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Underused Lots in New York City

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Abstract

Despite a robust real estate market for most of this decade, researchers and policymakers have observed that many areas of New York City have remained built out well below their zoning capacity. This study aims to contribute to our understanding of urban redevelopment by compiling and analyzing a large database of underdeveloped lots in the City. We identify about 200,000 such lots as of 2003 that were built out at less than 50% of their zoning capacity, representing about a quarter of all residentially zoned lots. Of these, about 8% were redeveloped during the subsequent four years. Our preliminary analysis reveals that underdeveloped lots are primarily made up of low density 1-4 family houses and are disproportionately located in poor and minority neighborhoods. We plan to use this analysis as the foundation for further analysis to assess whether market failures and regulatory and other barriers impede desirable development in mature cities.

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Underused Lots in New York City

Introduction

In response to soaring housing prices, expectations for one million additional residents by 2030 and a stated commitment to improving the City's environmental performance and quality of life, the current mayoral administration in New York City has spearheaded an ambitious planning program over the last eight years designed to remake large portions of the City. The primary tool used by the City has been zoning changes. While some zoning changes have decreased development capacity to preserve existing neighborhood character, others have increased capacity, allowing, theoretically, denser development patterns in affected neighborhoods.

Researchers have long recognized the environmental and fiscal benefits of residential density. Such development requires less infrastructure and fewer city services per capita and tends to promote less auto-dependency and lower energy demands in general (Glaeser 2000; Holtzclaw et al. 2002). Additionally, permitting higher densities of residential construction has the potential to relieve affordability concerns that remain in New York, despite the current economic downturn. During the recent boom, skyrocketing housing prices paired with stagnant incomes increased the housing burdens of many families. Affordable units were lost through market forces or as the subsidy periods that kept rents or sales prices low expired. Meanwhile, increasing maintenance, operating and construction costs made it ever more difficult to provide affordable housing in existing New York City neighborhoods.

Even before the rezonings of the current mayoral administration, however, observers and policymakers suspected that many areas of the City remained built-out well below their zoning capacity. For example, Manhattan Borough President Scott Stringer and teams of volunteers recently identified 2,228 properties in Manhattan that appear to be vacant or abandoned (Stringer 2007). Why such lots would remain under-used despite evident demand is puzzling. Previous research posits several hypotheses as to why landowners would decline to redevelop underused property, including low expectations of returns from alternative uses, uncertainty about future demand for the property, the presence of institutional or regulatory barriers, or unrecognized market failures. While development density below an assigned zoning capacity may not be a bad thing in itself, if such underdevelopment is a result of unintended regulatory barriers or market failures, these factors have the potential to frustrate the effectiveness of government planning initiatives to encourage additional housing construction and density.

At the heart of the question is understanding why the underuse of some properties persists and why other properties are, in fact, redeveloped. Several recent empirical papers have examined redevelopment of older urban areas and found that, as land values increase in centrally located neighborhoods with old or low-quality housing stock, these existing

structures are demolished and replaced with newer and usually larger structures (Brueckner and Rosenthal 2005; Dye and McMillen 2007; Helms, 2003; McMillen, 2003; Munneke 1996; Rosenthal and Helsley 1994; Weber et al. 2006). However, this is only one side of the equation. If market failures and unintended regulatory barriers are present, it is likely that the decision to develop faced by rational acting landowners may be altered in ways not very well understood at present. As a result, development patterns may be different from those that would otherwise occur as a result of an efficient housing market and zoning controls. The costs of this distortion include the opportunity costs of the site itself and the fiscal and lost environmental benefits of planned higher densities (if so designated).

This study extends the existing literature by creating a "geocoded" database of underused properties in New York City and identifying which of them are subsequently redeveloped at a higher density. We explore the lot-level, building-level and neighborhood-level characteristics of these properties to analyze the impacts of differences in these attributes. Our results provide a foundation for a better understanding of which factors influence whether or not an underused property is redeveloped. The paper is divided into five parts: In Part A, we review the theory and existing literature regarding the redevelopment of urban property. Part B describes our data sets and methodology for identifying underused and redeveloped properties. Parts C and D describes our results, summarizing the descriptive statistics we generate from our identification of these properties. Part E concludes.

Theory and Past Literature

Theoretical models of land development suggest that a landowner will develop or redevelop land (or unused development rights) when the net present value of the developed or redeveloped density exceeds the net present value of the current use of the land (or development rights) plus the costs of the development or redevelopment (see, for instance, Carrion-Flores and Irwin, 2004; Irwin and Bockstael 2004; Lubowski et al. 2006; McMillen 1989). Within this theoretical framework, previous research posits several hypotheses as to why landowners would choose to delay developing a parcel. First, the land owner may believe that given market conditions and redevelopment costs, the net present value of the current use in fact exceeds the net present value of redevelopment, so immediate redevelopment would not be profitable. Second, the landowner may face uncertainty that increases the value of waiting to develop the parcel or may anticipate higher profits from developing at a later date. Third, institutional or regulatory barriers may constrain development, even when the land would otherwise be profitably developed. Below we elaborate on some of the factors that affect the likelihood of each of these scenarios.

The traditional market-based explanation for land remaining vacant or underused is that the net returns to development are not sufficient to justify changing uses or densities. This may be true even in the face of apparently strong demand for housing. For instance, the underused land may have some idiosyncratic feature that either lowers the net present value of additional density, or makes the costs of adding density prohibitive. The land may have unusual value "as is," because of historic features or architectural significance, for example. Or some owners may be idiosyncratic in that they receive non-monetary utility from holding the land -- a family that has held the land for generations may have an emotional attachment to the land, for example. Alternatively, the land may have unusual topography such as steep slopes or irregular shapes that make it especially costly to develop. The small size of "remnant" parcels may make them uneconomical to develop (Northam 1971). Technological constraints such as the need for elevators or additional foundation work once size exceeds a particular threshold may make the development of additional capacity uneconomical. Pollution of the land or the existence of structures that would be costly to demolish may make certain lands unprofitable to develop (Harvey and Clark 1965). Some vacant or underused lands pose unusual difficulties for developers needing to assemble larger sites -- vacant lands interspersed with parcels subject to rent control, for example, may be especially difficult to assemble. Underused land may have such unusually poor access to infrastructure such as transportation systems that development is rendered unprofitable (Goldstein et al. 2001).

Under the second hypothesis, the net returns from development (or redevelopment) may exceed net returns from the current use, but the landowner may anticipate even greater returns from waiting to develop at a future date. If there is uncertainty about the future demands for the land (both in terms of the type of uses for which land will be needed, and in terms of the prices development at the most valuable use will command, then delaying

development is more likely to maximize profits (Cunningham 2006; Keuschnigg and Nielsen 1966; Titman 1985). If a landowner had perfect foresight and could anticipate the demand for different land uses in the future, then he or she would develop land today in a way that would allow the land to be cheaply converted in the future to meet demands as they arise. But where future needs are uncertain, and land use is not easily adaptable (because the developed structure is durable, and because technological, legal or political constraints may prevent easy modification of the structure or the land use), it may maximize the landowner's return to keep land undeveloped or underdeveloped (e.g., developed with only a "tax-payer" -- a cheaply constructed building that allows the land to be put to some current use without requiring significant demolition costs in the future) and reserve it for the more highly valued future use than to develop it today.

The landowner who keeps land or development capacity off the market (and doesn't develop the land himself) in such situations is taking an option on future development. The price of the option is the foregone return from current development. If the landowner develops the property or sells the land, she is going to demand a premium for foregoing the option. Several researchers have demonstrated either that uncertainty results in a price premium for vacant or underused land (after accounting for demolition costs), and/or that it reduces current development, suggesting that investors (and homeowners) recognize the value of real options in real estate investment (Bulan et al. 2006; Cunningham 2006; Downing and Wallace 2001; Grenadier 1996; Holland et al. 2000; Sing and Patel 2001; Sivitanidou and Sivitanides 2000; see also Quigg 1993). Dye and McMillen (2007) note that the benefits of redevelopment include additional tax revenue as old buildings are typically replaced with higher priced homes. In addition, redevelopment of existing lots may reduce urban sprawl as potential buyers with preferences for new residences have additional options to live in mature neighborhoods. The neighborhood-level costs are characterized as disruption during construction and potentially higher neighborhood prices, forcing existing residents to search elsewhere for accommodation.

The third hypothesis suggests that current (re)development is constrained, not by the landowners' calculation of expected returns, but by institutional or regulatory barriers. Legal problems related to the ownership of the land, such as problems with the title of the land, or disputes among co-owners, may prevent the land from being developed. Zoning ordinances, ad hoc planning processes, building codes, and historic preservation obligations may keep land from being developed even when development would result in greater social welfare than preservation of the land in its current state (Goldstein et al. 2001). Other tax or regulatory policies may distort the landowners' decisions about developing the land. If tax policies allow the owner to carry the land cheaply, for example, the landowner will be more likely to speculate, or hold the land for future appreciation (Goldstein, et al. 2001). Discrimination, undue risk aversion, and other barriers to obtaining financing in low income and minority neighborhoods may make it more costly to develop land in some areas of the City (Goldstein et al. 2001). Market features or governmental policies may also allow or encourage landowners to act anti-

competitively, by holding land or development capacity off the market in order to increase the landowner's returns on other land holdings. If a landowner benefits from a competitive advantage secured to a non-conforming commercial use, for example, the landowner may be reluctant to develop nearby land zoned for commercial use (Markusen and Scheffman 1978). Similarly, government inability or unwillingness to regulate, or enforce existing regulations addressing, uses with significant negative externalities might indirectly prevent landowners from redeveloping property near such uses (Irwin, 2004).

Empirical analyses of the factors that determine whether land is left vacant or developed (or left in its current use versus redeveloped) include Dye and McMillen's (2007) recent estimates of the features of property that increase the probability that current houses will be torn down and the property redeveloped, as well as similar work by Helms (2003) and Munneke (1994). Weber et al. (2006) also question why certain properties remain undeveloped when the rational response to rapidly rising land values is demolition (and presumably redevelopment) and suggest unobserved building and neighborhood characteristics are at play.

While the literature provides a detailed list of factors that will influence the value of the current use of the land, the value of more intense use, or the costs of development or redevelopment, little is known about which of the various factors are most likely to affect the development of land in different contexts, or about the circumstances under which the various factors have their most significant effect. In this paper, we take the first steps to extend the existing literature by creating an extensive database of underused properties in New York City and identifying which of them are subsequently redeveloped at a higher density. Through future analysis of this dataset, and additional qualitative research, we will be able to investigate the relative importance of individual factors that influence the redevelopment decisions that increase urban density.

Data and Methodology

To begin unraveling the tangle of factors associated with redevelopment decisions, we examine residential development patterns in New York City during the height of its recent real estate boom.[1] Specifically, we identify underdeveloped properties in the City in 2003 (the earliest year for which we have a reliable Geographic Information Systems (GIS) base map of the City's parcels of land) and reevaluate them in 2007, the peak of the housing market in New York City and the most recent year of data we have. We do this to determine whether or not each underdeveloped lot was redeveloped during this period.

After identifying underdeveloped 2003 lots and the subset of these that were redeveloped as of 2007, we then compare the 2003 characteristics of each group to one another and to the 2003 characteristics of lots that were fully developed. Finally, we compare neighborhoods with relatively high and low concentrations of underdeveloped properties across several neighborhood-level characteristics. Our methodology for identifying these different groups of properties is described in this section and the results of our comparisons are described in Section D.

The primary data source for our analysis is the New York City Real Property Assessment Database (RPAD), a massive proprietary data set maintained by the New York City Department of Finance for property tax assessment purposes. RPAD contains detailed information about each unique owned parcel of real property recognized by the City of New York (each known as a "tax lot") and is updated annually. Fields include the land area of the lot, the building area on the property, the zoning district the lot is in, and several other characteristics about the lot and any building(s) on the lot. RPAD identifies each tax lot using a unique identification number (known as a "BBL number") assigned by the City of New York based on the property's borough, block and position within the block. Other key data sources for our analysis include a variety of public and proprietary GIS files and other datasets developed by the Furman Center for Real Estate and Urban Policy or obtained from the City of New York. A list and description of all of our data sources is included in Appendix I.

Identifying Underdeveloped Sites

As the first step of our analysis, we (i) identify all parcels of land in New York City) that in 2003 were zoned with a residential zoning category[2] and (ii) for each of these parcels, determine whether the gross square footage of building area on the parcel is less than half

[1] A repeat sales-based housing price index calculated by the Furman Center indicates that residential properties in New York City appreciated, on average, 41% in real terms between 2003 and 2006.

[2] We include as residential zoning categories "mixed use" districts with a residential component and a portion of the special Battery Park City (BPC) zoning district that is primarily residential. We exclude from our study all public parks.

that permitted by New York City's zoning code. To identify the starting sample for this first step, we use 2003 GIS data to determine which tax lots in 2003 RPAD represent potentially developable parcels of land and not condominium units, air rights lots or other real property without a unique land area. Using these techniques we identify about 778,000 residentially zoned tax lots that form our main sample (see Map 1). A more detailed description of each step of our methodology is included in Appendix I.

In New York, as in most American cities, zoning is the primary tool for regulating land use and building density. The City's zoning code (known as the Zoning Resolution[3]) limits building size through a variety of measures, chief among them, rules that apply a maximum "floor area ratio" (FAR) to each parcel of land. FAR represents the ratio of a lot's gross building square footage to the lot's land area, so a maximum FAR effectively caps the amount of building area that can be built on a lot to a multiple of its land area. [4] Because it is the most significant limitation and the only one we can efficiently model for such a large sample, we focus on maximum FAR as our variable to calculate how much building capacity a given tax lot is permitted.[5]

The Zoning Resolution actually applies zoning restrictions not to tax lots, but to "zoning lots," which may consist of one or more tax lots. Property owners can form zoning lots made up of multiple tax lots by contractually agreeing to combine adjacent tax lots solely for zoning-compliance purposes. For example, if a developer who owns a lot has contracted with the owner of an adjacent lot to form a zoning lot composed of the two lots together (a "zoning lot merger"), whether a new building proposed by the developer on his or her lot complies with zoning requirements will be evaluated as if the building site included both lots. To our knowledge, there are no data sources compiling historical zoning lot mergers (other than recent zoning lot mergers being identified through other Furman Center research, which is briefly described in Appendix I). Accordingly, by performing our identification of underdeveloped sites at the tax lot-level, we effectively assume that each tax lot in our sample makes up a separate zoning lot. Although this may result in some misidentifications of underdeveloped lots,[6] we believe this assumption to be accurate in a vast majority of cases.

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[3] More information about New York City's zoning code is available at www.nyc.gov/html/dcp/html/subcats/zoning.shtml.

[4] For example, a 10,000 square foot lot with a maximum FAR equal to 2 cannot be developed with a building larger than 20,000 square feet.

[5] In most cases, substantially all of a tax lot's allowable FAR can, theoretically, be achieved despite other non-FAR limitations. Among the Zoning Resolution's non-FAR limitations on building size and form are yard or set-back requirements, open space requirements, parking requirements (which effectively require developers to set aside a certain amount of lot area to accommodate a specified number of parking spaces per residential unit), height limits, and bulk regulations, which require minimum sky exposure to the street. Because the exact impacts of these non-FAR limitations are very complex to model even on a property by property basis, we do not address them in our analysis. We hope to revisit some of these limitations, particularly parking requirements, in future research.

[6] For example, we may errantly identify a tax lot as "underdeveloped" if it is part of a larger zoning lot and the building area built on the zoning lot is disproportionately concentrated on the other lot(s) that make up the zoning lot.

To perform the building capacity calculation, we develop a model that determines the maximum allowable FAR for each lot in our main sample in 2003. The model makes this determination by starting with the default maximum FAR specified by the Zoning Resolution for the zoning district in which the tax lot is located. The model then adjusts that default maximum FAR based on other lot characteristics that, pursuant to the Zoning Resolution, affect the maximum FAR. These other characteristics, which we determine using GIS, include whether the lot is in a Special District (a mapped area with restrictions tailored to a specific neighborhood[7]) or Inclusionary Housing Area (a mapped area allowing developers to increase their FAR in exchange for providing affordable housing [8]), or is on a wide or narrow street (defined as rights of way of more or less than 75 feet wide). The model also makes several assumptions regarding discretionary and bonus programs in the Zoning Resolution that permit developers to either exceed the base maximum FAR if they include certain amenities (affordable housing, for example), or exclude the square footage of certain building elements (enclosed garages, for example) when calculating FAR. A description of our model for determining maximum FAR, including the assumptions it relies on, is attached as Appendix II.

We use 50% of FAR as the threshold to classify a tax lot as "underdeveloped" for two principal reasons, though such a bright line cut-off is, by definition, somewhat arbitrary. First, we wish to be conservative in our identification of underdeveloped sites so as not to include properties merely because of minor errors in the building square footage or lot area reported by our datasets.[9] Second, our use of a low FAR threshold reduces the chance that the tax lots we identify as underdeveloped are restrained by other, unobserved zoning restrictions, such as set-back or parking requirements, and are, in fact, developed to their maximum zoning capacity. Furthermore, a panel of New York City land use regulation experts we convened to advise us on this project agreed with our use of the 50% threshold for these same reasons. Of the nearly 778,000 residentially zoned tax lots in our main sample, approximately 201,000 meet this underdevelopment definition.

It is important to note that by relying exclusively on maximum allowed FAR, our yardstick for determining underdevelopment is the building capacity defined by zoning regulations, not neighborhood context and not how a building is sited on a lot. As a result, in neighborhoods with zoning designations that carry a maximum allowed FAR higher than the predominant existing building types, our model may classify as underdeveloped many lots which would appear fully developed if viewed from the curb.

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[7] For more information about Special Districts, see www.nyc.gov/html/dcp/html/zone/zh_special_purp_dist.shtml.

[8] For more information about New York's Inclusionary Housing Areas, see www.nyc.gov/html/dcp/html/zone/zh_inclu_housing.shtml.

[9] We have observed many clerical and other unexplained errors in RPAD, though we do not believe them to be widespread enough to meaningfully distort our results.

Our model does not seek to identify only those lots which are conspicuously vacant or underused.

We limit our analysis to tax lots in residential or mixed use zoning categories because other zoning districts, which in most cases do permit residential construction, often have multiple maximum FARs, dependent on the use (e.g. commercial or residential).[10] Because the underdevelopment evaluation compares a lot's existing development to the maximum development capacity, having multiple maximum capacities dependent on use would introduce subjectivity to the analysis, forcing us to choose one of multiple permitted uses as our yardstick. Because residential zones contain about 90% of the City's residential units, our omission of areas with commercial and manufacturing zoning classifications does not exclude many of the City's traditional residential neighborhoods.

Matching 2003 Lots to 2007 Lots

The second step of our analysis uses a GIS overlay process to match the geometry of all 2003 tax lots with unique land areas to the tax lots existing in 2007. In general we use BBL numbers to match lot and building characteristic information in RPAD to GIS and other data sources, and from one year to another. BBL numbers and tax lot characteristics are not completely static, however. In any given year, a tax lot may undergo a merger with adjacent lots, be subdivided into multiple lots, change BBL numbers or undergo any combination of these changes, resulting in a change to the official map of tax lots.[11]Any of these changes makes accurately tracking the affected parcel of land across time through its BBL alone virtually impossible. While the proportion of tax lots subject to such a change in any given year is typically small,[12] precisely because real estate development in New York City often involves lot assemblage, subdivision and condominium formation, each of which results in a tax map change, dropping these lots from longitudinal studies would significantly limit our ability to observe development activity.

