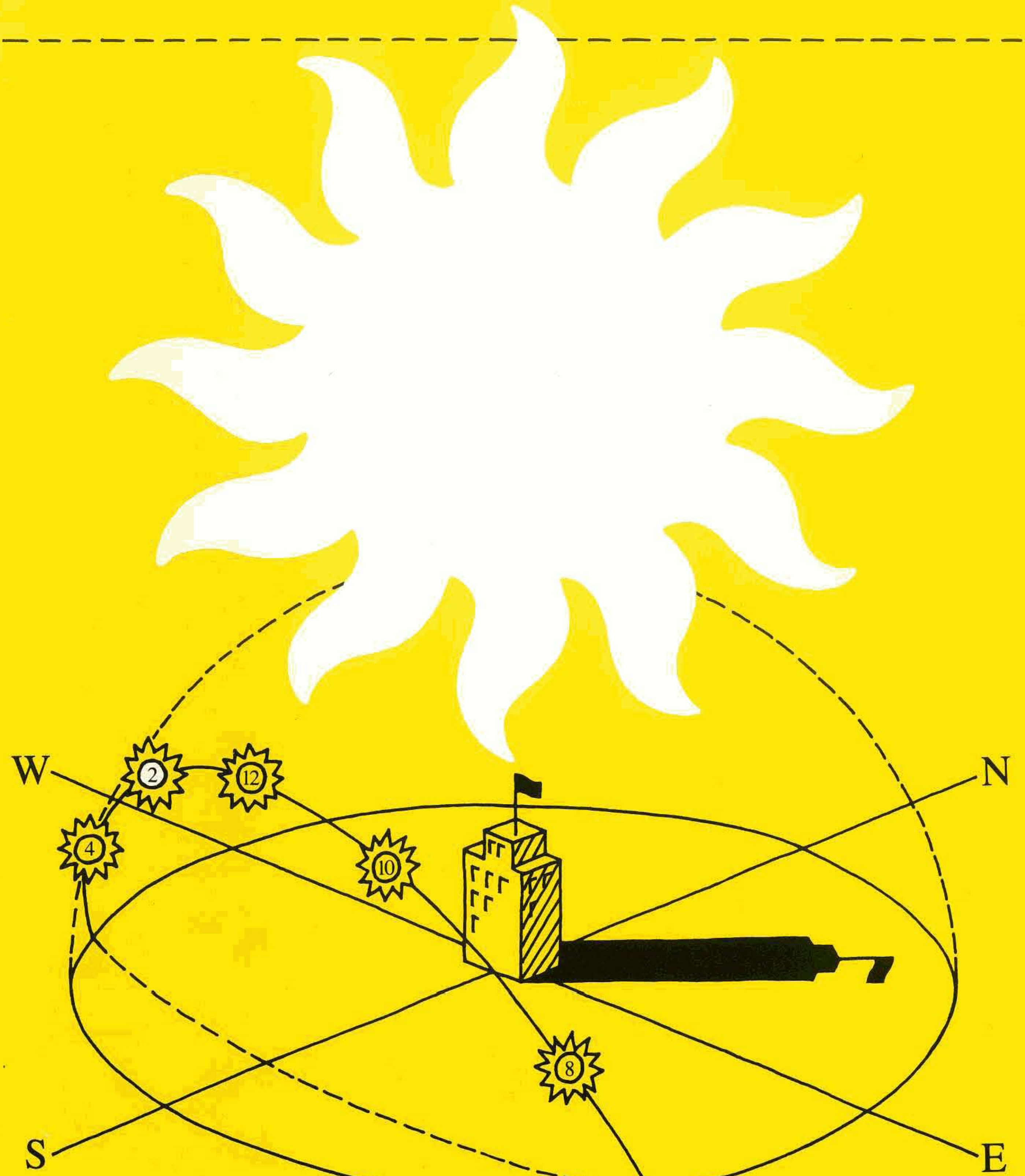
Preserving Sunlight in New York City's Parks: A Zoning Proposal



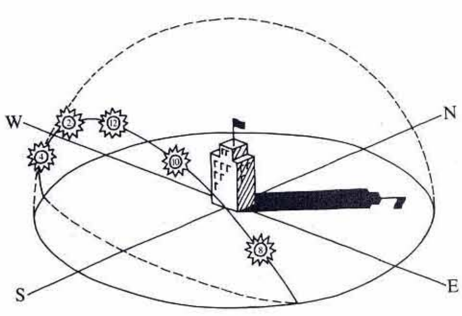
The Parks Council

Preserving Sunlight in New York City's Parks: A Zoning Proposal

The Parks Council

Consultants
Michael Kwartler and Associates

1991



PRESERVING SUNLIGHT IN NEW YORK CITY'S PARKS:

A ZONING PROPOSAL

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(Cont'd.)

Note: Background and technical accounts of the research on which this report is based are listed in the Reports Cited section and are available as separate documents, for a charge to cover costs of reproduction and postage. Please address inquiries to The Parks Council, 457 Madison Ave., New York, NY 10022, tel. 212-838-9410.

Figures

(Cont'd.)

Tables

Acknowledgment

The Parks Council acknowledges with gratitude the funding support for this phase of its Environmental Simulation Project by the Central Park Conservancy, Greenacre Foundation, the Honorable Manfred Ohrenstein, and The William and Mary Greve Foundation.

Our thanks to the New York City Department of City Planning, the New York City Department of Parks and Recreation, and the many planning officials throughout the United States and Canada who shared with us information about their own efforts to preserve solar access for public parks and open spaces.

We also thank the members of Zoning Study Subcommittee of The Parks Council's Design Committee for giving generously of their time and effort over the length of this project.

Arthur A. Baker, *Chairman*
Edward H. Auchincloss
Ellen Chesler
Patricia Conway
Marianne Cramer
Martin Gallent
Michael Gerrard
Amy Hines
Robert Kafin
Katherine Kennedy
Garrison McNeil
Allan Payne
Robert B. Stecker
William H. Whyte
Paul Willen

September 1991

Gerald A. Rosenberg
President
The Parks Council

Dear Gerald,

I am pleased to submit herewith "Preserving Sunlight in New York City's Parks: A Zoning Proposal" for endorsement by you and the Board of Directors.

When the Design Committee's Zoning Subcommittee first undertook this assignment, we had neither a clear understanding of the scope of the issue nor any certainty as to whether we would be able to formulate a series of simple amendments to the existing zoning regulations that would achieve our goals without placing undue restraints on the development of properties adjoining parks. Happily, we were able to accomplish our task, due mainly to the untiring efforts of everyone concerned.

Particular credit is owed to the members of the Zoning Subcommittee, who labored long, always keeping our deliberations focused on the goal of parkland protection; Michael Kwartler and Associates, who methodically and meticulously analyzed every aspect of the issues and proposed the ingenious "green line" concept of evaluating and regulating adjoining development; and Parks Council Design Program Director Charlotte Fahn, who was able to take our collective ideas and imbue them with clarity and form.

Considerable additional tasks must still be undertaken to turn our recommendations into reality. These tasks are outlined on page 17 of the report, and if I can further assist The Parks Council in this future effort, please do not hesitate to call upon me.

Yours sincerely,

Arthur A. Baker
Chairman, Zoning Subcommittee

Preface

Parks and open spaces are essential to the quality of life in dense urban areas such as New York City. Hundreds of small neighborhood parks and playgrounds as well as major parks like Central Park and Prospect Park grace the city and provide relief from the surrounding masses of concrete and steel.

New York is fortunate that, in years past, an enlightened citizenry preserved and developed large tracts of land as city parks. Now, the scarcity of both land and funds makes the creation of new parks extremely difficult. It is therefore increasingly important that existing parks be protected, not only from physical incursions and the diversion of parkland for other uses, but also from potentially adverse effects of neighboring development.

Development projects that appear reasonable when proposed are often found to inflict harsh environmental consequences on their neighborhoods once they have been built. Loss of sunlight, wind gusts, and temperature extremes are among the localized, "microclimate" effects that are frequently recognized too late. Yet modern methods of environmental simulation, using a combination of scale models, cinematic techniques, and computer technology, now make it possible to anticipate accurately sun, shadow, and wind effects at the design stage of a project.

In 1987 The Parks Council embarked on a long-term project to explore the effects of the city's current Zoning Resolution on the environment of the city's parks and consider what modifications might be needed to protect parks. As Phase I of this Environmental Simulation Project, we commissioned a microclimate study of development proposals for the Upper West Side of Manhattan to serve as an example of a method that can be used city-wide. The study was conducted by Professor Peter Bosselmann of the University of California, Berkeley. It concluded that, under present zoning practice, the delicate fabric and vitality of parks and open spaces are not adequately protected, and that large-scale development, if insensitively designed, can have serious detrimental effects on the quality of open spaces.

Phase II, the present study, has been conducted by the architecture, planning, and urban design firm of Michael Kwartler and Associates. It marks the beginning of a major undertaking in the protection of New York City parks and open space: the development of generic, as-of-right zoning regulations that can protect the most vulnerable qualities of urban open space without placing a burden on development.

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Based on an analysis of more than 1,000 computer simulations of potential shadows on the city's parks, the study finds that some 700 parks—half of the municipal park system—are at risk of shadowing from future development, and proposes zoning regulations to preserve sunlight in these vital public spaces. We present our proposal for discussion and comment by city officials, development professionals, and civic groups as the basis for drafting an amendment to the Zoning Resolution, in the hope that together we can guide development toward protecting parks and creating a more livable environment for all New Yorkers.

The Parks Council
New York City, October 1991

Summary

The neighborhood playground on a sunny but chilly day in early spring or late fall, with children scrambling over slides and swings while grown-ups talk on benches nearby, has long been a familiar and valued scene of life in New York City. Yet in shadow, that playground would likely be silent and empty.

New York's 1,300 public parks, playgrounds, and open spaces represent a collective inheritance of inestimable value, and it was the desire to keep them bright, cheerful, and sunny that impelled the study on which this report is based. Planning and zoning practice in the city has tended to ignore the role parks and public open spaces play in enhancing the quality of citizens' everyday lives. In fact, public policy has often encouraged oversized development around parks, viewing their abundance of light and air as a justification for doing so.

This view ignores the effect of such development on parks and the people who use them. Oversized development around parks deprives them of sunlight at critical times of the year, the colder months when the warmth we feel from the sun's rays allows us to be comfortable outdoors despite low temperatures. Reduced sunlight, often coupled with adverse pedestrian-level winds, discourages park use. This report addresses the need for simple and easily administered regulatory controls to prevent the environmental degradation of the city's inventory of parks at a time when resources are scant and it is urgent to extend to the greatest degree possible the use of parks we already have.

Several large North American cities, using a variety of approaches, already regulate the microclimate effects of development. San Francisco, for example, regulates solar access for 14 downtown parks on a discretionary, case-by-case basis. The task of this study was to propose solar access zoning regulations for New York City that would be sensitive to the diversity of its vulnerable public parks and their built contexts, would not place undue restraints on the development of properties adjoining parks, and, for practical reasons, could be administered on an as-of-right basis.

Unlike regulation by discretionary review, as-of-right regulation requires that a public purpose and benefit be identified *and* that the standard which achieves the public benefit be objectively measurable and applicable in all situations. To accomplish this, more than 1,000 simulations of potential shadows on the city's parks were analyzed. The study found that, under current zoning, some 700 parks—half of the municipal system—are at risk of overshadowing from future development, and proposes zoning regulations to preserve sunlight in these vital public spaces. Relying on the Common Law principle of a continuing public expectation and on the analysis of the shadow simulations, the study recommends that existing conditions of sunlight and shadow in parks, represented by "green lines," become the legislative standard. The key to the proposed regulations is the fact that they permit the green lines—the solar access standard—to adjust automatically to specific park conditions like orientation and built context.

Two parallel and equivalent methods are provided for evaluating whether a proposed new building near a park complies with the standard. The prescriptive method uses the traditional zoning technique of regulating building form by a series of theoretical inclined planes, in this case, sun exposure planes. The performance method eases the constraints of a single sun exposure plane by making it possible to determine whether the shadow of a proposed building form falls within the green lines of the affected park or, if it exceeds the green lines, within the shadow of an existing building. In either case, the proposed building would be in compliance with the regulations.

The proposed park solar access regulations represent a practical and legally defensible approach to modifying the city's zoning. Next steps include public discussion of the proposal and refinement of the regulations, culminating in the drafting of specific text to be proposed as an amendment to the New York City Zoning Resolution.

PART I

EXPLANATION OF THE PROPOSAL

Introduction

Why Protect Parks?

The neighborhood playground on a sunny but chilly day in early spring or late fall, with children scrambling over slides and swings while grown-ups talk on benches nearby, has long been a familiar and valued scene of life in New York City. Yet in shadow, that same playground would likely be silent and empty.

New York's parks, playgrounds, and open spaces represent a collective inheritance of inestimable value, and it was the desire to keep them bright, cheerful, and sunny that impelled the study on which this report is based. Planning practice in the city has tended to ignore the central role of parks and public open space in enhancing the quality of citizens' everyday lives. In fact, public policy, as reflected in provisions of the city's Zoning Resolution, has often encouraged oversized development around parks, embracing the view that their abundance of light and air justifies and indeed offers a particular opportunity for the construction of nearby buildings that elsewhere would be considered too large.

This view ignores the effect of such development on parks and the people who use them. Oversized development around parks can permanently deprive them of sunlight at critical times of the year, the colder months when the warmth we feel from the sun's rays allows us to be comfortable outdoors despite low temperatures. This reduction of sunlight, often coupled with adverse pedestrian-level winds, discourages park use and in doing so ultimately diminishes the quality of urban life, particularly at the densities at which New Yorkers live. This report addresses the need for simple and easily administered regulatory controls to prevent the environmental degradation of parks at a time when resources are scant and it is urgent to extend to the greatest degree possible the use of parks we already have.

The study considered New York's 1,300 parks and playgrounds and determined that almost half are currently protected from future shadowing and wind effects of nearby development by virtue of their location in low-density zoning districts. About 700, located in medium- and high-density districts, were identified as being at risk, in particular 134 in the city's densest sections. We propose a zoning approach that would generally maintain the existing conditions of sunlight the public has come to expect in these 700 parks by formulating a series of "green lines" as the sunlight standard for new development near parks. This proposal could readily be incorporated into the city's current Zoning Resolution.

Parks in Urban Life

Parks have long been central to the quality of urban life in the United States. Frederick Law Olmsted, who designed great parks not only in New York but in cities across America; the turn-of-the-century progressives with their focus on the neighborhood and the child-centered playground; and later generations of urban reformers and activists all conceived of parks as the democratic American equivalent of the European piazza, square, and private park. They imbued parks with ethical as well as recreational and formal esthetic values. Today, the centrality of parks in the lives of urban Americans—providing them with green and open space in which to play, enjoy nature, and escape from crowded streets and living conditions—remains as strong as ever.

What has been changing is the public's attitude toward parks. With the slowing pace of parkland acquisition in recent decades has come the growing realization that we cannot squander and abuse the parks we already have, that there are not "more where those came from," but rather that they are a finite resource that must be safeguarded for the generations who follow. Parks are recognized as critical elements of the city's natural environment and physical infrastructure. The important role they play in the city's economy, by increasing the value of properties that are near parks and enjoy sunny park views, is also now widely acknowledged. Parks serve as a stabilizing element in aging neighborhoods and as a stimulus for reinvestment.

Changing Regulatory Focus

Regulatory activity has been slow to keep pace with this change in focus. While Europeans have a history of regulating the size of buildings around parks in order to keep the parks as sunny and free of winds as possible, public parks in the United States have generally suffered from a lack of such controls.

Gradually, however, the concept of regulating the microclimate effects of development has taken hold. Several large cities in the United States and Canada—San Francisco, Toronto, Calgary, Edmonton, Seattle, and Portland (Oregon)—have already adopted such regulations, although their approaches differ from one another and not all are specifically focused on parks or other public open spaces[1]. This type of regulation has generally been sustained by the courts as falling within the same police powers of the state (to "...promote the

General Welfare") that permit governments to promulgate zoning and environmental regulations in the first place.

Although New York City has lagged behind these efforts, such considerations are not new to the city. It was in fact the seven-acre shadow cast by the 42-story Equitable Building, built in 1915, that helped to give rise to New York's original 1916 zoning ordinance, the first in the nation. The 1961 revision of the ordinance, another pioneering document, was similarly motivated by concerns for light, air, and the quality of life in open spaces, including the city's streets and sidewalks.

A still more recent precedent is provided by the Midtown Zoning Daylight Evaluation Regulations, adopted by the city in 1982, which set daylighting standards for midtown Manhattan. It is the legal, methodological, and regulatory approach of this set of regulations that forms the basis of the present proposal for extending the city's long-established protection of light and air to protection of sunlight in its parks.

Structure of the Report

This report is addressed to a diverse audience with widely varying degrees of interest and expertise in zoning matters. Part I provides the policy context and essential points of our zoning proposal for protecting sunlight in parks. Part II briefly describes the dynamics of the sun in relation to parks, and provides technical details of the study methodology and sunlight standard in a way that we hope will be informative to the general public. Part III discusses various aspects of the compliance methods and provides a step-by-step example of their application to a city playground.

The Zoning Proposal

General Description

The Parks Council recommends that controls on the shadowing of parks from new development be adopted that would generally maintain current conditions of sunlight in parks, especially during the solar-sensitive periods of late fall and early spring. The solar access standard would be based on current sunlight conditions in parks on November 1, and is derived from the average depth to which shadows from existing buildings at a given density and scale penetrate parks at specified 1-1/2 hour time intervals on that date (Fig. 1). These averaged depths of shadow penetration are termed "green lines."

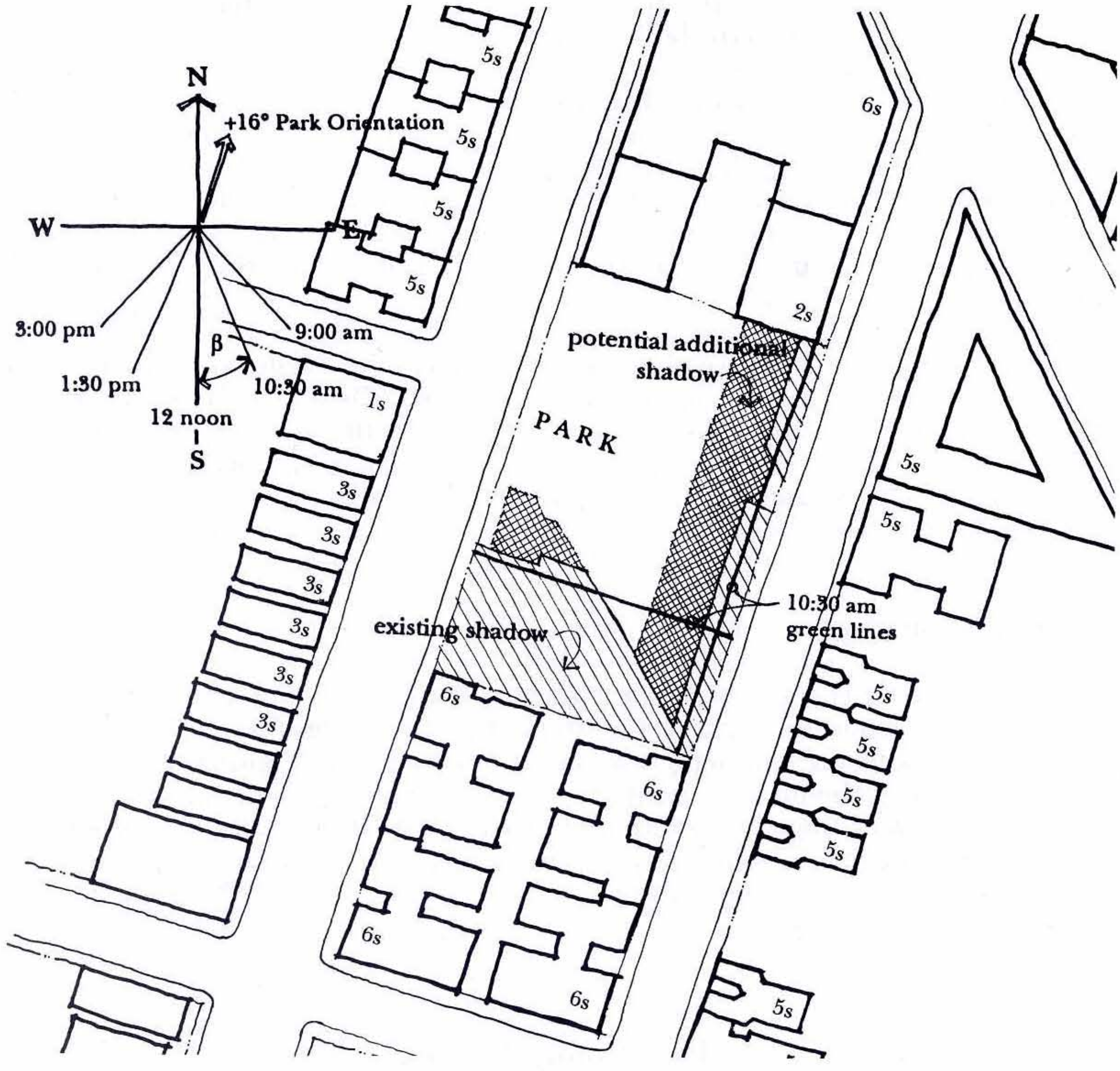

FIGURE 1. Existing Shadow on a Park Compared with Additional Shadow Possible in Absence of Solar Access Regulations

Diagram contrasts existing shadow (hatching) on a park with potential additional shadow from future development (cross-hatching) under present zoning regulations. The proposed solar access regulations would establish a minimum sunlight standard limiting the amount of new shadow that can be added to a park to an *average of the existing shadow* (termed a "green line"), thereby protecting current sunlight conditions. In this and other illustra-tions, the compass shows the park's orientation and the sun angles (β) used in the study, and 3s, 5s, 6s, etc., indicates the number of stories of the depicted buildings.

The regulations would apply to the approximately 700 parks in residential zoning districts R6 through R10 and their commercial equivalents in Brooklyn, the Bronx, Manhattan, and Queens, and would be administered on an as-of-right basis, requiring neither park-by-park public review nor administrative decision-making. These characteristics distinguish them from the park-oriented zoning regulations requiring discretionary review that have been adopted by other cities.

The regulations are designed to work within the current system of zoning and to be easily incorporated into the New York City Zoning Resolution. The city's contextual zoning regulations (the Quality Housing Program), adopted as part of the Zoning Resolution in 1987, would be mandated for any development that would cast a shadow on one of the 700-odd affected parks. At present, a developer has the option of using the Quality Housing regulations instead of tower regulations in areas not already mapped as contextual zones.

Contextual zoning regulates the height and bulk of new buildings, their street setbacks, and their width along the street frontage, to conform with the character of the neighborhood[2]. It results in a lower-rise, more traditional building form than the towers produced by standard zoning at the same density. These "contextual" buildings are generally compatible with existing buildings around parks and, as the study's research in building form demonstrated, usually have less shadow impact on parks than the conventional high-rise slab.

With the contextual regulations mandated for development around parks, sun exposure planes (see Part III) would supersede the Quality Housing Program's sky exposure planes in governing building form. The contextual regulations would be modified by the proposed solar access regulations where the latter are more restrictive. The solar access regulations would be adopted as an amendment to the text of the Zoning Resolution and would not require any changes or additions to the city's zoning maps.

