

## Abstract

Tidal Straits, such as the Long Island portion of the East River, are characterized for having salinity levels that fluctuate between fresh and saltwater levels, which presents varying osmotic pressures on lifeforms and affects the dissolution of oxygen in the water. Moreover, the natural fertility of brackish water and the contamination with sewer runoff can make the water nutrient-rich. Here we present the results of our experiments determining the physical-chemical characteristics of deepwater samples from LIC, as well as the bacterial class diversity obtained through metagenomic analysis of DNA samples purified from the LIC Deepwater samples. We also compare our data to the information obtained by another group using Long Island City Surface samples. We believe that the greater diversity of microorganisms found in the LIC Surface water is related to the dissolved oxygen (DO) and nitrate (RONO<sub>2</sub>) levels. The concentrations of pathogenic bacteria found in the water of LIC were unusual for brackish water. We posit that the pathogens must be coming from an unnatural source such as sewage and hospitals.

## Introduction

Many chemical and physical factors can influence the concentration of bacteria in a waterbody, such as levels of Salinity, Dissolved Oxygen (DO), Dissolved Carbon Dioxide (CO<sub>2</sub>), Nitrates, pH and temperature. Pollution from Combined Sewer Overflow (CSOs) and Stormwater Runoff can affect the quality of the water, adding pathogenic bacteria, nutrients, and reducing oxygen levels (DEC, 2011). The Combined Sewer System (CSS) is designed to overflow when there is an extra input of water, releasing stormwater runoff, domestic sewage, and industrial wastewater directly into water bodies ("What is Combined Sewer Overflow?" n.d.). As one of four determinants of water quality, the NYC Environmental Protection Agency considers levels of fecal coliforms and enterococci ("New York Harbor Water Quality Report," 2017). The lack of Metagenomic analysis of the bacteria in the water can allow for pathogens to go undetected, and cause health issues. The East River was determined to have abnormally high levels of pathogenic bacteria at some locations ("Bronx river/East river watershed," 2011). The Long Island City portion of the East River is considered Impaired for recreation and fish consumption, due primarily to CSO's and contaminated sediment runoff (2011). The LIC Tidal Estuary is located between two Wastewater Treatment Plants, Wards Island and Newtown Creek, in an area with a great concentration of CSO outfalls ("New York Harbor Water Quality Report," 2017). Here, we present our research into a possible source of pathogenic bacteria, the New York sewers.

## Materials and Methods

### Physical-chemical characteristics of the LIC water:

The temperature and pH of the water samples were measured at the time of collection. Tests were conducted to determine salinity, dissolved oxygen, dissolved carbon dioxide, nitrates (NO<sub>3</sub><sup>-</sup>) and presence of fecal coliform. The salinity was obtained by evaporation as well as exposing dialysis bags to different concentrations of NaCl and extrapolating from the results. Dissolved Oxygen and Carbon Dioxide levels were determined using the LaMotte Oxygen and Carbon Dioxide Titration kits. The Nitrates concentration was tested through the HACH Nitrate Test Kit. Lauryl Tryptose Broth (LTB) fermentation tubes were inoculated with 0.1mL of the water sample to indicate the presence of coliform bacteria.

### DNA isolation and Metagenomic analysis:

The DNA present in the samples was isolated using the MoBio WaterPower Kit. It was then amplified using the Polymerase Chain Reaction (PCR) or the Shotgun method. The genetic sequence was compared using the Basic Local Alignment Search Tool (BLAST).

