2.E SHADOWS

INTRODUCTION

As described in Chapter 1, Project Description, the Proposed Action would result in the construction of several new buildings on the properties under control of the applicant plus additional residential development on sites not controlled by the applicant. As modeled under the reasonable worst-case development scenario for this analysis, the buildings projected on these development sites, collectively, would range in height between 42 feet and 178 feet. This chapter assesses whether the Proposed Action would result in new shadows that would create a significant adverse impact on any nearby shadow-sensitive resources, including publicly accessible open spaces, historic resources with sunlight-dependent architectural features, or important natural features.

PRINCIPAL CONCLUSIONS

The incremental shadows generated by the full build out of the Proposed Action on the development sites in 2022 would not cause a significant adverse shadow impact. There are no shadow-sensitive historic structures within the area of potential shadow impacts. The Proposed Action would not result in significant new shadows being cast on any nearby open space during any of the CEQR seasonal analysis periods, with the exception of Boone Slope Park. However, Boone Slope Park, which measures 0.03 acres and is steeply sloped, is not publically accessible, and there are no current plans for its improvement to make it publically accessible. In the event the park was to someday be redeveloped for public use, the redesign could include varieties of vegetation which would be suitable for the resultant exposure times to direct sun. The two park areas for which sun exposure is important to existing or proposed vegetation (Starlight Park/Bronx River Greenway and Drew Gardens) would each still receive more than seven hours of direct sunlight in any analysis period, and therefore existing vegetative patterns would not be affected. Incremental shadows in Starlight Park and the Bronx River Greenway would not affect planned activities in those parks. West Farms Square at the northeast corner of East Tremont Avenue and Boston Road would experience only 50 minutes of incremental shadows during the winter solstice period, and then only at the end of the analysis period ending one and one-half hours before sunset. Each of the schoolyards in the analysis area (PS 6, PS 214, and PS 66) would experience additional incremental shadows either in the early hours of the day (PS 6, from 8:45 to 9:30 AM on the winter solstice only) or in the afternoon hours after the school day (PS 66 for 45 minutes during the summer solstice, at the end of the analysis period ending at 7:00 PM. No incremental shadows would be cast on the PS 214 playground before 3:00 PM during the equinoxes, the midpoints between the equinoxes, and the summer solstice. No incremental shadows would be cast on this playground during the winter solstice. The two open spaces further to the east (the 174th Street Playground and the HS 692/690/550/680 playing field) would either experience incremental shadows of five minutes or less during any analysis period (the 174th Street Playground) or no incremental shadows (the HS 692/690/550/680 playing field).

Special shadow impact analyses were undertaken for the Bronx River and the Bronx River House, a boathouse and multipurpose building that would be built within Starlight Park. This later special analysis was undertaken because photo voltaic solar panels are proposed atop the roof of the Bronx River House.

The special shadow impact study for the Bronx River showed that no significant impacts would be expected because the durations of shadows on the river would be relatively short and only at the end of the day during any analysis period. The analysis also showed that currents in the river

would minimize the time phytoplankton and other organisms would be in the shadows of Proposed Action buildings. No significant shadow impacts on the Bronx River are expected.

The special impact study undertaken for the Bronx River House also indicated that shadows cast by the Proposed Action would have a de minimus effect on power output from the proposed solar panels atop that building, again because of the short duration of the shadows and the late hour in the day when such shadows would cover the panels. The annual projected loss in power produced by the proposed solar panels was 1.04 percent. No significant shadow impacts on the Bronx River House solar panels are expected.

METHODOLOGY

Shadows vary according to time of day and season. Morning and evening shadows, when the sun is low in the sky, are longer, while midday shadows are shorter. Shadows in winter, when the sun arcs low across the southern sky, are longer throughout the day than at corresponding times in spring and fall, and in summer the high arc of the sun casts shorter shadows than at any other time of year. Early and late shadows in summer fall much farther towards the south than early and late shadows in winter.

According to the *CEQR Technical Manual*, a significant shadow impact may occur when there is substantial reduction in sunlight to a sun-sensitive use or feature, threatening the survival of vegetation or significantly reducing the usability of the open space, or in the case of an historically significant architectural feature, obscuring the elements or details that make that resource significant. The determination of impact significance is based on an assessment of how a project's incremental shadows specifically would affect sun-sensitive features of individual resources. However, as noted previously, there are no such sun-sensitive historic resources within the study area for the Proposed Action. (Also see Chapter 2.F, Historic Resources.) Therefore, the screening and detailed analyses discussion focuses on the open space and natural resources in the area. It should be noted that CEQR does not consider shadows on City streets, sidewalks, and other buildings to be significant.

In accordance with the criteria in the 2010 *City Environmental Quality Review (CEQR) Technical Manual ("CEQR Technical Manual")*, an analysis of shadows is conducted to determine whether a Proposed Action would cause a significant adverse impact on open spaces, natural features, or sun-sensitive historic resources. According to the *CEQR Technical Manual*, a shadows analysis is required for any action that would result in new structures or additions to existing structures that would be located near sun-sensitive resources (particularly actions that propose buildings 50 feet high or taller than existing conditions). As described below, building heights on the development sites would range in maximum height between approximately 42 and 178 feet. Therefore, the Proposed Action could result in an increase in shadows falling on nearby sun-sensitive resources.

The CEQR methodology does not consider shadows and incremental increases in shadows within 1½ hours of sunrise or sunset to be significant. Therefore, the analysis period on each of the four representative days is between 1½ hours after sunrise and 1½ hours before sunset. Additionally, CEQR does not consider shadows on city streets, sidewalks, and other buildings to be significant.

An adverse shadow impact is considered to occur when the shadow from projected/potential development falls on a publically accessible open space, historic landscape, or other historic resource if the features that make the resource significant depend on sunlight, or if the shadow falls on an important natural feature and adversely affects its use and/or important landscaping and vegetation. The uses and vegetation in an open space establish its sensitivity to shadows. Uses that rely on sunlight include passive use, such as sitting or sunning, and such activities as gardening, or children's wading pools and sprinklers. Vegetation requiring sunlight includes tree

canopy and flowering plants. Where lawns are actively used, the turf also requires extensive sunlight. For these activities and plants, four to six hours a day of sunlight, particularly in the growing season (defined as April to October), is often a minimum requirement.

The next step in the assessment of a project's shadow impacts is to determine whether project generated shadows would be long enough to reach any shadow-sensitive open spaces, natural features, or architectural resources at any time of year. If this preliminary or screening analysis indicates they might, then a detailed shadow analysis is warranted. The detailed analysis determines the extent and duration of project-generated incremental shadows on any sun-sensitive uses and vegetation of open spaces, or sunlight-sensitive features of architectural resources, and assesses the effects of new shadows on such resources.

Following the guidelines of the *CEQR Technical Manual*, this detailed analysis begins with and considers shadows on four representative days of the year: March 21 (equivalent to September 21, the equinoxes); June 21, the summer solstice; May 6 (equivalent to August 6, the midpoints between the equinoxes and summer solstice); and December 21, the winter solstice. As noted previously, the CEQR methodology does not consider shadows and incremental increases in shadows within 1½ hours of sunrise or sunset to be significant. Therefore, the analysis period on each of the four representative days is between 1½ hours after sunrise and 1½ hours before sunset.

PROPOSED ACTION CHARACTERISTICS

The Proposed Action would rezone the directly affected area to allow taller buildings than are currently permitted and to allow residential development where it is not now permitted. The proposed rezoning area is long and narrow, extending linearly in a north-northeast to south-southwest direction, along the long dimensions of seven blocks (with a multilane highway separating the two northernmost blocks from the rest of the area), but is only a block to a block and a half in width (along the short dimensions of the blocks). The southern end of the rezoning area is the intersection of Freeman Street and Boone Avenue; the northern end is the intersection of Tremont Avenue, Boston Road, and West Farms Road. There are no development sites, however, in the southernmost part of the rezoning area, south of the midpoint between Jennings and 172nd Streets. The eastern boundary is West Farms Road (except for the southernmost block, where it is the Sheridan Expressway). The western boundary is Boone Avenue at the southern end, which then jogs westward at East 172nd Street to the midpoint between Boone and Longfellow Avenues, and continues along Longfellow Avenue north of the Cross Bronx Expressway. South of the Cross Bronx Expressway, there is a marked change in grade between the eastern and western edges of the rezoning area, marking a descent from higher terrain to the west down to the valley in which the Bronx River runs. To the west of the rezoning area is a predominantly residential neighborhood, and to the east are the multilane Sheridan Expressway and a combination of open area (to the north) and industrial development (to the south) alongside the Bronx River.

Various portions of the study area would be rezoned to R6A, R7A, R7X, and R8X districts. The tallest buildings would be confined to the R8X districts that would be mapped on the two blocks north of the Cross Bronx Expressway and along the west side of West Farms Road to a line 70 feet east of Boone Avenue on Block 3014 (between East 172nd and East 173rd Streets) and extending 170 feet south of East 172nd Street on Block 3013. The R7X district would be mapped along the west side of West Farms Road (to a line 100 feet east of Boone Avenue) south of the Cross Bronx Expressway. Building heights would step down from east to west, with an R7A district mapped along the east side of Boone Avenue and an R6A district mapped along the avenue's west side. The longest shadows (occurring near sunrise and sunset at the time of the

winter solstice) cast by the tallest new buildings would be approximately 760 feet long, and the longest shadows cast by buildings in the R6A district would extend approximately 300 feet.

The study area for the shadow analysis is derived from the screening analysis, when the full extent of the area that could be reached by shadows generated by the Proposed Action is calculated for each of the analysis days and delineated on a street map. Because the winter solstice is the time of year when maximum shadow lengths occur, this date is used in the construct of the screening analysis for the northern extent of the potential shadows. Because the maximum extent of potential shadows towards the south occurs with the summer solstice, it also is used to construct the screening analysis.

The reasonable worst-case development scenario massing used in this analysis for the development sites under control of the applicant and subject to the Large Scale General Development special permit assumes those specific building designs which will be controlled by the special permit. For all other projected and potential development sites, the building envelopes were derived to maximize the permissible floor area ratio (and height) under the proposed rezoning. Table E-1 lists each development site and the associated building heights used for the building at that development site.

Table E-1: Height of Proposed Buildings Analyzed

Projected Building Heights in Feet at the Projected and Potential Development Sites	
Parcel 1 (Block 3013) /1,2	177.99
Parcel 2N (Block 3014 North) /1,2	174.29
Parcel 2S (Block 3014 South)/1,2	169.77
Parcel 3B	70 ft
Parcel 8	150 ft
Parcel 9D	150 ft
Non-Applicant Controlled Projected Development Sites	
3A	70 ft
3D	70 ft
3E	70 ft
4A	80 ft
4B	80 ft at Boone
4B	125 ft at West Farms
4C	80 ft at Boone
4C	125 ft at West Farms
5A	70 ft
5B	70 ft
5C	70 ft
5D	70 ft
5E	70 ft
6A	80 ft
6B	80 ft
6C	80 ft
6E	80 ft at Boone
6E	125 ft at West Farms
6G	125 ft
7A	70 ft
7B	70 ft
9C	150 ft
9E	150 ft
Non-Applicant Controlled Potential Development Sites	
3C	70 ft
4D	80 ft
4E	125 ft
4F	80 ft at Boone
4F	125 ft at West Farms
6D	80 ft
6F	125 ft
9A	150 ft
9B	150 ft
1/ Height is subject to LSGD Permit	
2/ Heights for buildings in the LSGD are indicated to top of elevator/mechanical penthouses	

The Proposed Action would create areas of publically accessible open space on the LSGD site (Blocks 3013 and 3014). According to CEQR methodology, shadows cast on open spaces that are part of a proposed project are not considered impacts of an action because without the action, the open space would not exist.

A screening analysis was performed to determine which open spaces, sunlight-sensitive historic resources, or important natural features could be affected by shadows from the Proposed Action at any time of year. To identify resources of concern, the maximum shadow length was calculated for the proposed development that would result on the various projected and potential development sites, taking into account time of day as well as season. For example, on the December 21 analysis day a building has a maximum shadow length factor equal to 4.3 times its height at the beginning and end of the analysis period when shadows are cast to the northwest and northeast, respectively. Toward midday, as the sun rises in the sky, the shadow length factor is reduced to 2.07 times the height of the building. Shadow length factors for the other analysis days throughout the calendar year are shorter than they are in December. However, the daylight hours are longer during the rest of the year, resulting in longer analysis periods and shadows that fall farther towards the southwest and southeast at the beginning and end of the day. During the December analysis day, shadows are cast up to 43 degrees east and west of true north, but in June shadows are cast up to 108 degrees east and west. Therefore, open spaces in the southern portion of a study area that could be reached by shadows in June would not be affected in December.

Results of the Screening Analysis

Resources of Concern

There are no historic resources in the vicinity of the rezoning area, but there are several public open spaces and schoolyards, and one natural resource (the Bronx River) which fall within the maximum shadow lines that might be cast by buildings resulting from implementation of the Proposed Action. (All are shown in Figure E-1.) None of the schoolyards are publically accessible. However, they are analyzed here because of the important resource they are to the schools. The potentially affected resources are as follows:

Parks

Starlight Park/Bronx River Greenway and Bronx River

Starlight Park is a mapped park between the Sheridan Expressway and the Bronx River, from East 172nd Street to East 174th Street, to the east of the rezoning area. Environmental remediation has been completed to prepare it for redevelopment as a recreational open space. Starlight Park is currently undergoing a major renovation and is scheduled to re-open to the public in 2012. When completed, the park will have ball fields, playgrounds, landscaped areas, a floating dock, and a boathouse. The link of the Bronx River Greenway in the immediate vicinity of the park stretches along the Bronx River between Westchester Avenue to the south and Tremont Avenue to the north, to the north and south of Starlight Park. Because of the large expanse of Starlight Park and the Bronx River Greenway, their land areas have been divided into sectors (See Figure E-1) for the purposes of the shadow analysis. The Bronx River meanders along the Bronx River Greenway, which when complete will extend the full 23 miles of the river.

It should be noted that although DPR has every intention to complete the Bronx River Greenway and Starlight Park as illustrated herein, that due to issues of funding and Amtrak coordination the actual completion date for certain sectors as described below is not known. Therefore, it is assumed for this EIS that these sectors will not be completed by the analysis year (2022) for the Proposed Action. These sectors include the area east of the Bronx River between East 172nd and 177th Streets (Sectors A4, A5, A6, and A7 in Figure E-1), and the area between Westchester

Avenue and East 172nd Street flanking the Amtrak right-of-way (Sectors B1 and B2 in Figure E-1). Although the funds and/or coordination with Amtrak do not allow for the completion of the Starlight Park and Bronx River Greenway at the present, DPR is actively working to resolve these issues, and these resources will at some point in the future be completed in accordance with DPR conceptual plans.

Activities within these park sectors include the following:

A-1 Starlight Park: Parking, kayak launch, a boat house and comfort station, and a double floating dock.

A2.1 and A2.2 Starlight Park: Multipurpose playing field (soccer, baseball, football, etc.) and a basketball court at the northern edge of these sectors.

A3 Starlight Park: Passive open space, playground for young children, and a play area for older children with a spray sprinkler area between the two.

A4, A5, A6, and A7 Bronx River Greenway: Passive open space with pathways. The area is already vegetated with new planting expected when the Greenway portion of the project is advanced. As noted above, these sectors will be constructed at a later date.

B1 and B2 Bronx River Greenway: Passive open space with pathways. As noted above, these sectors will be constructed at a later date.

C1, C2, and C3 Bronx River Greenway: Passive open space with pathways, active/passive open space in the form of a large multi-purpose lawn for pickup games (soccer, frisbee), events sunbathing and picnicking, a loop bordering the open lawn for walking or jogging.

C4 Bronx River Greenway. Passive open space with pathways and active/passive open space in the form of a multi-purpose lawn. Construction of this sector is being implemented by NYCDOT via the NYC Department of Design and Construction (DDC).

Drew Gardens

Drew Gardens is a larger open space, consisting of gardens and trees along the western shore of the Bronx River just south of Tremont Avenue, which is a block east of the northernmost development site.

Boone Slope Park

Boone Slope Park is a mapped but undeveloped small (0.03 acre) park that is now an inaccessible vacant, vegetated lot surrounded by fencing. It is steeply sloped. It is within the rezoning area (but would remain unzoned), between West Farms Road and Boone Avenue just south of an exit ramp from the Cross Bronx Expressway, to the immediate north of a development parcel. Although there are no plans and no funding to transform the lot into a functioning open space in the foreseeable future, it is included in the inventory of shadow sensitive locations because it is a mapped park and therefore a potential future open space resource. Also, because the extent of shadows on the park from the Proposed Action varies so greatly from its northern to southern sections, it has been divided into two sectors; one to the north, and one to the south. (See Figure E-1.)

West Farms Square

There is a small triangle with seating (benches) at the northeast corner of Boston Road and Tremont Avenue, northeast of the northernmost development parcel within the rezoning area. The area is paved; the only vegetation is street trees.

Schoolyards, Playgrounds and Playing Fields

P.S. 6 Schoolyard

The schoolyard is located on the south side of P. S. 6, a school on the south side of Tremont Avenue between Bryant and Vyse Avenues. The schoolyard is a block west of the rezoning area. The schoolyard is all paved with one basketball and one volleyball court. It is not accessible to the public.

P.S. 214 Schoolyard

This schoolyard is on the south side of P. S. 214, on the east side of West Farms Road north of Rodman Place, directly across West Farms Road from a portion of the rezoning area that would be zoned R8X. The schoolyard is completely paved with three tennis courts striped on the paved surface and not accessible to the public.

P.S. 66 Schoolyard

This schoolyard is on the north side of P. S. 66, on the west side of Boone Avenue on part of the midblock between Jennings and East 172nd Streets, southwest of the southernmost development site. The schoolyard is completely paved with no vegetation, and not accessible to the public.

174th Street Playground

This one acre park is located near the intersection of East 173rd Street and Manor Avenue, and contains seating, play equipment and a pool. This playground is publically accessible.

H.S. 692/690/550/680 Playing Field

This playing field serves the adjacent high school and occupies more than half of a city block. However, it also is not accessible to the public and is reserved for school use.