The regulations we propose would set clear limits on the extent of park shadowing permitted by new buildings or by enlargements to existing buildings. In doing so they would maximize the potential for park use by the public in the colder months of the year without stopping or excessively restricting development near parks. By making it clear where shadowing is—and is not—permitted, the regulations would in fact remove an element of uncertainty from the development process.

The proposed solar access regulations would have the important additional advantage of minimizing adverse pedestrian-level winds in parks. Such winds generally occur around buildings that are at least twice the height of adjoining buildings or that are designed without significant setbacks, which tend to prevent the downgusting wind frequently experienced around tall, sheer, free-standing buildings. The solar access regulations would generally induce building forms that have setbacks if the site's full development potential is to be realized. Therefore, in virtually all situations, compliance with the solar access regulations would minimize and in most cases eliminate winds that result from inappropriate building forms.

Compliance Methods

Two parallel and equivalent methods—one prescriptive, the other a performance method—would be provided for evaluating whether a proposed new building is in compliance with the solar access standard for parks. The dual methods are provided to take into account the diversity of the city's parks and their built contexts and orientations.

A prescriptive method is one in which the architect or developer, by following a prescribed set of calculations, arrives at a design solution that conforms to the regulatory standard. As applied here, the prescriptive method uses the traditional zoning technique of regulating building form by a series of theoretical inclined planes—in this case, sun exposure planes. The sun exposure planes would be determined from the green line data that would supplement the Zoning Resolution's contextual zoning regulations. This method is simple and direct, but in some instances may be unduly restrictive for a particular development lot. The architect or developer might then decide to use the performance method to achieve a solar access zoning envelope more precisely fitted to the development site.

In the performance method, the emphasis is on whether a particular design "performs"—that is, whether it meets the regulatory standard. Rather than being constrained by a single sun exposure plane, the architect or developer would analyze a proposed building design to see if the shadow falls within the green line of the affected park or, if it exceeds the green line, within the shadow of an existing building. If the design meets either of these two conditions, then it meets the standard. This method parallels current environmental impact statement practices, which generally require an analysis of a proposed building's shadow impacts.

In almost all cases modeled, the more precise zoning envelope resulting from use of the performance method accommodated greater development potential than that permitted under the prescriptive method, without diminishing the sunlight standard for the affected park. Developers and architects would have the option of using either the prescriptive method, which is based on averaging, or the context-specific performance method to evaluate compliance, thereby minimizing the number of potential applications for variances.

Both methods can be worked through manually, using information supplied in the regulations, or by computer. Both employ techniques that are already familiar to any architect, developer, or other interested party. Developers and architects routinely work through a checklist of height, bulk, setback, and other zoning restrictions that determine the size and shape of a building permitted on a lot. For lots near parks, there would now be an additional item on the checklist: regulatory constraints on the shadowing of parks.

Perhaps the best way to understand how to work through the proposed regulations is to follow their application to an actual situation. Part III provides details of the two compliance methods, using as an example a hypothetical development site opposite the playground adjoining Junior High School 22 in the Bronx, one of the representative parks examined in the study.

Variances and Discretionary Reviews

As mentioned above, the option to use the generalized prescriptive method or the more site-specific performance method to analyze a site should minimize the need for the Board of Standards and Appeals to grant variances from these regulations. However, if both methods still result in a significant loss of development potential (whether from a reduction in buildable floor area as a result of a highly restrictive envelope, or from an uneconomical building configuration, or both), then, under current law, a variance could be granted by the Board of Standards and Appeals in determining the minimum accommodation necessary to redress the hardship. The performance method would provide an objective means by which that minimum could be determined.

Both methods would also be used in discretionary reviews of special cases (see Part II): development near parks in historic districts, special zoning districts, and the high-density commercial areas of Midtown and Lower Manhattan; large-scale developments; transfers of development rights from landmarks and enlargements of landmark sites; and other development that could affect parks. In addition, development affecting a few special parks, like landmarked parks, would be governed by more finely tuned, park-specific green lines. The performance method would be used to evaluate the public harm from sunlight permanently lost to a park, compared with the public benefit to be gained from other aspects of such projects.

Arriving at the Recommendations

These zoning recommendations are the result of a study involving the intensive analysis of more than a thousand computer-generated shadow simulations of actual parks, coupled with extended discussions of the policy implications of the study's findings. For a brief description of the methodology used in the study, a discussion of why the "green line" was chosen as the solar access standard, and further details about the standard, see Part II of this report.

Which Parks Are Affected

The study looked at approximately 1,300 open spaces in the city and found that nearly half are already protected from shadowing by current zoning. The remainder, those targeted by our zoning recommendations, warrant "green line" protection. About 10% of the 1,300 are located within or border on the densest parts of the city and can be considered in critical need of protection.

This section of the report explains these conclusions in greater detail. The terms 'park' and 'open space' are used generically throughout the report to mean sites included in the New York City Department of Parks & Recreation's inventory of properties, whether or not they are green parks in the traditional sense. Certain properties in the Department's inventory, like parking lots, maintenance facilities, and indoor recreation centers, where solar access is inconsequential, were excluded from the study inventory.

The Study Inventory of Parks

The following types of city-owned open spaces were included in the study. (The categories are similar but not identical to those used by the Department of Parks & Recreation.)

- Triangles, squares, and sitting areas, typically half an acre or smaller in size, often irregularly shaped, and oriented toward passive activities. Examples: Verdi and Greeley squares in Manhattan.

- Community parks, generally one to five acres, occupying a small portion of a block, and accommodating a mix of active and passive uses. Examples: Cobble Hill Park in Brooklyn, Richmond Park in Queens, and Clement Clark Moore Park in the Chelsea section of Manhattan.

- Civic plazas, usually having formal architectural elements (an arch, memorial statue, or ornamental fountain) and used for passive activities. Examples: Grand Army Plaza in Brooklyn and the plaza at Lincoln Center in Manhattan.

- Playgrounds and recreation areas. Playgrounds are often associated with schools or public housing projects, typically are about one to two acres in size, and serve the immediate community around them. Recreation areas generally are four to six acres and serve a broader neighborhood population than playgrounds. Both are primarily active-use parks. Examples: the playground and schoolyard associated with Junior High School 22 in the Bronx, and the full-block Dr. Martin Luther King, Jr., Park in Brooklyn.

- Neighborhood parks, larger than five acres, occupying an entire block or large, irregular parcels, and combining a range of active and passive uses. These are typically between seven and fifteen acres in size in Manhattan and larger in the outer boroughs. (This category is similar to the Department of Parks & Recreation's "large park" category.) Examples: Tompkins Square Park in Manhattan and King Park in Jamaica, Queens.

- Major parks, generally irregularly shaped parks larger than 25 acres, often having unique features or facilities. These serve large portions of their boroughs with a mix of active and passive uses. Examples: Riverside Park in Manhattan, Cunningham Park in Queens, and Clove Lakes Park in Staten Island.

- Regional parks, drawing visitors from all parts of their boroughs and often from elsewhere in the city and beyond the city. Examples: Central Park in Manhattan, Flushing Meadow Corona Park in Queens, Prospect Park in Brooklyn, and Van Cortlandt Park in the Bronx.

Table 1 shows the breakdown of this study inventory, totaling 1,332 open spaces, by type of park and by zoning district. Both this overall total and the numbers of various park types shown in the table and discussed in the text should be regarded as close approximations rather than as precise counts. This is because several parks are in or adjacent to more than one zoning district and were therefore counted in more than one district.

Impact of Current Zoning Designations

The objective in creating this study inventory was to identify not only those parks subject to shadowing from existing, as-built conditions, but also parks in zoning districts whose height, setback, and density regulations would probably permit greater—in some cases, substantially greater—shadowing than now occurs. New York City's Zoning Resolution provides ten standard residential districts: R1, the lowest density district, through R10, the highest (the base densities in the higher districts can sometimes be increased, for example, by a plaza bonus). Some zoning districts within the Manhattan commercial cores can have densities substantially higher than the highest-density residential districts. Parks themselves generally have no zoning designation; they are legally dedicated ("mapped") as public parkland.

TABLE 1. Refined Study Inventory*
New York City Parks Distributed by Zoning District[1] and Park Type[2]

	No. of Parks by Residential Zoning District (or commercial equivalent)		
Borough	R1-R5	R6-R10	Total
Bronx	65	168	233
Brooklyn	136	238	374
Manhattan	0	233	233
Queens	324	68	392
Staten Island	100	0	100
New York City	625	707	1,332

	No. of Parks in or Adjacent to R6 to R10 Zoning Districts (or commercial equivalent)			
Park Type[2]	R6-R7	R8-R9	R10 & Higher	Total[3]
A. Small Parks				
Triangles	117	15	13	[145]
Sitting Areas	29	4	3	[36]
Community Parks	58	10	13	[81]
Civic Plazas	5	3	3	[11]
Miscellaneous	16	2	0	[18]
Subtotal	225	34	32	[291]
B. Playgrounds & Recreation Areas	281	30	5	[316]
C. Neighborhood Parks	60	14	9	[83]
D. Major Parks	23	6	2	[31]
E. Regional Parks	4	1	1	[6]
Total	593	85	49	[±727]

**Developed from the "Park Property and Facility List" (8 December 1988), prepared by the New York City Department of Parks and Recreation (DPR). Of the 1,548 properties under the jurisdiction of the DPR, 1,332 are public parks and open spaces. The other 216 properties, excluded from this refined study inventory, are those indicated by the DPR inventory as grass strips/center plots/malls, parking fields, indoor facilities (pools, recreation centers, museums, theaters), and parkways/drives without recreational facilities.*

[1] *Parks are categorized by zoning district as identified in the New York City Zoning Resolution (1990). Parks in or adjacent to both residential zoning district categories (or their commercial equivalents) of R1-R5 and R6-R10 are counted in the R6-R10 category.*

[2] *Park types are described in the text and are modified from categories used by the DPR.*

[3] *Several parks are in or adjacent to one or more zoning districts and have been counted in each; totals are, therefore, shown in brackets to emphasize that these figures are illustrative rather than precise counts.*

Development at the densities permitted in R1-R5 zones is considered to pose little or no threat to solar access in parks in those districts. The city's *Lower Density Contextual Zoning Regulations*, which in 1989 replaced the more permissive 1961 rules, limit new buildings or enlargements of existing buildings to a height of 35 to 40 feet in R3-R5 zones (R1 and R2 zones are for single-family homes). Shadowing from these low-rise buildings is deemed negligible when considered in an overall New York City context. San Francisco's solar access regulations similarly exempt parks in neighborhoods where the underlying zoning district restricts building heights to a maximum of 40 feet.

Thus, after analysis, we concluded that the 625 parks in the study inventory in low-density districts (those zoned R1 through R5) are already protected from adverse shadowing impacts. These parks comprise slightly under half of the total study inventory and include all parks in Staten Island and in large areas of Brooklyn, the Bronx, and most of Queens (Fig. 2).

Parks in the study inventory in zoning districts R6 through R10, on the other hand, were identified as being particularly susceptible to increased shadowing. These 700-odd parks, slightly more than half of the study inventory, are the ones that would be affected by the proposed regulations. Within this group, playgrounds and recreation areas are by far the largest single category by type (as they are in the R1-R5 group), and R6-R7 is the largest single category by zoning district.

Two further points should be made about this group. First, the city has recently been assigning lower zoning designations to various areas where actual development was at a density and scale below what the mapped zoning designation permitted. For example, a portion of Elmhurst in Queens was remapped from R6 to R5. In these areas, zoning designations are now appropriate to both the actual densities and the physical character of the neighborhood. Many parks are located in or border on R6-R7 districts whose existing buildings are at a scale and density more typical of districts zoned R5 and below. If the city continues its rezoning policy, the parks in or bordering on R6-R7 districts remapped to R5 or below will then be automatically protected by virtue of the lower density zoning designations.

This applies to many of the city's large parks, most of which are adjacent to districts zoned R5 and below or R6-R7 districts characterized by 4- to 8-story buildings. Parks in this category include Flushing Meadows-Corona, Prospect, Van Cortlandt, Morningside, Alley Pond, Silver Lake, and Crotona. In almost all cases these parks are "island" sites, bordered by wide streets, and are not subject to shadowing to any significant degree.

Second, as shown in Table 1, 134 parks (about 10% of the study inventory) are located in or border on high-density zoning districts (R8-R10). The fact that


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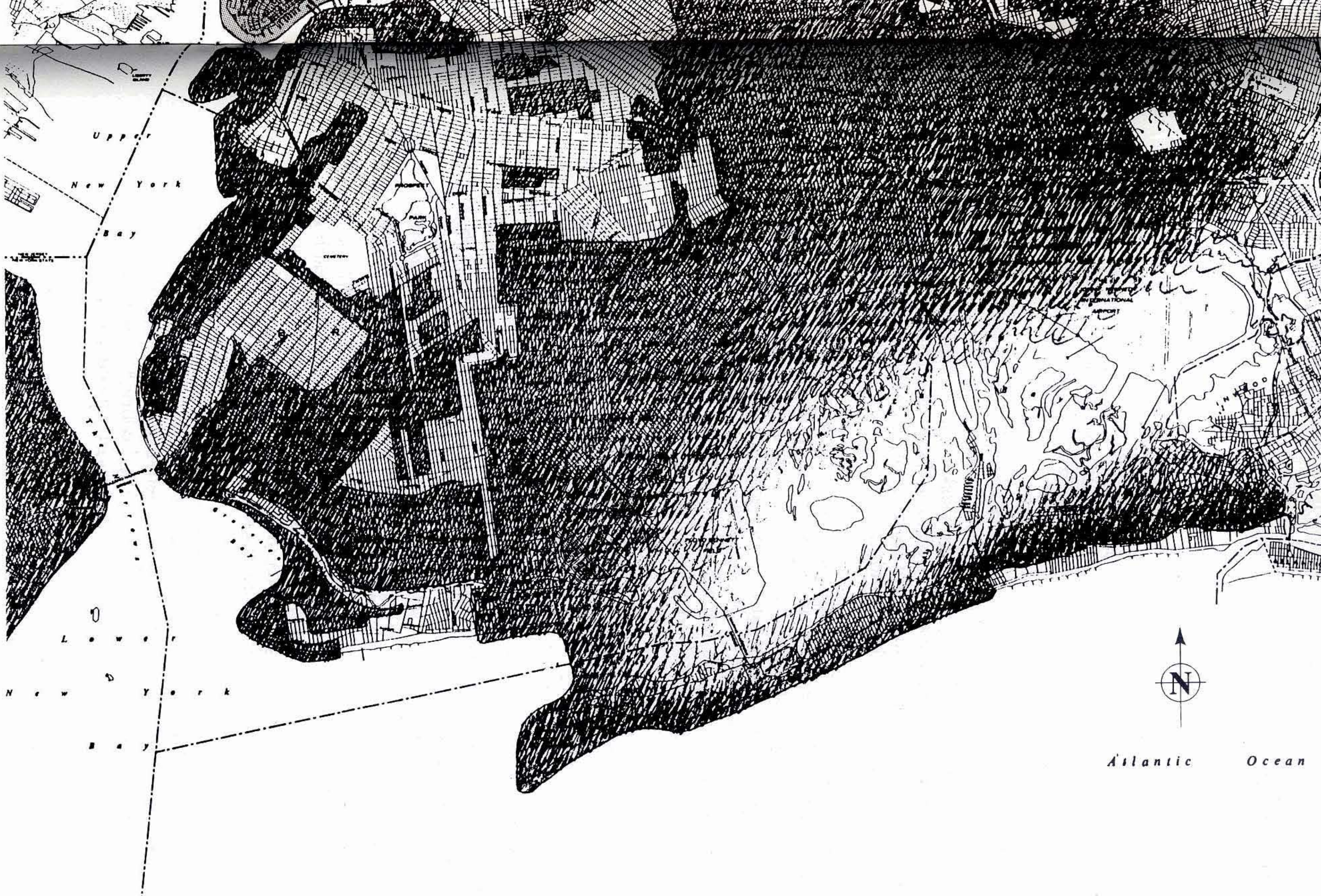


FIGURE 2. Areas of New York City Zoned for Densities of R5 and Below and High-Density Manhattan Cores

As shading indicates, all of Staten Island, most of Queens, and a good portion of the Bronx and Brooklyn are zoned with residential districts of R5 density or below. Parks in these districts (almost half of the public open spaces in the city) are essentially protected under current zoning. The remaining parks, including all Manhattan parks and the balance in the Bronx, Brooklyn, and Queens, are susceptible to overshadowing. Parks in the two high-density Manhattan cores (outlined areas), together with parks in residential districts of R8 and above or their commercial equivalents, make up the 134 parks deemed especially at risk of overshadowing from nearby development.

the parts of the city where population densities are greatest have so few parks increases their importance to the communities they serve, and makes their protection all the more critical.

Parks Representing Special Conditions

A small number of parks can be considered special cases as a result of highly specific locational conditions. These include parks in the city's very high density commercial zoning districts; landmarked parks; parks in or near special zoning districts, large-scale developments, and historic districts; and parks affected by developments requiring discretionary approvals for other reasons, for example, an air rights transfer from a landmarked building.

In most cases the underlying, as-of-right zoning does not recognize the unique settings of these parks, while agencies conducting discretionary reviews of proposed land use actions do not have at their disposal a standardized method to help them decide between competing public interests. The green line approach, applied as a park-specific standard, would provide the review agency with an objective method for evaluating the impact of a proposed action on a park's environment. "Special-case" parks are discussed in greater detail in Part II.

Legal Context

Constitutional Requirements

While the desirability of having bright, sunny, and comfortable public parks and open spaces appears to be a commonly held value, zoning regulations intended to secure these environmental conditions in parks must be able to meet a series of constitutional tests. The research on which the proposed regulations are based was designed in part with this requirement in mind.

For example, the regulations must have a clear public purpose and result in a perceptible public benefit if the government's police power to promote the general welfare is to be invoked in placing restrictions on the use of private property. In this case, the public purpose is to ensure the maximum possible public access to sunshine in parks.

Only when the public purpose and benefit have been identified and affirmed can the standard that achieves the public benefit be set. In zoning law terms, a *public expectation* (that a park should generally be bright, cheerful, and sunny) and a potential *harm* to that expectation (the loss of expected sunlight as a result of future building) have to be identified and a means devised by which to measure them. This was accomplished by the study's use of a sample representing various types of New York City parks and the methodology described below. It was then possible to design an appropriate *remedy* (the zoning regulations) that balanced these concerns using real situations.

Legislative Models

Other cities have regulated the microclimate effects of development[1] and such regulations have generally been sustained by the courts. Several other types of regulations, although only indirectly related to the present study, are worth mentioning.

Perhaps the most common example is provided by solar access regulations that have been widely adopted at both the state and local levels across the United States for purposes of energy conservation. A number of regulatory approaches are employed, from solar easements to solar envelopes and fans. One such approach, the solar fence concept, was influential in the formulation of the green line standard for parks. A solar fence (Fig. 3) is a relatively simple device which regulates building form and placement by describing the area on any given piece of property, such as a park, that would have unobstructed sunlight at designated times of the day and year. The edge of the shadow cast by the imaginary solar fence, located along the property's lot lines, defines the area of unobstructed sunlight. Shadows from adjoining buildings must fall within the shadow cast by the solar fence.

In the course of researching these and other solar access regulations, the literature on the English Law of Ancient Lights was also examined in some depth[3]. The most recent English legislation based on this Common Law doctrine rests on the principle that once a building interior has had access to daylight or sunlight for a specified period of time (at present, 27 years), then a continuing expectation—a right to that light—is legally established.

While American courts, starting in the nineteenth century, rejected the Law of Ancient Lights as being overly restrictive because it would have markedly limited the development potential of undeveloped land, contemporary courts and legislatures have begun to reappraise its applicability, particularly in dense urban settings. In this study, the concept of a continuing expectation, based on a period of uninterrupted sunlight already enjoyed, was critical. What has been added to it is the element of a public rather than a private benefit.

Other zoning precedents could be cited in support of regulations that protect sunshine in public parks[1]. For example, limited height districts enacted for esthetic purposes or to protect airspace around airports represent the use of zoning to

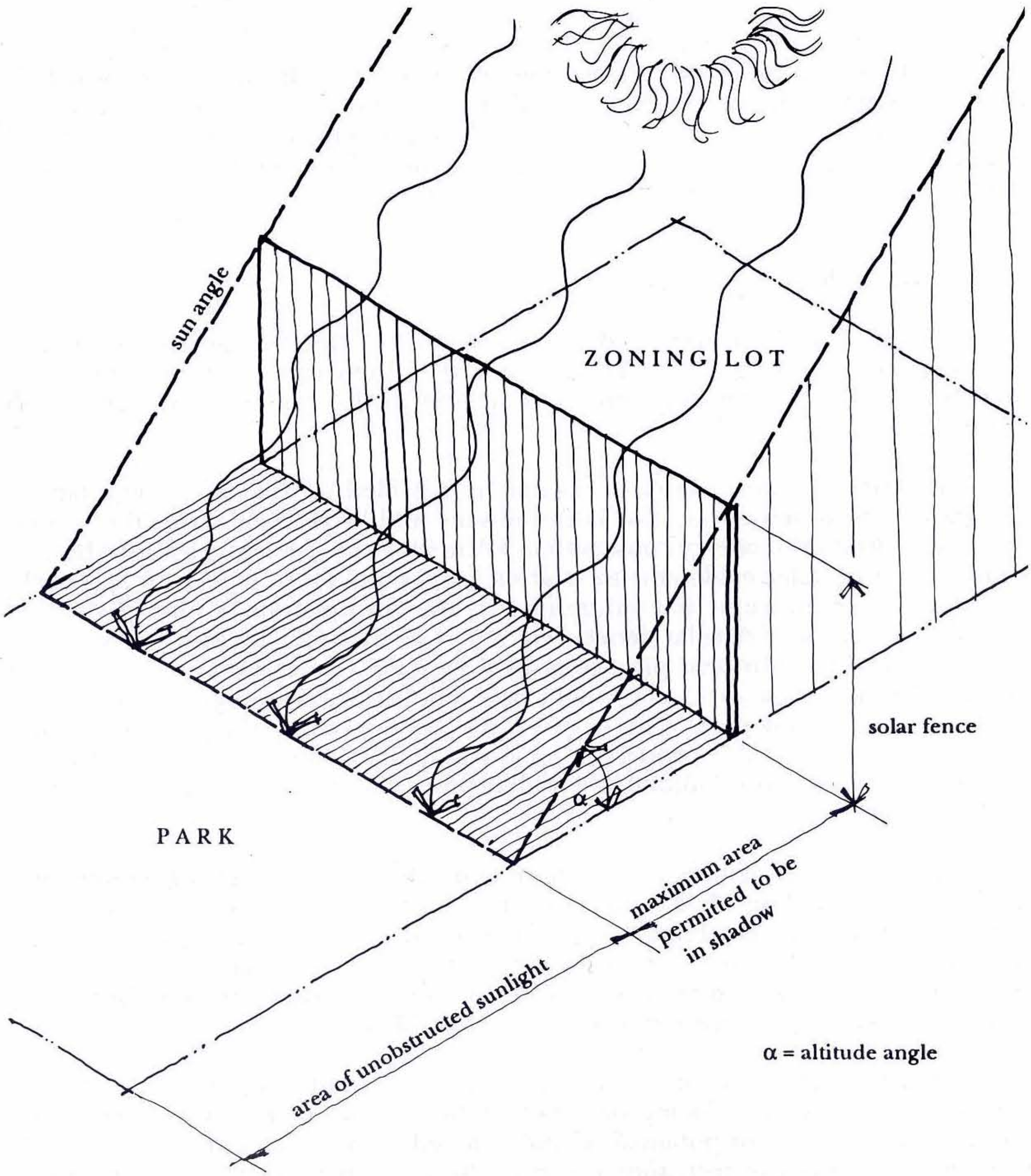


FIGURE 3. "Solar Fence" as a Regulatory Approach to Solar Access

Diagram illustrates concept of an imaginary lot-line fence (the "solar fence") that defines extent to which new development may cast shadows on a park. For a given time of day and year, the solar fence determines the extent of unobstructed sunlight that falls on the park. From this one can develop an imaginary plane that the building may not penetrate if it is avoid casting a shadow on the park beyond that permitted.

protect the public welfare by creating a public benefit. Taking into account, then, the models mentioned here as well as others not discussed, it seems clear that the proposed park regulations fall within a body of law that has a long history and tradition and is underlain by ample precedent as well as practical experience.