To address the challenge posed by tax map changes, our GIS overlay process uses the geographic boundaries of all 2003 tax lots and 2007 tax lots to match 2003 lots to 2007 lots (and 2007 RPAD data). By decomposing lots into components based on overlapping 2003 and 2007 lot boundaries, we create a system that determines whether each parcel of land identified with a BBL number in 2003:

[10] For example, the zoning district C5-3, the district that covers the site of the Empire State Building, permits commercial buildings with a maximum FAR of 15 and residential buildings with a maximum FAR of 10.

[11] The New York City Department of Finance now makes tax maps (and tax map changes going back to 2008) available through its Automated City Register Information System, accessible at www.nyc.gov/html/dof/html/property/property_info_taxmaps.shtml.

[12] In Manhattan, for example, for each year from 2003 to 2006, between 0.6% and 1% of all blocks had a different number of tax lots from one year to the next, the result of lot mergers and subdivisions.

(1) Remains unchanged;

(2) Changes BBL number but otherwise remains unchanged;

(3) Merges with other parcels of land to form a new tax lot (with either a reused existing BBL number or a new one);

(4) Is subdivided into multiple new tax lots (with all new BBL numbers or with new BBL number(s) and reuse of the original for a new, smaller lot); or

(5) Is merged with adjacent tax lots and immediately subdivided into new tax lots, none of which coincides with any of the original lots (a multi-lot redraw).

A more detailed description of the GIS overlay process is attached as Appendix III.

Reevaluating 2003 Sites in 2007 to Determine Redevelopment Status

Our third step is to use the results of the GIS matching process and 2007 RPAD to determine whether each underdeveloped 2003 lot was redeveloped as of 2007. In general, we classify a lot as "redeveloped" if, as of 2007, the building area on the lot is more than 25% greater than the building area reported in 2003. We use this 25% threshold to capture significant building expansions or replacements without including minor data corrections in RPAD or minor building additions. We also conducted analyses using 10% and 20% thresholds, but these alternative methodologies did not produce results that were substantially different from our adopted threshold. We do not include a lot's "underdevelopment" status (whether or not its built square footage is less than 50% of the maximum allowed by zoning) in 2007 as part of our "redeveloped" determination because many tax lots change zoning designations between 2003 and 2007 resulting, in many cases, in changes to the maximum FAR. In other words, we classify a lot as "redeveloped" if it increases in building area by more than 25%, even if in 2007 it would still be classified as "underdeveloped" by our 50% threshold standard, were we to re-test it.

For tax lots in our underdeveloped 2003 sample for which our GIS matching process reveals no geographic changes, the reevaluation in 2007 is a straightforward comparison of the building areas shown in 2003 and 2007 RPAD. For lots that have undergone lot mergers and subdivision we define rules to determine whether or not we classify the 2003 lot as redeveloped:

- If a 2003 tax lot has, by 2007, merged with one or more adjacent lots, we classify the 2003 lot as "redeveloped" if the gross building area on the new, larger tax lot

in 2007 is more than 25% greater than the combined gross building area in 2003 of all the lots that merged to form the new lot.

- If a 2003 tax lot has, by 2007, been subdivided into two or more new, smaller tax lots, we classify the 2003 tax lot as "redeveloped" if the combined gross building area on the multiple lots in 2007 is more than 25% greater than the gross building area of the single 2003 lot.

We omit from this redevelopment determination almost 5% of the sample of underdeveloped 2003 tax lots we identify in the second step of our analysis because we cannot easily match them to 2007 RPAD data. These lots fall into four main groups:

(1) All 2003 tax lots that were part of multi-lot redraws, because of the complexity of the spatial matching process;

(2) All 2003 tax lots that were merged with other lots and lots that were subdivided into multiple lots if, in either case, the land area shown in RPAD for the 2003 lot(s) does not approximately equal the land area for the corresponding 2007 lot(s) (+/- 10% of the 2003 lot area); [13]

(3) All 2003 tax lots that we are unable to match to 2007 tax lots through the GIS matching process because of changes to underlying block geometry in the GIS files or because of changes to lot identification numbers made in either the 2007 GIS file or 2007 RPAD, but not made to the other data source;

(4) All tax lots that in 2007 are no longer located in a residential zoning district, either because of a change in the zoning map, or because of a correction or undetected error in the data source from which we obtain 2007 zoning information. [14]

Although these four groups of "unmatchable" tax lots make up less than 5% of all underdeveloped 2003 tax lots, because lot reconfigurations and renumberings are often an indication of development activity, removing these lots from our sample likely results in a disproportionately large undercount of lots we classify as "redeveloped."[15]

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[13] We have observed that in several instances, the lot area field in RPAD is not properly updated immediately after a lot subdivision or merger, resulting in such cases in a portion of lot area being erroneously double counted (in the case of a subdivision) or not counted at all (in the case of a lot merger).

[14] As more fully explained in Appendix I, we use the Primary Land Use Tax Lot Output (PLUTO) database available from the New York City Department of City Planning to determine 2007 zoning information rather than RPAD because of PLUTO's more timely inclusion of the relatively large number of zoning changes between 2003 and 2007.

[15] Of the approximately 9,700 lots omitted for these four reasons, about 3,900 were involved in a multi-lot redraw or unmatchable lot merger or subdivision. Reviewing the list of owners of the omitted lots reveals some well-known non-profit developers, confirming that many of them were likely redeveloped.

Calculating Lot-Level Descriptive Statistics

Following our identification of (i) our main sample of all residentially zoned 2003 tax lots (ii) our sample of underdeveloped 2003 residentially zoned lots and (iii) the subset of underdeveloped lots that were redeveloped as of 2007, we use RPAD and other data sources described in Appendix I to calculate a large set of descriptive statistics for each sample and certain subsets of each sample. We examine lots across four main groups of characteristics of possible relevance to lot development.

First, we look at 2003 lot and location characteristics, including: lot size; whether the lot is irregularly shaped (meaning other than rectangular); whether the lot is a corner lot; whether the lot is on a wide street or a narrow street; whether the lot is within a quarter or half mile walking distance of a subway entrance; whether the lot is within 250 or 500 feet of a public park at least a quarter acre in size; and proximity to the Empire State Building (a proxy for distance to the central business district).

Second, we look at the 2003 use of the lots in each sample, including: the building type or property use; gross square footage of building area; building age; and the percentage of maximum allowable FAR that the gross building area takes up.

Third, we look at regulatory characteristics of the lots in each sample, including: the zoning category; the applicable parking requirements (expressed as a percentage equal to the ratio of required off-street parking spaces to new units constructed); the maximum allowable FAR; whether any part of the lot was landmarked;[16] and whether the lot is in a Special District, historic preservation district, or contextual zoning district.[17] Inclusionary Housing Areas and Low Density Growth Management Areas (described below) were first created after 2003, so they are not included in the 2003 lot characteristics we report.

Finally, we look at several types of regulatory and other changes affecting lots in each sample between 2003 and 2007 (what we refer to as "lot events"). The regulatory changes we test for include: any change to a lot's zoning designation; a change to the zoning designation resulting specifically from a City-initiated planning initiative; and the addition of a lot to a Special District, contextual zoning district, historic preservation

[16] Because of data availability, we can only test whether or not a lot was a City-designated landmark as of 2007. Because several properties are landmarked each year, our data may represent a slight over-count of the number of lots that were landmarked in 2003.

[17] Contextual zoning districts regulate the height and bulk of new buildings, their setback from the street line, and their width along the street frontage, to produce buildings that are consistent with existing neighborhood character. See http://www.nyc.gov/html/dcp/html/zone/glossary.shtml.

district, Inclusionary Housing Area or Lower Density Growth Management Area (a downzoning-like regulatory program applicable to certain parts of Staten Island and, to a lesser extent, the Bronx)[18] We also test for changes to a lot's geographic configuration (whether or not it is part of a lot merger, subdivision or multilot redraw); whether a lot transferred unused development rights to other lots or was the recipient of transferred development rights;[19] whether a lot was the subject of a mortgage foreclosure filing, arms-length conveyance (i.e., a sale for more than a nominal price), or property tax delinquency of at least $500 for at least one year; and whether a lot was identified by other Furman Center research as having been conveyed between 2003 and 2006 and the recipient of a demolition permit within three years following the sale (a so-called "teardown sale").[20]

For each of our three main samples (all residential lots, all underdeveloped lots and all redeveloped lots), we also calculate these descriptive statistics while omitting a small number of lots because of their extraordinary size, atypical use or ownership, and low likelihood of redevelopment. These lots include Ellis Island, Liberty Island and Governors Island (each of which is a large, historic, publicly owned facility) and lots that RPAD identifies as cemeteries, outdoor recreation areas, land under water and military or naval installations. We refer to all of these lots as "cemetery/outdoor recreation lots" throughout Parts C and D. Because there are fewer than 700 of these lots citywide, their omission generally does not significantly impact our results, except for calculations of aggregate land area or aggregate allowable FAR.[21]

Calculating Neighborhood-Level Descriptive Statistics

After identifying underdeveloped lots across the City, we use data from a wide variety of sources to explore some of the characteristics of the neighborhoods in which they are most likely to be situated. In order to do this, we use the results of our initial steps described above to calculate the proportion of residentially zoned tax lots that were underdeveloped in each of New York City's 59 Community Districts[22] as of 2003. We then divide the Community Districts into two groups: those with underdevelopment rates

[18] For more information about the Lower Density Growth Management Area, see www.nyc.gov/html/dcp/html/sigrowth/sigrowth1.shtml.

[19] The Zoning Resolution generally permits transfers of unused development rights between adjacent tax lots and in a limited number of other specific circumstances.

[20] For information about our teardown research, see associated paper *Teardowns and Land Values in New York City*, Been et al. (2009).

[21] Ellis Island and Liberty Island do not appear to be residentially zoned as of 2009. It is unclear whether their zoning designation was different in 2003 or if their residential zoning designation in 2003 RPAD was erroneous. Because of the size of our main sample of residentially zoned lots, whether or not these two are included does not meaningfully alter any of our results in any way.

[22] The City is divided for planning purposes into 59 official neighborhoods known as "Community Districts." Each district has a Community Board whose members are appointed by the Borough President of that district and nominated by City Council members who represent the district. In this analysis, we use "neighborhood" and "Community District" interchangeably.

above and below the median rate for all Community Districts. Finally, we calculate and compare the neighborhood characteristics of each group. Where appropriate, we also highlight significant trends in relevant neighborhoods.

We use data from the 2000 decennial census to calculate most of our neighborhood-level socio-economic and demographic characteristics,[23] such as racial composition, household income, educational attainment, poverty and unemployment. The census also provides us with some housing characteristics such as housing unit density, home ownership rates and median house prices. We include other Census characteristics to gain an understanding of some other measures such as car ownership and public transit usage. Using the Furman Center's Repeat Sales Index, we also calculate house price appreciation for each neighborhood from 2003 to 2007. Finally, we compare levels of public investment in housing in our two groups of neighborhoods, as measured by the percentage of units (as of 2000) that were built or rehabilitated using City funds between 1987 and 2003.[24]

[23] Census Data is reported at the Sub-Borough Area (SBA), a geographic unit created by the Census Bureau to coincide as closely as possible with Community Districts. However, because SBAs are constructed from whole census tracts, their match to Community Districts is not exact. Further, there are only 55 SBAs in the City compared to 59 Community Districts. Four pairs of Community Districts were combined to create four of the SBAs.

[24] The Ten-Year Plan launched by the New York City Department of Housing Preservation and Development in 1987 and subsequently extended to 2003 supported the construction and rehabilitation of more than 200,000 housing units. Over 100 separate programs were created, using over $5 billion of City capital funds, federal rent subsidies, low-income housing tax credits, and city-owned land (Van Ryzin and Genn, 1999; Schill et al., 2002). Our measure of City investment uses a similar definition as Schill et al. (2002). Units that received State or Federal government funds in addition to City funds are included in our dataset. However, units that were funded solely with State or Federal dollars are not included. For example, Section 8 and Section 202 units are not included.

Results: Lot-Level Descriptive Statistics

In this section we describe our findings from the identification of underdeveloped and redeveloped lots described above. First, we report the percentage of different types of lots in the City as a whole and in each Borough that are "underdeveloped" (built with less than 50% of the allowable building area)[25] and "fully developed" (built with 50% or more of the allowable building area). Next we compare underdeveloped lots to fully developed lots across several lot-level characteristics, at both levels of geography. Finally, we focus on the subset of underdeveloped 2003 lots that we identify as being subsequently redeveloped by 2007, comparing the redevelopment rates for different types of lots and comparing the 2003 characteristics of underdeveloped lots that were redeveloped to those that were not.

Fully Developed and Underdeveloped Lots

Table 1 shows the breakdown of the nearly 778,000 residentially zoned lots in New York City that make up our main sample between cemetery/outdoor recreation lots,[26] fully developed lots and underdeveloped lots. The table also shows for each group of lots their aggregate land area, total permitted building capacity (as determined by our maximum allowable FAR model) and total actual building area and number of housing units, in each case, as of 2003. As shown in column 7, approximately one quarter of all residentially zoned lots in New York City were underdeveloped in 2003 by our definition. While these underdeveloped lots accounted for about 35% and 38% of all the land area and allowable building capacity in residential zoning districts, respectively, because of their underdevelopment, they made up only about 13% of the total housing units and actual building area. Cemetery/outdoor recreation lots, make up only about 0.1% of all lots in our main sample, but account for almost 8% of all residentially zoned land area and 6% of all allowable building capacity (unusable as it may be).

The percentage of residential lots that were underdeveloped is not uniform across New York's five boroughs. As shown in Table 2, less than 20% of the residentially zoned lots in Queens were built out at less than 50% of their allowable FAR, while in the Bronx this percentage is almost 40%. As a result, while the Bronx only accounts for 10% of all residentially zoned lots in our citywide sample; it contained over 15% of the underdeveloped lots. In contrast, Queens contained almost 40% of all lots but less than 30% of the underdeveloped lots. Manhattan, Brooklyn and Staten Island each had underdevelopment rates between 26 and 30%. Maps 2-6 show the underdeveloped residentially zoned lots in each borough (excluding cemetery/outdoor recreation lots)

[25] Throughout this discussion, all counts and percentages of a residentially zoned lots and underdeveloped residentially zoned lots exclude the "unmatchable" lots omitted from the third step of our analysis.
[26] Which, as described above, also include land under water, military and naval installations and Governors Island, Ellis Island, and Liberty Island.

Table 3 shows the distribution of all residentially zoned lots (excluding cemetery/outdoor recreation lots) across different categories of property use and the percentage of lots within each use category that were fully developed and underdeveloped in 2003. As shown in the table, single family homes and 2-4 family homes together constituted about 80% of all lots in the City. Of these lots, 24% and 20%, respectively, were underdeveloped. We also see that larger residential buildings (i.e. Co-ops, 5+ unit apartment and Condominium buildings) are largely built out to their zoning capacity. About 33,000 lots are classified as vacant, representing approximately 4% of all lots. As we would expect, virtually all of these were underdeveloped.[27] These lots make up only a small portion (about 16%) of the more than 201,000 underdeveloped lots shown in Table 1, however, so underdevelopment in New York City, as we have defined it, is not, by and large, due to unused land. Lots with other types of uses, including religious structures, indoor recreational facilities and parking facilities and gas stations, also had relatively high underdevelopment rates, but these uses each accounted for 1% or less of all residentially zoned lots.

As a result of the property use distribution and underdevelopment rates, of the approximately 201,000 underdeveloped lots in our main sample, about 69% were occupied by single family and 2-4 family homes and 16% were vacant. The remaining 15% was composed of lots in several less common use categories.

In Table 4, we report the distribution of all residentially zoned lots in 2003 (excluding cemetery/outdoor recreation lots) across different allowable FAR ranges and parking requirements (expressed as a percentage equal to the ratio of required parking spaces to units constructed) and the percentage of all residentially zoned lots falling into other specified regulatory categories. The table also shows the percentage of lots in each FAR range, parking requirement category or other regulatory category that were fully developed and underdeveloped. As shown in column 2, despite New York City's iconic high-rise living, about 57% of residentially zoned lots have a maximum allowed FAR of less than 1, while less than 1% of lots have a FAR greater than 6.[28] As shown in column 4, only about 18% of the lots with a FAR less than 1 were underdeveloped. Lots in higher maximum allowed FAR ranges each made up a comparatively small share of all lots, but were generally underdeveloped at much higher rates. More than half of all lots with a maximum allowed FAR of 3 or higher (the three highest groups in the table), for example, were underdeveloped in 2003. As a result of these higher rates of underdevelopment, about 60% of all underdeveloped sites are concentrated among lots with relatively high zoning capacities (i.e., with an allowable FAR higher than 1). This

[27] As shown on Table 2, our data reports that a tiny portion (0.30%) of all vacant lots are classified as fully developed (built to 50% or greater of allowable FAR). These few observations are likely the result of errors in either the property type or building area field of 2003 RPAD.

[28] An FAR of 0.5, for example, would effectively limit a regularly shaped building that occupies one quarter of a lot's land area to only 2 stories.

suggests that when underdevelopment exists, it tends to occur in areas zoned for relatively higher densities.

As shown in Table 4, more than half of all lots in residential zoning districts had a parking requirement of 100% (meaning that each newly constructed housing unit must be accompanied by at least one new off-street parking space), and the remaining lots were primarily concentrated in the groups with parking requirements of 50% and 85%. Indeed, less than 4% of lots had parking requirements lower than 50%. Of the lots with a parking requirement equal to 50%, nearly half were underdeveloped. In contrast, the groups of lots with higher parking requirements (including 85% and 100%) each had underdevelopment rates lower than the City overall (ranging between 13% and 20%). In those areas with no minimum parking requirements (the "Manhattan Core" and parts of Long Island City, Queens), about one quarter of all lots were underdeveloped.

Table 4 also shows that almost 10% of residentially zoned lots in 2003 were located in a Special District and 10% were located in a contextual district. Of both groups of lots (which are not mutually exclusive), about 30% were underdeveloped, a slightly larger share than for the City overall. Finally, only 2% of all lots were in historic preservation districts in 2003, while an even smaller share (less than 0.1%) were designated as landmarks. Interestingly, despite restrictions on redevelopment, only about 16% of the lots in historic preservation districts were underdeveloped by our definition, suggesting that these lots were concentrated in areas with a maximum FAR roughly matching their existing as-built FAR.

Table 5 compares developed lots and underdeveloped lots in our sample (excluding cemetery/outdoor recreation lots) across several lot and building-level characteristics, including proximity to certain neighborhood amenities. We see that the median lot area of underdeveloped lots is some 20% larger than developed lots (3,000 square feet compared to only 2,500). Consistent with the experience reported by the panel of New York City land use experts we convened and the relevant literature (Northam, 1971); underdeveloped lots were also more likely to be irregularly shaped. While the median gross square footage of building area on underdeveloped lots (1,400) was smaller than that for fully developed lots (2,137), median building age was almost identical (73 and 72 years, respectively). As regards our amenity proximity variables, we find that underdeveloped lots were considerably more likely to be close to subway entrances (almost 30% of underdeveloped lots are within a quarter mile of a subway entrance compared to less than 20% of fully-developed lots). This finding is particularly interesting given the current mayoral administration's interest in directing development to areas well served by public transportation. Underdeveloped lots are also more likely to be close to a park, although this difference is not as large. The median fully developed lot was developed at about 88% of the applicable maximum FAR compared to 33% for the median underdeveloped lot, a difference driven largely by our definitions of "fully developed" and "underdeveloped."

