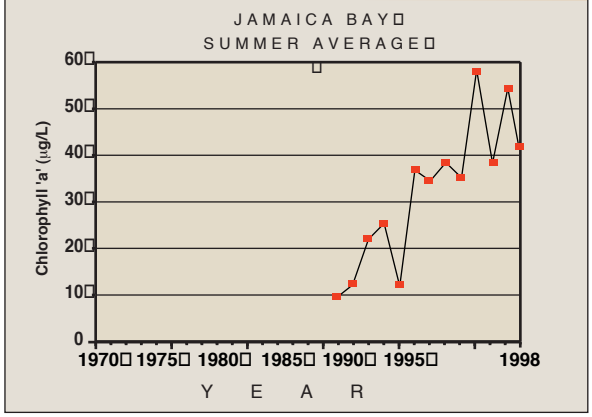
JAMAICA BAY



CHLOROPHYLL 'a'

High chlorophyll 'a' concentrations in Jamaica Bay are indicative of eutrophic conditions. The slow turnover of water within the Bay[7] allows for development of large standing phytoplankton populations. Of the four geographic Harbor Survey regions, Jamaica Bay continues to display the widest range of individual chlorophyll 'a' measurements. Values for 1998 ranged from a high of 84.8 µg/L at Fresh Creek (9A) to a low of 0.5 µg/L at Coney Island Outfall (N9A). For summer averages, 9 of 10 Harbor Survey stations have values above 20 µg/L, with only the Coney Island Outfall Station (outside of the Bay proper) having a lesser value. On average, chlorophyll 'a' concentrations for the Bay measured 41.3 µg/L. This is below the previous year's 53.9 µg/L value, but well above levels tell-tale of enriched or eutrophic waters.

CHLOROPHYLL 'a'



[7]**The slow turnover of water within Jamaica Bay-** is partially due to JFK Airport construction in the 1960s. Removal of over 70 million cubic meters of bottom material changed the Bay's mean depth from 3 to 16 ft and increased water residence time from 11 to 35 days.

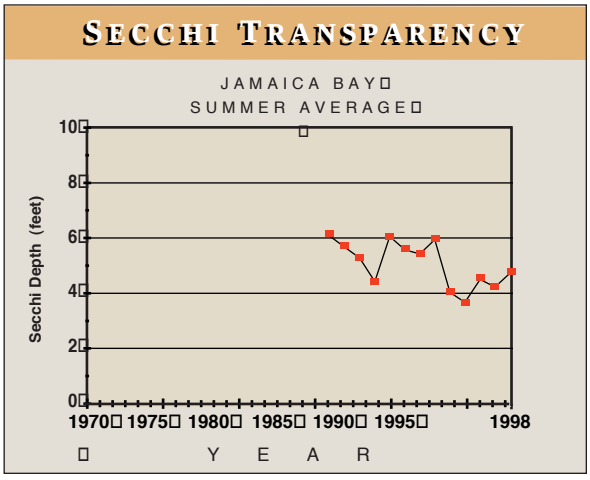
TRENDS

Chlorophyll 'a' concentrations in Jamaica Bay have shown tremendous increases over the past 13 years, with an average rate increase, of close to 10 µg/L every 2 years (from 1986-1995). Yearly summer averages peaked in 1995 at 57.6 µg/L. Average concentrations over the past 4 years have shown sharp fluctuations, both up and down, though not much below 40 µg/L. These conditions have coincided with prolonged algae blooms in Jamaica Bay and reports of nuisance algae at the head of bay tributaries and canals, as well as, dynamic DO fluctuations.

Nutrient loadings to Jamaica Bay are now being carefully monitored and nitrogen reduction actions have been implemented to control eutrophication of these waters. This will limit algal growth and mitigate other water quality concerns associated with eutrophic waters.