Conclusion

This study started from the concept that the city's parks are a vital and limited resource deserving protection from environmental degradation, and concluded that zoning is the appropriate legislative means of affording that protection. We have developed a practical, as-of-right, and legally defensible approach to modifying the city's Zoning Resolution to accomplish this purpose.

Additional tasks must be undertaken to make protection of parks through zoning a reality. Thorough discussion of the concept with city agencies, the civic, design, planning, legal, and development communities, and the public at large must take place. The base sample of representative parks may need to be broadened, the practical effects of the green line approach on building forms further explored, and the actual green lines developed for various built contexts. The study will be reevaluated and amended to reflect comments received. The Parks Council's overall Environmental Simulation Project will then culminate in the drafting of legislative text and a formal process for introducing the proposed regulations as an amendment to the Zoning Resolution.

Green Lines as Guidelines

The usefulness of this study is not limited to amending the city's zoning regulations. The green line approach can also be usefully applied to a variety of planning purposes. It can, for example, help to:

- formulate criteria to guide the public review of large-scale developments and rezoning proposals that involve parks and open spaces;
- provide empirically derived standards to be adhered to in future projects;
- map zoning districts, by illustrating the impacts of proposed zoning designations and regulations on the environmental quality of parks and open spaces;
- guide the selection of sites for future parks;

- guide the design or redesign of parks, including the location of facilities and activities within a park.

In selecting sites for new parks, the appropriate green lines can be overlaid on a map of a potential park site to predict, in general terms, the susceptibility of the site to adverse shadowing. In redesigning existing parks, the green lines can serve as a guide for moving various activities from shade to sunlight, particularly facilities (like tot lots) whose use in colder months depends heavily on the availability of sun.

In all applications of the green line approach detailed here, the primary focus remains the protection of parks. The park system is one of the city's major capital assets and an invaluable and essential ingredient of city life. We must put into place legislation that preserves sunlight in existing and future parks, while making every effort to do so in such a way as to enable the development process to move forward smoothly and with certainty as to the public's expectations. With these purposes in mind, The Parks Council will pursue the effort described in this report.

PART II

DETAILS OF THE METHOD AND STANDARD

A Word About Sunlight

Daylighting is the ambient and generally uniform lighting level in the sky. We experience daylight even on a cloudy or heavily overcast day. Sunlighting is distinct from daylighting in that it is based on light emanating from a single point source, the sun. This source is in apparent motion in relation to the earth, its path changing from day to day and season to season.

Because of the tilt of the earth's axis, the angle at which the sun's rays strike the earth varies markedly between winter and summer. This fact accounts for the long shadows of winter and short shadows of summer during the most common hours of park use (Fig. 4), as well as for the temperature differences between summer and winter.

Sunlight not only provides light but has the additional attribute of warming objects and people by direct radiation. We experience this radiation, to give one example, as warmth on the face and body while we sit and watch a child in a playground on a late October day. By producing the sensation of heat on the skin, sun rays compensate for the low air temperatures of late fall, moderate winter days, and early spring, allowing us to sit outside and still feel comfortable at these times of year (Fig. 5). To be in shadow means that an intervening object, such as a building, has intercepted the sun's rays, blocking them from reaching us as we sit on the park bench. Unlike buildings, deciduous trees provide shade in summer without impairing solar access during the colder months, when they lose their leaves.

The warmth from the direct rays of the sun is critical to the public benefit postulated by this study, which argues that keeping parks in sunlight during the colder months will maximize the periods of time during which the parks can be comfortably used, particularly for passive activities such as sitting and strolling. It is why the presence or absence of shadows on a park can make all the difference in whether the park is used or unused at certain times of day during the colder months.

Sunlighting has other characteristics that distinguish it from daylighting. Sunlighting changes with direction and time of day. For example, a six-story

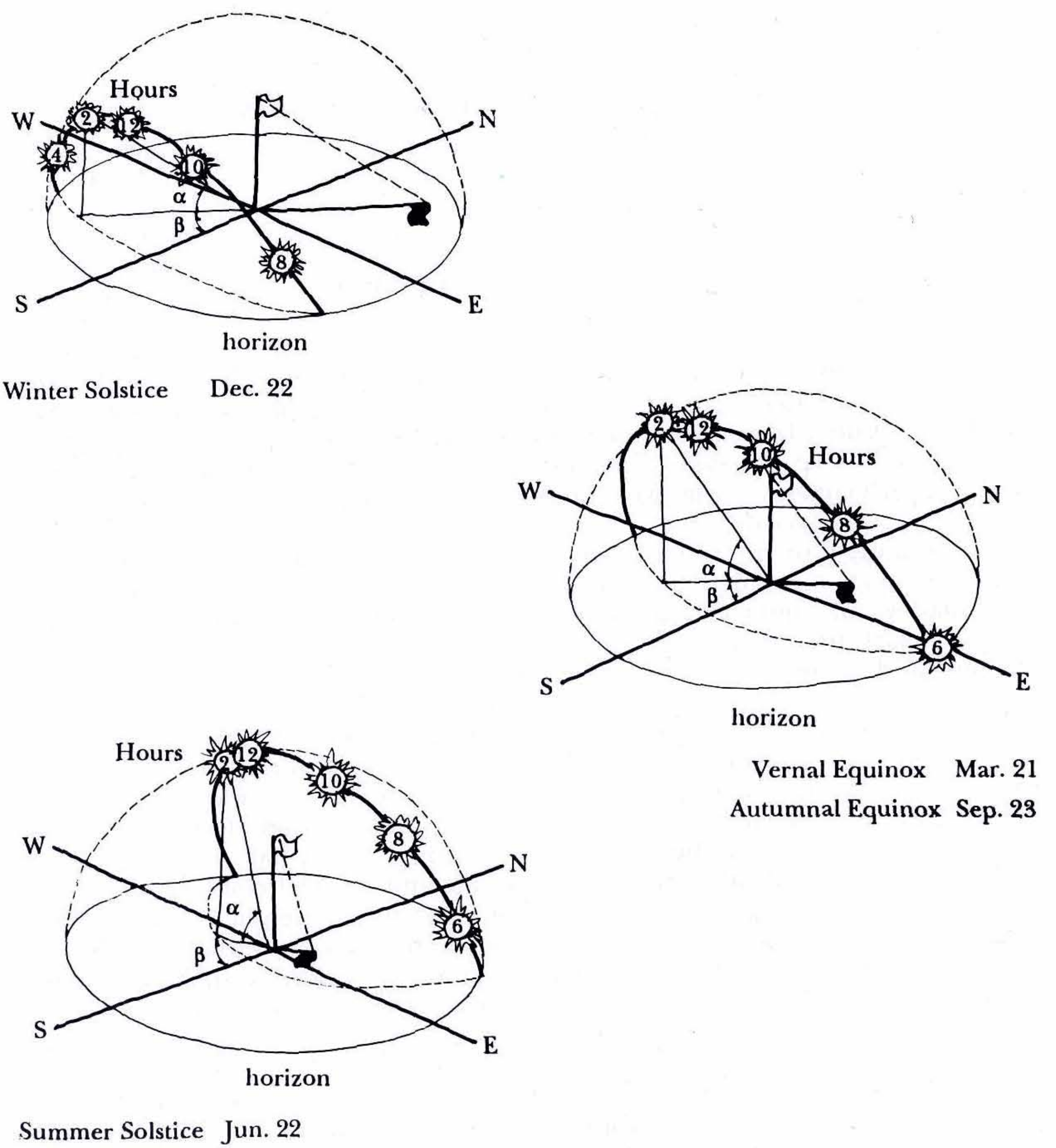


FIGURE 4. Sun Paths for Winter Solstice, Equinox, and Summer Solstice

The sun's position relative to a specific geographic location changes over the course of the day and year. These changes in the sun's path may be described in terms of altitude (α) and bearing (β) angles for any date and hour. In the diagrams shown here, shadows cast by the pennant at 2:00 pm illustrate the effect of seasonal changes. Modified from: *Architectural Graphic Standards,* John Wiley & Sons, Inc.

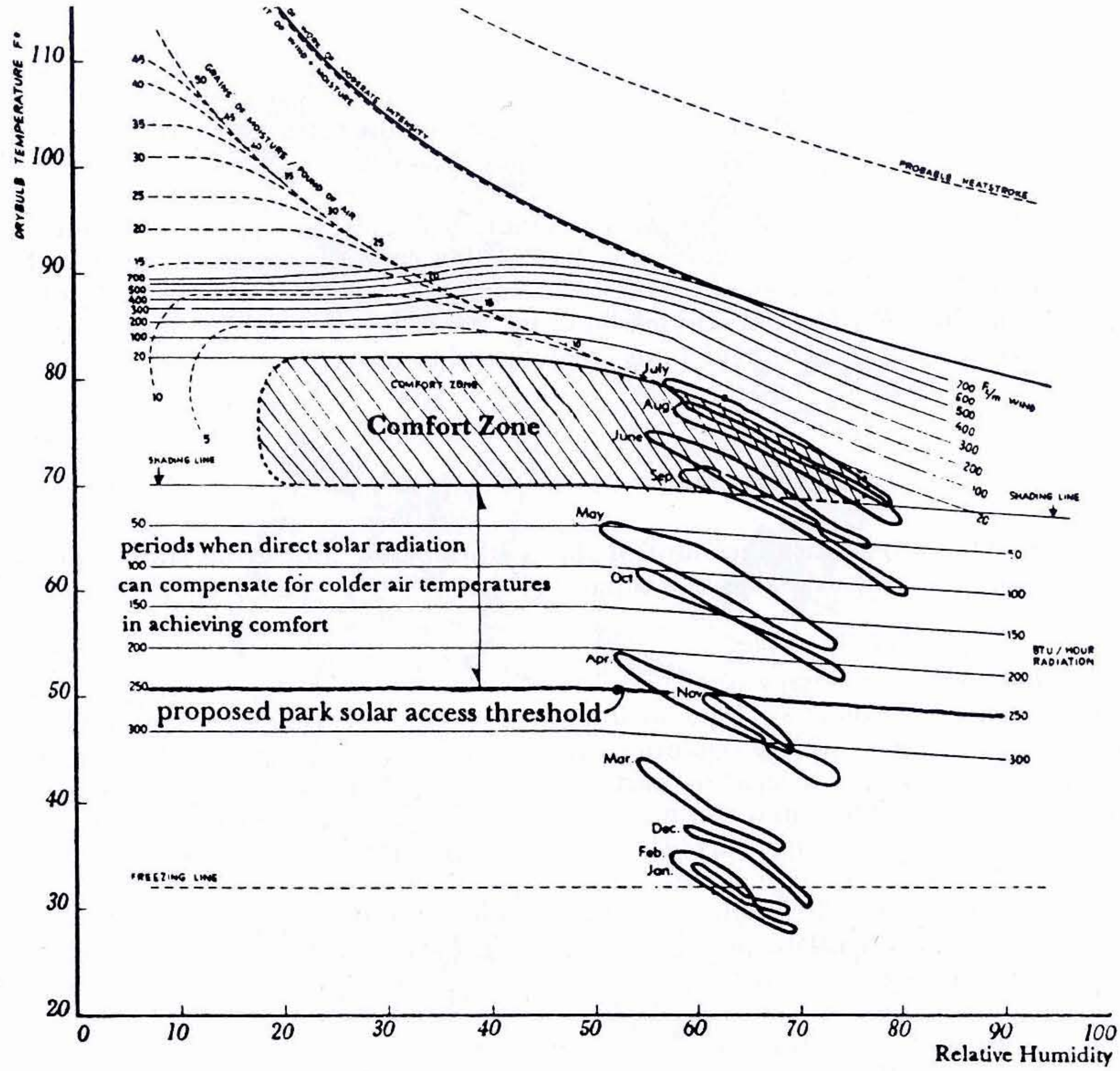


FIGURE 5. Typical Bioclimatic Patterns for New York City

A bioclimatic chart relates climatic elements like temperature, humidity, and wind to the degree of comfort or discomfort an individual experiences in a given environment. The shaded area in the center of the chart depicts the idealized "comfort zone" for the human body—the combination of climatic elements we normally consider comfortable and desirable outdoors. When conditions fall outside the comfort zone, compensatory climatic elements are required in order to feel comfortable, such as a light breeze or shade on a hot summer day. The closed curves indicate the typical monthly climatic conditions for the New York City area. As the chart illustrates, direct solar radiation counteracts cool temperatures in achieving outdoor comfort in the early spring and late fall. Modified from: *Design with Climate*, Victor Olgyay, Princeton University Press, 1963.

building north of a park will not cast shadows on the park, while the same building on the east, south, or west side will (Fig. 6). The length of shadows diminishes from sunrise to noon, when the sun is at its high point in the sky and shadows are shortest, and increases from noon to sunset, when the sun is at its lowest point in the sky or on the horizon and shadows are virtually infinite in length.

These and other effects of the sun's motion relative to a given park and the buildings around it are not academic. Rather, for each park they determine the pattern of sunlight and shadow that has come to be expected by the public throughout the day and from one season to the next. It is this public expectation of sunlight that the proposed regulations are designed to protect.

An Overview of the Study Method

A detailed technical account of the methodology underlying the proposed zoning regulations is available as a separate document[4]. A brief overview is given here.

The study's primary objective was to formulate as-of-right zoning regulations that would protect sunlight in the city's parks. To justify this regulation of private property, two critical conditions had to be established and compared: the pattern of sunlight and shadow park users now experience and have come to expect over many years, and the harm to the city's parks in the form of potential adverse shadowing if the current zoning regulations and planning attitudes remain unaltered. The first, the public's "expectation" of sunlight, would be used in formulating standards for the regulations, while the second, the potential harm to the parks, would establish the need for mitigation by means of appropriate zoning regulations.

As a practical matter, specific park user information does not exist for all 700 parks. Even if it did, and was a factor in determining what extent of shadowing is acceptable, the establishment of unique green lines for every park was impractical for an as-of-right zoning approach. Therefore, a more generic approach was taken which sought maximization of available sunlight as a resource in its own right, regardless of how a park is used or by whom, since both may change over time. This can be contrasted with San Francisco's approach, which is discretionary rather than as-of-right, and where the shadow analysis, standards, and regulations take current park activities and design into account. (San Francisco's regulations cover 14 parks, while those proposed for New York would apply to approximately 700.)

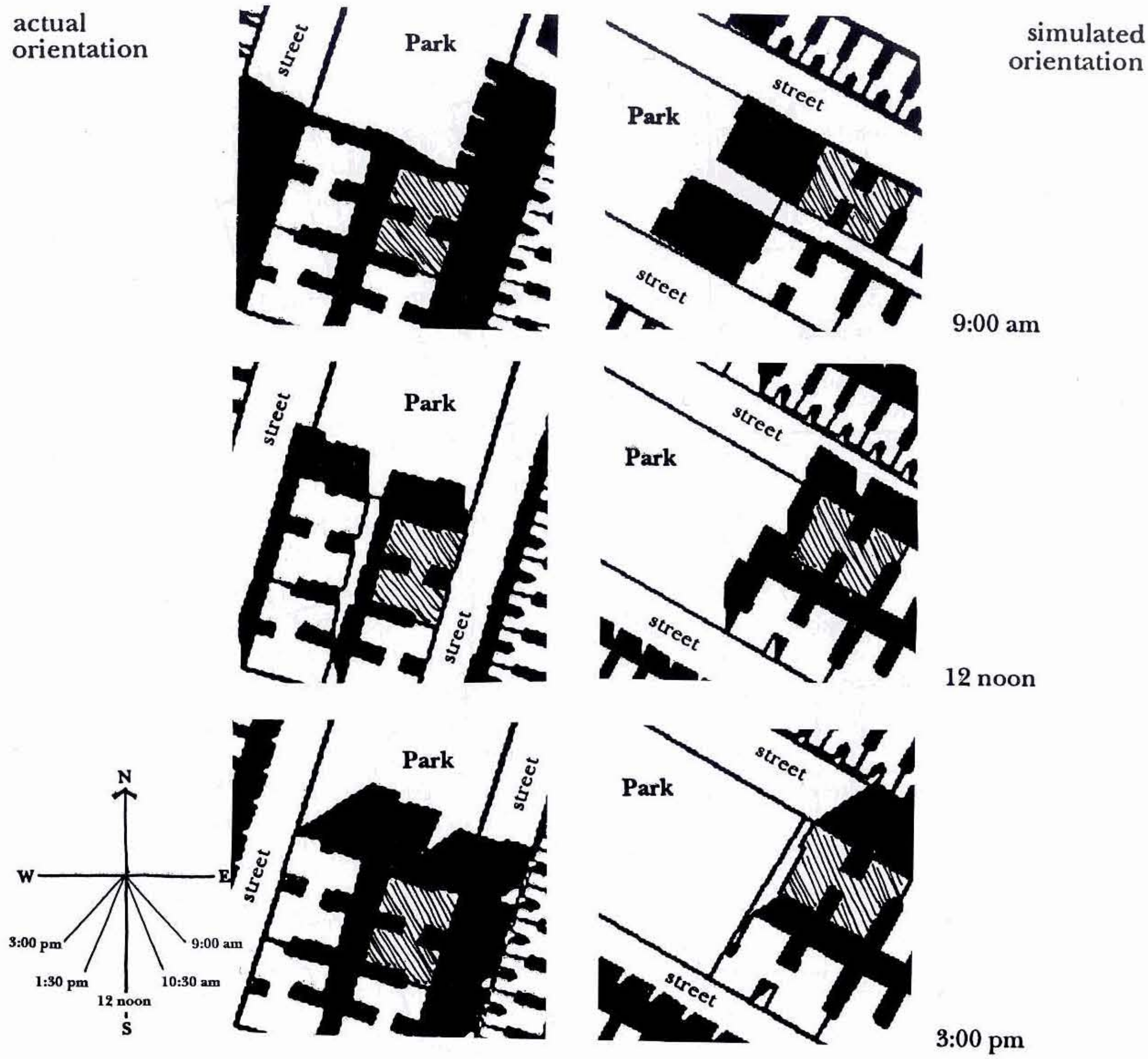


FIGURE 6. Effect of Street Grid Orientation and Relationship of Park to Its Built Context

The street grid orientation and a park's relationship to its built context are both signi-ficant determinants of shadow impact. They affect not only the extent to which the park is cast in shadow, but also the times of day and parts of the park most vulnerable to shadowing. The example, taken from the analysis of the J.H.S. 22 playground in the Bronx at the equinox, compares the effect of a six-story building (hatching) at the actual street grid orientation, in which the building is south of the park (left column), with that of an alternative street grid orientation (right column) with the building east of the park. The same building that casts shadow on the park throughout the day at the actual orientation would cast shadow only in the morning if it were east of the park.

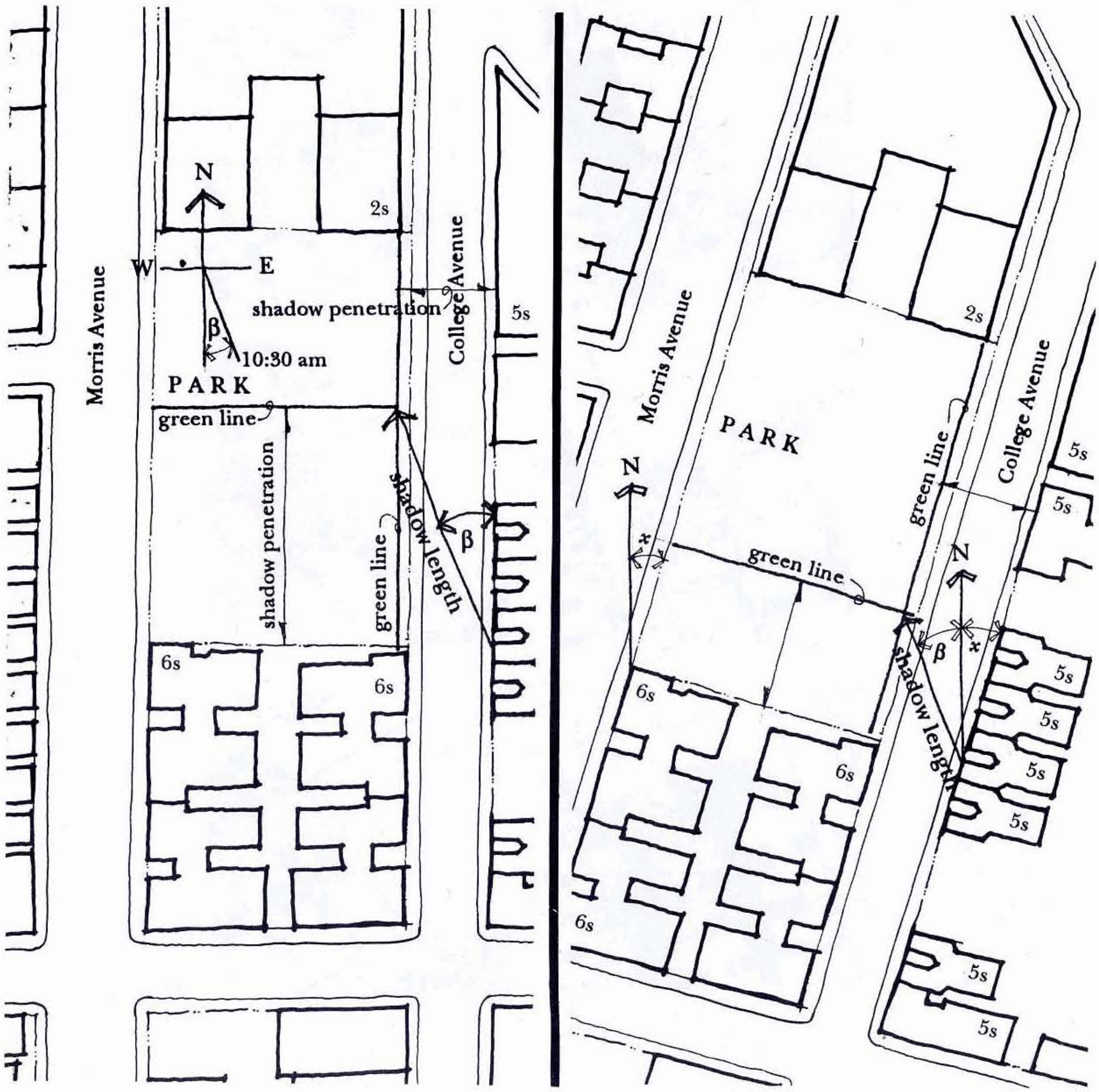


FIGURE 7. Green Lines "Self-Adjust" to Site-Specific Conditions

The green lines are based on the average shadow penetration into a park by a representative context of buildings for a given zoning density. While this dimension is the same for each park (since buildings of the same height cast shadows of the same length), the average shadow length may be adjusted by trigonometric relationships to the park-specific street grid orientation (x) in order to determine the perpendicular (adjusted) shadow length. Further adjustments for intervening streets and yards yields the shadow penetration for the specific park.

