New York City's Plans for Bus Rapid Transit as an Investment to Generate Economic Recovery

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ABSTRACT:

Bus Rapid Transit is increasingly advocated by policymakers and researchers as a tool to improve transit efficiency and as a way of increasing ridership and the modal share for buses. In recent years, there have also been some attempts to also explore its potential to act as an anchor for denser, sustainable development and specifically as an anchor for transit oriented development (TOD). Yet very little quantitative evidence exists of the potential land use impacts of BRT. In this paper, we begin to address this by focusing on unused residential development capacity in proximity to New York City's proposed Select Bus Service (SBS) corridors that are due to come on line in the next half decade. We explore if there is a need for additional criteria in selecting SBS corridors, especially relevant in the context of Federal attempts to better coordinate local transportation and land use planning. We use GIS tools to identify all residentially-zoned lots in New York City that were developed at less than 50% of their zoned capacity as of 2008 and compare these to 1/2 mile walking distance catchment areas around the proposed SBS corridors. We find significant unused capacity in these catchment areas; about 20% of lots are underdeveloped by our definition. This may highlight the need for policymakers to be cognizant of land use patterns when they are proposing transit improvement interventions. It may also create significant opportunities for City agencies to work together in response to the new Federal imperatives.
1. Introduction:
New York City policymakers are embarking on a range of bus priority measures throughout the five boroughs to improve the efficiency and attractiveness of buses. These strategies, labeled "Select bus service" (SBS) are the City's first real attempt at bus rapid transit (BRT) and, to varying degrees, involve the use of exclusive bus lanes, pre-boarding ticketing, transit signal priority, new branding and camera enforcement (1). At the time of writing, one scheme, the Fordham Road BX12 route in The Bronx is already fully operational. Since its inception, running times have been reduced by approximately 20% and ridership has increased by some 7% (2). A second scheme, the M15 corridor on First and Second Avenue in Manhattan, is due to start in early Fall. Three more routes are planned to be operational within the next 18 months and phase 2 will see the addition of a much wider network of SBS routes over the coming years. The pilot corridor selection process, launched jointly by the City of New York, the Metropolitan Transit Authority (MTA) and the New York State Department of Transportation, used a number of route performance and assessment criteria and identified five pilot corridors; one in each of New York's five borough. Since then, further corridors have been identified, both in phase one and phase two (the latter are still in planning stage). However, as far as the authors are aware, none of the selection criteria relate to the potential for the SBS schemes to act as anchor for transit oriented development (TOD) or economic regeneration in the surrounding neighborhoods.

This is of interest because both BRT and TOD are advocated as mechanisms for promoting sustainable transport and development patterns in urban and suburban areas. The former often involves the reallocation of road space for the exclusive use of buses and the introduction of ancillary measures to improve transit efficiency and ultimately to encourage travelers' shift to the improved transit service. The latter is aimed at promoting the development of higher density residential and commercial centers in proximity to transit stops to encourage greater transit ridership and more sustainable communities. Together, these strategies seek to make better use of existing infrastructure and land use resources to leverage more sustainable outcomes in transport and development patterns. This is a central policy goal of planners in any city and is especially important in the context of an economic downturn that is exacerbating an already chronic problem in financing transportation infrastructure and operations.

In this paper, we explore whether there is a role for a wider analysis of the SBS schemes as a potential anchor for more sustainable development patterns as well as, more generally, the impacts of BRT on surrounding neighborhoods. The question is particularly relevant as a result of the nascent Partnership for Sustainable Communities between the US Environmental Protection Agency (USEPA), the US Department of Transportation (USDOT) and the US Department of Housing and Urban Development (HUD). As part of this Federal-level coordination, recent grant programs available to local policymakers in the transportation and urban sphere have explicitly recognized the role of transportation as a driver of economic renewal. Further, a portion of USDOT's Transport Investment Generating Economic Recovery (TIGER) discretionary grant program is being awarded jointly with HUD's Community Challenge Planning Grant.
program to promote, amongst other aims, more sustainable development patterns and (re)development in existing communities.