SECCHI TRANSPARENCY

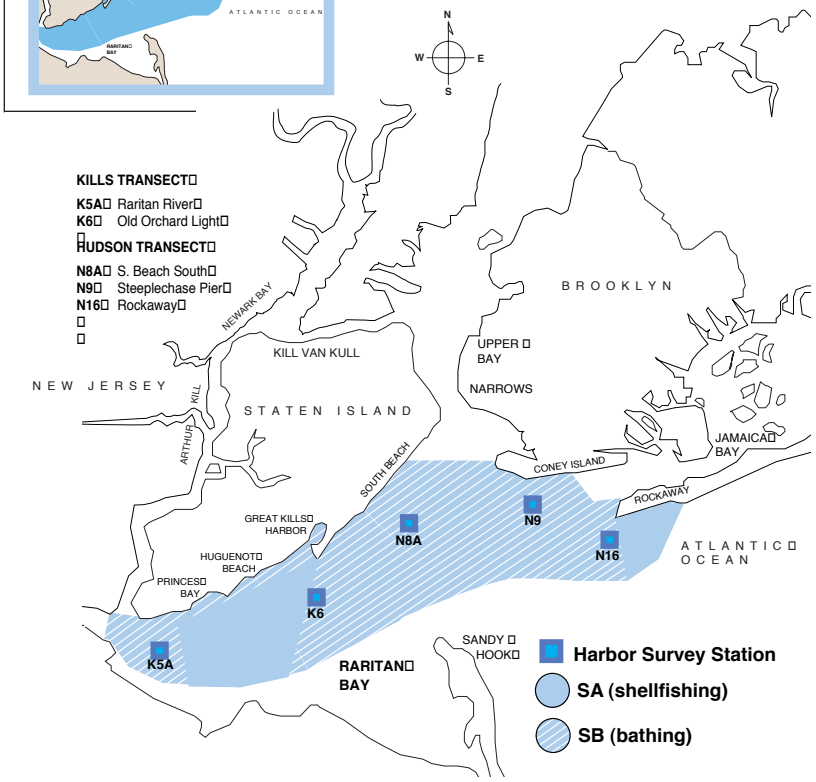
Average Secchi transparencies were never less than 3.6 feet at any of the Jamaica Bay sites. Two stations, one at Rockaway Inlet (J1) and the other at the mouth of the Bay near the Coney Island Outfall (N9A) had average readings well above 5 feet, depths associated with cleaner waters. Both of these locations were outside the Bay proper and experience greater water exchange than sites within the Bay. Average Secchi values for Jamaica Bay tributaries and canals were fairly consistent with values ranging from 3.6-3.9 feet.



TRENDS

Annual averages for Secchi transparency show high variability, with gradual declines from 1986-1989 and a sharp trend reversal in the early 1990s. Transparency values again declined, from a high of about 6 feet in 1993, to a low of 3.6 in 1995. This is followed by gradual improvements through 1998.

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 5 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 northwest, 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.

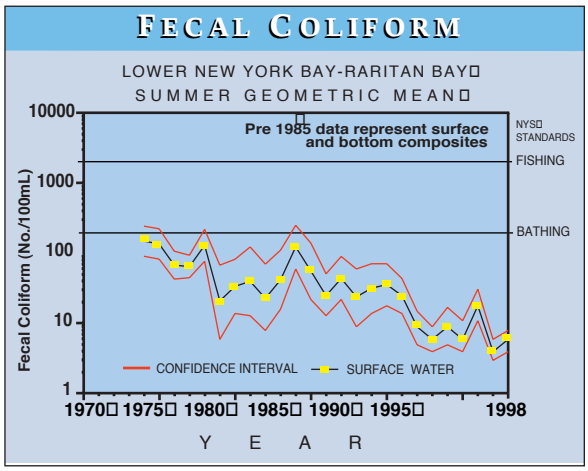
Fecal Coliform

Sanitary water quality as estimated by fecal coliform (FC) was superior for the Lower New York Bay–Raritan Bay (LNYB-RB) in summer 1998. Examination of seasonal FC numbers shows waters of the LNYB-RB to meet and surpass NYS standards for this area, with all locations having geometric mean values of less than 15 cells/100 mL.

Examination of wet weather data shows only the waters in the vicinity of Steeplechase Pier (N9) to experience temporal degradation or increased FC loadings following rain events. Under these conditions, FC increase from less than 100 to 100-200 cells/100 mL. While a similar effect is apparent for waters bordering the Lower Bay, such as the Upper NY Bay, the Narrows, and the Arthur Kill, the remainder of the LNYB-RB area remains unchanged, due to the dynamics of flushing and dilution.