To formulate regulations that could be administered on an as-of-right basis, the regulations were designed to "self-adjust" to the specific conditions that characterize any park in the study inventory (Fig. 7). This differs from the more conventional zoning approach in which the same restriction—a minimum setback requirement, for example—applies uniformly throughout a zoning district. The alternative to the as-of-right legislative approach proposed here would be a discretionary review procedure requiring the mapping of 700-odd special park zoning districts, a design and administrative nightmare.

Accepted criteria of human comfort in outdoor spaces were taken into consideration in formulating the proposed regulations. These criteria, dealing with such factors as air temperature, humidity, and wind velocity in relation to people's activity levels and modes of outdoor dress, are derived from a long-standing body of research on the subject[1].

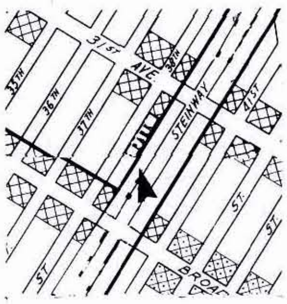
A Sample of Representative Park Types

Both the harm to the city's parks in the absence of solar access regulations and the public's expectation of sunlight vary from park to park because of a variety of complex and interactive factors. Rather than superficially examine each of the 700-odd parks in the study inventory having zoning designations of R6 and above, the dynamic relationship between the sun, a park, and the built context around the park was simulated through an in-depth analysis of a small group of carefully selected parks. While these parks are referred to in the report as a "sample," the term is used not in its statistical sense but rather to indicate that the group is illustrative of the city's inventory of parks and park conditions.

Taken as a group, the six parks selected for study represented a broad range of park characteristics: the type and size of park; edge conditions (whether it is corner park, mid-block park, through-block park, or full-block park); geographic orientation; surrounding development context (the heights and shapes of nearby buildings); and density, as reflected by mapped zoning designations. Brooklyn, the Bronx, Queens, and Manhattan are represented; no park from Staten Island was included because the borough has almost no districts zoned for R6 or above. The selection process was weighted toward playgrounds and recreation areas in R6-R7 districts because these constitute the largest single category in the group of approximately 700 affected parks (about 40%). It is also the largest single category of parks in each of the four boroughs represented. A brief description of each of the six follows (see also Table 2).

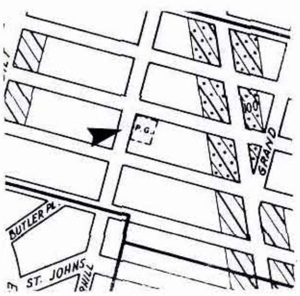
- A 0.6-acre playground in Long Island City, Queens, is on an interior lot with frontage on one street, backing up on a commercial street, Steinway Ave. Commercial and residential structures are in the two- to three-story

TABLE 2. Representative Parks



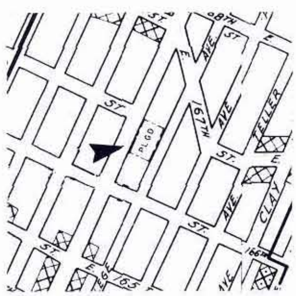
Playground

Long Island City, Queens (DPR park no. Q444). 0.6 acres. On interior lot located between 38th St., 31st Ave., and Broadway (Queens Community Board 1).
Street grid angle: +30 deg.
Facilities: Playground, athletic courts.



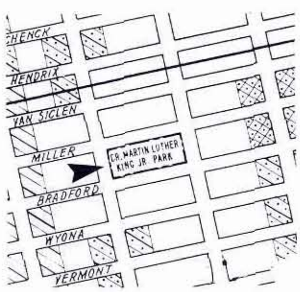
Playground

Bedford-Stuyvesant, Brooklyn (DPR park no. B161). 0.6 acres. At corner of Underhill Ave. and Prospect Place (Brooklyn Community Board 8).
Street grid angle: -75 deg.
Facilities: Playground, athletic courts.



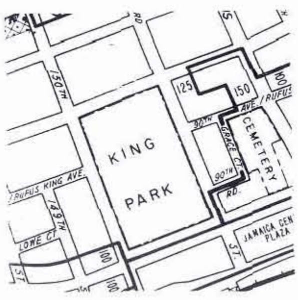
Junior High School 22 Playground

Morrisania, Bronx (DPR park no. X115). 1.5 acres. Park fronts on Morris and College Aves., between E. 166th and 167th Sts. (Community Board 4).
Street grid angle: +16 deg.
Facilities: Playground, tot lot, athletic courts and fields.



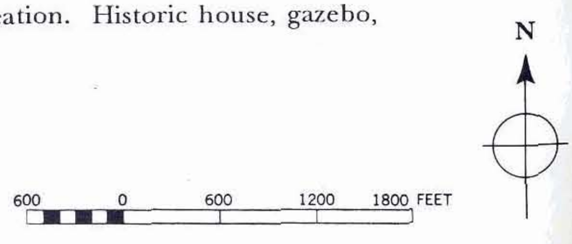
Dr. Martin Luther King, Jr., Park

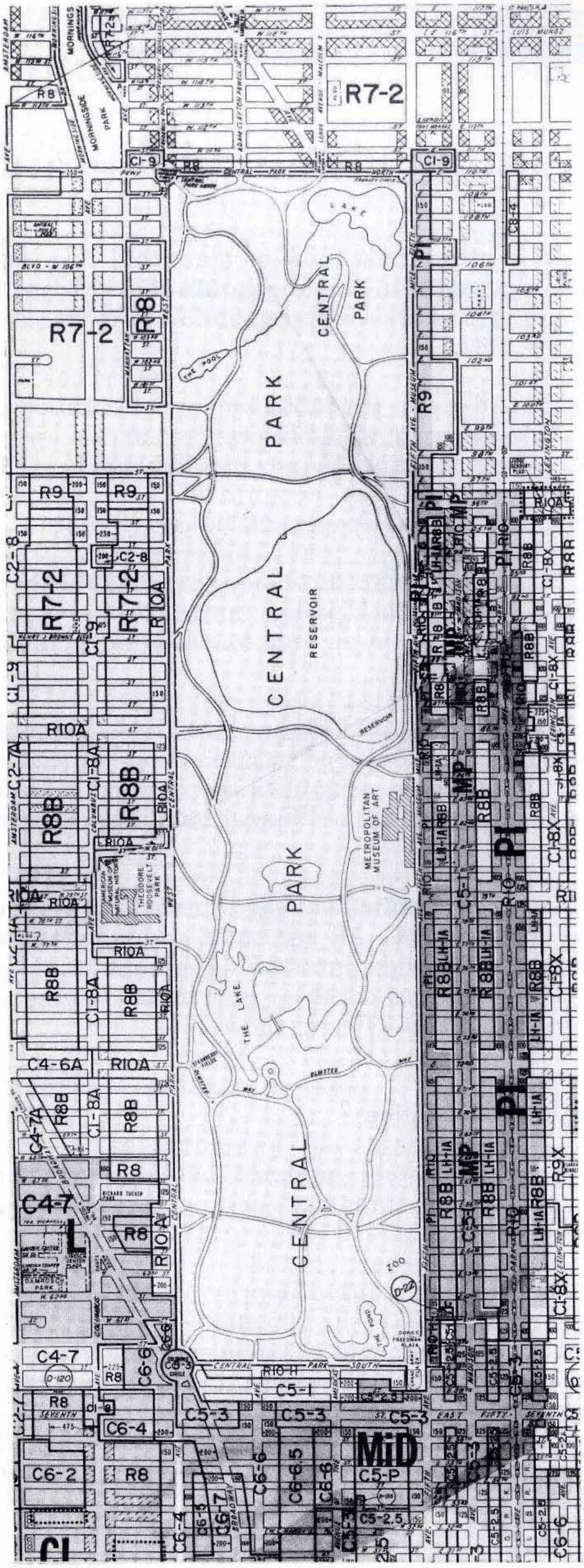
East New York, Brooklyn (DPR park no. B056). 2.3 acres. Bounded by Dumont, Blake, and Miller Aves. and Bradford St. (Brooklyn Community Board 5).
Street grid angle: -11 deg.
Facilities: Playground, basketball.



King Park

Jamaica, Queens (DPR park no. Q023). 11.5 acres. Bounded by Jamaica Ave., 153rd St., 89th Ave., and 150th St. (Queens Community Board 12).
Street grid angle: -12 deg.
Facilities: Mainly for passive recreation. Historic house, gazebo, basketball.





Central Park

Manhattan (DPR park no. M010). 840 acres. Bounded by 110th St., Fifth Ave., Central Park South, and Central Park West (Manhattan Community Boards 4, 5, 7, 8, 10, and 11).
Street grid angle: -61 deg.
Facilities: Comprehensive, for active and passive recreation.

Source (Zoning Maps): New York City Department of City Planning range, although the underlying zoning (R6, C4-2, R-5) would allow larger buildings.

- A 0.6-acre corner playground at the intersection of Underhill Ave. and Prospect Place, in the Bedford-Stuyvesant neighborhood of Brooklyn, is surrounded by a mix of two- and three-story rowhouses and four- to six-story tenement and apartment houses (R6).

- J.H.S. 22 and its 1.5-acre playground are in the Morrisania neighborhood of the Bronx. The playground, comprised of a children's play lot and a schoolyard, is a through-block park fronting on two parallel streets. The surrounding built context consists of J.H.S. 22 to the north and a mix of three-, four-, and five-story row, semi-detached, and tenement houses (R7-1).

- Dr. Martin Luther King, Jr., Park is a 2.3-acre recreation area in Brooklyn's East New York neighborhood. This full-block park is bordered by two- and three-story row and semi-detached houses in an area mapped for medium-density housing (R6).

- King Park is an 11.5-acre neighborhood park in downtown Jamaica, Queens. Built on its own superblock and buffered by intervening streets, its context is characterized by a mix of high-density institutional and commercial development and low- to medium-density residential buildings (R6, C4-2, and C6-1A).

- Central Park, occupying 840 acres in Manhattan, was chosen to represent the city's regional parks and major parks. All are large, wide, and separated from surrounding buildings by wide intervening streets. Central Park was also used to represent building contexts that occur in zoning districts mapped for densities of R8-R9 and R10 and above.

Expanding Applicability of the Sample by Simulation

The built contexts of these six parks were modeled by computer and conditions of solar access in the parks were simulated, testing the following variables:

- *Orientation of the park.* Some city parks lie primarily in an east-west direction, others northeast-southwest, etc. Of the 700 affected parks, almost 600 are in neighborhoods that have a traditional rectangular street grid, and about 85% of these 600 turned out to be located within three ranges of orientation. This finding made the simulation task considerably more manageable than it otherwise might have been, since sample parks had to be simulated at "only" the three predominant orientations (Fig. 8). It also allowed some general characterizations to be drawn about overall patterns of sunlight availability for the city's open space inventory and to identify the most critical aspects of these patterns[4].

- *Potential maximum build-out around the park.* This was simulated in a range of zoning densities and building forms (see discussion below).

- *Time of year.* Seasonal conditions at two times of year were simulated: December 22, the winter solstice, and March 21/September 23, the spring and fall equinoxes. Since shadow effects are the same on the two equinox dates, the report refers simply to the equinox.

- *Time of day.* Conditions at 1-1/2 hour intervals were simulated from 9:00 am to 3:00 pm for the winter solstice and from 9:00 am to 4:30 pm for the equinoxes, these being the most typical hours of park use in colder months and the hours during which the regulations have the greatest potential to affect solar access.

Sunlight and shadow patterns were simulated for five of the six parks for their actual neighborhood built context and street grid orientation, as well as at the three predominant grid orientations. Central Park was simulated only at its actual orientation, since for the purposes of this study it represented parks in high-density areas, all of which are in Manhattan and on the same street grid.

This set of analyses could then be said to constitute a reasonably representative sample of the city's parks under all combinations of edge conditions, built contexts, and orientations. The simulations, by guaranteeing that a reasonably full range of conditions had been studied, provided the basis for formulating generic regulations that could apply to all parks in the study inventory.

Hypothesizing Future Densities

Most sections of the city are not uniformly built out to the maximum density allowed by current zoning. This was true of the blocks around the sample parks. Yet the current zoning designation for an area is in itself a public expectation of sorts, since it tells us, in advance, what density and form future buildings there are likely to have if that zoning designation remains in place.

The study therefore simulated shadow conditions in the sample parks not only at existing levels of development, but also for hypothetical build-outs that would occur with zoning map designations above R5. (As mentioned, zoning designations of R1 to R5 are not considered to threaten solar access in parks.) Three density levels were identified for these hypothetical build-out scenarios: zones R6-R7, R8-R9, and R10. In the context of this study, these three groupings allowed some general characterizations to be drawn about overall patterns of sunlight availability for the city's open space inventory and to identify the most critical aspects of these patterns[4].

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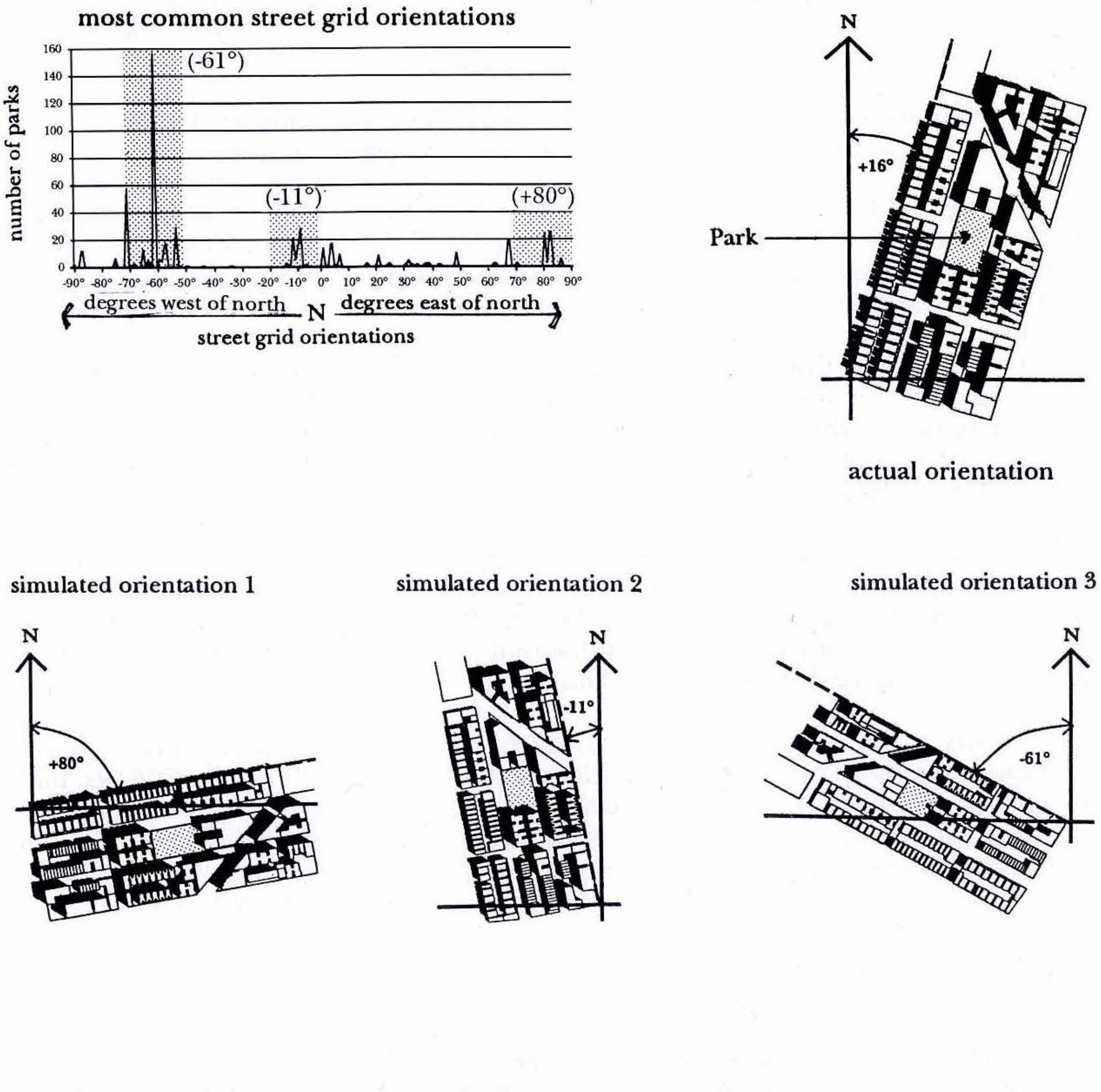


FIGURE 8. Predominant Street Grid Orientations

Graph illustrates the three street grid orientations (±10°) that account for nearly 85% of the 700 unprotected parks: -61°, the Manhattan street grid, and -11 and +80°, both more typical of the other boroughs. (Note that the street grid orientation is measured from true north to the axis formed by the long side of the predominant block pattern.) While the proposed green line method applies to all orientations, the shadow impacts for each representative park were studied at the actual orientation as well as at the three most common street grid orientations, as the diagrams illustrate. By virtue of intervening streets, park shape, and adjacency of the built context characteristic of each orientation, some orientations favored park solar access more than others.

were considered to represent low-, medium-, and high-density development, respectively.

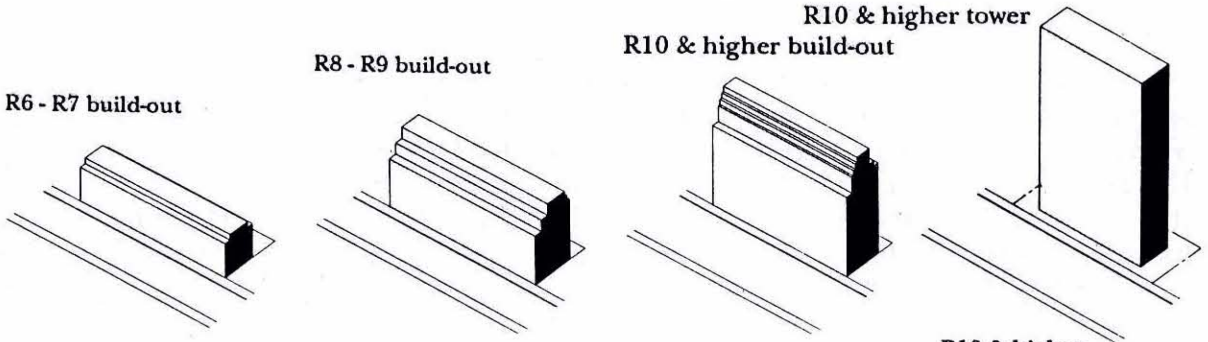
It was also necessary to consider building form in constructing the scenarios. Given current city policy that favors replacing tower-type buildings with the lower, bulkier buildings of comparable density called for in the Quality Housing contextual zoning regulations, it was assumed for most of the simulations that new buildings would conform to the Quality Housing regulations. For example, a typical eleven-story tower slab in an R6 zone would be replaced, in a hypothetical build-out scenario, with a lot-line contextual building having a two-story setback above a six-story base.

With these issues in mind, hypothetical scenarios were simulated for low-, medium-, and high-density build-out (R6-R7, R8-R9, and R10 and above, respectively) under contextual Quality Housing regulations, and also for high-density build-out under the tower regulations (Figs. 9 and 10). The tower regulations were modeled not only because the buildings they have engendered are common in high-density districts, but also because, when originally formulated, these regulations were loosely based on some notion of encouraging light and air. The simulations showed that, in actuality, the building form induced by the Quality Housing regulations poses less of a threat to parks than does the tower form, since the shadows cast by the lower buildings are shorter, penetrate the parks less deeply, and thus are of shorter duration (see below, "Shadow Penetration as the Basis for the Standard").

All the hypothetical scenarios were simulated for the sample parks at the parks' actual street grid orientation and the three predominant orientations, at the equinox and solstice, and for the same times of day used throughout the study (Fig. 11). The shadow patterns resulting from these build-out scenarios represent the maximum harm or diminution of sunlight that could occur under present as-of-right zoning in districts with designations of R6 and above. As such they also represent the public's worst-case future expectation for sunlight in parks in these districts.

Analysis of Shadow "Snapshots" and "Sweeps"

To recap, the computer simulations of the five local parks and Central Park were based on modeling both existing building conditions around a park and hypothetical build-outs for several zoning density categories and building forms. The hypothetical build-out scenarios assumed that all buildings around a park would conform to the maximum building envelope allowable under present zoning regulations.



	R6 - R7 build-out	R8 - R9 build-out	R10 & higher build-out	R10 & higher tower
FAR	3.6	8.1	14.4	14.4
Lot size	25,000 SF	25,000 SF	25,000 SF	25,000 SF
Street wall height (SW)	60 ft.	85 ft.	150 ft.	n/a
Front sky exposure plane (Fsep)	1:1 (at H = 60 ft.)	1.5:1 (at H = 85 ft.)	2.5:1 (at H = 150 ft.)	n/a
Lot coverage	60%	70%	70%	40% Tower
Rear sky exposure plane (Rsep)	1:1 (at H = 30 ft.)	1:1 (at H = 80 ft.)	1:1 (at H = 140 ft.)	n/a
Number of stories	7	13	21	36
Equivalent zoning districts	R6A, R6B, R7A, R7B, R7X	R8A, R8B, R8X R9A, R9X	R10A & commercial equivalents	R10 & commercial equivalents
Represent. zoning district	R7B	R8X	R10A (at 12 FAR)	R10 (at 12 FAR)

FIGURE 9. Theoretical Bulk Envelopes for Zoning Density Categories

In addition to examining existing conditions around the' representative parks, the study simulated hypothetical conditions of full build-out for varying zoning densities (R6-R7, R8-R9, and R10 and higher) under contextual regulations and, for the highest density, under the tower regulations as well. The above diagrams illustrate the theoretical bulk envelopes that formed the basis for these build-out scenarios for each of the zoning categories.

Assumptions: The bulk scenario envelopes derive from the New York City Zoning Resolution (1990) and standard practice assumptions. The simulated scenarios illustrate representative build-out conditions under contextual zoning district designations which produce bulk envelopes of comparable scale and character to historic patterns of local development. A residential tower scenario illustrates the non-contextual alternative for the highest density. The bulk envelopes were developed from the regulations governing the median-floor area ratio (FAR) zoning district of those contextual zoning districts deemed equivalent by virtue of the FAR, scale, and character. The bulk scenarios are based upon residential contextual zoning districts, since parks are most frequently found in residential zoning districts. The contextual zoning districts offer the most sensitive responses to neighborhood context, and have highly predictable envelopes. The bulk scenario envelopes approximate the "worst-case" conditions possible for the representative zoning districts, all assuming a 20% floor area bonus for Zoning Lot Merger's (ZLM's). The lot size is approximately 25,000 SF, with a typical depth of 100 feet. The resulting bulk envelopes are generated from standard practice assumptions about building configuration and are based upon a 10-foot floor-to-floor height. The R10 and higher scenarios assume a 20% bonus (thus 12 FAR) for inclusionary housing (contextual districts) or residential plaza (tower alternative), as well as the additional 20% bonus from ZLM's. The tower scenario follows the 40% tower regulations, with typical floor plates at 40% of the lot area with a standard practice configuration for a double-width corridor of typically 55 feet. The tower scenario assumes a height of 327 feet, which includes a 3-foot parapet but no additional height attributable to mechanical spaces. The slab is set back a minimum of 10 feet from wide streets and 15 feet from narrow streets, 0 feet or a minimum 8 feet from side lot lines, and a minimum 30 feet from the rear lot line. The tower scenario assumes a "worst-case" orientation relative to the park, with the placement respecting required setbacks but assuming a location whose resultant shadows prove most detrimental to the park. The bulk scenarios, when placed in the context of the park, assume the existing street widths for the R6-R7 and R8-R9 scenarios and a 100-foot street width for both R10 and higher scenarios, with continual placement along the leading edge of the blocks surrounding the park.