Redevelopment of Underdeveloped Lots

Of the approximately 201,000 underdeveloped 2003 lots in residential zoning districts we identified, we were able to match about 192,000 (95%) to 2007 data sources.[29] Of these "matchable" lots, almost 15,000 (8%) met our definition of "redeveloped" as of 2007. Table 6 shows the redevelopment rate for each borough. In Manhattan more than 10% of all the underdeveloped lots were redeveloped during this four year period,[30] though Manhattan contained the fewest underdeveloped lots of all five borough to begin with. Queens and Brooklyn, which had the largest number of underdeveloped lots in 2003, had redevelopment rates of 7% and 8%, respectively. The Bronx had the lowest redevelopment rate at only 6%. Maps 7-11 show the 2003 lots in each borough that were redeveloped as of 2007.

Columns 2-5 of Table 7 show the distribution across different categories of property use of all "matchable" underdeveloped lots and those underdeveloped lots that were redeveloped by 2007; column 6 of Table 7 shows the redevelopment rate of lots in each category. Roughly consistent with the distribution of all residential lots shown in Table 3, most underdeveloped lots in 2003 were single family or 2-4 family homes. About 8% of lots used for single family homes and 4% of lots used for 2-4 family homes were redeveloped as of 2007. Vacant properties, in contrast, made up only about 15 % of the 2003 underdeveloped lot sample, but had a redevelopment rate of 13%, among the highest of any property use type. As a result, vacant lots made up more than a quarter of all of the lots that were redeveloped by 2007. Mixed use buildings, industrial buildings and parking facilities/gas stations also had high redevelopment rates, but together these categories made up only about 7% of all underdeveloped lots, so their contribution to overall redevelopment activity was small.

A closer look at the vacant lot redevelopment pattern reveals considerable variation among the City's boroughs. Brooklyn, Queens and Staten Island each contained between 26 and 28% of the City's residentially-zoned vacant lots; the percentage in Staten Island is especially high given its share of total residentially zoned lots (14%). Manhattan, in contrast, only accounted for about 4% of vacant lots in the City. As shown in Table 8, about 20% of all residentially zoned vacant lots in Brooklyn were redeveloped as of 2007, accounting for over 40% of all of the vacant lots that were subsequently redeveloped citywide. This is an impressive redevelopment rate in only a four-year period and is the highest for any borough's vacant lots. At 7%, Staten Island's residentially zoned vacant lots had the lowest redevelopment rate, indicating that redevelopment activity in this borough was largely driven by other types of property.

[29] As mentioned above, the 5% of lots that we were unable to match consisted of multilot redraws, lots that were subdivided or merged but had suspect land area data, lots that we could not otherwise connect to 2007 RPAD, and lots that were rezoned to non-residential zoning categories.

[30] Our main data sources generally refer to July 1 of that year, so 2003-2007 is a four year period.

Indeed, almost 70% of the redeveloped lots in Staten Island were single family properties, a much higher share for single family than any other borough. Only about 3% of the redeveloped lots in Staten Island can be matched to our teardown sale database, suggesting that most redevelopment activity in Staten Island was the result of additions or alterations to single family homes, not the construction of new buildings.

In Table 9, we report the distribution of all "matchable" underdeveloped lots and redeveloped lots across different regulatory categories. In general, the distribution of redeveloped lots roughly tracks that of all underdeveloped lots, although we observe a relatively high redevelopment rate for lots with the most restrictive land-use regulations (maximum allowable FAR less than 1 and parking requirement equal to 100%, although these two restrictions are likely to be highly correlated geographically). In no category is the redevelopment rate above 10%. In general, lots with higher allowable FAR have lower redevelopment rates, perhaps suggesting relatively high expense or difficulty involved in redeveloping such high density zoned lots in our relatively short analysis period. While landmarked properties and those in historic preservation districts do have relatively low redevelopment rates, their relative insignificance in our sample is conspicuous: as discussed above, together they make up less than 2% of all underdeveloped 2003 residentially zoned lots.

In Table 10, we compares lot characteristic of the City's underdeveloped lots that were redeveloped by 2007 to those that were not redeveloped. Previously, we noted that underdeveloped lots were larger than fully-developed lots; here we see that among underdeveloped lots, those that were subsequently redeveloped were generally larger than those that remained underdeveloped. However, we see little difference in the redevelopment rates based upon the other characteristics we tested (e.g. irregular or corner lots, or near subway entrances or parks).

Table 10 also shows that the median building area of lots that were later redeveloped (976 square feet) was significantly smaller than that on lots that remained underdeveloped (1,468 square feet). Similarly, the lots that were subsequently redeveloped as of 2007 tended to be built out at a lower FAR in 2003 than those that remained underdeveloped. Given the typically lower demolition costs of smaller structures and the higher presumed increase in value that would result from their redevelopment, these findings are not surprising.

Tables 11 shows the percentage of (a) fully developed lots, (b) underdeveloped lots that remain underdeveloped and (c) underdeveloped lots that were redeveloped by 2007, that experienced different types of lot events between 2003 and 2007. The most conspicuous differences between the three groups of lots are the rates at which they underwent lot geometry changes, were conveyed in arms-length transfers and were subjects of teardown sales. About 14% of all 2003 underdeveloped lots that we identified as having been

redeveloped as of 2007 either merged with an adjacent lot or were subdivided into multiple new lots (the latter accounting for about two thirds of such events). For fully-developed lots and underdeveloped lots that remained so, less than 1% experiences such a change. This is not surprising, given the role of assemblage and subdivision in redeveloping lots that were first subdivided several decades ago for very different patterns of development.

Similarly, we matched about 5% of all redeveloped lots to our database of teardown sales. As expected, the percentage of fully developed lots we matched was close to zero, and the percentage for underdeveloped lots that remained so was well below 1%, suggesting that teardown sales occurring during this time period almost always targeted underused lots and were generally followed through with new development within only a few years.

Finally, more than 40% of all redeveloped lots were transferred in arms length conveyances between 2003 and 2007, compared to only 13% of underdeveloped sites that remained so and 15% of fully developed lots. For redeveloped lots, this relatively large percentage reflects both sales of underdeveloped lots from landowners to developers and sales of newly developed homes from developers to homebuyers.

To further unpack the role of lot events in redevelopment, Table 12 shows the number of underdeveloped lots and redeveloped lots affected by each type of lot event and the resulting redevelopment rate. Consistent with our interpretation of Table 11, we observe that a vast majority of underdeveloped lots that experienced subdivisions or mergers between 2003 and 2007 were, in fact, redeveloped by 2007. The same is true for the nearly 1,000 teardown sales we match to our sample of underdeveloped lots. Of the almost 29,000 underdeveloped lots that were conveyed in arms length transactions during this period, more than 20% were redeveloped by 2007, a rate much higher than the 8% redevelopment rate observed for all underdeveloped 2003 lots. While receiving transferred development rights and being added to an Inclusionary Housing Area also are also associated with a relatively high redevelopment rate, only a small number of underdeveloped lots were affected by these types of lot events.

With some minor exceptions (e.g., inclusion in a Special District or historic preservation district), we observe from our descriptive statistics no clear connection between changes in land use regulations and redevelopment rates. Lots affected by any rezoning were redeveloped at rates very close to the redevelopment rate for all underdeveloped lots. However, our measure of rezoning, a binary variable signifying if a lot has been part of any rezoning, does not capture the motivation and aims of the rezoning effort. We know that a vast majority of underdeveloped lots that were rezoned were done so as part of City-initiated rezoning programs. However, only some of these rezonings were designed to increase development by increasing allowable FAR; many others were designed to

protect the scale and low density of existing neighborhoods by reducing allowable FAR and preventing redevelopment not defined as "contextual." Further, it is difficult to separate out the causality of these policy interventions as some are initiated as a result of pre-existing development patterns and some are directed at incentivizing new development patterns. In related research we plan to use our geocoded database of tax lots to identify and test separately these two types of rezonings to better understand the intersection of zoning changes and redevelopment.

Results: Neighborhood-Level Descriptive Statistics

In this Section, we first describe general patterns of underdevelopment by Community District. Next we present results from correlation analysis aimed at further investigating the relationship between underdevelopment and redevelopment rates and other neighborhood characteristics. Finally we report key differences between the group of Community Districts with relatively high underdevelopment rates and the group with low underdevelopment rates in terms of socio-economic, demographic and other characteristics.[31]

In order to investigate some of the neighborhood characteristics associated with underdevelopment and subsequent redevelopment, we first divide the city into neighborhoods with above and below median development rates. Thus, we compare the 30 Community Districts with the highest percentages of underdeveloped residentially zoned lots to the 29 Community Districts with the lowest percentages of underdeveloped lots. For all 59 Community Districts, the median percentage of residential tax lot underdevelopment was 28.6% in 2003. A list of Community Districts in both groups and the rates of underdevelopment for each Community District is shown in Table 12.

Map 12 shows all of New York City's Community Districts and indicates which quartile of underdevelopment rate each is in (higher underdevelopment rates are indicated by the two darker shades). As shown in the map, we see a high degree of geographic concentration for both types of neighborhoods. For instance, every Community District in Staten Island and all but one in the Bronx had above median rates of underdeveloped lots while only one in Queens and two in Manhattan fell into this category. Only in Brooklyn was there a more mixed picture; however, most districts there had higher than median underdevelopment rates. We note, however, that despite this concentration, there is great diversity among the Community Districts within each group (high underdevelopment rate and low) in terms of all of the characteristics discussed below.

As mentioned above, the Bronx had the highest overall rate of underdevelopment of the five boroughs at nearly 40% of its residentially zoned tax lots. Looking within the Bronx, six of its Community Districts (all situated in South and Central Bronx) had an underdevelopment rate in excess of 60%. This group, along with Brownsville, represents the group of neighborhoods with the highest rate of underdevelopment in the City as of 2003. On the opposite end of the spectrum, Community Districts in southern Manhattan

[31] Our use of Community Districts as a geographical basis of analysis is consistent with other Furman Center research. While some data for our socio-economic and demographic analyses are available at smaller levels of geography (e.g. census tract), other data are only available at Community District or Sub-Borough Area (SBA) levels. Therefore, we restrict our neighborhood analysis to a common measure as data at smaller levels of geography can be aggregated up but some Community District-level data can not be disaggregated.

and Central Queens had the lowest rates of underdeveloped lots; only one neighborhood in Queens, Rockaway/Broad Channel, had an underdevelopment rate exceeding 30%. The only Manhattan neighborhoods that exceeded the median are Central and East Harlem. Underdevelopment rates in Brooklyn show less variability, with all but five neighborhoods falling in the range of 20-40%, but these neighborhoods are divided between the above-median underdevelopment group and the below-median group because they straddle the median rate of all Community Districts. Each of the three Staten Island neighborhoods had above median rates of underdevelopment, but at between 28.7% and 30.2%, the differences were minor.

For New York's 59 Community Districts, the median percentage of underdeveloped lots that were redeveloped by 2007 was 6.99%. Map 13 shows all of New York City's Community Districts and indicates which quartile of redevelopment rate each is in (higher redevelopment rates are indicated by the two darker shades). Closer analysis indicates that there is little relationship between those neighborhoods with higher than median rates of underdevelopment and areas that saw above median rates of redevelopment.[32] Looking at our socio-economic, demographic and neighborhood characteristics indicates that the only variables with a significant relationship with neighborhood redevelopment rates are median house values and vacancy rates reported in the 2000 census.[33]

Socioeconomic Characteristics of High and Low Underdevelopment Neighborhoods

Turning to socioeconomic data, despite the diversity of neighborhoods represented within each of the two cohorts of Community Districts, Table 13 shows clear overall difference between them. Those neighborhoods with above median rates of underdeveloped lots in 2003 tended to exhibit socioeconomic characteristics that were lagging. For instance, the average median household income (in 2007 dollars) for the former group (weighted by the number of households in the component census tracts) was only about 67% of the average median income in neighborhoods with fewer underdeveloped sites.[34] Similarly, the poverty rate and unemployment rate, again as measured by the 2000 Census, were much higher in the former group than in the latter.

This divergence is also seen in the educational attainment rates for our neighborhood cohorts. While the proportions of residents with only a high school diploma were similar,

[32] The correlation between Community District underdevelopment and redevelopment rates at R= -0.13, shows a slightly negative relationship between the two variables; however, we also find that this is not significant at the 10 per cent level.

[33] Both relationships are positive, indicating the areas of higher median house prices and higher vacancy rates (as per the Census 2000) are positively related to areas of higher redevelopment. However, the correlations are relatively small at R=0.22 and R=0.39 respectively.

[34] The reported median is the household-weighted average of the median incomes for each Community District in each group.

the neighborhoods with fewer underdeveloped lots had twice as many college graduates per capita as the neighborhoods in the other group. This gap in educational attainment extends to the performance of students still in school as of 2000. As reported by the New York City Department of Education, only a quarter of students in the median high-underdevelopment rate neighborhood performed at or above grade level in math and only a third performed at or above grade level in English. This compared with two-fifths and nearly one-half of students respectively in the median low-underdevelopment rate neighborhood.

We also observe that households in the neighborhoods with more underdeveloped lots were less likely to own a car and more likely to be public transit users for their commute. This is not surprising, given the socio-economic differences, though proximity to public transit could also play a role.[35]

Demographics of High and Low Underdevelopment Neighborhoods

In Table 14, we also see a divergence between the neighborhood groups in terms of demographic makeup. Neighborhoods with higher rates of underdevelopment also tend to be denser and are, in aggregate, majority black or Hispanic. In contrast, neighborhoods with lower rates of underdevelopment have, in aggregate, higher percentages of non-Hispanic white and Asian residents.

Building Characteristics of High and Low Underdevelopment Neighborhoods

In order to give our analysis a further context, we investigate some of the housing and building characteristics of the neighborhoods with above and below median underdevelopment rates. These indicators, reported in Table 15, cover a wide variety of characteristics related to housing density and appreciation and the predominant tenure type. We find that, unlike population densities, housing unit density does not differ markedly between the neighborhood groups (the higher underdevelopment cohort was slightly more dense in 2000). Perhaps unsurprisingly, given the economic characteristics outlined above, the average median house price (reported by the 2000 Census) was also lower for the high-underdevelopment rate cohort of neighborhoods. However, according to the Furman Center Housing Price Appreciation, these neighborhoods recorded slightly higher rates of appreciation during our study period.

[35] Although, when we tested the relationship between subway proximity (percentage of units in a Community District within half a mile walk from a subway station entrance) and underdevelopment rates, we found that the relationship, while positive, was not significant at the 10% level.

Using data provided by the New York City Department of Housing Preservation and Development, we estimate the rate of City capital investment in each of our Community Districts. We see that almost 10% of the building stock in the neighborhoods with more underdeveloped lots received City capital investment. In contrast, the building stock in the neighborhoods with fewer underdeveloped rates received almost no City capital investment.

Finally, we examine building tenure characteristics of our two types of neighborhoods. While there is no difference in the proportion of residents living in the same housing unit as five years before, the homeownership rate in high-underdevelopment rate neighborhoods is much lower than that in the neighborhoods with fewer underdeveloped lots (which were also economically better off).

These results seem to suggest some geographic clustering of underdeveloped lots in areas of the city that were economically disadvantaged. As we have noted, despite these divergences, we see that there is no significant difference between the median redevelopment rates for the two cohorts and that only median price and vacancy rates had significant relationships with redevelopment.

Conclusion and Next Steps

The dataset of underdeveloped and redeveloped residentially zoned lots we have assembled offers a rich opportunity for adding to our knowledge of redevelopment in mature cities. Even though this paper represents only a first step in our investigation of this data, our initial descriptive analysis yields some important results. We observe that more than a quarter of all residentially zoned lots in New York City were underdeveloped in 2003 (i.e., were built out at less than 50% of their zoning capacity). Even with this conservative definition of "underdeveloped", we see that vacant lots, the most visible example of underdevelopment, made up only about 15% of these lots. In fact, most underdeveloped lots were occupied by 1-4 family houses, the dominant residential property types in the City. We calculate that between 2003 and 2007, approximately 8% of all underdeveloped lots increased in building area by at least 25% (a sign of significant redevelopment of such lots). Finally, we confirm that there is wide variation in underdevelopment and redevelopment from one neighborhood to another, but neighborhoods with the most underdevelopment tended to be poorer and have higher concentrations of racial minorities.

We hope to extend our inquiry in several ways. First, regression analysis will allow us to estimate the significance of individual lot and building attributes and neighborhood characteristics in the probability that a lot was underdeveloped and, if so, whether it was redeveloped in the subsequent few years. Second, with building permit data and more recent versions of RPAD we can revisit the lots that were redeveloped as of 2007 and analyze the characteristics of the buildings that resulted from this redevelopment. In doing so, we can differentiate between new buildings and building expansions and can calculate the number of housing units that were added by these redevelopments. Finally, we hope to refine our methodology by including additional lot characteristics and more lots that underwent boundary changes during our study period, to increase the sample of redeveloped lots.

We also plan to supplement our quantitative analysis by interviewing a sample of property owners to better understand their individual redevelopment decisions. Although impossible to undertake at a large enough scale to represent all lots in a city as large as New York, such qualitative work will add to our understanding of non-property factors (e.g., legal disputes, lack of interest) that could contribute to underdevelopment, as well as a more nuanced interpretation of our quantitative analysis.

Ultimately, our complete analysis should be of great value to policymakers in New York City and other urban areas. A better understanding of why some owners fail to fully develop their properties will allow for more targeted incentive programs aimed at increasing redevelopment. Identifying which areas are largely underdeveloped could point to regulatory barriers holding back redevelopment. Finally, tracking where and in

what form redevelopment occurs will allow local governments to ensure that planning initiatives and infrastructure continue to meet the needs of the evolving City.

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Table 1
Fully Developed and Underdeveloped Residentially Zoned Lots in New York City as of 2003

	All 2003 Lots	Cemeteries and Outdoor Recreation Lots[1]		Fully-Developed Lots[2]		Underdeveloped Lots[3]	
		#	% of All	#	% of All	#	% of All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of Lots	777,780	684	*0.09%*	575,706	*74.02%*	201,390	*25.89%*
Aggregate Land Area (sf)	3,924,080,873	310,837,927	*7.92%*	2,235,954,841	*56.98%*	1,377,288,105	*35.10%*
Aggregate Permitted Building Area (sf)	5,505,182,338	308,520,036	*5.60%*	3,107,843,320	*56.45%*	2,088,818,981	*37.94%*
Aggregate Building Area (sf)	3,611,677,289	12,212,673	*0.34%*	3,105,343,774	*85.98%*	494,120,842	*13.68%*
Total Housing Units	2,970,446	905	*0.03%*	2,589,481	*87.17%*	380,060	*12.79%*

[1] Includes cemeteries, outdoor recreation facilities, land under water, military and naval facilities, Governors Island, Liberty Island and Ellis Island.

[2] Lots with gross building area equal to or greater than 50% of maximum allowed FAR (excluding cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island).

[3] Lots in residential zoning districts with gross building area less than 50% of maximum allowed FAR (excluding cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island).

Table 2
Percentage of 2003 Lots that are Fully Developed and Underdeveloped, by Borough

	All 2003 Lots	Cemeteries and Outdoor Recreation Lots[1]		Fully-Developed Lots[2]		Underdeveloped Lots[3]	
		#	% of All	#	% of All	#	% of All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bronx	80,744	183	*0.23%*	48,904	*60.57%*	31,657	*39.21%*
Brooklyn	253,623	146	*0.06%*	182,721	*72.04%*	70,756	*27.90%*
Manhattan	28,062	68	*0.24%*	20,723	*73.85%*	7,271	*25.91%*
Queens	303,549	170	*0.06%*	244,927	*80.69%*	58,452	*19.26%*
Staten Island	111,802	117	*0.10%*	78,431	*70.15%*	33,254	*29.74%*
New York City	777,780	684	*0.09%*	575,706	*74.02%*	201,390	*25.89%*

[1] Includes cemeteries, outdoor recreation facilities, land under water, military and naval facilities, Governors Island, Liberty Island and Ellis Island.

