Amended Environmental Assessment of Proposed NYC Simulant Particle Releases for the Viral Phenomenology Program

Prepared for the Department of Homeland Security Science and Technology Directorate

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Version 5

EXECUTIVE SUMMARY

There is currently a lack of measurable evidence regarding the exposure risk of the SARS-CoV-2 virus on public transportation as well as what actions can be taken to effectively reduce its spread. In order to collect this evidence, the Department of Homeland Security's Science & Technology (DHS S&T) Directorate proposes to release and measure safe simulant materials designed to mimic the spreading of the SARS-CoV-2 virus in respiratory secretions (e.g., droplets and aerosolized particles) in mass transit environments (e.g., subway car or bus). The ultimate goal of these tests is to provide transit authorities with actionable evidence to ensure passenger and worker health and safety. The tests and measurements would also aid in modeling the spread of the SARS-CoV-2 virus within mass transit environments, as well as describe the effectiveness of mitigation methods.

This Environmental Assessment (EA) documents the analysis of potential effects on the environment resulting from the Proposed Action. This EA is being coordinated with stakeholders and the public for information and comment, in accordance with the National Environmental Policy Act (NEPA) of 1969 as outlined in 40 CFR Parts 1500-1508 and DHS Directive 023-01, Rev. 01 and DHS Instruction Manual 023-01-001-01, Rev.01, implementing NEPA. Recent changes to the Council on Environmental Quality (CEQ)_ regulations implementing NEPA (40 CFR Parts 1500-1508) became effective on September 14, 2020. As stated in 40 CFR Part 1506.13, the new regulatory changes apply to any NEPA process begun after September 14, 2020. This EA substantively commenced prior to that date; therefore, this EA conforms to the CEQ NEPA implementing regulations that were in place prior to September 14, 2020. A Finding of No Significant Impact (FONSI) was published on January 21, 2021. This EA is amended to encompass additional follow-on test activities which have been determined to be consistent with prior analysis.

The Proposed Action would be conducted in areas in which passengers and the public are not present. Tests involve the release of a liquid/particulate aerosol simulant and would provide highly specific and/or real-time results. There would be up to four simulant releases per day over an approximately 7-day window at several different discrete mass transit sites. Releases would be conducted either as a short burst release (i.e., to mimic a cough or sneeze), or dispersed over approximately one minute (i.e., to mimic normal breathing). Different types of mass transit environments (e.g., a subway car or bus) may be evaluated. The preferred liquid/particulate alternative (P1) was considered in this EA. Alternative P1 consists of aerosolized water containing salt, glycerol, and/or Optical Brightener (OB) 220 as well as sub-micron amorphous silica particles coated with non-coding deoxyribonucleic acid (DNA) oligos (Silica-DNA). Alternative P1 meets the purpose and need of the Proposed Action and was selected based on the safety of the materials, the ease of material production and prior experience with similar materials. The No Action Alternative (P2) would not result in testing and measuring the simulated spread of SARS-CoV-2 in mass transit environments or identify potential mitigation measures and therefore does not meet the purpose and need of the Proposed Action.

The simulant materials will be aerosolized in droplet sizes that are respirable. As a result, existing airborne exposure limits were considered regarding the usage of Alternative P1 (Silica-DNA). The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have both established 8-hour exposure limits for workers in occupational settings for a range of materials. Guidelines set by the Environmental Protection Agency (EPA) have also been established to protect public health, including the health of sensitive immune-compromised populations. There would be no anticipated adverse effects to the public from any of the simulant materials being released since the materials at testing levels are safe and testing sites are not accessible to the public. No appreciable risk to passengers, residents of New York City (NYC) or the greater regional area, tourists, transit workers, or field test personnel would occur. The Proposed Action and preferred Alternative are shown to be well within all established exposure limits set by OSHA and the EPA, including those exposure limits developed to protect public health, including that of health-compromised sensitive populations.

Due to the selection of preferred test materials, the limited quantity of materials to be released, the confined nature of the test environment, which would not be accessible during testing to the public, and the temporary nature of the Proposed Action, no effects are anticipated on noise, hazardous materials, water resources, vegetation, or land use and infrastructure. Negligible effects are anticipated on biological resources, cultural resources and historic properties, environmental justice communities, and air quality. A beneficial impact on public health and safety is anticipated as the results of the Proposed Action would increase the understanding of how the SARS-CoV-2 virus spreads. There would be no anticipated cumulative effects as a result of the Proposed Action, or Preferred Alternative, when considered in context with other recent past, present and reasonably foreseeable future actions.

A FONSI was published on January 21, 2021. This amended EA and FONSI are being published to encompass additional follow-on test activities which have been determined to be consistent with prior analysis. For this reason, no additional analysis will be conducted.

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ACGIH – American Conference of Governmental Industrial Hygienists
ANL – Argonne National Laboratory
ARPA - Archaeological Resources Protection Act
APS – Aerodynamic Particle Sizer
ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Engineers
BGEPA - Bald and Golden Eagle Protection Act
BGM – Below Ground Model
CAS – Chemical Abstracts Service
CDC – Centers for Disease Control and Prevention
CEQ – Council on Environmental Quality
CERCLA - Comprehensible Environmental Response, Compensation, and Liability Act
CFR – Code of Federal Regulations
COPD – Chronic Bronchitis/Chronic Obstructive Pulmonary Disease
COVID-19 – Coronavirus Disease 2019
CT – Census Tract
DFU – Dry Filter Unit
DHS S&T – Department of Homeland Security Science & Technology
DNA – Deoxyribonucleic Acid
DNATrax – DNA Tagged Reagents for Aerosol Experiments
EA – Environmental Assessment
EC_0 – No-Effect Concentration
EC_{50} – 50% of Maximal Effect Observed
EJSCREEN – Environmental Justice Screening Tool
EPA – Environmental Protection Agency
ESA – Endangered Species Act
ETAD – Ecological & Toxicological Association of Dyes & Organic Pigments Manufacturers
FDA – Food & Drug Administration
FIOH – Finish Institute for Occupational Health
GRAS – Generally Recognized As Safe
HVAC – Heating, Ventilation & Air Conditioning
IBAC – Instantaneous Biological Analyzer and Collector
MBTA – Massachusetts Bay Transportation Authority
MBTA – Migratory Bird Treaty Act
MIT LL – Massachusetts Institute of Technology Lincoln Laboratory
MMAD – Mass Median Aerodynamic Diameter
MTA – Metropolitan Transportation Authority
NAAQS – National Ambient Air Quality Standards
NAGPRA - Native American Graves Protection and Repatriation Act
NEPA – National Environmental Policy Act
NHPA – National Historic Preservation Act
NRHP – National Register of Historic Places

NYC – New York City
NYCCAS – New York City Community Air Survey
NYCT – New York City Transit
NYDEC – New York City Department of Environmental Conservation
NYSHPO – New York State Historic Preservation Office
OB – Optical Brightener
OSHA – Occupational Safety and Health Administration
PCR – Polymerase Chain Reaction
PEL – Permissible Exposure Limit
PM_{10} – Particulate Matter under 10 microns
PM_5 – Particulate Matter under 5 microns
$PM_{2.5}$ – Particulate Matter under 2.5 microns
PNOS – Particle Not Otherwise Specified
PPE – Personal Protective Equipment
PPL – Particles Per Liter of Air
PSU – Portable Sampling Unit
RCRA – Resource Conservation and Recovery Act
SARS-CoV-2 – Severe Acute Respiratory Syndrome Coronavirus 2
SAS – Synthetic Amorphous Silica
SDS – Safety Data Sheet
SPCC – Spill, Prevention, Control, and Countermeasures
TLV – Threshold Limit Value
TSP – Total Suspended Particulates
TWA – Time Weighted Average
USFWS – U.S. Fish and Wildlife Service
UTR – Underground Transportation Restoration
WMATA – Washington Metropolitan Area Transit Authority

Section 1. Purpose and Need of the Proposed Action

Since the beginning of the SARS-CoV-2 virus (i.e., COVID-19, Coronavirus Disease 2019) pandemic, there has been a clear need to understand the exposure risk of the virus on public transportation as well as what mitigation actions can be taken to effectively reduce spread. A significant amount of research is underway to understand how the virus spreads and infection rates within enclosed environments, but there have been conflicting articles in the popular press and scientific literature regarding the safety of public transport.[1,2,3,4,5] While there have been modeling efforts to measure the risk of exposure in mass transit environments such as planes and buses as well as retrospective epidemiological studies, there is limited quantitative data to support these studies. Measured data of how a safe simulant of the virus spreads in such environments, as well as how mitigation factors reduce the spread, will help provide transit authorities with measurable, actionable evidence to ensure the safety of their ridership and employees.