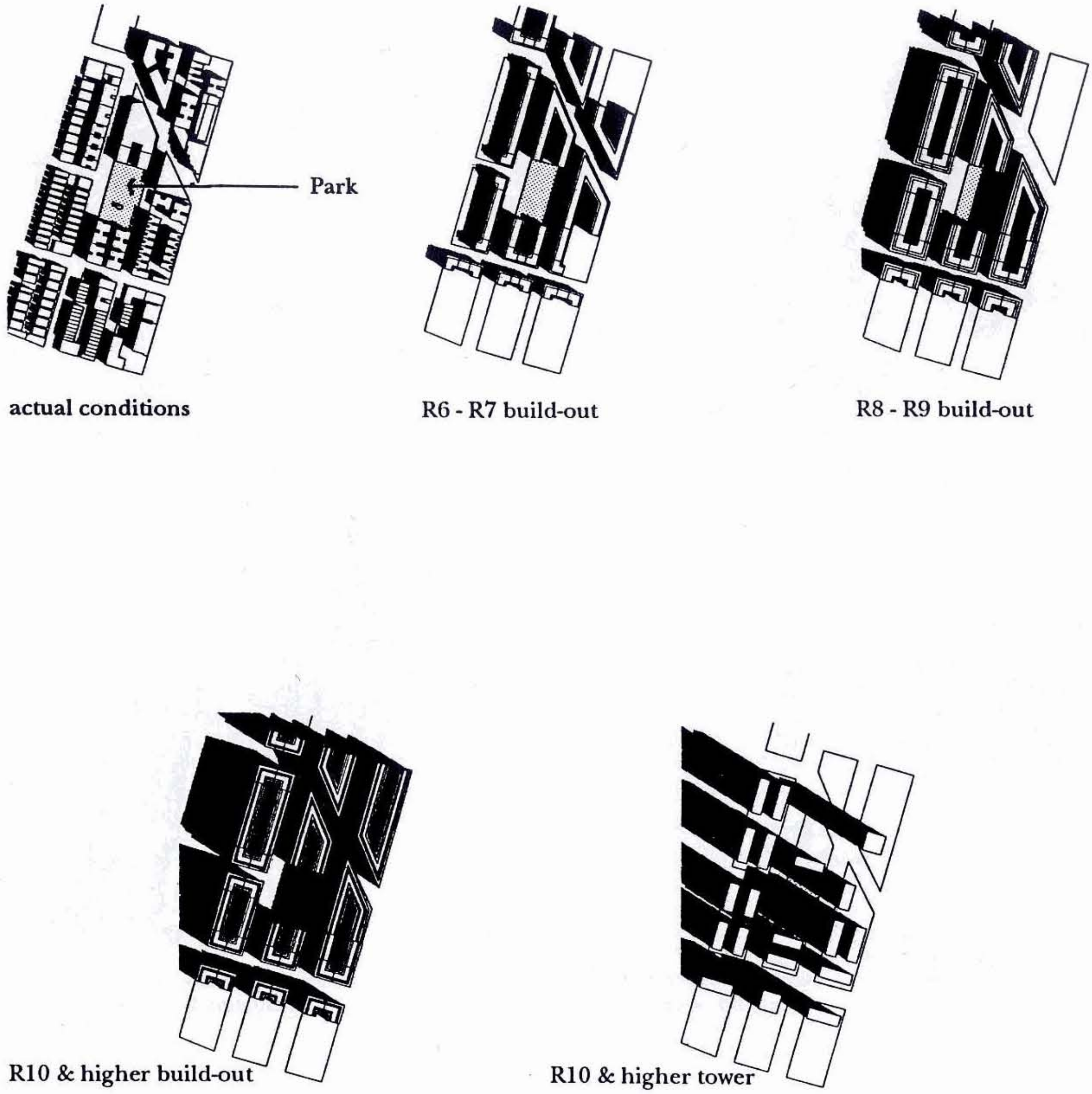


FIGURE 10. Actual Conditions Compared with Simulated Build-Out Scenarios

Hypothetical build-out scenarios were simulated for current zoning, as well as other zoning density categories, to illustrate potential worst-case future conditions for each representative park. The diagrams above compare actual conditions at the J.H.S. 22 playground at the equinox at 9:00 am with the simulated potential build-out scenarios. Note the significant increase in shadow impact as the zoning density increases, as well as the building type comparison at the highest density.

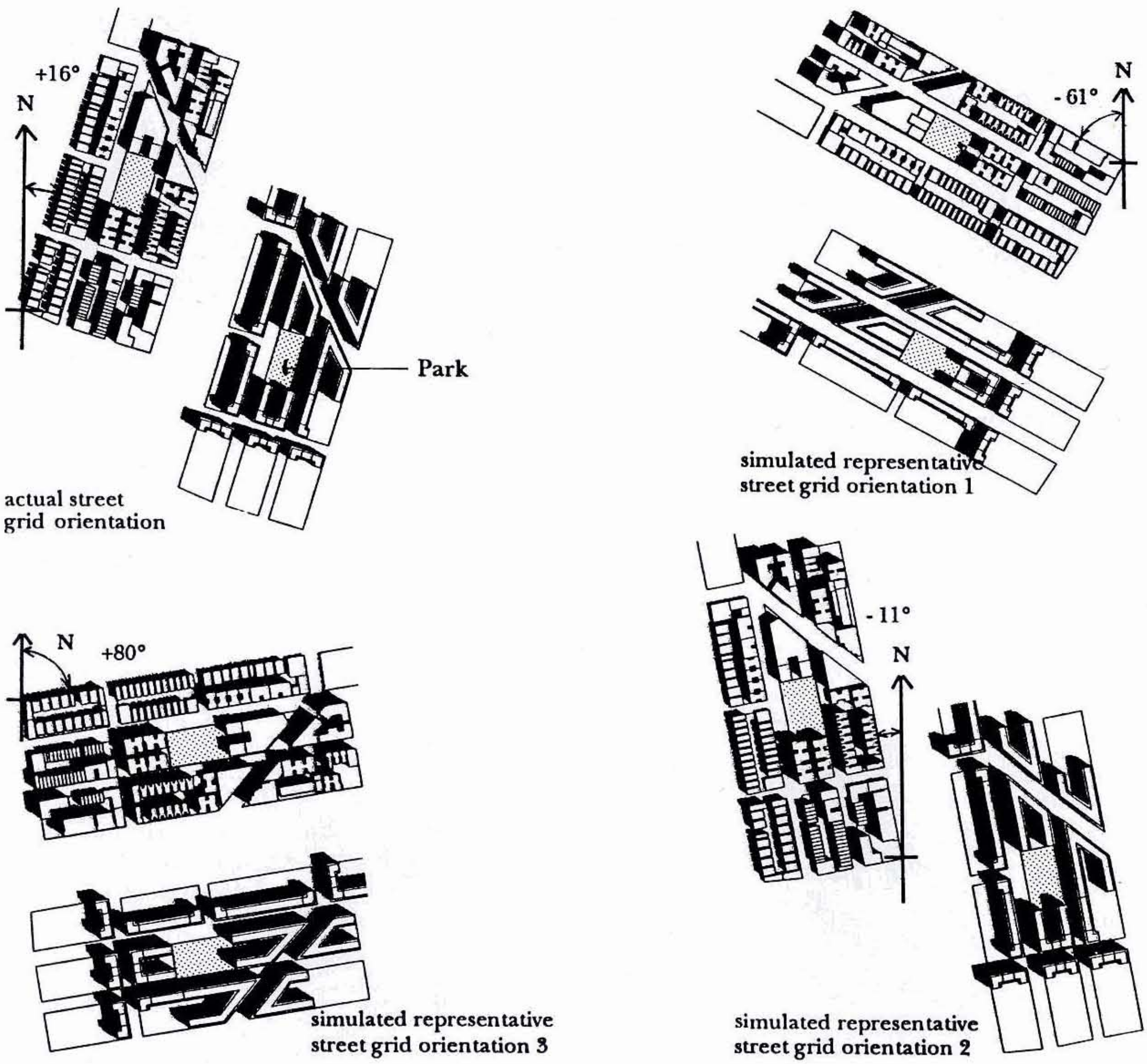


FIGURE 11. Actual Conditions and Comparable Simulated Build-Out Scenario for Different Street Grid Orientations

Actual conditions for each representative park along with simulated build-out scenarios were studied at the park's street grid orientation as well as at the three predominant street grid orientations. The example contrasts shadow impacts on the park for the existing built context and comparable build-out conditions under R6-R7 contextual zoning for the J.H.S. 22 playground at the winter solstice at 9:00 am. Since this is the actual zoning designation for the neighborhood around this playground, the build-out simulation shows the potential increased shadow impact under current zoning.

Each park simulation was examined on the basis of two analytic approaches, illustrating different aspects of park shadowing. First, shadow "snapshots" were produced to show the length and area of shadow on a park at hour-and-a-half intervals starting from 9:00 a.m. These are, in effect, static representations of shadowing for a single date and time (Fig. 12).

Second, more dynamic representations were achieved by overlapping consecutive snapshots one upon the next to form a shadow composite or "sweep," showing cumulative shadow effects (Fig. 13). These sweeps provide a picture of the area and length of time during the day that parts of a park are in shadow.

Snapshots and sweeps were generated for existing conditions and hypothetical build-outs at the three predominant orientations during the equinox and winter solstice. In all, more than one thousand simulations were generated.

Setting a Standard for Solar Access

Shadow Penetration as the Basis for the Standard

Before a standard for solar access in parks could be arrived at, it was necessary to decide in what terms to define and measure the standard. Both shadow penetration—the depth to which shadows penetrate a park—and the duration of shadows on a park were considered. Shadow duration, the length of time that parts of a park remain in shadow, is clearly an important determinant of park use. During the equinox, for example, areas of a park can be in shadow for the entire time period analyzed, from 9:00 am to 4:30 pm, effectively discouraging their use.

For a combination of reasons, the standard was premised on preventing or minimizing increases in shadow penetration rather than shadow duration. One of the findings that resulted from the analysis of shadow sweeps and snapshots was that the duration of shadows on a park varies proportionately with the length of shadows being cast. The deeper the shadow of a new building extends into a park, the greater will be the effect on the duration of shadowing. While the proportion of this increase in duration varies from park to park, owing to the combination of a unique context and orientation, the relationship of shadow penetration to duration is applicable to all park situations.

In addition, basing the standard on duration would require the use of calculus in applying the regulations to particular building lots, while shadow penetration entails the use of less complicated trigonometric relationships. Since shadow penetration is easier to calculate, and its direct relationship with shadow

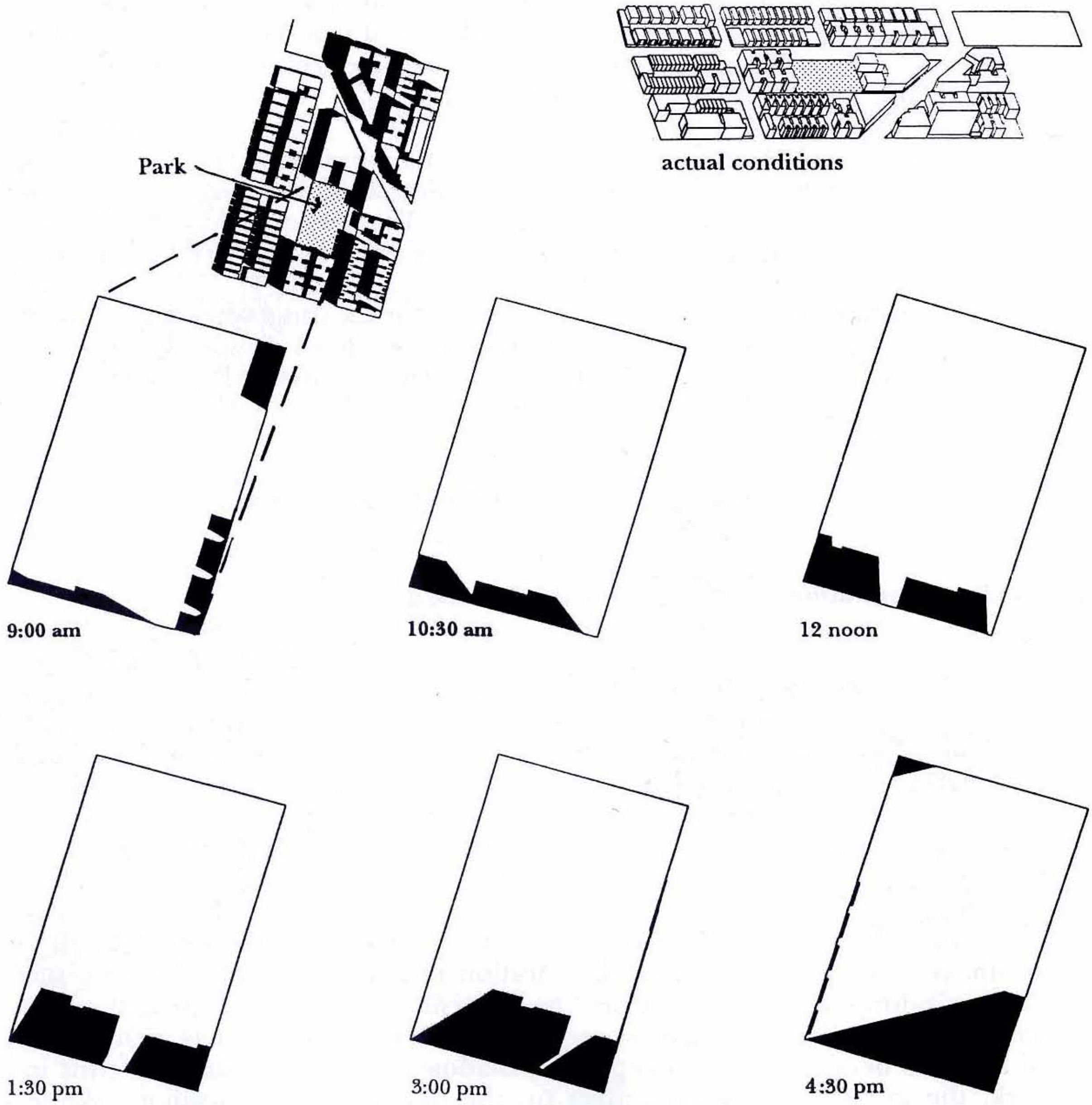


FIGURE 12. Shadow "Snapshots"

Simulated shadow impacts on the six representative parks were quantified both for area and duration. These shadow "snapshots" depict the *area* of shadow coverage (in black) at regular intervals over the course of a given day for each park. This snapshot series simulates conditions for the J.H.S. 22 playground at the equinox at the actual street grid orientation. The plan view and axonometric site plan at top illustrate the playground's relationship to its built context.

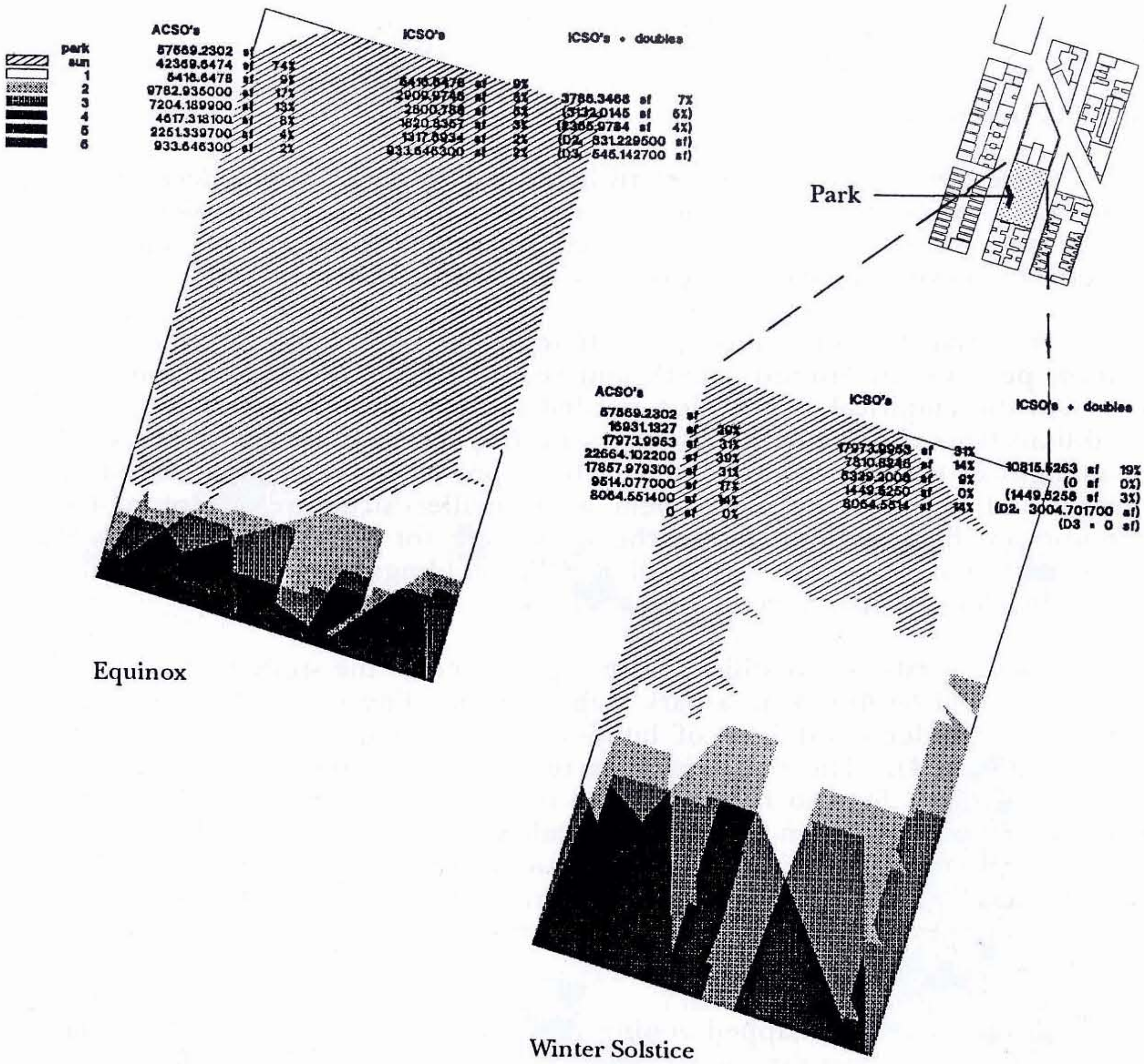


FIGURE 13. Shadow "Sweeps"

Shadow "sweeps" measure *duration* , another significant aspect of shadow impact on parks. A shadow sweep is a composite of consecutive shadow snapshots, indicating the portions of the park continually in shadow over the course of the day. These simulations illustrate the equinox and winter solstice conditions for the J.H.S. 22 playground and are the counterparts of the shadow snapshots in the previous figure. The darkest tones indicate the portions of the park regularly in shadow for the longest cumulative period of time over the course of the day; the white areas are in shadow for the shortest time. Diagonal striping shows the portion of the park in unobstructed sunlight at each snapshot interval.

duration means that by regulating penetration, duration of shadowing is also regulated, it was chosen as the basis for the standard.

Red and Green Lines

Once the basis for the standard had been chosen, the key decision to be made was where to set the standard: to what extent, if any, should shadowing of parks from new development be permitted under zoning regulations intended to preserve the environmental quality of parks as a public benefit?

The snapshot simulations, which modeled both existing conditions of shadow penetration around a park and shadows from hypothetical build-outs, provided the empirical information needed to determine the standard. Shadow conditions from existing buildings represent the "best case" for the public's access to sunlight in parks, because it can not be improved upon short of demolishing these buildings and replacing them with smaller structures. Zoning-based hypothetical build-outs represent the worst case for sunlight access: shadow conditions that would prevail if all nearby buildings were developed to the maximum density that current zoning allows.

These worst-case conditions were represented in the study by "red lines"—lines that could be drawn on a park map corresponding to the depth of shadow penetration under conditions of build-out at the one-and-one-half-hour time intervals (Fig. 14). The red lines were rejected as the standard for protecting sunlight in parks for two reasons. One is excessive penetration of the representative parks. At a given time of day, shadows from build-out conditions extend into the parks to depths as much as ten to twenty times greater than do those from existing development. Build-out under current zoning represented precisely the harm that the regulations are meant to prevent—parks enveloped far more deeply in shadow than they are now.

Second, current mapped zoning designations, which the build-out simulations represent, reflect the zoning standard for maintaining the public's access to light and air on the city's streets. Parks, a vital and limited resource, warrant a higher regulatory standard than that applied to streets and avenues. (Both the city's lower-rise contextual building regulations and the equivalent tower regulations were designed with daylighting rather than solar access in mind.)

After extended discussion and analysis, we concluded that the best case should prevail: maintaining existing conditions of shadow penetration was set as the solar access standard for parks and for the resulting as-of-right zoning regulations. This standard is represented by "green lines," lines drawn on a park map corresponding to the greatest depth to which shadows from existing buildings extend into a park, *on average*, drawn at the study's hour-and-a-half intervals.