Natural Resources

There is one important natural resource within the potential shadow impact area, and that is the Bronx River. As described in the City's Draft Bronx River Waterbody/Watershed Facility Plan,

> "The Bronx River is a tributary of the East River and flows generally from north to south through Westchester County and central Bronx County. The headwaters of the Bronx River are at Davis Brook and the Kensico Dam and extend to the mouth between Hunts Point and Classon Point along the East River. The northern portion of the river upstream of East Tremont Avenue is freshwater. South of this point, the river is tidally influenced and generally brackish.
>
> In the 17th Century the Bronx River was referred to as Aquehung or "River of High Bluffs" by the Mohican Indians who first lived off of the river. At the beginning of the 18th Century, roughly 12 water mills were producing paper, pottery, flour, tapestries, and snuff along the Bronx River. Much of the valley remained densely vegetated and forested well into the 19th Century. However, in the 1840s during railroad construction, the valley was turned into an industrial corridor. In 1905, Westchester County constructed the Bronx River Valley Sewer which discharged into the Bronx River. New York City's demand for water continued to rise and the construction of the Kensico Dam diverted the upper reaches of the Bronx River into the reservoir, cutting the river's water flow by approximately 25 percent in 1915. The river's history since the 1880s has been an effort to reclaim and protect it from urbanization. In 1888, Bronx Park was created by

consolidation of surrounding properties to buffer against development on both sides of the river. The Bronx River Parkway was completed in 1925, and includes a collection of lakes, parks, and limited access roadways stretching from the Kensico Dam to Bronx Park. Throughout the 1960s and 1970s, city and state highway projects distanced the

Bronx River communities from each other as well as the river. In 1974, as a response to the poor conditions of the Bronx River, local residents formed the Bronx River Restoration Project, Inc. The group was successful in removing debris from the shoreline of the Bronx River. In 1996, the Restoration Project was strengthened with the Bronx Riverkeeper Program, created in a partnership with the City of New York Parks and Consolidated Edison Corporation. In 1997 the Bronx River Working Group expanded the effort to include over 60 community groups, government agencies, schools, and businesses. Additionally, the Bronx River Alliance was created in 2001 as the next step in the effort to restore and protect the Bronx River.

The freshwater portion of the Bronx River within New York City is classified as a Class B waterbody with best usages of primary and secondary contact recreation and fishing. The tidal portion of the Bronx River is classified by the State of New York as a Class I waterbody, with designated best usages of secondary contact recreation and fishing. To support these uses, numerical criteria for dissolved oxygen (DO) and bacteria concentrations have been established, but both the numerical and narrative standards require that contravention never occur. The freshwater portion is in compliance with DO standards. Historical dissolved oxygen concentrations are frequently found to show impairments and excursions below the allowable levels in the tidal section. However, recent water quality modeling shows compliance with the 4.0 mg/L standard in the tidal portion of the Bronx River varies from 83 to 100 percent.

Total and fecal coliform bacteria data indicate that recreational uses of the Bronx River are impaired in the freshwater section of the Bronx River and the first half mile of the tidal portion immediately downstream of the freshwater section. Water quality modeling indicates that upstream flows entering the City must be greatly improved for standards attainment to be realized. Upstream communities have been working to improve water quality, and Westchester County and the NYCDEP recently completed a joint sampling program to augment the limited data set available on existing water quality conditions."[1]

As for Starlight Park and the Bronx River Greenway, the same sectors were established for purposes of discussing geographical limits of incremental shadow locations.

Other Sun-Sensitive Resources

Within Starlight Park, along the Bronx River, a facility named the Bronx River House is planned. This facility will include a boathouse, offices, a multipurpose room and a classroom. The building will have a total of 7,000 square feet, and will have photo voltaic solar panels installed atop its roof.

Because potentially shadow sensitive sites are within the area which could become subjected to Proposed Action shadows, a detailed analysis has been prepared, as described below.

[1] New York City Draft Bronx River Waterbody/Watershed Facility Plan

Description of the Detailed Analysis

The detailed analysis compares shadows generated by the Proposed Action to a baseline condition representing the future without the Proposed Action. As described in the project description, the year for the full build-out of this project is 2022. The future without the Proposed Action baseline condition assumes that none of the proposed discretionary actions are approved, and that all the existing structures on the project sites would remain, with the exception of the parcel at the far northern end of the area to be rezoned (referenced as Parcel 9C in the project description). This analysis therefore compares shadows that would be cast by the Proposed Action to those that would be cast by the existing structures and the 9C parcel in the 2022 future without the Proposed Action.

For the detailed analysis, shadows were modeled using the solar rendering capabilities of Autodesk Revit Architecture 2010. A three-dimensional model was provided by Dattner Architects. Existing buildings were modeled based on information compiled from New York City Department of Buildings' Building Information System (BIS), New York City's Open Accessible Space Information System (OASIS) and the Sanborn Map Company (Insurance Maps of New York). Existing topography was modeled based on information compiled from the US Geological Survey and land surveys provided by Control Point Associates and Joseph Nicoletti Associates for the Applicant Controlled Development Sites. Buildings in applicant controlled development sites are based on reasonable worst case scenarios for Parcels 3B, 8 and 9 and subject to LSGD permit for Parcels 1, 2N and 2S. Buildings in non-applicant controlled properties are based on reasonable worst case zoning envelope scenarios.

In accordance with *CEQR Technical Manual* procedures, shadow diagrams (included as Figures E-2 through E-40) were prepared, which show shadows cast by the anticipated new projected and potential buildings as well as existing shadows at 9 AM, 12 noon, and 3 PM for the spring and fall equinoxes (March 21 and September 21), the summer solstice (June 21), the winter solstice (December 21), and interim dates midway between the spring and fall equinoxes and the summer solstice (May 6 and August 6). Additional analysis hours for each of the analysis days were added to illustrate incremental shadows, as necessary. All times are shown according to Daylight Savings Time or Eastern Standard Time, whichever is applicable for the analysis date. The diagrams show the locations of the open spaces listed above. Because the daily duration of sunlight a particular resource may get is so important, especially during the growing seasons, a separate analysis was conducted for buildings and resources to the east of the Bronx River. (See Figures E-32 through E-40.) Any effect on the duration of sunlight hours at any of the sensitive resources is reflected in Table E-2 below.

The diagrams distinguish between shadows that would exist without the Proposed Action and the additional shadows that would be cast by development resulting from the Proposed Action, falling on locations that would otherwise be in sunlight. With one exception, the former are shadows from existing buildings. As described previously, the exception involves the northernmost development parcel within the proposed rezoning area, within the triangle just south of the intersection of Boston Road and West Farms Road, which will be redeveloped whether or not the Proposed Action is taken (referenced as Parcel 9C). Since the action would rezone that site from R7-1 to R8X, a larger, taller building would be constructed in the future action scenario. The shadow diagrams show the shadows from the as-of-right R7-1 building as "shadow from existing buildings," as the legend in each figure identifies them, and the additional shadows that would result from the larger R8X building as "incremental shadow from proposed building."

It should be noted that, because of the changing solar angle, shadows are longest at the time of the winter solstice and shortest at the time of the summer solstice. Shadows grow progressively longer between June 21 and December 21, then progressively shorter from December 21 to June 21. On any day, shadows are longest near sunrise and sundown and shortest at noon.

Results of the Detailed Shadow Analysis

The above described methodology yielded the results in Table E.2 below for each of the shadow sensitive land uses within the potential area that could receive incremental shadows.

Table E-2: Incremental Shadow Durations

Resource / Sectors	Equinoxes (March 21 and September 21)	Midpoints between Summer Solstice and Equinoxes (May 6 and August 6)	Summer Solstice (June 21)	Winter Solstice (December 21)
	Analysis times 8:30 AM - 5:39 PM EST	Analysis times 7:19 AM - 6:26 PM EST	Analysis times 7:00 AM - 7:00 PM EST	Analysis times 8:45 AM - 3:00 PM EST
	Sunrise 7:00 AM & Sunset 7:09 PM EST	Sunrise 5:49 AM & Sunset 7:56 PM EST	Sunrise 5:30 AM & Sunset 8:30 PM EST	Sunrise 7:15 AM & Sunset 4:30 PM EST
Starlight Park				
Sector A1				
Incremental Shadow Times	3:39 PM to 5:39 PM	3:45 PM to 6:26 PM	4:15 PM to 6:50 PM	–
Sunlight Duration (no action / action)	9 h 09m / 7 h 09m	11 h 07m / 8 h 26m	12 h 00m / 9 h 25m	–
Incremental Shadow Duration	2 h 00m	2 h 41m	2 h 35m	–
Incremental Shadow Coverage (% of sector)	47% at 4:30pm / 70% Max. at 5:30pm	53% at 4:55pm / 85% Max. at 6:00pm	49% at 5:15pm / 70% Max. at 6:15pm	–
Sector A2.1				
Incremental Shadow Times	3:39 PM to 5:39 PM	3:40 PM to 6:26 PM	3:45 PM to 7:00 PM	–
Sunlight Duration (no action / action)	9 h 09m / 7 h 09m	11 h 07m / 8 h 21m	12 h 00m / 8 h 45m	–
Incremental Shadow Duration	2 h 00m	2 h 46m	3 h 15m	–
Incremental Shadow Coverage (% of sector)	53% at 4:15pm / 97% Max. at 5:30pm	55% at 4:55pm / 90% Max. at 6:00pm	41% at 5:15pm / 76% Max. at 6:15pm	–
Sector A2.2				
Incremental Shadow Times	4:30 PM to 5:39 PM	4:55 PM to 6:26 PM	5:15 PM to 7:00 PM	–
Sunlight Duration (no action / action)	9 h 09m / 7 h 30m	11 h 07m / 9 h 36m	12 h 00m / 10 h 15m	–
Incremental Shadow Duration	1 h 39m	1 h 31m	1 h 45m	–
Incremental Shadow Coverage (% of sector)	47% at 4:45pm / 100% at 5:30pm	51% at 5:25pm / 80% Max. at 6:00pm	45% at 6:00pm / 58% Max. at 6:15pm	–
Sector A3				
Incremental Shadow Times	4:15 PM to 5:39 PM	4:05 PM to 6:20 PM	4:30 PM to 6:50 PM	–
Sunlight Duration (no action / action)	9 h 09m / 7 h 45m	11 h 07m / 8 h 52m	12 h 00m / 9 h 40m	–
Incremental Shadow Duration	1 h 24m	2 h 15m	2 h 20m	–
Incremental Shadow Coverage (% of sector)	52% at 4:45pm / 62% Max. at 5:30pm	50% at 5:00pm / 95% Max. at 6:00pm	60% at 5:30pm / 80% Max. at 6:15pm	–
Boathouse				
Incremental Shadow Times	4:45 PM to 5:39 PM	5:10 PM to 6:20 PM	5:30 PM to 6:45 PM	–
Sunlight Duration (no action / action)	9 h 09m / 8 h 15m	11 h 07m / 9 h 53m	12 h 00m / 10 h 45m	–
Incremental Shadow Duration	0 h 54m	1 h 10m	1 h 15m	–

Table E-2: Incremental Shadow Durations (Continued)

Bronx River Greenway				
Sector C1				
Incremental Shadow Times	3:30 PM to 5:39 PM	3:40 PM to 6:25 PM	3:50 PM to 6:50 PM	2:45 PM to 3:00 PM
Sunlight Duration (no action / action)	9 h 09m / 7 h 00m	11 h 07m / 8 h 22m	12 h 00m / 9 h 00m	6 h 15m / 6 h 00m
Incremental Shadow Duration	2 h 09m	2 h 45m	3 h 00m	0 h 15m
Incremental Shadow Coverage (% of sector)	65% Max. at 5:00pm	45% at 5:30pm / 70% Max. at 6:00pm	45% at 6:00pm / 60% Max. at 6:15pm	13% Max. at 3:00pm
Sector C2				
Incremental Shadow Times	4:15 PM to 5:37 PM	5:05 PM to 6:26 PM	5:15 PM to 7:00 PM	–
Sunlight Duration (no action / action)	9 h 09m / 7 h 47m	11 h 07m / 9 h 46m	12 h 00m / 10 h 15m	–
Incremental Shadow Duration	1 h 22m	1 h 21m	1 h 45m	–
Incremental Shadow Coverage (% of sector)	55% Max. at 5:30pm	45% at 6:00pm / 75% Max. at 6:20pm	25% at 6:15pm / 72% Max. at 6:55pm	–
Sector C3				
Incremental Shadow Times	5:15 PM to 5:37 PM	5:40 PM to 6:26 PM	6:00 PM to 7:00 PM	–
Sunlight Duration (no action / action)	9 h 09m / 8 h 47m	11 h 07m / 10 h 21m	12 h 00m / 11 h 00m	–
Incremental Shadow Duration	0 h 22m	0 h 46m	1 h 00m	–
Incremental Shadow Coverage (% of sector)	25% Max. at 5:30pm	34% Max. at 6:20pm	36% Max. at 6:55pm	–

Table E-2: Incremental Shadow Durations (Continued)

Drew Gardens				
Incremental Shadow Times	4:25 PM to 5:37 PM	4:55 PM to 6:20 PM	5:15 PM to 7:00 PM	–
Sunlight Duration (no action / action)	9 h 09m / 7 h 57m	11 h 07m / 9 h 42m	12 h 00m / 10 h 15m	–
Incremental Shadow Duration	Total: 1 h 12m	Total: 1 h 25m	Total: 1 h 45m	–
Incremental Shadow Coverage (%)	20% Max. at 4:39pm	35% Max. at 5:15pm	14% Max. at 6:00pm	–
Boone Slope Park				
Sector D1				
Incremental Shadow Times	8:30 AM to 5:05 PM	9:15 AM to 5:45 PM	10:00 AM to 6:15 PM	8:45 AM to 3:00 PM
Sunlight Duration (no action / action)	9 h 09m / 0 h 34m	11 h 07m / 2 h 37m	12 h 00m / 3 h 45m	6 h 15m / 0 h 00m
Incremental Shadow Duration	8 h 35m	8 h 30m	8 h 15m	6 h 15m
Incremental Shadow Coverage (% of sector)	80% at 12:00pm / 100% at 4:25pm	62% at 3:40pm / 100% Max at 4:45pm	65% at 4:00pm / 100% at 4:30pm	60% at 11:00am / 100% at 3:00pm
Sector D2				
Incremental Shadow Times	3:05 PM to 5:05 PM	3:00 PM to 5:45 PM	3:30 PM to 6:00 PM	11:15 AM to 3:00 PM
Sunlight Duration (no action / action)	9 h 09m / 7 h 09m	11 h 07m / 8 h 22m	12 h 00m / 9 h 30m	6 h 15m / 2 h 30m
Incremental Shadow Duration	2 h 00m	2 h 45m	2 h 30m	3 h 45m
Incremental Shadow Coverage (% of sector)	45% at 3:15pm / 100% at 3:45pm	70% at 3:40pm / 100% Max at 4:00pm	50% at 3:45pm / 100% at 4:15pm	45% at 12:00pm / 100% at 3:00pm
West Farms Square				
Incremental Shadow Times	–	–	–	2:10 PM to 3:00 PM
Sunlight Duration (no action / action)	–	–	–	6 h 15m / 5 h 25m
Incremental Shadow Duration	–	–	–	Total: 0 h 50m
Incremental Shadow Coverage (%)	–	–	–	45%

Table E-2: Incremental Shadow Durations (Continued)

P.S. 6 Schoolyard				
Incremental Shadow Times	–	–	–	8:45 AM to 9:30 AM
Sunlight Duration (no action / action)	–	–	–	6 h 15m / 5 h 30m
Incremental Shadow Duration	–	–	–	0 h 45m
Incremental Shadow Coverage (%)	–	–	–	36%
P.S. 214 Schoolyard				
Sunlight Duration (no action / action)	3:15 PM to 5:35 PM	3:00 PM to 6:26 PM	3:00 PM to 7:00 PM	–
Incremental Shadow Duration	Total: 2 h 20m	Total: 3 h 26m	Total: 4 h 00m	–
P.S. 66 Schoolyard				
Incremental Shadow Times	–	7:19 AM to 7:30 AM	7:00 AM to 7:45 AM	–
Sunlight Duration (no action / action)	–	11 h 07m / 10 h 56m	12 h 00m / 11 h 15m	–
Incremental Shadow Duration	–	0 h 11m	0 h 45m	–
Incremental Shadow Coverage (%)	–	6%	19%	–
174th Street Playground				
Incremental Shadow Times	5:35 PM to 5:39 PM	–	6:55 PM to 7:00 PM	–
Incremental Shadow Duration	Total: 0 h 04m	–	Total: 0 h 05m	–
H.S. 692/690/550/680 Playing Field				
	–	–	–	–

Table E-2: Incremental Shadow Durations (Continued)

Bronx River				
Sector A4				
Incremental Shadow Times	–	5:30 PM to 6:24 PM	5:10 PM to 7:00 PM	–
Sunlight Duration (no action / action)	–	11 h 07m / 10 h 13m	12 h 00m / 10 h 10m	–
Incremental Shadow Duration	–	0 h 54m	1 h 50m	–
Sector A1/A5				
Incremental Shadow Times	4:10 PM to 5:39 PM	4:40 PM to 6:26 PM	5:00 PM to 6:50 PM	–
Sunlight Duration (no action / action)	9 h 09m / 7 h 45m	11 h 07m / 9 h 21m	12 h 00m / 10 h 10m	–
Incremental Shadow Duration	1 h 29m	1 h 46m	1 h 50m	–
Sector A2.2/A6				
Incremental Shadow Times	4:45 PM to 5:39 PM	5:25 PM to 6:26 PM	5:45 PM to 7:00 PM	–
Sunlight Duration (no action / action)	9 h 09m / 8 h 15m	11 h 07m / 10 h 06m	12 h 00m / 10 h 45m	–
Incremental Shadow Duration	0 h 54m	1 h 01m	1 h 15m	–
Sector A3/A7				
Incremental Shadow Times	4:39 PM to 5:39 PM	5:10 PM to 6:26 PM	5:30 PM to 6:45 PM	–
Sunlight Duration (no action / action)	9 h 09m / 8 h 09m	11 h 07m / 9 h 51m	12 h 00m / 10 h 45m	–
Incremental Shadow Duration	1 h 00m	1 h 16m	1 h 15m	–
Sector C1/C2				
Incremental Shadow Times	4:00 PM to 5:39 PM	4:40 PM to 6:26 PM	5:00 PM to 6:45 PM	–
Sunlight Duration (no action / action)	9 h 09m / 7 h 40m	11 h 07m / 9 h 21m	12 h 00m / 10 h 15m	–
Incremental Shadow Duration	1 h 39m	1 h 46m	1 h 45m	–
Sector C3				
Incremental Shadow Times	5:15 PM to 5:39 PM	5:30 PM to 6:26 PM	6:00 PM to 7:00 PM	–
Sunlight Duration (no action / action)	9 h 09m / 8 h 45m	11 h 07m /10 h 11m	12 h 00m / 11 h 00m	–
Incremental Shadow Duration	0 h 24m	0 h 56m	1 h 00m	–
Sector C4				
Incremental Shadow Times	4:45 PM to 5:39 PM	5:10 PM to 6:26 PM	5:40 PM to 6:40 PM	–
Sunlight Duration (no action / action)	9 h 09m / 8 h 15m	11 h 07m / 9 h 51m	12 h 00m / 11 h 00m	–
Incremental Shadow Duration	0 h 54m	1 h 16m	1 h 00m	–

As may be noted from the table, for each open space resource or each sector of a resource, the analysis hours, the incremental shadow durations, the amount of time the resource is in sunlight under both the no action and action condition, and the incremental shadow coverage are given for each of the analysis days.