[2] Lots with gross building area equal to or greater than 50% of maximum allowed FAR (excluding cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island).

[3] Lots in residential zoning districts with gross building area less than 50% of maximum allowed FAR (excluding cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island).

Table 3

Distribution of 2003 Lots[1] and Percentage Fully Developed and Underdeveloped, by Property Use

	All 2003 Lots			
	#	*Distribution*	% Fully-Developed[2]	% Underdeveloped[3]
	(1)	(2)	(3)	(4)
Single-family homes	313,509	40.34%	75.70%	24.30%
Coop buildings	5,959	0.77%	96.14%	3.86%
2-4 family homes	308,282	39.67%	79.69%	20.31%
5+ unit apartment buildings	45,772	5.89%	92.70%	7.30%
Condominium buildings	1,495	0.19%	93.58%	6.42%
Mixed use buildings	30,224	3.89%	84.15%	15.85%
Store / office buildings	14,544	1.87%	61.93%	38.07%
Religious structures	4,803	0.62%	50.07%	49.93%
Educational structures	2,243	0.29%	65.80%	34.20%
Indoor recreational facilities	820	0.11%	58.54%	41.46%
Industrial buildings	2,732	0.35%	54.58%	45.42%
Parking & Gas Stations	9,620	1.24%	9.46%	90.54%
Vacant	33,224	4.28%	0.30%	99.70%
Other	3,869	0.50%	47.40%	52.60%
All Uses	777,096	100.00%	74.08%	25.92%

[1] Lots in residential zoning districts (excluding cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island).

[2] Lots in residential zoning districts with gross building area equal to or greater than 50% of maximum allowed FAR.

[3] Lots in residential zoning districts with gross building area less than 50% of maximum allowed FAR.

Table 4

Distribution of 2003 Lots[1] and Percentage Fully Developed and Underdeveloped, by Regulatory Category

	All 2003 Lots			
	#	*Distribution*	**% Fully-Developed[2]**	**% Underdeveloped[3]**
	(1)	**(2)**	**(2)**	**(4)**
Max FAR Range:				
Less than 1	439,216	56.52%	81.86%	18.14%
1.00-2.99	240,464	30.94%	69.69%	30.31%
3.00-5.99	89,871	11.56%	49.89%	50.11%
6.00-8.99	5,570	0.72%	52.10%	47.90%
9.00+	1,975	0.25%	42.89%	57.11%
	777,096	100.00%		
Parking requirement (as % of units)				
0%	23,388	3.01%	76.97%	23.03%
20%	512	0.07%	82.62%	17.38%
30%	1,188	0.15%	64.98%	35.02%
40%	664	0.09%	72.74%	27.26%
50%	171,883	22.12%	50.73%	49.27%
66%	6,348	0.82%	86.52%	13.48%
85%	127,276	16.38%	79.71%	20.29%
100%	445,837	57.37%	81.17%	18.83%
	777,096	100.00%		
Other Regulatory Groups[4]				
In a Special district	76,119	9.80%	67.15%	32.85%
In a Contextual district	63,947	8.23%	71.85%	28.15%
In a Historic district	16,273	2.09%	83.51%	16.49%
Landmarked (as of 2007)	566	0.07%	48.23%	51.77%

[1] Lots in residential zoning districts (excluding cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island).

[2] Lots in residential zoning districts with gross building area equal to or greater than 50% of maximum allowed FAR.

[3] Lots in residential zoning districts with gross building area less than 50% of maximum allowed FAR.

[4] Categories are not mutually exclusive or exhaustive, so columns do not sum to 100% of sample.

Table 5
2003 Lot and Building Characteristics of Residentially Zoned 2003 Lots

	Fully-Developed Lots[1]	Underdeveloped Lots[2]
	(1)	(2)
Median Lot Area (sf)	2,500	3,000
Irregular Lot (%)	11.57%	17.00%
Corner Lot (%)	11.31%	11.56%
Within 1/4 Mile of Subway Entrance (%)	19.47%	28.56%
Within 500 feet of Nearest Park (%)	29.07%	35.25%
Median Building Area (sf)	2,137	1,400
Median Building Age (years)	72	73
Median % of Max FAR Used	87.50%	33.32%

[1] Lots with gross building area equal to or greater than 50% of maximum allowed FAR (excluding cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island).

[2] Lots in residential zoning districts with gross building area less than 50% of maximum allowed FAR (excluding cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island).

Table 6

Number of Underdeveloped and Redeveloped 2003 Tax Lots and Redevelopment Rate, by Borough[1]

Borough	# Underdeveloped Lots[2]	# Redeveloped as of 2007[3]	Redevelopment Rate
(1)	(2)	(3)	(4)
Bronx	30,477	1,791	5.88%
Brooklyn	68,406	4,684	6.85%
Manhattan	6,875	713	10.37%
Queens	56,004	4,698	8.39%
Staten Island	29,888	2,653	8.88%
New York City Total	191,650	14,539	7.59%

[1] Excludes 2003 lots that cannot be matched to 2007 lots; excludes cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island.

[2] Lots in residential zoning districts with gross building area less than 50% of maximum allowed FAR.

[3] Underdeveloped lots with a greater than 25% increase in gross building area from 2003 to 2007.

Table 7

Distribution and Redevelopment Rate of Underdeveloped 2003 Residentially Zoned Lots, by Property Use[1]

	All Underdeveloped Lots[2]		Redeveloped by 2007[3]		
Lot or Building Type	*#*	*Distribution*	*#*	*Distribution*	**Redevelopment Rate**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Property Use					
Single-family homes	73,292	38.24%	5,838	40.15%	7.97%
Coop buildings	228	0.12%	2	0.01%	0.88%
2-4 family homes	61,006	31.83%	2,425	16.68%	3.98%
5+ unit apartment buildings	3,241	1.69%	273	1.88%	8.42%
Condominium buildings	95	0.05%	6	0.04%	6.32%
Mixed use buildings	4,631	2.42%	513	3.53%	11.08%
Store / office buildings	5,288	2.76%	312	2.15%	5.90%
Religious structures	2,336	1.22%	73	0.50%	3.13%
Educational structures	752	0.39%	20	0.14%	2.66%
Indoor recreational facilities	326	0.17%	15	0.10%	4.60%
Industrial buildings	1,161	0.61%	153	1.05%	13.18%
Parking & Gas Stations	8,201	4.28%	938	6.45%	11.44%
Vacant	29,202	15.24%	3,788	26.05%	12.97%
Other	1,891	0.99%	183	1.26%	9.68%
	191,650	100.00%	14,539	100%	

[1] Excludes 2003 lots that cannot be matched to 2007 lots; excludes cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island.

[2] Lots in residential zoning districts with gross building area less than 50% of maximum allowed FAR.

[3] Underdeveloped lots with a greater than 25% increase in gross building area from 2003 to 2007.

Table 8

Redevelopment Rate of 2003 Residentially Zoned Vacant Lots[1], by Borough

Borough	# Vacant Lots	# Redeveloped by 2007[2]	Redevelopment Rate
(1)	(2)	(3)	(4)
Bronx	4,204	635	15.10%
Brooklyn	8,249	1,682	20.39%
Manhattan	1,182	183	15.48%
Queens	7,903	783	9.91%
Staten Island	7,664	505	6.59%
New York City Total	29,202	3,788	12.97%

[1] Excludes lots that cannot be matched to 2007 lots; excludes cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island.

[2] Vacant lots with a greater than 25% increase in gross building are from 2003 to 2007.

Table 9

Distribution and Redevelopment Rate of Underdeveloped 2003 Residentially Zoned Lots, by Regulatory Category[1]

	All Underdeveloped Lots[2]		Redeveloped by 2007[3]		
Lot or Building Type	*#*	*Distribution*	*#*	*Distribution*	**Redevelopment Rate**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Max FAR Range					
Less than 1	74,185	38.71%	6,883	47.34%	9.28%
1.00-2.99	70,477	36.77%	4,608	31.69%	6.54%
3.00-5.99	43,333	22.61%	2,843	19.55%	6.56%
6.00-8.99	2,556	1.33%	141	0.97%	5.52%
9.00+	1,099	0.57%	64	0.44%	5.82%
Parking Requirement (as % of units)					
0%	5,223	2.73%	378	2.60%	7.24%
20%	84	0.04%	1	0.01%	1.19%
30%	405	0.21%	17	0.12%	4.20%
40%	163	0.09%	15	0.10%	9.20%
50%	81,660	42.61%	5,168	35.55%	6.33%
66%	833	0.43%	52	0.36%	6.24%
85%	24,862	12.97%	1,767	12.15%	7.11%
100%	78,420	40.92%	7,141	49.12%	9.11%
Other Regulatory Groups[4]					
In a Special district	23,561	12.29%	1,679	11.55%	7.13%
In a contextual district	16,672	8.70%	1,443	9.93%	8.66%
In a Historic district	2,660	1.39%	140	0.96%	5.26%
Landmarked (as of 2007)	280	0.15%	10	0.07%	3.57%

[1] Excludes 2003 lots that cannot be matched to 2007 lots; excludes cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island.

[2] Lots in residential zoning districts with gross building area less than 50% of maximum allowed FAR.

[3] Underdeveloped lots with a greater than 25% increase in gross building area from 2003 to 2007.

[4] Categories are not mutually exclusive or exhaustive, so columns do not sum to 100% of sample.

Table 10

2003 Lot and Building Characteristics of Redeveloped and Un-Redeveloped 2003 Lots[1]

2003 Lot Characteristic	Not Redeveloped by 2007[2]	Redeveloped by 2007[3]
(1)	(2)	(3)
Median Lot Area (sf)	2,904	3,800
Irregular Lot (%)	16.71%	15.60%
Corner Lot (%)	11.21%	13.36%
Within 1/4 Mile of Subway Entrance (%)	29.13%	25.51%
Within 500 feet of Nearest Park (%)	35.04%	35.55%
Median Building Area (sf)	1,468	976
Median Building Age (years)	74	73
Median % of Max FAR Used	34.23%	24.91%

[1] Excludes lots that cannot be matched to 2007 lots; excludes cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island.

[2] Lots with a 2007 gross building no more than 25% higher than in 2003.

[3] Lots with a greater than 25% increase in gross building area from 2003 to 2007.

Table 11

Percentage of Residentially Zoned 2003 Lots[1] Affected by Indicated Property Event between 2003 and 2007

Lot Event (2003-2007)[2]	Fully-Developed Lots[3]	Underdeveloped Lots[4]	
		Not Redeveloped by 2007	*Redeveloped by 2007*[5]
(1)	(2)	(3)	(4)
Development rights recipient/zoning lot merger (2004-2005)	0.00%	0.01%	0.13%
Development Rights Conveyed (2004-2005)	0.00%	0.01%	0.00%
Lot merger	0.13%	0.14%	4.31%
Lot Subdivided	0.23%	0.06%	9.93%
Multilot Redraw	0.17%	N/A	N/A
Change in zoning designation	N/A	27.09%	27.43%
City-initiated change in zoning designation	24.78%	28.47%	29.97%
Inclusion in Special District	N/A	0.25%	0.16%
Inclusion in Inclusionary Housing Area	N/A	0.38%	0.54%
Inclusion in Contextual District	N/A	20.52%	21.86%
Inclusion in new Historic District	N/A	1.64%	1.05%
Inclusion in Low Density Growth Management District	N/A	16.43%	19.46%
Tax Delinquency	4.47%	6.89%	7.94%
Lis Pendens Filed	3.00%	3.17%	4.47%
Arms Length Sale	15.62%	12.90%	41.99%
Teardown sales (2003-2006)	0.07%	0.16%	4.66%

N/A indicates that the variable was not calculated for the indicated group of lots.

[1] Excludes lots that cannot be matched to 2007 lots; excludes cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island.

[2] Categories are not mutually exclusive or exhaustive, so columns do not sum to 100% of sample.

[3] Lots with gross building area equal to or greater than 50% of maximum allowed FAR

[4] Lots with gross building area less than 50% of maximum allowed FAR..

[5] Underdeveloped lots with a greater than 25% increase in gross building area from 2003 to 2007.

Table 12

Redevelopment Rate of Residentially Zoned 2003 Lots[1], by Property Event Type

Lot Event (2003-2007)[2]	# Underdeveloped Lots Affected[3]	# Redeveloped by 2007[4]	Redevelopment Rate
(1)	(2)	(3)	(4)
Development rights recipient/zoning lot merger (2004-2005)	36	19	52.78%
Development Rights Conveyed (2004-2005)	13	-	0.00%
Lot merger	868	626	72.12%
Lot Subdivided	1,546	1,443	93.34%
Change in zoning designation	51,972	3,988	7.67%
City-initiated change in zoning designation	54,789	4,357	7.95%
Inclusion in Special District	473	23	4.86%
Inclusion in Inclusionary Housing Area	759	78	10.28%
Inclusion in Contextual District	39,517	3,178	8.04%
Inclusion in new Historic District	3,052	153	5.01%
Inclusion in Low Density Growth Management District	31,930	2,829	8.86%
Tax Delinquency	13,350	1,155	8.65%
Lis Pendens Filed	6,269	650	10.37%
Arms Length Sale	28,959	6,105	21.08%
Teardown sales (2003-2006)	963	678	70.40%

[1] Excludes lots that cannot be matched to 2007 lots; excludes cemeteries, outdoor recreation, land under water, military & naval, Ellis Island, Liberty Island and Governors Island.

[2] Categories are not mutually exclusive or exhaustive, so columns do not sum to 100% of sample.

[3] Lots with gross building area less than 50% of maximum allowed FAR..

[4] Underdeveloped lots with a greater than 25% increase in gross building are from 2003 to 2007.

Table 13

Socio-economic Data (2000 Census) for Above and Below Median Neighborhoods

	Neighborhoods with above Median Underdeveloped Rate (2003)	Neighborhoods with below Median Underdeveloped Rate (2003)
	(1)	(2)
Median Household Income last year (2007$)[1]	38,998	57,788
% Below Poverty Line (2000)	28.08%	15.35%
% Unemployment (2000)	12.71%	7.39%
% Over 25 with a High School Diploma (2000)	48.76%	41.97%
% Over 25 with a College Degree (2000)	17.38%	34.87%
Median % of Student at/above grade Level - Math (2000)*	24.54%	41.88%
Median % of Student at/above grade Level - English (2000)*	32.42%	47.96%
% of Households with at least one car (2000)[1]	44.64%	55.81%
% of persons over 16 traveling by public transit (2000)[2]	52.23%	52.91%

*Data from the New York City Department of Education

[1]Weighted average for all census tracts in group, weighted by number of households

[2]Weighted average for all census tracts in group, weighted by population

Table 14

Demographics (2000 Census) for Above and Below Median Neighborhoods

	Neighborhoods with above Median Underdeveloped rate (2003)	Neighborhoods with below Median Underdeveloped rate (2003)
	(1)	(2)
Population Density (residents/square mile)	24,232	28,611
% Non-hispanic White	25.29%	43.33%
% Non-hispanic Black	35.75%	14.81%
% Hispanic	31.45%	23.13%
% Non-hispanic Asian	4.30%	14.43%
% Other	3.21%	4.31%

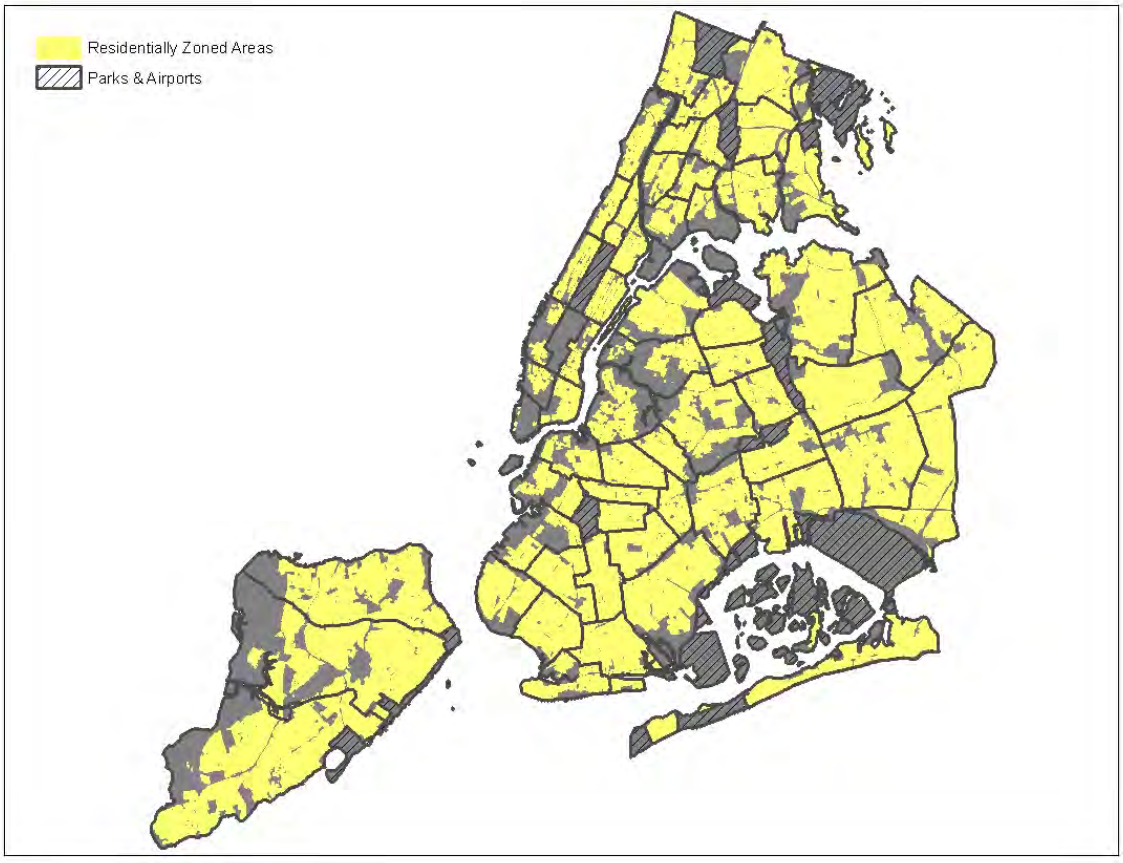
Table 15
Building Characteristics for Above and Below Median Neighborhoods

	Neighborhoods with above Median Underdeveloped rate (2003)	Neighborhoods with below Median Underdeveloped rate (2003)
	(1)	(2)
Housing Density (Housing units/square mile, 2000)	8,491	11,459
Median Reported House Price (2000 $)[1]	216,645	279,635
Median % Housing Price Appreciation (2002-2007)*	68.00%	62.10%
% of building stock in receipt of City capital investment (1987-2003)**	9.71%	0.82%
% of Persons in the same house 5 years ago (2000)	57.74%	56.32%
Home Ownership Rate (2000)	25.00%	34.10%
Vacant Unit Rate (2000)	2.55%	5.12%

