Chapter 6: Shadows

A. INTRODUCTION

This chapter examines the potential for the Proposed Project to cast new shadows on sunlight-sensitive resources, which include publicly accessible parks and other open spaces, sunlight-sensitive features of historic resources, and natural resources that depend on sunlight. Following the guidelines of the 2021 *City Environmental Quality Review (CEQR) Technical Manual*, a shadow study is required if a proposed project would result in structures 50 feet or more in height, or of any height if the project site is located adjacent to, or across the street from, a sunlight-sensitive resource. As described in Chapter 1, "Project Description," the Proposed Project includes the adaptive reuse of the Armory and the redevelopment of the National Guard Site with a new 16-story residential building that would replace a one-story garage and a two-story office building. While the adaptive reuse of the Armory building would include some minor changes to the structure such as the installation of new skylights, new entrances, and rooftop solar panels, none of these modifications are anticipated to result in new structures greater than 10 feet in incremental height, and therefore, per CEQR guidelines, a shadows analysis of the Armory itself is not warranted. The shadow study presented below analyzes the potential for the new residential building to affect sunlight-sensitive resources.

PRINCIPAL CONCLUSIONS

The analysis concluded that the Proposed Project would not result in any new shadows on sunlight-sensitive resources, for reasons described in detail below, and therefore would not cause any significant adverse shadow impacts.

B. DEFINITIONS AND METHODOLOGY

This analysis has been prepared in accordance with New York City CEQR procedures and follows the guidelines of the *CEQR Technical Manual*.

DEFINITIONS

Incremental shadow is the additional, or new, shadow that a structure resulting from a proposed project would cast on a sunlight-sensitive resource.

Sunlight-sensitive resources of concern are those that depend on sunlight or for which direct sunlight is necessary to maintain the resource's usability or architectural integrity. Such resources generally include the following:

- *Public open space* such as parks, beaches, playgrounds, plazas, schoolyards (if open to the public during non-school hours), greenways, and landscaped medians with

seating. Planted areas within unused portions of roadbeds that are part of the Greenstreets program are also considered sunlight-sensitive resources.

- *Features of architectural resources that depend on sunlight for their enjoyment by the public.* Only the sunlight-sensitive features need be considered, as opposed to the entire resource. Such sunlight-sensitive features might include: design elements that depend on the contrast between light and dark (e.g., recessed balconies, arcades, deep window reveals); elaborate, highly carved ornamentation; stained glass windows; historic landscapes and scenic landmarks; and features for which the effect of direct sunlight is described as playing a significant role in the structure's importance as a historic landmark.
- *Natural resources* where the introduction of shadows could alter the resource's condition or microclimate. Such resources could include community gardens, surface water bodies, wetlands, and designated resources such as coastal fish and wildlife habitats.

Resources not subject to shadows analyses include the following, for the purposes of CEQR:

- *City streets and sidewalks* (except Greenstreets);
- *Private open space* (e.g., front and back yards, stoops, vacant lots, and any private, non-publicly accessible open space); and
- *Project-generated open space* cannot experience a significant adverse shadow impact from the project, according to CEQR, because without the project the open space would not exist. However, a high-level assessment of sun and shade conditions on the new open space that would be developed as part of the Proposed Project is presented at the end of the chapter.

A significant adverse shadow impact occurs when the incremental shadow added by a proposed project falls on a sunlight-sensitive resource and substantially reduces or completely eliminates direct sunlight, thereby significantly altering the public's use of the resource or threatening the viability of vegetation or other resources. Each case must be considered on its own merits based on the extent and duration of new shadow and an analysis of the resource's sensitivity to reduced sunlight, and seasonal conditions.

METHODOLOGY

Following the guidelines of the *CEQR Technical Manual*, a preliminary screening assessment must first be conducted to ascertain whether a project's shadow could reach any sunlight-sensitive resources at any time of year. The preliminary screening assessment consists of three tiers of analysis. The first tier determines a simple radius around the new residential building representing the longest shadow that could be cast. If there are sunlight-sensitive resources within this radius, the analysis proceeds to the second tier, which reduces the area that could be affected by project shadow by accounting for the fact that shadows can never be cast between a certain range of angles south of the project site due to the path of the sun through the sky at the latitude of New York City.