Parks

Starlight Park, Bronx River Greenway and the Bronx River

Potential Effects on Vegetation: As noted above, because of the expansive area of Starlight Park and the Bronx River Greenway, their land areas were divided up into sectors which are shown in Figures E-1 through E-40. Detailed plans were obtained for the park and greenway from the NYC Department of Parks and Recreation which show the planting and other park/greenway design elements. After the sectors were established, detailed computations were made to arrive at the shadow/sunshine duration data contained in the table. The planting schedule was then assessed for sunlight requirements. These requirements were then compared, sector by sector, to determine whether any of the proposed vegetation would be impacted by the incremental shadows cast by the Proposed Action buildings. (The planting plan and technical impact assessment appear in Appendix 3.)

The amount of sunlight considered as adequate to support vegetation classified as needing "full sun" is 6 hours daily during the growing season. As Table E-2 above indicates, there would be no sectors within either Starlight Park or the Bronx River Greenway which would receive less than 7 hours of sunlight for any of the analysis days and most would receive far more. Not surprisingly, the incremental shadows first begin closest to the Proposed Action in the sectors closest to the Sheridan Expressway. However, even these sectors only receive partial incremental shadows toward the end of the day. See Table E-2 for a detailed analysis of the impact of the Proposed Action on each sector of Starlight Park, the Bronx River Greenway and the Bronx River.

Because every section of Starlight Park, the Bronx River Greenway and the Bronx River will receive considerably more than the continuous direct sunlight requirements for no impact, the shadows would not pose a threat to planned or existing vegetation, and the incremental durations are not long enough to curtail park activities.

Potential Effects on Planned Park Activities: Below is an assessment of the potential effects on the planned park activities, presented by park sector.

Sector A1: Parking, a kayak launch, a boat house and comfort station are planned within this sector, which is on the west side of the Bronx River. These uses would not be considered as being shadow-sensitive with the exception of the boathouse (the Bronx River House), which will have photo voltaic solar panels on its roof. A special analysis was undertaken for this facility, and is discussed at the end of this section.

Sectors A2.1 and A2.2: These sectors are west of the Bronx River and contain the active open space uses proposed for the park. A multipurpose playing field and a basketball court would be in these sectors, with their land area allocated about equally between the two. The incremental shadows on portions of these fields and court would occur starting in the late afternoon, starting between 3:39 and 3:45 for Sector A2.1 and starting from 4:30 to 5:15 for Sector A2.2 on the various analysis days, excluding the winter solstice (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, and E-23 through E-25). The incremental duration would be from two hours to three hours and 15 minutes in Sector A2.1, and from one hour and thirty nine minutes to one hour and forty five minutes in Sector A2.2. This incremental change of about one and a half to three hours would not result in a substantial reduction in the usability of these facilities as a result of the increased shadows on them.

Sector A3: This sector is west of the Bronx River and contains passive open space, a playground for young children, and a play area for older children with a spray sprinkler area between the two. Incremental shadows would not occur during the winter solstice, but would occur for between one hour and thirty-nine minutes and one hour and forty-five minutes on portions of this sector, starting later in the afternoon between 4:30 and 5:15, depending on the analysis day (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, and E-23 through E-25). The limited duration of the incremental shadows would not result in a substantial reduction in usability for these recreational purposes.

Sector A4: This sector is not expected to be completed by 2022, and therefore is not considered for impact purposes herein. It is assessed here for informational purposes. This sector is located east of the Bronx River and contains passive open space including paths and walkways. Incremental shadows would occur on portions of this sector only during the midpoints between the summer solstice and equinoxes and during the summer solstice. They would be of a duration lasting from forty-six minutes to an hour and a half depending on the analysis day (see Table E-2 and Figures E-14 through E-16 and E-23 through E-25). The incremental shadows would begin at around 5:30 in the afternoon. The limited duration of the incremental shadows would not result in a substantial reduction in the sector's usability for passive recreational purposes.

Sector A5: This sector is not expected to be completed by 2022, and therefore is not considered for impact purposes herein. It is assessed here for informational purposes. This sector is located east of the Bronx River and contains passive open space including paths and walkways. Incremental shadows would occur on portions of this sector during the equinoxes, the midpoints between the summer solstice and equinoxes and the summer solstice, and be of a duration lasting from forty-nine minutes to an hour and a half depending on the analysis day (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, and E-23 through E-25). The incremental shadows would begin between 4:50 and 5:30 in the afternoon. The limited duration of the incremental shadows would not result in a substantial reduction in the sector's usability for passive recreational purposes.

Sector A6: This sector is not expected to be completed by 2022, and therefore is not considered for impact purposes herein. It is assessed here for informational purposes. This sector is located east of the Bronx River and contains passive open space including paths and walkways. Incremental shadows would occur on portions of this sector during the equinoxes, the midpoints between the summer solstice and equinoxes and the summer solstice, and be of a duration lasting from forty-four minutes to an hour and ten minutes. The incremental shadows would begin between 4:55 and 5:50 in the afternoon depending on the analysis day (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, and E-23 through E-25). The limited duration of the incremental shadows would not result in a substantial reduction in the sector's usability for passive recreational purposes.

Sector A7: This sector is not expected to be completed by 2022, and therefore is not considered for impact purposes herein. It is assessed here for informational purposes. This sector is located east of the Bronx River and contains passive open space including paths and walkways. Incremental shadows would occur on portions of this sector during the equinoxes, the midpoints between the summer solstice and equinoxes and the summer solstice, and be of a duration lasting from forty-four minutes to an hour and ten minutes. The incremental shadows would begin between 4:55 and 5:50 in the afternoon depending on the analysis day (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, and E-23 through E-25). The limited duration of the incremental shadows would not result in a substantial reduction in the sector's usability for passive recreational purposes.

Sectors B1 and B2: These sectors are not expected to be completed by 2022, and therefore are not considered for impact purposes herein. They are assessed here for informational purposes. These sectors are located east and west of the Bronx River and contain passive open space including paths and walkways. There would be no incremental shadows in sector B2. Incremental shadows would occur on portions of sector B1 only during the summer solstice, and be of a duration lasting forty-five minutes. The incremental shadow would begin at 6:15 summer solstice analysis day (see Table E-2 and Figure E-26). The limited duration of the incremental shadows would not result in a substantial reduction in the sector's usability for passive recreational purposes.

Sector C1: Sector C1 is located north of East 174th Street and west of the Bronx River. This sector contains passive open space, which is grassed area with tree plantings, and a pathway which comes in from the east and turns south to access other parts of Starlight Park. Incremental shadows would occur on portions of this sector during the equinoxes, the midpoints between the summer solstice and equinoxes, the summer solstice and the winter solstice, and be of a duration lasting from fifteen minutes to three hours depending on the analysis day (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, E-23 through E-25, and E-31). The incremental shadows would begin between 2:45 and 3:50 in the afternoon. The area would experience seven hours or more of full sunlight for each of the analysis days, except the winter solstice. On that analysis day, it would experience six hours of full sun, but have an incremental shadow lasting only fifteen minutes at the end of the analysis period. Similarly, the incremental shadows during the other analysis days would occur at the end of the day but last for longer periods of time (e.g., from about two to three hours). Because there are no sun-sensitive activities planned for this sector, the incremental shadows would not lessen its usability.

Sector C2: This sector is also located north of East 174th Street but east of the Bronx River. Predominant in this area is a large, open lawn space for pickup games (soccer, Frisbee), events, sunbathing, and picnicking. The loop bordering the open lawn is considered for a walking or jogging loop. There is also a pathway which comes in from the north and traverses the Bronx River to Sector C1. Incremental shadows would occur on portions of this sector during the equinoxes, the midpoints between the summer solstice and equinoxes, the summer solstice and the winter solstice, and be of a duration lasting from one hour and 21 minutes to one hour and forty-five minutes, depending on the analysis day (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, and E-23 through E-25). The incremental shadows would begin between 4:15 and 5:15 in the afternoon. The area would experience seven hours or more of full sunlight for each of the analysis days. The incremental shadows during these analysis days would occur at the end of the day and last for one hour and twenty-two minutes to one hour and forty -five minutes). Because the incremental shadows would occur so late in the day within this sector, they would not lessen its usability.

Sector C3: This sector, which is north of the Cross Bronx Expressway, contains passive open space and the northbound off-ramp from the Sheridan Expressway to the westbound Cross Bronx Expressway. The area is programmed for native flowering plantings to the east of the elevated ramp, but otherwise left in its natural state. Incremental shadows would occur on portions of this sector during the equinoxes, the midpoints between the summer solstice and equinoxes, and the summer solstice, and be of a duration lasting 22 minutes to one hour, depending on the analysis day (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, and E-23 through E-25). The incremental shadows would begin between 5:15 and 6:00 in the late afternoon. The area would experience eight hours or more of full sunlight for each of the analysis days. The incremental shadows during these analysis days would occur at the end of the day and last for one hour and twenty-two minutes to one hour and forty-five minutes). Because there are no sun-sensitive activities planned for this sector, the incremental shadows would not lessen its usability.

Sector C4: This sector, which is north of the northbound Sheridan Expressway final exit onto local streets, is programmed to contain both active and passive open space. The area is to be left in its natural state. Incremental shadows would occur on portions of this sector during the equinoxes, the midpoints between the summer solstice and equinoxes, and the summer solstice, and be of a duration lasting 30 minutes to one hour, depending on the analysis day (see Table E-2 and Figures E-6 through E-8, E-14 through E-16, and E-23 through E-25). The incremental shadows would begin between 5:00 and 5:50 in the late afternoon. The area would experience eight hours or more of full sunlight for each of the analysis days. The incremental shadows during these analysis days would occur at the end of the day and last for from thirty minute to one hour and five minutes. Because there are no sun-sensitive activities planned for this sector, the incremental shadows would not lessen its usability.

No significant shadow impacts would therefore be expected at Starlight Park, the Bronx River Greenway or the Bronx River as a result of the proposed action.

Drew Gardens

As Table E-2 above indicates, Drew Gardens would experience shadows from the Proposed Action during the equinoxes (March 21 and September 21), the midpoints between the summer solstice and the equinoxes (May 6 and August 6), and the summer solstice, but not on the winter solstice. During the equinoxes, project-related shadows would enter the garden at 4:25 PM and continue across the garden until 5:37 PM (one and one-half hours before sunset), for an incremental duration of one hour and fifteen minutes. (See Figures E-7 through E-9.)

During the midpoints between the equinoxes, project-related shadows would enter the garden at 4:55 PM and continue to progress across the garden until 6:20 PM. By 6:20 PM, most of the garden would be covered by shadows from the no action condition. (See Figures E-15 through E-17.) As may be noted from Figures E-15 and E-16, the incremental shadows on the garden would be minor, concentrated on its south end. Total duration of the incremental shadows for this analysis period would be one hour and 25 minutes. (The maximum percentage of the garden that would be affected by incremental shadows from the Proposed Action would be 35 percent during the midpoints between the summer solstice and equinoxes analysis day. During the other analysis periods, the maximum percentage of the garden that would be affected by incremental shadows would be 14 to 20 percent.)

During the summer solstice, project-related shadows would enter the garden at about 5:15 PM, and continue to progress across the garden until about 7:00 PM. At 5:15 PM, most of the shadows on Drew Gardens would be cast by the neighboring PS 214. And by 7:00 PM, shadows from the no action condition would cover most of the park. (See Figures E-24 through E-26.) Total duration of the incremental shadows would be 1 hour and 45 minutes.

During the winter solstice, proposed action-related shadows would not enter the garden before 3:00 PM, an hour and a half before sunset.

In each instance discussed above, the incremental shadows from the Proposed Action would be a minor addition to the existing shadows. Under the Proposed Action conditions, the garden would be shadow free during each of the analysis days for a minimum of almost eight hours. Thus, the shadows would not pose a threat to vegetation, and the incremental durations are not long enough to curtail park activities. No significant shadow impacts would be expected at Drew Gardens as a result of the proposed action.

Boone Slope Park

As noted previously, Boone Slope Park is not publically accessible, and there are no current plans to redevelop the park and make it publically accessible. It is, however, included in this analysis in the unlikely event that this small, steeply sloped property would be redeveloped in the future.

Also, as noted previously, the park has been divided into two sectors, because the shadow effects on the park are so different between the north and south portions of the park. Within Table E-2 above, D1 represents the southern half of the park, and D2 represents the northern half.

As shown in Table E-2 above, the southern half of Boone Slope Park (sector D1) would experience incremental shadows from the Proposed Action during the equinoxes (March 21 and September 21), the midpoints between the summer solstice and the equinoxes (May 6 and August 6), the summer solstice, and the winter solstice (all analysis periods).

During the equinoxes, for the southern half of the park, project-related shadows would enter the park at 8:30 AM, and continue through the day until 5:05 PM. By noon, the incremental shadows would cover 80 percent of the southern portion of the park (see Figure E-4). By about 4:30 PM, the park would be completely within the incremental shadows of the proposed action. The incremental shadows would continue to 5:39 PM, an hour and a half before sunset. On the equinoxes, Sector D1 would receive only about 34 minutes of direct sunlight. (See Figures E-3 through E-9.)

During the midpoints between the equinoxes and the summer solstice (May 6 and August 6), project-related shadows would enter Sector D1 of the park at 9:15 AM. By noon, the incremental shadows would cover about a third of the sector (see Figure E-12). At about 3:20 PM, projected development on the north side of Boone Avenue across from the sector would start casting shadows along its western edge. By about 4:00 PM, this sector of the park would be completely within the incremental shadows of the Proposed Action. The incremental shadows would continue to 5:45 PM. On these analysis days, this sector of the park would experience two hours and thirty-seven minutes of direct, unobstructed sunlight.

During the summer solstice, project-related shadows would enter this sector of the park at about 10:00 AM. Shadows from the projected and potential development across Boone Avenue from the park would begin to cast shadows on the western edge of the park at about 3:30 PM. These shadows would extend progressively across the park until about 6:15 PM, when no-action shadows would cover the park. (See Figures E-21 through E-26.) On this analysis day, this sector of the park would experience three hours and forty-five minutes of direct, unobstructed sunlight.

During the winter solstice, project-related shadows would enter this sector of the park at about 8:45 AM. Buildings to the south of the park would continually cast shadows over this sector of the park for the entire day, until 3:00 PM, the end of the analysis period. (See Figures E-27 through E-31.) On this analysis day, this sector of the park would constantly experience incremental shadows over the course of the day.

With the Proposed Action incremental shadows included, Sector D1 of Boone Slope Park would experience direct sunlight over its entire area for about 34 minutes during the equinoxes, two hours and thirty-seven minutes during the midpoints between the summer solstice and equinoxes, and about three hours and forty-five minutes at the summer solstice during the analysis periods (which extend from one and one-half hours after sunrise to one and one-half hours before sunset). During the winter solstice, the park would experience incremental shadows over the course of the entire analysis period.

As also shown in Table E-2 above, the northern half of Boone Slope Park (Sector D2) would experience incremental shadows from the Proposed Action during the equinoxes (March 21 and

September 21), the midpoints between the summer solstice and the equinoxes (May 6 and August 6), the summer solstice, and the winter solstice (all analysis periods).

During the equinoxes, project-related shadows would enter the northern half of the park at 3:05 PM, and continue through the day until 5:05 PM. By 3:40 PM, the incremental shadows would cover 45 percent of the northern portion of the park (see Figure E-5). By about 4:25 PM, this portion of the park would be completely within the incremental shadows of the Proposed Action. The incremental shadows would continue to 5:05, an hour and a half before sunset. On the equinoxes, Sector D2 would receive about seven hours and nine minutes of direct sunlight. (See Figures E-3 through E-9.)

During the midpoints between the equinoxes and the summer solstice (May 6 and August 6), project-related shadows would enter the Sector D2 of the park at 3:00 PM. By 3:40 PM, the incremental shadows would cover about 70 percent of the sector (see Figure E-14). By about 4:00 PM, this sector of the park would be completely within the incremental shadows of the Proposed Action. The incremental shadows would continue to 5:45 PM. On these analysis days, this sector of the park would receive about eight hours and 22 minutes of direct, unobstructed sunlight.

During the summer solstice, project-related shadows would enter this sector of the park at about 3:30 PM. Shadows from the projected and potential development across Boone Avenue from the park would begin to cast shadows on the western edge of the park at about 3:30. These shadows would extend progressively across the park until about 6:00 PM, when no-action shadows would cover the park. (See Figures E-21 through E-26.) On this analysis day, this sector of the park would receive nine and one-half hours of direct, unobstructed sunlight.

With the Proposed Action incremental shadows included, Sector D2 of Boone Slope Park would experience direct sunlight over its entire area for about 7 hours and 49 minutes during the equinoxes, eight hours and 37 minutes during the midpoints between the summer solstice and equinoxes, about nine hours and 30 minutes at the summer solstice, and two hours and 30 minutes at the winter solstice during the analysis periods (which extend from one and one-half hours after sunrise to one and one-half hours before sunset).

The park is not now publically accessible, and there are no current plans to redevelop the park and make it publically accessible. In the event the park was to someday be redeveloped for public use, the redesign could include varieties of vegetation which would be suitable for these exposure times to direct sun. Therefore, the Proposed Action would not result in significant adverse impacts on Boone Slope Park due to incremental shadows.