TRENDS

Coliform concentrations for LNYB-RB show significant declines (more than an order of magnitude) from the early 1970s to the present time. While FC concentrations for surface waters were below 200 cells/100 mL (and therefore in compliance with bathing standards) as early as 1974, recent average FC levels are below 5 cells/100 mL (potentially satisfying shellfishing standards). Though FC counts declined in 1979, strong variation is evident through 1984, after which FC have shown more consistent decreases. Subsequent to these improvements, 30,000 acres of shellfishing beds have been approved for clamming off the Rockaways and in Raritan Bay. Even greater FC decreases (improvements to sanitary water quality) occurred after 1991, coinciding with improved NYC sewage system operations and implementation of USEPA's recommended CSO controls.[8] These improvements have allowed for the opening of all NYC public beaches since 1992 and the lifting of wet-weather swimming advisories for all but three beaches.

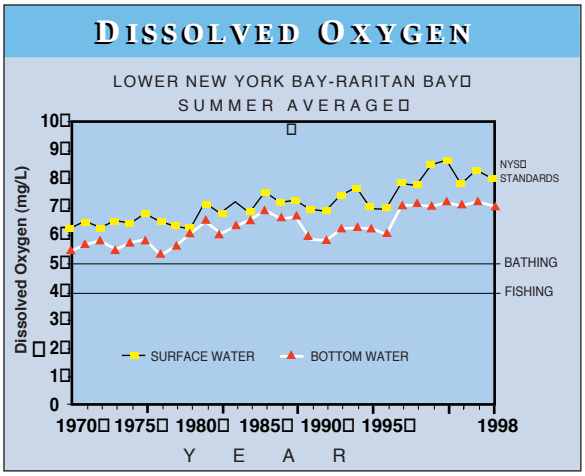


DISSOLVED OXYGEN

Dissolved oxygen (DO) values for top and bottom waters show strong compliance with the NYS DO standard of 5 mg/L. Average DO values for LNYH-RB waters for summer 1998 were always above the DO standard. Actual DO values were found to be below this level only 6 times out of 144 measurements and minimum DO values were never below 3.0 mg/L. This is true despite the Lower NY Bay's proximity to more degraded waters in the Arthur Kill, Narrows, and mouth of Jamaica Bay.

TRENDS

Since 1970, average DO concentration have increased about 1.5 mg/L, from just over 6 mg/L to nearly 8 mg/L for surface waters, and from about 5.5 mg/L to nearly 7 mg/L for bottom waters. Most of the general improvement in this vicinity is attributable to improved water quality of K5A (located due east of the Raritan River and south of the Arthur Kill). This improvement reflects loading decreases in sanitary waste in the vicinity of Arthur Kill and the Raritan River.

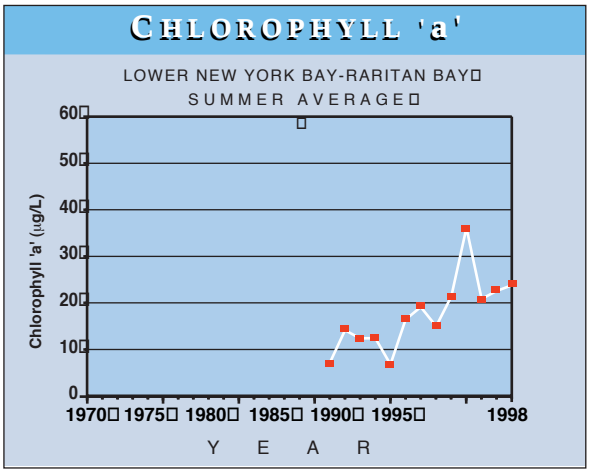


[8] **USEPA recommended CSO controls** - a set of management actions issued in 1996 by the US Environmental Protection Agency for the purpose of mitigating CSO impacts. These actions are collectively referred to as 'The Nine Minimum Controls' (see full 1998 Harbor Survey Report).