## Results

### Waste Treatment Plants & CSOs

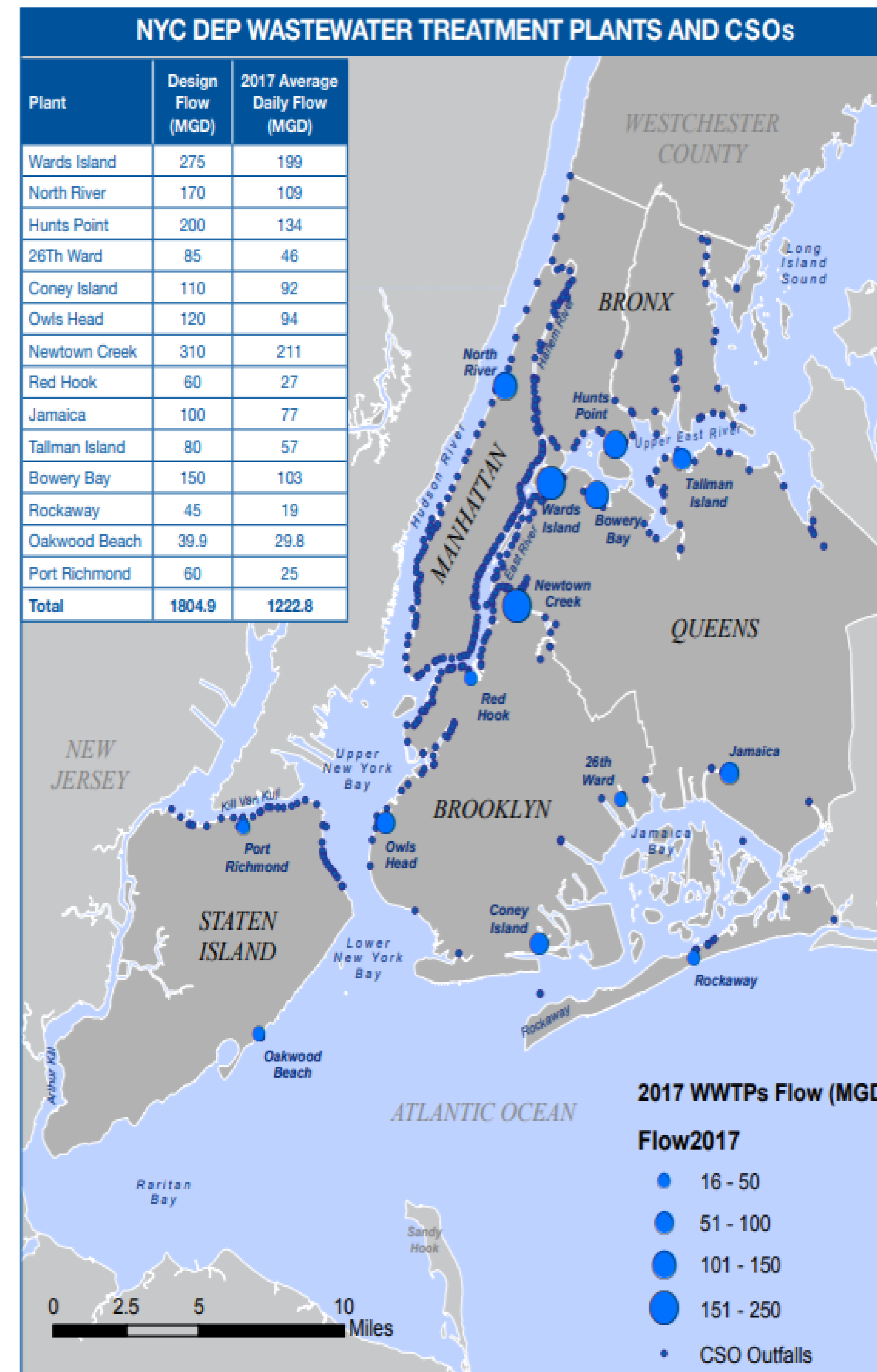


Figure 3. New York City Wastewater Treatment Plants Locations and Combined Sewer Overflow Outfalls (<https://www1.nyc.gov/assets/dep/downloads/pdf/water/nyc-waterways/harbor-water-quality-report/2017-new-york-harbor-water-quality-report.pdf>).