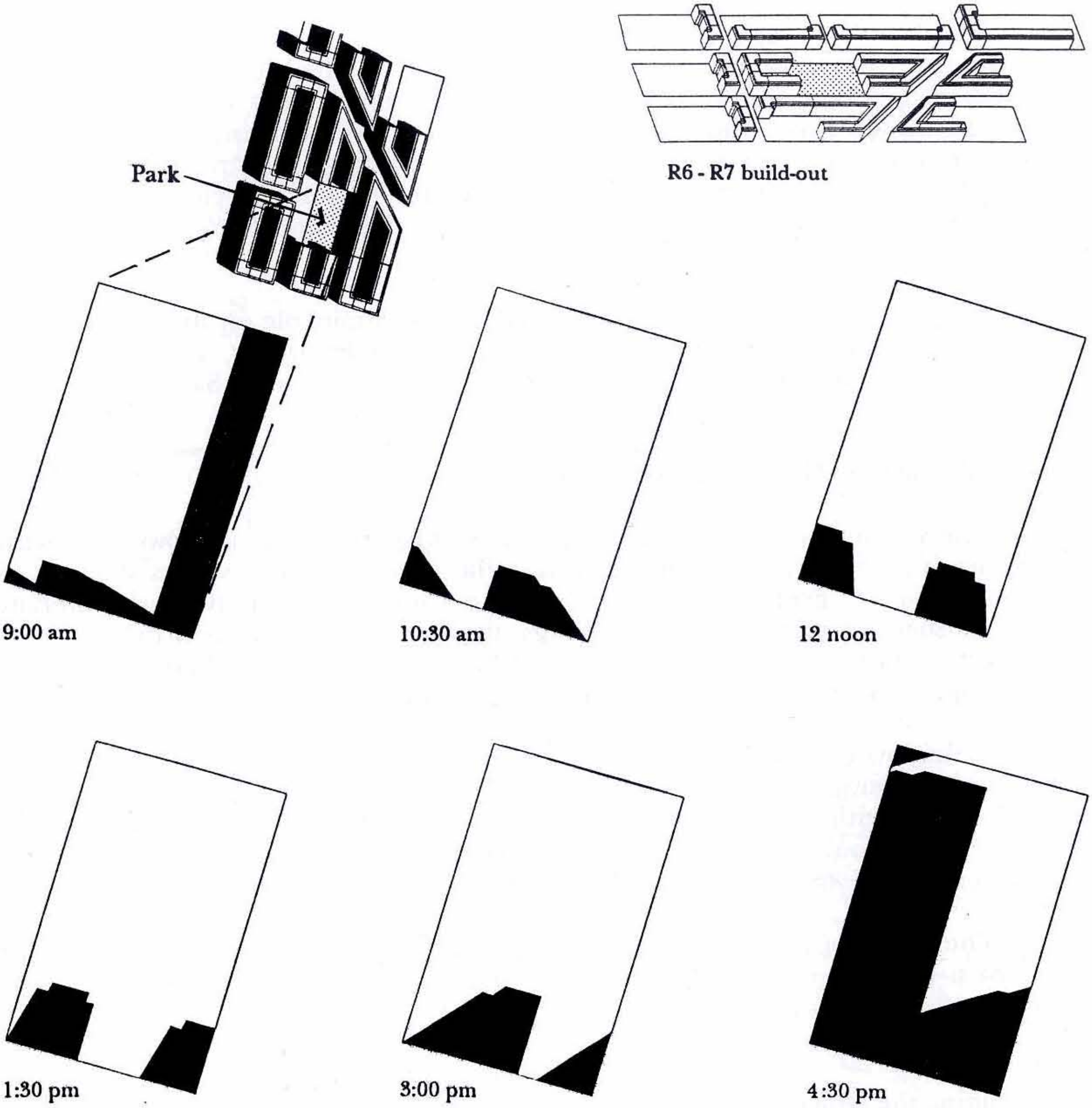


FIGURE 14. Simulation of Worst-Case Shadow Penetration

Using the theoretical bulk envelopes shown in Figure 9, a worst-case hypothetical shadow penetration was determined for each build-out scenario. These worst-case penetrations (the basis of the "red lines" discussed in the text) show the potential future shadow impact of current zoning regulations on the representative parks. The series above are snapshots of the R6-R7 contextual build-out scenario for the J.H.S. 22 playground at the equinox. They are the counterparts of those shown for actual conditions in Figure 12.

This standard, reflecting existing expectations, represents a generic best-case scenario for solar access in parks. By minimizing the depth to which new shadows may extend into parks, it effectively eliminates the possibility of increased duration of shadowing and largely preserves existing sunny areas of parks. In doing so it represents the best practical benefit to the public that can be achieved by as-of-right regulation, without precluding new development around parks. Rather, it sensitizes development to the public expectation of sunlight in parks.

Selecting the best case as the standard is also sustainable on the grounds that a public benefit is achieved by protecting a nonrenewable, nonrecoverable resource—namely, sunlight. This was the rationale also used in San Francisco.

Effect of Using the Green Line Standard

The green line standard, if adopted, would permit new shadows to be cast on a park if they fall within the area where the public already expects shadows to fall. Because the green line at any given time interval is based on the average length of shadows from existing buildings, the existing shadows will rarely fill up the permissible shadow area (Fig. 15). Within this area, a new shadow could fill in existing chinks of sunlight, overlay existing shadows, or both (see Fig. 1).

A shadow from a new building that extends beyond the green line for the time interval being evaluated—e.g., the 10:30 am green line—would be permitted only if it falls within the shadow of an existing building. This provision would respond to the public's specific expectation of sunlight in parks where shadows already extend beyond the green line.

The effect of using the green line standard would be to ensure that those parts of a park that now enjoy unobstructed sunshine beyond the green lines would continue to do so.

Determining the Green Lines

Since the green lines are based on existing development, which varies from park to park, determination of the green lines for the three density groups (R6-R7, R8-R9, and R10 and above) presents a complex problem, even within the same zoning district. An as-of-right approach requires that the zoning density categories, in order to share a common generalized green line, have similar neighborhood building conventions. This is not always the case. For example, in some districts designated R6-R7, existing buildings are consistently low, while in other neighborhoods they are mixed in height. These observations suggested that the R6-R7 low-density category be redefined into two subcategories, one for the outer

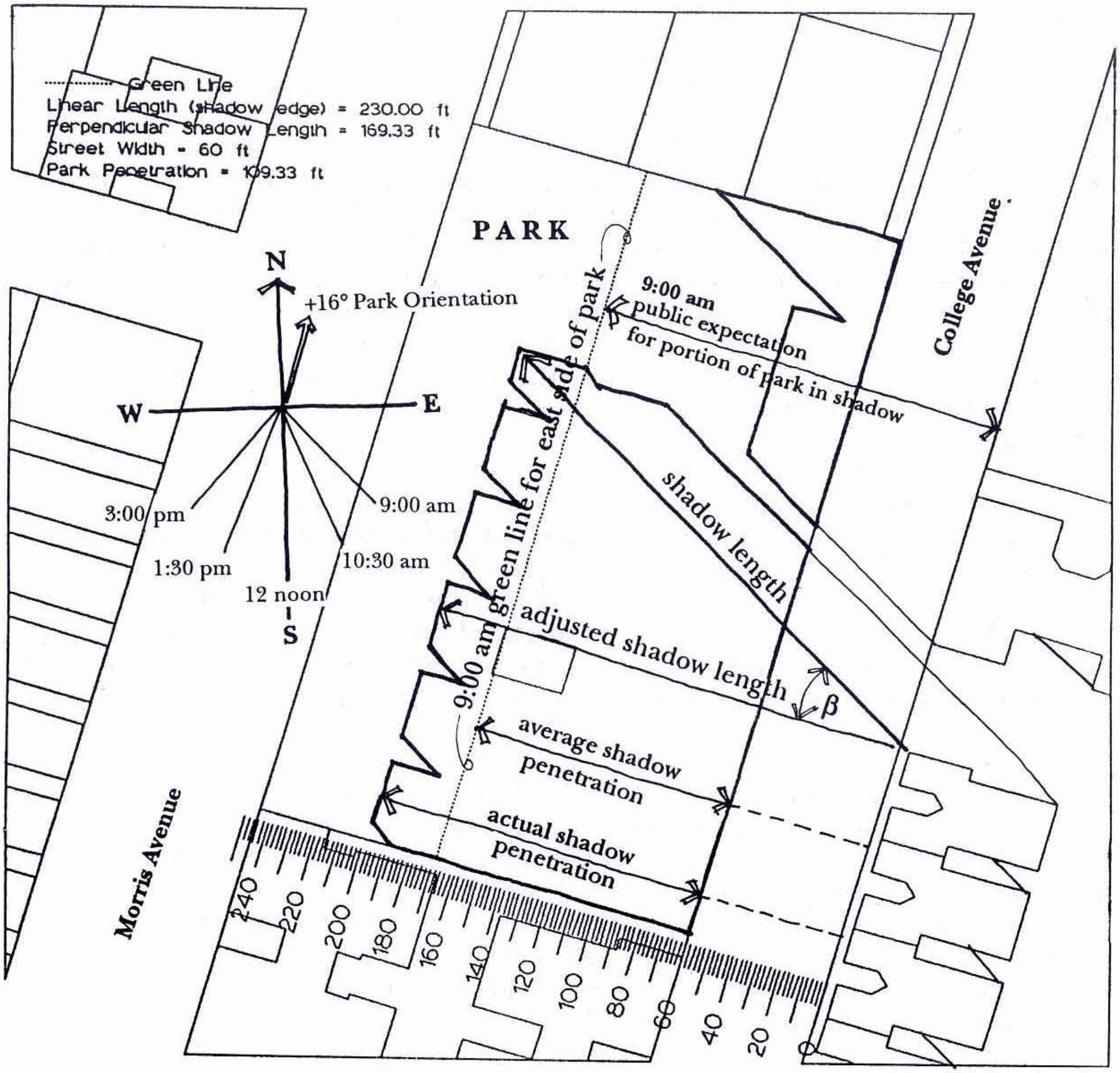


FIGURE 15. Actual Shadow Penetration Compared with Average Shadow Penetration ("Green Line")

Diagram compares the average shadow penetration—the "green line"—with the actual shadow penetration of the J.H.S. 22 playground for buildings on the east side of the park at the winter solstice. Note that the shadow length is determined by the buildings' position relative to the sun while the *adjusted* shadow length is determined in relation to the street grid. Intervening streets or yards buffer the park from shadow impacts.

boroughs and one for Manhattan, to reflect more accurately the different mix of buildings that occur in R6-R7 zones in those two locations. Furthermore, the location of the green lines depends on the method devised to determine the average existing shadow penetration of parks and on the relevant time of year and time of day.

This study premises the establishment of a set of green lines for each of four built contexts (R6-R7 in the outer boroughs, R6-R7 in Manhattan, R8-R9 in all boroughs, and R10 and higher city-wide) by generalizing the length of shadows on November 1 at 9:00 am, 10:30 am, 12:00 noon, 1:30 pm, 3:00 pm, and 4:30 pm from a reasonable sample of parks. While the sample of six parks used in the study is undoubtedly too small to use in setting the green lines with confidence at this stage, the underlying approach and the methods used to determine them could be applied to a larger sample in order to set a more refined series of standards.

Two methods for determining the green lines have been considered. The first would measure and average the length of shadows cast onto each park in whatever final sample of representative parks is chosen, for each of the four building contexts and for each of the specified times of day on November 1, as simulated by computer. The second method would determine an average building height for each of the four built contexts and then calculate the length of the shadow cast by a building of that height for each specified time of day on November 1.

Whichever method is used, four sets of green lines, each corresponding to one of the four built contexts, would be determined and serve as the basis of the solar access regulations. Each development site around a regulated park would be governed by one of the four sets of green lines. Each green line is set assuming a true north-south orientation, but would be modified by the actual street grid orientation and configuration of the park's built context (for example, whether streets separate the park from the buildings around it), and thus would be self-adjusting to site-specific conditions (see Fig. 7).

Each particular development site would be governed by the time of day at which it poses the greatest threat of shadowing to the park. The corresponding sun exposure planes would translate into the most restrictive building envelope meeting the standard set by the regulations. Some sites, because of their orientation relative to the park and existing buildings, might be able to develop a composite envelope of several sun exposure planes that responds more exactly to the site's shadowing effect upon a park. This would maximize the potential building envelope under the regulations.

Choosing a Time of Year for the Standard

Since the pattern of shadowing varies from day to day and season to season, it is necessary to choose a day of the year in proposing a maximum permitted shadow penetration as a regulatory standard. Setting the standard at the winter solstice, December 22, was considered but rejected because the air temperature is too low on that date to be fully compensated for by the warming effects of sunlight; there is little expectation of reasonable periods of unobstructed sunlight at that time of year; and, most importantly, the sun is so low in the sky at the winter solstice that sunlight falls on most parks (all but the very largest) for only a few hours in the middle of the day.

Similarly, the spring and fall equinoxes, March 21 and September 23, were rejected because air temperatures are not symmetrical on those dates. Because the earth and oceans retain the heat of the summer months, the air temperature on September 23 is considerably warmer than on March 21. Since the objective of the study is to increase the time periods during which parks can be comfortably enjoyed, a day between the autumn equinox and the winter solstice should be selected.

Given these constraints, the date we propose for the standard is November 1. Temperatures at this time of year are still moderate, so that warmth from the sun's rays, if they are not blocked by nearby buildings, will substantially extend park use; there is still a reasonable public expectation of continued enjoyment of parks; and shadows are intermediate in length and therefore can still be regulated without being overly restrictive.

Special Cases

A limited number of parks are characterized by very specific special conditions. Solar access protection for these parks would be provided by park-specific green lines, discretionary review, or both. Several such parks fall into more than one "special-case" categories.

Parks in Very High Density Commercial Zoning Districts

A small number of parks in the city's very high density commercial areas are characterized by unique circumstances and do not lend themselves to the generalized green linc treatment of entire classes of zoning districts that would apply to most other parks. These parks are generally located in or border on midtown and lower Manhattan, where the density of commercial development is very high and the building forms are quite different from, and often less predictable than, than those in residential neighborhoods. A set of green lines (the solar access standard) unique to each such park would be formulated, based on the surrounding built context and the public's current expectations of sunlight for that particular park.

Madison Square and Union Square, for example, would have similar yet different green lines, based on the local expectation of sunlight in each location. Individualized green lines would also be formulated for Central Park and Bryant Park, both of which are affected by development in midtown Manhattan, and City Hall Park and Battery Park in lower Manhattan. Both the prescriptive and performance methods of compliance would apply in these cases even though the specific standard would vary by park and location.

Land use actions affecting these parks are generally governed by environmental reviews, discretionary zoning reviews, or both, in some instances because the parks themselves are landmarked, in other cases because the parks are in historic districts or special zoning districts, or because of other specific circumstances (for example, a landmarked building borders the park). For such parks, the solar access zoning regulations would be adjusted to reflect the specifics of these unique situations. The modified regulations would then be integrated into the existing special zoning regulations that govern these highly complex areas.

In discretionary reviews of actions affecting these parks, the solar access standard—maintaining the pattern of sunlight that the public has come to expect, as defined by the park-specific green lines—would still be a governing standard. In weighing competing public benefits, the reviewing agency would be required to find overwhelming cause before it could modify this standard in any way that lessens protection of sunlight in the park.

Parks Designated as Landmarks

Each park designated by the city as a scenic landmark, such as Central, Prospect, and Riverside parks, would have its own unique set of green lines. The use of park-specific green lines in these cases recognizes the critical relationship between the parks and their surrounding context of buildings in defining park image and character.

Although the park-specific green lines will usually provide the desired protection, one can contemplate situations where a proposed building might shadow an important park feature like a garden or conservatory while still complying with the park's solar access standard. In these instances, the Landmarks Preservation Commission would be empowered to review the building project and suggest changes to minimize the negative impact.

Parks that lie in historic districts or are adjacent to landmarked buildings are also special cases. A proposal to enlarge a landmarked building that borders a park, or to transfer development rights from such a building to a nearby site, presents a dilemma of competing public benefits: preserving solar access in the park and preserving the landmarked building.

These situations can not be resolved in as-of-right regulations. Rather, modifications to the solar access height and setback regulations recommended here could be made in much the same way as modifications to the height and setback regulations of the Special Midtown Zoning District are now handled in landmark situations: a daylighting evaluation of a proposed building, comparing the building's performance relative to the daylight standard, must be submitted by the building project's sponsor as part of the discretionary review.

In the case of solar access regulations the affected park would, in most situations, be governed by the green lines appropriate to its zoning district. A shadow evaluation, comparing the performance of the proposed project with this green line standard, would be carried out for the discretionary review. The reviewing agency would, in weighing competing public benefits, make its decision on required modifications to the project relative to the green line standard for protecting sunlight in the park.

Central Park

The city's regional and major parks are fundamentally different, in their size and configuration and in their relationship to surrounding building forms, from the other parks studied. Most are larger than a city block, house a wide array of facilities and unique features, are intensively landscaped, and serve diverse populations. They often have both a local constituency, made up of regular users drawn from the surrounding neighborhoods, and a regional constituency of visitors who live at a greater distance and come to the park intermittently. These parks have, over the years, become inseparable from the buildings that border and define them, forming, with their settings, unique urban compositions.

Central Park was the prototype for the city's large parks—the first such park designed by Olmsted, who went on to plan Prospect, Riverside, and Morningside parks. The park is 843 acres in size, two and a half miles long and half a mile wide, and is a city-designated scenic landmark as well as a National Historic Landmark. It is one of only two regional parks in the study located in high-density areas (the other is Riverside Park). It is heavily used and a unique asset and resource for the city.

Much of Central Park is surrounded by blocks zoned for high-density development—R10 and greater. These blocks are substantially built out, with most buildings as large as permitted under current zoning designations, or nearly so. The east and west sides of the park north of 96th Street and the north side (on Central Park North, or 110th Street) are generally bordered by lower buildings, reflecting to some degree a different development pattern later formalized in a lower-density (R8) zoning district. These lower buildings have a minimal shadowing effect on the park and as a group present a different character from that of the higher-density development south of 96th Street. Midtown skyscrapers south of the park have a somewhat less predictable effect on the park. Central Park South is essentially built out under current zoning, but some parcels as far as two or three blocks away are not, and buildings on these lots can cast substantial shadows on the park.

Despite the high-density development surrounding so much of Central Park, shadow simulations, carried out using the same study design as for all other parks, showed that at present much of the park has considerable protection from shadowing because of the interplay of such factors as its size, orientation, and wide surrounding streets. During the equinox, shadows from buildings around the park (typically 12- to 15-story traditional apartment houses) are virtually clear of the park by 10:30 am and completely out of the park by noon. The park's west side is similarly protected: buildings fronting Central Park West during the equinox cast only minimal shadows at 3:00 pm and have no substantial effect until late afternoon, about 4:30 pm.

To protect existing sunlight conditions, Central Park and other unique parks in high-density areas would be treated as special cases in the solar access regulations, as noted earlier in the report. Thus, Central Park's green lines will be based on the actual shadows now cast on the park by buildings in the adjacent zoning district, giving park planners and review agencies a more accurate and appropriate standard of sunlighting against which to measure the impact of development proposals than green lines generalized for an entire class of zoning districts would provide.

The use of green lines as the solar access standard means that new shadows can not be cast beyond a park's green lines unless they fall within existing shadows. For Central Park, since build-out under current zoning has substantially occurred, the green line (representing existing conditions, and therefore the best-case scenario for the future) and the red line (representing build-out, the worst-case scenario) are relatively close to each other, although by no means identical. Substantial opportunity still exists to prevent further significant and undesirable shadowing on the park.

In recent years, sponsors of new development projects that cast shadows on previously unshadowed parts of Central Park have argued that the impact on the park of an individual project is minimal. Park advocates have stressed the potential degradation of the park's environment that would result from the *cumulative* impact, over time, of shadows from multiple new projects. The practical effect of adhering to Central Park's green lines, if they are formulated and adopted as we recommend, would be to protect from shadows those areas of the park that the public has come to expect to be sunny. This would protect the park from cumulative shadowing effects in a way that allows developers to know what is permitted when they start planning their projects, thus helping to avoid prolonged public controversy and possible litigation on the shadowing issue.

Parks like Central Park that constitute special cases raise another issue: do specific facilities for which sunlight might be viewed as being particularly critical require a very precise degree of solar access protection? The neighborhoods around Central Park have the highest population density of any in the city, and the playgrounds, tot lots, and seating areas that dot the perimeter of the park are generally the only such facilities available to local area residents (the remainder of the perimeter area is generally wooded, with occasional meadows). Park use patterns gleaned from studies carried out for the Central Park Conservancy indicate that these facilities, located 100 to 200 feet inside the park's perimeter wall, are especially heavily used, on a regular basis, by local children and the elderly, in contrast with regional visitors who come less often and use the park differently.

Given the high population density and dearth of other active and passive park space for people living within a 10-minute walk of the park, the study tested the possibility of protecting existing conditions of sunlight for the facilities on the park's eastern perimeter, where morning shadows would limit use. (Facilities on the western edge of the park are in sunlight in the morning and for most of the hours of maximum afternoon use as well, although their use late in the day is similarly curtailed.) By overlaying a map of these facilities on a representation of the shadows cast by existing buildings, it was found that almost all the facilities south of 96th Street are already in shadow in the early morning, until about 10:30 am. This is less true north of 96th Street, where buildings are generally lower.

This situation seems unlikely to change very much, since with few exceptions, the buildings casting the shadows on the eastern edge of the park can not be enlarged under current zoning, and common sense suggests that they will not be replaced by smaller ones. Moreover, as with the entire park perimeter, there is a general recognition that the extraordinary wall of buildings visible from the park's interior on all sides has become an integral part of the image of Central Park itself. The lack of exhaustive studies documenting the specifics of how the perimeter facilities are used—precise locations, times, and activities—argued against treating the park as a series of discrete parts. Finally, the perimeter facilities (and most other facilities) have changed and will continue to change as long as the park is seen as an organic, working part of the city. For all these reasons, the concept of attempting to protect solar access to facilities in the park's perimeter was rejected.

Nonetheless, there are instances where a perimeter facility of the park still enjoys unobstructed sunlight, or where important park features like Conservatory Garden may be adversely affected by new development. In such cases, where the opportunity for protecting sunlight exists and the purpose for doing so is clear, a more restrictive approach than that provided by the park's green lines might be appropriate and could be achieved as part of a discretionary review process. This could apply to the other special-case parks as well.

The city's Landmarks Preservation Commission already oversees a good portion of the east and west sides of Central Park, since they are within historic districts where any new development must undergo Commission review. The Commission at present can not consider the impact on the park of the shadows from a proposed building. It should be empowered to do so, and to determine whether or not the impact is detrimental to the park's historic character. Its findings could result in a more restrictive green line to protect existing sunlight for some special facilities or features.

Central Park's green lines would also provide the basis for siting facilities in the park in the future, by delineating which parts of the park are in unobstructed sun. By careful review, the access to sunlight of a perimeter facility that is either redesigned or moved to a new site in the park can be improved, while the favorable conditions of facilities already in sunlight can be maintained.

PART III

COMPLYING WITH THE REGULATIONS

How the Regulations Work

Both the prescriptive and performance methods of complying with the proposed solar access regulations share the same methodological approach and use traditional zoning conventions familiar to practitioners. For simplicity, the methods assume the ground plane for both the park and the surrounding buildings to be flat. The elevation differences and variations in park topography for the playgrounds, schoolyards, and neighborhood parks that together represent more than half of the 700 parks to be regulated are probably not significant enough to warrant the complexities in application and administration that would result from taking them into account. During the process of refining the proposed regulations, consideration will be given to modifications that reflect topographic conditions in cases where they would have a marked impact on the location of the green lines.

The zoning text would include, in table form, all the baseline information needed to map the green lines for a particular park:

- A list of all parks to which the regulations apply.
- The orientation of each park relative to true north.
- A table grouping all zoning districts from R6 through R10 (and their commercial equivalents) into the four generalized building contexts (R6-R7, outer boroughs; R6-R7, Manhattan; R8-R9, all boroughs; R10 and above, city-wide).
- The sun angles for each of the regulated times (9:00 am, 10:30 am, 12 noon, and 1:30, 3:00, and 4:30 pm) on November 1.
- A list of the base green lines, given as shadow penetration distances, for the four generalized built contexts for each of the specified times. These would assume the park is oriented to the cardinal points, with its major axis oriented north-south.
- The orientation formula which adjusts the basic green lines to the actual street grid orientation of the park being evaluated (the green line's

generalized shadow penetration is always measured normal to the park edge).

The step-by-step process for the prescriptive and performance evaluation methods would then be outlined in the zoning text.