DHS S&T proposes to test and measure the spread of a safe simulant that mimics the SARS-CoV-2 virus in mass transit environments. This test is being conducted in partnership with the New York City Metropolitan Transportation Authority (NYC MTA). The testing consists of dispersing a viral simulant in a manner that mimics a human breathing normally or coughing or sneezing. These trials would take place on at least two mass transit vehicles, including a bus and subway car. The test environments would not be accessible to the public during testing. For each location, different mitigation factors would be investigated, including window operation, door operation, modifying heating, ventilation and air conditioning (HVAC) settings, modifying air filter types, and wearing masks. The air and surfaces inside the environments would be investigated to determine simulant concentration and droplet/particle sizes. Filters from HVAC systems would be retrieved and analyzed as well. Samples would be collected from study personnel (for example, cloth coupons, personal air sampler filters, skin wipes, nose filters, face masks) to illustrate exposure levels to people in the environment. The initial study took place over approximately 7 days in February 2021. Additional follow-on test activities which have been determined to be consistent with prior analysis are planned. Test duration is expected to be similar to initial activities (approximately 7 days).

Section 2. Test Alternatives to Meet the Purpose and Need

This section discusses the range of reasonable alternatives to meet the purpose and need of the Proposed Action. The analysis of the alternatives is in accordance with the National Environmental Policy Act (NEPA) of 1969 as outlined in 40 CFR (Code of Federal Regulations) Parts 1500-1508 and DHS Directive 023-01, Rev. 01 and DHS Instruction Manual 023-01-001-01, Rev.01, implementing NEPA. Recent changes to the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 CFR Parts 1500-1508) became effective on September 14, 2020. As stated in 40 CFR Part 1506.13, the new regulatory changes apply to any NEPA process begun after September 14, 2020. This EA substantively commenced prior to that date; therefore, this EA conforms to the CEQ NEPA implementing regulations that were in place prior to September 14, 2020.

2.1 Simulant Testing Location and Liquid/Particulate Simulant (Preferred Alternative)

The Proposed Action would require both a location to perform testing as well as the use of a particulate to simulate SARS-CoV-2. The Action Alternative includes these two components and is further discussed below.

2.1.1 Testing Location

Testing is planned in prioritized MTA buses and/or subway cars in order to understand viral exposure risks in public transit. Specific simulant release locations would be selected based on discussions with MTA to fulfill the key goals of the Proposed Action. Proposed test sites include MTA buses (potentially several different models) and subway cars. The bus(es) or subway car(s) being tested would not be used for customer service during testing and would be operated in an area determined by MTA that is not accessible to the public. Limited personnel supporting the test will be present on the bus or subway car during testing and would thus come into contact with the released materials. Depending on the specific mitigation being tested, the vehicles may be stationary or in motion. For example, testing the efficacy of a particular filter type at removing particulates from the air may not require the vehicle to be moving, but testing the efficacy of opening windows would require vehicle motion to generate air flow. The specific route to be driven by the vehicles during testing will be determined in coordination with MTA to ensure that the vehicle is not accessible to the public.

In cases where testing is specifically evaluating the effectiveness of door or window opening on reducing particle concentrations, there is a small potential for simulant material to disperse from the test vehicle to the environment. However, as discussed below, the simulant release amounts would be very low and are well within existing exposure limit guidelines, even within the enclosed test environment. Rapid reduction in concentration would be expected outdoors, resulting in minimal to no exposure risk to anyone in the near vicinity of the test.

Initial testing occurred in NYC in February 2021, and additional follow-on test activities which have been determined to be consistent with prior analysis are planned. As shown in TABLE 1, the proposed test schedule will involve up to four simulant releases per day over an approximately 7-day window at several different discrete mass transit sites. At least two enclosed mass transit environments (e.g., a subway car or bus) would be evaluated. For each test environment, one day would be dedicated to set up sensors and other test equipment. On testing days, each day would begin by collecting baseline aerosol and surface particle measurements of the environment. The four consecutive release events (separated by approximately 2 hours) could include the dissemination of a simulant with an output speed and release duration that mimics, for example, a person breathing, coughing, or sneezing. The simulant would consist of sub-micron particles (i.e., amorphous silica (P1)) associated with short, non-coding DNA barcodes, suspended in a solution with similar thickness and salinity as respiratory secretions. The liquid may contain a fluorescent dye. The simulant would be released in several defined droplet size distributions: for example small droplets ~5 μm and large droplets ~40-50 μm. For each trial, the simulant particles would be tagged with unique barcodes that discriminate between small and large droplets. Dfferent release events will also consist of unique barcodes, enabling further discrimination by test. Additional follow-on test activities will stay within the initial scope outlined in this EA, and will encompass a smaller subset of test conditions.

In general, the quantities of simulant materials being released would be very small. Likely quantities of liquid and particulates to be used in each release event are described in TABLE 2. Each release event would involve several hundred microliters (μl) of liquid, with aerosolized droplets representing both small and large size distributions and containing between 10-1000 simulant particles per droplet. Each release event corresponds to a total release mass of 285 micrograms (μg) of amorphous silica particles. The simulant release quantities are discussed in more detail in the following sections.

TABLE 1. Example Test Schedule for Simulant Releases

Location 1 *for example: bus*				Location 2 *for example: subway car*		
Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Equipment setup	Release*	Release	Release	Equipment setup	Release	Release
	Release + Mitigation**	Release + Mitigation	Release + Mitigation		Release + Mitigation	Release + Mitigation
	Release + Mitigation	Release + Mitigation	Release + Mitigation		Release + Mitigation	Release + Mitigation
	Release + Mitigation	Release + Mitigation	Release + Mitigation		Release + Mitigation	Release + Mitigation

** Simulant release method would be dispersed to mimic normal breathing, talking, coughing, singing or sneezing.*
*** Mitigation methods may include open windows, increased time or frequency of door opening, altered HVAC operation, etc. Each release trial includes a clean-up period after the dispersion test.*

TABLE 2. Likely Parameters for Each Liquid/Particulate Simulant Release Event

Droplet size (diameter)*	Simulant particles per droplet	Volume of liquid released¥	Mass of silica particles** released
5 μm	10	100 μl	259 μg
50 μm	1000	100 μl	26 μg

** The precise droplet sizes and liquid release volumes are subject to change slightly. Two representative "small" and "large" target droplet sizes are shown here. It is anticipated that the silica mass will remain constant even if droplet size or volume changes slightly (by modifying the number of simulant particles per droplet).*

*** Assuming a density for amorphous silica of 2 g/cm^3*

¥ There may be up to four release events per day

Distribution of the simulant materials could occur as a short burst release or would be spread out over a period of approximately one minute. The maximum amounts of particulate simulant material released at a particular location over fifteen minutes and 8 hours are 285 micrograms (for a single release event) and 1140 micrograms (for the maximum of four releases in an 8-hour period), respectively. The particulate release amount has been chosen because it provides enough simulant material for sampling measurements to take place within the planned time and distance scales, while remaining within regulatory guidelines and not substantially affecting air quality (see Section 3.1.5 and 3.1.6). Aerosol droplet sizes from a cough, sneeze or talking vary by a wide distribution ranging from sub-micron to hundreds of microns. It is not practical to generate this range with a single aerosol generator. A combination of two devices will be used to generate an aerosolized form of the liquid simulant material in two different size ranges, ~5 μm and ~40-50 μm. In addition, an aerosol holding chamber would be utilized to allow a buildup of aerosol before being released. This method will allow either short bursts or as a slow continual release. The aerosol devices are shown in Figure 1, and include a nebulizer (~5 μm) and a droplet generator (~40-50 μm).

Figure 1. Photographs of possible liquid/particulate simulant release devices. A combination of a nebulizer (left) and a droplet generator (right) would be used to generate small and large droplet size distributions. During the study, release devices may be linked together with small holding chambers and source of compressed air to generate a specific release velocity.

The samples to measure the concentration and particle/droplet size of the simulant in the air over time would be collected over a period of 1-2 hours, and provided for laboratory analyses. Air sampling units that may be used include portable sampling units (PSU), dry filter units (DFU), personal air samplers (PAS), and/or cascade impactors. Examples of measurement equipment are shown in Figure 2. Filters would then be analyzed in the laboratory for the presence of simulant using polymerase chain reaction (PCR). Real-time aerosol concentration measurements may also be obtained from devices such as the Instantaneous Biological Analyzer and Collector (IBAC) sensor and Aerodynamic Particle Sizer (APS) particle counters, which use elastic scattering for particle counting and sizing. Additionally, particulate surface deposition measurements would be made by collecting samples using gauze wipes on specified locations (either native surfaces or pre-placed coupons) within the test environment. Coupons may be laid out before the trial on surfaces at select locations inside and around the environment, then retrieved after each trial. If available, filters from the HVAC system may be evaluated as well.