In this context, it is likely that policymakers, especially in the transportation sphere, who are interested in promoting sustainable development advocated and co-financed by the Federal government, are going to be concerned with how proposed transit investments relate to surrounding neighborhoods and what benefits they might provide. Without knowledge of the land uses and potential capacity, it will be difficult to begin quantifying these benefits. With a knowledge of how many lots are built out at well below their zoned capacity in areas close to new BRT corridors, policymakers can begin to identify areas that may be particularly ripe for regeneration, as *de facto* transit oriented development.

Our research focuses on augmenting understanding of development potential near this form of transit and analyzing how a wider analysis of BRT impacts can include its scope to mirror some of the development benefits of rail. To do this, we use geographic information systems (GIS) to develop catchment areas around the proposed and operating SBS schemes in New York City. Using techniques we developed as part of a related project identifying underdeveloped lots in the City (Been et al, 2009), we are then able to identify what residential capacity exists and how it differs in relation to proximity to the SBS routes. In this way, we can see how the SBS routes could potentially be leveraged to act as a regeneration tool at a neighborhood level. The paper is outlined as follows; the next section presents some of the research relating to BRT and land use and they have been analyzed to date; then we explore policy context in New York and the recent movements for coordinated transportation and land use planning at a Federal level. This is followed by the methodology section in which we outline our GIS-based analysis. Results and conclusions follow.

2. Literature Review:

The interrelationships between land use and transportation have been heavily studied (3, 4, 5). Johnson (4) notes, those relationships are murky but research tends to point towards the existence of a positive feedback loop between transit and land use. Transit availability increases accessibility of any given plot of land, the characteristics of that land determines whether people visit it; the greater the intensity of land use, the greater the demand is for accessibility and transportation.

At the same time, TOD has created considerable excitement in planning circles (6). However, when academics and policymakers refer to TOD, they are generally alluding to development strategies centered on rail transit stops (either heavy or light rail). There is a large and growing literature on rail TOD (RTOD) and their impacts on both transit use and neighborhood impacts (see for instance: 7, 8, 9).

In contrast, the question of bus transit operations being used as a similar anchor for TOD, known as BTOD, has largely escaped research focus. This is primarily due to the fact that relatively low frequency suburban bus systems without fixed infrastructure lack both magnitude and perceived permanence, accordingly, the risks to potential developers are potentially higher than for rail investments (10). Despite this, almost 10% of TOD plans
are anchored by bus operations in the United States (6, 8) and the advent of BRT operations in many cities has reframed the concept of BTOD.

BRT is envisioned to be a flexible, high performance rapid transit mode combining equipment, service and intelligent transportation systems into a permanently integrated system with a quality image and identity (11). In this regard, it may be able to tap into some of the advantages that fixed-rail transit maintains over local on-street bus operations without the associated high capital costs, lengthy construction time, and the inflexibility of the resulting fixed-route service (10, 12). Paaswell et al. (13) note that BRT should not be seen as an alternative to rail but instead should be used to mitigate competition over New York’s shared but limited street space and to improve the streets’ efficiency.

What is less well understood is BRT’s impact on surrounding neighborhoods and its potential role as an anchor for BTOD. This is especially pertinent given that the pilot SBS route selection process, as outlined by McNamara et al. (14), involved seven selection criteria, none of which are related to any explicit neighborhood impacts and land development potential. Authors such as Levinson et al. (12) have indicated that BTOD has the potential to be an important selling point of new BRT operations and Paaswell et al. (13) advocate for the development of a BRT network in New York in addition to incentive strategies to support high density TOD.

The existing focus on rail anchored TOD is not surprising given the relatively new nature of BRT and the perceived advantages that rail has over on-street bus operations in terms of permanence and service attributes (both by potential riders and by potential developers). In addition, rail generally supports higher densities than typical bus services. However, authors such as Currie (10) have shown that the advantage that rail holds over on-street bus services in terms of consumer perception is significantly reduced by BRT operations that achieve similar service levels and characteristics.

Not all BRT is the same, Kantor et al. (15) characterizes bus rapid transit as “BRT-heavy” and “BRT-lite”. The former is defined as using dedicated right-of-ways and often other attributes such as off-board ticketing, queue jumping and signal priority. The latter lacks exclusive right-of-ways and typically uses fewer BRT ancillary measures. For the reasons given above, we would expect that BRT-heavy will have stronger impacts both transit attractiveness and possibly on its ability to act as an anchor for TOD.