If the second tier of analysis does not eliminate the possibility of new shadows on sunlight-sensitive resources, a third tier of screening analysis further refines the area that could be reached by project shadow by looking at specific representative days in each

season and determining the maximum extent of shadow over the course of each representative day.

If the third tier of analysis does not eliminate the possibility of new shadows on sunlight-sensitive resources, a detailed shadow analysis is required to determine the extent and duration of the incremental shadow resulting from the project. Incremental shadows are determined by establishing a baseline condition in the future *without* the Proposed Project (the "No Action" condition) and comparing it to the future condition *with* the Proposed Project (the "With Action" condition), thus illustrating the baseline shadows cast by existing (or future No Action) buildings and distinguishing the additional (incremental) shadows cast by a proposed project. The detailed analysis provides the data needed to assess the shadow impacts. The effects of the new shadows on the sunlight-sensitive resources are described, and their degree of significance is considered. The results of the analysis and assessment are documented with graphics, a table of incremental shadow durations, and narrative text.

C. PRELIMINARY SCREENING ASSESSMENT

A base map was developed using Geographic Information Systems (GIS)[1] showing the location of the Project Site and the surrounding street layout and topography (see **Figure 6-1**). Mapped databases of parks and other public open spaces, City, State, and national historic resources, and natural resources were added to the map.[2] Potential sunlight-sensitive resources were considered in coordination with the land use, open space, and historic and cultural resources assessments presented in other sections of this DEIS.

TIER 1 SCREENING ASSESSMENT

For the Tier 1 assessment, the longest shadow that the new residential building could cast is calculated, and, using this length as the radius, a perimeter is drawn around the Project Site. Anything outside this perimeter representing the longest possible shadow could never be affected by project-generated shadow, while anything inside the perimeter needs additional assessment.

According to the *CEQR Technical Manual*, the longest shadow that a structure can cast at the latitude of New York City occurs on December 21, the winter solstice, at the start of the analysis day (90 minutes after sunrise[3]) and is equal to 4.3 times the height of the structure.

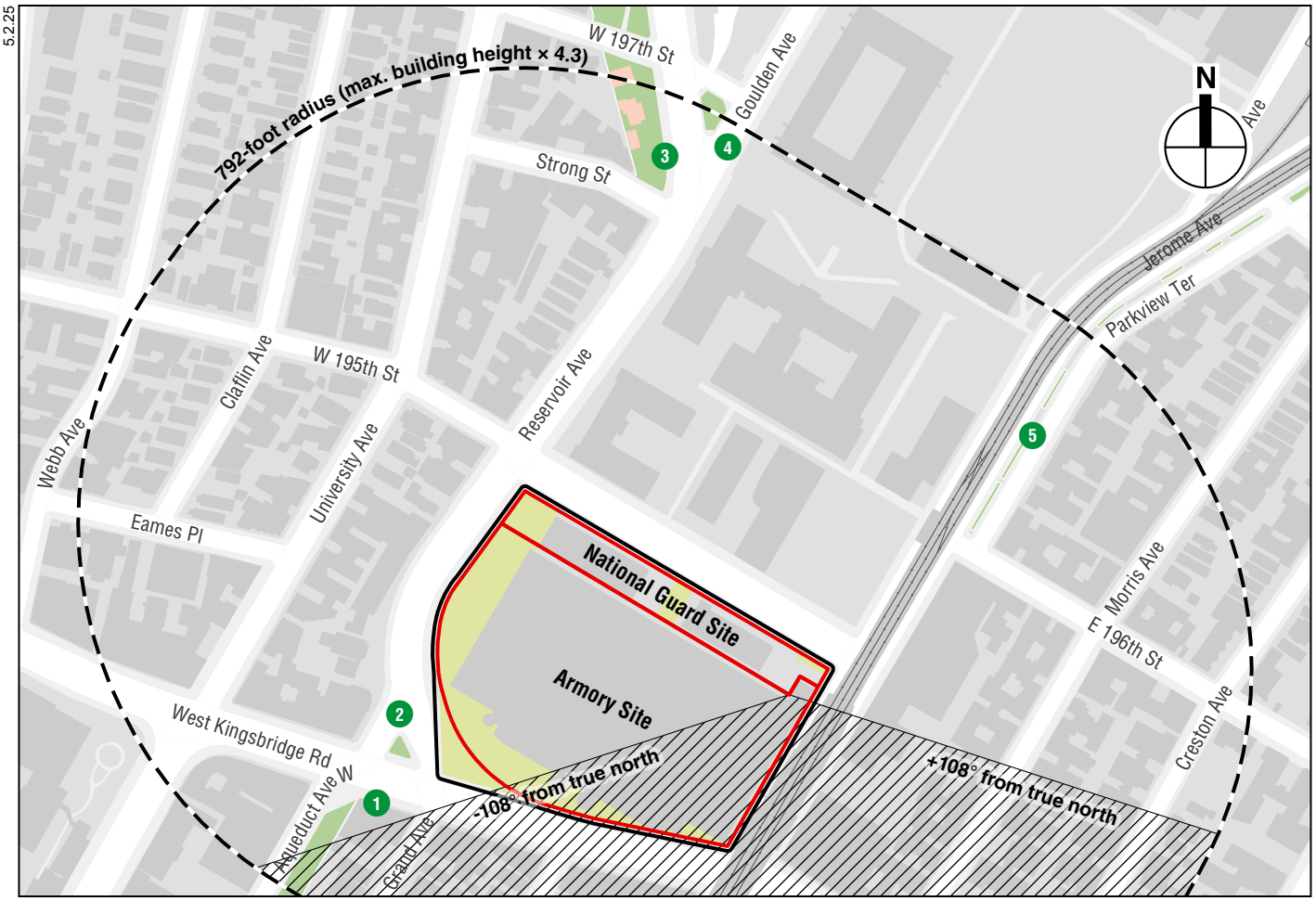
Therefore, at a maximum height of 184 feet, including rooftop bulkhead, the new residential building could cast a shadow up to 792 feet in length (184 × 4.3). Using this