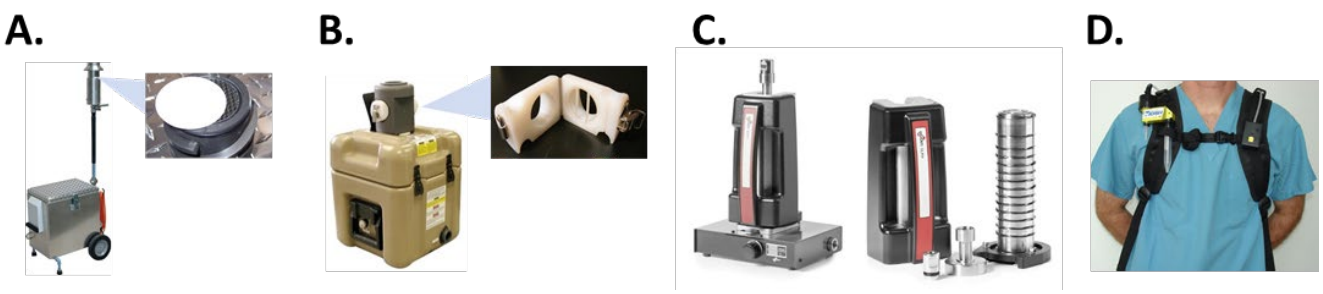

Figure 2. Photographs of particle simulant measurement equipment. (A) A Portable Sampling Unit (PSU). (B) A Dry Filter Unit (DFU). Inserts show the filter housings in both cases. (C) An assembled DLPI+ cascade impactor (left) and disassembled unit showing 14 stages (right). (D) A personal BC 251 cyclone sampler.

Most equipment would be located within the test vehicle, which would not be accessible to the public. Some measurements may be collected immediately outside the vehicle (for example on a subway platform just outside the doors). It is anticipated that these measurement locations would also not be accessible to the public. No permanent physical changes would take place to locations from the use of the measurement equipment.

The three trials that follow the simulant-only trial would include measures such as opening windows, or increasing the time or frequency that doors are open, or changing HVAC filter types. Note that these tests would likely result in the release of smaller amounts of simulant material than assumed in normal situations (i.e. baseline). However, this EA assumes baseline conditions in the following resource analysis.

Thorough cleaning of the environment, consistent with Centers for Disease Control and Prevention (CDC) guidelines, would occur between each trial, and airborne particle concentrations would be evaluated in real-time. When the measured concentration has returned to baseline levels, the next trial may continue.

Simulant testing would allow DHS S&T to meet the purpose and need of the Proposed Action and is therefore the preferred alternative.

2.1.2 Liquid/Particulate Simulant (P1)

Simulant Alternative P1 (Silica-DNA) would consist of aerosolizing water droplets containing some or all of the following components: (1) salt, (2) glycerol, (3) Optical Brightener (OB) 220, (4) commercially-available amorphous silica particles between 100-1000 nm in diameter that may be streptavidin- or avidin-functionalized, and (5) non-coding DNA oligos that may be biotinylated.

From the perspective of evaluating the safety of these materials, it is important to note that no specific regulatory limits exist that are applicable to exposure of the public to these materials. However, a variety of relevant guidelines and regulations do exist regarding occupational exposure over an 8-hour work day (i.e., set by OSHA and other international occupational safety organizations), environmental air pollution (i.e., set by the EPA), minimum concentrations resulting in observed health impacts (i.e., set by the ACGIH), and ingestion (i.e., set by the Food and Drug Administration (FDA)). These guidelines and regulatory limits were assessed for comparison purposes in order to contextualize the relative safety and risk of using these materials in the described amounts. More details are provided below.

In general, each individual component of Alternative P1 is non-hazardous. Salt (sodium chloride), glycerol (i.e., glycerin), and biotin (Vitamin B7) are all classified by the FDA as "Generally Recognized As Safe" (GRAS) and are common components in many food products[6]. The OB 220 is used in several consumer products such as laundry detergent and paper production. Amorphous silica, the primary component of the particles in Alternative P1, is used as an anti-caking agent and a carrier for liquid active ingredients in human and animal nutrition. The DNA oligos are short (~200 bp) sequences that are designed to not encode for a functional product. Short non-coding DNA sequences have been safely used previously in other tracer particles such as DNATrax (DNA Tagged Reagents for Aerosol Experiments)[7]. DNATrax was initially developed for food safety tracing and has also been used in open-air tracer testing. DNA sequences are common in the environment and are produced by all living matter. DNATrax has been classified as GRAS by the FDA[8]. In addition to the links provided above, Safety Data Sheets for each component of Alternative P1 can be found in Appendix A of the original EA. Based on the low quantities planned for release, the common use of these materials in many existing consumer products, and the safety information presented in Appendix A, salt, glycerol, biotin, OB 220, amorphous silica, and non-coding DNA oligos planned for use in the Proposed Action present a relatively low risk to the environment or human health.

Use of particles in the respirable range (i.e., a mass median aerodynamic diameter (MMAD) less than 10 μm) for testing must adhere to exposure limits set by organizations such as OSHA and the EPA. OSHA specifically regulates amorphous silica exposure levels: the 8-hour Time Weighted Average (TWA) respirable Permissible Exposure Limit (PEL) is 0.8 mg/m^3. The EPA has established a 24-hour national air quality PM_{10} (particulate matter with a diameter below 10 µm) standard for ambient air of 150 $\mu g/m^3$ that provides health protection for the public, including the health of "sensitive" or immunocompromised populations (e.g., asthmatics, children and elderly). This EA also considers guidelines set by the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH does not specifically regulate amorphous silica but has established a Threshold Limit Value (TLV) of 3 mg/m^3 (respirable) for "particles not otherwise specified (PNOS)".

These existing regulations do not specifically cover particulates in the nanomaterial size range, which is defined as materials with at least one dimension less than 100 nm[9,10,11]. The size range of the amorphous silica particles proposed in Alternative P1 falls in between the size ranges of canonical "nano"-particles and "micro"-particles and are collectively referred to as sub-micron particles. Relatively little data is available regarding the long-term safety of nanomaterials, and official regulatory limits have only been established for a handful of materials[12,13,14]. The only recommendations regarding silica nanomaterials come from the Finish Institute of Occupational Health (FIOH), which has proposed an 8-hour time-weighted average Occupational Exposure Limit (OEL) of 0.3 mg/m^3 for amorphous silica nanoparticles[15]. This value has also been proposed by the German Research Foundation (DFG) as a default threshold in situations where no other data is available regarding safety[16].

To be conservative, release amounts for the Proposed Action were scoped such that they were in compliance with the lowest recommended exposure limit by the FIOH for nano-scale amorphous silica, even though the silica particles described in Alternative P1 do not technically fit the definition of nanomaterials. Of note, particles in the proposed size range for Alternative P1 (i.e., 100 nm – 1 µm) have been shown to deposit less in the upper airways and alveolar spaces compared to both smaller canonical nanomaterials (<100 nm) as well as larger microparticles (1 – 10 µm) (Figure 3).

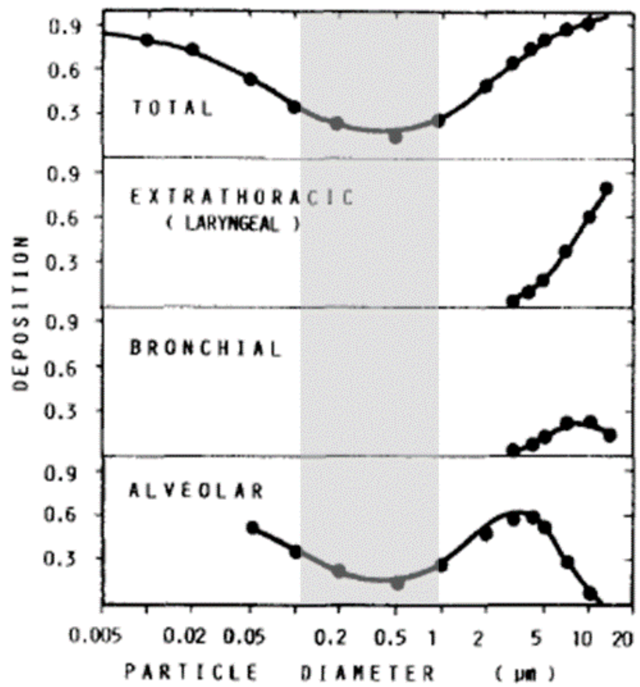

Figure 3. Relative deposition frequencies of different sized particles in the respiratory tract. Extracted from Heyder et al. 1986 [17].