West Farms Square

This small park, located at the northeast corner of Boston Road and Tremont Avenue, would experience incremental shadows from the Proposed Action only during the winter solstice analysis period. During that day, the park would experience incremental shadows only between 2:10 and 3:00 PM, a duration of only fifty minutes. (See Figures E-30 and E-31.) The park contains seating and street trees. However, because of the limited added incremental shadows, a significant shadow impact to this park would not be expected to occur.

Schoolyards and Playing Fields

P.S. 6 Schoolyard

The PS 6 schoolyard would experience incremental shadows from the Proposed Action only during the winter solstice analysis period, between 8:45 AM and 9:30 AM. The duration of added incremental shadows is 45 minutes, and a maximum of 45 minutes of added incremental shadows covering at most approximately 1/3 of the yard would be expected over this period. The

limited added incremental shadows will not result in a significant shadow impact to this schoolyard.

P.S. 214 Schoolyard

As Table E-2 above indicates, the PS 214 schoolyard would experience incremental shadows from the Proposed Action during the equinoxes (March 21 and September 21), the midpoints between the summer solstice and the equinoxes (May 6 and August 6), and the summer solstice, but not on the winter solstice.

During the equinoxes, project-related shadows would enter the schoolyard at 3:15 PM and continue across the schoolyard until 5:35 PM (one and one-half hours before sunset), for an incremental duration of two hours and twenty minutes. (See Figures E-5 through E-9.)

During the midpoints between the equinoxes and the summer solstice, project-related shadows would enter the schoolyard at 3:00 PM and continue to progress across the schoolyard until 6:20 PM. By 6:20 PM, most of the schoolyard would be covered by shadows from the no-action condition. (See Figures E-13 through E-17.) Total duration of the incremental shadows for this analysis period would be three hours and twenty-six minutes.

During the summer solstice, project-related shadows would enter the schoolyard at about 3:00 PM, and continue to progress across the schoolyard until about 7:00 PM. Again, shadows from the no-action condition would cover most of the schoolyard by the 7:00 PM period. (See Figures E-22 through E-26.) Total duration of the incremental shadows would be 4 hours.

During the winter solstice, Proposed Action-related shadows would not enter the schoolyard before 3:00 PM, an hour and a half before sunset. (See Figure E-31.)

In each instance of incremental shadows discussed above, the schoolyard would not receive incremental shadows from the Proposed Action before 3:00 PM, approximately at the end of the school day. Thus, the shadows would not arrive early enough nor be of long enough duration to curtail schoolyard activities during the school day. The School Construction Authority has indicated that the school day for this school ends at 3:00 PM, by which time the playground is no longer in use. No significant shadow impacts would be expected at the P.S. 214 playground as a result of the proposed action.

P.S. 66 Schoolyard

The P.S. 66 schoolyard would experience incremental shadows from the Proposed Action only during the midpoints between the summer solstice and the equinoxes and the summer solstice analysis periods, between 7:00 AM and 7:45 AM. The duration of added incremental shadows ranges from eleven minutes to 45 minutes, and approximately six to nineteen percent of the playground area would be covered during this period. During that period, incremental shadows on the schoolyard due to the Proposed Action would be limited to a very small corner in the northeast portion of the yard. (See Figure E-18.) The limited added incremental shadows will not result in a significant shadow impact to this schoolyard.

East 174th Street Playground

As shown in Table E-2, the Proposed Action would result in incremental shadows on the East 174th Street Playground only during the equinoxes and the summer solstice. The incremental shadows during these periods would occur at the end of the analysis day and last only four to five minutes. (See Figure E-33.) No significant shadow impacts would be expected at the East 174th Street Playground as a result of the Proposed Action.

H.S. 692/690/550/680 Playing Field

The high school playing field would not experience additional incremental shadows as a result of the Proposed Action. (See Figures E-32 and E-33.) No significant shadow impacts would be expected at the H.S. 692/690/550/680 playing field as a result of the Proposed Action.

Bronx River

The Bronx River is a significant natural feature in the study area. Throughout its length, the river also serves as a recreation corridor lined with parks, gardens, canoe launches and a planned greenway now under development. Recreation in the river includes canoeing and kayaking and, despite public health advisories, swimming and fishing. The parklands north of the Bronx draw a considerable number of bicyclists; plans to extend this greenway and make it continuous through the Bronx are expected to greatly increase the number of bicyclists using the corridor.

The physical characteristics of the Bronx River watershed and the human actions within it affect the water quality and hydrology of the river, as well as the flora, fauna and human activities the river is capable of supporting. Despite being highly affected by pollution and urban development, the Bronx River supports aquatic insects, fish, small mammals, and diverse vegetation. It is also an important tributary feeding regional water bodies downstream including the East River and Long Island Sound. The riparian area and shoreline contain extensive deciduous tree coverage with thick canopies.

The Bronx River meanders eastward or "away" from the proposed project site in the immediate stretch of the project site. This natural meander serves to reduce the amount of shading that occurs from the proposed buildings given the increased distance between the river segments and the proposed buildings. Shadows from potential and projected new buildings will extend to the Bronx River on a limited and sporadic basis. Computer-generated simulations of the shadows under existing and proposed conditions were prepared on six reference days: March 21 and September 21 (equinoxes), May 6 and August 6 (midpoints between equinoxes), June 21 (summer solstice) and December 21 (winter solstice). These simulations indicate the extent of shading of the Bronx River at different times of the year. These simulations are shown in Figures E-2 through E-40.

A closer look at the simulations indicates that portions of the river in Sectors A1/A5 and C1/C2 will exhibit the greatest extent of shading. It is notable that these segments of the river are at the ends of the meander, more specifically, these are the two river segments that are closest to the proposed buildings and therefore capture the shadows coming off of the tops of the buildings.

Incremental shadow durations along the Bronx River were measured and recorded for each sector. The results of the incremental shadow durations are presented in Table E-2. The following conclusions can be drawn from this analysis:

- The longest duration of shading over the Bronx River will occur in Sectors A1/A5 and C1/C2 as previously stated. Available sunlight will be reduced as much as 1 hour and 45 minutes in the late afternoon on or about the summer solstice and midpoints between the summer solstice and equinoxes. However, there will still be a minimum of 9 hours and 21 minutes of sunshine over the river during these periods. During the equinoxes, these segments of the Bronx River will have a minimum of 7 hours and 45 minutes of sunshine, which is more than adequate for optimal photosynthesis.
- Given that the Bronx River meanders in an easterly direction between Sectors A1/A5 and C1/C2, there will be approximately 30 less minutes of shading in Sectors A2.2/A6 and A3/A7. This segment of the river will have sunshine for a minimum of 9 hours and 51 minutes during the summer solstice and midpoints between the summer solstice and

equinoxes. During the equinoxes, these segments of the river will have a minimum of 8 hours and 9 minutes of sunshine.

- During the winter solstice, there will be no shading of the Bronx River in any of the sectors.

In addition to analyzing the duration of shading, the simulations also show that the proposed buildings will cast a narrow shadow on relatively small portions of the Bronx River. Shadows from the peak of the buildings reach the Bronx River, resulting in narrow and incremental shadow coverage. Shadows cast by the buildings would be intermittent and diffuse. Diffuse shadows are not considered a significant change to habitat conditions, as they are temporary and unlikely to change the habitat condition. The aquatic life in the Bronx River is continuously carried by strong and tidal currents and would be exposed to these shadows for short periods of time.

Measured current velocities in the vicinity of the project area range from 0.9 to 2.5 feet per second, and would therefore move phytoplankton and other natural organisms quickly through the shaded areas. Project-generated shadow is not expected to affect primary productivity. Shading from the proposed buildings will not occur long enough to impair photosynthesis in the aquatic or riparian plants. The level of light at which photosynthesis exactly balances respiration is called the "light compensation point." This point is unique for each species of plant and may vary according to a number of factors. Below this average level of light, plants may die or simply not grow and reproduce. However, the effect of shading on the aquatic and riparian vegetation is expected to be small and acceptable. The loss of 90 minutes of sunlight on an irregular and sporadic basis for these two very small areas (approximately 150 feet in width each) is not expected to result in an adverse impact on the river ecology.

Bronx River House

Because of the sensitivity of the solar panels that will be installed atop the Bronx River House, a special analysis was undertaken. From the above shadow analysis, the times were determined for when the shadows cast by Proposed Action buildings would begin to shade the rooftop PV array. A simulation was generated with this input data using an industry-leading PV simulation tool, PVSyst, in order to predict the annual energy production lost due to building shading.

The analysis conservatively assumes that once first shading occurs, the entire PV array is fully shaded until sunset. In reality, at the time the first shading occurs, only a small portion of the PV array is actually shaded and the remainder of the array continues to be exposed to direct solar irradiation, until the shadow elongates to cover it. However, it was not possible with the data available to precisely predict the PV array output when it is partially shaded. Therefore, by assuming the entire array was fully shaded from the moment of first shading, worst-case scenarios for energy production losses due to the building shading were determined.

Table E-3 reflects the outcome of the simulation.

Table E-3: Estimated Annual Power Loss for the Bronx River House As a Result of Proposed Action Shadows

	Global Irradiation Incident in Collector Plane (kWh/m²)	Global Irradiation Corrected for Far Shadings (kWh/m²)	Far Shadings Loss (kWh/m²)	Far Shadings Loss (%)
January	80.7	80	0.719	0.89%
February	103.1	101.8	1.296	1.26%
March	137.1	135.4	1.67	1.22%
April	161.6	159.7	1.852	1.15%
May	177.2	175.5	1.655	0.93%
June	187.8	186.4	1.45	0.77%
July	189.4	187.7	1.778	0.94%
August	176.5	174.7	1.837	1.04%
September	150	147.9	2.101	1.40%
October	125.2	123.5	1.748	1.40%
November	76.1	75.5	0.549	0.72%
December	73.1	72.7	0.38	0.52%
Year	**1637.8**	**1620.8**	**17.034**	**1.04%**

The analysis shows that, because the sun angles would be so low by the time the Proposed Action shadows would reach the building, the projected effects on power loss would be minimal. The Proposed Action would not cause significant shadow impacts to the Bronx River House.

CONCLUSION

The incremental shadows created by the full build out of the Proposed Action on the projected and potential development sites in 2022 would not cause a significant adverse shadow impact.



Figure E-1: Preliminary Screening Analysis

LEGEND

Development Sites

Perimeter Showing Longest Possible Shadow Length

Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-2: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 8:30 AM

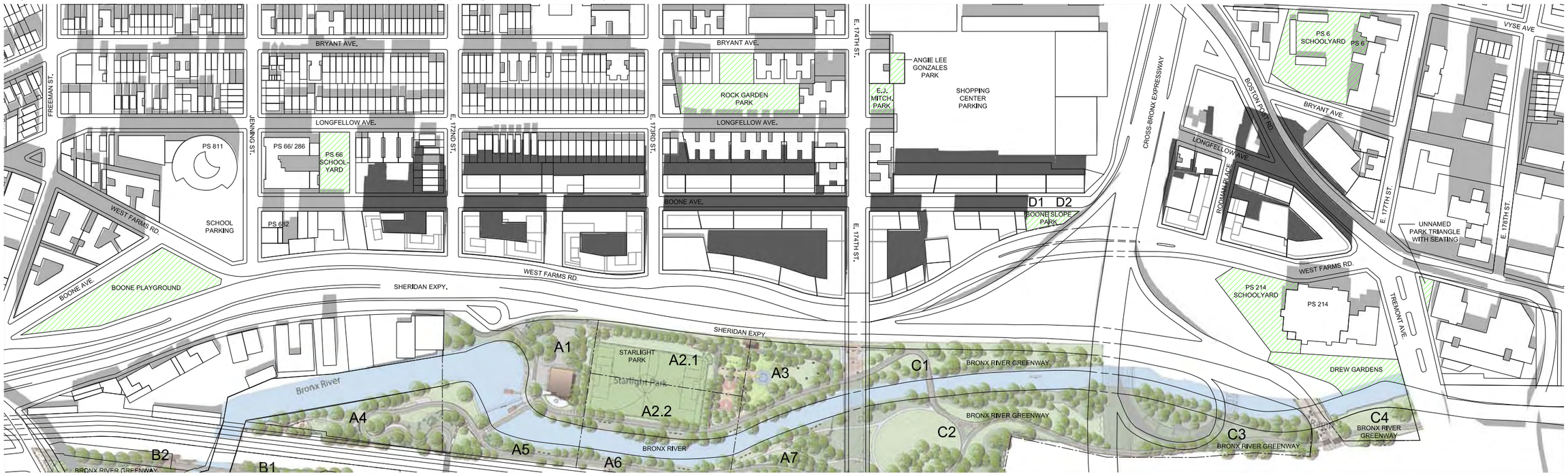
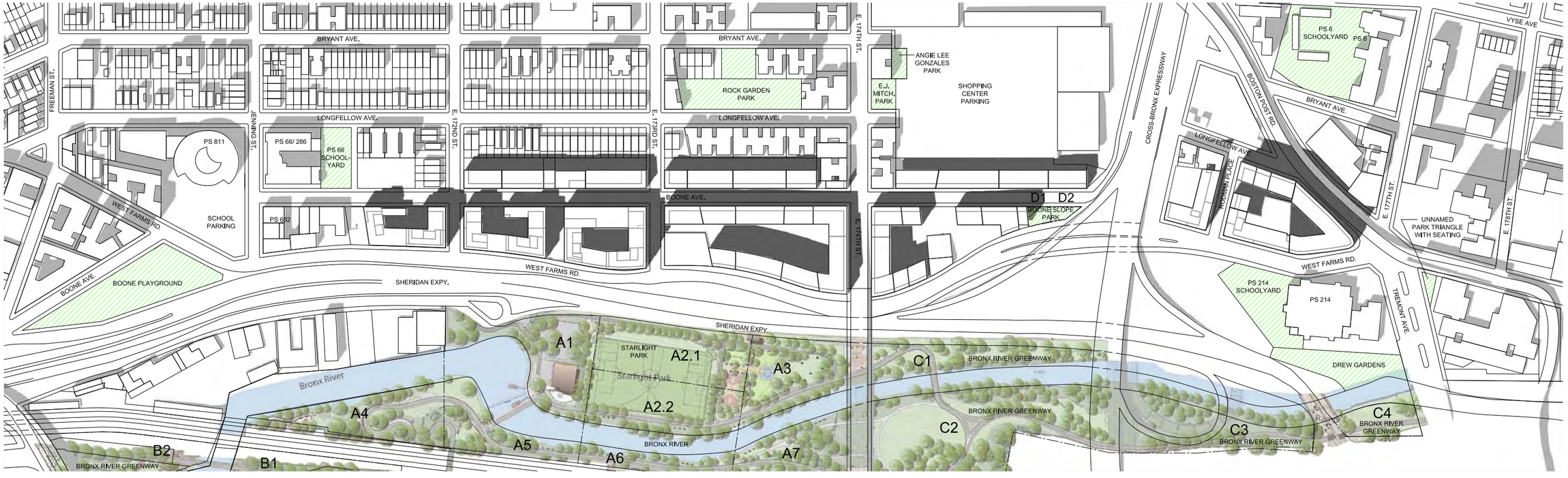


Figure E-3: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 10:30 AM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-4: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 12 PM

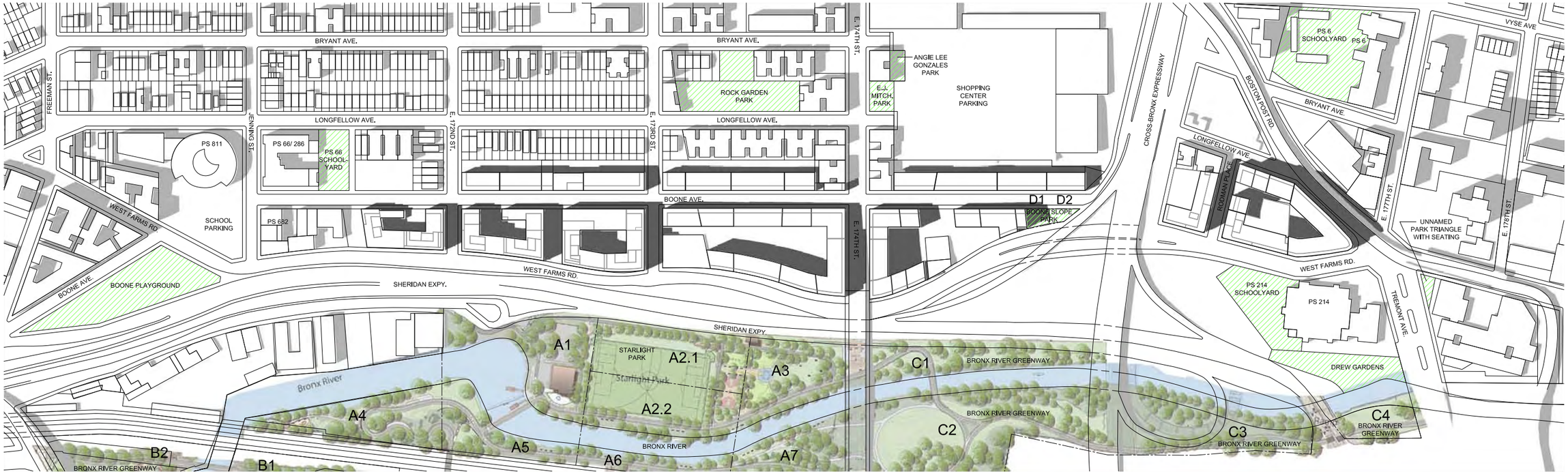
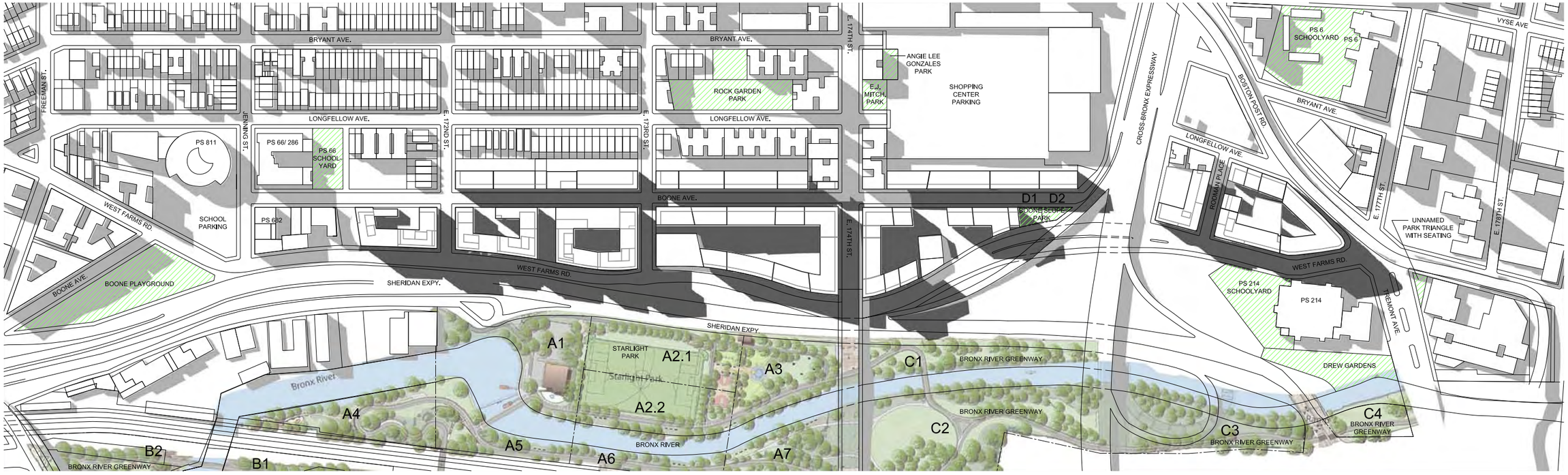