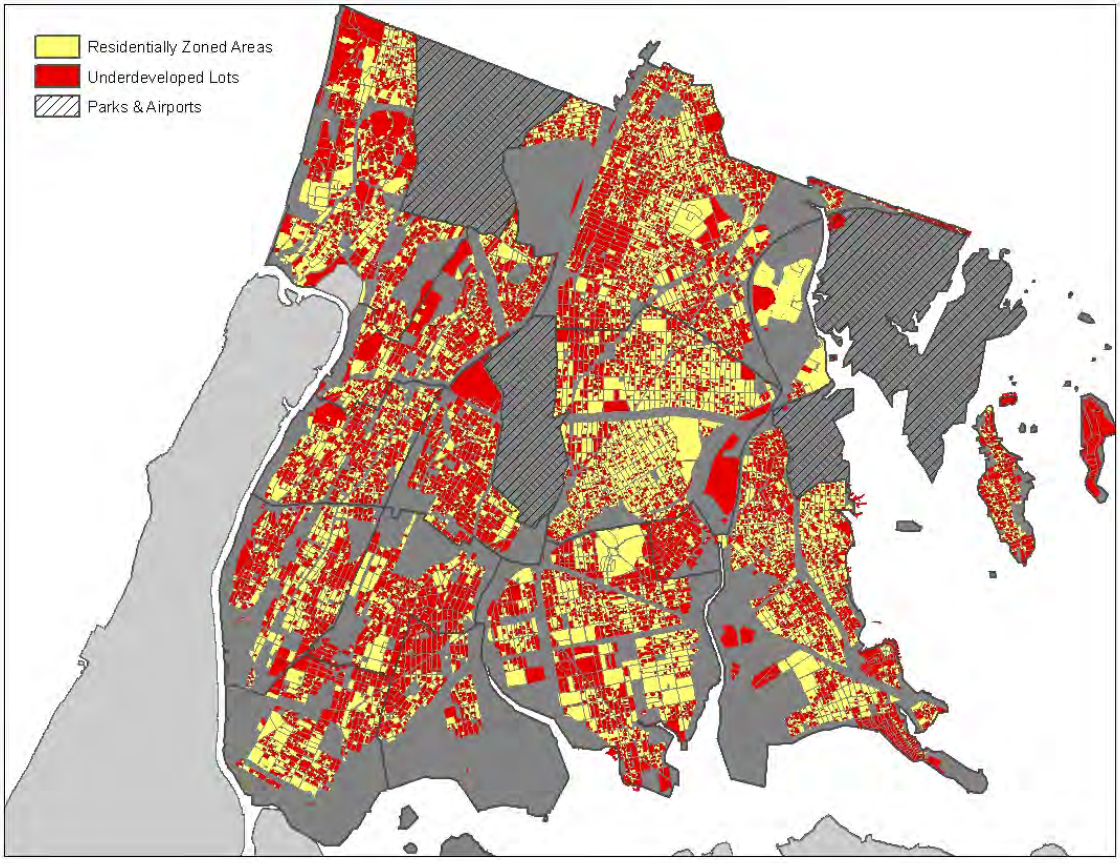
*Data from the Furman Center Housing Price Appreciation Index
**Data from City Capital Investment in Housing Dataset; percentage is of total units in 2000.

[1]Weighted average for all census tracts in group, weighted by number of households

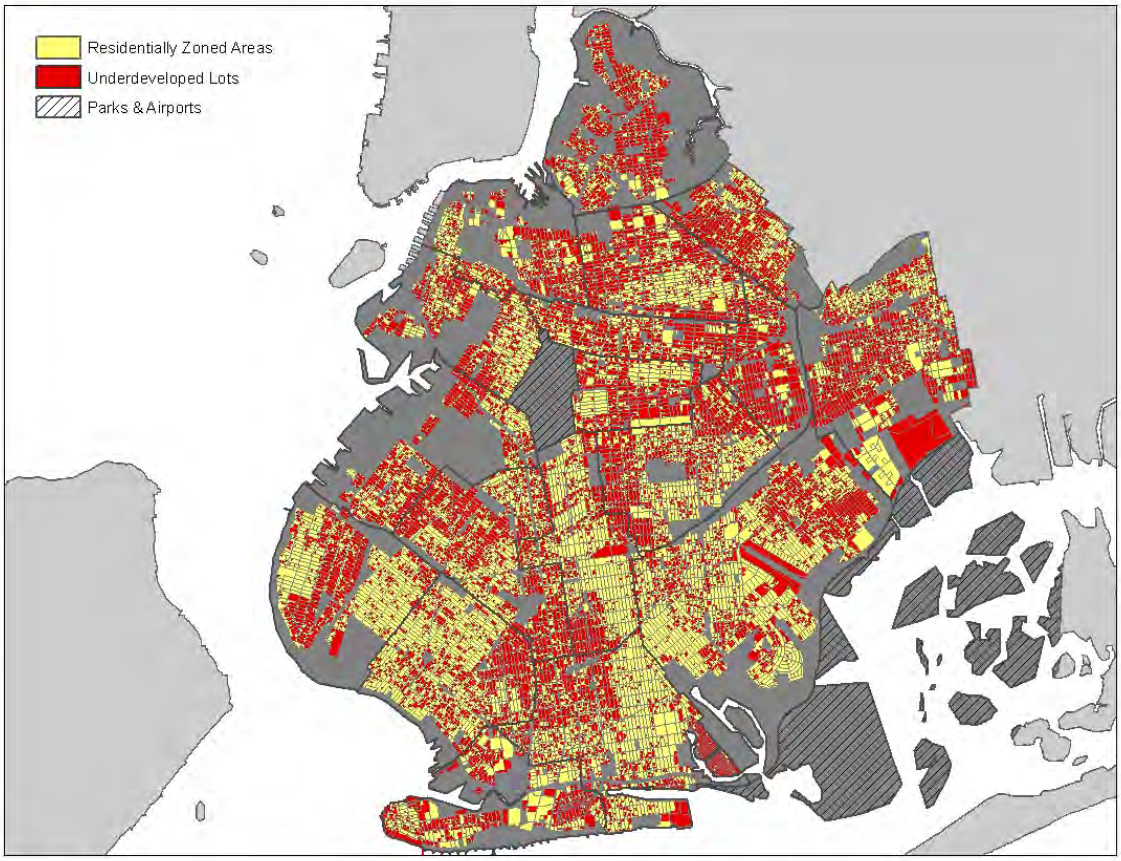
Map 1
Residentially Zoned Areas in New York City (2003)



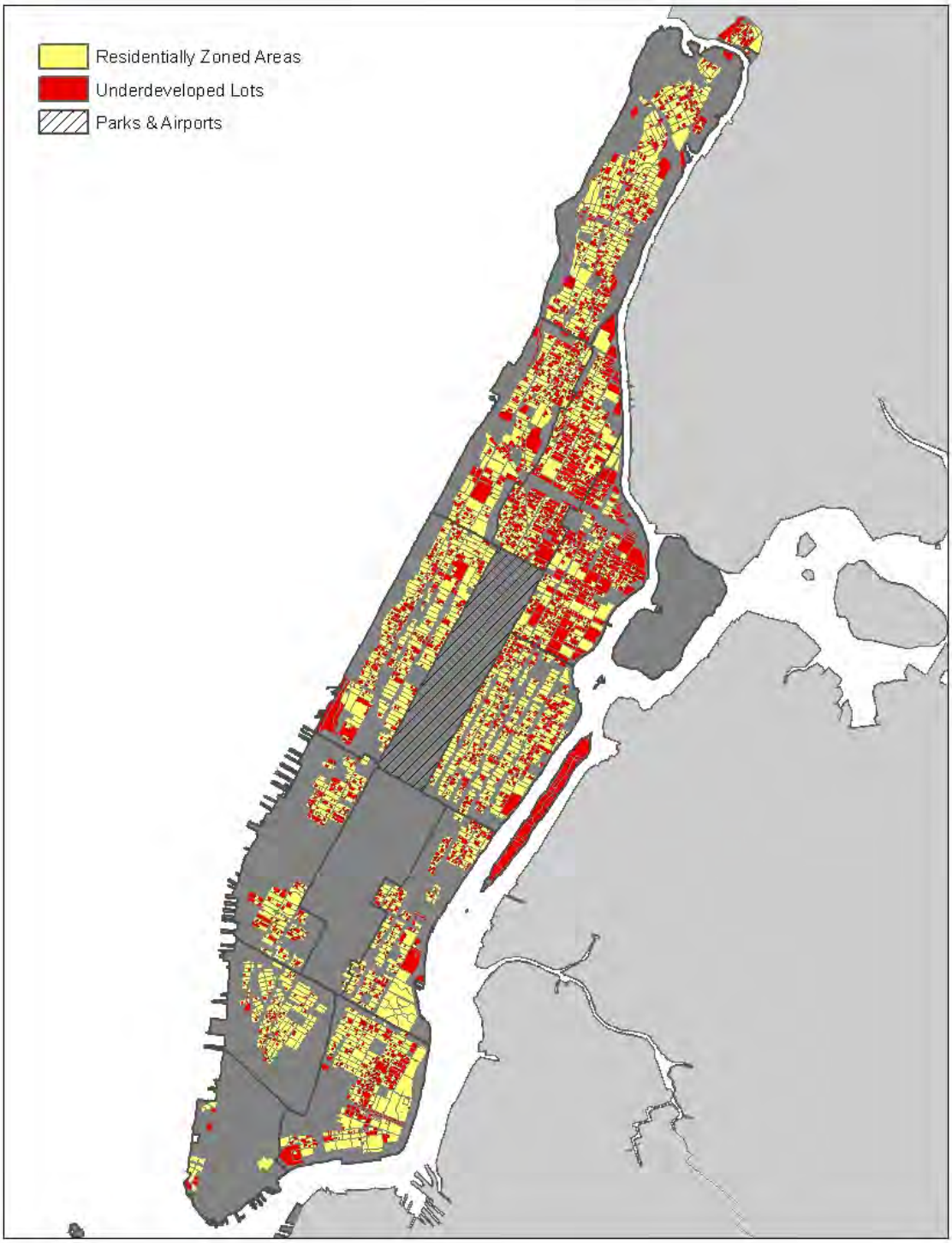
Map 2
Underdeveloped Lots in The Bronx (2003)



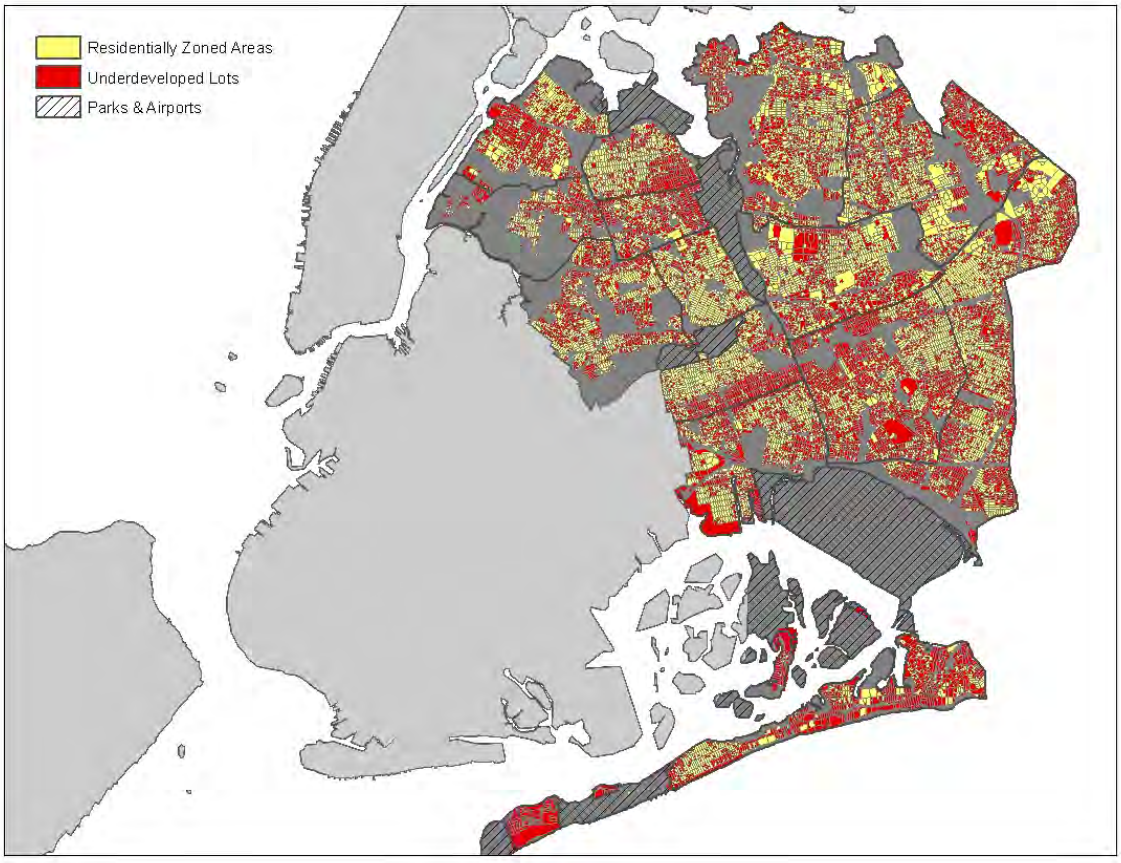
Map 3
Underdeveloped Lots in Brooklyn (2003)



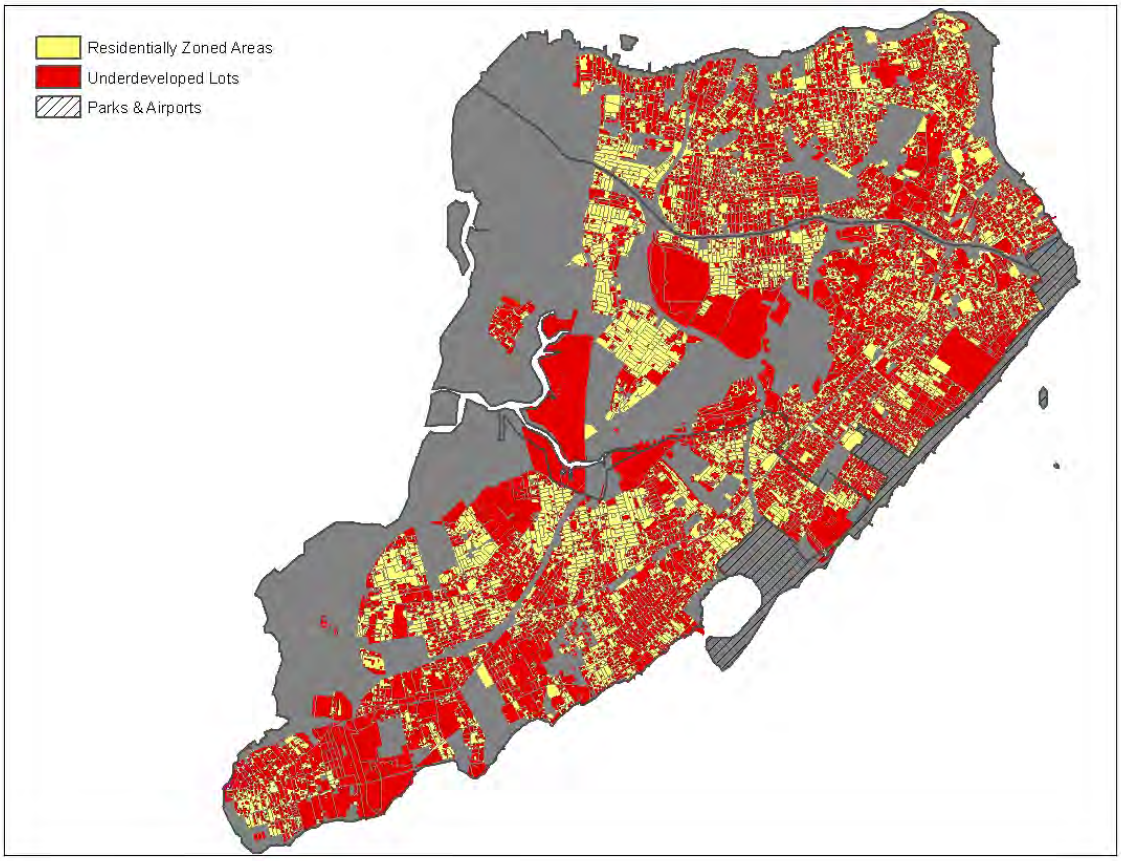
Map 4
Underdeveloped Lots in Manhattan (2003)



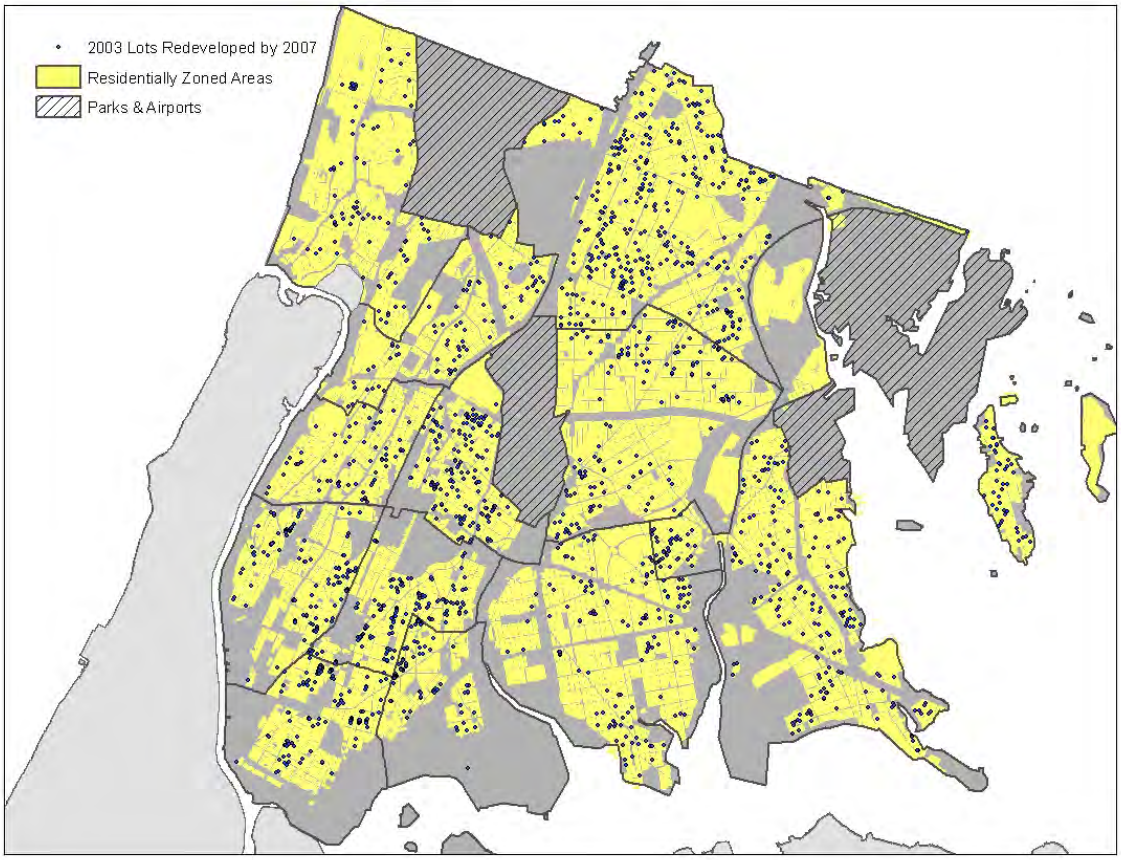
Map 5
Underdeveloped Lots in Queens (2003)