The small quantity of particulate material proposed for these tests would result in 8-hour maximum average mass concentrations (i.e., at the release point) that are 40-60 fold lower than the established limits by OSHA and ACGIH for particles not otherwise regulated (i.e., inert or nuisance dusts), respectively, and half of the EPA 24-hour standard. The 8-hour TWA mass concentration is 4-fold lower than the FIOH guideline for nano-scale silica. Of note, the 8-hour average concentrations reported here represent maximum likely concentrations, assuming air exchange rates significantly below those expected and no mitigation strategies implemented. Actual concentrations during the test event are anticipated to be significantly lower. For more details, refer to Section 3.1.5 Public Health and Safety and TABLE 3.

2.2 No Action Alternative

Under the No Action Testing Location and Liquid/Particulate Alternative (P2), the proposed testing of the release of a safe material mimicking SARS-CoV-2 would not occur. This alternative would not help to measure the spread of viral particles in transit environments and thus does not meet the purpose and need of the Proposed Action. The No Action Alternative is carried forward for analysis in this EA to provide a comparison of baseline conditions to the Proposed Action, as required by the CEQ NEPA implementing regulations.

Section 3. Affected Environment and Environmental Consequences

This chapter describes the current environment for resource areas that may be affected by the Proposed Action Alternatives and the No Action Alternative, and the potential environmental consequences associated with these alternatives. Resource areas analyzed include soil resources; water resources; biological resources; hazardous waste and materials; cultural and historic resources; air quality; noise; human health and safety; socioeconomics; environmental justice; and land use and infrastructure.

The affected environment summarizes the current physical, biological, social, and economic environments of the area within and surrounding the Proposed Action. For each resource area, the bounds of the area for analysis that could be impacted by the Proposed Action Alternative and No Action Alternative are broadly defined, and the elements or components of the resource area that may be potentially affected are described. For many of the resource areas potentially affected by the alternatives, the area of analysis is confined to the test area.

The analysis of environmental consequences for each resource area begins by explaining the methodology used to characterize potential impacts, including any assumptions made. The impacts analysis considers how the condition of a resource area would change as a result of implementing each of the alternatives and describes the types of impacts that would occur (e.g., direct, indirect, beneficial, adverse). The impact types and significance criteria are described below. The terms “impacts” and “effects” are used interchangeably in this chapter.

3.1 Test Site Overview

The simulant (P1) would be released in transit environments such as a subway car and a bus within NYC. The test site would not be accessible to the public, which would prevent exposure. Depending on the specific mitigation actions being evaluated, the test vehicles may be stationary or in motion (see Section 2.1.1). DHS S&T is working with MTA to identify appropriate sites for testing. As an example, the subway car being tested could be stationary in a train yard or decommissioned station or could be moving along a non-operational section of track. The bus being tested could be following a “shadow service” model or could be parked or operated at a bus depot to provide a more controlled environment for testing.

3.1.1 Geology, Soils, Topography and Geological Hazards

Geological resources consist of the surface and subsurface materials that make up the Earth’s crust. Within a land area, these resources are described with the study of geology, soils, and topography. In the U.S., geologists separate geologically similar areas into physiographic provinces. Provinces are grouped based on similarities between landforms’ physical features and processes, and their relation to geologic structures, terrain, sediment, history, and rock types. Information about an area’s physical features and processes can identify important aspects of the land’s structural integrity, capacity for construction, and potential for geologic hazards. The prevalence of geologic hazards is based on the forces that act on geological resources. These hazards pose a threat to human safety and the built environment; examples include erosion, earthquakes, landslides, and sinkholes.

NYC is located on the eastern Atlantic coast, at the mouth of the Hudson River. It is made of five boroughs separated by various waterways. Brooklyn and Queens occupy the western portion of Long Island, while Staten Island and Manhattan are completely on their own land mass. Bronx, to the north, remains attached to the New York State mainland. The geological history of NYC is long and includes several formations, most notably those of bedrock and remnants of glacial activity. The soil as described by the Natural Resource Conservation Service is primarily a fine-loamy, mixed, active mesic Glossic Hapludalfs. The topography of New York City is very diverse but has been substantially altered through construction activity. Several fault lines reside under NYC and sedimentation and erosion are present.

The Preferred Alternative would have no impact on these resources as activities would occur within a transit vehicle in a previous utilized transit location. Under the No Action Alternative, the proposed testing would not occur. Therefore, there would be no changes to these resources and no significant effects under the No Action Alternative.

3.1.2 Hydrology and Water Resources

Hydrology is the study of how water naturally distributes and circulates. Water resources consist of the use and quality of both groundwater and surface water, floodplains, and wetlands. Water quality refers to the chemical and physical composition of water, usually in respect to its suitability for a particular purpose, such as drinking.

NYC is located within the 02030201 and 02030202 hydrological unit codes and contains many jurisdictional waters and wetlands subject to the Clean Water Act. Areas determined to be floodplains and coastal zone exist within NYC, especially along waterfront and coastal areas. According to the New York Department of Environmental Conservation (NYDEC), the Long Island Aquifers under the city are among the most productive aquifers in the U.S. Additionally, NYC drinking water supply system is the largest unfiltered water supply in the United States. It provides approximately 1.2 billion gallons of high-quality drinking water to nearly one-half the population of New York State every day.

The Preferred Alternative (P1) would have no impact on these resources as activities would occur within a transit vehicle in a previous utilized transit location. Under the No Action Alternative, the proposed testing would not occur. Therefore, there would be no changes to these resources and no significant effects under the No Action Alternative.

3.1.3 Biological Resources

Biological resources at the Project Site may include vegetation, wildlife, and special status species. The Migratory Bird Treaty Act of 1918 (MBTA) (16 U.S.C. § 703 *et seq.*) protects migratory birds. Other laws that protect terrestrial and avian special status species include the Endangered Species Act of 1973 (ESA) (16 U.S.C. § 1531 *et seq.*), the Bald and Golden Eagle Protection Act of 1940 (BGEPA) (16 U.S.C. § 668 *et seq.*) and species protected by the State of New York. Together, these resources form the ecological character of a given site.

New York is home to many animal and plant species and their habitat. The potential for exposure of terrestrial wildlife to the particulate materials was evaluated. Aerosolized releases of Alternative Particulate P1 would involve very small amounts of material released within a discrete environment such as a subway car or bus. It is anticipated that vehicle doors or windows may be opened during the test to evaluate the effectiveness of these actions in reducing spread of the simulant materials, creating a small potential for simulant material to disperse from the test vehicle to the environment.

Silica-DNA (P1) would not impact the surrounding environment. The primary component, amorphous silica, is found naturally in marine plant fossil skeletons and is already used extensively in several products commonly found in Manhattan such as toothpaste, anti-caking agents (i.e., dried eggs) and carriers for liquid active ingredients in human and animal nutrition. The DNA oligos are safe and are comprised of the same four nucleotides as all other DNA (i.e., uniqueness comes from differences in sequence)[18]. The particular sequence will be made to look distinctly different from known pathogens that are searched for within the DHS BioWatch air sampling program. OB 220 is used in several commercial products found commonly in Manhattan (i.e., paper, clothing). It has been tested extensively on animals and has presented little to no risk. The OB is soluble in water and is removed by >75 percent to >95 percent through absorption from sewage with direct photolysis a second elimination process (half-life for the OB on surface water is 3.9 – 5.2 hours)[19]. OB acute toxicity levels are known for several species, and are well below the maximum 10 mg of OB released over the duration of all proposed tests (approximately one week). Toxicity levels for *Daphnia magna* (the lowest toxicity level) would only be exceeded if the entire OB supply were deposited in a water reservoir containing 88 milliliters (approximately the size of a carry-on shampoo bottle).

According to the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation, there is no critical habitat in the proposed project area. Four threatened and endangered species (piping plover, red knot, roseate tern, and seabeach amaranth) reside within the county but are all coastal species, and are not anticipated to be present in the subway system or along roadways used for bus testing as the appropriate habitat does not exist in these areas. Therefore, there would be no effect on threatened and endangered species from the proposed testing and consultation with the USFWS is not required. Other urban wildlife including birds, coyotes, deer, rodents, fish, reptiles, and amphibians are present in NYC. While urban wildlife and their habitat may be present in the proposed project area, no effect is anticipated on wildlife. There would be no significant effects to wildlife or special-status species under the

Preferred Alternative. The Preferred Alternative would similarly have no effect on vegetation or special plant species as testing would occur within a transit vehicle and industrialized area. Under the No Action Alternative, the proposed testing would not occur. Therefore, there would be no changes to these resources and no significant effects under the No Action Alternative.

