NEW YORK CITY DEPARTMENT OF
HEALTH AND MENTAL HYGIENE
Michelle Morse, MD, MPH
Acting Health Commissioner

Central Business District Tolling Plan Air Quality Monitoring Program Methods Overview

Summary

Since 2009, the New York City Department of Health and Mental Hygiene (DOHMH) and Queens College (CUNY) have conducted the New York City Community Air Survey (NYCCAS) to study how pollutants from traffic, buildings (boilers and furnaces) and other sources impact air quality in different neighborhoods.

The Triborough Bridge and Tunnel Authority (TBTA) has partnered with DOHMH to monitor the impact of the Central Business District Tolling Program (CBDTP) on air quality across the city and in specific environmental justice (EJ)-designated communities to fulfill reporting requirements for CBDTP. Using CBDTP funds, DOHMH has deployed additional real-time monitoring equipment and increased the frequency of sampling at some monitoring locations. Real-time data for particulate matter from the CBDTP-funded, additional equipment is published with data from other locations at https://a816-dohbesp.nyc.gov/IndicatorPublic/data-features/realtime-air-quality/.

However, because air pollution in New York City comes from a variety of sources and has strong seasonal patterns, it is essential to account for annual and seasonal trends in data and examine traffic patterns when analyzing for the impact of CBDTP on air quality. Therefore, an assessment of CBDTP on air quality will incorporate data from over one year prior to CBDTP beginning operations on January 5, 2025, and one year after, following the methodology described in this document. Findings will first be reported in 2026.

Background

This document outlines the methodology for monitoring the air quality impacts of the Central Business District Tolling Program (CBDTP) with emphasis on Environmental Justice (EJ)-designated communities with pre-existing pollutant and chronic-disease burdens identified in the CBDTP Final Environmental Assessment (EA) as having potential traffic-diversion effects. The monitoring will provide air quality data and analysis required for the statutorily mandated evaluation report as well as commitments made in the Final EA and re-evaluation. The DOHMH and its consultants have begun managing air quality data collection and analysis as an extension of the New York City Community Air Survey (NYCCAS), a neighborhood air quality surveillance network mandated by local law that has been running since 2009.

Data will be collected and analyzed for concentrations of the pollutants listed in Table 1, below. Table 1 also describes, based on DOHMH modeling analyses of NYCCAS data since 2009, the motor-vehicle sources of these pollutants that may be affected by CBDTP.

Table 1: Monitored Air Pollutants and their Sources from Motor Vehicles

Pollutant	**Source**
Fine particulate matter (PM2.5)	Brake, tire and road wear from vehicles, diesel exhaust
Nitrogen Dioxide (NO2), Nitric Oxide (NO)	Fresh vehicle exhaust
Black Carbon (BC)	Diesel exhaust (component of PM2.5)
Ozone (O3)	Absence of fresh vehicle exhaust (fresh vehicle exhaust reacts with ozone, removing it from the air) and warmer temperatures

Air pollution in New York City comes from a variety of sources which vary depending on the pollutant sampled. Most pollutants have strong seasonal patterns, either because of atmospheric chemistry and weather or because of activity patterns. For example, ozone is highest in the summer because of hotter temperatures driving reactions that form ozone in the atmosphere while nitrogen dioxide (NO2) and fine particulate matter (PM2.5) are higher in the winter due to fossil fuel combustion for indoor heating. In addition, pollution levels have been decreasing over the past decades and are expected to continue to do so as regulations reduce emissions from vehicles, power plants and buildings. For these reasons, it is essential to account for annual and seasonal trends in data and examine activity patterns when analyzing for the impact of specific interventions, such as CBDTP.

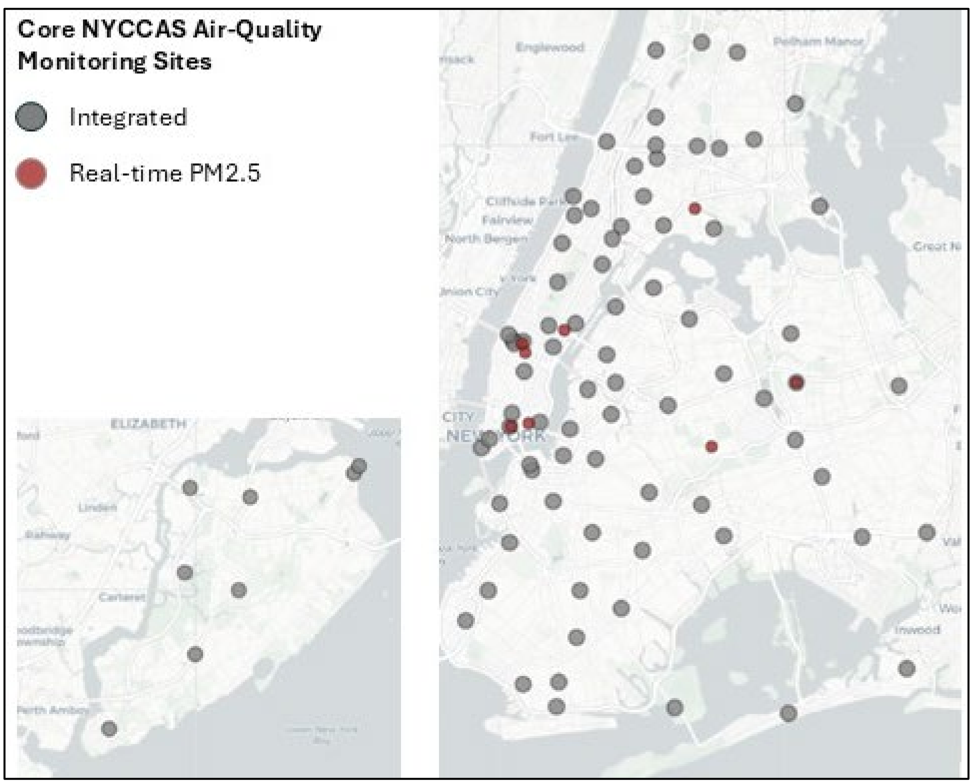
Analysis will be conducted at two geographic scales:

1. Citywide, relying on the core NYCCAS network as well as additional monitoring equipment deployed using funds from the Central Business District Tolling Program (CBDTP).
2. Six neighborhoods designated as environmental-justice communities in the CBDTP Final EA as having potential traffic-diversion effects that may result in increased localized emissions, relying on monitoring equipment deployed using funds from the CBDTP as well as additional sampling conducted at existing NYCCAS sites using funds from the CBDTP.

Citywide Air Quality Monitoring

The core of the NYCCAS monitoring network is a network of research-grade integrated sampling units that are deployed for two weeks once per season (December through mid-March for winter, mid-March through early June for spring, early June through late August for summer, and September through November for fall) at each of 84 sites across NYC neighborhoods. These units provide seasonal averages of the pollutants listed in Table 1 except ozone which is only monitored in the summer. These core data are presented in the NYCCAS annual report (https://nyccas.cityofnewyork.us/report) through which the DOHMH has reported on neighborhood air quality and the factors that drive it since 2009. The strategy of capturing snapshots of pollution levels seasonally provides high quality data from all the pollutants of interest but do not describe hourly or daily pollution patterns. The core NYCCAS project includes a smaller network of eight real-time PM2.5 monitors that provide insight into time-of-day pollution patterns related to traffic activity. These are sited in locations that have the best chance of capturing changes in PM2.5 resulting from changes in traffic. Field-deployable research quality continuous sensors have been available for PM2.5 for some time, for BC only recently and are not available for NO, NO2 and O3. Figure 1 is a map of all core NYCCAS sites, both integrated (gray dots) and real-time (red dots).

Figure 1. Core NYCCAS monitoring integrated (gray dots) and real-time PM2.5 (red dots) monitors; see Figure 2 for additional real-time sites installed using CBDTP funds and integrated monitoring sites where additional sampling is occurring with CBDTP funds.



Using data from the core integrated and real-time networks, the NYCCAS team will evaluate the impact of the CBDTP on **citywide** air quality using a methodology similar to that used to evaluate the impacts of NY Pause (Pitiranggon, et al. 2022). In that study, the difference-in-difference (DiD) method was employed to separate seasonal and long-term trends in PM2.5 and NO2 concentrations from the effect of the COVID-19 shutdown in NYC. Briefly, DiD is a causal inference method that is used to evaluate the effect of an intervention by comparing changes in an outcome over time between a group that was exposed to the intervention (intervention group) and one that was not (control group). A key component of the DiD study design is that the control group experiences the same non-intervention-related trends as the intervention group, thereby making it possible to isolate the effect of the intervention. We implemented the DiD approach in regression modeling, where the effect of intervention is estimated by the interaction between the time variable (pre- or post-intervention) and treatment group indicator (intervention or control). For the CBDTP citywide impact evaluation, we plan to use data from the season immediately before go-live and the season immediately after go-live as the intervention group. The control group data will be taken from the same two seasons of the prior year. The difference in the change between the two seasons with the introduction of CBDTP and the change between the same two seasons without the introduction of CBDTP will provide the basis for evaluating the impact of CBDTP on citywide air quality.

Any observed changes in pollution levels cannot be attributed to the CBDTP unless there is evidence of changes in traffic. Therefore, temporal patterns in data from real-time PM2.5 monitors will be compared to data from traffic sensors using correlation to provide insight as to whether the changes in air pollution may be related to changes in traffic occurring after implementation of the Program. TBTA, NYCDOT, and NYSDOT analyses of traffic volume and vehicle class patterns from the CBDTP tolling equipment and short counts on highways will be used to identify CBDTP-related traffic changes post go-live. Where real-time traffic data are available, we will make comparisons of time-of-day and weekday/weekend patterns. Where only short-counts are available, we'll aggregate the pollution data on the same time-scale for comparison. These will be correlative not causal analyses.

Site-Specific Monitoring in Select EJ-Designated Neighborhoods

In addition to evaluating the effects of CBDTP on citywide air quality, DOHMH was asked to develop a strategy that would evaluate changes in air quality attributable to the CBDTP for each of 6 EJ-designated communities surrounding key highway segments listed below (monitoring site names in parentheses, see Appendix A for specific locations and cross-streets). These segments were identified by TBTA following the publication of the Final Environmental Assessment. Each of the highway segments listed below has a core integrated NYCCAS within the adjacent EJ-designated community which is sampled once per season; however, more frequent (monthly) monitoring is required to draw conclusions about neighborhood impacts of the CBDTP for each of the individual highway segments. The addition of real-time PM2.5 monitors at locations closer to the highways themselves will allow for robust correlation analyses of changes in traffic and PM2.5 patterns. Real-time BC monitors placed alongside the integrated monitors will capture potential changes in diesel truck traffic in the neighborhoods surrounding the road segments. See Figure 2 for the locations of the monitoring supported by TBTA, also available as an interactive map. One existing NYCCAS site near the Van Wyck

Expressway, where traffic is not expected to change due to the CBDTP, was chosen as a control site.

1. The Trans-Manhattan Expressway between the George Washington Bridge and the Alexander Hamilton Bridge (Hamilton Bridge);
2. The full Cross-Bronx Expressway (Cross Bronx Expy);
3. The Franklin Delano Roosevelt Drive between E. 10th St. and the Manhattan Bridge (FDR);
4. The Robert F. Kennedy Bridge and connecting links in the Bronx, Manhattan, and Queens (Mott Haven);
5. The Brooklyn-Queens Expressway between Metropolitan Ave. and DUMBO (BQE);
6. The Staten Island Expressway and connections to the Bayonne Bridge (SI Expwy).
7. Control site (Van Wyck)

Figure 2. Locations of CBDTP-funded monitoring. Blue dots are integrated and real-time BC sites while yellow dots are real-time PM2.5 sites.

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Analysis Strategy for Integrated Sampling Data

Once monitoring data is received by DOHMH from Queens College through our established protocols, we will review to identify data quality issues and work with Queens College team to address any issues immediately. Data review will include completeness and an assessment of the CBDTP data alongside core NYCCAS data by pollutant to ensure that data from the CBDTP sites are consistent with previous and current trends. With any monitoring campaign, there is the possibility of equipment failure and human error resulting in missing data. We will work with Queens College to minimize missing data and assess any impact on planned analyses. The existence of historical data at all these locations along with real time data allow us to impute missing data for the analyses.

The formal evaluation analysis will use interrupted time series analysis (ITS) to estimate the magnitude of change in PM2.5, BC, NO and NO2 due to CBDTP and at each of the six sites in EJ-designated communities (intervention effect). This involves comparing annual trends before and after go-live between the control site and each of the CBDTP-funded sites. The Van Wyck Expressway was chosen as a control site because it is a roadway not anticipated to experience changes in traffic due to CBDTP, thus any changes in traffic patterns on air pollution on the Van Wyck will be taken to represent secular trends that are not included in the calculation of expected pollution levels in the absence of the CBDTP (counterfactual) at the other sites. We will use a CEQR-based threshold to determine whether a statistically significant intervention effect reaches the level of an "adverse effect."[1] An adverse effect occurs when the increase in annual average pollution that we can attribute to CBDTP (the intervention effect) at each site exceeds half the difference between annual average baseline at the same site and the National Ambient Air Quality Standard for annual average of the pollutant (https://www.epa.gov/criteria-air-pollutants/naaqs-table). For illustrative purposes, see examples of findings of no effect of an intervention (Figure 3) and a negative effect (reduction of pollution) of an intervention (Figure 4). We will be relying on TBTA and NYC DOT analyses of traffic volume and vehicle class patterns to identify CBDTP-related traffic changes post go-live. Any observed changes in pollution levels cannot be attributed to the CBDTP unless there is evidence of changes in traffic in the TBTA/NYCDOT traffic analysis results.

ITS analysis requires 8-12 data points before and 8-12 after intervention for a robust estimate of intervention effects therefore formal analysis of CBDTP impacts on air pollution at

[1] Here, statistical significance is determined through regression analysis of pollutant-concentration readings before and after CBDTP go-live. DOHMH will fit a model to the pollutant-concentration readings that includes a "dummy" or "indicator" variable for "pre-intervention" (before CBDTP go-live) or "post-intervention" (after CBDTP go-live). The effect of CBDTP will be determined to be significant if the p value for the indicator variable term is less than 0.05.

each of the EJ-designated sites will be performed after one year of monthly integrated samples have been collected following CBDTP go-live.

Figure 3. Example of findings of no effect of an intervention.

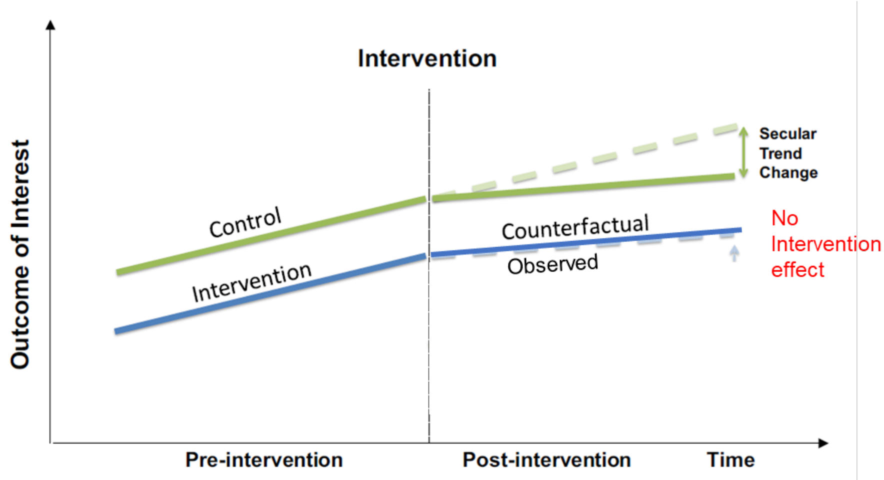
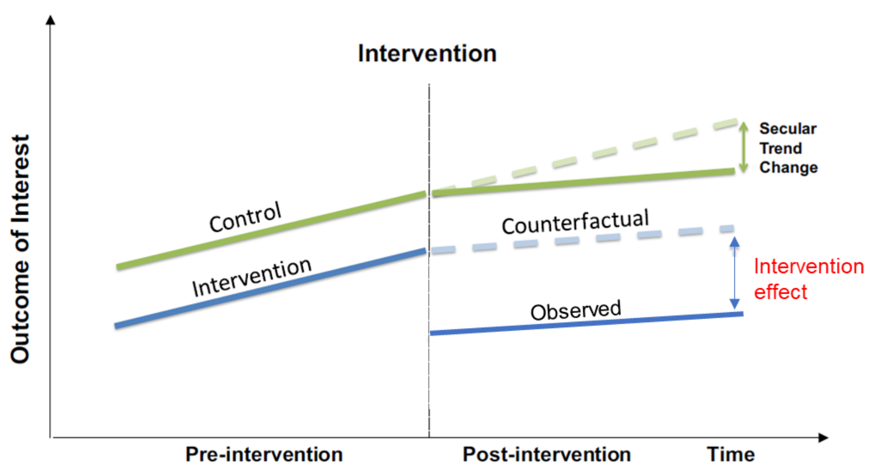


Figure 4. Example of negative effect (reduction of pollution) of an intervention.



Analysis Strategy for Real-time Sampling Data

One real-time PM2.5 and one real-time BC monitor at each of seven aforementioned sites will allow for the evaluation of changes in diurnal patterns of air pollution, additional data to support imputation of missing data at the integrated monitoring sites, and public facing data feeds. Temporal patterns in data from real-time monitors at the sites in the EJ-designated communities will be compared to the Van Wyck control data to assess for consistency of patterns and identify outliers through visual inspection of plotted data.

As with the citywide analysis, any observed changes in pollution levels cannot be attributed to the CBDTP unless there is evidence of changes in traffic. Therefore, temporal patterns in data from real-time PM2.5 monitors will be compared to data from traffic sensors using correlation to provide insight as to whether the changes in air pollution may be related to changes in traffic occurring after implementation of the Program. TBTA, NYCDOT, and NYSDOT analyses of traffic volume and vehicle class patterns from the CBDTP tolling equipment and short counts on highways will be used to identify CBDTP-related traffic changes post go-live. Where real-time traffic data are available, we will make comparisons of time-of-day and weekday/weekend patterns. Where only short-counts are available, we'll aggregate the pollution data on the same time-scale for comparison. These will be correlative not causal analyses.

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Appendix A

Table A-1. Real Time BC Monitoring Locations

Monitoring Location	Latitude	Longitude	Street Segment
SI Expwy	40.627925	-74.145883	East side of Willow Rd W between St. Adalbert Pl S and Dixon Ave
BQE	40.702929	-73.964861	North side of Ross St between Kent Ave and Wythe Ave
Van Wyck	40.693873	-73.807525	North side of Liberty Ave on NE corner of Brisbin St
FDR	40.718787	-73.979475	West side of Columbia St between E Houston St and Stanton St.
Hamilton Bridge	40.849181	-73.937962	North side of W 179th St between Broadway and Fort Washington Ave
Cross Bronx Expwy	40.847658	-73.908112	West side of Grand Concourse between E 176th St and Morris Ave
Mott Haven	40.809549	-73.928962	East side of Third Ave between E 136th St and E 135th St

Table A-2. Real Time PM2.5 Monitoring Locations

Monitoring Location	Latitude	Longitude	Street Segment
SI Expwy	40.609209	-74.151182	South side of Victory Blvd between Gannon Ave S and I-278 (in front of staging area)

BQE	40.702798	-73.960824	West side of Williamsburg St W between Bedford Ave and Wythe Ave
Van Wyck	40.690155	-73.809080	Northbound Van Wyck Expressway access road between 106th Ave and 142nd St
FDR	40.722288	-73.974651	Southbound FDR access Road between E 10th St and E 6th St
Hamilton Bridge	40.846544	-73.933023	North side of W 178th St between Audubon Ave and Amsterdam Ave
Cross Bronx Expwy	40.845170	-73.906100	North side Cross Bronx Expressway Service road between Monroe and Topping
Mott Haven	40.806486	-73.922487	North side of E 135th St between Brown Pl and Willis Ave

Table A-3. Integrated Monitoring Locations

Monitoring Location	Latitude	Longitude	Street Segment
SI Expwy	40.627484	-74.144312	South side of Dixon Avenue, first post west of Trantor
BQE	40.702929	-73.964861	North side of Ross St between Kent Ave and Wythe Ave
Van Wyck	40.693079	-73.805665	105-13 Princeton Avenue
FDR	40.718522	-73.979379	SE Corner of Columbia St and Stanton St
Hamilton Bridge	40.849181	-73.937962	North side of W 179th St between

			Broadway and Fort Washington Ave
Cross Bronx Expwy	40.847658	-73.908112	SB Grand Concourse between E 176th St. and Morris Ave
Mott Haven	40.809549	-73.928962	East side of Third Ave between E 136th St and E 135th St

Table A-4. Traffic Count Locations Corresponding to Air-Quality Monitoring Locations

Corresponding Monitoring Location (see Tables Above)	Latitude	Longitude	NYSDOT Count Site ID, Location Description
SI Expwy	40.607717	-74.087303	060020 (aka, 06S000000001), I-278 from Richmond Rd, Hyland Blvd Exit to Lilypond Ave/S Beach Bay St (aka MTA Site I)
	40.629490	-74.145540	060016 (aka, 06S000000002), NY440 from Forest Ave Exit to New Jersey State Line (aka, MTA Site J)
BQE	40.705484	-73.958869	020020 (aka 02S000001), I-278 from Flushing Ave (Underpass) to Exit 32 Williamsburg Bridge (aka MTA Site D)
Van Wyck	40.68398	-73.80617	050067 (aka 05S000002), I-678 from Rockaway Blvd Over to 9th Ave Overpass (aka MTA Site H)

Corresponding Monitoring Location (see Tables Above)	Latitude	Longitude	NYSDOT Count Site ID, Location Description
FDR	40.72012	-73.97469	040902 (aka, 04S000000002), 907L from E Houston St to ACC E 23rd St, (aka, MTA Site B)
	40.711028	-73.980526	04S000001, FDR Dr between Jackson St and Cherry St (aka MTA Site A)
	40.70962	-73.992948	04S000004, FDR Dr btw Market Slip and Manhattan Bridge (aka MTA Site F)
Hamilton Bridge	40.847295	-73.934029	040003 (aka 04S000000003), I-95 from End 1/9/95I OLAP Start 1/95I to Audubon Ave Overpass (aka MTA Site E)
Cross Bronx Expwy	40.825106	-73.825999	0191, 239 Ft West of Jerome Avenue (Note: Continuous count station)
Mott Haven	40.809107	-73.928794	010021 (aka 01S000001), I-87 from Willis Ave (Overpass) to ACC East 138th St (aka MTA Site C)