Earlier research by Cervero (16) found little evidence of TOD projects in bus-dominated suburban markets. However, more recent analysis identified a small number of BTOD projects in operation (8). The Transportation Research Board analyzed the role of bus transit services in land use and characterized the implementation barriers as institutional; resource and financial; and stakeholder interactions (6). Institutional barriers require overcoming the normal division of responsibilities and policy focus with regard to transportation and land use. We have seen this problem tackled to some extent in New York with the cross-agency coalition for SBS. However, land use was not explicitly addressed by the formation of this coalition. One of the goals of the HUD Community Challenge Planning Grant program is to facilitate better land use transportation policy
coordination. In addition, the report finds that coalition building with other stakeholders (i.e. developers, communities, other agencies etc.) for potential BTOD projects is effective. Financial and resource challenges are generally the main obstacles faced by transit service providers. Typically, land use policy is beyond the jurisdiction of transit agencies; development and planning resources are typically devoted to direct provision of services rather than interaction with other agencies and private entities. On the developer side, it is likely that lenders, unfamiliar with the BTOD (and TOD in general) may be less likely to fund these types of projects.

Despite the growing research into using buses, and specifically, BRT as an anchor for denser development, little quantitative assessment has been conducted on how such schemes relate to development patterns in the catchment areas and what potential residential capacity exists at the time of construction. While policymakers can intervene to incentivize developments with various tools (zoning changes, transit overlays etc.) and most TOD is created through such processes, the administrative burden can be relatively significant. For instance, in New York City, City-initiated rezonings have to go through a complicated land use review process and broad consultation period that may take anywhere up to two years (17). Accordingly, BRT proposals, which are typically led by policymakers in the transportation sphere, need to engage deeply in the land use debate, which may be beyond the normal transit skill set. Therefore, any analysis that adds to the understanding of adjacent development capacity should be of use. This is especially true in the context of the recent Federal moves to sponsor and facilitate the integration of land use and transportation planning (discussed in detail below). Our research aims to present policymakers with the tools to develop comprehensive development capacity analyses for BRT, something that escaped research focus until now.

3. The Policy Context: The Partnership for Sustainable Communities, TIGER and Community Challenge Planning Grant:

In June 2009, the Environmental Protection Agency (USEPA), The Department of Transportation (USDOT) and the Department for Housing and Urban Development (HUD) came together for the first time to coordinate Federal housing, transportation and environmental policy and investments. The aim was to increase access to affordable housing, present more transportation options and lower transportation costs while also protecting the environment (18). The new Obama Administration engaged the three agencies that most directly impact the physical form of communities to help reshape the role of the Federal government in promoting sustainability. The three agencies agreed on six "Livability Principles" as part of the partnership: providing more transportation choices, promoting equitable, affordable housing, enhancing economic competitiveness, supporting existing communities, coordinating and leveraging Federal policies and investment and valuing communities and neighborhoods (18). HUD was designated the lead in funding, evaluating and supporting integrated planning; DOT focuses on capacity building for transportation agencies and the EPA provides technical assistance to communities and States (19).

Simultaneously, the US Congress was engaged in passing the American Recovery Act (2009) to stimulate the economy through direct government investment. As part of that
act, the USDOT was appropriated $1.5 billion to supplement grants supporting the national transportation system. USDOT initiated a discretionary grant program, Transportation Investment Generating Economic Recovery (TIGER), to disperse the appropriation with an initial application deadline of September 2009. The long term goals of TIGER were to: ensure a state of good repair and minimizing life-cycle costs; enhance economic competitiveness over the medium to long term; improving "livability" and the quality of life for residents and workers; ensure sustainability through improving energy efficiency, reduce dependence on oil and emissions of greenhouse gases; and improving the safety of U.S. transportation facilities and systems (20). Applications were for up to $300 million per project and applicants needed to outline the expected benefits from investment in relation to these five areas.

Of the $1.5 billion, New York City received approximately $83 million, granted to Moynihan Station Phase 1 as a result of the project's ability to improve access to Manhattan's West Side, an area identified as likely to undergo significant residential and office development in the coming years. Meanwhile, Washington D.C., along with Maryland and Virginia, received almost $60 million to help finance 13 bus transit corridors (21). The remainder of the funds were dispersed throughout the country.