3.1.4 Hazardous Materials and Environmental Compliance

Hazardous materials and wastes are physically hazardous and include combustible and flammable substances, compressed gases, and oxidizers. Health hazards are associated with materials that cause acute or chronic reactions, including toxic agents, carcinogens, and irritants. In addition to being a threat to humans, the improper release or storage of hazardous materials, hazardous wastes, and petroleum products can threaten the health and well-being of wildlife species, habitats, soil and land use, and water resources.

For this analysis, the terms hazardous waste, hazardous materials and toxic substances include those substances defined as hazardous by the Comprehensible Environmental Response, Compensation, and Liability Act (CERCLA) (i.e., superfund), Resource Conservation and Recovery Act (RCRA), and the Spill, Prevention, Control and Countermeasures (SPCC) Rule under the Clean Water Act. In general, they include substances that, because of their quantity, concentration, or physical, chemical or toxic characteristics, may present a danger to public health or welfare or the environment when released into the environment. Regulated substances include the storage, transportation, handling, and use of hazardous materials, as well as the generation, storage, transportation, handling, and disposal of hazardous wastes. The purpose of CERCLA, often referred to as Superfund, is to clean up contaminated sites so that public health and welfare are not compromised. RCRA provides for “cradle to grave” regulation of hazardous wastes. An SPCC Plan can be developed, if required, to outline the methods and procedures established to minimize the potential for spills and discharges into waterways from the facility.

New York City is home to sites subject to CERCLA and RCRA and contains many areas where hazardous materials and waste are present. Equipment used to generate releases and collect samples during the Proposed Action would be properly stored before and during use before being returned to the laboratory where they would be cleaned and evaluated for reuse. All sampling waste generated during sample collection (e.g., gloves, filters) would be disposed of according to regulations. Test vehicles would be in good operating order and it would not be anticipated that any oil or gasoline would leak. All test vehicles would be cleaned after testing, using both standard cleaning procedures as well as additional steps to ensure removal of simulant particles. Real-time measurement equipment would enable confirmation that aerosol levels have returned to baseline following each test, and analysis of surface samples would be conducted to confirm removal of the simulant after testing has concluded. None of the materials brought to the stations are RCRA regulated hazardous waste.

The Preferred Alternative would have no impact on these resources as activities would occur within a transit vehicle in a previous utilized transit location. Under the No Action Alternative, the proposed testing would not occur. Therefore, there would be no changes to these resources and no significant effects under the No Action Alternative.

3.1.5 Public Health and Safety

Public health and safety are largely a matter of adherence to regulatory requirements outlined by the OSHA and local police, fire, and medical services. The OSHA standards specify the amount and type of safety training and education required for industrial workers, the use of protective equipment and clothing, engineering controls, and maximum exposure limits with respect to workplace stressors like air, noise, and spilled pollutants (29 C.F.R. Part 1910). In order to adhere to OSHA regulations, employers typically have internal processes and procedures in place to protect the safety of employees, contractors, and the public. Employers must review potentially hazardous workplace conditions; monitor exposure to workplace chemical, physical, and biological agents, and ergonomic stressors; and recommend and evaluate controls to ensure exposure to personnel is eliminated or adequately controlled. Additionally, employers are responsible for ensuring a medical surveillance program is in place to perform occupational health physicals for those workers subject to the use of respiratory protection, engaged in work that involves hazardous waste, asbestos, lead, or other activities requiring medical monitoring.

This section discusses all human health and safety effects related to the Proposed Action. Test events in MTA buses and subway cars would occur in areas that are not accessible to the public. Buses and train cars being used for testing would not be used for customer service during the test window; therefore, the public would experience extremely limited to no exposure with the liquid/particulate releases. It is anticipated that vehicle doors or windows may be opened during the test to evaluate the effectiveness of these actions in reducing spread of the simulant materials, creating a small potential for simulant material to disperse from the test vehicle to the environment.

Personnel directly involved in testing may contact the materials through inhalation, ingestion, or dermal contact. The test evironment would be cleaned in between tests and at the end of each test day to minimize the amount of simulant materials on surfaces and reduce the likelihood of re-aerosolization over time. The personnel supporting the test are comprised of healthy working adults, but immune-deficient or immune-compromised individuals may be present. Personnel may wear personal protective equipment (PPE) during testing such as gloves, which would minimize dermal exposure, as well as masks. All efforts will be made to be compliant with any existing state and local guidelines related to COVID-19 that are in place at the time of testing. For example, personnel may maintain social distancing, or may use cloth face coverings or surgical-style masks, which should reduce inhalation exposure. Respirators such as an N95 or KN95 may also be used, depending on supply chain availability. A discussion of the anticipated maximum levels of simulant exposure will first be discussed followed by the individual environmental consequences of each individual liquid/particulate alternative.

As discussed in Section 2, the maximum amounts of particulate amorphous silica simulant material released in a test environment (i.e., a bus or subway train car) over fifteen minutes and 8 hours are 285 and 1140 micrograms, respectively, corresponding to a maximum of four release events per day. The majority of released material are respirable, in the range of < 10 µm. Personnel would be present in the test environment during the release and afterwards to operate the release device and measurement equipment and collect samples. Extremely small amounts of material are being released and the material would be directed into the airspace to be rapidly mixed, minimizing exposure of any one individual to simulant materials.

TABLE 3 presents computer modeling results in order to predict the particle concentrations at the release site. Two different models were used to estimate particle concentrations, including a simple analytical model as well as the Below Ground Model (BGM) from Argonne National Laboratory. The analytical model represents a maximum concentration scenario, assuming very low air flow and diffusion rates in a bus, with no mitigations actions implemented. The BGM assumes more realistic conditions in a subway car. The reported particle concentrations reflect those resulting from four simulant releases, separated by two hours, within an 8-hour period. Several OSHA and ACGIH regulatory limits are also provided for reference. Measurements from the analytical modeling results indicate particle concentrations that are between two-fold and sixty-fold lower than all established permissible exposure limits for an 8-hour average exposure. The BGM results suggest particle concentrations that are several orders of magnitude below all established exposure limits.

TABLE 3. Estimated Mass Concentrations from Computer Modeling

Model	Particle	Release Size	Release Location	15-min PM_{10} (mg/m^3)	1-hr PM_{10} (mg/m^3)	3-hr PM_{10} (mg/m^3)	8-hr PM_{10} (mg/m^3)
Analytical Model[20]	DNA-tagged Silica	285 μg in 200 μl (burst)	40 foot bus	0.59	0.15	0.09	0.08
Below Ground Model	DNA-tagged Silica	285 μg in 200 μl (burst)	Subway car	0.00032	0.00008	0.00005	0.00004

** The following regulatory limits are provided for comparison: OSHA Nuisance Dust PEL = 5 mg/m^3; ACGIH Nuisance Dust TLV = 3 mg/m3; OSHA Amorphous Silica PEL = 0.8 mg/m^3; FIOH Nano-scale Silica PEL = 0.3 mg/m^3.*

Simulant alternative P1 (Silica-DNA) would consist of aerosolizing water droplets containing some or all of the following components: (1) salt, (2) glycerol, (3) OB 220, (4) commercially-available streptavidin- or avidin-functionalized amorphous silica particles between 100-1000 nm in diameter, and (5) non-coding biotinylated DNA oligos. The salt and glycerol enable the fluid to more closely mimic the properties of respiratory secretions. The OB has been added to make simulant discrimination easier for real-time biological trigger sensors utilizing fluorescence techniques. The DNA oligos coat the particles and enable sensitive and specific quantification of the particles in the environment using molecular biology techniques.

Salt, glycerol (i.e., glycerin), and biotin (Vitamin B7), are all common components of food products, are all classified by the FDA as GRAS[20]. Safety Data Sheets (SDS) are also provided for these materials in APPENDIX A of the original EA.

The incorporated DNA sequences are randomly generated and designed so as not to produce a functional product. The DNA sequences are inert, non-living, and have been verified as dissimilar from other known biological sequences. Environmental DNA is already ubiquitous in byproducts (e.g., skin, hair, urine) from all organisms; therefore, there is no additional impact or burden placed on the environment from use of the material. DNA has been used as a component in past simulant materials, including DNATrax, which was used for testing in the MTA New York City Transit (NYCT) subway system previously with no recorded negative health impacts [21].