### Metagenomic Profile

#### Classes of Bacteria in Long Island City Surface (%)

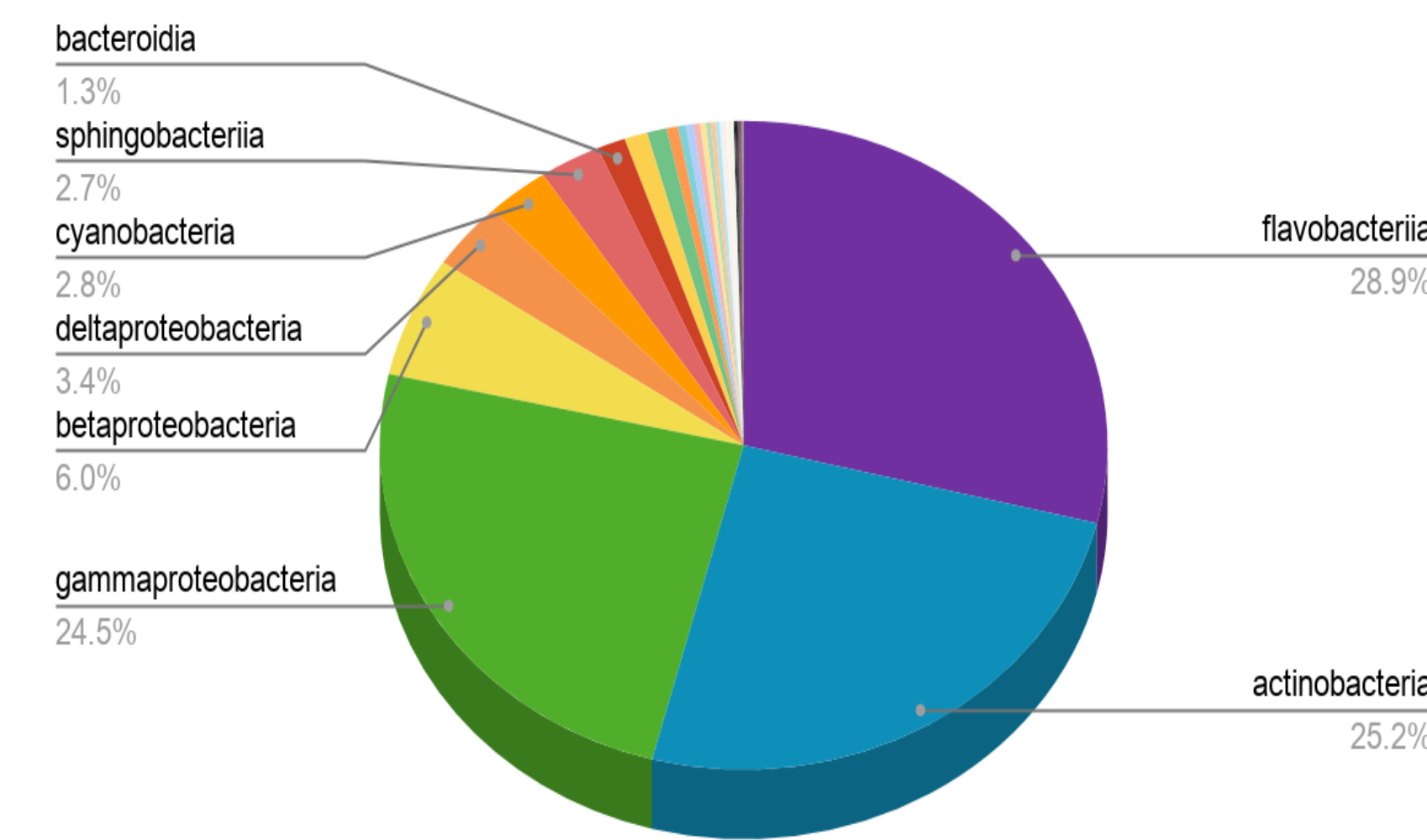


Figure 1. The Classes of Bacteria found in LIC surface of the East River from 10/02/2019 were mostly pathogenic to humans.