In late 2009, the USDOT was authorized to award an additional $600 million in what is known as TIGER II discretionary grants under the FY 2010 Appropriations Act with a deadline of July 26th, 2010 for pre-applications. Approximately $35 million of this program is to be granted in tandem with the US Department of Housing and Urban Development (HUD) Community Challenge Planning Grant program (21). HUD's program is aimed at reducing barriers to achieving affordable, economically vital and sustainable communities through such actions as amending local master plans, zoning codes and building codes. These actions can be done on a jurisdiction-wide basis or in specific neighborhoods, districts, corridors to promote mixed-use development, affordable housing, or the reuse of older buildings with the goal of promoting sustainability. The program is also aimed at promoting the acquisition of land for affordable housing and the adoption of inclusionary zoning ordinances (19).

At the time of writing, no final grants have been by the joint USDOT HUD program; however, the focus of the grants dovetail with a broader analysis of the impacts of the SBS scheme. By estimating what potential residential capacity exists in the surrounding neighborhoods, New York policymakers are able to begin quantifying the potential economic impacts a SBS route may have. It is also likely that this joint grant program will be the first of many focusing on facilitating denser, more sustainable development plans in the vicinity of new transit infrastructure.

The Select Bus Service:
New York City Transit operates in excess of 200 local, limited-stop and express bus services carrying over 2.5 million riders daily - thirty-five of those services carry more than 20,000 passengers per day (14). It, like many other transit agencies in the United States, has been hit hard by the economic downturn and related decline in revenues. As a result, it has introduced a number of service cuts and changes (22).
The competition for scarce urban road space the bus faces from private motor vehicles, commercial vehicles, and non-motorized modes has been partially responsible for an average bus speed less than 8 miles per hour – one of the slowest average speeds in the United States (23). Despite the financial constraints it faces, the Metropolitan Transportation Authority (MTA) along with the New York City Department of Transportation (NYCDOT), and New York State Department of Transportation (NYSDOT) embarked on a joint project to introduce BRT in New York City. Five high quality SBS demonstration routes were proposed, one in each borough.

The strategy is drawn from PlaNYC 2030, Mayor Bloomberg’s long-range sustainability plan which foresees a city of 9 million residents by 2030 (23). The strategy notes that of the 231 counties in the United States with populations in excess of 250,000, the four with the longest commute times are four of New York City’s five boroughs: Queens, Staten Island, The Bronx and Brooklyn. PlaNYC envisions the extensive use of BRT in corridors not optimally served by the subway network. Almost 30% of city residents live more than one-half a mile from a subway station and twenty-two areas of the city are identified as having high concentrations of Manhattan-bound car-using commuters because of a lack of a transit alternative.

The selection criteria for the SBS demonstration routes involved initially selecting 80 candidate corridors for which there were more than 15,000 daily riders and whittling these down to 36 using 7 selection criteria: daily ridership; limited-stops; peak time headway; off-peak time headways; the speed ratio (average peak journey times/night time journey times); the presence of a central business district on the route; and ridership history (14). Candidate corridors were further reduced from 36 to 15 by investigating the potential benefits of BRT implementation in a given corridor and the potential ease of implementation in the corridor (i.e., BRT compatibility). Finally, five demonstration projects were then selected, one in each borough. Since the five routes were selected, stakeholder interactions derailed the Queens demonstration corridor after intense opposition to the reallocation of road space from parking. Instead, an additional Manhattan bus priority corridor was added on 34th Street (24). These routes are outlined in Figure 1 below:
In May 2009, the MTA launched a second phase of BRT corridors that were selected to meet a number of defined characteristics. Firstly, nine transit-underserved neighborhoods were identified, these areas were categorized as neighborhoods further than half a mile from a subway station with population densities great than 26,000 per square mile; two were in The Bronx, five were in Queens and two were in southern Brooklyn. Nine corridors were identified as "difficult trip" corridors and were defined as trips taking longer than 30 minutes and traveling at slower than 8 miles per hour. This process identified four cross-town Manhattan routes, four Brooklyn routes and one each in Staten Island and Queens. Seven sections of the subway network, mostly in and around Manhattan, were identified as operating at or above 95% load capacity at peak times. Finally, five areas; the South Bronx, Queens waterfront, Brooklyn waterfront and two
neighborhoods in Staten Island, were identified as limited transit areas undergoing significant growth in housing units.