Lower New York Bay–Raritan Bay

Chlorophyll 'a'

Of the five Lower New York Bay–Raritan Bay (LNYB-RB) sites, the 3 stations paralleling the Staten Island beaches into Raritan Bay, had average chlorophyll 'a' concentrations close to, or well above 20 µg/L, levels indicative of eutrophic conditions. Based on an increase of citizen complaints, phytoplankton blooms[9] (algae slicks) appear to have become more common place to these waters in the past few years. This vicinity of relatively shallow, slower moving water appears ideal for phytoplankton bloom formation, as nutrient rich Harbor waters empty into the LNYB-RB area. Slower moving waters allow for the condensing of organic material and the growth of algae into tangible slicks, often visible from shore bathing areas. Contact with nutrient-rich oceanic waters only further serves to fuel additional phytoplankton growth, until slicks are dispersed again or washed out of the Bay area. The two most eastern LNYB-RB stations had average concentrations well below 20 µg/L. This is likely due to better tidal flux (active exchange of Harbor and oceanic waters).



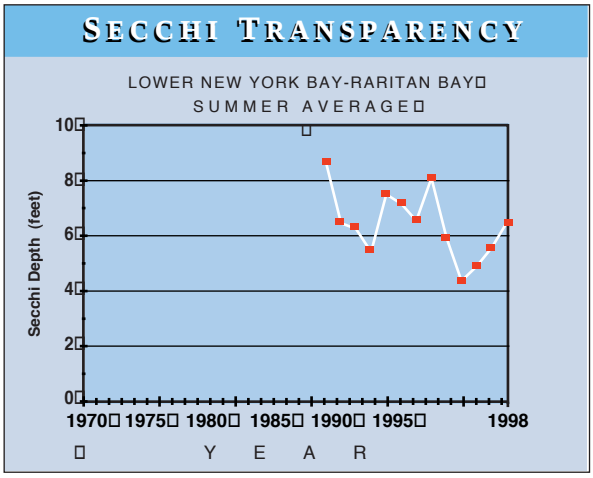
[9] **Phytoplankton blooms-** recognized as a concern by the NY/NJ Harbor Estuary Program (HEP), algae blooms are the focus of increased monitoring in LNYB-RB waters.

TRENDS

Average chlorophyll 'a' concentrations for the LNYB-RB area remained at or below 15 µg/L until 1991. From this time on, concentrations began to raise slightly, first exceeding 20 µg/L in 1994. Despite a 1995 spike in chlorophyll 'a' , group values of the past 3 years have remained above, but close to 20 µg/L.

SECCHI TRANSPARENCY

Average Secchi values for LNYB-RB stations were all above 3 feet. Secchi depths can be seen to increase, moving from the most western Raritan Bay site (K5A), eastward, across the Lower New York Bay. A high average value of 12 feet was recorded at Rockaway Point (N16). This site, the most oceanic of the Harbor Survey's 53 monitoring stations, commonly experiences the widest range in Secchi values. In 1998, measurements at N16 ranged from 8-24 ft, indicative of superior water clarity and extremely clean conditions.



TRENDS

While group average values for the LNYB-RB sites are typically 1-2 feet higher than those of Jamaica Bay, Secchi trends show similar patterns for both vicinities. Transparency in LNYB-RB is seen to decrease from 1986-1989, with a nearly full trend reversal occurring from 1990-1993. Secchi transparency dropped off again from a high of over 8 feet in 1993, to a low of 4.4 feet in 1995, before showing gradual improvement over the past three years.

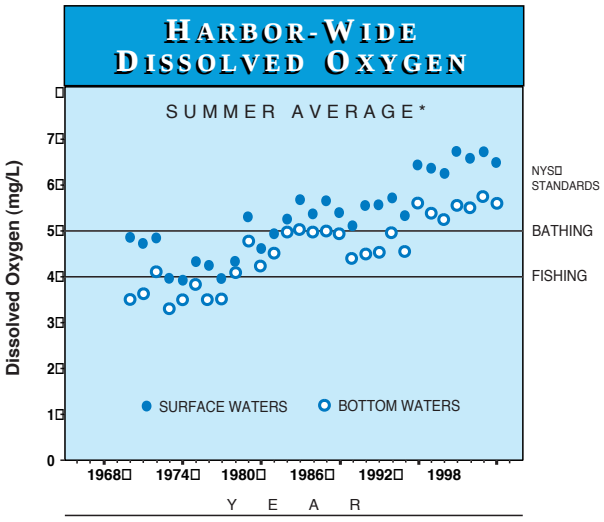
HARBOR-WIDE IMPROVEMENTS

The regional trends noted above for fecal coliform (FC) and dissolved oxygen are further reflected in Harbor-wide water quality improvements. Harbor-wide, fecal coliform concentrations have decreased nearly two orders-of-magnitude from 1974 through 1998, with the most marked changes occurring from 1974 through 1988. These declines are primarily due to the abatement of raw sewage discharges through construction and upgrading of water pollution control plants (WPCPs). Further improvements since 1989 are attributed to increases surveillance and maintenance of the entire sewage collection system.