#### Classes of Bacteria in Long Island City Deep (%)

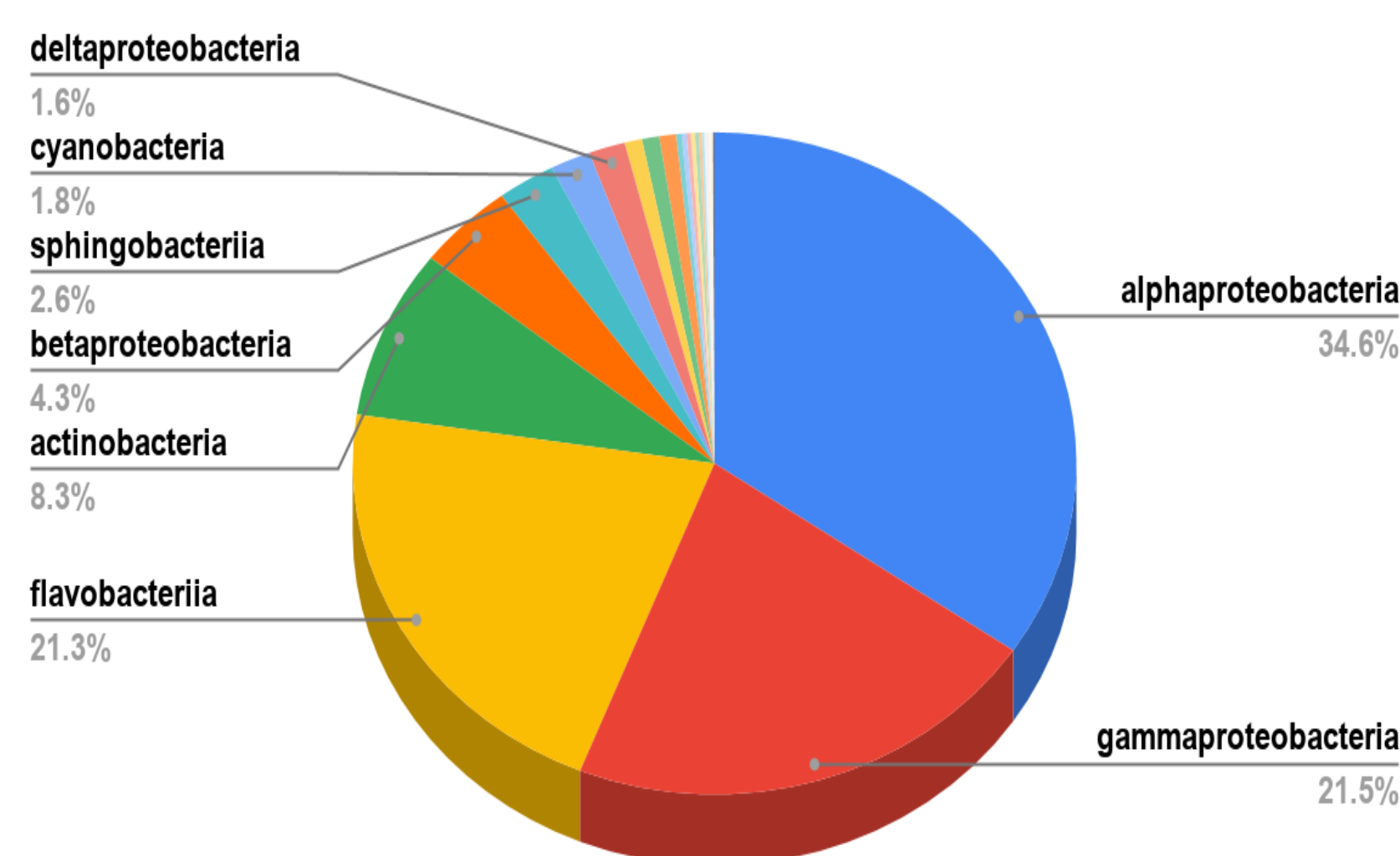


Figure 2. The Classes of Bacteria found in the LIC deep from 10/02/2019 were mostly pathogenic to humans.

## Physical and Chemical characteristics the LIC water samples

Sample	Collection Time & Date	Temperature	pH	Salinity	Dissolved O2	Dissolved CO2	Nitrate
LIC Deep	9/26/2019 at 7:50am	21.00°C	8	100,000 mg/L	-	-	-
LIC Surface	9/26/2019 at 7:55am	20.05°C	7.8	200,000 mg/L	-	-	-
LIC Deep	10/5/2019 at 1:25pm	23.00°C	7.5	-	5.4ppm	-	-
LIC Surface	10/5/2019 at 1:25pm	20.00°C	7	-	5.0ppm	-	-
LIC Deep	10/15/2019 at 7:50am	21.00°C	8	-	-	23.75mg/L	4mg/L

Table 1. Data obtained from the Samples used to determine the Salinity (tide 4.5ft), Dissolved Oxygen (tide 3.5ft), Dissolved CO<sub>2</sub> and Nitrate levels (tide 2.5ft) of LIC water.

## Discussion and conclusions

- Four out of the five bacteria most abundant in the samples are pathogenic to humans and can be transmitted through human waste, supporting the idea of sewer contamination.
- The Nitrates and Dissolved Oxygen (DO) levels were acceptable, not suggesting CSO's contamination. This can be a product of many factors, including low tide (2.5ft), the colder climate of the Fall and the salinity of the river.
- The presence of coliform and the abundance of fecal bacteria in the metagenomic profile indicate sewer contamination.
- The high concentration of CSO outfalls along in the Inner East River corroborates the idea that the pathogens must be coming from the sewer.
- The centralized distance from the two closest Sewer Treatment facilities can mean less input of treated water into LIC waters, raising pathogen concentrations.
- The study sheds light into the need for the use of metagenomic analysis in addition to the global factors (oxygen, coliforms, chlorophyll A and secci transparency) to assess the quality of a waterbody, and its importance to the health of the community of Long Island City.
- We learned how the physical and chemical properties of the water affect the microorganisms in it (biological), such as salinity affecting the osmotic equilibrium of cells.
- Our research gave us an understanding of how little is known about pathogenic bacteria in tidal straits and the need for stronger regulations.
- A possible solution for the effects of CSOs is to build more Waste Treatment Facilities, have stricter government policies put in place to regulate what goes into water bodies or expand sewer systems.

## Future work

- Collecting more data throughout the seasons to take into account more variables, such as the season, to identify with greater precision the source of pathogenic bacteria.
- Research the dumping permits of companies around the area.
- Obtain specific records of where the discharge in each of the CSO Outfall areas between the two Sewer Treatment Facilities is coming from, to find out if it is a point source.

## References

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