From these criteria, four potential SBS corridors were identified in The Bronx, seven were identified in Brooklyn, four in Manhattan, nine in Queens and three in Staten Island (1). It is these corridors, along with the phase 1 corridors, that we explore in this research.

**Methodology:**
To explore what residential capacity exists near to the existing and proposed SBS routes, our methodology involves two distinct steps. The first step identifying each residentially zoned lot in New York City that was built out at less than its potential zoned capacity. We do this to establish which lots are grossly underdeveloped and, accordingly, are the most likely candidates to be redeveloped in the future; this work builds upon the work of a related research project, Been et al. (25). The second element involves mapping each of the SBS corridors in phase 1 and phase 2 and then mapping an associated catchment area. From this we can identify what proportion of lots in the catchment areas are significantly below their zoned capacity, what sort of development potential exists in these areas and how that differs based on geographical location.

We define a lot as grossly underdeveloped if its actual built out area is less than 50% of its potential residential capacity. We use such a cutoff point because these lots are most likely to be attractive for redevelopment, it is less likely that a building that is almost at its full capacity will be fully redeveloped; for more see Been et al (25). In order to identify lots with more than 50% unused zoning capacity in 2008, the most recent year we have data for, we estimate for each lot the maximum amount of permitted residential development, for which we use (i) New York City's Department of Finance’s Real Property Assessment Data (RPAD) to determine the lot’s size and zoning designation, (ii) our own analysis of New York City’s Zoning Resolution to determine the default applicable maximum floor area ratio (FAR), and (iii) geographical information systems (GIS) to determine if the lot is subject to any additional rules that, per the Zoning Resolution, would change the default FAR. FAR represents the ratio of the building area on a lot to the size of the lot. For example, if a 10,000 square foot lot has a maximum FAR of 2.5, a developer may build no more than 25,000 square feet of building area on that lot. If the actual size of the building on the lot in 2008, as reported by RPAD, was less than half of our estimate of permitted residential development, we flag the lot as having substantial unused capacity. Our reliance on FAR as the sole determinant of allowable development size ignores many constraints on development included in the Zoning Resolution (such as yard requirements and height limits), but we believe it provides a reasonable estimate of total lot capacity (for more see: 25). With this data, we are able to identify all residentially zoned lots that are built out well below their zoned capacity. A map of New York City’s underdeveloped sites is shown below:
The second stage of our research methodology involves identifying and mapping the proposed SBS routes and associated corridors. This is a relatively difficult task as some of the corridors proposed by the MTA are only indicative; no specific routes or SBS station locations have been identified. This is particularly difficult for the corridors designated as "difficult trips" and most pronounced in Brooklyn (1, p.24-25). To date, these potential corridors are only identified as sweeping arrows with little to tie them to exact geographies. To overcome these problems, we developed a number of strategies such as looking at existing local and limited service bus routes in the areas and identifying local large streets. We excluded from our analysis any corridors that run primarily on highways (including the Long Island Expressway in Queens, The Gowanus Expressway in Brooklyn; the Major Deegan and Brukner Expressways in The Bronx and the Staten Island Expressway). These routes carry express buses with very few intermediate stops. Future analysis will include the origin data for these express routes.
For each of the remaining routes (shown in Map 2 below), we mapped corridors on the major roads closest to the indicated corridors. For instance, in Queens the phase 2 report identifies Jamaica Avenue/Hillside Avenue and Southeast Queens as underserved areas. We follow their indicative corridors and apply them to routes where there is currently bus service.

Station locations offer a further complication, as noted we exclude expressway-based routes because of the inability to select accurate station locations. The SBS routes are designed as limited-stop; as a result, selecting each existing bus stop on the routes is likely to overstate the accessibility of the proposed service. Instead, for each of our remaining proposed SBS corridors, we identified "likely station locations" at major intersections and at subway or railroad stations or at existing express bus stop locations. We created three different half mile catchment areas extending from each route in GIS. The City Environmental Quality Review (CEQR) manual identifies the appropriate distance for measuring land use impacts of transportation investments in New York as a half mile (26). The first catchment area is a simple "as-the-crow-flies" buffer around each route; while simple, it does not account for actual walking distances and barrier effects. The second measure, All Intersections, created using Network Analyst in ArcGIS, defines a half mile walking distance from every intersection on each proposed corridor. The final catchment area, Likely Intersections, looks only at areas falling within a half mile walk of one of the likely SBS stations. Any lot centroids that were intersected by these buffers were considered proximate to the SBS routes. Our analysis focuses only on the results, at the City and borough levels, for All Intersections and Likely Intersections.
4. Results