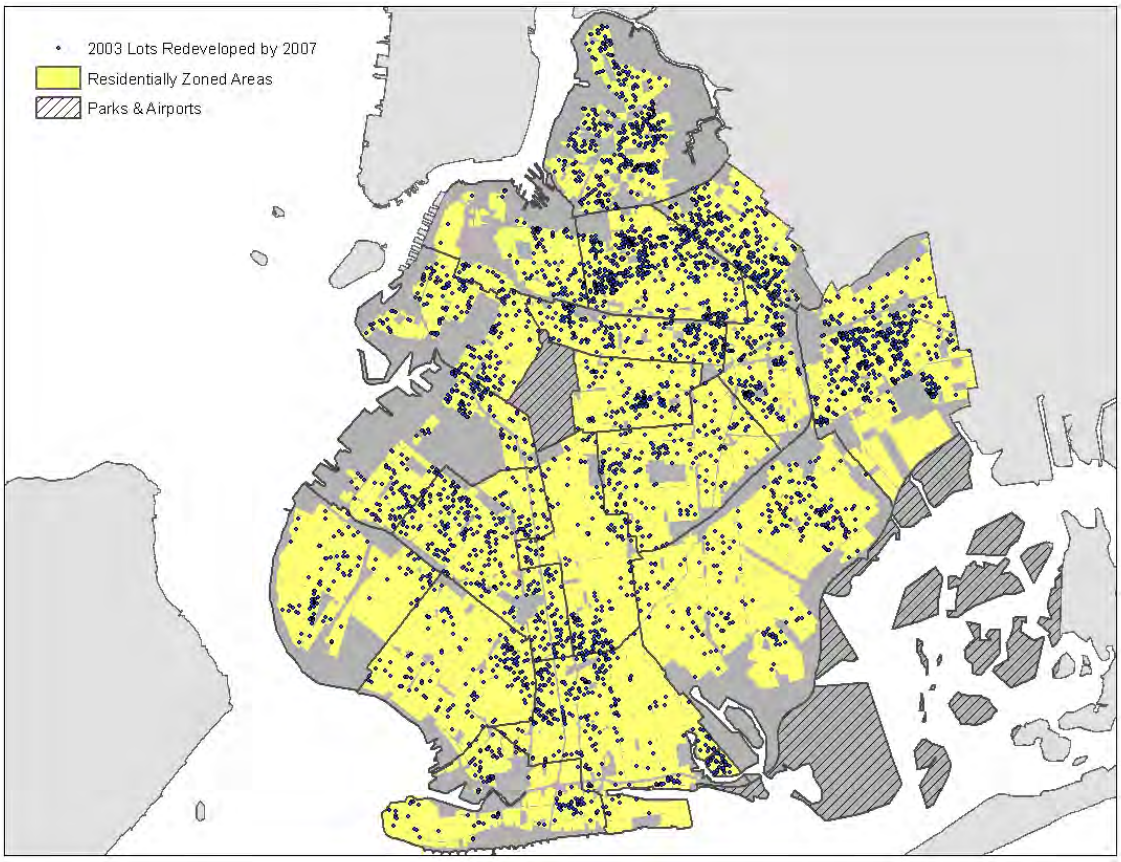
Map 6
Underdeveloped Lots in Staten Island (2003)



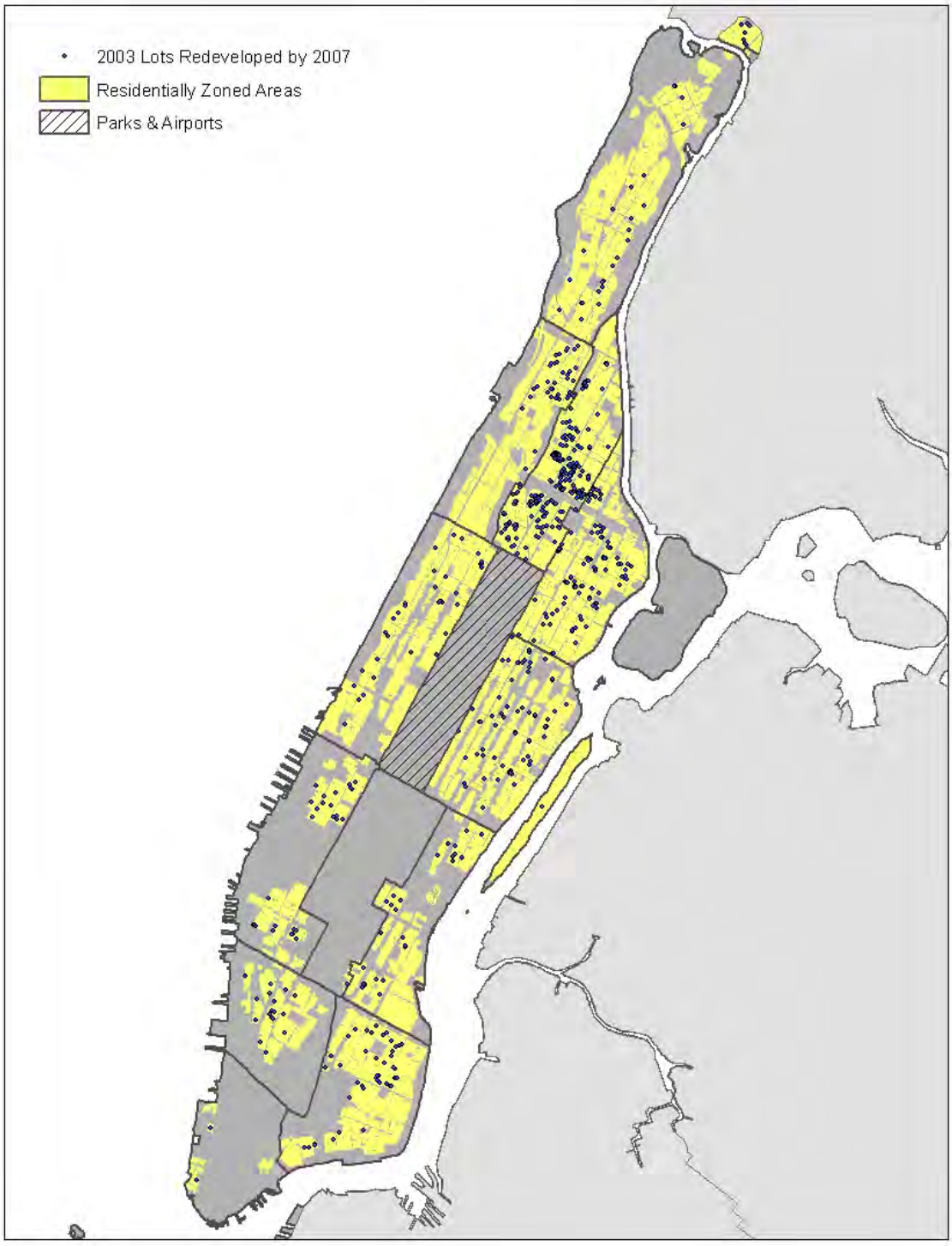
Map 7
2003 Underdeveloped Lots Redeveloped by 2007 (The Bronx)



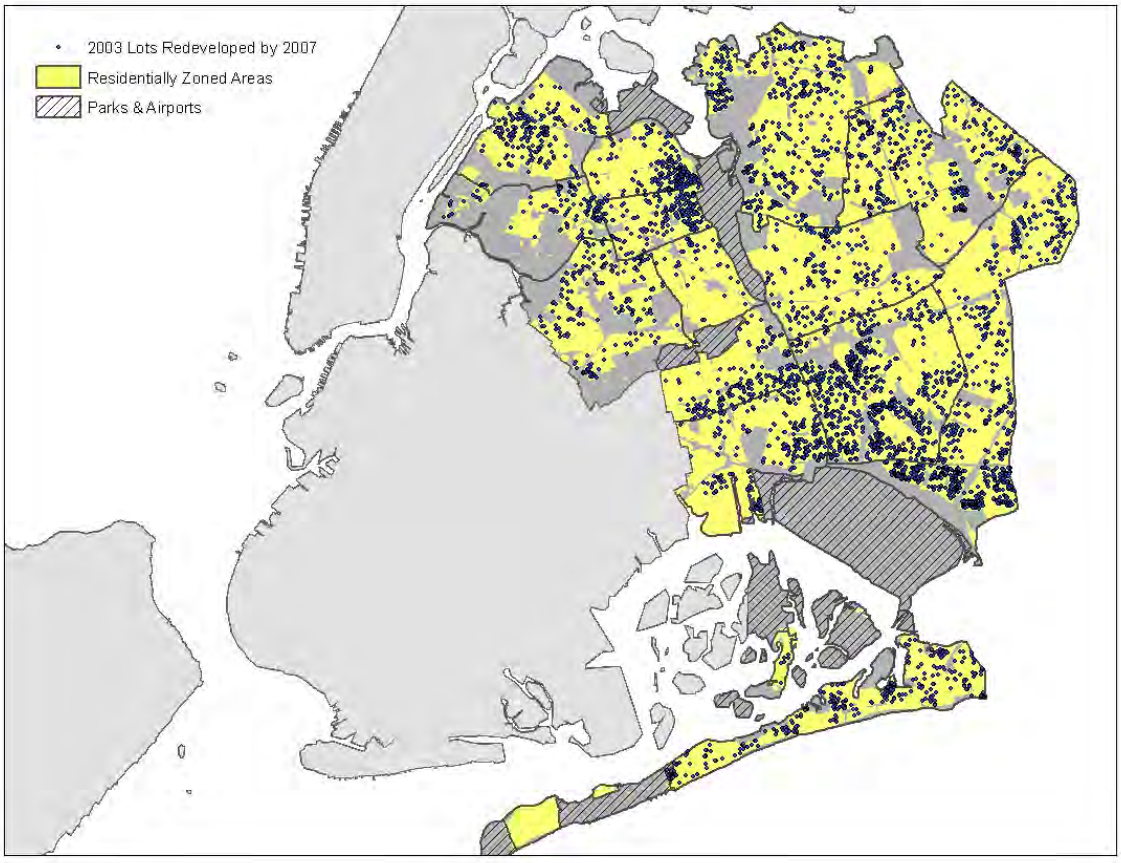
Map 8
2003 Underdeveloped Lots Redeveloped by 2007 (Brooklyn)



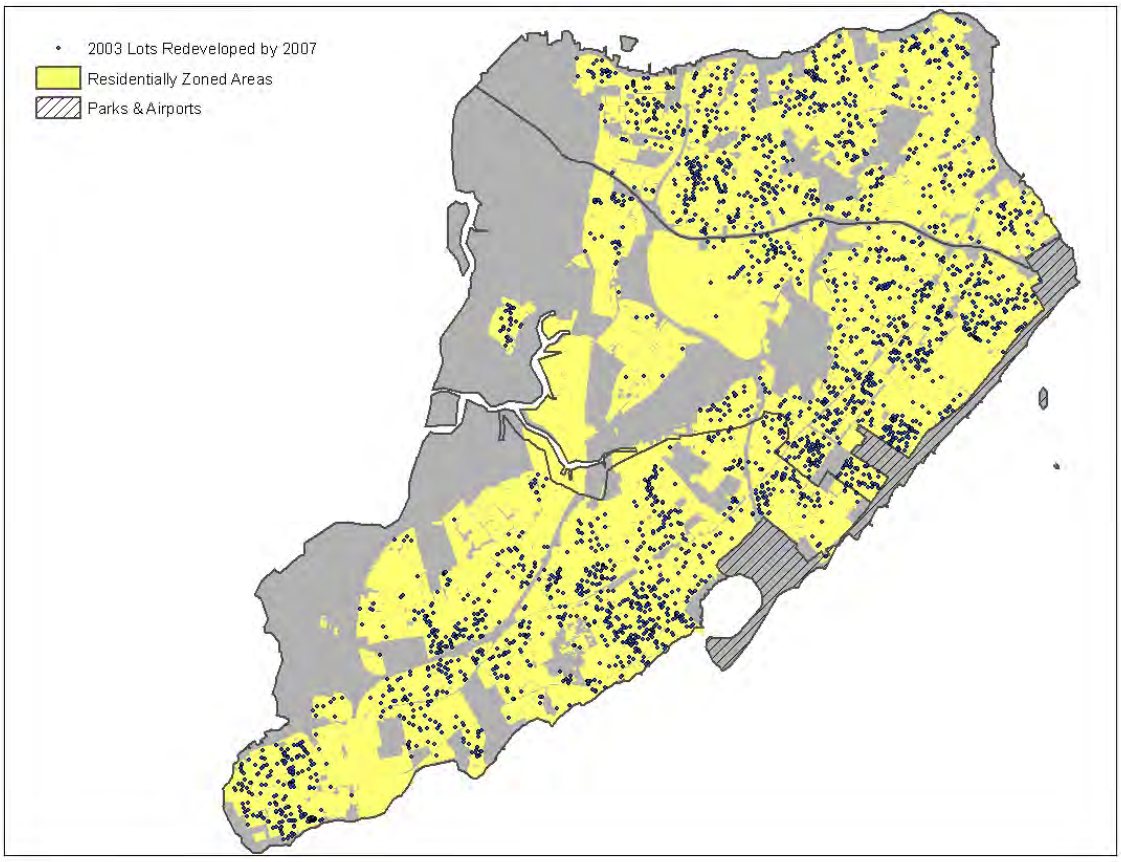
Map 9
2003 Underdeveloped Lots Redeveloped by 2007 (Manhattan)



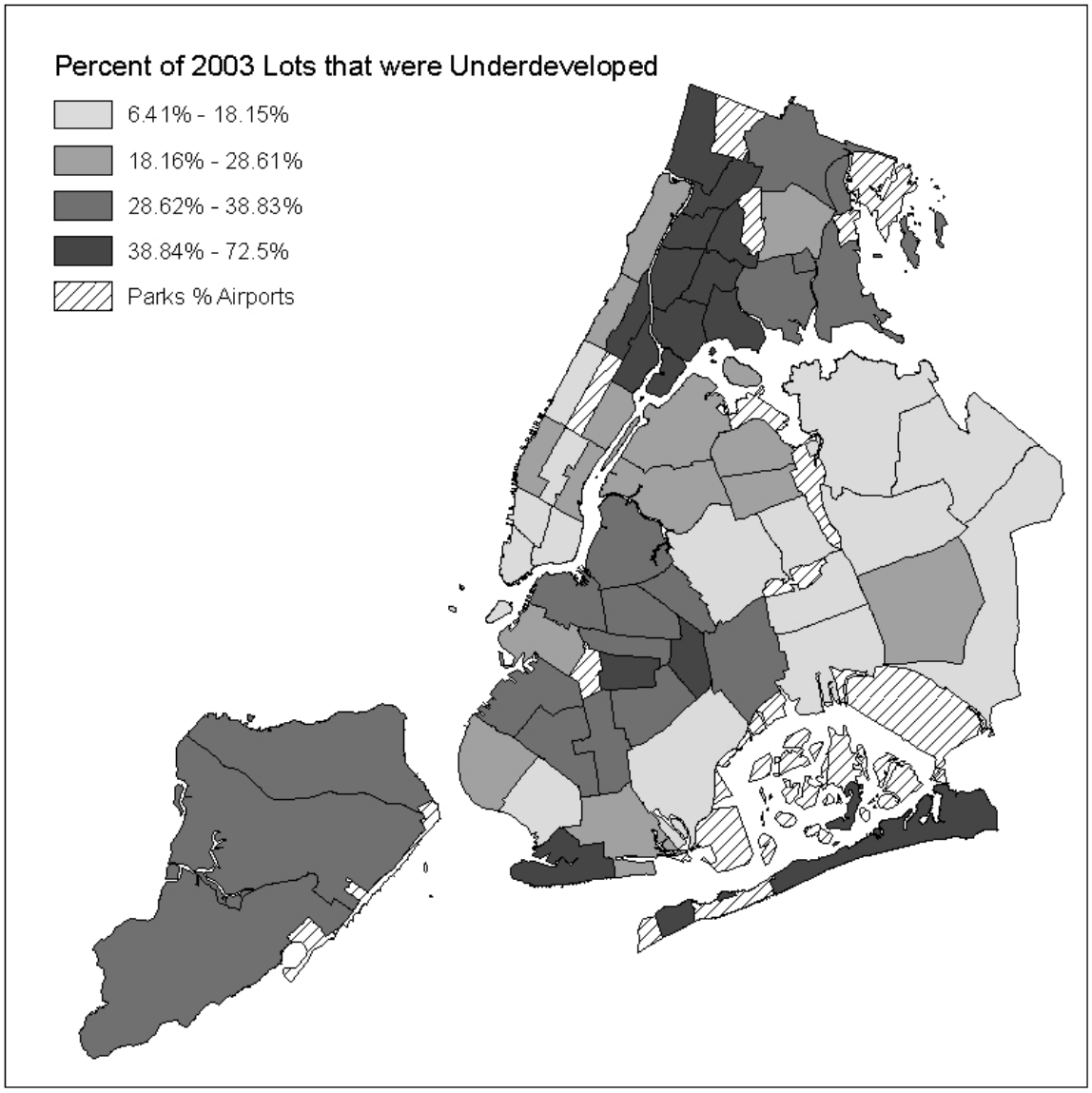
Map 10
2003 Underdeveloped Lots Redeveloped by 2007 (Queens)



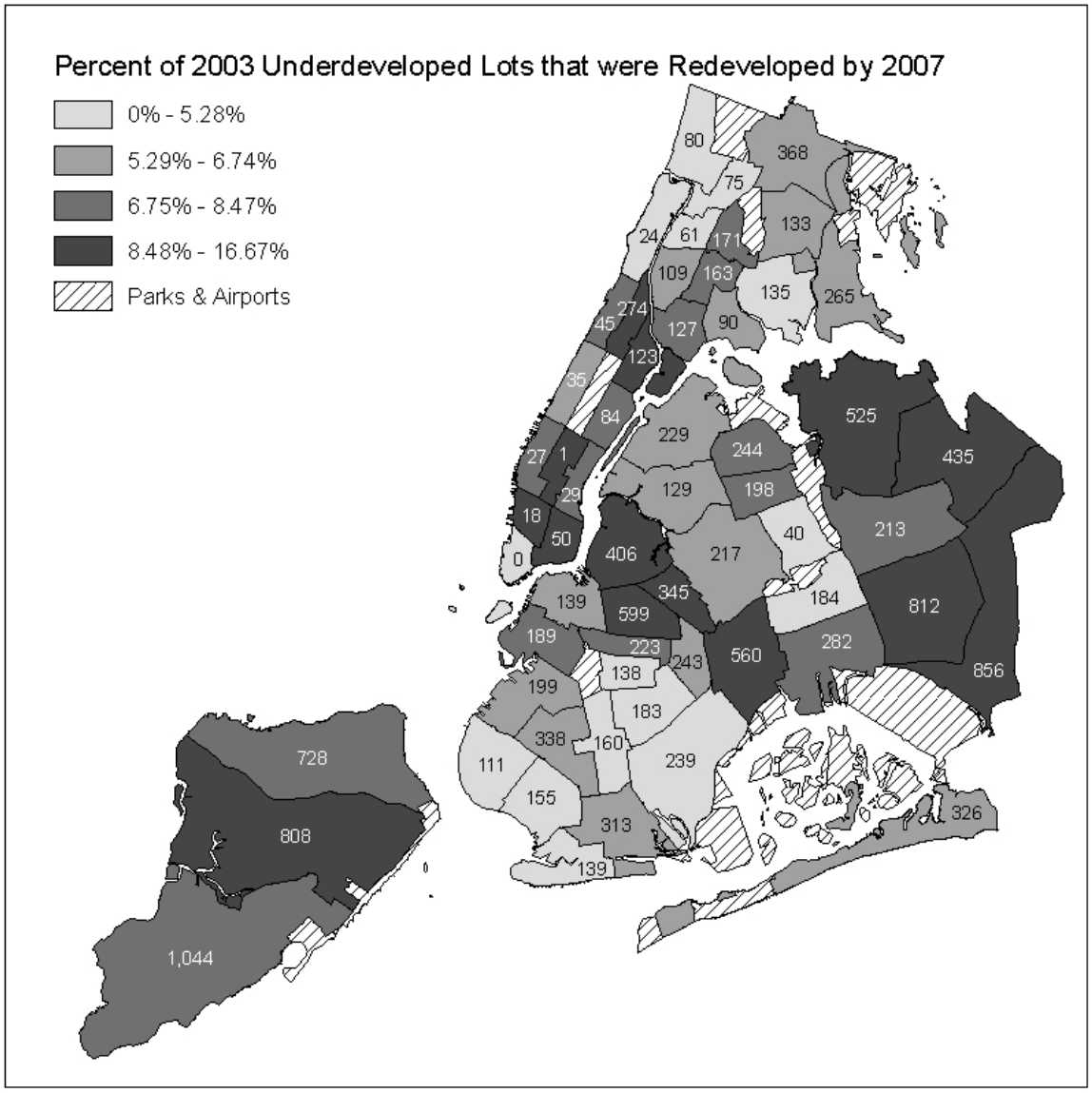
Map 11
2003 Underdeveloped Lots Redeveloped by 2007 (Staten Island)