Figure E-5: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 3:15 PM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-6: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 3:39 PM

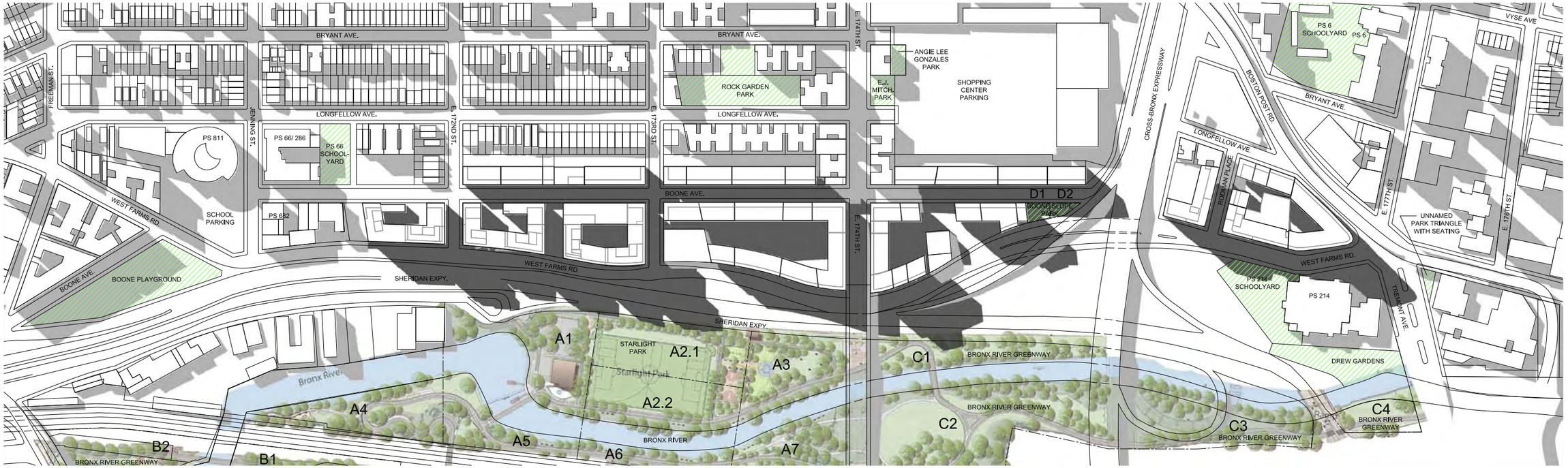
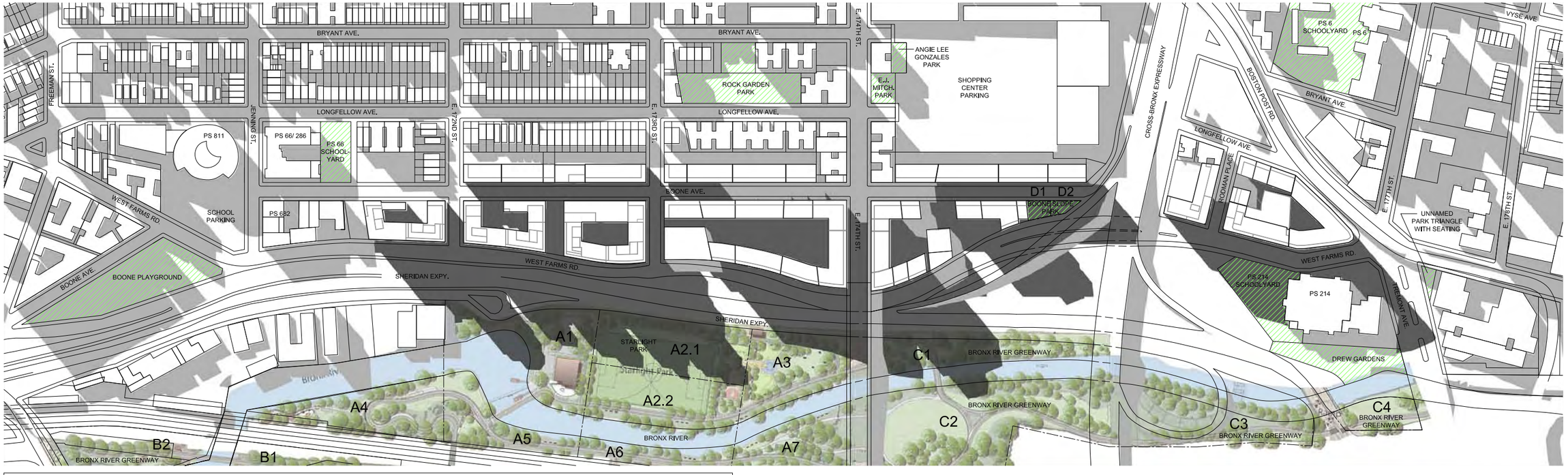


Figure E-7: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 4:25 PM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-8: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 4:39 PM

Figure E-9: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 5:39 PM

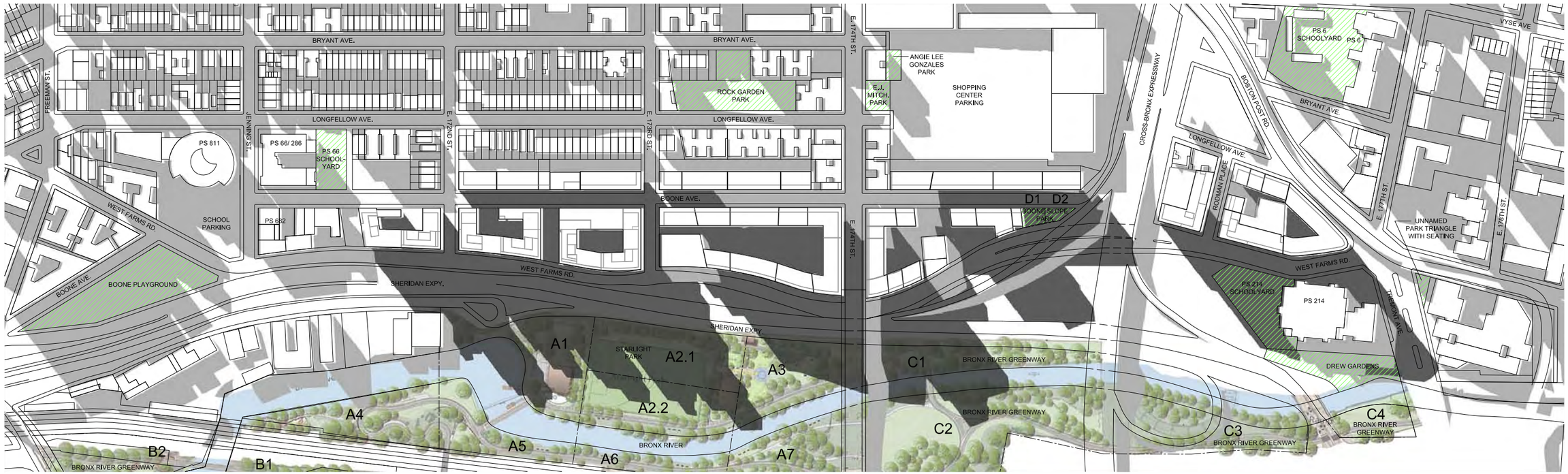


Figure E-10: Shadow Study, May 6 / August 6 - 7:19 AM

Figure E-11: Shadow Study, May 6 & August 6 - 11:45 AM



Figure E-12: Shadow Study, May 6 & August 6 - 12:00 PM

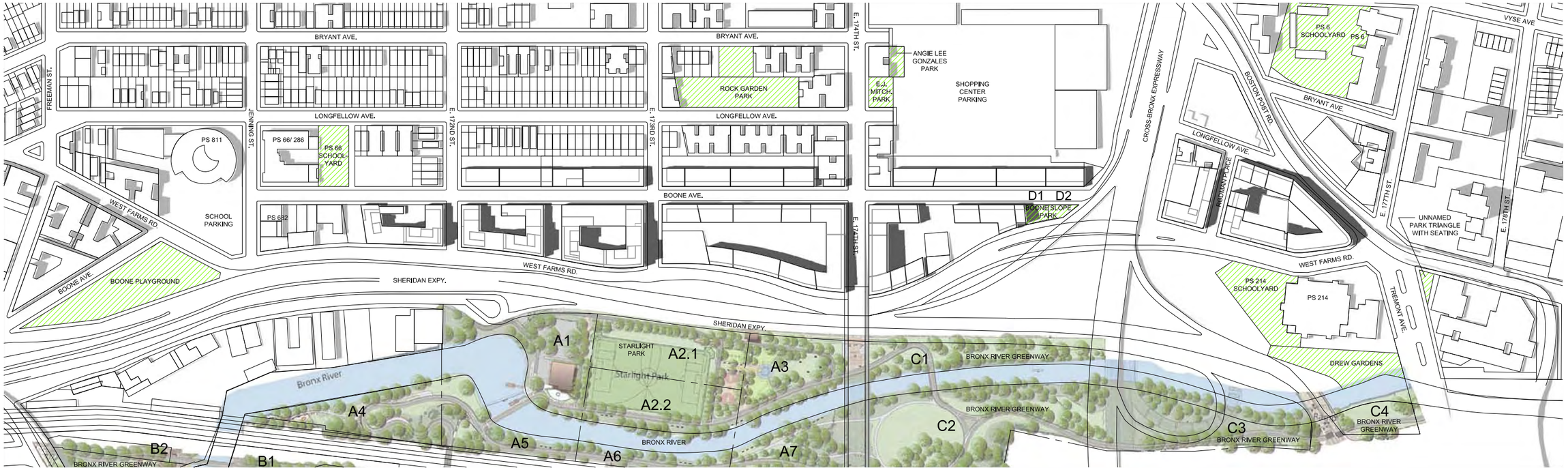
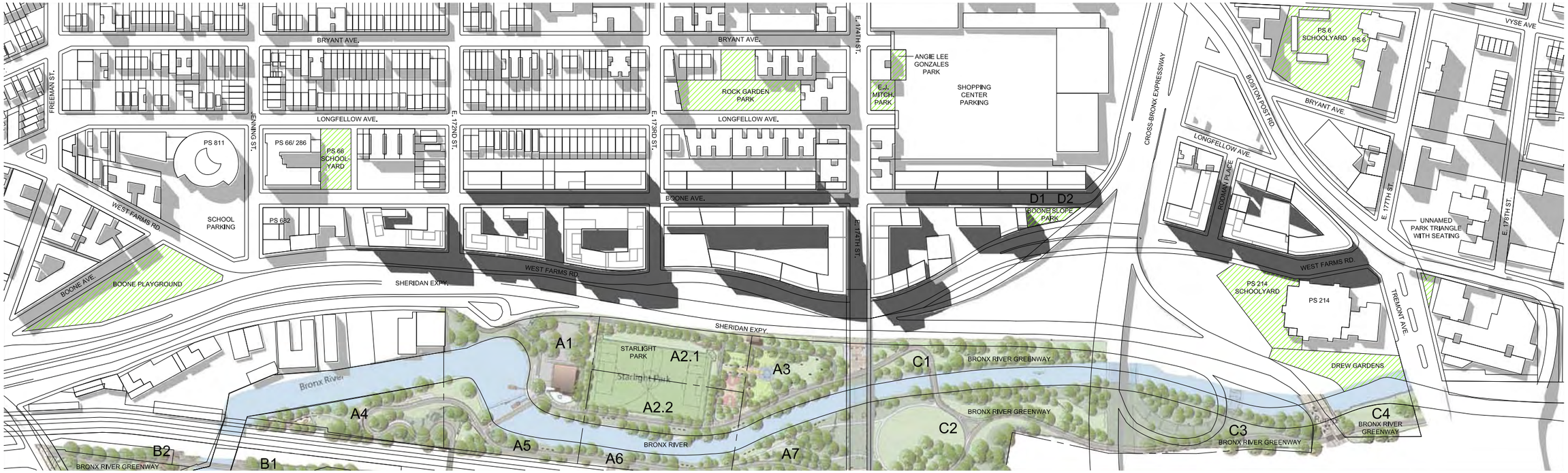


Figure E-13: Shadow Study, May 6 / August 6 - 3:00 PM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-14: Shadow Study, May 6 / August 6 - 3:40 PM