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[1] Software: Esri ArcGIS Pro 3.3

[2] Data: City, State, and Federal agencies including New York City Parks Department; New York City Office of Technology & Innovation (OTI), New York City Department of City Planning, New York City Landmarks Preservation Commission, New York City Department of Transportation, New York State Office of Parks, Recreation, and Historic Preservation, New York State Dept. of Environmental Conservation (NYSDEC), U.S. Fish and Wildlife Service, and others; supplemented by Nearmap hi-resolution imagery, and AKRF site visits.

[3] As explained in more detail below in the "Tier 3 Screening Assessment" section, shadows occurring within 90 minutes of sunrise or sunset are not considered significant under CEQR.



Project Site

Armory and National Guard Sites

Tier 1 Shadow Study Area Perimeter (radius = max. proposed building height × 4.3)

Tier 2: Area South of Site That Could Never Be Shaded by Proposed Project

Existing/Future No Action Publicly Accessible Open Space

Project-Generated Open Space

Map Key	Resource
1	Aqueduct Walk
2	Barnhill Square
3	Washington's Walk
4	Croton Aqueduct Triangle
5	Greenstreets, Jerome Ave and E 196th St

Tier 1 and Tier 2 Assessments

length as the radius, a perimeter was drawn around the Project Site to establish the study area (see **Figure 6-1**).

The Tier 1 assessment showed that there are five sunlight-sensitive resources (all publicly accessible open spaces) within the study area. Therefore, the next tier of assessment was conducted. No historic resources with sunlight-sensitive features are located in the study area.[4]

TIER 2 SCREENING ASSESSMENT

Because of the path that the sun travels across the sky in the northern hemisphere, no shadow can be cast in a triangular area south of any given Project Site. In New York City this area lies between -108 and +108 degrees from true north. **Figure 6-1** illustrates this triangular area south of the Project Site. The complementary area to the north within the longest shadow study area represents the remaining area that could potentially experience new project-generated shadow.

The Tier 2 assessment concluded that all or part of five publicly accessible open space resources are in the remaining longest-shadow study area and require further assessment. The five resources include: the northern end of Aqueduct Walk, a linear park that extends south from West Kingsbridge Road; Barnhill Square, a triangular Greenstreets median with plantings and benches at the intersection of West Kingsbridge Road and Reservoir Avenue; the southeastern portion of Washington's Walk between West 197th Street and Strong Street, known as the Strong Street playground; the Croton Aqueduct Triangle, a Greenstreets median with trees and other plantings (but no benches or other recreational amenities) located at West 197th Street and Reservoir Avenue near the Strong Street Playground; and Greenstreets plantings along Jerome Avenue extending north from East 196th Street.

These five resources requiring a Tier 3 assessment are listed in **Table 6-1**, along with the Tier 3 analysis results.

TIER 3 SCREENING ASSESSMENT

The direction and length of shadows vary throughout the course of the day and also differ depending on the season. In order to determine whether project-generated shadow could fall on a sunlight-sensitive resource, three-dimensional computer modeling software[5] is used in the Tier 3 assessment to calculate and display the proposed project's shadows on individual representative days of the year. A computer model was developed containing three-dimensional representations of the elements in the base map used in the preceding assessments, the topographic information of the study area, and a reasonable worst-case three-dimensional representation of the Proposed Project.

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[4] The Armory itself, which is a New York City Landmark (NYCL) and is also listed on the State and National Registers of Historic Places (S/NR), does not have any sunlight-sensitive architectural elements that contribute to its historic significance.

[5] Bentley MicroStation

REPRESENTATIVE DAYS FOR ANALYSIS

Following the guidance of the *CEQR Technical Manual*, shadows on the summer solstice (June 21), winter solstice (December 21), and spring and fall equinoxes (March 21 and September 21, which are approximately the same in terms of shadow patterns) are modeled, to represent the range of shadows over the course of the year. An additional representative day during the growing season is also modeled, generally the day halfway between the summer solstice and the equinoxes, i.e., May 6 or August 6, which have approximately the same shadow patterns.

TIMEFRAME WINDOW OF ANALYSIS

The shadow assessment considers shadows occurring between one and a half hours after sunrise and one and a half hours before sunset. At times earlier or later than this timeframe window of analysis, the sun is down near the horizon and the sun's rays reach the Earth at very tangential angles, diminishing the amount of solar energy and producing shadows that are very long, move fast, and generally blend with other shadows. Consequently, shadows occurring outside the timeframe window of analysis are not considered significant under CEQR, and their assessment is not required.

TIER 3 SCREENING ASSESSMENT RESULTS

Figure 6-2 illustrates the range of shadows that would occur, in the absence of intervening buildings, from the new residential building on the four representative days for analysis. As they move clockwise and generally west to east over the landscape, the shadows are shown occurring approximately every 60 minutes from the start of the analysis day (90 minutes after sunrise) to the end of the analysis day (90 minutes before sunset). **Table 6-1** summarizes which analysis day or days each resource could potentially receive project-generated shadow.

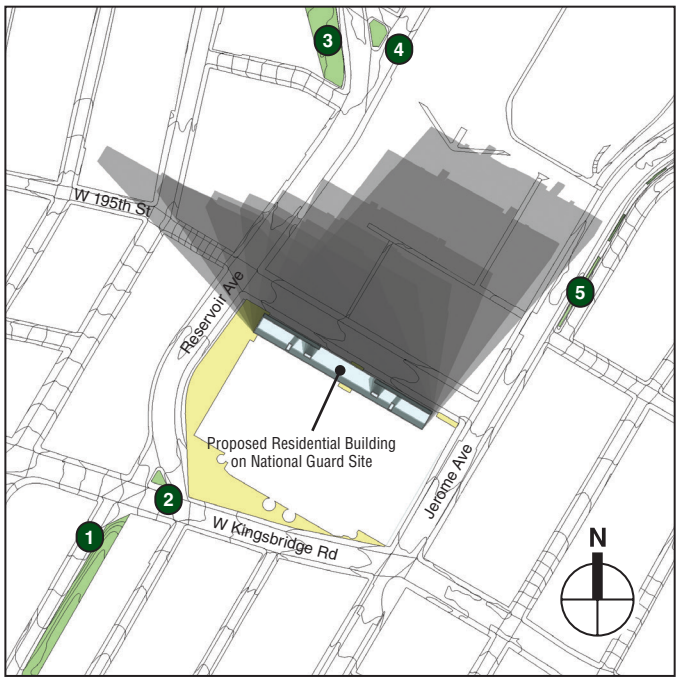
Table 6-1
Tier 3 Assessment

Map Reference	Name	Potential Incremental Shadow			
		December 21	March 21/ September 21	May 6/ August 6	June 21
Publicly Accessible Open Spaces					
1	Aqueduct Walk	No	No	No	No
2	Barnhill Square	No	No	No	Potential
3	Washington's Walk	No	No	No	No
4	Croton Aqueduct Triangle	No	No	No	No
5	Greenstreets, Jerome Ave and E. 196th St	No	Potential	No	No