Characteristics of the SBS Catchment Areas:
Table 1 presents the initial results of our analysis, of the nearly 800,000 residentially zoned lots in New York City, over 37% of them are within the All Intersections catchment area, meaning that almost four in ten residentially zoned lots in New York are within a 10 minute walking distance of an intersection that is designated to have SBS on it. This shows the broad nature of the proposed interventions. When we confine the catchment areas to Likely Intersections, almost 32% of residentially zoned lots are within a half mile walk of a likely SBS station location. Perhaps indicating their respective positions as most and least dense boroughs, Manhattan and Staten Island have very different exposures to the SBS schemes. However, there are also four proposed schemes in Manhattan in addition to the First and Second Avenue demonstration corridor. In
contrast, there are two schemes in Staten Island (as noted, we exclude from analysis the Staten Island Expressway corridor).

Almost 50% of the lots that were in the SBS catchment areas were also within a half mile walk of a rail transit station entrance (either New York City Transit Subway, Long Island Railroad or Metro-North). Interestingly, this figure is broadly similar to the City average. There is no difference in rail accessibility in Manhattan or Queens between the SBS catchment areas and the borough as the whole. The catchment areas in Brooklyn and Staten Island are less likely to have rail accessible lots; 67% of residentially zoned lots in Brooklyn are within a half mile walk of rail, compared to about 55% of lots in SBS Likely Intersection areas. For Staten Island, those figures are 19% versus 12%. The Bronx is an outlier; almost 58% of residentially-zoned lots in the borough are close to rail by our definition. However, almost 70% of lots in the SBS Likely Intersection areas are close to rail. This is likely due to the existing Fordham Road Bx12 east-west service, it connects eight mostly north-south subway lines.

Table 1: Geographical Spread of SBS Catchment Areas

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<tr>
<th></th>
<th>Bronx</th>
<th>Brooklyn</th>
<th>Manhattan</th>
<th>Queens</th>
<th>Staten Island</th>
<th>New York City</th>
</tr>
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<tbody>
<tr>
<td>Residentially Zoned Lots:</td>
<td>82,970</td>
<td>256,634</td>
<td>27,856</td>
<td>310,355</td>
<td>118,422</td>
<td>796,237</td>
</tr>
<tr>
<td>All Intersection Areas:</td>
<td>15,840</td>
<td>108,815</td>
<td>20,520</td>
<td>137,223</td>
<td>14,383</td>
<td>296,781</td>
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<tr>
<td>%</td>
<td>19.1%</td>
<td>42.4%</td>
<td>73.7%</td>
<td>44.2%</td>
<td>12.1%</td>
<td>37.3%</td>
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<tr>
<td>Likely Intersection Areas:</td>
<td>13,660</td>
<td>91,493</td>
<td>20,370</td>
<td>118,592</td>
<td>11,013</td>
<td>255,128</td>
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<tr>
<td>%</td>
<td>16.5%</td>
<td>35.7%</td>
<td>73.1%</td>
<td>38.2%</td>
<td>9.3%</td>
<td>32.0%</td>
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</table>

Rates of Underdevelopment in the SBS Catchment Areas:
Our analysis shows that almost 22% of all residentially zoned lots in New York City were developed to less than 50% of their zoned capacity in 2008, translating to some 174,000 lots. The residential underdevelopment rate ranges from a low of 16% in Queens to over one third of lots in the Bronx. This suggest that there remains significant residential development capacity in the City, even after the City's recent rezoning efforts which focused on contextual rezonings and limited upzonings (16). It also suggests that there is tremendous scope for transportation investments to generate development and activity in their proximity.