Streptavidin is a protein originally isolated from environmental soil bacteria that is used widely in a range of molecular biology and biotechnology applications because of its extremely strong interaction with biotin. Avidin is also a biotin-binding protein and is isolated from egg whites. Streptavidin or avidin is being used in Alternative P1 to enable easy coupling of the DNA sequences to the particle surface. Other than binding to biotin, streptavidin and avidin have no other enzymatic functions and is considered safe. Of note, excess streptavidin or avidin sites on the silica particles will be quenched with biotin prior to testing. SDS's for streptavidin and avidin are also provided in APPENDIX A of the original EA.

Several toxicology studies have been performed on OB 220 (also referred to as Fluorescent Brightener 220) and related optical brighteners[22,23]. These materials are generally not irritating to skin and eyes. Toxicity studies of this brightener and a related compound in rats and other mammals observed no fatalities or signs of toxicity via ingestion at a range of doses[24,25,26]. Several inhalation toxicity studies have also been conducted in rats using closely related OBs. No mortality was observed, although temporary reductions in overall health were observed at the highest attainable concentrations[27,28]. Animals appeared healthy during the 14 days following exposure and had normal weight gains. Finally, a review of toxicity studies for OBs, including OB 220, carried out by the German Institute for Consumer Health Protection and Veterinary Medicine[29] also concluded that they pose no risk to consumers. An SDS for OB 220 (i.e., Fluorescent Brightener 220) is provided in APPENDIX A of the original EA.

The amorphous silica particles will have a MMAD between 100 – 1000 µm, which is considered respirable. Amorphous silica (SiO_2, CAS: 7631-86-9), the primary component in Alternative P1, is used as an anti-caking agent (e.g., dried eggs), filler for the rubber industry, and a carrier for liquid active ingredients in human and animal nutrition. Amorphous silica is found naturally in dust from microscopic marine plant fossil skeletons (i.e., diatomaceous earth). One of the major problems with assessing the health effects from amorphous silica is contamination from crystalline silica[30]. Crystalline silica can cause several negative human health effects such as silicosis, tuberculosis, chronic bronchitis/chronic obstructive pulmonary disease (COPD) and lung cancer. However, all amorphous silica that is proposed for use will be synthetically manufactured, avoiding contamination with crystalline silica. No silicosis has been found in the epidemiological studies involving workers with long-term exposure to intentionally manufactured Synthetic Amorphous Silica (SAS)[30]. In addition, long-term animal inhalation experiments exposed to high concentrations of amorphous silica (> 10 mg/m^3) showed no obvious pathology[30]. No adverse changes were observed in Wistar rats exposed to three different types of respirable SAS particles[31].

A variety of products containing silica are considered safe. Silica gels are considered GRAS when used as anti-foaming agents[32]. Silicon dioxides are considered GRAS as substances migrating from paper and paperboard products used in food packaging[33]. In 2018, the FDA updated silicon dioxide as a food additive permitted for direct addition to food for human consumption. The amorphous silica SDS (provided in APPENDIX A of the original EA) lists the OSHA PEL as 80 / %SiO_2 mg/m^3 (respirable fraction) and ACGIH TLV as 3 mg/m^3 (respirable fraction) [34,35]. As shown in TABLE 3, the maximum concentrations encountered after particle releases are lower than the established limits by OSHA and ACGIH. Amorphous silica particles have been used safely in previous open-air tracer tests in NYC (i.e., the 2016 Underground Transportation Restoration test), although in larger micron-scale particle sizes[79].

Alternative P1, consisting of streptavidin- or avidin-coated amorphous silica particles, OB 220, DNA oligos, salt, and glycerol is not anticipated to present a significant risk to human health and safety. Therefore, there would be no significant effects to air quality or human health and safety as a result of the Preferred Alternative. The Preferred Alternative would result in beneficial impacts on public health and safety by aiding in the research and understanding of how the SARS-CoV-2 virus spreads and how mass transit authorities can mitigate potential exposure to the public and MTA employees.

Under the No Action Alternative, the proposed testing would not occur. Therefore, there would be no changes to existing air quality or human health and safety and no significant effects under the No Action Alternative.

3.1.5.1 Environmental Noise

Noise can be transmitted or continuous, steady or impulsive, and can involve any number of sources and frequencies. It can be easily identifiable or generally nondescript. Although human response to noise varies, measurements can be calculated with instruments that record instantaneous sound levels in decibels (dB). The dB is a logarithmic unit that expresses the ratio of a sound pressure level to a standard reference level. A-weighted decibels (dBA) characterize sound levels that can be sensed by the human ear. "A-weighted" denotes the adjustment of the frequency range to what the average human ear can sense when experiencing an audible event. The threshold of audibility is generally within the range of 10 to 25 dBA for normal hearing. The threshold of pain normally occurs in the region of 135 dBA (USEPA, 1981).

Existing noise within NYC results from ongoing construction activities, vehicular traffic, and air traffic. None of the equipment or personnel would generate loud noises that would increase existing noise levels. Noise due to equipment would not exceed 82 dBA at any test site and would be well-below this level for any release site not requiring generator power.

3.1.6 Air Quality

This section describes the ambient NYC outdoor, mass transit bus, and subway air quality. The Proposed Action is anticipated to have little to no additional impact on air quality, which is already characterized by high particulate concentrations. An aggregation of air quality studies from several subway stations around the world has been provided in TABLE 4 for perspective.

3.1.6.1 NYC Metropolitan Outdoor Air Quality

Outdoor air quality in NYC has historically been poor and the city estimates that 6 percent of the city's annual deaths are attributable to air pollution[36]. The Clean Air Act, last amended in 1990, required the EPA to develop National Ambient Air Quality Standards (NAAQS) for particulate matter with a diameter below 10 µm (PM_{10}) and 2.5 µm ($PM_{2.5}$). NAAQS define primary standards, which protect the health of "sensitive" populations such as asthmatics, children, and the elderly. In addition, NAAQS define secondary standards which protect against decreased visibility and damage to animals, crops, vegetation, and buildings. Primary and secondary levels for annual average $PM_{2.5}$ have been set at 15 µg/m^3 and 12 µg/m^3, respectively. A PM_{10} 24-hr average of 150 µg/m^3 has been defined for primary and secondary concentrations[37]. The city launched an effort in 2007 to achieve the highest outdoor air quality of a major city by the year 2030. The NYC Community Air Survey (NYCCAS) reported annual average $PM_{2.5}$ concentrations for 2016 that range from 4.5 – 16.8 µg/m^3 depending on the measurement location, with the highest concentrations recorded in Manhattan. These 2016 levels represent an average 28 percent decline in $PM_{2.5}$ levels compared to 2009[38]. Outdoor PM_{10} levels have remained steady for the same time period, averaging 60 µg/m^3 for 2005 – 2011[39]. While outdoor PM_{10} concentrations for NYC are well below NAAQS, outdoor $PM_{2.5}$ concentrations still remain above primary and secondary standards which protect against environmental harm. NYC continues to work towards reducing particulate emissions and meeting national standards.

3.1.6.2 Ultrafine Particles (<300 nm) in Mass Transit Environments

In a compilation of previously conducted studies[40], ultrafine nanoparticles (10-300 nm diameter) were measured in different environments, including mass transit environments. In general, ultrafine particle concentrations range from $<1\times10^4$ particles/m^3 for clean outdoor/indoor environments, to high levels of >1x10^6 particles/m^3 that could originate from indoor cooking, butane heaters, or exhaust from taxis. These studies showed that the average amount of ultrafine particles (2.3x10^4 particles/m^3) in subway environments was greater than the ambient background air environment (1.4x10^4 particles/m^3). Likewise, the number of ultrafine particles measured when riding a bus was four times greater than the background air (5.4x10^4 particles/m^3), although this concentration varied greatly by bus fuel type and the duration of a ride. This variability was mainly due to the large number of ultrafine particles emitted from hydrocarbon combustion plumes from the bus exhaust pipes.

3.1.6.3 Mass Transit Vehicle Air Quality

The air quality inside vehicles used for mass transportation is proportional to the air exchange rate, or how often the air inside is refreshed with new air. Several studies have been conducted regarding air exchange rates for mass transit vehicles. For example, the Massachusetts Bay Transit Authority's (MBTA) transit buses have an air exchange rate of once every 6 minutes with windows closed and once every 1.5 minutes with windows fully open[41]. Additionally, the air inside the above-ground light-rail cars in Denver's Regional Transport District is fully exchanged every 59 seconds. The ratio of fresh air to recirculated air is about 25 percent versus 75 percent[42]. Many of the MTA's subway cars are equipped with air filtration systems that include filters with a MERV-7 to MERV-10 rating[43,44] which filter out up to 65 percent of particles 1-3 μm and >85 percent of particles 3-10 μm. These subway cars have an average air exchange rate of 18 times per hour, which is much higher than the minimum recommended 6 air exchanges per hour for Intensive Care Units (ASHRAE standard 170-2017) or airborne infection isolation rooms (CDC)[43]. Carbon dioxide (CO_2) levels in buses and subway cars can range from ambient outdoor air concentration values (400 ppm) to above the World Health Organization's recommended 1000 ppm[45] during the course of a ride, depending on the amount of crowding and the ventilation system[40]. These studies emphasize the importance of air exchange rates in enclosed environments from multiple health standpoints.