Figure E-15: Shadow Study, May 6 / August 6 - 4:55 PM



Figure E-16: Shadow Study, May 6 / August 6 - 5:00 PM

Figure E-17: Shadow Study, May 6 / August 6 - 6:26PM

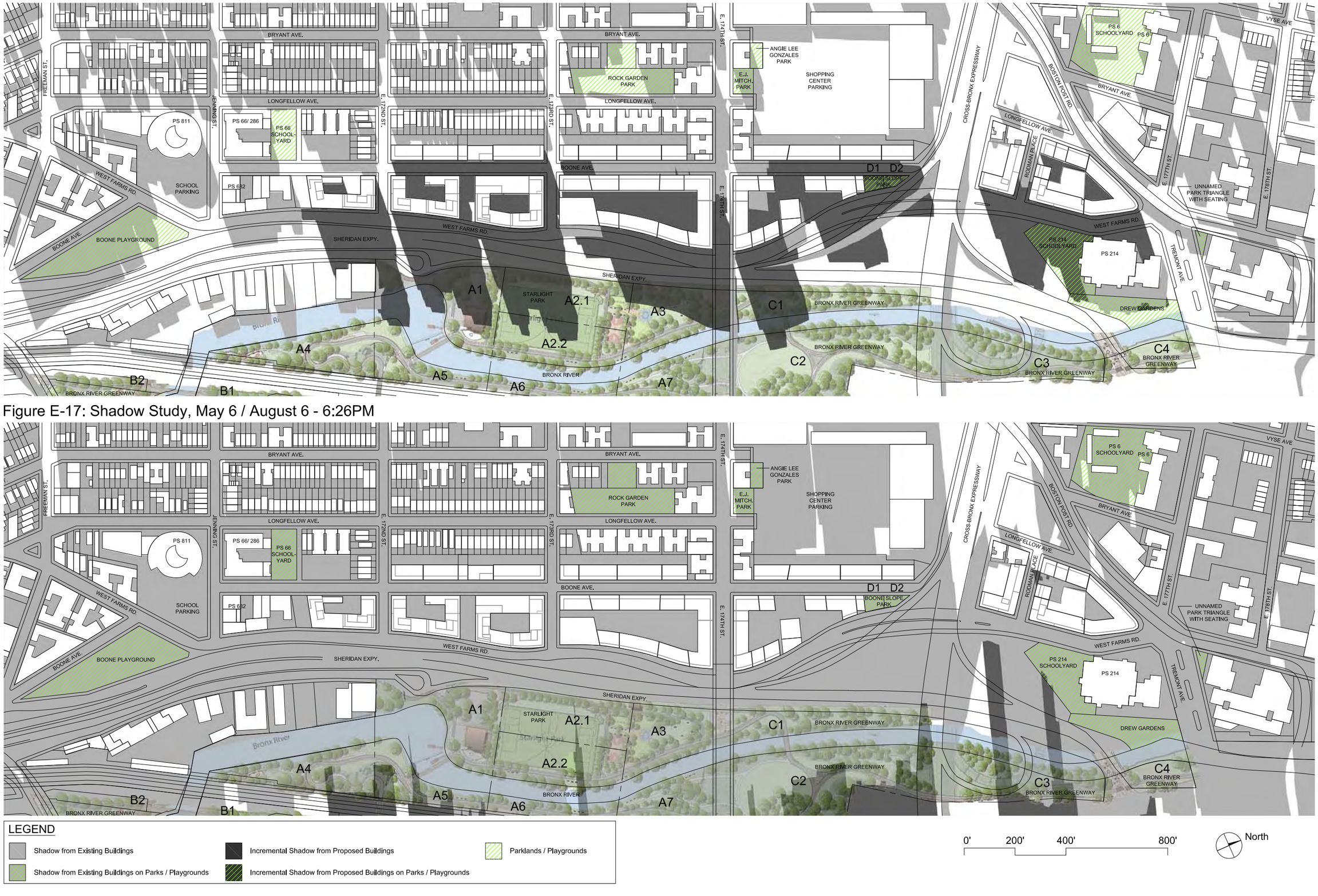


Figure E-18 Shadow Study, June 21 (Summer Solstice) - 7:00 AM

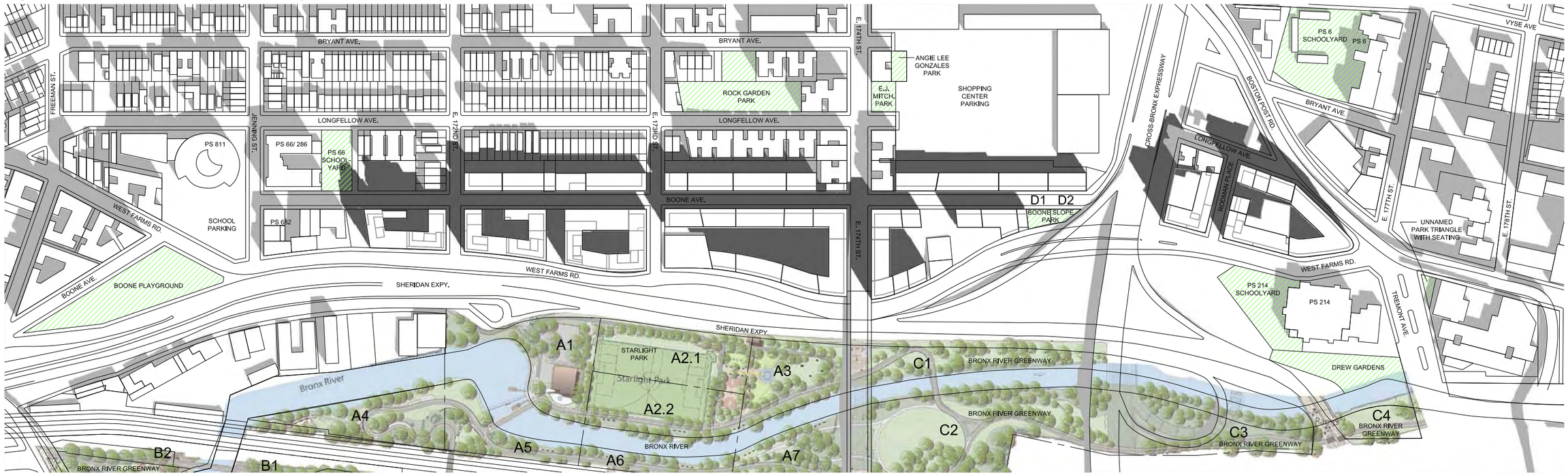
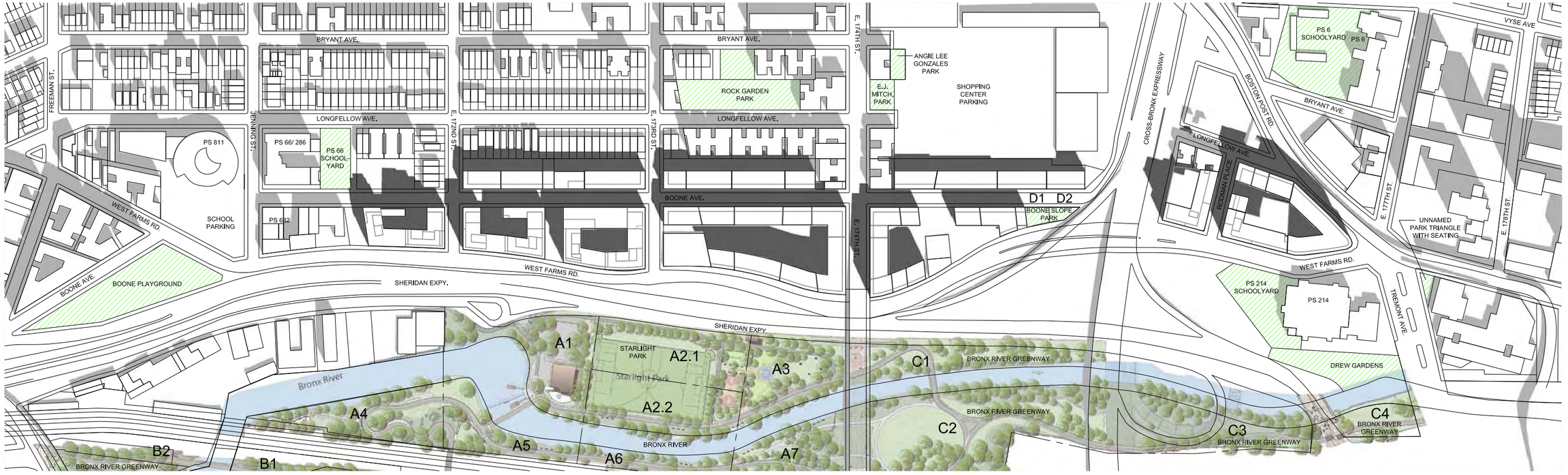


Figure E-19: Shadow Study, June 21 (Summer Solstice) - 7:45 AM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-20: Shadow Study, June 21 (Summer Solstice) - 12:00 PM

Figure E-21: Shadow Study, June 21 (Summer Solstice) - 12:45 PM

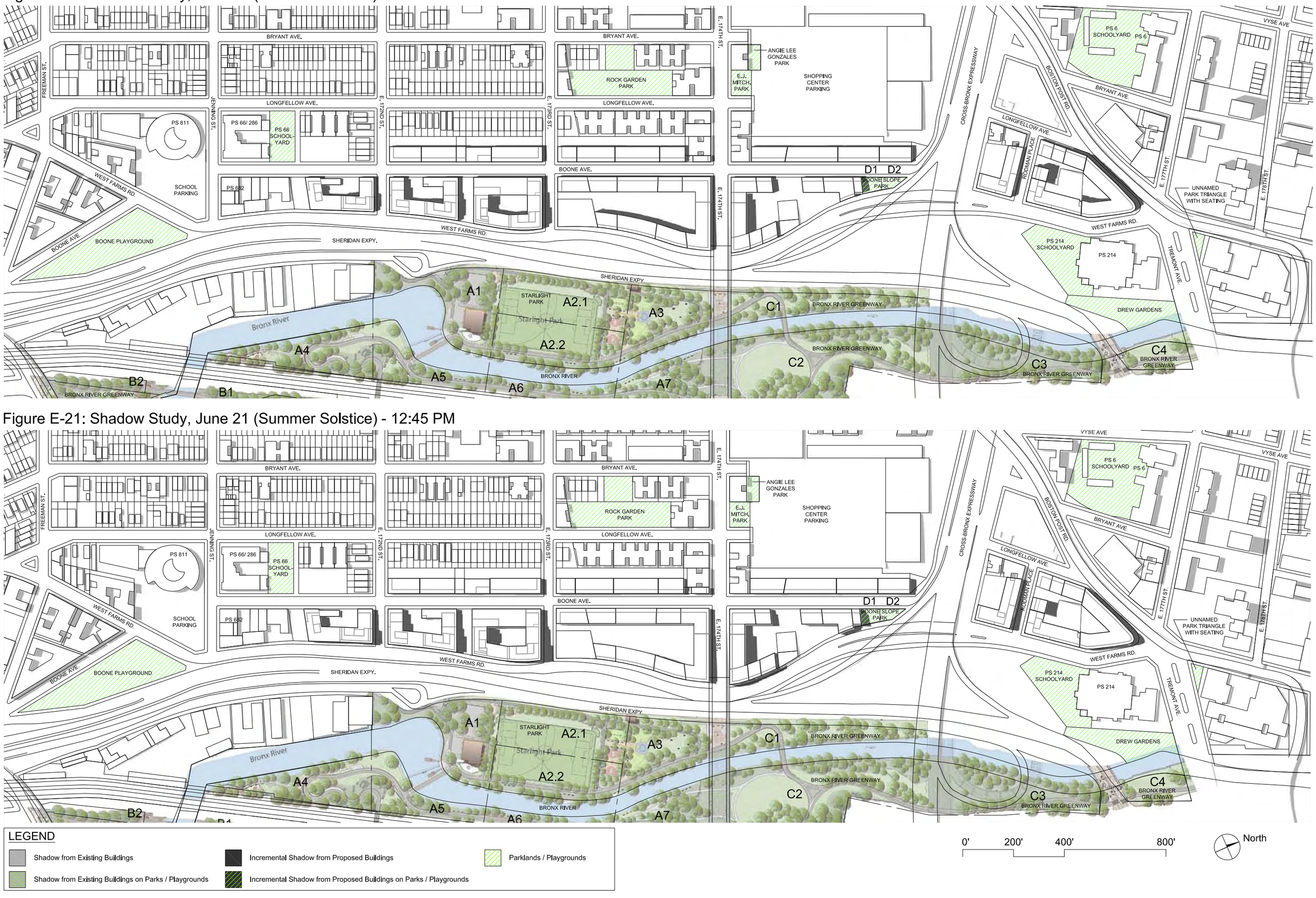


Figure E-22: Shadow Study, June 21 (Summer Solstice) - 3:00 PM

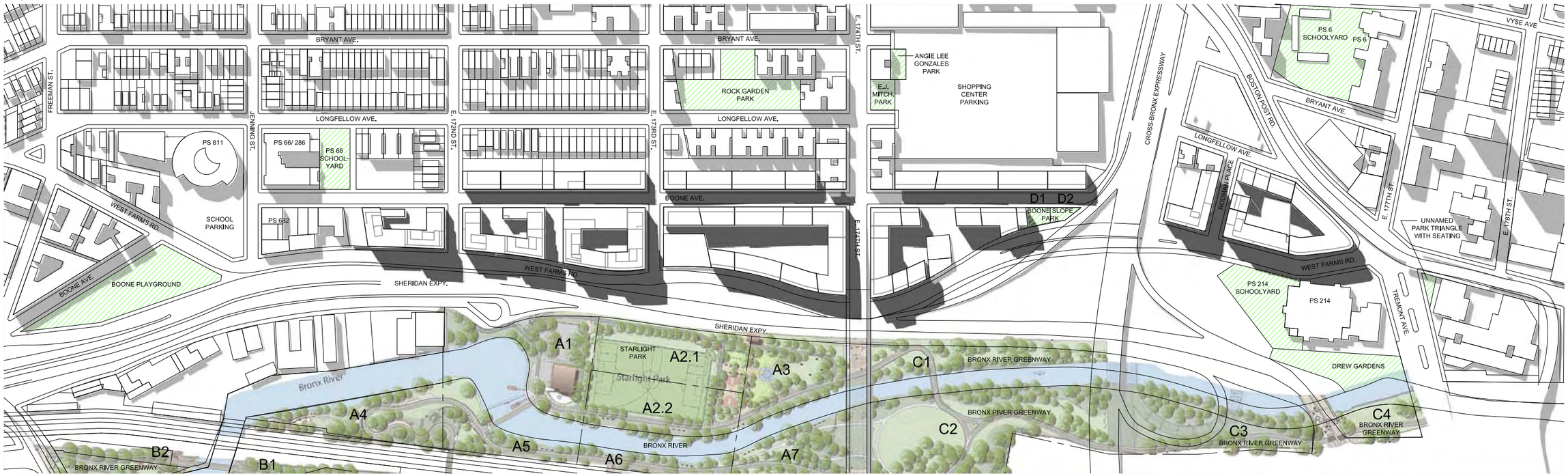
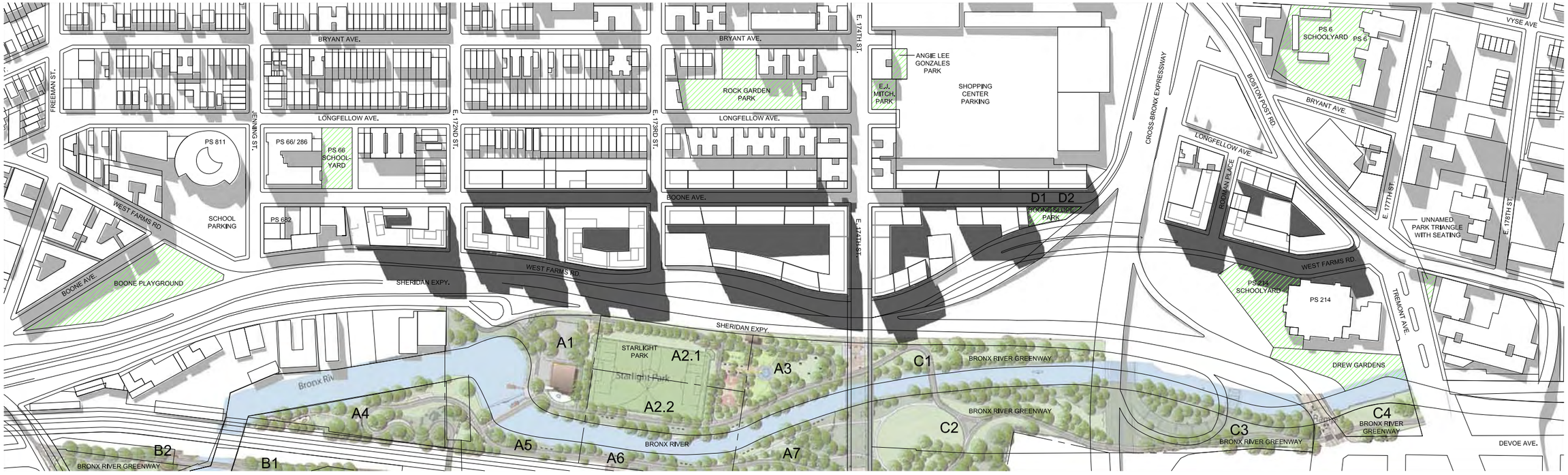


Figure E-23: Shadow Study, June 21 (Summer Solstice) - 3:45 PM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-24: Shadow Study, June 21 (Summer Solstice) - 5:15 PM



Figure E-25: Shadow Study, June 21 (Summer Solstice) - 5:30 PM



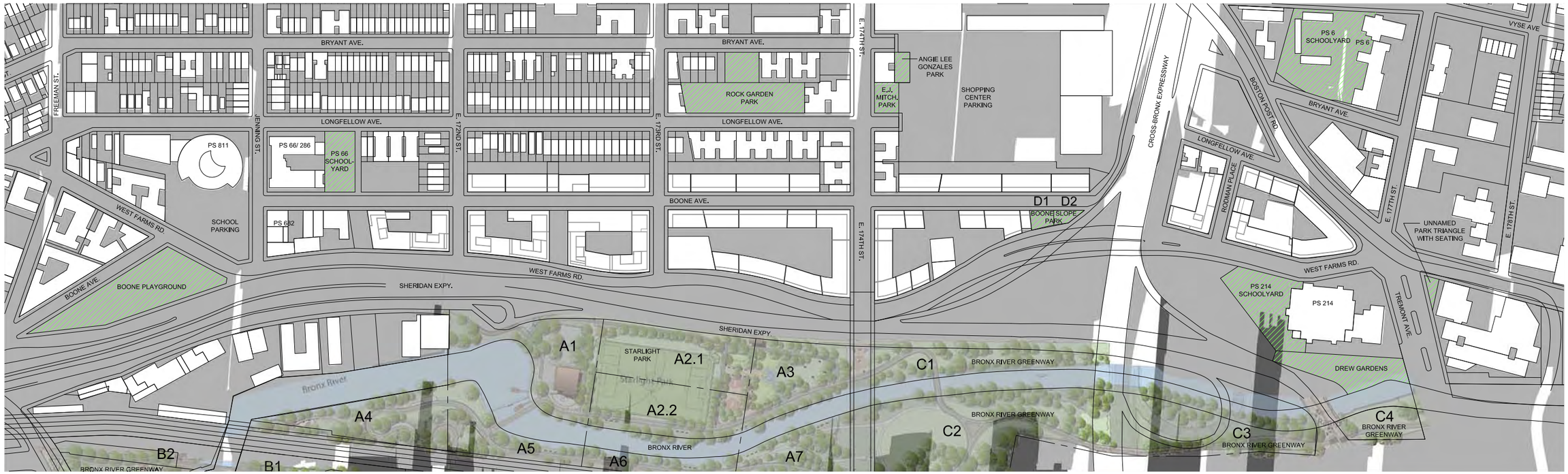
LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-26: Shadow Study, June 21 (Summer Solstice) - 7:00 PM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