Progressive improvement (decreases in FC) for four time periods (each reflective of enhanced sewage treatment and operational controls) is portrayed in the figure on page 23. In **1974**, prior to secondary upgrades, waters did not meet levels appropriate for fishing in the Inner Harbor Area, nor bathing in outlying waters. Significant improvement can be seen following plant expansion and upgrades (**1985**) and start-up of the City's last two WPCPs (**1988**). Together, operation of the North River and Red Hook plants ended the discharge of 210 million gallons per day (mgd) of untreated sewage to the Manhattan and Brooklyn shorelines. Further water quality improvements (**1998**) are attributable to increased surveillance and maintenance of the entire sewage collection. This has resulted in the abatement of 2.5 mgd of illegal discharges, practically eliminated raw sewage bypassing, and increased the capture of rainfall that enters the combined sewer system to an average of 44%.

Although, as a result of these actions, average FC in 1998 met New York State bathing standards in all Harbor waters (with the exception of Flushing Bay and Sheepshead Bay), NYCDOH requirements preclude bathing at locations near sewer outlets and where coliform exceeds bathing criteria after significant rainfall. Therefore, bathing activities are permitted only at designated areas.

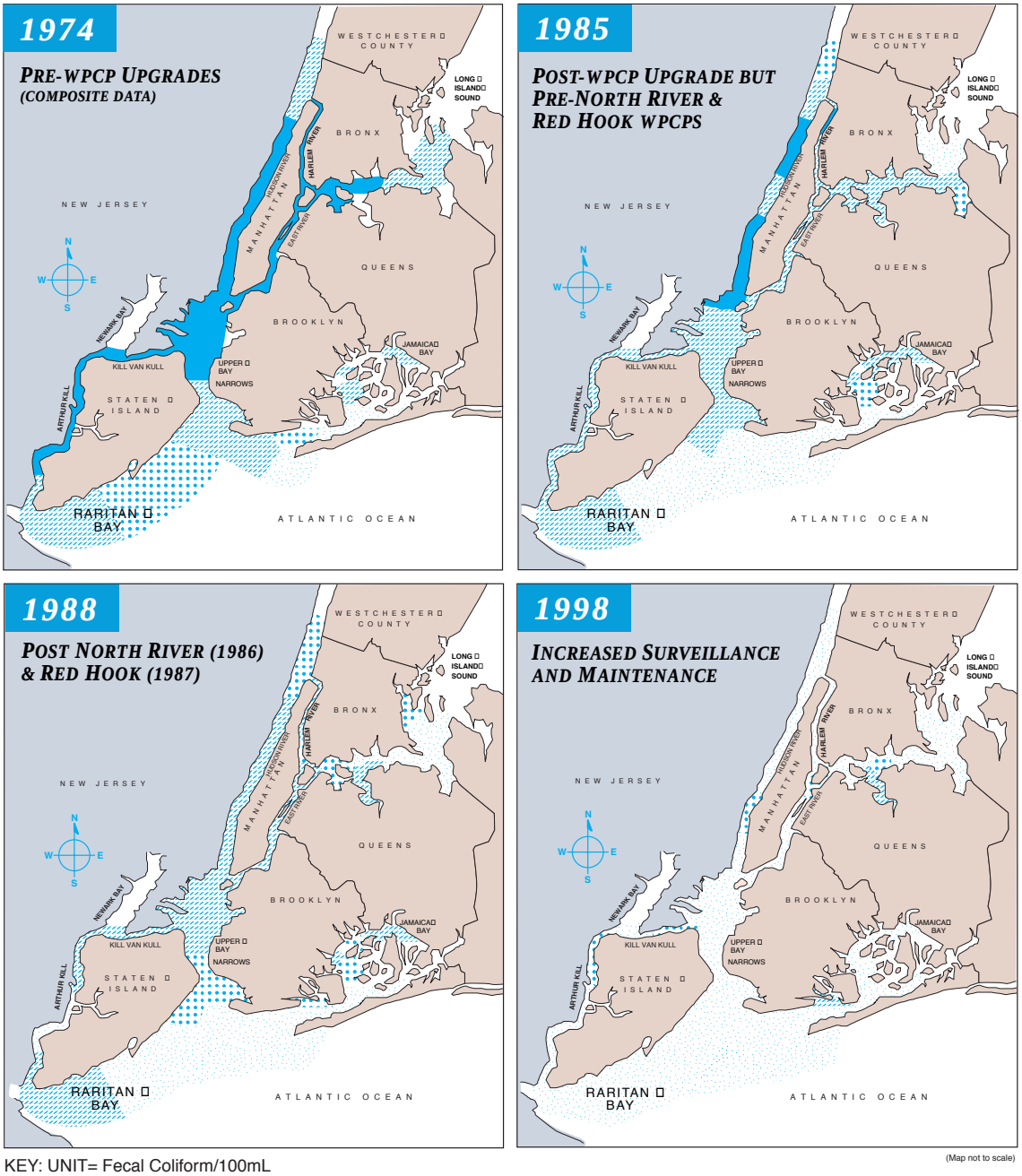
Area-wide decreases in sewage loading have resulted in greater environmental improvement in the Harbor. Indicative of this improvement are dissolved oxygen (DO) levels. Harbor Survey monitoring has documented significant Harbor-wide increases in DO concentrations (~2mg/L) over the past 29 years (see below). The greatest improvement has occurred in Inner Harbor Areas and Lower NY Bay-Raritan Bay waters (see earlier sections).