3.1.6.4 Subway Indoor Air Quality

This section describes the characteristic background particulate matter found in air/surface samples in several transit environments. It should be emphasized that passenger entrances, ventilation shafts, and tunnels allow for a large exchange of air with the outside environment.

Airborne particulate mass concentrations have been previously measured at several subway systems around the world. A summary of average results is presented in TABLE 4. Airborne particulate mass concentrations were almost always significantly higher inside subway stations than ambient air outside of the stations[46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65]; generally by at least a factor of 4. The exception to this was Guangzhou China where outdoor air pollution was much higher than other cities. Notice that there is a wide range of concentrations depending on the subway system. Significant mass concentration variations were also measured between stations[66], seasons[48,52,67,68], and time of day[65,68] for the same city.

TABLE 4.

Average Mass Concentration Measurements (μg/m³) Taken in Different Subway Systems

City	Outdoor $PM_{2.5}$	Outdoor PM_{10}	Subway $PM_{2.5}$	Subway PM_5	Subway PM_{10}	Subway TSP	Description
Berlin[46]					147		
Buenos Aires[66]						211	*Platform*
Budapest[63]					155		*Platform*
Boston[69]					205		*Platform (Winter)*
Cairo[58]						938	
Guangzhou[70]	106		44		55		
Helsinki[47]	10, 17		54, 21				*Platform (Winter), Subway Car (Winter)*
Hong Kong[46]			33		44		
London	23.5 [48], 34.5 [48]		165, 103 [48], 375 [71],239 [48]	801 [50]	1,250		*Subway Drivers Cab, Platforms (Winter and Summer)*
Mexico City[72]	71, 38		61				
NYC	13 [53]		62 [53], 56 [54]				*Platforms & Cars, Subway Workers*
Prague[52]		74			103, 114		*Station, Subway Car*
Rome[61]		101			166, 407		*Subway Drivers Cab, Platforms*
Seoul			66 [68], 118 [51], 111		144, 126, 137 [73]		*Subway Car, Platforms*
Stockholm[47]	23		212		386		
Toronto[74]	15		159				
Washington DC[57]						333	

The elevated mass concentration values in the subway are thought to be influenced by passenger activity, floor cleaning, station depth, date of construction, ventilation rate, proportion of frictional to regenerative braking, train frequency, wheel type (rubber vs. steel), and the presence or absence of platform-edge doors and/or air-conditioning in subway cars and stations[54,58]. Analysis has been conducted on collected particulate samples to determine the constituent materials. Iron oxides (e.g., Fe_3O_4, Fe_2O_3) make up the majority of subway particulate mass (e.g., 64 – 71 percent in London subway[49]). The iron oxides generally create a passivation layer on the surface of iron. Airborne iron is primarily attributed to wear debris from the subway car wheel-rail interface and braking (contributed 15 percent total mass[75]). TABLE 5 reports the percentage iron content from other cities. A NYC study found that iron content percentage in the air varied depending on the location within the subway system (e.g., 14 percent for overhaul shop workers, 27 percent for track workers, 43 percent for train operators)[54].

TABLE 5. Percent Iron in Subway Dust

City	Iron %
Budapest[63]	42
Buenos Aires[66]	21
Helsinki[47]	54
London[49]	45
NYC[53]	42
Rome[61]	10
Seoul[68]	45
Stockholm[62]	40
Washington, DC[57]	55

Other metals found in elevated percentages to the outdoors were chromium (present in steel), manganese (present in steel), copper (present in current collector shoes rubbing against conductor rail), zinc (vehicular traffic), and barium (present in some brakes[46]). The metals are not generally present as elements but as compounds (e.g., oxides, chlorides, sulfides)[57]. Steel, manganese and chromium were found to be more than 100 times higher in the NYC subway system than outdoors[53]. Carbon-rich particles are generally found, attributed to carbon inclusion in steel, oils, and human debris (e.g., clothes fibers, hair, skin)[57,50,46]. Other non-metals found were silica quartz (e.g., 7.2 percent in Washington, DC), attributed to concrete (i.e., construction, degradation)[57], and chlorides[50,59,68] attributed to the use of road salts for de-icing. A Washington, DC, study found that subway dust from older Washington Metropolitan Area Transit Authority (WMATA) rail lines was not significantly different than dust from newer lines[57]. Also of interest was that power washing only reduced mass concentrations by roughly 10 percent[55]. The same factors that affect mass concentration levels also affect the composition of subway dust. Therefore, it is important for each facility to conduct analysis on their inherent subway particles.

While some of the underground subway increase in airborne mass concentration is attributable to higher particulate density (i.e., iron), it is also attributed to an increase in total particle counts.

Measurements in the WMATA subway system found that the total particle counts (Smithsonian Station) were at least 2 – 3 times lower in magnitude immediately outside the station for all particle sizes between 0.5 – 9.4 μm[76]. Compared to the outdoors, the subway environment has particles that are heavier (i.e., iron oxides) and in greater numbers. Typical subway station total particle counts (>0.5 μm) reached 10,000 – 100,000 Particles Per Liter (ppl) of air depending on train operation and time of day[59,67,76]. Fluorescent particles have been reported at <1 percent of total particle counts[59]. Also of interest is that NYC air-conditioned subway cars reduced particle counts by 75 – 90 percent compared to the subway station[56].

With respect to airborne particle sizing, significant increases in coarser particles (i.e., >2 μm) have been measured for subway dust[49,50]. Measurements in Washington, DC, found the largest subway station particle increases (compared to outdoors) in the 1.1 – 3.2 μm particle size range[76]. These coarse particles typically come from grinding activities (wheel-rail interface) and other geological origins (e.g., spores, waste residues)[61]. Many subway particles are angular in shape which is consistent with metal surface abrasion[54]. A Seoul Korea study found that subway dust in the 2.5 – 10 μm range and 1 – 2.5 μm range were made of 77.3 percent and 70.9 percent iron, respectively[77]. It is thought that this increase in coarser sized particles is due to the liberation of iron particles at the wheel-rail interface and from braking systems. Park & Ha assert that many smaller particles (< 2 μm) are from vehicle exhausts and other sources of combustion based on measuring a strong positive correlation between $PM_{2.5}$ and CO concentrations[78].

Bulk dust samples were collected from subway surfaces and analyzed[57]. Particle sizing was conducted with an average normalized distribution of 23.3 percent (< 2.5 μm), 27.2 percent (2.5 – 10 μm), 42.9 percent (10-25 μm), and 6.5 percent (>25 μm). A shift to larger particles is seen in the deposited particles. The primary constituent material (40 percent) was iron.

Real-time background particle concentration data gathered as a part of the 2016 Underground Transportation Restoration (UTR) study indicated high background levels of particles in the Grand Central (>100,000 ppl for particles 0.52 – 2.13 μm diameter) and Times Square (>50,000 ppl for particles 0.52 – 2.13 μm diameter) stations in NYC[79].

A 2015 NYC subway system sampling campaign examined the types of microorganisms found within stations[80]. The findings suggest a rich and diverse background of microorganisms in the subway environment. Hundreds of organisms classified as bacterial, viral, archaeal, and eukaryotic taxa were found in the subway; however, most organisms were considered harmless. There were several *Bacillus* species found within the subways, with the most abundant being *B. cereus* (some strains of which can cause foodborne illness).

3.1.7 Cultural Resources and Historic Properties

This section describes the current setting for cultural resources and evaluates the potential effects to cultural resources as a result of the Proposed Action. Cultural resources, while not defined in statute or regulation, are generally inclusive of historic properties as defined by the National Historic Preservation Act of 1966 (NHPA) (54 U.S.C. § 300101 *et seq.*) cultural items as defined by the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) (25 U.S.C. § 3001 *et seq*.); archaeological resources as defined by the Archaeological Resources Protection Act of 1979 (ARPA) (16 U.S.C. § 470aa *et seq*.); sacred sites as defined by Executive Order 13007, *Indian Sacred Sites*; and collections and associated records as defined by 36 C.F.R. Part 79.