Map 12
Percentage of 2003 Lots that were Underdeveloped (By Community District)



Map 13
Percentage of 2003 Underdeveloped Lots that were Redeveloped (By Community District) and Number of Redeveloped Lots



Appendix I -
Methodological Notes and Data Sources

Identification of Underdeveloped 2003 Tax Lots

To identify underdeveloped residentially zoned tax lots, we began with all tax lots in 2003 RPAD, and then omitted the following observations:

- tax lots not in 2003 LotInfo (i.e., lots we could not match to geographical boundaries);
- tax lots with Lot Area = 0, other than some condominium buildings, (see Section E of this Appendix I);
- tax lots with a zoning designation other than residential, mixed use with a residential component, or Battery Park City (BPC) special district;
- tax lots in BPC special district subzones B and C, which are designed for commercial and mixed use development with ancillary retail and service use;
- tax lots with a zoning designation = R10H (hotel zoning);
- tax lots with a 2003 RPAD zoning designation that does not match any zoning designation actually defined by the Zoning Resolution, unless the mismatch was the result of an unambiguously correctable typographic error in RPAD, in which case the error was corrected and the lot was retained in the sample (for example, "R4=1" was corrected to "R4-1.");
- tax lots corresponding to individual condominium units (see Section E of this Appendix I for further information about condominiums);
- tax lots in Block 1171 in Manhattan, a large block undergoing comprehensive redevelopment and complex lot boundary revisions as of 2003; and
- tax lots identified as public parks by the 2003 RPAD building class field.

For the resulting sample of 2003 tax lots, we determined underdeveloped status using the following variables:

Variable	*Data Source*
2003 Lot Area	2003 RPAD
2003 Building Area	2003 RPAD
2003 Zoning Designation	2003 RPAD
2003 Allowable FAR	Furman Center FAR Model (see Appendix II) & Furman Center GIS selections for street width and special districts

Identification of 2003 Tax Lots that were Redeveloped as of 2007

For our calculation of redevelopment status as of 2007, we omit from the sample of underdeveloped 2003 tax lots the following observations:

- tax lots that were part of subsequent lot area swaps or multi-lot redraws (Types B, E, F and G in Appendix III);
- tax lots in blocks for which geographic boundaries in 2003 LotInfo did not approximately match 2007 PLUTO and, as a result, could not be automatically spatially related;
- tax lots matched to 2007 tax lots that were not in 2007 RPAD; and
- tax lots involved in lot mergers and lots splits in which the combined lot area of the "children" lots is more than +/- 10% different from the 2003 lot area of the "parent" lots.

For the resulting sample of 2003 tax lots, we determined whether or not the tax lot was redeveloped as of 2007 using the following variables:

Variable	*Data Source*
Corresponding 2007 Tax Lot	Furman Center Spatial Matching File (See Appendix III)
2007 Lot Area	2007 RPAD
2007 Building Area	2007 RPAD
2007 Zoning Designation	2007 PLUTO
2007 Maximum Allowable FAR	Furman Center FAR Model (see Appendix II) & Furman Center GIS lot selections for street width, special districts and inclusionary housing areas

Descriptive Statistics

The 2003 lot-level descriptive statistics we report were generated by matching the BBL number for each 2003 tax lot in the applicable sample to the following data sources:

Variable	*Data Source*
Land area	2003 RPAD
Irregular lot	2003 RPAD
Corner lot	2003 RPAD
Street width	Furman Center GIS analysis

Walking distance to nearest subway station entrance	MTA Subway Stop GIS Data, Furman Center GIS analysis
Proximity to Empire State Building	Furman Center GIS analysis
Proximity to nearest park	New York City Department of Parks & Recreation GIS Data, Furman Center GIS analysis
Building area	2003 RPAD
Building age	2003 RPAD
Housing units	2003 RPAD
Building type	2003 RPAD
Assessed value	2003 RPAD
Zoning district	2003 RPAD
Special district	Furman Center GIS analysis
Contextual district	2003 RPAD
Historic district	LPC Historic District GIS Data, Furman Center GIS analysis
Landmark status	2007 PLUTO
Maximum allowable FAR	Furman Center FAR Model (see Appendix II) & Furman Center GIS selections for street width, special districts and inclusionary housing areas
Parking Requirements	2003 RPAD, Furman Center analysis of Zoning Resolution (see Appendix IV)
Percent of FAR Built	Furman Center FAR Model (see Appendix II) and 2003 RPAD

Descriptive statistics regarding "lot events" affecting 2003 tax lots between 2003 and 2007 were generated by matching the 2003 BBL number for each 2003 tax lot in the applicable sample to the data sources listed below. For changes in zoning designation, inclusion in contextual districts and inclusion in lower density growth management district, the corresponding 2007 BBL number for each tax lot in the applicable sample was also matched to RPAD 2007 to determine whether or not such a change had occurred.

Variable	*Data Source*
Lot Merger	Furman Center Spatial Matching File (see Appendix III)

Lot Subdivision	Furman Center Spatial Matching File (see Appendix III)
Multilot Redraw	Furman Center Spatial Matching File (see Appendix III)
TDR recipient/Zoning lot merger	Furman Center Development Right Transfer Database
Development Rights Conveyed	Furman Center Development Right Transfer Database
Change in zoning designation	RPAD 2003 and 2007
City-initiated change in zoning designation	City-Initiated Rezonings GIS Data
Inclusion in Special District	Furman Center GIS analysis
Inclusion in Inclusionary Housing Area	Furman Center GIS analysis
Inclusion in Contextual District	RPAD 2003 and 2007
Inclusion in new Historic District	LPC Historic District GIS Data, Furman Center GIS analysis
Inclusion in Lower Density Growth Management District	RPAD 2007
Tax Delinquency	DOF Tax Delinquency Data
Lis Pendens Filed	PDC Lis Pendens Data
Arms Length Sale	DOF Sales Data
Teardown sale	Furman Center Teardown Database

The neighborhood-level descriptive statistics reported in this article were derived by matching the applicable Community District or Sub-Borough Area (or constituent census tracts) to the following data sources:

Variable	*Data Source*
Population density	2000 Census
Household income	2000 Census
Housing density	2000 Census
Housing values	2000 Census
Price appreciation	Furman Center Repeat Sales Index
Percent over 25 with High School	2000 Census

Diploma	
Percent over 25 with College Degree	2000 Census
Percent of students performing at or above grade level - math	DofED Student Performance Data
Percent of students performing at or above grade level - English	DofED Student Performance Data
Percent of households with at least one car	2000 Census
Percent of persons over 16 years old traveling by public transit	2000 Census
Percent below poverty rate	2000 Census
Percent Non-Hispanic White	2000 Census
Percent Non-Hispanic Black	2000 Census
Percent Non-Hispanic Asian	2000 Census
Percent Hispanic	2000 Census
Percent Other	2000 Census
Percent of housing that is owner-occupied	2000 Census
Percent of housing that is vacant	2000 Census
Percent of persons in same house 5 years earlier	2000 Census
Percent of building stock in receipt of City capital investment (1987-2003)	City Capital Investment in Housing Data

Data Source Descriptions

Further information regarding each data source we use in our analysis (other than the 2000 Decennial Census) is below:

- *RPAD 2003 & 2007*

  New York City Real Property Assessment Database, a proprietary data set maintained by the New York City Department of Finance for property tax assessment purposes.

- *2003 LotInfo Tax Lot GIS Data*

  GIS shape file of tax lot boundaries based on a Department of City Planning base map; part of LotInfo, a privately marketed data product about New York City properties.

- *PLUTO 2007 and PLUTO 2007 Tax Lot GIS Data*

  Primary Land Use Tax Lot Output 2007 (PLUTO 2007) is a database created and sold by the New York City Department of City Planning containing a wide array of tax-lot level data. PLUTO contains a wide variety of information for each tax lot in the city, compiled from data held by Department of City Planning (DCP), Department of Finance (DOF), Department of Citywide Administrative Services (DCAS), and the Landmarks Preservation Commission (LPC). 2007 PLUTO also includes a tax lot basemap which we use for our 2003-2007 spatial matching process.

- *DCP City-Initiated Rezonings GIS Data*

  GIS shape file provided by the New York City Department of City Planning (DCP) of boundaries of 27 areas that were subject to large rezonings initiated by the City to implement specific planning goals.

- *LPC Historic District GIS Data*

  GIS shape file from Landmarks Preservation Commission of historic districts; includes designation date.

- *New York City Department of Parks & Recreation GIS Data*

  GIS shape files of all parks provided to the Furman Center by the New York City Department of Parks & Recreation.

- *MTA Subway Stop GIS Data*

  New York City Transit, a division of the Metropolitan Transportation Authority (MTA), provided the Furman Center location info for entries to over 450 subway stations. The Furman Center supplemented this with location information for Staten Island Railroad stations determined using GIS.

- *City Capital Investment in Housing Data*

  The New York City Department of Housing Preservation and Development (HPD) provided the Furman Center data with property-level information on all projects completed up to 2006 which existed in the HPD database. It includes not only 10 Year Plan housing but also part of the federal housing and some older (pre-1987) city-subsidized housing.

- *DOF Sales Data*

  Tax-lot level logs of property transactions provided by the New York City Department of Finance.

- *DOF Tax Delinquency Data*

  Tax-lot level logs of properties that are tax delinquent for one year or more, if the amount owed is over $500; provided by the New York City Department of Finance.

- *PDC Lis Pendens Data*

  Listings of filed *lis pendens* (notices of pendency) are purchased from Public Data Corporation, a private vendor, and analyzed by the Furman Center to identify only those *lis pendens* related to mortgage foreclosure filings.

- *Furman Center Teardown Database*

  The Furman Center used DOF sales data and New York City Department of Buildings demolition permit data to identify tax lots in existence as of 1993 that were sold after July 1, 2003 and for which a demolition permit was issued within three subsequent years.

- *Furman Center Development Right Transfer Database*

  The Furman Center used New York City's online Automated City Register Information System (ACRIS) to identify transfers of development rights from 2004 to 2006 and other zoning lot mergers during this period.

- *Furman Center Repeat Sales Index*

  The Furman Center uses DOF Sales Data to calculate a repeat sales-based index of housing price appreciation for the City, each borough and each community district.

- *DofED Student Performance Data*

  Information regarding students performing at or above grade level in math and English for grades three through eight provided by the New York City Department of Education (DofED). The data is provided at the school district level, but is aggregated by the Furman Center at the community district level.

Changes to Certain Condominium Properties

Because an individual condo unit does not have land area associated with it such that it could be considered "fully-developed" or "underdeveloped" we omit the individual condo unit BBLs from our sample. Most condominiums have a condo "billing lot" (an RPAD entry that covers the entire condominium development) as well as a series

identification number. In order to determine the underdevelopment status of condo properties, we performed the following operations with RPAD:

1. Identify all condominium series in RPAD that have a series identification number and a condo billing lot; if a condo series has no series identification number or no billing lot, it is not included in our starting sample of tax lots.
2. For billing lots with 0 for total units and/or residential units, we add up the total number of individual condominium unit lots and residential unit lots within that condo series to populate these fields in RPAD.
3. For billing lots with 0 for land area, we assign the largest land area shown for any unit within that condo series (which, in our experience, usually reflects the land area of the entire project); if all units in that series have lot area = 0, the condo is omitted from our sample.
4. For billing lots with 0 for building area, we sum the square footage of all individual condo units in that series and multiply time 1.2 to account for common areas (e.g., lobbies, hallways, elevators).

Other Methodological Notes

- There is a time gap between enactments of zoning map changes and when they are reflected in RPAD. For instance, we have observed that a November, 2005 zoning map change was not reflected in 2007 RPAD, which generally should reflect conditions as of July 1, 2007. Accordingly, to improve accuracy, for 2007 we have used zoning information from PLUTO which, in our experience, has more current information for this field. For 2003, however, the lag cannot be corrected.

- Because RPAD and tax lot GIS shape files are routinely changed to correct past data errors, some of the changes we observe between 2003 and 2007 are the result of data corrections, as opposed to lot reconfigurations or development.

- In many cases, zoning boundaries cut through tax lots (so called "split lots"). Per the Zoning Resolution, the maximum allowable FAR for a split lot is generally the weighted average of the two zoning districts. Because our model relies on the single zoning designation RPAD assigns to each tax lot in 2003, the accurate maximum FAR will not be calculated for split lots divided by zoning categories with different maximum FAR.

- Demolition permits, a main data source used to create the Furman Center Teardown Database, are identified by the BBL used when the permit was issued, which may not match the 2003 BBL of a lot included in our sample. Additionally, demolition permits issued before 2004 were identified with Building Identification Numbers (BINs), not all of which the Furman Center was able to match to BBLs.

- For many BBLs, the "year built" field in RPAD is shown as "0". For our statistics regarding building age, these BBLs are omitted.

- We only have landmark status data as of 2007, so our statistics do not differentiate between landmark designations already in place as of 2003 and those that occurred during our study period.

- A relatively small number of buildings encroach on the air space of neighboring lots. In these cases, the portion of the building not located above the tax lot on which the building's foundation is located is granted its own "air rights" tax lot. Because air rights tax lots do not exist at ground level, they are not included in the 2003 LotInfo shape file or 2007 PLUTO shape file. Accordingly, the components of buildings located in air rights are not included in our gross building area data.

- The Furman Center Development Right Transfer Database does not contain any data about development right transfers that occurred before 2004. Accordingly, some of the 2003 tax lots we identify as "underdeveloped" may instead be fully developed if they had granted unused development rights to neighboring lots as part of a "zoning lot merger" permitted by the Zoning Resolution. Through our own analysis as well as from examining the history of development in New York City in general, we believe such instances to be relatively rare in residential zoning districts, particularly outside of Manhattan.

Appendix II -
Maximum Floor Area Ratio Model

Our model assigns a maximum allowable FAR to every tax lot in our starting sample based on rules set forth in the Zoning Resolution. For lots in some zoning categories, the model simply applies the sole maximum FAR the Zoning Resolution specifies for that zoning category. For many lots, however, calculating a maximum FAR may depend not only on the underlying zoning category, but also on (i) which of multiple alternative maximum FAR formulations available to the lot owner is applied, (ii) whether or not certain FAR bonus provisions are pursued, (iii) the lot's location on a wide or narrow street, and/or (iv) overriding rules contained in any applicable Special Districts. The model's treatment of such factors is outlined below.

Default Zoning Resolution Allowable FAR

In the absence of overriding factors (such as inclusionary housing, special districts, etc.) maximum allowable FAR for a tax lot is dictated purely by the lot's zoning designation in the Zoning Resolution (ZR 23-141, 23-142, 23-145). Our model starts with the default maximum FAR for each zoning category and adjusts it based on the considerations and assumptions described below.

Assumptions Regarding Developer Discretion

In many cases, the Zoning Resolution's maximum FAR for a given lot will depend on which formulation of building form restrictions a developer elects to comply with and whether or not the developer provides certain public amenities or building features. The model makes the following assumptions regarding such discretionary factors:

<u>The Quality Housing Formula</u>

In non-contextual R6, R7 and R8 districts, developers have a choice of building according to "Height Factor" regulations (ZR 23-142) or according to optional "Quality Housing" regulations (ZR 23-145). Generally, buildings developed pursuant to Quality Housing regulations are permitted larger FAR and greater lot coverage, resulting in larger, but lower buildings. Height Factor buildings, conversely, result in taller, narrower, and smaller buildings.

Except in certain special districts and the waterfront where Quality Housing regulations are unavailable, our Zoning Dictionary applies the optional Quality Housing regulations as the baseline for maximum FAR, assuming that developers will pursue the greater square footage at the expense of height.

Attic Allowances

A number of residential zones (R2X, R3s, and some R4 zones) allow for a 20 percent increase in FAR for including an attic (ZR 23-141(b)(1)) which we include in our model. While this is essentially a bonus provision, as was confirmed by a panel of New York land use experts we convened and consistent with the content of a maximum FAR field included in 2007 PLUTO, planners expect that most, if not all developments will take advantage of the provision.

Lots zoned R1 and R2 that are subject to commercial overlays are also eligible for a 20 percent increase in FAR for attic space (permitting attics to increase FAR from a maximum of 0.5 to 0.6). Because RPAD does not include any information about commercial overlay coverage, we are unable to systematically identify which lots were eligible for this allowance in 2003, though we estimate they totaled less than 1000.

Other Discretionary Choices Ignored

The model assumes that developers will decline several other bonus provisions made available by the Zoning Resolution. These disregarded bonus provisions include:

- **Use Distinctions and Special Permits**

  The model ignores FAR increases that are dependent upon specific building uses or available only by special permit. For example, buildings that include community facility uses (ZR 24-11) or non-profit residences for the elderly (ZR 23-147) are permitted higher FAR than pure residential use in the same zone and are thus disregarded.

- **Optional Regulations**

  Aside from the choice of Quality Housing, the model ignores other optional provisions within the Zoning Resolution that allow a developer different choices of regulations governing floor area. The optional provisions we ignore include, for example, infill housing regulations (ZR 23-141(c)) and optional provisions for certain parts of Brooklyn (ZR 23-146).

- **Bonus Considerations**

  The model disregards any bonus FAR increases that may be available in certain districts to developers who choose to incorporate a plaza or arcade (ZR 24-14 & 24-15) or provide affordable housing in an R10 district (ZR 23-941).

- **Square Footage Exemptions**

  The Zoning Resolution allows for square footage exemptions for an enclosed garage in a side lot ribbon (23-141(b)(3) & (5)) as well as for refuse storage (ZR 28-23), laundry facilities (ZR 28-24) and natural light (ZR 28-25). Consistent with our overall conservatism in identifying underdeveloped sites, the model does not apply an increase in FAR to eligible lots, because these amenities may not be provided in the majority of new construction and These provisions are either unlikely to be realized by the bulk of new construction or are unlikely to result in significant additional square footage.