*Harbor-Wide averages represent 40 stations

HARBOR-WIDE WATER QUALITY IMPROVEMENTS OVER FOUR TIME PERIODS

SUMMER GEOMETRIC MEAN FOR
FECAL COLIFORM IN SURFACE WATERS



(Map not to scale)

KEY: UNIT= Fecal Coliform/100mL

Not Measured	POOR (>2000)	FISHING (201-2000)	BATHING (100-200)	SUPERIOR (<100)

NYS Best-Use Classifications: ≤ 200 FC/100mL=SB (Bathing); ≤2000 FC/100mL=I (Fishing)
Poor does not meet fishing standards; Superior does not imply shellfishing quality

Conclusion

Based on the above water quality indicators and trends, as well as other performance measures, there is overwhelming evidence that New York Harbor's environment is cleaner and the water quality better than it has been since the turn of the century. Improvements range from the re-establishment of breeding populations of water fowl in several areas of the Harbor, to improved benthic (bottom-dwelling) communities in the lower New York Bay, and include:

- the opening of all NYC public beaches since 1992 and the lifting of wet-weather swimming advisories for all but three of these beaches;
- the upgrading of 68,000 acres of shellfish beds since 1985, including the removal of shellfishing restrictions for 30,000 acres off of the Rockaways and in Raritan Bay;
- recovery of Hudson River shortnose sturgeon to record breaking numbers;
- the heavy re-infestation of woodpilings by marine wood-borers and other aquatic organisms;
- decreases in chemical concentrations in fish tissues and a subsequent relaxing of state advisories on human consumption of striped bass in parts of the Hudson River; and
- a 50-90% reduction from peak levels of priority pollutants in fine-grained sediment in the Hudson River.

These improvements can be attributed in large part to the continued development and upgrading of the City's sewage treatment system, and the implementation of a suite of aggressive pollution control programs. These actions, together with operational improvements implemented over the past 10 years, have:

- virtually eliminated raw sewage discharges;
- reduced illegal discharges by more than 90%;
- increased wet-weather related floatables capture to 68%;
- increased capture of rainfall that enters the combined sewer system to an average of 44%; and
- reduced toxic metals loading to the waste stream from industrial sources by over 90%.

Despite the milestones noted above, a number of environmental problems remain unresolved for New York Harbor and the region's estuarine environment. Some of these concerns include: sediment contamination and limitations on dredge spoil disposal; remaining fish advisories; episodically low dissolved oxygen; and nuisance algae and algal slick formation. These challenges defy political boundaries and require continued regional adherence to, and support of, strong environmental control programs. Only through broad stakeholder involvement throughout the Harbor's watershed can we anticipate further enhancement of New York Harbor and its environs.

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