Figure E-27: Shadow Study, December 21 (Winter Solstice) - 8:45 AM

Figure E-28: Shadow Study, December 21 (Winter Solstice) - 9:30 AM

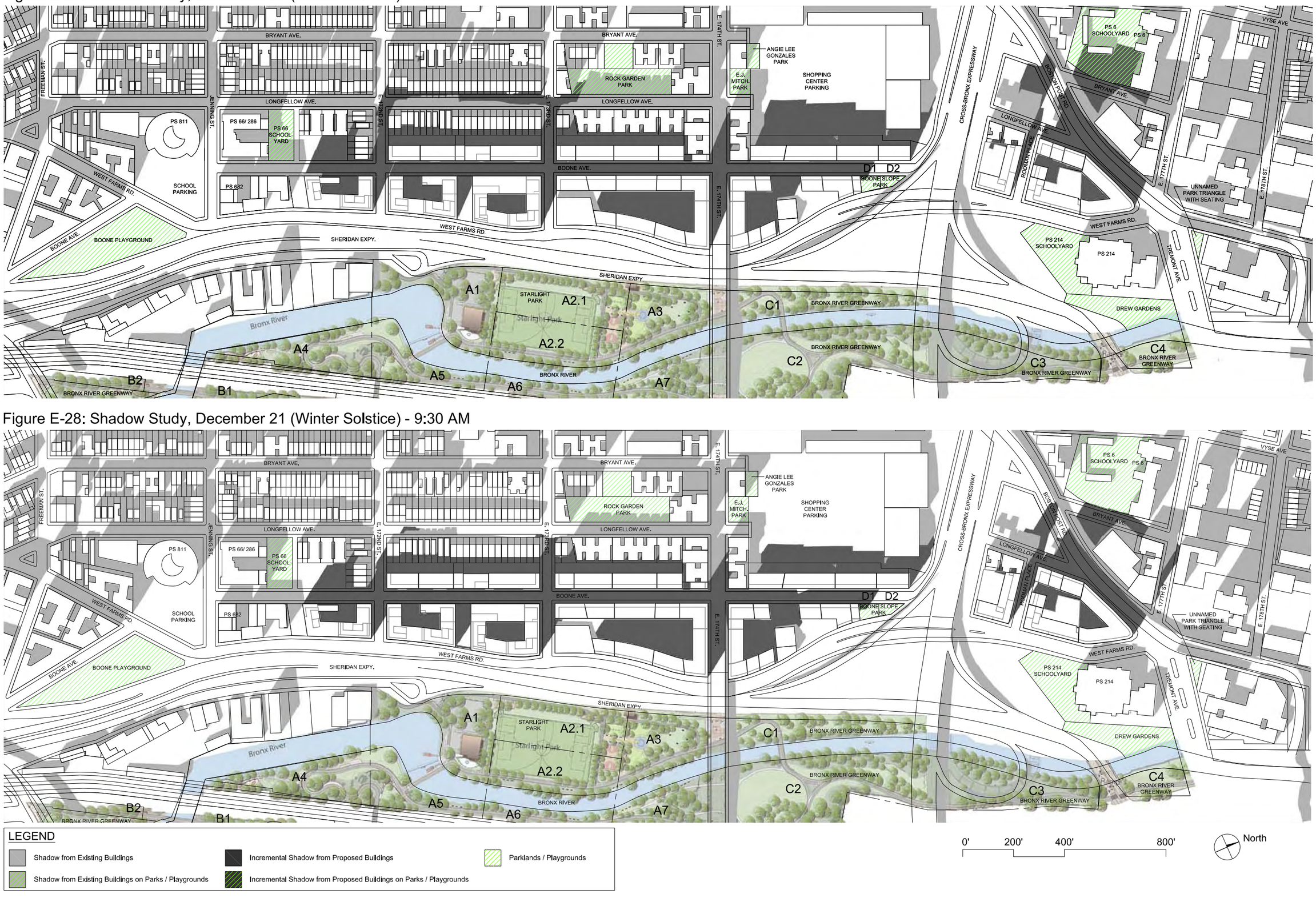


Figure E-29 Shadow Study, December 21 (Winter Solstice) - 12:00 PM

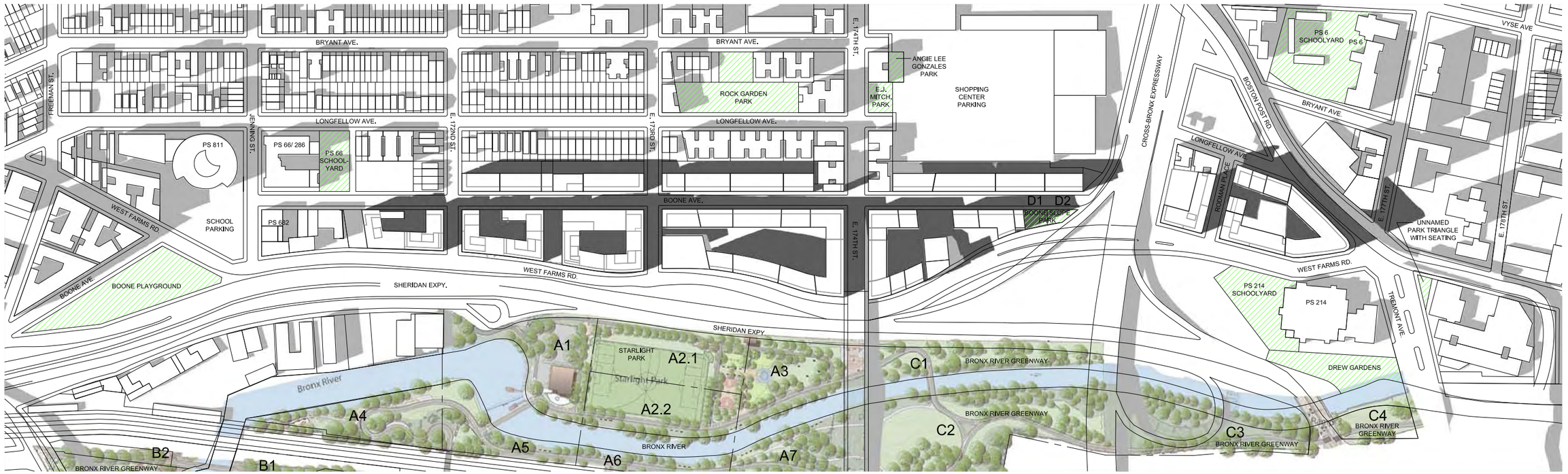
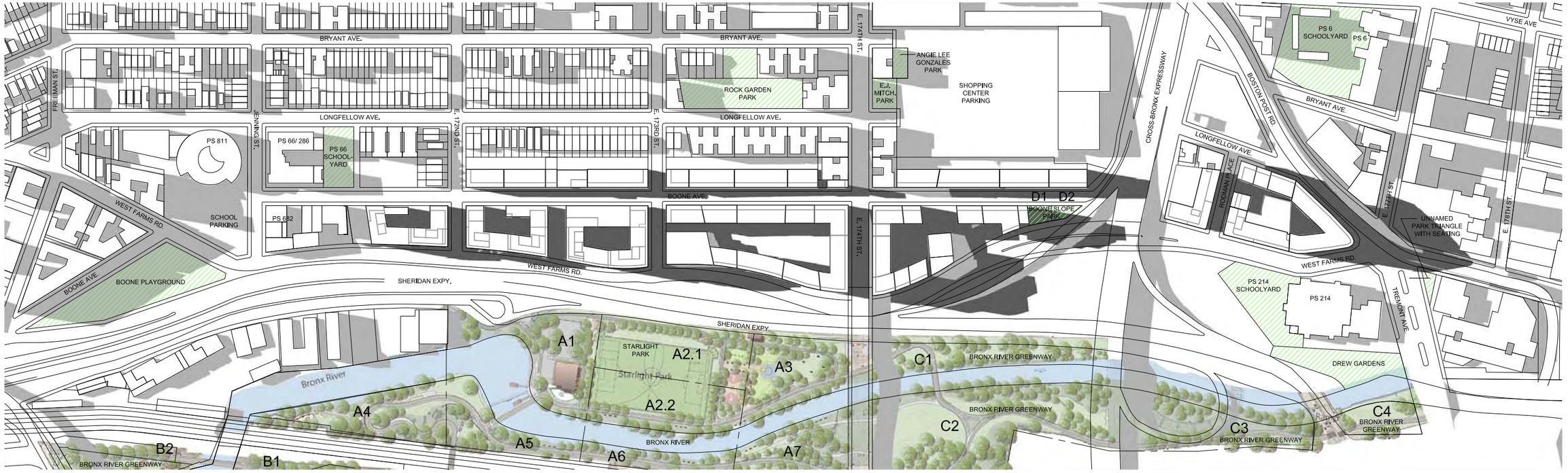


Figure E-30 Shadow Study, December 21 (Winter Solstice) - 2:10 PM



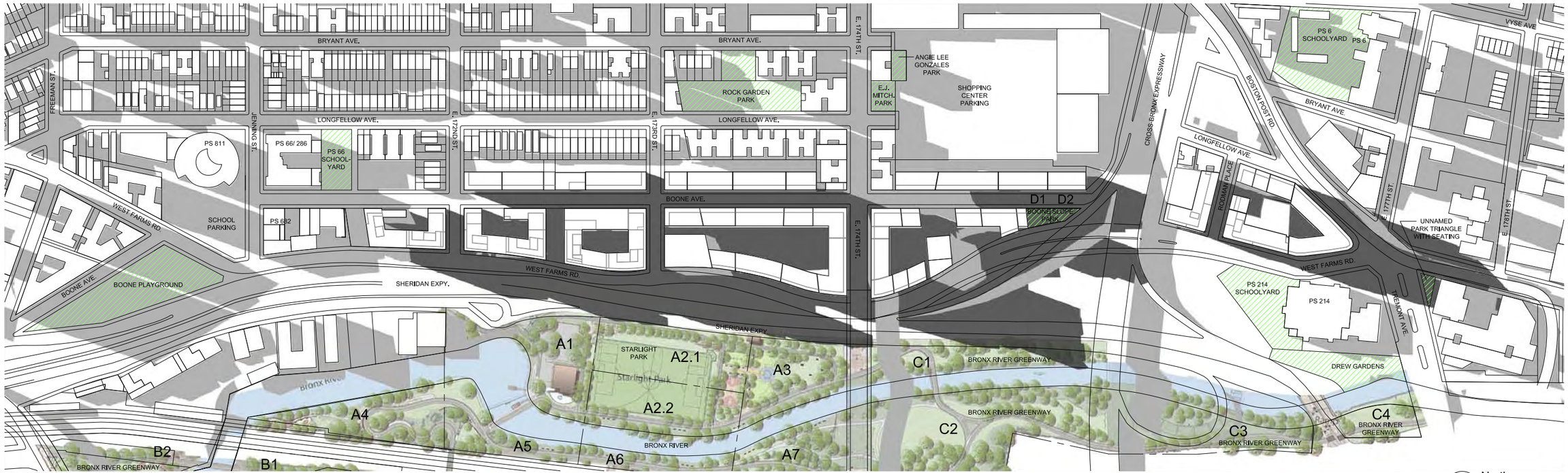
LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

0' 200' 400' 800'

North

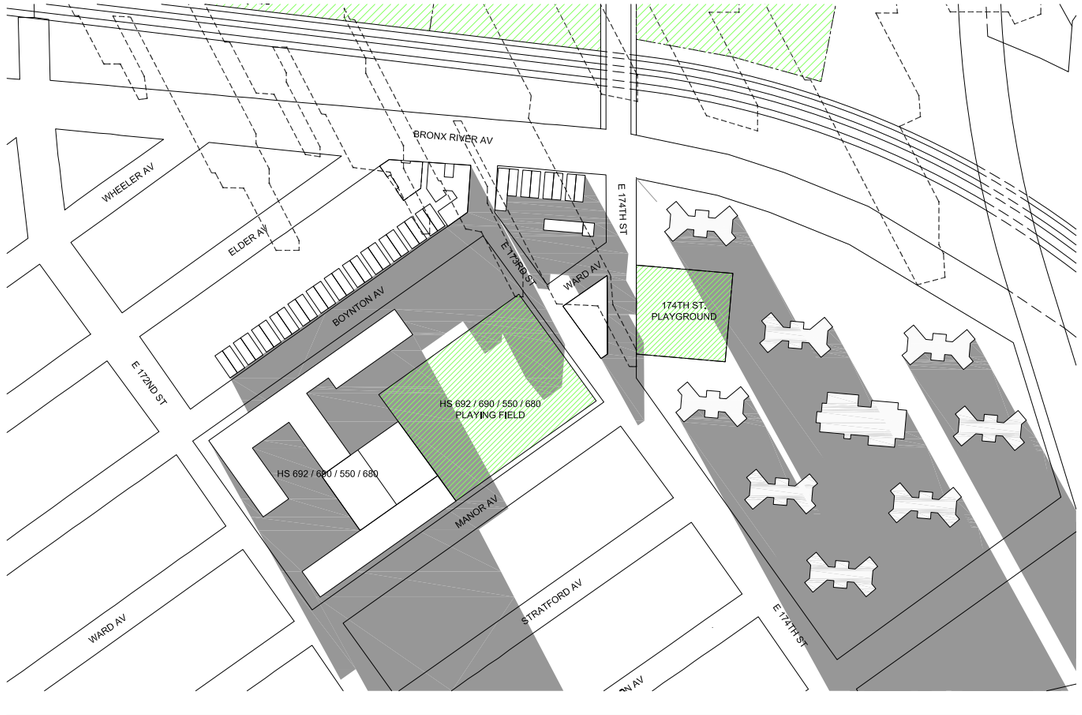
Figure E-31 Shadow Study, December 21 (Winter Solstice) - 3:00 PM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

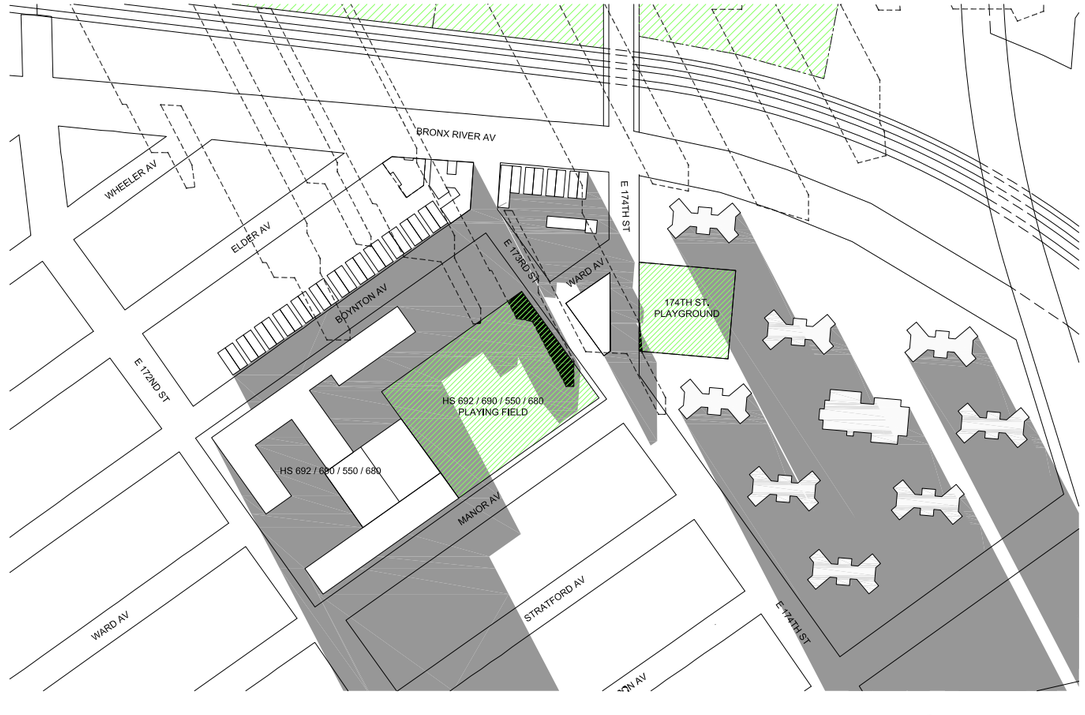
Figure E-32: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 5:35 PM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

Figure E-33: Shadow Study, March 21 / September 21 (Spring / Fall Equinox) - 5:39 PM



0' 200' 400' 800'

North

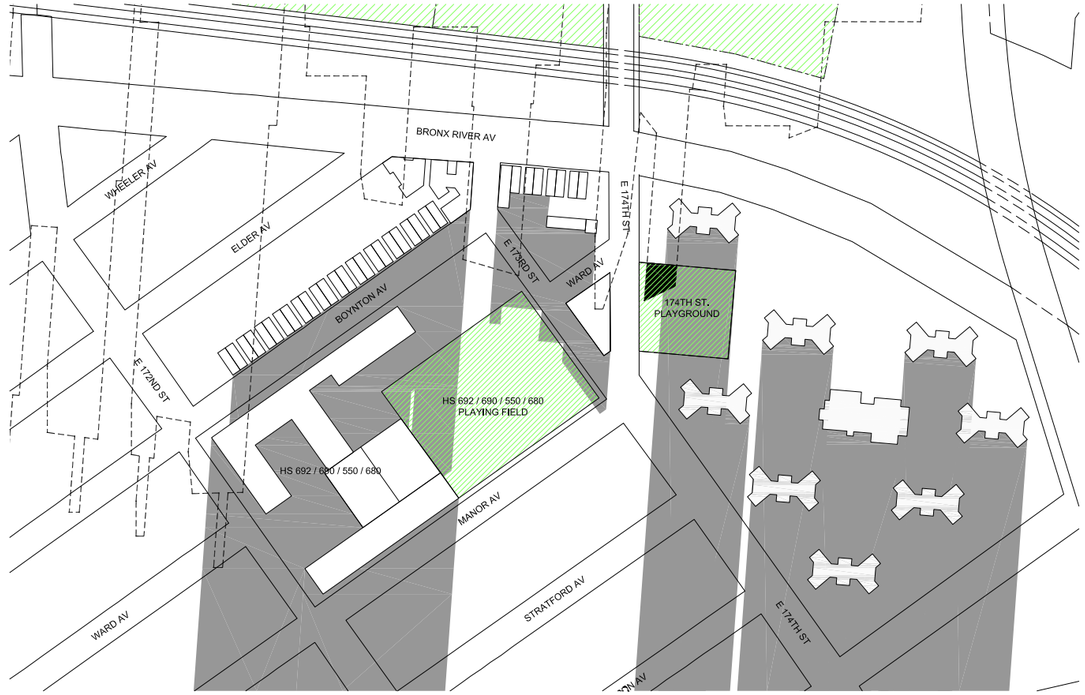
Figure E-34: Shadow Study, June 21 (Summer Solstice) - 6:55 PM



LEGEND

- Shadow from Existing Buildings
- Shadow from Existing Buildings on Parks / Playgrounds
- Incremental Shadow from Proposed Buildings
- Incremental Shadow from Proposed Buildings on Parks / Playgrounds
- Parklands / Playgrounds

Figure E-35: Shadow Study, June 21 (Summer Solstice) - 7:00 PM



0' 200' 400' 800'

North

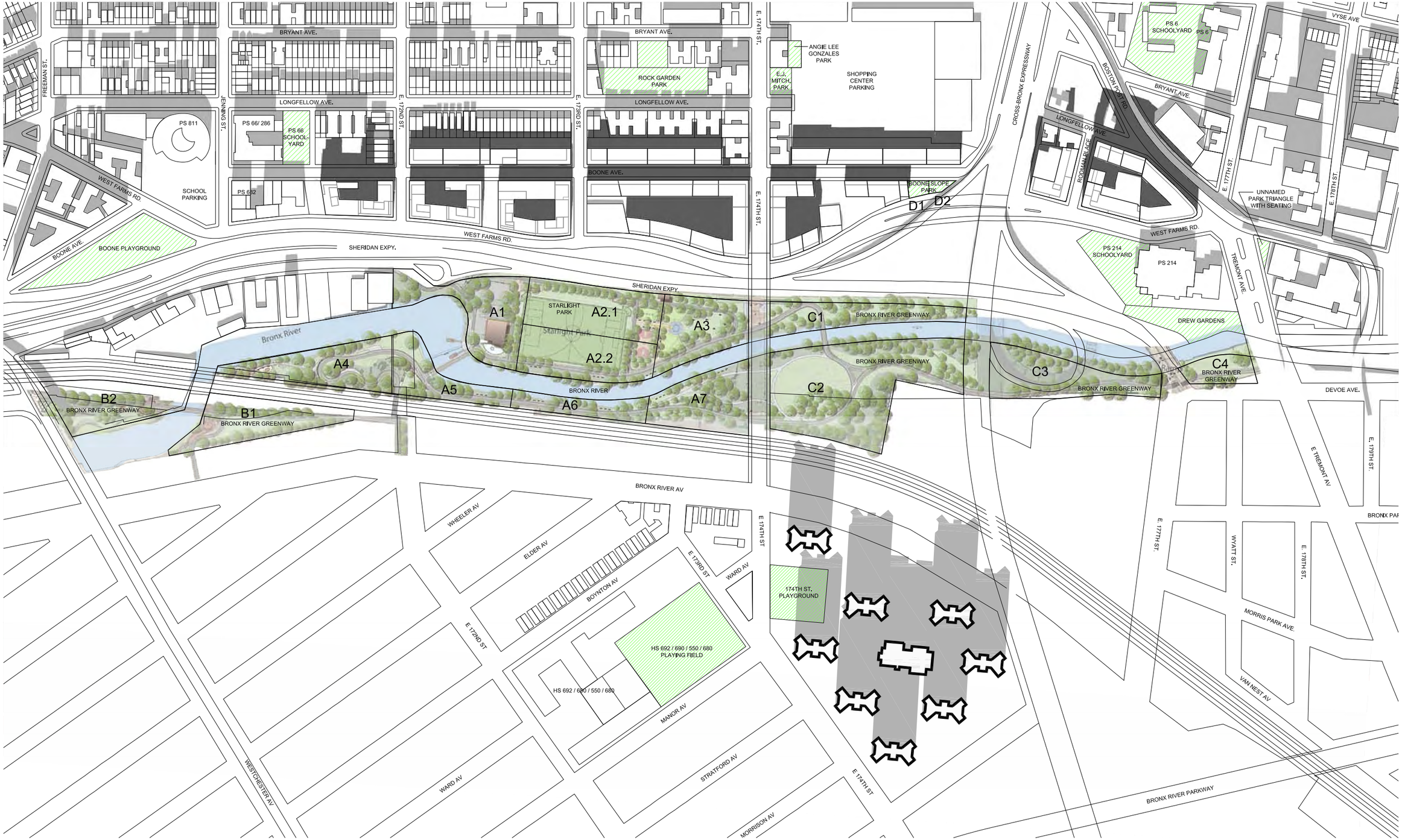


Figure E-36: Shadow Study for Existing NYCHA Buildings east of Bronx River- March 21 / September 21 - 8:30 AM