Prescriptive Method and the Sun Exposure Plane

In most cases the prescriptive method, which is simple, direct, and predictable, would be employed. This method uses the traditional zoning technique of regulating building form by a series of planes, in this case sun exposure planes, to supplement the contextual zoning regulations in determining the zoning envelope. As with the more familiar sky exposure plane, the height of a building on any given lot would not be permitted to penetrate the sun exposure plane (Fig. 16). This plane would rule when it is more restrictive than the underlying contextual bulk regulations; otherwise, the underlying contextual bulk regulations would apply.

While the purpose of the sky exposure plane is to protect ambient daylight, the sun exposure plane is meant to protect sunlight, which comes from a single point source and which, unlike daylight, varies from site to site. Thus its slope is set by the actual angle of the sun's rays as they strike the earth at a given time of the day and year. Any portion of a building that stays beneath a theoretical plane projected from the green line along the path of the sun's angle will not cast a shadow beyond the green line. This defines the sun exposure plane.

As the sun exposure plane rises away from the green line, it limits the height of building walls but allows them to rise progressively higher as they set back from the park edge (Fig. 17). Each green line, after being adjusted to a particular park, generates a particular sun exposure plane. This plane is determined by a formula that will be provided as part of the proposed zoning regulations.

The sun exposure plane for a particular site near a particular park would be determined by the most restrictive green line, or time of day, pertaining to the site. For example, sites on the east side of a park will generally be governed by the morning green lines. If analysis showed that a building on a site to the east of a park would cast a shadow on the park at 9:00 am when the green line extends 50 feet into the park, and at 10:30 am when the green line extends 20 feet into the park, then the 9:00 am green line would be used to determine the governing sun exposure plane for that site. Other building sites to the east of the park might be governed by the less restrictive 10:30 am or 12 noon green lines, depending on their location relative to the park.

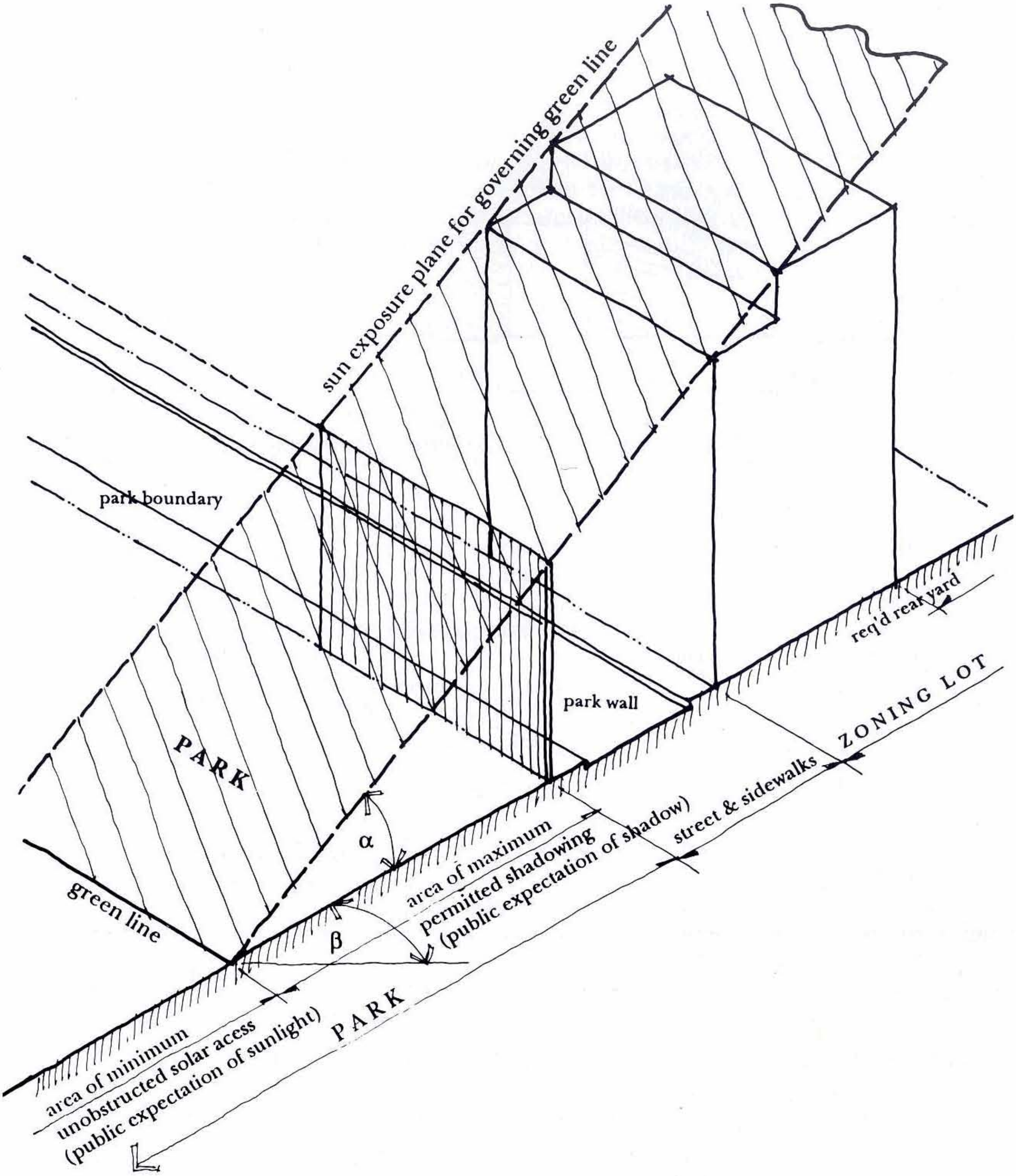


FIGURE 16. Bulk Envelope Generated by Green Lines

A bulk envelope may be developed from a sun exposure plane derived from the governing green line and its associated altitude (α) and bearing (β) angles.

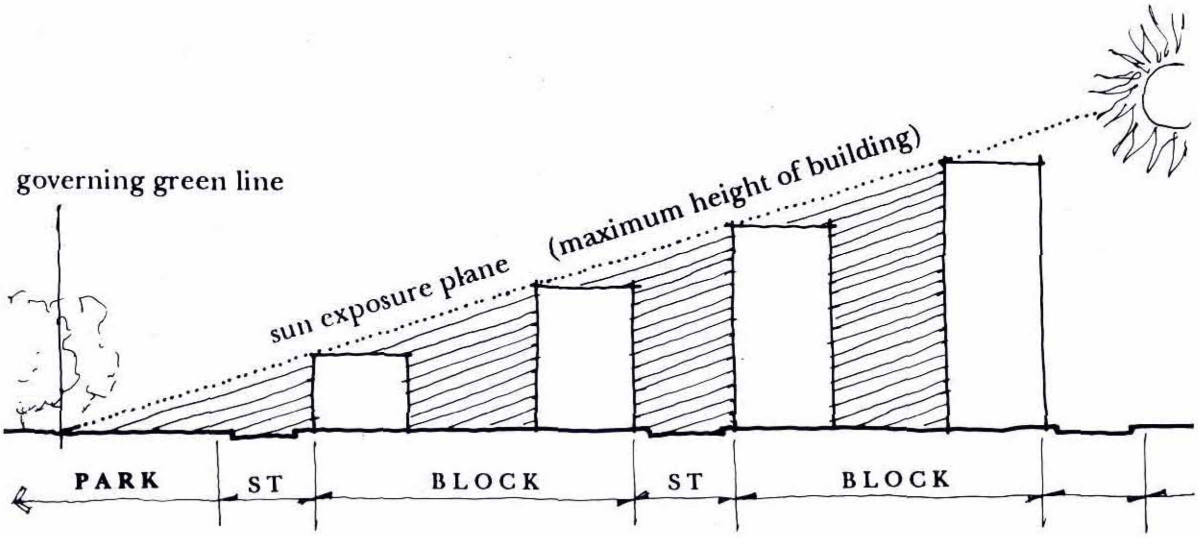


FIGURE 17. Effect of Sun Exposure Planes on Surrounding Park Context

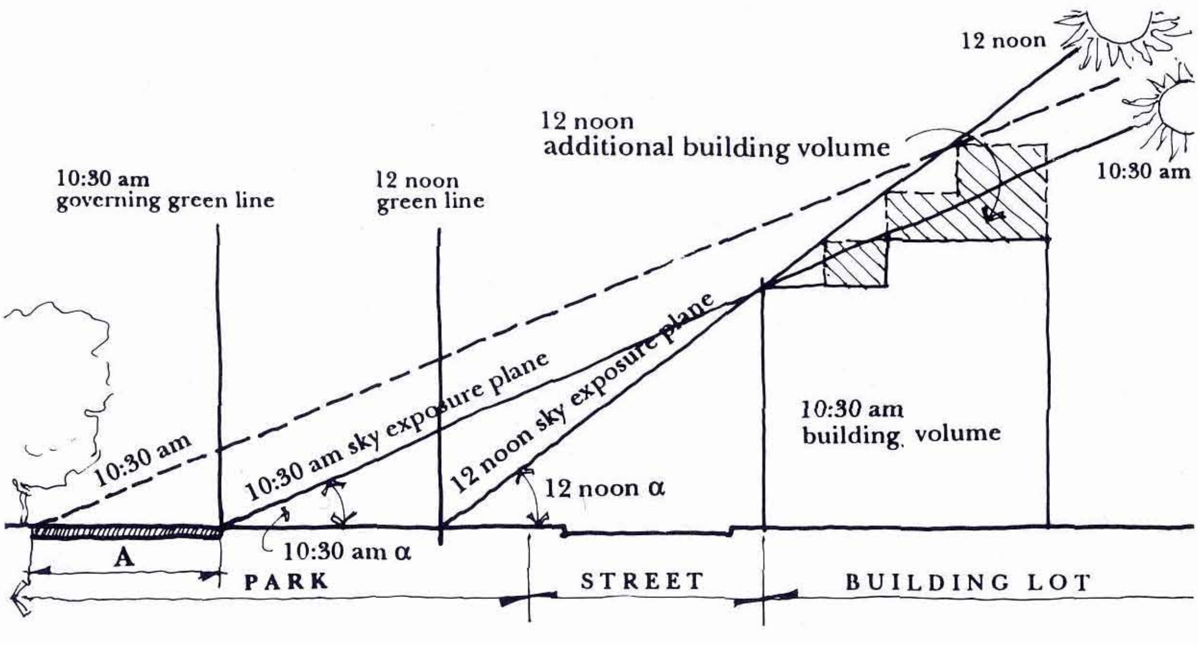


FIGURE 18. Why Longest Shadow Always Governs in Prescriptive Method

In Figure 17, the sun exposure plane progressively restricts the height of new development (and, consequently, potential shadow impacts) around the park. In Figure 18, the governing green line (a function of the lowest sun angle (α), and therefore the deepest potential shadow penetration of the park permitted by new development) yields the most restrictive building envelope of all the green lines affecting an individual parcel and the maximum bulk envelope that will comply with the minimum sunlight expectation for the park. While the building shown casts shadows on the park at both 10:30 am and 12 noon, the additional portion of the building that might be accommodated under the 12 noon envelope (hatched area) would cast a shadow that exceeds (by the distance 'A') the maximum shadow impact allowed at 10:30 am.

This can best be explained by the accompanying diagram (Fig. 18). The azimuth, or altitude of the sun in the sky, is higher at 12 noon than at 10:30 am. If the less restrictive green line (12 noon) and corresponding sun exposure plane were to define the building envelope, the additional setback floors would cast a shadow at 10:30 am that would exceed the 10:30 am green line. The sunlight expectation for that park at that hour would be diminished and the standard exceeded, although the same building setbacks would conform to the 12 noon green line.

Performance Method

Because the generalizations that make the prescriptive method simple to use may in some cases cause excessively restrictive results, it is possible to extend the analysis of a building site by proceeding to the performance method. In this method, both proposed shadows and shadows from existing buildings that extend beyond the green lines are modeled, allowing the architect to more precisely fit the zoning envelope to the development site (proposed shadows may overlay existing shadows). Doing so may yield greater development potential for the site without diminishing the sunlight standard. The method can be performed manually, using the information supplied in the regulations, or by computer.

This approach would determine not a single worst-case green line for the site as a whole (the result one gets with the prescriptive method), but a green line for each portion of the site. Different portions of the development site would have different height restrictions based on the applicable green lines and the corresponding altitude of the sun.

Although this flexibility, together with the fact that overlaying existing shadows would be permitted, may in some cases offer somewhat more square footage on a site than would the prescriptive method, development would still have to remain within the relevant green lines and within any existing shadows that extend into the park beyond the green lines. The ability to achieve a precisely defined building envelope resides in this concept of *performance,* whereby the applicant must prove, using a standardized format, that the proposed building "performs"—i.e., conforms to the standards.

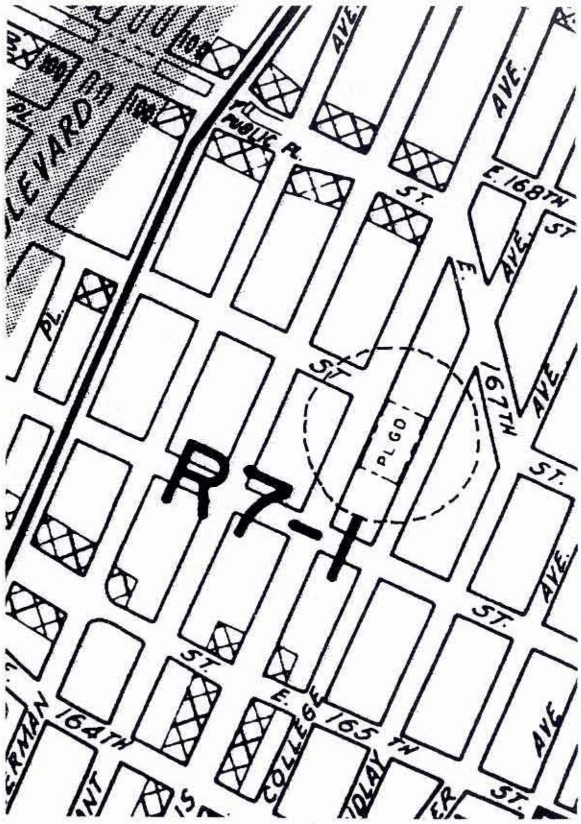
An Example

The best way to explain the regulations is by applying them to an actual situation. The example used is Junior High School 22, a playground and adjoining schoolyard in the Bronx that was one of the representative parks in the study.

The neighborhood around J.H.S 22 is typical of an outer borough R6-R7 built context, consisting of a mix of 3-, 4-, and 5-story buildings, the majority of which were built before World War II. The park, in zoning terms, is a through-lot (going from street to street) with existing buildings built to both the southerly and northerly lot lines. In addition, the bordering streets vary in width. In contrast to conventional zoning practice, the actual recorded street width is used for this example. (Conventional zoning practice typically distinguishes only between "wide" streets—those at least 75 feet wide—and "narrow" streets—those narrower than 75 feet.) The winter solstice is employed for the example to illustrate the most restrictive case. We recommend that November 1 be used in setting the actual green line standards, since it marks the period over which the regulations have their greatest potential for extending park use.

The green lines used in this example are based on the built context for the lower-density R6-R7 parks examined in this study. The street wall heights around this limited sample range from 30 to 44 feet. Because the sample is too small to generalize from, the example employs the weighted average of street wall heights around J.H.S 22, 44 feet. This figure is by no means definitive.

The first series of steps outlined below (Steps 1 through 6) are common to both the prescriptive and performance methods. These initial steps result in the determination of the green lines for the J.H.S 22 playground, which would determine the maximum zoning envelope for the site used in this example. The hypothetical site is located on the easterly side of the playground across the street and slightly south of the playground's southerly boundary. The commonality of the green lines to both methods allows the user to decide which method is most suitable for determining the maximum zoning envelope for the site being evaluated.

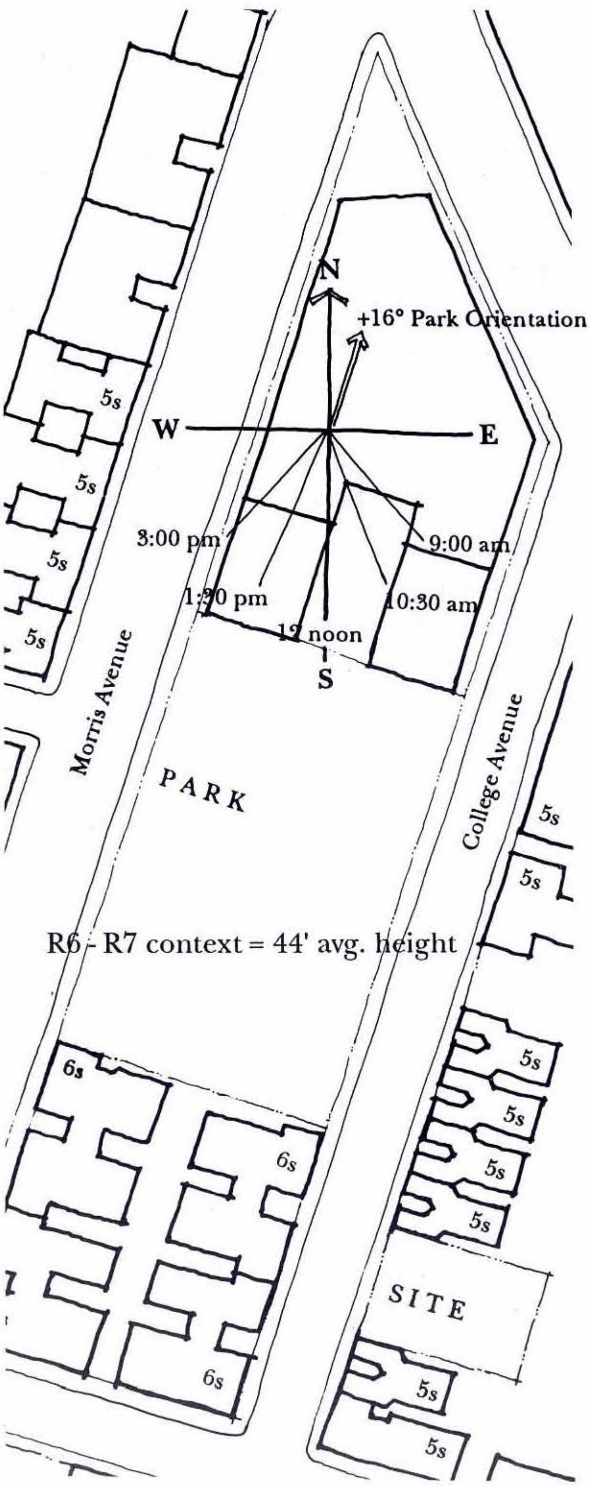


STEP 1a

Determine the applicability of the solar access zoning regulations. The J.H.S. 22 playground would be listed in the Zoning Resolution as one of the parks around which new development must comply with the solar access regulations.

STEP 1b

Determine which of the four generalized park contexts is applicable to the development site. In this case the entire area around J.H.S. 22 is mapped R7-1, the low-density, outer-borough context. The contextual zoning equivalent for the R7-1 zone is the contextual R7 narrow street density and height and setback regulations, which, for the purposes of this example, assume an average streetwall height of 44 feet.

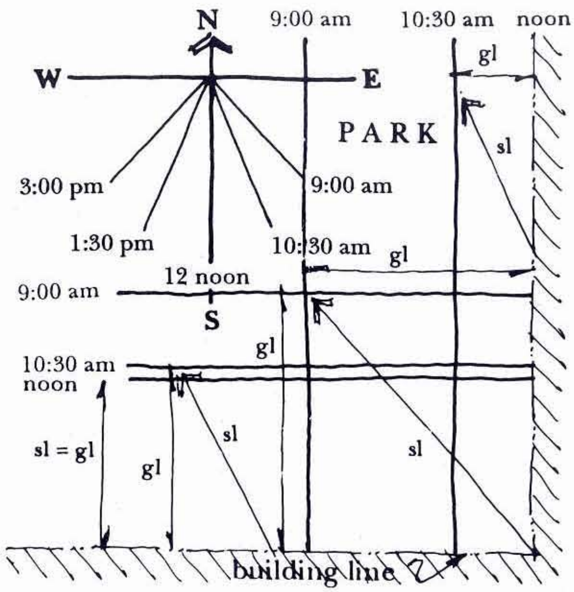


STEP 2a

Determine the orientation of the park and adjacent street grid. From the table to be provided in the zoning text, find the orientation of J.H.S. 22 relative to true north. J.H.S. 22 is 16 degrees east of true north. Draw true north on the Sanborn map that includes the park and its neighboring built context.

STEP 2b

Draw the sun bearing angles. On the north arrow, draw the sun (bearing) angles for each of the five regulated times (9:00 am, 10:30 am, 12 noon, 1:30 pm, and 3:00 pm) for the winter solstice. Because of the site's relative location on the easterly side of the park, the controlling time intervals are 9:00 am, 10:30 am, and 12 noon.



STEP 3

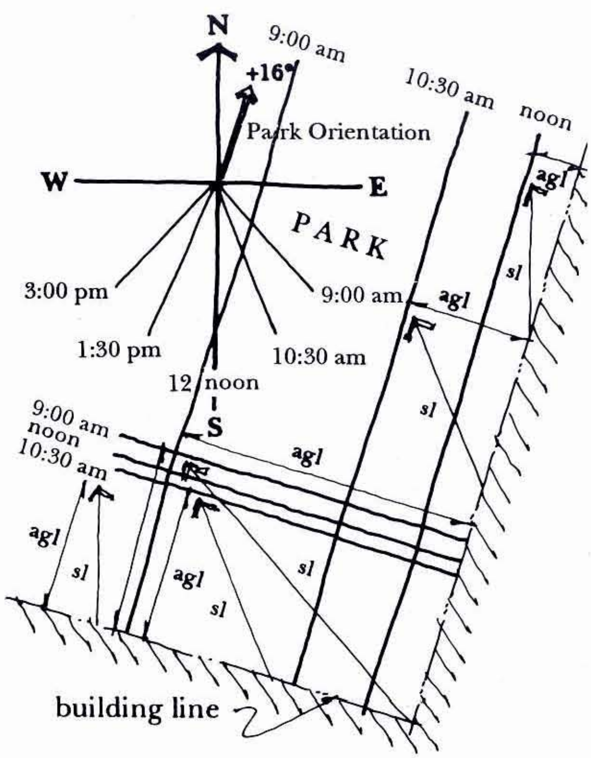
Determine from the "menu" of tables the base green lines for the R6-R7 outer-borough context. This table applies to all outer-borough parks with an R6-R7 context. Based on average shadow length (sl), the base green lines (gl) would be given for the relative eastern, southern, and western sides of a park.

East side:

9:00 am	sl = 182 ft	gl = 122 ft.
10:30 am	sl = 105 ft.	gl = 40 ft.
12 noon	sl = 90 ft.	gl = 0 ft.

South side:

9:00 am	sl = 182 ft	gl = 135 ft.
10:30 am	sl = 105 ft.	gl = 97 ft.
12 noon	sl = 90 ft.	gl = 90 ft.



STEP 4

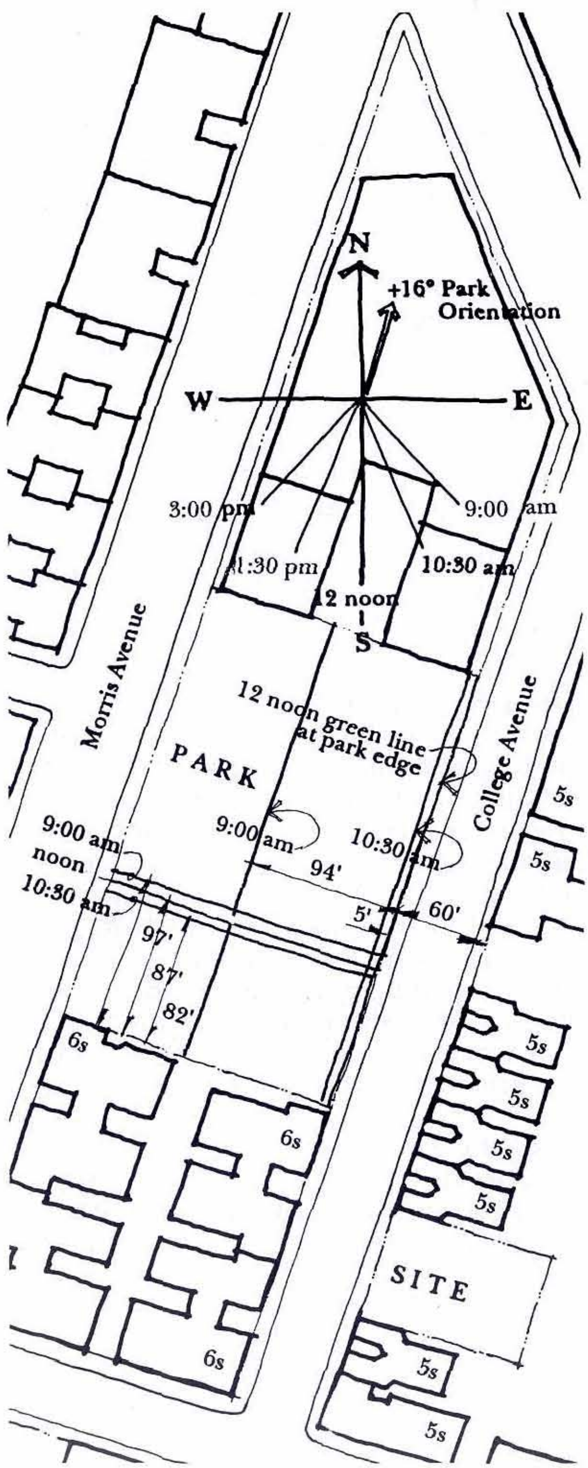
Determine the park-specific green lines. Using the orientation factor in the table, adjust the basic green lines according to the actual orientation of the park—16 degrees east of north for J.H.S. 22. This results in the adjusted green lines (agl) for each relevant side of the park. The green lines (generalized shadow penetration depths) are measured from the edges of the park and assume buildings located at the park lot lines. The width of intervening streets will, where appropriate, be subtracted from the green lines in Step 5.

East side:

9:00 am	sl = 182 ft	agl = 154 ft.
10:30 am	sl = 105 ft.	agl = 65 ft.
12 noon	sl = 90 ft.	agl = 25 ft.

South side:

9:00 am	sl = 182 ft	agl = 97 ft.
10:30 am	sl = 105 ft.	agl = 82 ft.
12 noon	sl = 90 ft.	agl = 87 ft.



STEP 5

Adjust for intervening streets. Correct the green lines for intervening streets by subtracting 60 feet for College Avenue from the morning shadows. If the adjusted green line (agl; shadow penetration depth) in those instances where there is an intervening street is less than the street width (sw), assume that the green line at that interval is located at the edge or lot line of the park. This will be the case for the 12 noon green line.

The resulting green lines, by relative side of the park, are:

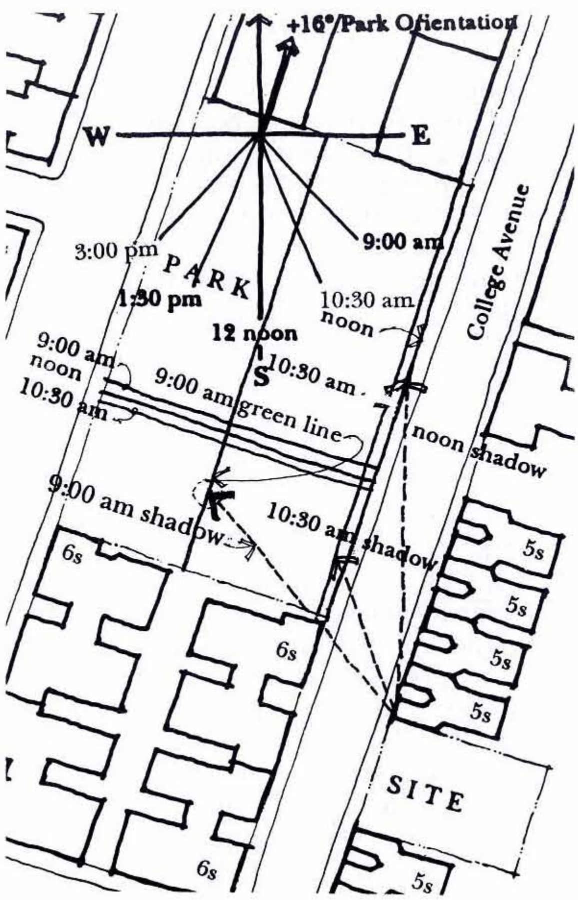
Easterly side (morning shadows):

9:00 am	154 ft. (agl) – 60 ft. (sw) = 94 ft.
10:30 am	65 ft. (agl) – 60 ft. (sw) = 5 ft.
12 noon	25 ft. (agl) – 60 ft. (sw) = -35 ft. [move to park lot line]

Southerly side:
[unchanged, since there are no intervening streets]

9:00 am	97 ft. (agl)
10:30 am	82 ft. (agl)
12 noon	87 ft. (agl)

With the adjusted green lines determined, draw them on the Sanborn map. These adjusted green lines are now the standard of solar access for the park. They will be used to determine compliance by describing the maximum allowable solar access zoning envelope for the prescriptive compliance evaluation method, and the baseline solar access standards under the performance method.



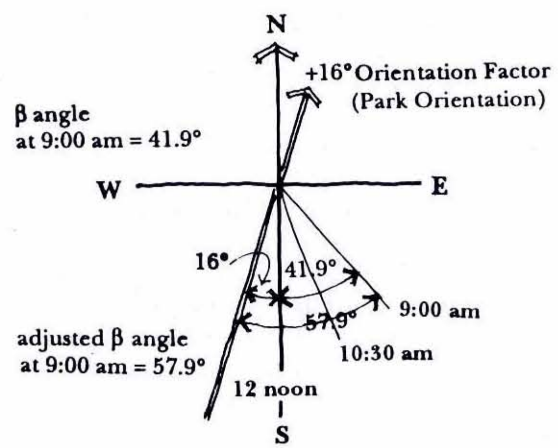
STEP 6

Determine the governing green line. Find on the Sanborn map the development lot to be evaluated for compliance. Using the sun angle diagram (Step 2b), project the sun (bearing) angle for 9:00 am, 10:30 am, and 12 noon from the corner of the lot that determines the leading edge of the shadow, in this case the northerly corner of the street lot line on College Avenue. The projection of the corner of the development lot intersects the 9:00 am, 10:30 am, and 12 noon adjusted green lines. The 9:00 am green line governs; it has the greatest shadow penetration into the park because the sun is lower in the sky at 9:00 am than at 10:30 am or 12 noon.

A user electing the prescriptive method would determine the park sun exposure plane for the 9:00 am green line. The same 9:00 am green line also serves as the point of entry for the performance method. Both methods are described below.

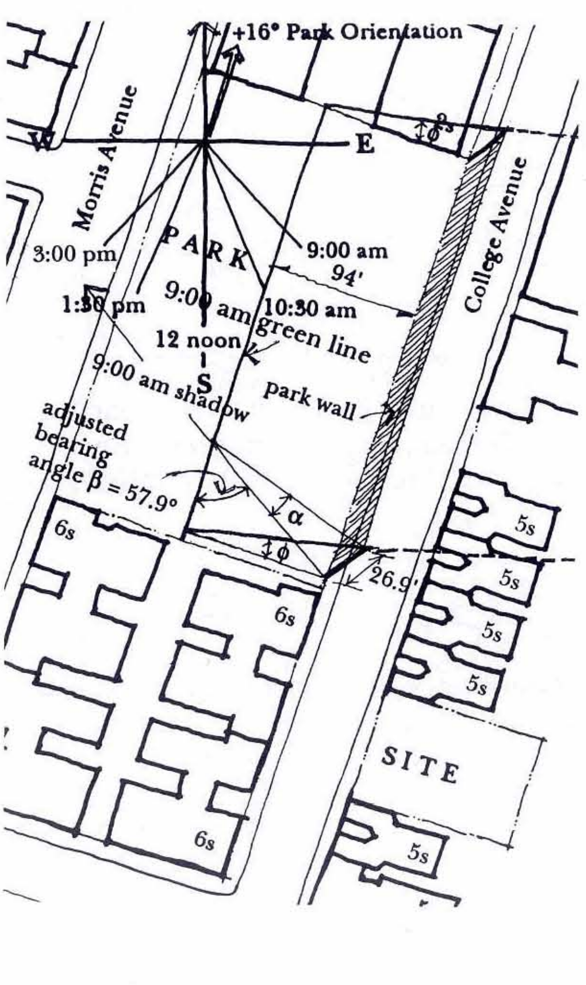
Prescriptive Method: Next Steps

The prescriptive method uses basic trigonometry to construct a sun exposure plane. As with the traditional sky exposure plane already a part of common zoning practice, the sun exposure plane must be normal to the development lot's street lot line and rise uniformly above the development lot. Steps 7 through 11 below translate the green line and the sun's bearing angle and altitude into the sun exposure plane for the governing time interval, in this case 9:00 am at the winter solstice.



STEP 7

Determine the adjusted bearing angle. Having established in Step 6 that the worst-case condition for this site is at 9:00 am, determine the adjusted bearing angle (β) by adding the orientation factor (park orientation of 16°, per Step 4) to the bearing angle (β) for 9:00 am at the solstice (41.9°). The bearing angle (β) of the sun has now been adjusted to the specific orientation of the park (41° + 16° = 57.9°).



STEP 8

Determine the height of the "park wall." Enter the adjusted bearing angle (β) and the adjusted green line distance at 9:00 am from Step 4 into the park wall formula. The park wall is the height of a theoretical wall at the park line that would cast a shadow to the green line. Using basic trigonometric relationships, solve for the height of the park wall, which is determined by the altitude of the sun (angle α = 13.6°) and the penetration of the 9:00 am shadow into the park (94 feet).

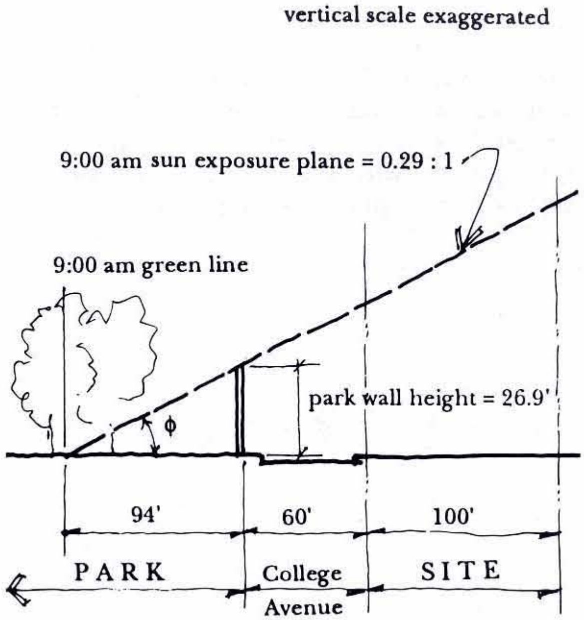
$$x = \frac{\text{green line penetration distance}}{\text{adjusted sun bearing angle } (\beta)}$$

$$x = \frac{94'}{\text{SIN } 57.9°} = 111'$$

park wall height =
x [tangent of altitude angle (α)]

park wall height = 111'(TAN 13.6°)

park wall height = 26.9'



STEP 9

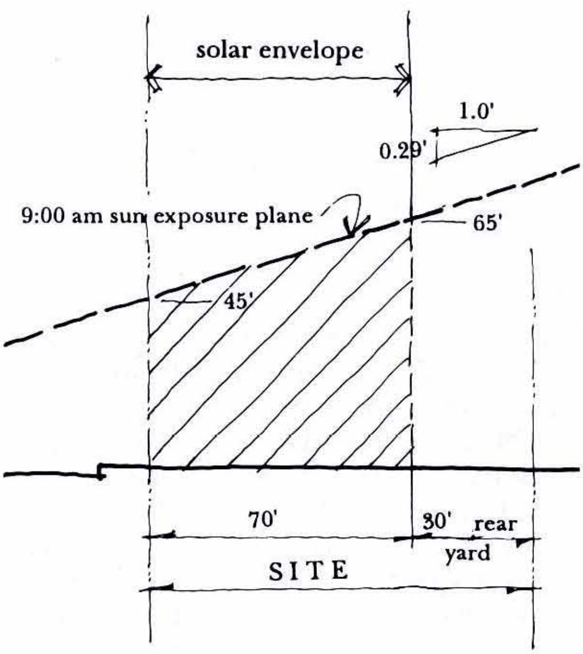
Determine the sun exposure plane for the governing green line (in this case, 9:00 am). The sun exposure plane is similar, in concept, to both the sky exposure plane of traditional zoning and the solar fence. It is a uniform inclined plane projected from the governing green line over the development site. This angle (ϕ) is expressed as a slope or ratio of vertical distance (v) to horizontal distance (h), or $v{:}h$ where $h = 1$.

$$\text{sun exposure plane} = \frac{\text{park wall height}}{\text{green line}} : 1$$

$$= \frac{26.9}{94} : 1'$$

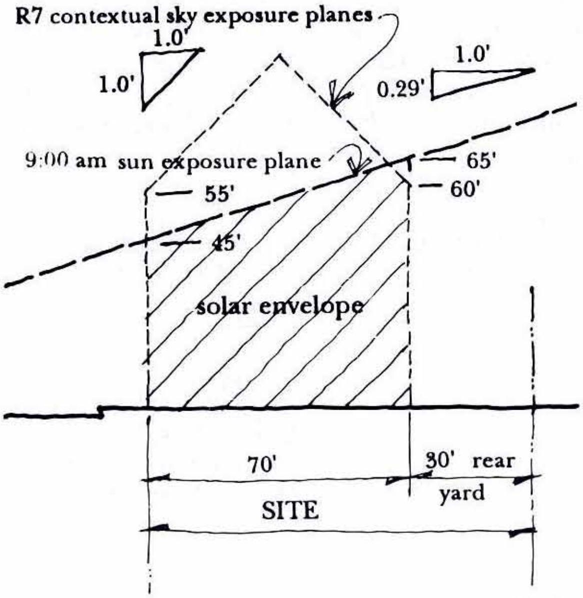
$$= 0.29 : 1$$

which may be expressed as 0.29 feet vertically for every 1 foot horizontally



STEP 10

Establish the solar envelope for the site. Determine the maximum height of the front wall of a proposed building at the lot line. Having calculated the sun exposure plane as a ratio of the vertical rise per increment of horizontal distance, the height of the building at the lot line is the distance at 9:00 am from the green line to the site's lot line multiplied by the vertical rise (0.29), which is about four stories (±45 feet). The same procedure is repeated for the maximum height of the rear building wall, about 65 feet. The area under the sun exposure plane and delineated by both the street and rear building walls is the solar envelope.



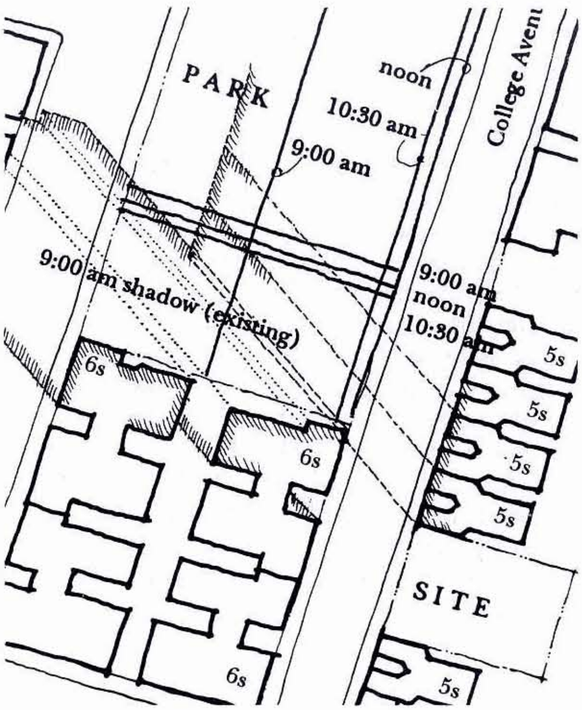
STEP 11

Compare the building envelope that meets the solar access standard with that allowed under the R7 contextual zone. In this instance, the sun exposure plane is more restrictive than the sky exposure plane and would therefore govern, with the exception of the rear sky exposure plane, which is more restrictive.

Performance Method: Next Steps

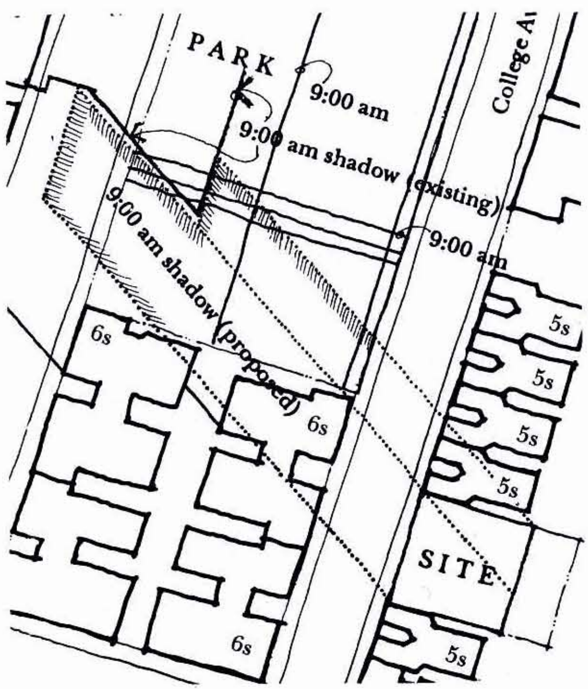
The prescriptive method of compliance for the lot being evaluated is regulated by the 9:00 am green line, which results in a 45-foot-high streetwall (approximately four stories) at the lot line with an additional story setback from the streetwall. Because the 9:00 am shadow from the site would hypothetically project across the six-story buildings located along the southerly park lot line and a portion of the five-story building to the north, it is likely that the shadow will fall within the shadows of the taller existing buildings. If this proves to be the case, the height of the site's streetwall can probably increase by one or two stories, as long the site's shadows stay within the shadows of the taller existing buildings. In order to check if there is a potential for an expanded zoning envelope based on existing 9:00 am shadows which exceed the 9:00 am green line, the user would employ the performance method outlined below (Steps 12 through 14).

STEP 12



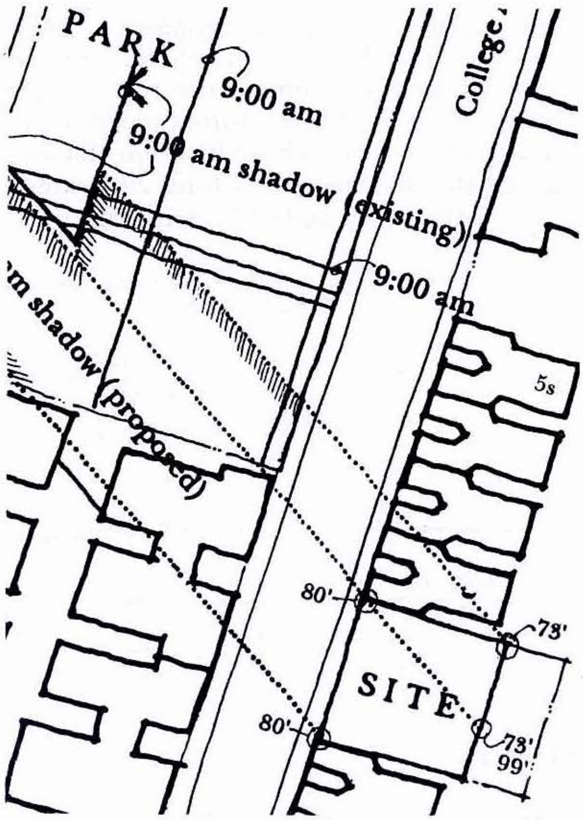
Cast shadows from existing buildings. Begin by casting the 9:00 am shadow for the five-story building adjacent to the site and the two six-story buildings which border the park to the south. These 9:00 am shadows exceed the 9:00 am green lines and extend as far as the street bed of Morris Avenue.

STEP 13



Fitting the site's shadows into the existing shadows. After allowing 30 feet for the site's required rear yard, project the hypothetical shadow lines from the corners of the potential building volume until they intersect the corresponding 9:00 am shadows cast by the existing five- and six-story buildings. The resulting shadow, which falls within the larger existing shadow, is the maximum allowable shadow that can be cast by a building on the site. Although this shadow exceeds the 9:00 am green line, by falling within the area of existing shadows it does not increase the actual shadowing of the park.

STEP 14



Determine the solar zoning envelope. Using the azimuth angles (the angle that determines the height of the sun in the sky) supplied in the prescriptive method regulations, calculate the adjusted allowable height of the streetwall for the site. In this case the adjusted streetwall height is 80 feet, or about eight stories. The maximum streetwall height allowed by the Quality Housing regulations for a site in an R7 district on a narrow street is 55 feet, or five to six stories, which can be accommodated within the performance method zoning envelope. The underlying contextual envelope governs in this instance because the existing shadow already has deprived the park of sunlight at that location. The performance method accommodates to the park-specific sunlight expectation.

Observations on the Example

In this instance, the performance method, by more closely modeling the zoning envelope to *actual* rather than *generalized* expectations of sunlighting, has resulted in a less restrictive envelope than allowed by the prescriptive method alone. Had the southern boundary of the site been aligned with the southerly park lot line, the prescriptive and performance methods would have produced almost identical solar envelopes because the green lines, in the absence of longer existing shadows, would have governed. Had the site been further north on the block, the site might have not been affected by the solar access regulations at all, or perhaps only a portion of the site might have been affected by the 9:00 am green line, indicating that under the performance method, the remaining portion of the site would be regulated by the underlying R7 contextual zoning regulations. Had the site been further away from the park, for example, on the other side of the block used in the example, the solar access regulations would probably not have pertained, although in less uniform or higher density situations, the regulations may have a wider relevancy than the example indicates.

REPORTS CITED

(References 1, 3, and 4 are unpublished reports prepared by Michael Kwartler and Associates, New York, New York, for The Parks Council in the course of carrying out this study.)

1. Environmental Zoning Study, Task 1 Report [comprising sections on human comfort criteria, evaluation methods, regulations in other cities, and a 16-page bibliography]. 1989, 80 pp.

2. *Zoning Handbook. A Guide to New York City's Zoning Resolution.* New York Department of City Planning, New York, NY, Publication No. NYC DCP 90-37, 1990, 160 pp.

3. Law of Ancient Lights and Solar Access Regulations: An Overview of the Literature. 1989, 11 pp.

4. Environmental Zoning Study for New York City's Public Parks and Open Spaces: Research Design and Simulations. 1990, 116 pp.

The Parks Council
The Urban Center • 457 Madison Avenue • New York, NY 10022 • 212-838-9410