Contextual Factors

As directed by the Zoning Resolution, the model adjusts the baseline FAR determined from the factors outlined above as a result of a lot's context with respect to wide and narrow streets, the "Manhattan Core" and special districts.

Street Width and Manhattan Core

The FAR allowable for a given lot under the Quality Housing program varies considerably depending on whether the lot is on a "wide" street (defined as 75 feet or greater in width, ZR 12-10) and whether or not the site is located within the "Manhattan Core" (see ZR 23-145). Accordingly the model considers whether a given lot is in fact on a "wide" street or located within the "Manhattan Core" (defined as Manhattan Community Districts 1 through 8, ZR 12-10), spatial characteristics which we determine for every lot in our sample using GIS. Consistent with the Zoning Resolution, our GIS analysis flags a lot as "on" a wide street if it either fronts one or is located on a narrow street within 100 feet from an intersection with a wide street. (ZR 23-145).

Special Districts

There are over 45 special zoning districts in New York City, many of which include multiple subdistricts. Each Special District (and any corresponding subdistricts) has unique zoning regulations which may include changes to allowable building form, use, and floor area.

Using GIS, we identified all of the lots in our starting sample that were located within Special Districts and their constituent subdistricts as of 2003 throughout the City. Those Special Districts that have a direct affect on the allowable FAR are reflected in the FAR model. A number of Special Districts, such as Hudson Yards or Midtown, are allowed enormous amounts of FAR in bonus or transfer provisions. Consistent with our other bonus exclusions, the model conservatively applies only the basic maximum FAR without regard to these bonus provisions.

Inclusionary Housing

Beginning in 2005, New York City has been rapidly expanding its Inclusionary Housing program. We have mapped all the Inclusionary Housing areas (ZR 23-922) using GIS.

- **Application of Base FAR:** Our Zoning Dictionary applies the "base" FAR[36] (ZR 23-942) for all Inclusionary Housing designated areas instead of using the fully maximized FAR that could be achieved by providing affordable housing.

- **Date Sensitivity**: Because additional Inclusionary Housing areas have been added over time, the Zoning Dictionary only includes the adjusted basic FAR for those lots that, as of July 2007, are within Inclusionary Housing areas. Note that because the program was not enlarged until May 2005, there are no FAR adjustments to 2003 BBLs.

Waterfronts

Using GIS, we have identified all of the waterfront lots and mapped all blocks within the Waterfront Access Plan BK-1, which are subject to specific regulations in the Zoning Resolution (ZR 62-30). The Zoning Dictionary also recognizes that the bulk regulations on waterfronts may be different in certain areas. As described earlier in regards to Quality Housing, the Zoning Dictionary recognizes that waterfront lots are ineligible for the additional FAR allowance otherwise available to lots located on a wide street.

[36] For Inclusionary Housing designated areas, this "base" FAR is lower than, and overrides, the maximum FAR otherwise permitted by the underlying zoning designation outside of Inclusionary Housing designated areas.

Appendix III –
2003-2007 Lot Spatial Matching Methodological Notes

Because tax lots can experience a variety of changes over time, relating one tax lot in 2003 to the same tax lot in 2007 using only the BBL number can often be inaccurate, misleading or impossible. We utilized ArcGIS software to compare digital tax lot maps for 2003 and 2007 to document changes in the size, shape, and numbering of parcels in order to more properly compare tax lots over time. A sequential series of logical tests were then applied to classify changes as lot divisions, mergers, renumbering, etc. Manual on-screen comparison was used to check the results of the rules-based steps and to classify remaining parcels.

The source datasets are LotInfo parcel data published in 2003 and PLUTO parcel data published in 2007 (described in Section D of Appendix I). Though the 2003 and 2007 data are generally well aligned, there are a variety of mapping irregularities between datasets, especially in parts of Staten Island and along the waterfronts of all five boroughs. The data were prepared for analysis by correcting simple alignment errors in the 2003 data using the newer 2007 data as a basemap. The 2003 parcel data were overlaid on the 2007 data and misaligned blocks were corrected manually by shifting, rotating, and/or proportionally scaling the 2003 lots to the 2007 base map. During this process, lots were generally modified in contiguous block groups, not individually.

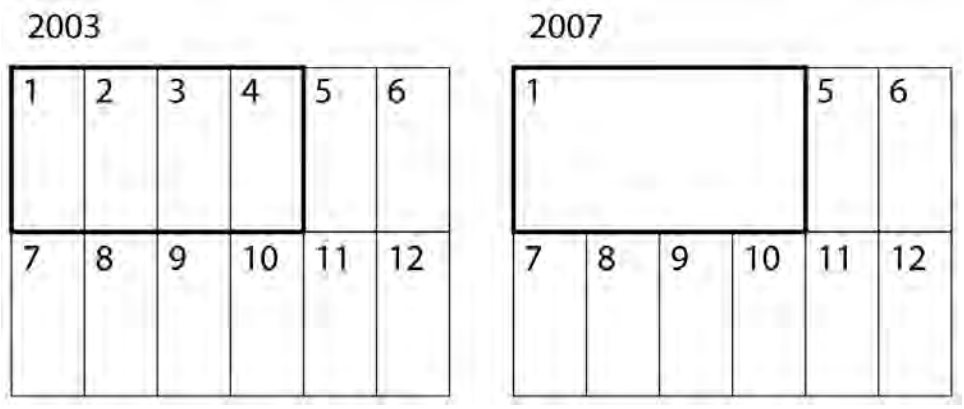
The degree and amount of manual correction of the 2003 data varied according to borough. Between 2003 and 2007, the City re-mapped many waterfront lots and updated the location of the shoreline. Because these areas could not be accurately compared in GIS, many piers and some waterfront lots were ignored by the change analysis. The Staten Island data presented additional difficulties as there is poor alignment between the 2003 and 2007 layers in many areas that could not be corrected without substantial editing of individual lots. This required a greater amount of manual classification.

The shifted 2003 tax lots were merged with the 2007 data using the ‘Union’ function in ArcGIS. This tool intersects the geometry and the attributes of the 2003 and 2007 data, creating polygon features with the smallest common geometry between the two dates. A spatial tolerance of 2 feet was used to reconcile minor spatial differences between the datasets. This user-defined tolerance setting minimizes the creation of ‘sliver’ polygons created by minor differences in line locations, but is also small enough to avoid altering the principal geography and topology of the parcel datasets.

The unioned polygons were classified using a series of rules to compare the block and lot numbers and the areas between 2003 and 2007. Classification rules were narrowly defined to avoid errors of commission. The rules compare the 2003 and 2007 areas of overlapping parcels, the number of overlaps, and the boundaries of contiguous areas of change to describe different patterns of lot change. Polygons that were not classified during the rule application were classified manually at the end of the process.

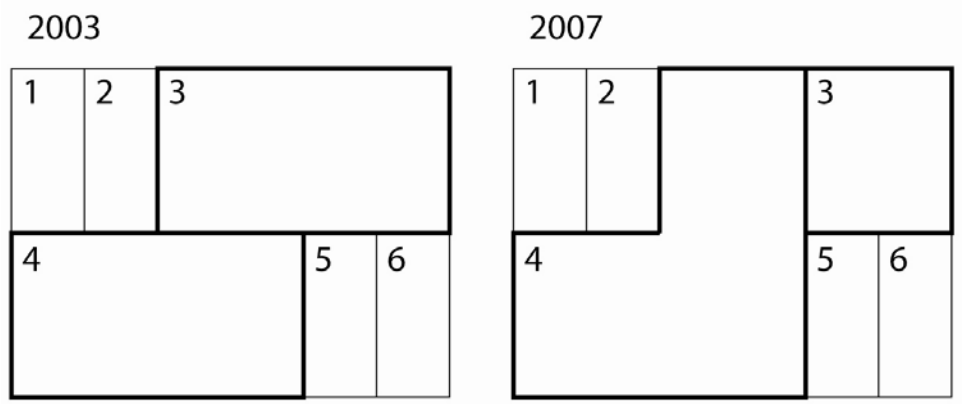
Type A -- Lot merger

One-to-many spatial relationship; area of 2007 is equal to the sum of the areas of merged 2003 lots.



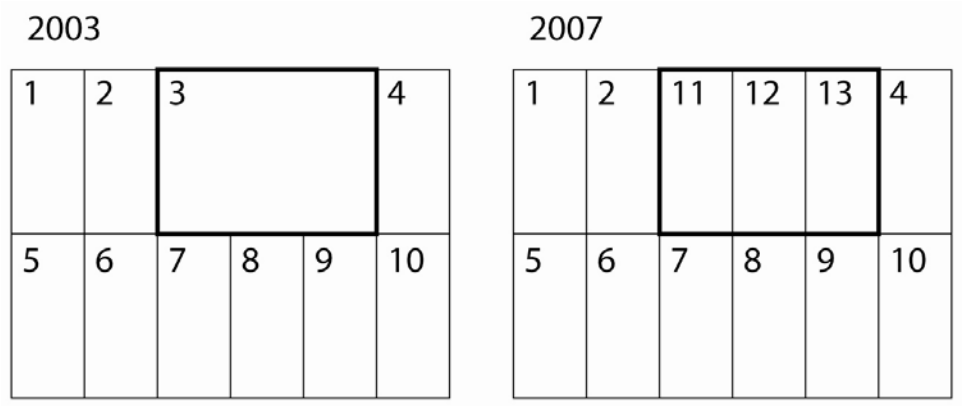
Type B – Area Swap

Two adjacent lots trade area; the entire change is limited to these two lots.



Type C – Lot Division

One-to-many relationship; the total area of the 2003 BBL equals the sum of the areas of the corresponding 2007 BBLs within 3%.

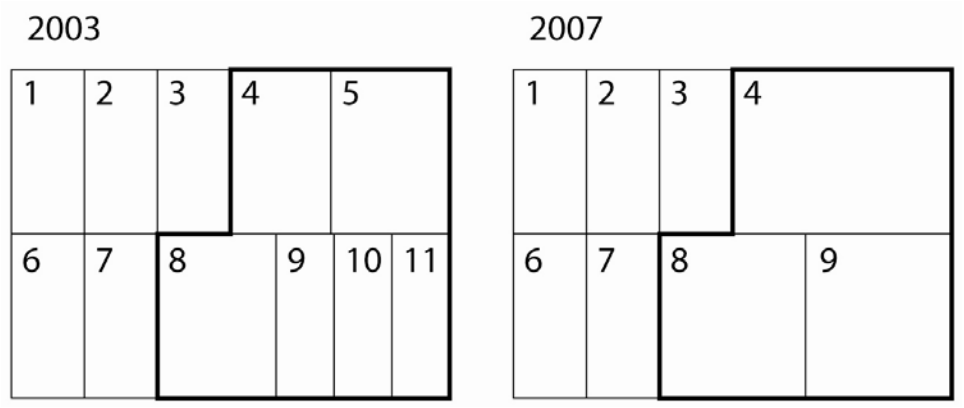


Type D – Lot re-name

Lot geometry remains the same, but the lot number changes. This frequently occurs with condominium development.

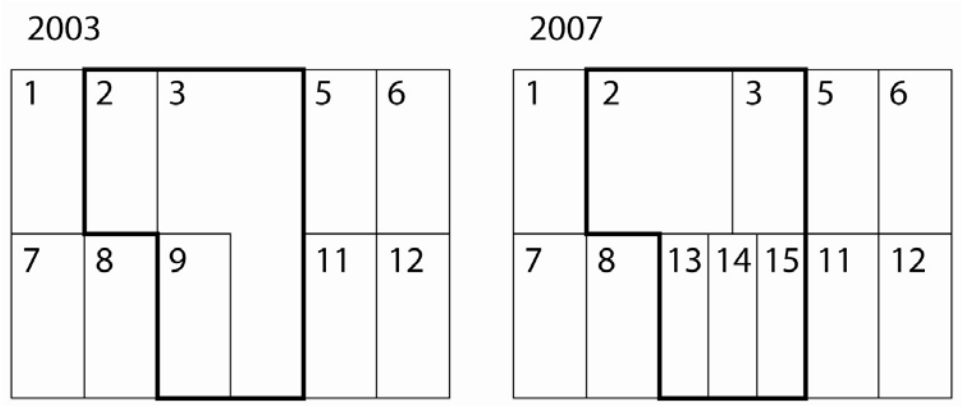
Type E – Contiguous lots re-mapping with net *loss* of parcels

A group of adjacent lots are reconfigured without discrete Type A merger or Type C division. There are fewer BBLs in 2007 than existed in 2003.



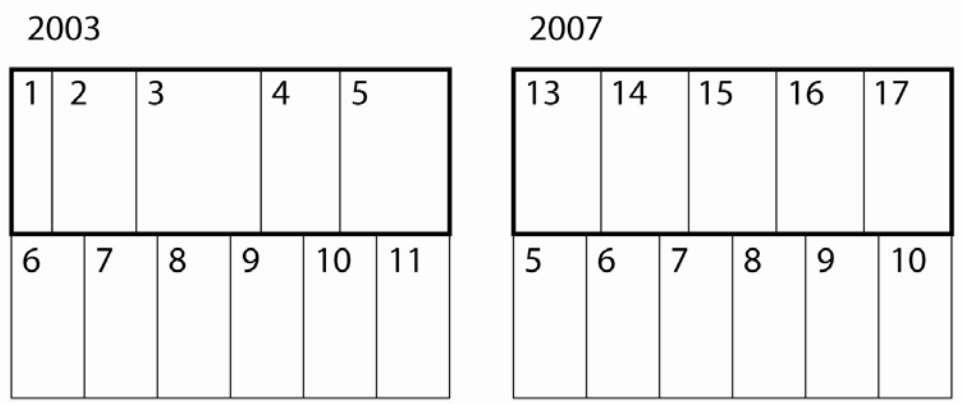
Type F – Contiguous lots re-mapping with net *gain* of parcels

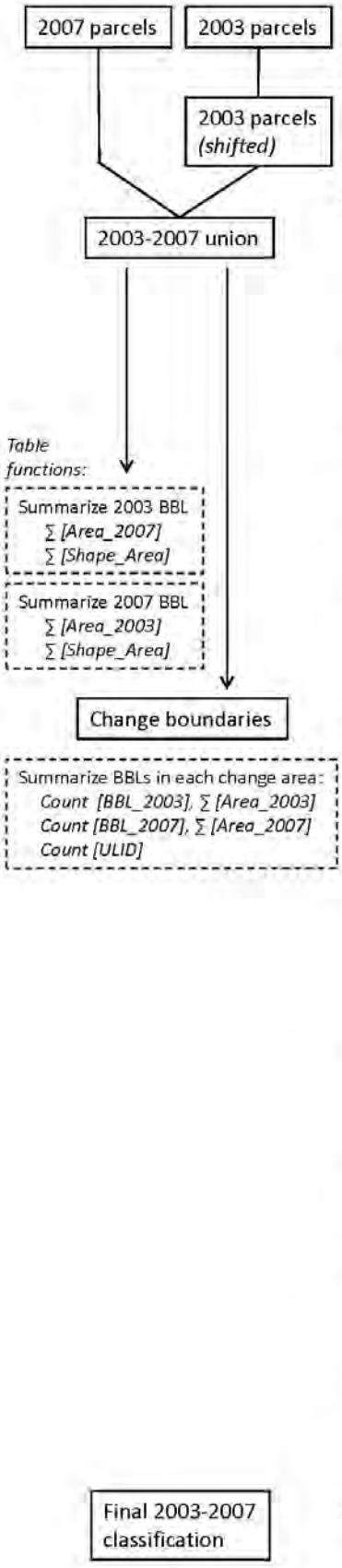
A group of adjacent lots are reconfigured without discrete Type A merger or Type C division. There are more BBLs in 2007 than existed in 2003.



Type G – Contiguous lots re-mapping with no net change in number of parcels

A group of adjacent lots are reconfigured without discrete Type A merger or Type C division. There is the same number of BBLs in 2007 and 2003.





1. Manual alignment

2. Union (2 ft. X-Y tolerance)

Type U (unchanged block of lots):
BBL 2003 = BBL 2007; Area 2003 = Area 2007 (+/- 3%) for all parcels in a block.

Type 0 (unchanged lot):
BBL 2003 = BBL 2007; Area 2003 = Area 2007 (+/- 3%)

Type X (missing area in 2003):
BBL 2003 = <NULL> (features not present in 2003 data)

Type C (lot division): 1 2003 BBL contains 2+ 2007 BBLs
∑ Area of 2007 BBLs (+/- 3%) = Area 2003 BBL

Type A (lot merge): 1 2007 BBL contains 2+ 2003 BBLs
∑ Area of 2003 BBLs (+/- 3%) = Area 2007 BBL

3. Dissolve contiguous unclassified ULIDs

Type B (area swap between 2 BBLs):
Count [BBL_2003] = Count [BBL_2007] = 2
∑ [Area_2003] = ∑ [Area_2007] (+/- 3%)
Count [ULID] = 3 or 4

Type D (lot re-name):
Count [ULID] = 1
[BBL_2003] ≠ [BBL_2007]
∑ [Area_2003] = ∑ [Area_2007] (+/- 3%)

Type E (area re-draw that loses lots):
Count [BBL_2003] > Count [BBL_2007]
∑ [Area_2003] = ∑ [Area_2007] (+/- 3%)

Type F (area re-draw that gains lots):
Count [BBL_2003] < Count [BBL_2007]
∑ [Area_2003] = ∑ [Area_2007] (+/- 3%)

Type F (area re-draw that gains lots):
Count [BBL_2003] < Count [BBL_2007]
∑ [Area_2003] = ∑ [Area_2007] (+/- 3%)

Type G (area re-draw with no net change in lots):
Count [BBL_2003] = Count [BBL_2007]
∑ [Area_2003] = ∑ [Area_2007] (+/- 3%)

4. Manual classification of remaining ULIDs

Appendix IV –
Minimum Parking Requirements

The Zoning Resolution generally requires new housing units to be accompanied by a minimum number of ancillary off-street parking spaces. This minimum is expressed as a percentage equal to the ratio of required new spaces to newly constructed residential units. A 50% requirement, for example, means that a developer of a new building with 10 residential units must provide 5 off-street spaces. We calculate the minimum parking requirement for each 2003 tax lot in our sample based on the lot's zoning category (from 2003 RPAD) and the other factors described below. Note that we only calculate required *minimum* parking, and do not evaluate the permissible parking regulations (i.e., maximums) that are also included in the Zoning Resolution.

In general, each residential zoning classification has a single minimum default parking requirement, which is the default requirement, subject to the following additional factors:

- In the "Manhattan Core" and parts of Long Island City, Queens (defined in the Zoning Resolution), minimum parking requirements are waived entirely (except for publicly-assisted housing) because of historical air quality concerns, so the minimum parking requirement equal to 0 (ZR 13-41) .

- In certain zoning districts, parking requirements are either reduced or waived for zoning lots of less than 15,000 square feet or less than 25 feet wide (ZR 25-24). Because we generally have no data on zoning lots, and have no data on lot width, we instead use 2003 RPAD data regarding the lot frontage and lot area of tax lots to calculate parking requirement ratios.

- In 2004, the City adopted the Lower Density Growth Management text amendment to the Zoning Resolution. The amendment greatly increased the required parking for certain zoning districts in Staten Island and part of the Bronx (ZR 25-23). Because this change occurred during the years of our study, we treat it as a "lot event", but the increased parking requirements are not taken into our account of 2003 lot characteristics.

- We calculate parking requirements in special mixed use districts (where a residential zone is paired with a manufacturing zone) based entirely on the residential component. In reality, parking in mixed use districts varies depending upon the percentage of a building utilized for residential or manufacturing uses (ZR 123-72).