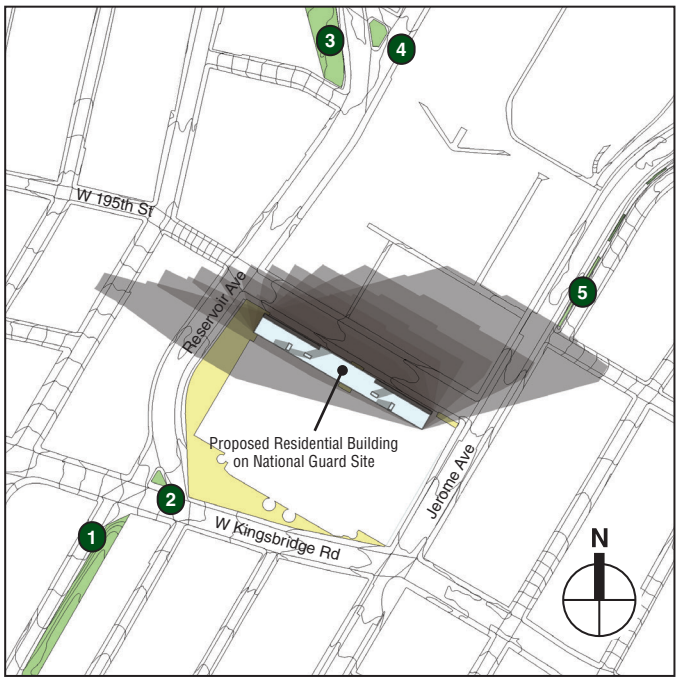
Notes:
See **Figure 6-2** for corresponding resource locations and shadow sweeps.
In the columns representing the analysis dates, "No" means project-generated shadow could not reach the resource, even without accounting for intervening buildings. "Potential" means project-generated shadow could potentially reach the resource on this date and requires further assessment.

The Tier 3 assessment concluded that the southern edge of the Jerome Avenue Greenstreets plantings could potentially be reached by project-generated shadow at the end of the March 21/September 21 analysis date, and Barnhill Square could potentially

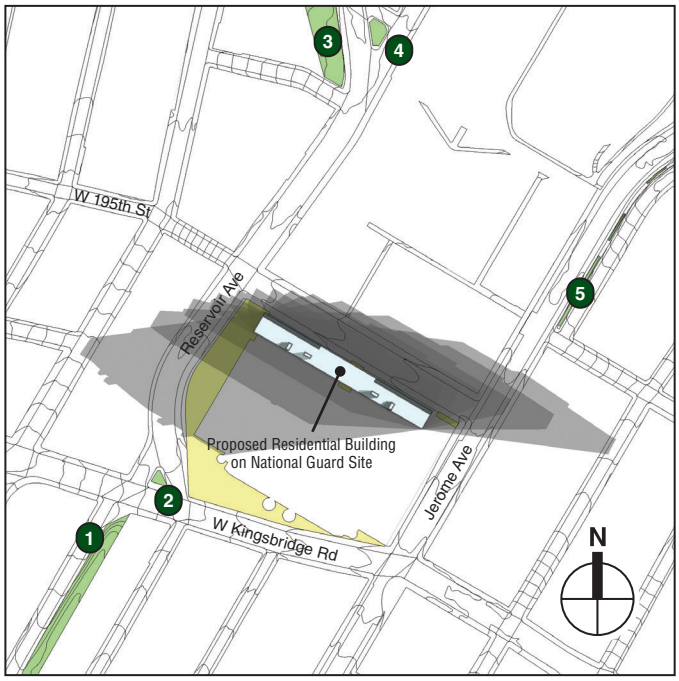
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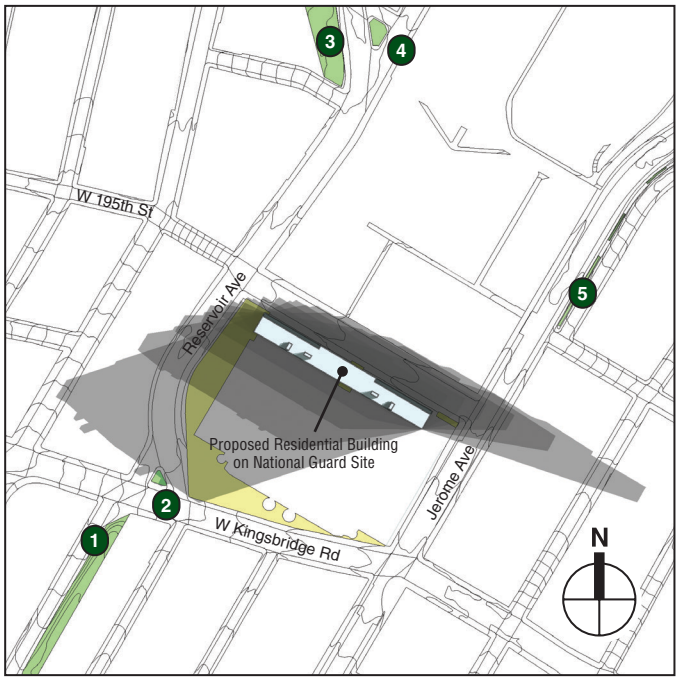
December 21



March 21 / September 21



May 6 / August 6



June 21

Publicly Accessible Open Space

Project-Generated Open Space

Map Key Open Space Resource

1. Aqueduct Walk
2. Barnhill Square
3. Washington's Walk
4. Croton Aqueduct Triangle
5. Greenstreets, Jerome Ave and E 196th St

This figure illustrates the range of shadows that would occur from the proposed building on each of the four representative analysis days. The shadows are shown occurring approximately every 60 minutes from the start of the analysis day (90 minutes after sunrise) to the end of the analysis day (90 minutes before sunset). The Tier 3 assessment does not account for future No Action shadows, and the shadows shown in this figure do not represent incremental shadows. The Tier 3 assessment serves to illustrate the daily path or "sweep" of the proposed building's shadows across the landscape, indicating which resources could potentially be affected on that analysis day, absent intervening or surrounding buildings, by project-generated shadow. Daylight Saving Time was not used, per *CEQR Technical Manual* guidelines.

Tier 3 Assessment

be reached at the start of the June 21 analysis date, and therefore these resources required further analysis on these dates. The other three resources could not be reached by project-generated shadow on any analysis date and required no further analysis.

D. DETAILED SHADOW ANALYSIS

A detailed analysis is warranted when the screening assessment does not rule out the possibility that project-generated shadows would reach sunlight-sensitive resources. The detailed analysis establishes a baseline condition, the No Action condition, to illustrate the shadows cast by existing buildings (and other planned developments in the vicinity expected to be completed by the Proposed Project's build year). This baseline is then compared to the With Action condition to distinguish the additional (incremental) shadow cast by the Proposed Project. The purpose of the detailed analysis is to determine the extent and duration of new incremental shadow that would be cast on a sunlight-sensitive resource as a result of the Proposed Project. Because existing (or future No Action) buildings may already cast shadows on a sunlight-sensitive resource, the Proposed Project may not result in additional, or incremental, shadows on that resource.

Following the analysis framework described in Chapter 1, "Project Description," a detailed analysis was performed for the analysis year of 2032, comparing the Proposed Project to the future No Action condition. In the No Action condition, it is assumed that none of the Proposed Actions would be sought or approved, and the Project Site would remain unchanged from its current state. To represent future baseline conditions, three-dimensional representations of existing buildings and future planned developments in the study area were added to the 3D model using best-available spatial and imagery data from the City, Nearmap, and other sources, and information from publicly available filings with the New York City Department of Buildings.

Shadows are in constant movement. The computer simulation software produces a minute-by-minute animation showing the movement of shadows over the course of each analysis period. The analysis determines the time when incremental shadow would enter each resource, and the time it would exit. Shadow analyses were performed for each of the representative days and analysis periods indicated in the Tier 3 assessment.

DETERMINATION OF IMPACT SIGNIFICANCE

The determination of significance of shadow impacts on a sunlight-sensitive resource is based on (1) the information resulting from the detailed shadow analysis describing the extent and duration of incremental shadows; and (2) an analysis of the resource's sensitivity to reduced sunlight. The goal of the assessment is to determine whether the effects of incremental shadows on a sunlight-sensitive resource are significant under CEQR.

A shadow impact occurs when the incremental shadow from a proposed project falls on a sunlight-sensitive resource or feature and reduces its direct sunlight exposure. Determining whether this impact is significant or not depends on the extent and duration of the incremental shadow and the specific context in which the impact occurs.

Per CEQR, a significant shadow impact generally occurs when an incremental shadow of 10 minutes or longer falls on a sunlight-sensitive resource and results in one of the following:

- **Vegetation:**
  - A substantial reduction in sunlight available to a sunlight-sensitive feature of the resource to less than the minimum time necessary for its survival (when there was sufficient sunlight in the No Action condition). In the growing season, six to eight hours of direct sunlight is typically a minimum requirement for vegetation. Four to six hours a day of sunlight is a minimum requirement for vegetation that can tolerate partial sun, such as established tree canopies, shrubs, or perennials.
  - A reduction in direct sunlight exposure where the sensitive feature of the resource is already subject to substandard sunlight (i.e., less than the minimum time necessary for its survival).
- **Historic and Cultural Resources:**
  - A substantial reduction in sunlight available for the enjoyment or appreciation of the sunlight-sensitive features of a historic or cultural resource.
- **Open Space Utilization:**
  - A substantial reduction in the usability of open space as a result of increased shadows, accounting for anticipated new users and the open space's utilization rates throughout the affected time periods.
- **For Any Sunlight-Sensitive Feature of a Resource:**
  - Complete elimination of all direct sunlight on the sunlight-sensitive feature of the resource, when the complete elimination results in substantial effects on the survival, enjoyment, or, in the case of open space or natural resources, the use of the resource.

SUMMARY OF ANALYSIS RESULTS

The detailed analysis showed that no new shadow would fall on the two analyzed resources. The southern edge of the Jerome Avenue Greenstreets plantings would be in pre-existing shadow from the elevated subway line above Jerome Avenue for several minutes when shadow from the new residential building could otherwise reach it. Barnhill Square would be in pre-existing shadow from the Armory building during the first several minutes of the June 21 morning when shadow from the new residential building could otherwise reach it.

PROJECT-GENERATED OPEN SPACE

As described in Chapter 1, "Project Description," and Chapter 5, "Open Space," the Proposed Project would include the development of new publicly accessible open space, which would largely be concentrated in the areas west and south of the Armory along Reservoir Avenue and West Kingsbridge Road. The open space is being designed to maximize the Project Site's optimal location by creating a flexible plaza that can support community interests while also providing varied programming to complement the new uses at the Armory. The open space would include landscaping, planted areas, paved public plazas, and seating areas. In comparison, absent the Proposed Project, the new publicly accessible open space would not be developed on the Project Site, and the areas south and west of the Armory would remain fenced off and underutilized.

Per *CEQR Technical Manual* guidelines, the Proposed Project could not result in a significant adverse shadow impact to open space that would be developed as part of the Proposed Project, because without the Proposed Project, the Project Site open space would not be created. However, shadow effects on the proposed open space were assessed for disclosure purposes, and to inform the open space's programming as the design progresses.

The assessment showed that the southern part of the open space, along West Kingsbridge Road, would generally be sunny virtually all day throughout the year, with the exception of early mornings in the spring, summer, and fall, when shadow from the Armory would briefly fall on it. The western part of the open space along Reservoir Avenue would generally be shady in the mornings (primarily from the Armory), and sunny in the afternoons. Shadow from the proposed residential building on the National Guard Site would only ever affect the northwest corner of the open space, in the mornings of the spring, summer, and fall, and negligibly in winter.

E. CONCLUSIONS

The analysis concluded that Proposed Project would not result in any new shadows on sunlight-sensitive resources as described in detail above, and therefore would not result in any significant adverse shadow impacts. ✷