0' 200' 400' 800'

North

LEGEND

Existing NYCHA Buildings

Shadow from Existing Buildings

Parklands / Playgrounds

Shadow from Existing Buildings on Parks / Playgrounds

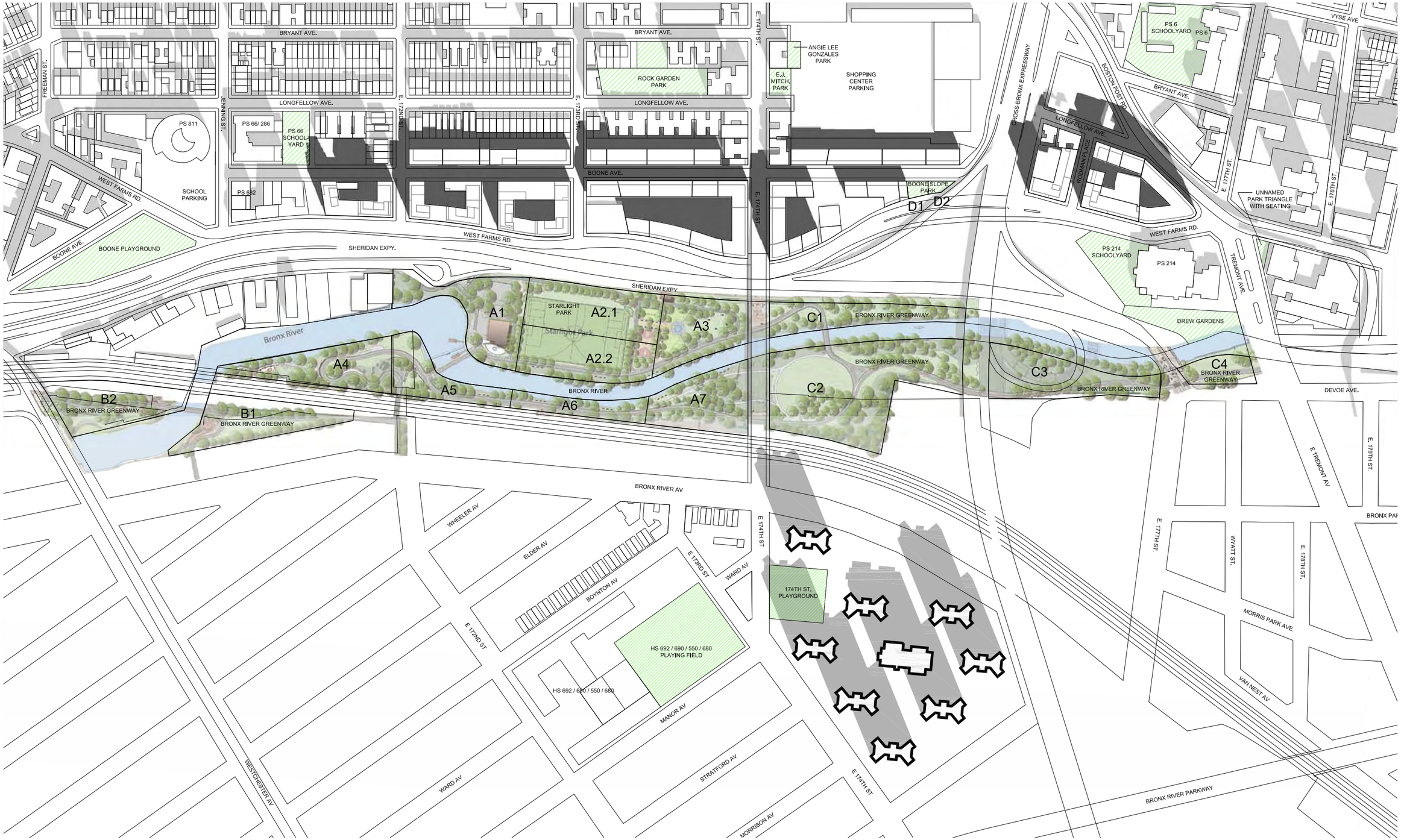


Figure E-37: Shadow Study for Existing NYCHA Buildings east of Bronx River- May 6 / August 6 - 7:19 AM

0' 200' 400' 800'

North

LEGEND

Existing NYCHA Buildings

Shadow from Existing Buildings

Parklands / Playgrounds

Shadow from Existing Buildings on Parks / Playgrounds

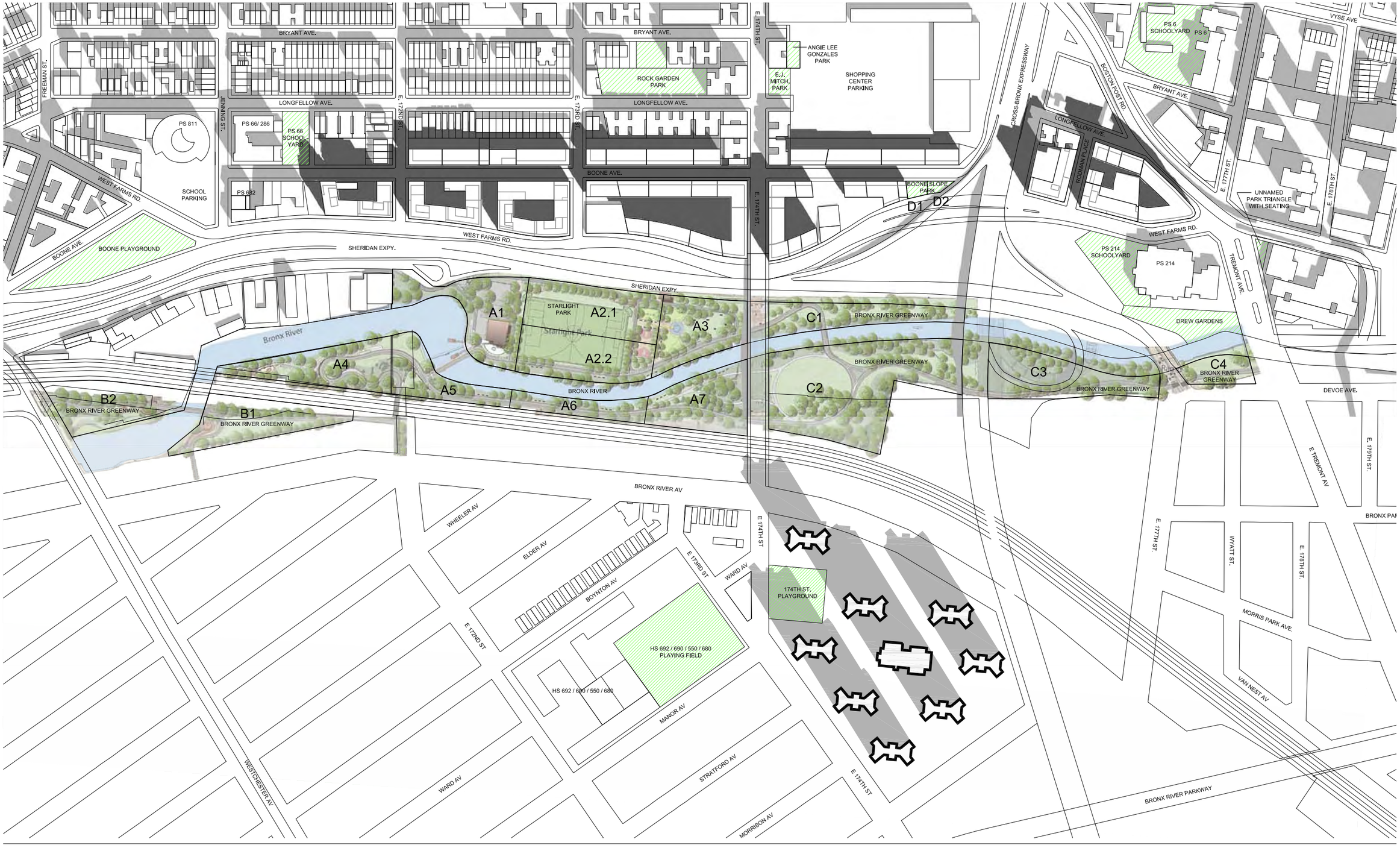


Figure E-38: Shadow Study for Existing NYCHA Buildings east of Bronx River- June 21 - 7:00 AM

0' 200' 400' 800'

North

LEGEND

Existing NYCHA Buildings

Shadow from Existing Buildings

Parklands / Playgrounds

Shadow from Existing Buildings on Parks / Playgrounds

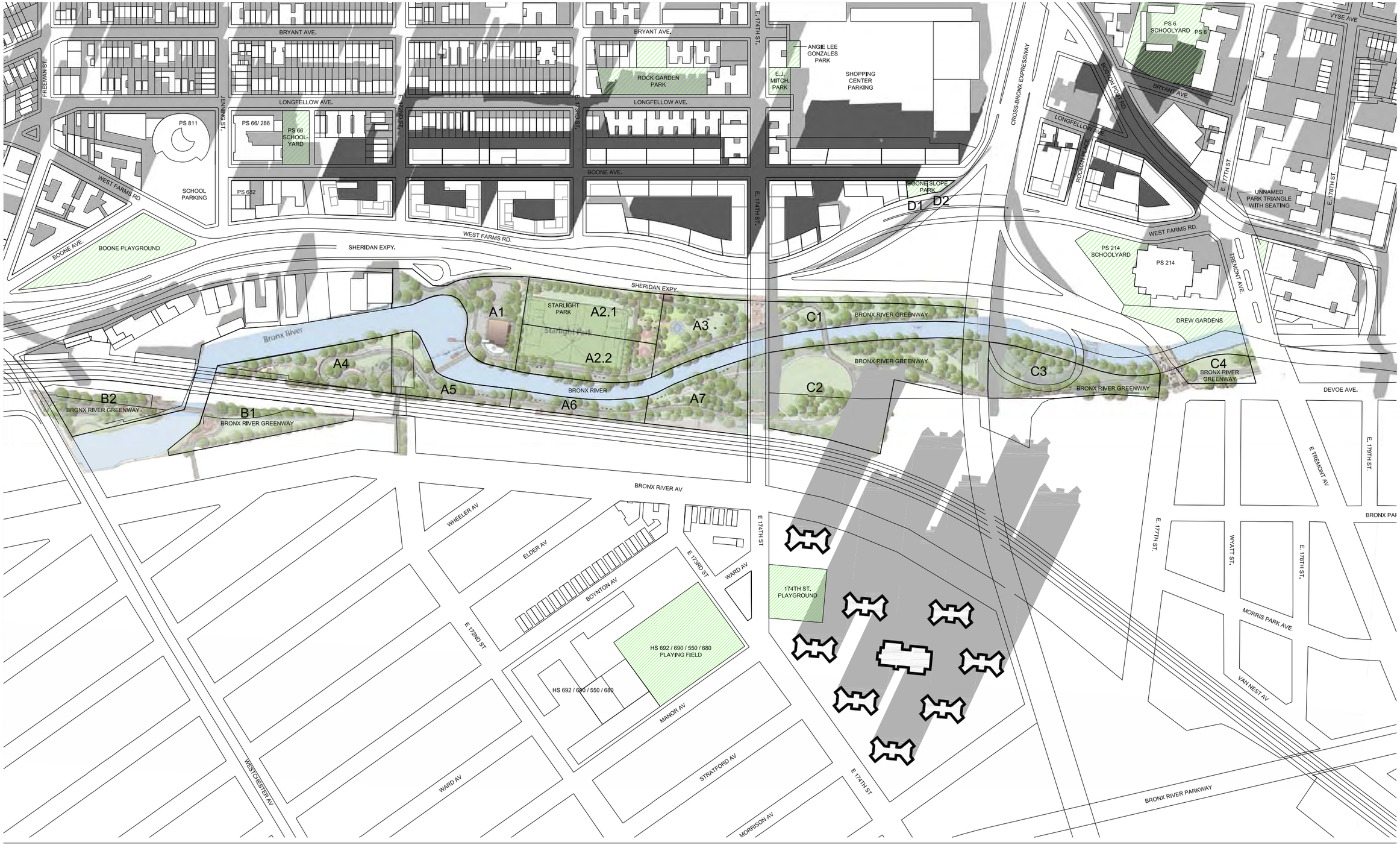


Figure E-39: Shadow Study for Existing NYCHA Buildings east of Bronx River- December 21 - 8:45 AM

0' 200' 400' 800'

North

LEGEND

Existing NYCHA Buildings

Shadow from Existing Buildings

Parklands / Playgrounds

Shadow from Existing Buildings on Parks / Playgrounds

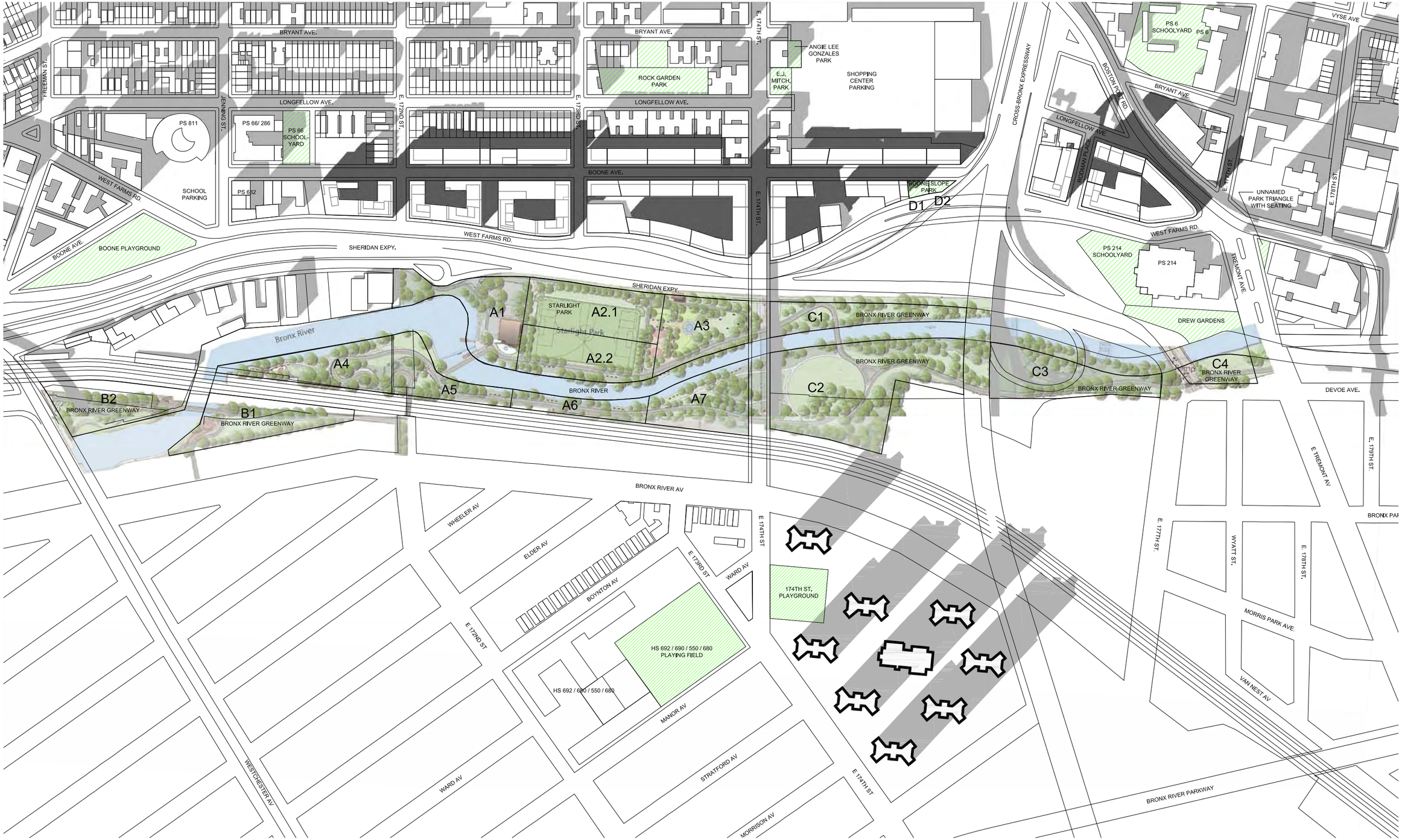


Figure E-40: Shadow Study for Existing NYCHA Buildings east of Bronx River- December 21 - 10:15 AM

LEGEND

Existing NYCHA Buildings

Shadow from Existing Buildings

Parklands / Playgrounds

Shadow from Existing Buildings on Parks / Playgrounds

0' 200' 400' 800'

North