Cultural resources are associated with human use of an area. They may include archaeological sites, historic properties, or locations of ethnographic interest associated with past and present use of an area. A cultural resource can be physical remains, intangible traditional use areas, or an entire landscape encompassing past cultures or present, modern-day cultures. Physical remains of cultural resources are usually referred to as archaeological sites or historic properties. Cultural resources of significance to Native American tribes can include archaeological resources, structures, prominent topographic features, vegetation, animal species, and minerals that Native Americans consider essential for the preservation of traditional culture. Cultural resources that are listed in or eligible for listing in the National Register of Historic Places (NRHP) are known as historic properties.

Almost 7,000 National Register of Historic Places listed properties and 116 National Historic Landmarks as reported by the National Park Service and one World Heritage Site as designated by the United Nations Educational, Scientific and Cultural Organization are present within the city. Additionally, the NYC vicinity and surrounding area has been inhabited by Native Americans for thousands of years and many sites remain which may have cultural significance.

Consideration was given to the impact of the tests on any cultural resources or historic properties. Testing is planned on transit vehicles such as trains and buses, which are not cultural resources or historic properties. However, many of the stations in the NYC subway system are listed on the NRHP. There would be no ground disturbing activities or need to permanently affix equipment to any structures or walls within subway stations. The placement and use of testing equipment would not result in visual or audible impacts given the temporary nature of the activity. The simulant material used for testing would also have no direct or indirect effect to any contributing features of any historic properties. As such, the Preferred Alternative would have no adverse effect on historic properties. Therefore, there would be no significant effects to historic properties under the Preferred Alternative.

Under the No Action Alternative, the proposed testing would not occur. Therefore, there would be no changes to existing cultural resources or historic properties and there would be no significant effects under the No Action Alternative.

3.1.8 Socioeconomics and Environmental Justice

The analysis of socioeconomic impacts identifies those aspects of the social and economic environment that are sensitive to changes and that may be affected by activities associated with the Proposed Action. Socioeconomic factors describe the local demographics, income characteristics, and employment of the region of influence.

The EPA defines environmental justice with a goal of "fair treatment" to identify potential disproportionately high and adverse impacts to minority and low-income communities and identify alternatives to mitigate any adverse impacts as defined in EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. Federal agencies are required to ensure that these potential effects are identified and addressed. For purposes of assessing environmental justice under NEPA, the CEQ defines a minority population as one in which the percentage of minorities exceeds 50 percent or is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis (CEQ, 1997). A low-income population is defined as a Census tract (CT) with a median household income lower than the poverty threshold. A CT usually covers a contiguous area, and its boundaries usually follow visible and identifiable features (e.g., road, river). CTs were designed to be relatively homogeneous units with respect to population characteristics, economic status, and living condition.

According to the U.S. Census Bureau, the estimated population of NYC in 2014 was 8.1 million people. Based on data from 2014, land usage is a mixture of single- and multi-family residential use (39%), open space/recreation (27%), transportation/utility (8%), commercial (7%), industrial (4%), and other (15%)[81]. There are 1,585,873 people living in Manhattan, 48% non-Hispanic White, 25.4% Hispanic, 12.9% non-Hispanic black, 11.2% non-Hispanic Asian, and 0.1% non-Hispanic American Indian[82]. The average New Yorkers is female (52%) and between the ages of 19-64 (61%). The majority (68%) of people in NYC rent their homes, with the median household income being $60,762 and 19% of the population living in poverty.

Areas in and around NYC do contain areas with potential environmental indicators according to the EPA's Environmental Justice Screening Tool EJSCREEN. These indicators are not necessarily surprising for a dense urban area and include diesel exposure, cancer risk, respiratory hazard, traffic proximity, lead paint exposure, superfund proximity, hazardous waste proximity, and wastewater discharge indicators. Importantly, many of these areas are distributed throughout the city and would not be expected to be disproportionately affected by any of the activities in the Proposed Action.

With respect to health effects from particulate simulants, the small quantity of material proposed for release in the Proposed Action would result in upper bound concentrations (i.e., next to release site) that are well under the established limits by OSHA and ACGIH, as well as existing guidelines for nanoscale materials (See Section 3.1.5 Public Health and Safety). All releases would occur on transit vehicles that are not accessible to the public. In general, however, testing in the greater NYC area means testing in an environment that is extremely diverse in terms of land use and demographics. Of note, the results of this test have the potential to positively impact and increase the safety of all public transit riders. While environmental justice communities may be present or reside within the proposed project area, no disproportionately high or adverse impacts on low-income or minority populations are anticipated from the Preferred Alternative. Therefore, there would be no significant effects to environmental justice communities under the Preferred Alternative.

Under the No Action Alternative, the proposed testing would not occur. Therefore, there would be no changes to the existing socioeconomic environment or any disproportionate high and adverse impacts on environmental justice communities. There would be no significant effects under the No Action Alternative.

3.1.9 Land Use and Infrastructure

Land use refers to classifications that indicate the types of human activity occurring on a parcel of land. A predominant factor affecting land use is compliance with local zoning ordinances. Other relevant factors include existing land use and the types of land use on adjacent properties. Land use changes occur regularly throughout the U.S. and have potential negative impacts to the human environment depending on its classification change and scope. In some cases, land use may have positive impacts to the human environment, such as habitat restoration or reclaiming previously contaminated lands for development. Utilities and infrastructure are crucial components of the human environment.

This section describes the potable water supply, sanitary sewer and wastewater treatment, stormwater management, electricity and natural gas supply, waste management, and fencing and security features at the site.

NYC is an urban environment comprised of residential, commercial, and industrial land use classifications with recreational areas such as parks and playgrounds located throughout. The area has been heavy impacted by construction activities and maintains an infrastructure to support more than 8 million people. As the Proposed Project is utilizing existing transportation infrastructure and a change of land use is not expected. The Proposed Action would include public transit vehicles that are not in use by the public and would not impact public transportation access or use. While testing material may require the use of an electrical outlet, there would be no appreciable increase on the city's electric system or capacity. Use of potable water, sanity sewer and wastewater infrastructure, natural gas, waste management, or additional security would not be required. Therefore, there would be no significant effects to land use or infrastructure under the Preferred Alternative.

Under the No Action Alternative, the proposed testing would not occur. Therefore, there would be no changes to these resources. There would be no significant effects under the No Action Alternative.

Section 4. Cumulative Effects

This section analyzes the impact to the human environment which results from the incremental impact of the Proposed Action Alternative and No Action Alternative when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. These cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.

There are numerous projects occurring in NYC that may require environmental analysis and public input. Past and ongoing actions in the area would be primarily associated with the maintenance of supporting infrastructure such as roadways and utility systems as well as residential housing and commercial districts. It is assumed these actions, in addition to a myriad of others including scientific research, development, testing, and evaluation, would continue in the future. Unless within the DHS S&T mission and determined to be a major federal action, DHS S&T has no ability to prevent future foreseeable actions due to its limited statutory authority for projects that would occur regardless of the Proposed Action.

The impact on the environment which would result from the incremental impact of the Proposed Action, or Preferred Alternative, when added to other past, present, and reasonably foreseeable future actions have been considered. Resource areas analyzed include soil resources; water resources; biological resources; hazardous waste and materials; cultural and historic resources; air quality; noise; human health and safety; socioeconomics and environmental justice; and land use and infrastructure. Due to the selection of preferred test materials, the limited quantity of materials to be released, and temporary nature of the Proposed Action, no effects are anticipated on noise, water resources (surface water, ground water, floodplains, wetlands), geology, soils or topography, vegetation, air quality, biological resources, cultural resources and historic properties, socioeconomic; and environmental justice communities. Land use and the infrastructure would not be significantly affected as the proposed testing would not alter any existing land use designations and test sites would not be accessible to the public. By aiding in research on the SARS-CoV-2 virus, the Proposed Action would have a beneficial impact on human health and safety. The Proposed Action Alternative would result in no significant cumulative effects when considered with other recent past, ongoing, or reasonably foreseeable future actions in the project area.

Under the No Action Alternative, the Proposed Action would not occur; therefore; there would be no significant cumulative effects.

Section 5. Conclusions and Identification of the Proposed Action

As a result of the information presented within the EA, DHS S&T has determined there would be no significant impacts on the environment or human health, nor would there be any significant cumulative effects. The Preferred Alternative (Testing Location and Silica-DNA (P1)) considered for the Proposed Action would enable realistic simulant dispersion and highly sensitive and specific measurements. The Preferred Alternative would allow for an evaluation of the effectiveness of different measures at reducing simulant levels in the air. Additionally, P1 was selected due to the ease of material production, safety, and prior experience with similar materials. The No Action Alternative would not help to validate current particulate models and therefore does not meet the purpose and need of the Proposed Action.

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Appendix A: Safety Data Sheets

Safety Data Sheets were included in Appendix A of the original EA.

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