Lots that are located in All Intersection and in the Likely Intersection catchment areas largely mirror the wider City. Overall, about 20% of lots in these areas are underdeveloped as of 2008, again suggesting significant existing capacity. The borough results are also largely similar with the major exception of the Bronx; almost 50% of lots in the catchment areas are underdeveloped by our definition suggesting significant residential capacity potential. In Staten Island, the underdeveloped rate is slightly lower in the catchment areas than in the borough as a whole. The Bronx is once again an outlier; residentially-zoned lots in SBS catchment areas are much more likely to be
underdeveloped, despite the fact that they are also more likely to be near rail transit. Even when we look at underdeveloped lots that are in both the SBS and rail catchment areas, we see that 52\% are underdeveloped by our definition. Map 4 indicates the SBS routes, their catchment areas and the underdeveloped lots in New York City as of 2008.

Table 2: Rates of Underdevelopment in New York City and in the SBS Catchment Areas.

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<tr>
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<th>Bronx</th>
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<td>310,355</td>
<td>118,422</td>
<td>796,237</td>
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<tr>
<td>All Underdeveloped Lots:</td>
<td>28,651</td>
<td>58,928</td>
<td>6,460</td>
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<td>29,549</td>
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<td>%</td>
<td>34.53%</td>
<td>22.96%</td>
<td>23.19%</td>
<td>16.24%</td>
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<td>Lots Underdeveloped in All Intersection Areas:</td>
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<td>14,383</td>
<td>296,781</td>
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<td>%</td>
<td>50.39%</td>
<td>22.18%</td>
<td>22.63%</td>
<td>15.77%</td>
<td>19.07%</td>
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<td>20,370</td>
<td>118,592</td>
<td>11,013</td>
<td>255,128</td>
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<tr>
<td>%</td>
<td>50.05%</td>
<td>22.79%</td>
<td>22.67%</td>
<td>15.86%</td>
<td>18.55%</td>
<td>20.84%</td>
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5. Conclusions:
As Orcutt (27) notes, the integration of transportation and land use planning is increasingly seen as essential to promoting more sustainable development patterns, something that is enshrined in the concept of TOD. However, explicit analysis of the impacts of BRT-related developments and development potential has largely escaped research and policy focus. This is likely to change in the face of the new Federal interventions to coordinate land use and transportation planning. In New York, this is especially important in the context of the Select Bus Services route selection process and there is a need to investigate whether there is a role for additional selection criteria.
In our analysis, we see that there is tremendous untapped residential capacity potential in the areas surrounding the proposed SBS schemes, as there is in the City. As a whole, about 20% of residentially-zoned lots in Likely Intersection station catchment areas are underdeveloped by 50% or more. In the Bronx, this figure rises to over 50% of residentially zoned lots.

Most TOD developments in the United States are in suburban areas surrounding train stations (6) and are often incentivized by a host of land use interventions (capacity bonuses, reduced minimum parking requirements, transit overlays etc.; 8) to encourage denser development. What we see in New York City, which contains some of the densest neighborhoods in the United States, is that there remains tremendous residential capacity under the current zoning regulations. Yet, the ability of the SBS schemes to actually incentivize development in the surrounding neighborhoods has been overlooked. At the same time, the City is embarking on the largest rezoning program since the adoption of the 1961 Zoning Resolution (17). Our analysis shows that there are opportunities for policymakers to explore the economic and development impacts of SBS but it also points to the need for land use experts to be cognizant of such large transportation investments. As we have seen, fully one third of residentially-zoned lots will be impacted by the proposed routes. McDonnell et al. (17) found that most lots that were upzoned (given additional residential capacity through City rezonings) were close to rail transit; however, the majority of lots that had residential capacity taken away were also near transit. As far as the authors are aware, no such analysis has been conducted in relation to the existing and proposed SBS scheme.

Many questions remain unanswered; firstly, we still do not know which corridors will actually be developed and the precise form of their routes. When we know that, we can explore with more precision the catchment areas and subsequent land use impacts. Secondly, our analysis only explores the existence of underdeveloped sites, not the extent of unused capacity (beyond the fact that lots are underdeveloped by 50% or more). In ongoing research, we are adding this element to the research so we can estimate the existing square footage potential in SBS catchments areas. We can also then explore how the City's recent rezoning interventions have impacted that capacity to investigate how those actions relate to this major transportation investment. This will also allow us to more accurately estimate the land use impacts in the impacted neighborhoods and act as an aid to policymakers exploring the relationship between those impact and transportation.
References:


